

2021 DSM PROGRAMS EVALUATION REPORTS

EFFICIENCYONE

Final DSM Reports

March 17, 2022



TABLE OF CONTENTS

- 1. 2021 DSM PROGRAMS EVALUATION EXECUTIVE SUMMARY**
- 2. 2021 DSM PROGRAMS EVALUATION EXECUTIVE SUMMARY APPENDICES**
- 3. RESIDENTIAL EFFICIENT PRODUCT REBATES PROGRAM**
- 4. RESIDENTIAL EFFICIENT PRODUCT REBATES PROGRAM APPENDICES**
- 5. EXISTING RESIDENTIAL PROGRAM**
- 6. EXISTING RESIDENTIAL PROGRAM APPENDICES**
- 7. NEW RESIDENTIAL PROGRAM**
- 8. NEW RESIDENTIAL PROGRAM APPENDICES**
- 9. EFFICIENT PRODUCT REBATES PROGRAM**
- 10. EFFICIENT PROUCT REBATES PROGRAM APPENDICES**
- 11. CUSTOM INCENTIVES PROGRAM**
- 12. CUSTOM INCENTIVES PROGRAM APPENDICES**
- 13. DIRECT INSTALLATION PROGRAM**
- 14. DIRECT INSTALLATION PROGRAM APPENDICES**
- 15. MARKET TRANSFORMATION AND CODES AND STANDARDS**
- 16. 2020-2022 DSM MEASURE ASSESSMENT**

2021 DSM PROGRAMS EVALUATION EXECUTIVE SUMMARY

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ABBREVIATIONS

AMH	Affordable Multifamily Housing
ARet	Appliance Retirement
BER	Business Energy Rebates
BNI	Business, non-profit and institutional
C&S	Codes and Standards
DSM	Demand-side management
EMIS	Energy Management Information Systems
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
EPI	Efficient Product Installation
EUL	Effective useful life
GHG	Greenhouse gas
HEA	Home Energy Assessment
LED	Light-emitting diode
M&V	Measurement and verification
MA	Measure Assessment
MHEEP	Mi'kmaw Home Energy Efficiency Project
MSHP	Mini-split heat pump
MT	Market Transformation
NHC	New Home Construction
NS Power	Nova Scotia Power
NSUARB	Nova Scotia Utility and Review Board
NTGR	Net-to-gross ratio
PV	Photovoltaics
SBES	Small Business Energy Solutions
SEM	Strategic Energy Management

DEFINITIONS

Accuracy	Reflects the proximity of measurements to the true value.
Adjustment ratio	The ratio of evaluated results to tracked results. This ratio expresses the adjustment made to tracked savings or other tracked values such as effective useful life.
Baseline	To determine gross savings, a baseline (or base case) is established providing detailed information about the reference (e.g. pre-existing or standard) measure or equipment chosen to be compared with the efficient measure or equipment. For the reference measure or equipment, the baseline may include such information as the hours of operation, wattage and the base consumption.
Bias	Systematic deviations of measurements from the true value.
Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
Displaced wattage	The displaced wattage is defined as the difference between the wattage values of the baseline equipment or product and the efficient equipment or product.
EnerGuide rating	An EnerGuide (official brand of Natural Resources Canada) rating is a standard measure of the home's energy performance. It is a measure of the efficiency of the building only and does not take into account occupant behaviour. It shows how energy efficient the home is through modelled heat losses of the home, based on several factors including building envelope characteristics, heated volume, heating systems and air leakage.
Effective useful life	The period a measure is expected to be in service and provide both energy and peak demand savings. This value combines the equipment life and the measure persistence, which includes factors such as business turnover or early retirement.
Equipment life	The number of years installed equipment will operate before it fails.
Equivalent CO ₂	A unit of measurement indicating the amount of carbon dioxide to which various kinds of emitted greenhouse gases are equivalent in terms of warming effects. In this report, the gases' global-warming potential is estimated over a timescale of 100 years.
Equivalent effective useful life	The number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. This value takes into account variations in annual energy savings throughout the effective useful life due to increased baselines.

Evaluated savings	Gross and net energy or peak demand savings calculated by the Evaluator using the parameters (unitary savings values, installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process. Unless otherwise specified, the evaluated savings are the first-year savings.
Evaluation plan	The evaluation plan summarizes the program description, objectives, base cases, documentation, evaluation methodology, budget and schedule.
First-year savings	The first full year of energy or peak demand savings generated by an energy efficiency measure.
Free-ridership	Percentage of gross savings attributable to participants who would have implemented the same or similar energy efficiency measures, with no change in timing, in the absence of the program.
Gross savings	Change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated.
Induced consumption	Energy consumption of appliances that would have been unplugged and not replaced by participants in the absence of the program.
Interactive effects	Effects on the energy consumption of other systems in the building (such as heating and cooling) due to the installation of an energy efficiency measure.
Participant spillover	Savings attributable to participants who continue to implement the energy efficiency measure introduced by a program after participating in it once, without participating in the program a second time.
In-service rate	The proportion of incentivized products that are installed and operating. This rate is usually applied to programs through which rebates are offered in-store and products are likely to be stored for a certain period before being installed, such as Light-emitting diode (LED) lamps.
Installation rate	The proportion of incentivized products reported as installed that remain installed and operating at the time of evaluation. This rate is usually applied to direct install or mail-in rebate programs through which measures are expected to be installed immediately at the time of participation.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for a measure's effective useful life and any increase in the baseline efficiency level (which reduces attributable annual savings) over its lifetime.
Line loss factor	The multiplier to convert savings at the customer meter to savings at the utility generator. It accounts for the electrical losses of the transmission and distribution system.
Margin of error	The amount of random sampling error.
Market effects	The impact of the program on the market (such as increased product availability, practices, and prices) that extends beyond changing the program participants' behaviour. This includes spillover among non-participants.

Net savings	Energy or peak demand savings that can be reliably attributed to a program. This includes effects, such as free-ridership and spillover, that negatively or positively affect the savings attributable to a program.
Net-to-gross ratio	The ratio of net energy savings to gross energy savings.
Non-sampling error	Errors arising during the course of all survey activities other than sampling. Non-sampling errors tend to lead to bias in measurements and are very difficult to quantify.
Peak coincidence factor	The percentage of measure demand savings that coincide in time with the annual peak demand of the entire electricity system.
Peak demand savings	The demand savings that coincide in time with the expected annual peak demand period of the entire electricity system.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	The error in measurement due to the fact that measurements are taken from a subset of the population and not the entire population.
Realization rate	The ratio of evaluated savings to tracked savings.
Sample size	The number of observations or replicates included in a statistical sample.
Secondary market impacts	Energy consumption of appliances that would have been transferred to the secondary market if said appliances had not been retired.
Tracked savings	Gross and net savings calculated based on various parameters such as number of participants or units installed or sold, unitary savings values, installation rates, interactive effects, and the net-to-gross ratio. Those parameters, with the exception of the number of participants or units installed or sold, are obtained from the previous evaluation.
Unitary savings	Energy or peak demand savings established on a unitary basis. This unit can either be a product (e.g., an 8 W LED lamp), a capacity (e.g., one-ton capacity of an air-source heat pump) or a participant (e.g., one participant taking part in a behaviour-based program).

TABLE OF CONTENTS

INTRODUCTION	1
1 EVALUATION SCOPE AND OBJECTIVES	3
1.1 Impact Evaluation Objectives and Scope	4
1.2 Process and Market Evaluation Objectives and Scope	6
1.3 Evaluation Research Objectives and Scope.....	7
1.3.1 Market Transformation and Codes and Standards	7
1.3.2 Evaluation Approaches for Event-based Demand Response Pilots.....	7
2 EVALUATION METHODOLOGY	8
2.1 Impact Evaluation.....	8
2.1.1 Tracking Sheet Audits	8
2.1.2 Data-collection Tool Development and Sampling Strategy	8
2.1.3 Data Collection.....	9
2.1.4 Effective Useful Life Review.....	13
2.1.5 Gross Savings Analysis	13
2.1.6 Net Savings Analysis	14
2.2 Process and Market Evaluation.....	16
2.3 Evaluation Research	17
3 IMPACT EVALUATION RESULTS	18
3.1 Individual Impact Evaluation Results.....	18
3.1.1 Residential DSM Programs	21
3.1.2 Business, Non-profit, and Institutional DSM Programs	23
3.2 Net-to-gross Ratio	26
3.3 Lifetime Energy Savings	28
3.4 Greenhouse Gas Emission Reductions	29
4 DSM PORTFOLIO PERFORMANCE	30
4.1 Participant and Partner Satisfaction	30
4.2 Annual Savings Performance by Program Component.....	31
4.3 Historical Portfolio Analysis	33
5 MARKET EVOLUTION.....	37
6 EVALUATION RESEARCH SUMMARY	40
6.1 Market Transformation and Codes and Standards	40
6.2 Evaluation Approaches for Event-based Demand Response Pilots.....	41
CONCLUSION AND RECOMMENDATIONS	43

LIST OF TABLES

Table 1: 2021 Portfolio Evaluation Plan	4
Table 2: 2021 Participant Surveys	9
Table 3: 2021 Interviews Completed	10
Table 4: 2021 On-site Visits	11
Table 5: 2021 Project Reviews with Follow-up Interviews	12
Table 6: Comparison of 2021 Evaluated and Tracked Energy Savings at the Generator	19
Table 7: Comparison of 2021 Evaluated and Tracked Peak Demand Savings at the Generator	20
Table 8: 2021 Free-ridership, Spillover and NTGRs	26
Table 9: 2021 Evaluated Net Lifetime Energy Savings at the Generator	28
Table 10: 2021 Evaluated Avoided GHG Emissions	29
Table 11: 2021 Satisfaction Results	30
Table 12: 2021 Planned Savings and Evaluated Results	31
Table 13: Evaluated Net Energy Savings at the Generator, 2017-2021	34
Table 14: Evaluated Net Peak Demand Savings at the Generator, 2017-2021	35
Table 15: 2021 Recommendations on Residential Program Components	43
Table 16: 2021 Recommendations on Business, Non-profit, and Institutional Program Components	44

INTRODUCTION

EfficiencyOne (EOne), an independent, non-profit organization, is responsible for helping Nova Scotians improve the energy efficiency of their homes and workplaces by designing, marketing, and delivering energy efficiency and conservation programs for Nova Scotians. EOne receives funding for its electricity demand-side management (DSM) activities from Nova Scotia Power (NS Power) ratepayers.

EOne has a DSM portfolio of three residential programs and three business, non-profit, and institutional (BNI) programs that are marketed to Nova Scotians through the Efficiency Nova Scotia (ENS) franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2021 DSM program portfolio. In addition, Econoler conducted research to inform EOne's approach to market transformation and treatment of codes and standards as well as evaluation approaches for event-based demand response.

To carry out these services, Econoler collaborated with Equilibrium Engineering, Bouthillette Parizeau, Richard Patterson of CDM Energy Solutions, Narrative Research and Energetix. Econoler served as team leader and was involved in every aspect of the evaluation. Specifically, Econoler was in charge of coordinating and supervising all activities, conducting final reviews of all data-collection instruments, performing process and market evaluations and impact evaluation calculations, as well as preparing and reviewing evaluation reports. Bouthillette Parizeau and Richard Patterson conducted desk reviews. Equilibrium Engineering conducted desk reviews and on-site visits for selected program components. These organizations also contributed to certain impact evaluation analyses. Narrative Research conducted interviews and surveys with participants and partners, as well as analyzed and reported on the data collected from those activities. Energetix provided insight on evaluation planning activities for EOne's demand response initiatives planned for the 2021-2022 winter peak period. Throughout this report, this team is referred to as the Evaluator.

For each program, the Evaluator prepared a DSM evaluation report presenting general findings, electrical first-year energy savings results, lifetime energy savings, peak demand savings, and avoided annual greenhouse gas (GHG) emissions.¹

The evaluation revealed that the EOne DSM program portfolio achieved a total of 109.418 GWh in net electrical energy savings and 27.484 MW in net peak demand savings at the generator in 2021. These savings represent 63,911 tonnes of CO₂ eq in terms of annually avoided GHG emissions. The total net lifetime energy savings amount to 1,548.786 GWh.

¹ Unless specified otherwise, energy savings refer to first-year energy savings rather than lifetime energy savings throughout this report.

This report presents the evaluation results of the overall EOne DSM program portfolio along with the results of each program and their components and services. The following sections summarize evaluation objectives and scopes, evaluation methodologies, impact evaluation results, overall DSM portfolio performance, and recommendations to enhance the EOne program portfolio.

1 EVALUATION SCOPE AND OBJECTIVES

The 2021 Portfolio Evaluation Plan was based on the Evaluation Schedule outlined in the Overall Strategic Evaluation Plan,² which provides a framework and approach to guide evaluation planning and implementation for the 2020–2022 demand-side management (DSM) activities. The Evaluator is responsible for designing annual evaluation plans that meet the evaluation goals and principles and for conducting a third-party independent review of EOne program results.

The following factors are used to guide the prioritization of evaluation activities in the development of annual evaluation plans:

- › The level of program savings compared to portfolio savings; more resources should be allocated to a program that accounts for a relatively large portion of a portfolio's total savings.
- › Uncertainty regarding the expected savings; those initiatives with lower uncertainty regarding results should be given a lower evaluation priority. Similarly, evaluation efforts should prioritize those program characteristics or assumptions associated with a higher level of uncertainty.
- › Changes to program design or delivery; changes to a program that could affect parameters such as baseline scenarios indicate that a comprehensive evaluation is likely warranted.
- › Timely feedback in the program life cycle; information valuable to planning a new initiative (e.g. a pilot) or improving an ongoing program should be prioritized. Process evaluations should be scheduled to obtain early feedback to help ensure that a program is on track to meeting its goals.
- › Regulatory requirements: the information needed to respond to regulatory orders or requirements should have a higher priority than the information not needed for that purpose.
- › Evaluation scheduling: the evaluation schedule should be carefully thought out to optimize the robustness and usefulness of evaluation results (e.g. the need to evaluate a program after changes are made to program offerings, the length of the interval between two consecutive evaluations of a program).

The 2021 Portfolio Evaluation Plan also considered uncertainties and realities associated with the COVID-19 pandemic, thus adapting evaluation activities where possible (e.g. shifting on-site visits to project reviews) and, if not possible, deferring activities to future years.

There are three broad evaluation categories: impact evaluations, process evaluations, and market evaluations. Based on the three evaluation categories, Table 1 below presents a summary of the 2021 Portfolio Evaluation Plan. The table also indicates the scopes of the impact evaluations (comprehensive or condensed), which are further detailed in the following subsection.

² Econoler, *Overall Strategic Evaluation Plan*, February 2022.

It should be noted that some program components are further divided into services that are discussed throughout this report. Such is the case for the Custom component that includes the Retrofit, New Construction, and Building Optimization services, as well as for the Business Energy Rebates component comprised of two services, namely Mail-in and Instant Rebates.

Table 1: 2021 Portfolio Evaluation Plan

DSM Program	Program Components	Impact	Process	Market
Residential				
Residential Efficient Products Rebates	Appliance Retirement (ARet)	Condensed		
	Instant Savings	Comprehensive		X
Existing Residential	Efficient Product Installation (EPI)	Comprehensive		
	Mi'kmaw Home Energy Efficiency Project (MHEEP)	Condensed		
	Green Heat	Condensed		X
	Home Energy Assessment (HEA)	Condensed		
	Affordable Multifamily Housing (AMH)	Comprehensive		
New Residential	New Home Construction (NHC)	Condensed		
BNI				
Efficient Product Rebates	Business Energy Rebates (BER)	Comprehensive		X
Custom Incentives	Custom	Comprehensive	X - NC	
	Energy Management Information Systems (EMIS)	Comprehensive		
	Strategic Energy Management (SEM)	Comprehensive		
Direct Installation	Small Business Energy Solutions (SBES)	Condensed		
Selected market evaluation themes were also added to impact evaluation activities for the following program components: Efficient Product Installation, Affordable Multihousing, Energy Management Information Systems, Small Business Energy Solutions, Strategic Energy Management, and Residential Solar Photovoltaic. The SBES evaluation included the SBES Direct Install pilot, while the Custom evaluation included the OEM Operational Demand Savings pilot.				

The following subsections describe the objectives of the impact, process, and market evaluations.

1.1 Impact Evaluation Objectives and Scope

The impact evaluation activities were aimed at determining:

- › Gross electrical energy and peak demand savings at the meter and at the generator
- › Net-to-gross ratios (NTGRs), including free-ridership and spillover levels where appropriate
- › Net electrical energy and peak demand savings at the meter and at the generator
- › Effective useful life (EUL) of program measures
- › Lifetime electrical energy savings
- › Quantification of avoided greenhouse gas (GHG) emissions linked to evaluated net electrical.

Impact evaluations were conducted for all program components. As explained below, there were two types of impact evaluations.

- › **Comprehensive impact evaluation** – A comprehensive impact evaluation consists in reviewing the following four key elements: (1) the baseline definition; (2) the savings calculation methodology; (3) the values of the parameters used to calculate savings; and (4) NTGRs. The specific activities to be carried out for such reviews may include surveys, desk reviews, site visits, billing analyses, literature reviews, etc.
- › **Condensed impact evaluation** – A condensed impact evaluation consists in using some or all of the previous year's impact evaluation parameters—such as unitary savings values, adjustment ratios, installation rates, and NTGRs—to provide evaluated results.

At least one comprehensive impact evaluation will be conducted every three years for all program components, with the exception of program components that represent a small proportion of portfolio savings, or whose savings calculation methodologies rely on parameters that are evaluated through another program component comprehensive evaluation. To determine which type of impact evaluation (comprehensive or condensed) should be planned for each program component, when they should be conducted, and why, the Evaluator applied the priorities outlined above. For impact evaluation, factors driving uncertainty include:

- › Program maturity and stability of impact evaluation parameters (e.g. adjustment ratios and free-ridership levels) over time. Mature and stable programs warrant fewer comprehensive impact evaluations.
- › Complexity of savings calculations. Complex or custom savings calculation methodologies that are more likely to result in errors indicate that a comprehensive evaluation is likely warranted.

The impact evaluation schedule was developed to also take into account uncertainties in 2021 associated with the COVID-19 pandemic.

While the response to the COVID-19 pandemic likely had an impact on energy consumption in 2021, the 2021 evaluation captures savings assuming 2021 was a typical year across the portfolio. This approach is considered prudent given the fact that savings are extrapolated over the life of measures and there is little information available on COVID-19 impacts by end use and over time. In addition, there is little information or consensus on how other jurisdictions are dealing with this issue. Literature on this topic is being closely monitored and will be used to inform future evaluations as publications become available.

Measure Assessment Document

The impact evaluation scope for 2021 also included an update of the Measure Assessment (MA) document. The MA was updated with a new edition to include new products added to program offerings or new savings parameters in cases where a comprehensive impact evaluation is planned (e.g. new installation rates from the site visits conducted for EPI in 2021). In addition, the following parameters, which are planned to be updated annually in the Measure Assessment, were updated in 2021:

- › LED lighting
 - Baseline definition (from participant survey)
 - Analysis of wattage for popular models
- › Central air-source heat pumps³
 - Rated heating capacity of the new heat pump at outdoor air temperature of -15°C
 - Coefficient of performance of the new heat pump at -15°C
- › Freezer and refrigerator retirements and replacements⁴
 - Proportion of units per manufacture-year class
 - Average unit size
- › Solar air heating
 - Average energy savings

For all other measures, the unitary savings were based on the values presented in the 2020 edition of the MA. The document also includes effective useful life (EUL) values for any new measures in the portfolio.

1.2 Process and Market Evaluation Objectives and Scope

Process evaluation activities were completed for New Construction in 2021 and were aimed at achieving the following objectives:

- › Collect information on the New Construction participant decision-making process
- › Analyze decision-making process to inform how to undertake the most accurate and reliable free-ridership assessments

Market evaluations were completed for residential LED lighting in Instant Savings, for commercial LED lighting in Business Energy Rebates and for mini-split heat pumps (MSHPs) in Green Heat.

³ The number of units rebated in 2020 was too low to establish a value with high confidence to be used in 2021 and 2022.

⁴ The average efficiency level and size of retired equipment are likely to evolve as more recent appliances are replaced.

Market evaluation activities were aimed at achieving the following objectives:

- › Characterize current market trends and conditions
- › Assess satisfaction with, awareness about, and influence of program components on the market.

1.3 Evaluation Research Objectives and Scope

In 2021, the Evaluator was asked to conduct two pieces of research to inform EOne's current and future demand response activities, as well as potential strategies related to market transformation and codes and standards. The objectives of this work are outlined in the following sections.

1.3.1 Market Transformation and Codes and Standards

The objectives of this research were as follows:

- › Identify practices of other jurisdictions concerning Market Transformation (MT) and Codes and Standards (C&S) attribution in terms of interventions and evaluation approach
- › Understand the regulatory and legislative context that enables jurisdictions to design and report savings from MT or C&S programs
- › Identify measures, programs, or markets that are likely to be evaluated under an MT framework
- › Provide guidance on which mechanisms, if any, EOne could undertake to evaluate their influence on the new construction market, particularly in the residential sector

1.3.2 Evaluation Approaches for Event-based Demand Response Pilots

EOne began developing demand response projects focused on reducing demand during the Nova Scotia peak period in 2021. The objective of the research was to explore options to evaluate and report peak demand reductions achieved by event-based DR pilots and future broader event-based DR programs.

2 EVALUATION METHODOLOGY

This section presents the methodology used and the activities carried out to evaluate EOne DSM program components and services through impact, process, and market evaluations as well as other research for 2021.

2.1 Impact Evaluation

The impact evaluations were conducted through a range of activities such as tracking sheet audits, data-collection tool development, energy model reviews assisted by participant follow-up interviews, as well as other data-collection activities and analyses. The following describes the steps that were followed to execute the impact evaluations.

2.1.1 Tracking Sheet Audits

The final tracking sheets submitted to the evaluator by EOne contain data for all completed projects for 2021 and the tracked results required to calculate final savings. The final tracking sheets were audited to assess the consistency and completeness of the program data, including discrepancies that needed to be clarified to enable savings calculations. Following this analysis, the Evaluator determined corrected tracked values and then compiled evaluated savings.

The Evaluator audited the project tracking sheet for each program component. The tracking sheet audits resulted in adjustments of 0.8% decrease in gross energy savings and 1.9% increase in gross peak demand savings overall. Therefore, the tracked savings results presented in this report refer to the corrected tracked savings obtained by the Evaluator.

2.1.2 Data-collection Tool Development and Sampling Strategy

Data-collection tool development and sampling were carried out for Instant Savings, Efficiency Product Installation, Affordable Multifamily Housing, Green Heat, Business Energy Rebates, Custom, Energy Management Information Systems, and Strategic Energy Management.

The Evaluator developed the relevant data-collection instruments - namely survey questionnaires, interview guides, project review protocols, and desk review checklists. Data-collection instruments were informed by documentation reviews, program staff interviews, and preliminary tracking sheets.

Using an integrated approach, the data-collection tools also included questions to inform process and market evaluation activities.

2.1.3 Data Collection

Surveys and Interviews

This subsection describes the data-collection activities conducted for the impact evaluations. It should be noted that surveys and interviews were often integrated to collect impact, process, and market information, as discussed in Subsection 2.2 below.

- › **Participant surveys** were used to collect data on free-ridership and spillover. Most participant surveys were conducted by telephone to ensure consistency with past evaluations. Similar to 2020, the Evaluator opted to conduct an online survey instead of an in-person intercept survey as in past evaluations for Instant Savings due to COVID-19 constraints. Between October and December 2021 inclusively, the Evaluator conducted surveys with 502 participants. Table 2 lists the surveys completed for each program component and the number of respondents to each survey.

Table 2: 2021 Participant Surveys

Program Component	Participants
Residential	
Instant Savings	120
Green Heat	140
Efficient Product Installation	100
BNI	
Business Energy Rebates - Mail-in	42
Business Energy Rebates - Instant Rebates	50
Small Business Energy Solutions	50
Total	502

- › **In-depth interviews** were conducted as part of impact evaluation activities with program staff, participants, partners, and other key stakeholders or trade allies to collect data on free-ridership and spillover. Between August 2021 and January 2022, the Evaluator conducted 114 interviews with various market actors and stakeholders. The number of completed interviews for each program component is presented in Table 3.

Table 3: 2021 Interviews Completed

Program Component	Program Manager ¹ / EOne Staff	Service Provider/ Distributors	Participants	Retailers	Program Administrators
Residential					
Appliance Retirement	2	-	-	-	-
Instant Savings	2	-	-	8	-
Home Energy Assessment	2	-	-	-	-
Green Heat	2	5	-	-	-
Efficient Product Installation	2	-	-	-	-
Mi'kmaw Home Energy Efficiency Project	2	-	-	-	-
Affordable Multifamily Housing	2	-	6 ²	-	-
New Home Construction	2	-	-	-	-
BNI					
Business Energy Rebates	2	8	-	-	-
Custom	10 ³	-	42 ⁴	-	-
Energy Management Information Systems	2	1	1 ⁵	-	-
Strategic Energy Management			3	-	-
Small Business Energy Solutions	2	-	-	-	-
Market Transformation and Codes and Standards	1	-	-	-	7
Total	33	14	52	8	7

¹ Two rounds were performed with the program manager (round 1 – May 2021 and round 2 – September 2021)

² AMH: Participant interviews were completed as part of a participant follow-up phone interview, on-site visits, or desk reviews

³ Custom: Six program manager interviews were conducted (two for Retrofit, two for New Construction and two for Building Optimization), two EOne Staff interviews (for New Construction) and two EOne Business Development Managers interviews (for New Construction)

⁴ Custom: 30 interviews were conducted with participants (16 for Retrofit, 11 for New Construction and four for Building Optimization) - for Retrofit and Building Optimization, the majority of interviews were completed as part of a participant follow-up interview during the project review. In addition, five interviews were conducted with participants who have recently signed CPAs for New Construction, and six interviews were conducted with participants and OEMs for OEM Demand Savings Pilot

⁵ EMIS participant was also an SEM participant

Site Visits

The Evaluator performed a total of 106 on-site visits during the summer and fall of 2021. For Business Energy Rebates, the objective of on-site visits was to collect data to establish or validate some of the parameters used in the savings calculations, namely installation rates, interactive effects, participant spillover, and the technical characteristics of implemented measures. For Affordable Multifamily Housing, the site visits were aimed at validating that the inputs used in the simulation model - namely the installed measure and building characteristics - were appropriate and that the savings tracked by EOne were consistent with the simulation outputs. The site visits performed for Efficient Product Installation served to establish new installation rates of the products installed through that program component.

Table 4 indicates the number of on-site visits conducted for each program component. The complete results of the on-site visits are provided in the individual program component evaluation reports.

Table 4: 2021 On-site Visits

Program Component	2021 On-site Visits Completed
Residential	
Efficient Product Installation	63
Affordable Multifamily Housing	3
BNI	
Business Energy Rebates	40
Total	106

Energy Model Reviews Assisted by Participant Follow-up Interviews

After initial file reviews, the Evaluator concluded that the virtual site visits were not required given the available documentation, and instead opted to complete energy model reviews with follow-up telephone interviews. The Evaluator performed energy model reviews for the 12 Custom New Construction projects to verify the accuracy of energy models. These activities involved comparing energy models against as-built drawings, project documentation, and results of follow-up interviews results. The Evaluator also compared baseline energy models against the appropriate baseline definition for each project. The resulting adjusted models were then used to establish evaluated savings.

Technical Project Reviews Assisted by Participant Follow-up Interviews

For those program components whose savings were established based on customized calculations for each measure, the Evaluator reviewed the savings calculations for a sample of projects to assess them for accuracy and consistency with site conditions. As outlined in Table 5, the Evaluator carried out full technical reviews of project documentation for several program components. Pursuant to the project reviews, follow-up telephone interviews with participants were conducted to finalize project reviews. The telephone interviews were also used to collect information on free-ridership and spillover as well as participant perspectives on the relevant program component. In the case of Custom New Construction, multi-source interviews on free-ridership were collected for six projects.

Table 5: 2021 Project Reviews with Follow-up Interviews

Program Component	2021 Project Reviews Completed
BNI	
Custom	47*
Energy Management Information Systems	1
Strategic Energy Management	6
Total	54
* This number differs from Table 3 (Custom - interview with participants) because some projects were reviewed, but no participant was reached for a follow-up interview and/or for some projects it is the same participant who answered for multiple projects.	

Unitary Savings Review

For program components with unitary savings values - namely Appliance Retirement, Instant Savings, Home Energy Assessment, Green Heat, Efficient Product Installation, Mi'kmaw Home Energy Efficiency Project, the Business Energy Rebates Instant Rebate service, and the Small Business Energy Solutions Commercial Direct Installation pilot - the Evaluator validated the parameters and equations used to obtain these values and updated them where necessary through the development of the 2020-2022 Measure Assessment. As part of the 2021 evaluation, selected parameters for select measures were updated, including installation rates for the Efficient Product Installation program derived from site visit results. Moreover, new measures introduced in 2021 were added to the Measure Assessment. Unitary savings values were reviewed using one or more of the following approaches: literature reviews of technical reference manuals; metering studies and evaluation reports; engineering calculations; adjustments based on data collected through participant surveys or site visits; and secondary research about household/facility characteristics such as types of heating and cooling systems.

Other Data-collection Activities

This subsection provides descriptions of other data-collection and evaluation activities carried out to achieve the impact evaluation objectives, as follows:

- › **Desk reviews** – Desk reviews were carried out for Affordable Multifamily Housing. The Evaluator reviewed the documentation of four prescriptive projects that generated electrical savings to validate the consistency of the savings tracked by EOne using calculations, photos, and invoices.
- › **Savings calculation reviews** – This activity was conducted for Mi'kmaw Home Energy Efficiency Project, Home Energy Assessment, New Home Construction, Business Energy Rebates, and Small Business Energy Solutions. Once all the savings algorithm parameters were determined, whether from current or previous evaluations, the savings calculation reviews served to validate that savings were correctly and consistently compiled by applying the right equations and all necessary parameters.

2.1.4 Effective Useful Life Review

The Evaluator reviewed the EUL values for any new measures to ensure they were valid and revised them where appropriate. The EUL update was based on a literature review of the most recent technical reference manuals from other jurisdictions. EUL values were included in the 2020-2022 Measure Assessment. The EUL values of select existing measures were also revised.

In addition, for some measures, the Evaluator considered not only the measure life, but also the evolution of the baseline over the lifetime of the measure. Lifetime energy savings were calculated based on the existing baseline up until the end of the period when the equipment would have been replaced and then based on the new standard baseline for the remaining EUL of the measure. The adjusted EUL of a given project was then calculated as the lifetime energy savings divided by first-year energy savings.

2.1.5 Gross Savings Analysis

Gross savings refer to changes in energy consumption resulting from actions taken by participants regardless of their reasons for participating. Upon completion of the impact evaluation activities described above, the Evaluator analyzed the data collected to calculate evaluated gross savings and compare results with the data tracked by EOne. Establishing gross savings consists of compiling all measures implemented through a program component with the evaluated parameters.

- › **Interactive effects** are considered whenever energy efficiency measures directly affect the energy consumption of other systems, such as heating and cooling. Interactive effects were only calculated as impacts to participants' electrical energy consumption. Calculating interactive effects can be site-specific (e.g. Custom) or calculated as a provincial average (e.g. Efficient Product Installation). The Evaluator used engineering assumptions, findings from literature reviews, and data collected during virtual site visits, project reviews with follow-up interviews, or desk reviews to calculate interactive effects that are representative not only of the Nova Scotia climate, but also the participating homes and facilities.
- › **Peak demand savings** were calculated from gross electrical energy savings based on the projected electricity peak demand period in Nova Scotia⁵. For residential program components, peak demand savings were calculated using peak demand-to-energy ratios established for EOne as part of their planning. Engineering calculations were used for products generating significant peak demand savings, and for which load profiles during peak hours can be estimated (e.g. electric thermal storage, heat pumps). For BNI program components, peak demand savings were calculated for the sample of reviewed projects and corresponding adjustment ratios, or peak coincidence factors were applied to all program component demand savings to determine peak demand savings.

⁵The projected electricity peak demand period in Nova Scotia is between 5 p.m. and 7 p.m. from December to February on non-holiday weekdays.

2.1.6 Net Savings Analysis

Net-to-gross Assessment and Net Savings Calculations

Free-ridership levels were established for most program components by conducting surveys or in-depth interviews. These surveys and interviews included a set of questions used to establish program component attributions for the free-ridership calculations. A self-report approach was used consisting of asking questions to participants to assess the planning, quantity, efficiency, period, cost, and influence of a program component. For midstream or upstream program components like BER Instant Rebates, both market actor (distributor) and end-user (participant) perspectives were used to assess free-ridership. Based on survey or interview results, a free-ridership level was established for each respondent. Subsequently, a weighted average based on each respondent's savings was used to estimate overall program component free-ridership levels. Since 2016, the free-ridership calculation methodology takes into account the impact of cross-influence of previous participation in other EOne program components.

As part of the 2021 evaluation, the free-ridership level was updated for the following program components: Business Energy Rebates, Custom, Green Heat, Efficient Product Installation, Instant Savings, and Small Business Energy Rebates.

For the 2021 evaluation of Custom New Construction, the Evaluator used the new free-ridership questionnaire developed as part of the process evaluation to better capture all influence factors that can have an impact on building design decisions, such as the energy model, modelling, and implementation incentives as well as on technical assistance provided by the energy modeller, BDMS, and New Construction staff.

The free-ridership levels from past evaluations were used for Appliance Retirement, Home Energy Assessment, and New Home Construction.

The impact evaluation included an assessment of spillover levels for program components wherein spillover was a factor. For all program components with the exceptions of Instant Savings, Home Energy Assessment, and New Home Construction, the spillover levels corresponded to participant spillover. Participant spillover assessments were conducted through telephone surveys or during follow-up interviews for project reviews. In all cases, participants were asked if they had implemented additional energy efficiency measures without receiving funding or assistance from EOne. If so, participants were then asked a set of questions designed to identify the additional energy efficiency measures implemented and their associated savings. Subsequently, another question was asked to quantify the level of influence a given program component had on their decision to implement the additional measures. Thereafter, the value established on the level of influence was used to determine the portion of the additional savings attributable to the component. Finally, the level of participant spillover was established by dividing the total additional savings attributable to the component by the total savings achieved by the component for all survey respondents.

When the activities of a program component result in a broader influence on the market (e.g. Instant Savings and New Home Construction), spillover was measured in the form of market effects to cover impacts not only on program participants, but also on non-participants due to program advertising, greater knowledge and awareness among market actors, etc. For Instant Savings, the Evaluator used interviews with retailers to establish an estimate of the number of LED lamps and fixtures sold without an Instant Savings rebate and the proportions of those sales that were indirectly attributable to Instant Savings. Similarly, the market effects for New Home Construction were established based on interviews with builders, which served to determine increased efficiency in non-participating homes that was due to the influence of New Home Construction. For Home Energy Assessment, the Evaluator included participant spillover and unconverted D assessment spillover, the latter corresponding to savings generated by participants that did not complete the full Home Energy Assessment process.

As part of the 2021 evaluation, the spillover level was updated for the following program components: Instant Savings, Efficient Product Installation, Business Energy Rebates, and Custom. The spillover levels from past evaluations were used for Appliance Retirement, Home Energy Assessment, and New Home Construction.

The Evaluator did not establish free-ridership and spillover levels for the following program components and services:

- › Energy Management Information Systems and Strategic Energy Management – The limited market penetration of these components and the limited knowledge of participants on recommissioning or energy management information systems prior to participation explain why free-ridership and spillover were considered to be nil.
- › Measures and program components offered to low-income participants and Mi'kmaw communities were also considered to have nil free-ridership and spillover levels.

Avoided GHG Emission Calculations

The Evaluator estimated the avoided annual GHG emissions resulting from the evaluated electrical savings for all program components. Avoided GHG emissions were estimated by using a Nova Scotia-specific factor⁶ for GHG emissions generated by electricity production. This factor was updated with the most recent NS Power data on total system emissions and electricity generation.

⁶ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:
Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),
Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021
https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

2.2 Process and Market Evaluation

The process and market evaluations were conducted using a range of activities such as program component documentation and secondary data reviews and in-depth interviews with program staff, stakeholders, and participants. The following describes the key tasks the Evaluator carried out to execute the New Construction process evaluation and the market evaluations for Instant Savings, Green Heat and Business Energy Rebates.

Documentation Review

The Evaluator reviewed all relevant evaluation and program component specific documentation such as program manuals, marketing materials, application forms, tracking sheets, and any other information on changes made to program components since the previous evaluation. Additionally, the Evaluator used annual staff interviews to follow up on past evaluation recommendations and become aware of any component improvements and changes.

Data-collection Tool Development and Sampling Strategy

As described in Subsection 2.1.2 above, the Evaluator used an integrated approach to developing data-collection tools that serve all three evaluation types where possible. For instance, interview guides included questions for the process, market, and impact evaluations. This approach reduces respondent burden and ensures that evaluation results are integrated.

Data Collection

This subsection describes the data-collection activities conducted for the process and market evaluations. As discussed above, interviews were often integrated to collect impact, process, and market information.

- › **Secondary data** on lighting and fixture shipments provided by Electro-Federation Canada were used to understand the evolution of the LED lamp and LED fixture markets for Instant Savings and Business Energy Rebates. Secondary data on heat pump installations taken from NS Power Load Forecasts⁷ were used to evaluate the evolution of the MSHP market for Green Heat.
- › **In-depth interviews** were conducted with program staff, participants, partners, and other key stakeholders or trade allies to collect data on their involvement in a program component, as well as their experience and satisfaction with it, among other things. Unlike participant surveys that require interviewers to ask questions in the exact same way, in-depth interviews are semi-directed, thus allowing for more flexibility and discussion. They are a great option for evaluations that require exploring certain research areas or asking in-depth and complex questions that are not suited to a survey. The number of completed interviews for each program component are presented in Table 3 in Subsection 2.1.3.

⁷ Nova Scotia Power 2020 Load Forecast Report Synapse IR-06 Att 5 ELECTRONIC; Nova Scotia Power 2021 Load Forecast Report.

Analysis

The results of the process and market evaluation activities were analyzed in relation to the research objectives identified in Section 1.2. Results from all evaluation activities were consolidated and triangulated to ensure that findings are based on a preponderance of results.

2.3 Evaluation Research

The evaluation research on Market Transformation and Codes and Standards as well as Evaluation Approaches for Event-based Demand Response pilots, was conducted with two main activities, as described below.

Documentation Review

The Evaluator reviewed all relevant evaluation and program component specific documentation.

Data Collection

In-depth interviews, some of which included jurisdictional scans, were conducted as data-collection activities. Refer to Table 3 in Subsection 2.1.3 above to review the number of interviews completed.

- › **In-depth interviews** were conducted with program staff on the research topics to understand context and current and future work on the topics.
- › **Jurisdictional scans** were conducted for both research topics to collect data on programs and initiatives from other jurisdictions. The goal of a jurisdictional scan is to gather information on best practices and lessons learned to inform evaluation approaches. Jurisdictional scan activities also included interviews with program staff from other jurisdictions to collect in-depth data. The Market Transformation and Codes and Standards research included interviews with program administrators from six jurisdictions that have integrated MT programs to varying degrees in their portfolio.

3 IMPACT EVALUATION RESULTS

This section presents an analysis of the impact evaluation results for all program components by comparing 2021 tracked energy and peak demand savings with evaluated energy and peak demand savings. Evaluated net-to-gross ratios, lifetime energy savings, and GHG emission reductions are also presented in the subsections below.

3.1 Individual Impact Evaluation Results

Table 6 and Table 7 below respectively list the evaluated energy and peak demand savings as well as the corresponding savings tracked by EOne for each program component offered in 2021. Net savings were calculated by multiplying gross savings by the NTGR. Lifetime energy savings are equal to the savings generated by efficiency measures over their EUL. The line loss factors correspond to the values submitted to the Nova Scotia Utility and Review Board (NSUARB) as part of the 2014 Cost of Service Study Progress Update.⁸

⁸ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 6: Comparison of 2021 Evaluated and Tracked Energy Savings at the Generator

DSM Program	Program Component	Tracked Results		Evaluated Results ⁹				Net Realization Rate
		Annual Gross Savings (GWh)	Annual Net Savings (GWh)	Annual Gross Savings (GWh)	NTGR	Annual Net Savings (GWh)	Lifetime Net Energy Savings (GWh)	
Residential								
Residential Efficient Products Rebates	Appliance Retirement	4.542	2.549	4.462	0.55	2.474	9.925	97%
	Instant Savings	15.559	13.820	15.792	0.91	14.314	121.022	104%
Existing Residential	Home Energy Assessment	3.618	3.481	3.618	0.96	3.481	72.399	100%
	Green Heat	11.218	5.580	11.218	0.61	6.795	122.306	122%
	Efficient Product Installation	8.347	7.621	8.174	0.96	7.812	65.169	103%
	Mi'kmaw Home Energy Efficiency Project	0.316	0.316	0.316	1.00	0.316	6.633	100%
	Affordable Multifamily Housing	0.522	0.522	0.402	1.00	0.402	7.117	77%
New Residential	New Home Construction	6.245	5.496	6.245	0.91	5.683	173.548	103%
Residential Subtotal		50.367	39.384	50.228	0.82	41.276	578.116	105%
BNI								
Efficient Products Rebates	Business Energy Rebates	49.141	37.345	48.962	0.68	33.491	488.237	90%
Custom Incentives	Custom	29.014	22.263	26.729	0.87	23.293	337.282	105%
	Energy Management Information Systems	0.027	0.027	0.027	1.00	0.027	0.053	100%
	Strategic Energy Management	1.859	1.859	1.845	1.00	1.845	10.402	99%
Direct Installation	Small Business Energy Solutions	10.937	10.169	11.105	0.85	9.486	134.696	93%
BNI Subtotal		90.978	71.663	88.668	0.77	68.142	970.670	95%
Portfolio Total		141.346	111.047	138.896	0.79	109.418	1,548.786	99%
* Subtotal NTGR values represent average values for the Residential and BNI portfolios. The Total Portfolio NTGR value represents an average value for all programs. * Numbers may not add up due to rounding.								

⁹ Evaluated gross and net savings includes 0.104 GWh and 0.116 GWh respectively generated by the Klondike pilot.

Table 7: Comparison of 2021 Evaluated and Tracked Peak Demand Savings at the Generator

DSM Program	Program Component	Tracked Results		Evaluated Results ¹⁰			Net Realization Rate
		Annual Gross Savings (MW)	Annual Net Savings (MW)	Annual Gross Savings (MW)	NTGR	Annual Net Savings (MW)	
Residential							
Residential Efficient Products Rebates	Appliance Retirement	0.652	0.369	0.640	0.56	0.357	97%
	Instant Savings	1.790	1.567	1.819	0.90	1.629	104%
Existing Residential	Home Energy Assessment	1.722	1.495	1.722	0.87	1.495	100%
	Green Heat	10.319	5.179	10.370	0.62	6.451	125%
	Efficient Product Installation	1.157	1.062	1.143	0.96	1.098	103%
	Mi'kmaw Home Energy Efficiency Project	0.147	0.147	0.147	1.00	0.147	100%
	Affordable Multifamily Housing	0.154	0.154	0.186	1.00	0.186	121%
New Residential	New Home Construction	2.511	2.210	2.511	0.91	2.285	103%
Residential Subtotal		18.452	12.183	18.539	0.74	13.649	112%
BNI							
Efficient Product Rebates	Business Energy Rebates	8.282	6.227	7.979	0.68	5.401	87%
Custom Incentives	Custom	7.119	5.488	6.897	0.89	6.105	111%
	Energy Management Information Systems	0.003	0.003	0.003	1.00	0.003	100%
	Strategic Energy Management	0.172	0.172	0.282	1.00	0.282	164%
Direct Installation	Small Business Energy Solutions	2.365	2.199	2.397	0.85	2.045	93%
BNI Subtotal		17.941	14.089	17.557	0.79	13.835	98%
Portfolio Total		36.393	26.272	36.096	0.76	27.484	105%
* Subtotal NTGR values represent average values for the Residential and BNI portfolios. The total portfolio NTGR value represents an average value for all programs.							
* Numbers may not add up due to rounding.							

¹⁰ Evaluated gross and net savings includes 0.077 MW and 0.059 MW respectively generated by the Klondike pilot.

The following subsections discuss how evaluated savings compared to EOne tracked savings for each program and component.

3.1.1 Residential DSM Programs

Residential Efficient Product Rebates

In 2021, Residential Efficient Product Rebates achieved net electrical energy and peak demand savings of 16.788 GWh and 1.987 MW respectively at the generator. The two components under this program are Appliance Retirement (ARet) and Instant Savings. The results of each program component are provided below.

Appliance Retirement

- › ARet achieved its net electrical energy savings targets but not its peak demand savings targets.
- › ARet participation, as well as energy and peak demand savings, increased in 2021 compared to 2020 levels partly because of the latent demand created by impacts from the COVID-19 pandemic in 2020, the expansion of public events in 2021, and the rebate increase for full-size appliance retirements.
- › The differences between evaluated gross energy and peak demand savings determined by the Evaluator and the gross savings tracked by EOne are minimal and are due to small variations in the unitary savings values of each appliance type after accounting for the characteristics (e.g. size and age) of the appliances retired in 2021.

Instant Savings

- › Instant Savings net electrical energy savings and peak demand savings surpassed the targets.
- › Instant Savings maintained a high level of participation despite challenges from the COVID-19 pandemic, with a minimal decrease (2%) in overall products sold compared to 2020.
- › Efforts taken to diversify the program showed strong gains in 2021, with non-lighting products providing the majority of the gross savings.
- › The free-ridership level for LED lamps increased significantly from 2020 (64% in 2021 vs. 42% in 2020).
- › The spillover for LED fixtures increased significantly in 2021 (32% in 2021 vs. 16% in 2020).
- › The evaluated net energy and peak demand savings determined by the Evaluator are higher than the initial net savings tracked by EOne.

Existing Residential

In 2021, the net energy savings of Existing Residential reached 18.806 GWh while the net peak demand savings amounted to 9.378 MW at the generator. Existing Residential is comprised of Home Energy Assessment, Green Heat, Efficient Product Installation, Mi'kmaw Home Energy Efficiency Project, and Affordable Multifamily Housing. The results of these five program components are discussed below.

Home Energy Assessment

- › HEA net electrical energy and peak demand savings fell short of targets.
- › Savings per home continued to decrease but to a smaller extent than what has been observed since HEA has been open to both electrically and non-electrically heated homes.
- › Both the evaluated net energy and peak demand savings determined by the Evaluator were identical to those tracked by EOne.
- › The Evaluator noted that the HEA tracking sheet could become more prone to calculation errors as it is added to and modified over time.

Green Heat

- › Green Heat net electrical energy and peak demand savings exceeded targets.
- › Green Heat participation levels reached a new high in 2021, driven in large part by growth in demand reduction measures.
- › Green Heat free-ridership levels for MSHPs decreased in 2021 and remained stable for the other measure categories.
- › Both the evaluated net energy and peak demand savings determined by the Evaluator were significantly higher than the savings tracked by EOne due to the new free-ridership level established in 2021 for MSHPs.

Efficient Product Installation

- › EPI net electrical energy and peak demand savings fell short of targets.
- › Savings per participant continued to decrease, driven by a further decrease in the number of LED lamps installed per household compared to 2020.
- › The new installation rates established through the 2021 on-site visits resulted in a slight decrease in evaluated savings, notably due to a small decrease to the LED lamp installation rate.
- › Free-ridership levels for EPI remains similar to the previous levels established in 2019, while spillover increased.
- › The differences between evaluated net energy and peak demand savings determined by the Evaluator and the initial net savings tracked by EOne are minimal.

Mi'kmaw Home Energy Efficiency Project

- › MHEEP net electrical energy and peak demand savings fell short of targets.
- › Average electrical savings per participant increased in 2020, especially for peak demand savings.
- › The evaluated net energy and peak demand savings determined by the Evaluator were identical to the initial net savings tracked by EOne.

Affordable Multifamily Housing

- › AMH net electrical energy and peak demand savings fell short of targets in 2021.
- › AMH continued to grow and achieved its highest level of participation since its launch in 2018, largely driven by an increase in prescriptive projects.
- › Following the project reviews, the Evaluator made downward adjustments to energy savings and upward adjustments to peak demand savings, with the largest adjustments made to prescriptive projects.
- › The differences between evaluated net energy and peak demand savings determined by the Evaluator and the net savings tracked by EOne are negligible.

New Residential

New Residential is comprised of one program component: New Home Construction. In 2021, New Home Construction achieved net energy savings of 5.683 GWh and net peak demand savings of 2.285 MW at the generator.

New Home Construction

- › NHC net electrical energy savings surpassed targets but net peak demand savings fell short of targets.
- › In 2021, NHC participation levels were lower than in 2020.
- › Evaluated gross savings were identical to the savings tracked by EOne, while net evaluated savings were slightly higher.

3.1.2 Business, Non-profit, and Institutional DSM Programs

Efficient Product Rebates

Efficient Product Rebates is comprised of one program component-, Business Energy Rebates, which is further comprised of two services, namely Mail-in and Instant Rebates. In 2021, Business Energy Rebates achieved 33.491 GWh in net energy savings and 5.401 MW in net peak demand savings at the generator.

Business Energy Rebates

- › BER net electrical energy and peak demand savings fell short of targets.
- › Participation increased for both Mail-in and Instant Rebates in 2021 and total gross energy and peak demand savings increased compared to 2020 levels.
- › Following the site visits, the Evaluator made downward adjustments to energy and peak demand savings for Mail-in.
- › Average free-ridership levels for both Mail-in and Instant Rebates increased in 2021 compared to previous levels, while spillover for Mail-in remained nil.
- › Evaluated net energy and peak demand savings were respectively 10% and 13% lower than the values tracked by EOne.

Custom Incentives

In 2021, Custom Incentives achieved 25.165 GWh in net energy savings and 6.390 MW in net peak demand savings at the generator through its three components, namely Custom, Energy Management Information Systems, and Strategic Energy Management. Custom comprises three services, Retrofit, New Construction, and Building Optimization. In 2021, the Retrofit service also included the OEM Operational Demand Savings pilot.

Custom

The key findings of the Custom impact evaluation overall were as follows:

- › Custom net electrical energy and peak demand savings fell short of targets in 2021.
- › Compared to 2020, Custom participation increased in 2021 due in part to higher participation from New Construction and the closure of 18 multiyear projects in Retrofit.
- › Participant satisfaction with Custom continues to be very high across the three services. Participant satisfaction was also high with the OEM Operational Demand Savings Pilot.
- › Following the project reviews, the Evaluator adjusted the energy and peak demand savings for OEM Operational Demand Savings, Retrofit and New Construction as well as the energy savings for Building Optimization.
- › There has been a trend in recent years of more projects closing after the sampling period necessitated by the evaluation timetable. While having a minimal impact on 2021 results, this could create future challenges related to the quality of the adjustment ratios and NTGRs if larger projects are not well represented in the sample.
- › Retrofit free-ridership increased slightly, while free-ridership for New Construction was measured with a new approach to capture all levels of influence, including the modelling.
- › Both the evaluated net energy and peak demand savings determined by the Evaluator were higher than the savings tracked by EOne.

The key findings specific to the Retrofit impact evaluation were as follows:

- › The pay-for-performance projects reviewed by the Evaluator included an excellent client-led M&V approach that required almost no adjustments, had a free-ridership rate of zero, and high customer satisfaction.
- › During Retrofit project reviews, the Evaluator made adjustments and further observations relating to the specific measurement and verification (M&V) approach used for solar photovoltaics (PV) and compressed air leak repair projects.

The key findings specific to the New Construction impact evaluation were as follows:

- › EOne succeeds in influencing New Construction building design through the many influence factors, and influence on design occurs by the end of the design phase.

The key findings specific to the OEM Operational Demand Savings Pilot impact evaluation were as follows:

- › The incentive had the desired effect of prompting participants to look for rapid and low-cost measures to reduce their energy demand during the system peak period. That said, the nature of participating projects provides insights for potential improvements and clarifications to program guidelines.
- › M&V methodologies for peak reduction projects can be further refined.

Energy Management Information Systems

The key findings of the EMIS impact evaluation were as follows:

- › Due to a low level of participation, EMIS net energy savings did not reach target levels.
- › Both the evaluated energy and peak demand savings determined by the Evaluator were identical to those tracked by EOne.

Strategic Energy Management

- › SEM net energy and peak demand savings did not meet targets.
- › The SEM participation level has remained stable over the past four years
- › While adjustments to energy savings were minor, adjustments made to peak demand savings were significant, since EOne did not report savings for some projects that did generate peak demand savings.
- › Applying a different methodology for estimating EUL values resulted in higher average EUL for SEM.

Direct Installation

Direct Installation consists of one program component, namely Small Business Energy Solutions. In 2021, Direct Installation achieved 9.486 GWh in net energy savings and 2.045 MW in net peak demand savings at the generator.

Small Business Energy Solutions

- › Net energy savings were within 1% of targets, while peak demand savings fell short of targets.
- › Although participation in the Audit path remained low, participation, as well as gross energy and peak demand savings, considerably increased in 2021 compared to 2020.
- › The average free-ridership level for DIY participants was established at 15%.
- › The evaluated net energy and peak demand savings determined by the Evaluator were 7% lower than the net savings tracked by EOne.

3.2 Net-to-gross Ratio

The NTGRs outlined in Table 8 below were applied to gross savings to estimate net savings. NTGRs were established based on the levels of free-ridership and, in some cases, spillover. Based on the established free-ridership and spillover levels, NTGRs were calculated using the following equation:

$$NTGR = (1 - \% \text{ Free-ridership} + \% \text{ Spillover})$$

NTGR estimations were based on a self-reporting approach and the methodology described in Subsection 2.1.6 above. Appendix III presents examples of the calculations used to establish the free-ridership, spillover, and NTGR values through the 2021 evaluation.

Table 8 summarizes the free-ridership and spillover levels used in the 2021 evaluation as well as the resulting NTGRs for each program component.

Table 8: 2021 Free-ridership, Spillover and NTGRs

Program Component and Measure Type		Free-ridership Levels	Spillover Levels	NTGR
Residential				
Appliance Retirement ^a	Refrigerators	-	0%	0.56
	Freezers	-		0.47
	Air Conditioners	-		0.53
	Small Refrigerators	-		0.69
	Small Freezers	-		0.69
	HomeWarming and MHEEP Appliances	-	-	1.00
Instant Savings	LED Lamps	46%	9%	0.63
	LED Fixtures	41%	32%	0.91
	All Other Products	-	-	1.00
Home Energy Assessment		26%	1%	0.75
Green Heat	MSHPs	39%	-	0.61
	Centrally-ducted Heat Pumps	33%	-	0.67

Program Component and Measure Type		Free-ridership Levels	Spillover Levels	NTGR
	Solar and Biomass Measures	41%	-	0.59
	Water Heating Measures	-	-	1.00
	Electric Thermal Storage	-	-	1.00
	Klondike Pilot	-	-	1.00
Efficient Product Installation ^b	LED Lighting Non-Low Income Participants	25%	10%	0.90
	LED Lighting Low-income Participants	-	-	1.00
	Low-flow Showerheads Non-Low Income Participants	10%	10%	1.00
	Low-flow Showerheads Low-income Participants	-	-	1.00
	Other Products - Non-Low Income Participants	0%	10%	1.10
	Other Products - Low-income Participants	-	-	1.00
Mi'kmaw Home Energy Efficiency Project		-	-	1.00
Affordable Multifamily Housing		-	-	1.00
New Home Construction		24%	16%	0.92
BNI				
Business Energy Rebates – Mail-in Rebates		26%	0%	0.74
Business Energy Rebates – Instant Rebates	LED Linear Fixtures	40%	-	0.60
	LED Outdoor Fixtures	35%		0.65
	LED Linear Lamps	30%		0.70
	Other Measures	-		1.00
Custom	Custom Retrofit	Retrofit Projects	0%	0.84
		OEM Demand Savings Projects	0%	1.00
	New Construction		0%	0.85
	Building Optimization		0%	0.91
Energy Management Information Systems		-	-	1.00
Strategic Energy Management		-	-	1.00
Small Business Energy Solutions	Audit Path	12%	0%	0.88
	DIY Path	15%		0.85
	Commercial Direct Install Pilot	-	-	1.00

^a For Appliance Retirement, the Evaluator complied with Uniform Methods Project guidelines and no free-ridership level was calculated.

^b Net-to-gross ratios were determined based on the results of past evaluations.

3.3 Lifetime Energy Savings

The Evaluator reviewed the effective useful life values for measures offered by EOne and their associated lifetime energy savings. The Evaluator found that the DSM portfolio generated 1,548.786 GWh in lifetime energy savings. As presented in Table 9 below, the weighted average EUL of measures offered in the EOne portfolio is 14.2 years. Program components with measures affecting building envelopes, such as insulation, generate significant lifetime savings due to the persistence of these types of measures. For example, New Home Construction has an average EUL of 30.5 years and, while this program component accounts for 5% of annual net energy savings, it generates 11% of portfolio lifetime energy savings. Similarly, Home Energy Assessment has an average EUL of 20.8 years and, while it contributes to 3% of annual energy savings, it generates 5% of lifetime energy savings. Program components composed of mainly lighting measures, such as Instant Savings and Efficient Product Installation, generate lower lifetime energy savings compared to annual savings due to the shorter equivalent EUL of these types of products.

Table 9: 2021 Evaluated Net Lifetime Energy Savings at the Generator

DSM Program	Program Component	Annual Net Energy Savings (GWh)	Lifetime Net Energy Savings (GWh)	Weighted Average EUL (years)
Residential				
Residential Efficient Product Rebates	Appliance Retirement	2.474	9.925	4.0
	Instant Savings	14.314	121.022	8.4
Existing Residential	Home Energy Assessment	3.481	72.399	20.8
	Green Heat	6.795	122.306	18.0
	Efficient Product Installation	7.812	65.165	8.3
	Mi'kmaw Home Energy Efficiency Project	0.316	6.633	21.0
	Affordable Multifamily Housing	0.402	7.117	17.7
New Residential	New Home Construction	5.683	173.548	30.5
Residential Subtotal		41.276	578.116	14.0
BNI				
Efficient Product Rebates	Business Energy Rebates	33.491	488.237	14.6
Custom Incentives	Custom	23.293	337.282	14.5
	Energy Management Information Systems	0.027	0.053	2.0
	Strategic Energy Management	1.845	10.402	5.6
Direct Installation	Small Business Energy Solutions	9.486	134.696	14.2
BNI Subtotal		68.142	970.670	14.2
Portfolio Total		109.418	1,548.786	14.2
* Numbers may not add up due to rounding.				

3.4 Greenhouse Gas Emission Reductions

The Evaluator established the reduced GHG emissions due to the DSM portfolio at 63,911 tonnes of CO₂ eq in terms of annually avoided GHG emissions. Table 10 below presents the GHG emission reductions of each program component in 2021 as well as those for the portfolio total.

Table 10: 2021 Evaluated Avoided GHG Emissions

DSM Program	Program Component	Avoided GHG Emissions in CO ₂ eq Tonnes	Evaluated Results (GWh)
Residential			
Residential Efficient Product Rebates	Appliance Retirement	1,445	2.474
	Instant Savings	8,361	14.314
Existing Residential	Home Energy Assessment	2,033	3.481
	Green Heat	3,969	6.795
	Efficient Product Installation	4,563	7.812
	Mi'kmaw Home Energy Efficiency Project	184	0.316
	Affordable Multifamily Housing	235	0.402
New Residential	New Home Construction	3,320	5.683
Residential Subtotal		24,110	41.276
BNI			
Efficient Product Rebates	Business Energy Rebates	19,562	33.491
Custom Incentives	Custom	13,605	23.293
	Energy Management Information Systems	16	0.027
	Strategic Energy Management	1,078	1.845
Direct Installation	Small Business Energy Solutions	5,541	9.486
BNI Subtotal		39,801	68.142
Portfolio Total		63,911	109.418
* Numbers may not add up due to rounding.			

4 DSM PORTFOLIO PERFORMANCE

This section presents a comparison of evaluated savings with EOne planned savings at the program and component levels. It also addresses satisfaction results, annual savings performance, as well as the historical performance and contribution of individual program components to portfolio savings.

In 2021, the performance of the DSM portfolio was affected by the public health guidelines associated with the COVID-19 pandemic. From April 28 to June 1, 2021, EOne suspended in-home visits, assessments, and business audits. Although these activities were suspended, EOne continued to operate its programs during that time with some modifications. As a result of the suspension of activities and other constraints due to COVID-19 (e.g. project delays, supply chain challenges), EOne energy and peak demand savings were negatively impacted.

4.1 Participant and Partner Satisfaction

The 2021 evaluation revealed very high participant satisfaction with EOne and its programs. Green Heat, Business Energy Rebates – Mail-in and Small Business Energy Solutions all received participant satisfaction average scores of nine or higher. Participants of several program components (EPI, BER-IR, MER-MI, and SBES) provided consistently high scores for the service they received from program partners. The Evaluator interviewed program partners for two program components. Program partners were generally satisfied with Instant Savings and Business Energy Rebates – Mail-in. Table 11 presents the 2021 average participant and partner satisfaction scores for program components where this metric was measured.

Table 11: 2021 Satisfaction Results

DSM Program	Program Component	Participant Satisfaction	Partner Satisfaction
Residential			
Residential Efficient Product Rebates	Instant Savings	-	8.0
Existing Residential	Green Heat	9.0	-
	Efficient Product Installation	8.7	-
BNI			
Efficient Product Rebates	Business Energy Rebates - Mail-in	9.1	-
	Business Energy Rebates - Instant Rebates	8.9	8.0
Custom Incentives	Custom - Retrofit	8.4	-
	Custom - New Construction	8.0	-
	Custom - Building Optimization	8.5	-
Direct Installation	Small Business Energy Solutions	9.1	-

The average participant satisfaction scores for all program components were 8.0 or higher on a 10-point scale.

4.2 Annual Savings Performance by Program Component

Table 12 presents the EOne planned savings,¹¹ evaluated results, and the variance between them.

Table 12: 2021 Planned Savings and Evaluated Results

Program Component and DSM Program	Planned Savings		Evaluated Results*		Variance	
	GWh	MW	GWh	MW	GWh (%)	MW (%)
Residential						
Residential Efficient Product Rebates	13.012	1.654	16.788	1.987	29%	20%
Appliance Retirement	2.408	0.414	2.474	0.357	3%	-14%
Instant Savings	10.604	1.240	14.314	1.629	35%	31%
Existing Residential	24.266	11.163	18.806	9.378	-23%	-16%
Home Energy Assessment	5.529	2.481	3.481	1.495	-37%	-40%
Green Heat	5.561	5.685	6.795	6.451	22%	13%
Efficient Product Installation	10.698	2.067	7.812	1.098	-27%	-47%
Mi'kmaw Home Energy Efficiency Project	0.956	0.517	0.316	0.147	-67%	-71%
Affordable Multifamily Housing	1.521	0.413	0.402	0.186	-74%	-55%
New Residential	5.338	2.377	5.683	2.285	6%	-4%
New Home Construction	5.338	2.377	5.683	2.285	6%	-4%
Residential Subtotal	42.615	15.195	41.276	13.649	-3%	-10%
BNI						
Efficient Product Rebates	35.681	7.236	33.491	5.401	-6%	-25%
Business Energy Rebates	35.681	7.236	33.491	5.401	-6%	-25%
Custom Incentives	33.610	8.476	25.165	6.390	-25%	-25%
Custom	30.310	8.166	23.293	6.105	-23%	-25%
Energy Management Information Systems	0.300	0.000	0.027	0.003	-91%	-
Strategic Energy Management	3.000	0.310	1.845	0.282	-39%	-9%
Direct Installation	9.600	2.274	9.486	2.045	-1%	-10%
Small Business Energy Solutions	9.600	2.274	9.486	2.045	-1%	-10%
BNI Subtotal	78.891	17.985	68.142	13.835	-14%	-23%
Portfolio Total	121.506	33.180	109.418	27.484	-10%	-17%
* Numbers may not add up due to rounding.						

¹¹ EfficiencyOne's 2021Q3 Demand Side Management (DSM) Report (M10363) at page 5, Table 1: 2021 Year-End Forecast by Program, 2021 Mid-Course Adjustment [filed November 25, 2021].

The EOne portfolio of DSM program components achieved 109.418 GWh in total net energy savings and 27.484 MW in peak demand savings at the generator, representing 10% lower savings than the planned energy savings and 17% lower savings than planned peak demand savings for 2021. The Residential Efficient Product Rebates program exceeded its planned energy and peak demand values in 2021 (by 29% and 20% respectively), and New Residential exceeded its planned energy savings by 6%, just missing its peak energy savings values by 4%. Direct Installation came close to attaining both target values and Efficient Product Rebates also almost reached its planned energy savings targets, but was 25% below its planned peak savings target. Existing Residential and Custom Incentives fell short.

Residential programs achieved 41.276 GWh in net energy savings and 13.649 MW in net peak demand savings at the generator. Residential energy savings were 3% lower than planned due to lower than expected savings in Existing Residential (-23%). Both Residential Efficient Products and New Residential exceeded targets (29% and 6% respectively). Residential peak demand savings were 10% below the planned values because of shortfalls in Existing Residential (-16%) and New Residential (-4%) and despite Residential Efficient Product Rebates (20%) exceeding the planned values. Results by residential program component are as follows:

- › Driven by increases in participation, Appliance Retirement slightly surpassed its 2021 energy savings targets and achieved 17% more savings than in 2020. While it did not achieve its 2021 peak demand savings targets, these savings were 16% higher than in 2020.
- › Instant Savings, which represents the largest share of residential energy savings (35%), maintained a high level of participation in 2021. The program component surpassed its energy savings target by 35% and its peak demand savings target by 31%. Gross savings from lighting products decreased by 9%, while savings from other products increased by 76%.
- › Participation in Home Energy Assessment was 8% lower in 2021 than in 2020, and both net energy savings and net peak demand savings decreased by 9% and 18% respectively. Consequently, energy and peak demand savings targets were not met.
- › With 3,654 measures installed, the 2021 participation level was the highest ever observed for Green Heat, and the component increased its energy and peak demand savings by 26% and 36% respectively compared to 2020, surpassing its targets by 22% and 13% respectively.
- › Participation increases in Efficient Product Installation resulted in a 15% increase in the number of products installed compared to 2020, however the program fell short of its targets as energy savings per participant continues to decline.
- › While both the energy and peak demand savings for the Mi'kmaw Home Energy Efficiency Project component increased significantly compared to 2020, in-home activities were temporarily suspended in response to the COVID-19 pandemic, which caused the program to largely miss its 2021 targets. The pandemic continued to cause some project delays that negatively impacted participation levels, and some communities remained closed even when the service was not suspended.

- › Affordable Multifamily Housing achieved its highest level of participation since its launch in 2018, largely driven by an increase in prescriptive projects. That said, both electrical energy and peak demand savings fell well short of targets.
- › New Home Construction achieved its energy savings target in 2021, but just missed its peak demand savings target. Participation levels were 8% lower in 2021 compared to 2020, leading to 3% lower net energy savings and 5% lower peak demand savings.

EOne BNI programs achieved 68.142 GWh in net energy savings and 13.835 MW in peak demand savings at the generator in 2021, falling short of planned energy savings by 14% and peak demand savings by 23%. Efficient Product Rebates and Custom Incentives missed energy savings targets by 6% and 25% respectively; Direct Installation missed the target by only 1%. Results by BNI program component are as follows:

- › Business Energy Rebates did not achieve the energy and peak demand savings targets set for 2021, falling short by 6% and 25% respectively. While energy savings were comparable to those in 2020, peak demand savings were 5% lower. This program component continues to represent the largest share of overall BNI savings (49%). Although Mail-in participation recorded a similar level of participation when compared to 2020, savings decreased in 2021. The number of products sold under Instant Rebates increased by 18% helping to bolster savings for this program component in 2021.
- › For Custom, participation, energy savings, and peak demand savings increased by 180%, 31%, and 152% respectively compared to 2020. That said, targets, which were higher than in previous years, were not attained.
- › EMIS net energy savings did not reach target levels due to low participation. Participation levels and savings have been steadily decreasing since program inception in 2015.
- › Participation in Strategic Energy Management remained consistent with the participation level of the past three years. Peak demand savings increased by 17% compared to 2020, while energy savings decreased by 13%. The program component fell short of both its energy and peak demand savings targets.
- › Despite a 77% increase in participation over 2020, when the COVID-19 pandemic significantly impacted participation levels, Small Business Energy Solutions did not meet its net energy nor its peak savings targets in 2021, although energy and peak demand savings were respectively 75% and 83% higher than in 2020.

4.3 Historical Portfolio Analysis

This subsection presents year-over-year program performance and the contribution of individual program components to portfolio savings. Table 13 and Table 14 below provide a historical overview of component performance and changes in DSM portfolio composition from 2017 to 2021.

Table 13: Evaluated Net Energy Savings at the Generator, 2017-2021

DSM Program	Program Component	Energy Savings (GWh)					Energy Savings (%)				
		2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
Residential											
Residential Efficient Product Rebates	Appliance Retirement	3.094	2.657	2.545	2.111	2.474	2%	2%	2%	2%	2%
	Instant Savings	19.543	21.93	13.148	10.533	14.314	15%	14%	11%	11%	13%
Existing Residential	Home Energy Assessment	7.007	5.724	5.455	3.823	3.481	5%	4%	4%	4%	3%
	Green Heat	2.98	4.227	5.196	5.407	6.795	2%	3%	4%	6%	6%
	Efficient Product Installation ^a	17.88	12.78	11.96	7.402	7.812	14%	8%	10%	8%	7%
	Mi'kmaw Home Energy Efficiency Project	--	--	0.284	0.088	0.316	--	--	0%	0%	0%
	Affordable Multifamily Housing	--	--	0.255	0.676	0.402	--	--	0%	1%	0%
New Residential	New Home Construction	3.371	4.515	5.214	5.867	5.683	3%	3%	4%	6%	5%
Residential Subtotal		53.872	51.831	43.798	35.908	41.276	41%	34%	35%	38%	38%
BNI											
Efficient Product Rebates	Business Energy Rebates	46.583	75.298	48.012	33.687	33.491	36%	50%	39%	35%	31%
Custom Incentives	Custom ^b	21.005	11.603	19.281	17.790	23.293	16%	8%	15%	19%	21%
	Energy Management Information Systems	1.402	1.616	0.322	0.605	0.027	1%	1%	0%	1%	0%
	Strategic Energy Management	--	1.455	1.949	2.120	1.845	-	1%	2%	2%	2%
Direct Installation	Small Business Energy Solutions	7.887	9.589	10.934	5.415	9.486	6%	6%	9%	6%	9%
BNI Subtotal		76.877	99.562	80.754	59.616	68.142	59%	66%	65%	62%	62%
Portfolio Total		130.749	151.393	124.552	95.524	109.418	100%	100%	100%	100%	100%
a Rental Properties and Condos and Residential Direct Install were combined into Efficient Product Installation as of 2017. b Custom includes Custom Retrofit, Custom New Construction, and Existing Building Commissioning. * Numbers may not add up due to rounding.											

Table 14: Evaluated Net Peak Demand Savings at the Generator, 2017-2021

DSM Program	Program Component	Peak Demand Savings (MW)					Peak Demand Savings (%)				
		2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
Residential											
Residential Efficient Product Rebates	Appliance Retirement	0.443	0.378	0.382	0.309	0.357	2%	1%	2%	1%	1%
	Instant Savings	2.558	2.572	0.842	1.206	1.629	11%	10%	4%	6%	6%
Existing Residential	Home Energy Assessment	1.981	1.6	1.599	1.823	1.495	8%	6%	7%	9%	5%
	Green Heat	3.073	4.042	4.438	4.741	6.451	13%	16%	19%	22%	23%
	Efficient Product Installation ^a	2.129	1.463	1.505	1.007	1.098	9%	6%	7%	5%	4%
	Mi'kmaw Home Energy Efficiency Project	--	--	0.084	0.026	0.147	--	--	0%	0%	1%
	Affordable Multifamily Housing	--	--	0.076	0.181	0.186	--	--	0%	1%	1%
New Residential	New Home Construction	0.954	1.278	1.545	2.397	2.285	4%	5%	7%	11%	8%
Residential Subtotal		11.138	11.333	10.396	11.689	13.649	47%	44%	46%	55%	50%
BNI											
Efficient Product Rebates	Business Energy Rebates	7.286	11.327	7.742	5.711	5.401	31%	44%	34%	27%	20%
Custom Incentives	Custom ^b	3.637	1.2	2.071	2.427	6.105	15%	5%	9%	11%	22%
	Energy Management Information Systems	0.255	0.051	0.039	0.000	0.003	1%	0%	0%	0%	0%
	Strategic Energy Management	--	0.19	0.099	0.241	0.282	-	19%	0%	1%	1%
Direct Installation	Small Business Energy Solutions	1.363	1.441	2.37	1.120	2.045	6%	6%	10%	5%	7%
BNI Subtotal		12.541	14.209	12.396	9.500	13.835	53%	56%	54%	45%	50%
Portfolio Total		23.679	25.542	22.793	21.189	27.484	100%	100%	100%	100%	100%
a Rental Properties and Condos and Residential Direct Install were combined into Efficient Product Installation as of 2017. b Custom includes Custom Retrofit, Custom New Construction, and Existing Building Commissioning. * Numbers may not add up due to rounding.											

In 2021, EOne achieved a total of 109.418 GWh in net energy savings and 27.484 MW in net peak demand savings at the generator. These values represent increases compared to 2020: the residential and BNI programs respectively experienced a 15% and a 5% increase in energy savings, and a 17% and a 7% increase in peak demand savings.

In 2021, the residential sector accounted for 38% of energy savings and the BNI sector accounted for 62% of energy savings. The share of BNI sector energy savings appears to have been trending downwards since a high point in 2018. Compared to 2020, the share of lighting in the overall portfolio savings remained stable at 43%.

EOne began to put a greater focus on achieving peak demand savings in 2020 with, for instance, the introduction of selected measures targeted specifically at achieving peak demand savings in certain program components. In 2021, the program components that generated the largest shares of peak demand savings are Green Heat (23%), Custom (22%), Business Energy Rebates (20%) and New Home Construction (8%).

5 MARKET EVOLUTION

In 2021, the Evaluator again analyzed market indicators and monitored three distinct measures in three program components to identify when program component offerings should be adapted. These components and measures were:

- › Instant Savings: Residential LED lamps and fixtures
- › Business Energy Rebates: Commercial LED lamps and fixtures
- › Green Heat: MSHPs

Market data such as measured free-ridership, market share, and prices were analyzed to determine if observed trends persisted over time and to glean insights on the current state of market transformation for these products in Nova Scotia.

Instant Savings: LED Lamps and Fixtures

EOne has been active in the LED market since 2011 through Instant Savings. Electro-federation Canada (Electrofed) data available up to the year 2020 were used to estimate residential lighting market sales and shares in Atlantic Canada. While overall residential lamp shipments have been decreasing since 2017, LED lamp shipments continued to grow in 2020, representing 62% of the market. CFLs have an ever-decreasing share with 5% reported in 2019¹². The movement of the market toward LEDs and away from other technologies, including CFLs, echoes trends in the U.S. market.

LED shipments of non-A-type/BR/R lamps grew proportionally more than A-type lamps in 2020 compared to 2019, although for now A-types still have the largest share of LED shipments (66% in 2020). Some large retailers mentioned stock disruptions and lack of product availability as outcomes of the pandemic. Their 2021 sales experiences are varied, with both increases and decreases being noted (depending on levels of foot traffic and extent of supply issues). Retailers primarily forecast that 2022 LED lamp sales will be consistent with those in 2021, barring any further COVID-19-related supply chain disruptions.

Turning to the residential/commercial fixture market, the volume of fixture shipments (including LED fixtures) decreased by 25% between 2019 and 2020. On the other hand, shares of LED fixtures continued to increase and represented almost the entirety of integrated fixture shipments reported by Electrofed in 2020. As is the case for LED lamps, retailers predict 2022 sales will be similar to those in 2021, barring any further COVID-19-related supply chain disruptions.

¹² Electro-Federation Canada data for CFLs were unavailable for 2020.

LED lamps and fixtures continue to have a strong and growing presence in the Nova Scotia market. The market evolution analysis suggests that LED non-A-type lamps continue to be in a sustained growth phase, approaching maturity, with some growth in sales, and shipments growing faster than A-type lamps, which are considered a mature market. LED fixtures are similarly in a sustained growth phase, although less information specific to the residential market was available for this product. Retailer feedback on both markets were mixed, between those that believe that the products are still in growth phases and those that believe that sales are close to levelling off.

Business Energy Rebates: LED Lamps and Fixtures

To establish key market indicators and understand the state of the Nova Scotia BNI LED lighting market, the Evaluator analyzed ElectroFed commercial and industrial market data for lamps and fixtures available for 2018 to 2020 as well as BER tracking sheets.

Total commercial and industrial lamp shipments in Atlantic Canada decreased by almost half (- 46%) between 2018 and 2020. This includes a drop in LED lamp shipments (-53%). The share of LED linear lamps declined by 17 percentage points between 2016 and 2020 (from 62% to 45%), likely due to the gradual replacement of ballast fixtures (housing fluorescent tubes) as they fail by integrated LEDs. The average retail price of LED linear lamps has stabilized.

Despite decreasing industrial fixture (including LED fixture) shipments, which dropped by 39% between 2018 and 2020, the share of LED fixtures continued to grow, representing almost the entirety (92%) of the total fixture shipments reported by Electro-Fed in 2020. This trend was also reflected in the increase in free-ridership for LED fixtures in 2021 compared to 2020. Distributors perceive more market potential for LED fixtures than for LED lamps, particularly due to more efficient models becoming available over time and a larger variety of styles and features. The average retail price and rebate value for LED linear fixtures appear to be stabilizing.

The market evolution analysis suggests that the LED fixture category is beginning to approach the maturity phase. However, as suggested by increasing LED fixture shares and distributors' opinions on the increasing sales and efficiency of these products, there is still some growth potential. For LED lamps, the category appears to have reached maturity and is now in a levelling-off phase as inferred by the decline in shipment shares, price stability and customer preference for integrated lamps.

Green Heat: Mini-split Heat Pumps

Key sources of information for the market evolution assessment were heat pump data and assumptions included in the 2020 and 2021 NS Power load forecast and associated regulatory filings. In addition, the Evaluator completed in-depth interviews with five MSHP distributors in Nova Scotia. NS Power predicted a relatively flat market for MSHPs in 2020 and 2021 and estimated that 35% of households in Nova Scotia would use a heat pump for some or all of their heating requirements in 2021. Distributors report increased sales of MSHPs in 2021, with homeowners choosing to invest more in home improvement than in other areas during the pandemic, and they believe that sales will continue to increase in 2022.

The annual number of incented MSHP systems has increased by 8% and 7% in 2020 and 2021 respectively. The Evaluator also estimated that, in 2020 and 2021 respectively 48% and 52% of incremental MSHPs installed in existing Nova Scotia homes received an incentive from EOne through either Green Heat or HEA. These results are similar to the 2019 proportion of 55%.

The 2021 evaluation results suggest that the MSHP market is in a sustained growth phase as there is still strong consumer interest and sales potential in MSHPs moving forward.

6 EVALUATION RESEARCH SUMMARY

6.1 Market Transformation and Codes and Standards

The literature review was first aimed at defining MT: “The strategic process of intervening in a market to create lasting change in market behaviour by removing identified barriers or exploiting opportunities to accelerate the adoption of all cost-effective energy efficiency as a matter of standard practice.”¹³

MT programs are becoming more attractive to certain program administrators for two main reasons. First, as baseline products become increasingly energy efficient, incremental energy savings decrease, thereby challenging the cost-effectiveness of traditional incentive-based programs. Second, the savings achievable through RA might not be sufficient to attain ambitious energy efficiency targets or at least, might not be the most effective way to influence market-level changes.

The MT programs administered by the selected jurisdictions covered various technologies from consumer goods such as lighting to complex building systems. Building code programs that target either compliance or new code development are especially common. The Evaluator found various examples of new construction MT programs that included activities such as capacity building through training and tool development, support to code enforcement, and development of marketing tools. The design of market interventions in this sector can therefore be based on proven initiatives.

Several jurisdictions were found to be implementing C&S programs. The Evaluator analyzed the relation between C&S programs and MT programs and found two likely scenarios. MT programs either focus on C&S adoption or enhanced compliance as their main end goal or include C&S as one of many elements in their strategy. This implies that all C&S programs are a form of MT program and, based on the literature review, should be designed and evaluated as such. However, the jurisdictional review showed that C&S programs may be supported by regulators who do not support an MT framework, due to their narrower scope and more predictable and shorter-term savings.

The experience from other jurisdictions indicates that MT programs are becoming increasingly accepted as a cost-effective way to reach larger markets and achieve energy savings. While jurisdictions that claim savings from MT use well-established methodologies, a key challenge in claiming savings from MT programs is establishing an evaluation framework that will satisfy regulatory requirements, which is a consideration for EOne that, until now, has focused their DSM Plans on RA programs only. The jurisdictional scan served to establish that the regulator and stakeholders’ support is key in establishing such an evaluation framework.

¹³ NEEA, *NEEA 2020–2024 Strategic and Business Plan*, 2018, available at <<https://neea.org/img/documents/NEEA-2020-2024-Strategic-and-Business-Plans.pdf>>

In the Evaluator's opinion, if EOne considers recognizing savings from MT programs, the next step in EOne's process related to MT programs would be to conduct a preliminary assessment of potential markets for MT programs. This assessment would involve identifying markets where one or multiple positive factors are present, such as having some market-level interventions already in place, an upcoming technology for which adoption can be increased, or synergy with other regional and national efforts. The size of Nova Scotia may not allow EOne to have a significant impact on some markets that are driven by larger provinces and states, especially where energy efficiency regulations are under federal jurisdiction and the development of new technologies and distribution of certain goods occur through national channels. However, there may be markets where the main barriers are local (e.g. trained workforce, availability of products through local retailers). The new construction market should be a priority for such an assessment, targeting two programs (New Home Construction and New Construction) for which EOne has been in the market for several years, but where the potential for savings is dwindling due to increasingly stringent codes and standard building practices. With the adoption of building codes being under provincial jurisdiction, this is a market that is within EOne's range of influence.

In conducting the preliminary assessment, EOne should consider the following potential paths:

- › Focus on building code programs only: As demonstrated in this report, some jurisdictions claim savings from code development and compliance initiatives despite not recognizing MT frameworks. Although it would still require some work before developing the program, this approach may find easier acceptance from regulators and stakeholders. This approach could have the advantage of providing a proving ground for MT programs. Conversely, it could prevent EOne from implementing other MT programs outside of building codes, at least as long as the second approach below is not adopted.
- › Establish a broader MT framework that allows multiple types of programs: Considering that interest in MT programs is increasing rapidly, it may be preferable to develop an MT framework that would allow MT initiatives for any markets wherein potential has been identified.

6.2 Evaluation Approaches for Event-based Demand Response Pilots

The 2021-2022 winter peak period is the first time EOne will have a demand response pilot implemented, piloting a domestic hot water demand response pilot as well as a demand response aggregator pilot. In terms of the evaluation for these demand-response initiatives, it was determined that EOne delivers programs in a unique regulatory context, as described below:

- 1 EOne is responsible via its programs to make available a defined amount of DR capacity for NSP to deploy on the grid as needed.
- 2 NSP determines the timing and number of peak events.
- 3 Peak demand reductions achieved through DR programs and energy efficiency programs are treated as equivalent in value.

Given this context, Econoler recommends that EOne:

- 1 Apply ex-ante evaluation approaches to quantify and validate the DR capacity that EOne programs will make available to the grid operator.
- 2 Refine ex-ante estimation with ex-post evaluation.

This evaluation approach will enable EOne to claim DR savings based on the evaluated ex-ante estimates of DR capacity that EOne programs make available to the grid operator. Econoler believes that ex-ante estimation of DR capacity informed by ex-post analysis in the initial two years of the event-based DR initiatives will provide assurances of demand savings available to NSP at a cost and rigour commensurate with the evaluation methodology applied to the balance of the energy efficiency portfolio. In the Evaluator's view, this approach would remain appropriate until peak demand reductions are assigned a value distinct from the avoided cost assigned to other peak demand savings in EOne's portfolio, at which point more complex and rigorous real-time ex-post evaluation methodologies may be more appropriate.

This research will inform evaluation activities for these initiatives to be undertaken as part of the 2022 Evaluation Plan.

CONCLUSION AND RECOMMENDATIONS

Overall savings achieved in 2021 were below target levels, with the residential portfolio coming closer to meeting targets than the BNI portfolio. The Evaluator made a cross-cutting recommendation in the 2020 evaluation to monitor program performance as the response to the COVID-19 pandemic evolves thus allowing it to continue making adjustments to programs as needed. EOne made a number of adjustments to adapt to the COVID-19 pandemic, including increasing incentives and marketing, altering the service offer, adding pilots and measures, and providing recruitment support in select programs and measures. This had some success, with a number of program components – Appliance Retirement, Instant Savings, and Small Business Energy Solutions – getting back to pre-pandemic savings. However, there continues to be lags in performance for other programs, where shut-downs had more of an impact on participation or where customers may be slower to respond due to project lag times. Further, market evolution work completed this year also highlighted the potential for supply issues to impact certain measures going forward. EOne should continue to monitor program performance for impacts from COVID-19.

The Evaluator did not make any cross-cutting recommendations in 2021. Evaluator recommendations on individual program components are outlined in individual reports as well as in Table 15 and Table 16 below.

Table 15: 2021 Recommendations on Residential Program Components

No.	Recommendation
Instant Savings – R1	Update the LED lamp and fixture baselines in the 2020-2022 Measure Assessment to reflect updates to regulations, the growing presence of LEDs in the market as well as the decreased market share of CFLs. The Evaluator currently applies a baseline for LED lamp and fixtures to establish their equivalent EUL values that are used to obtain lifetime savings. The current baseline uses a CFL equivalent for 2024 to the end of product life. This baseline should be updated to reflect market trends; given CFL market shares are becoming very small, it is highly likely that the upcoming U.S. regulation banning halogen lamps will effectively results in a complete shift to LEDs.
HEA – R1	Update and simplify the tracking sheet in time for next year's evaluation to minimize risks of calculation errors. For instance, columns could be reorganized to follow the calculations steps from gross savings at meter to net savings at generator in that order. Also, formulas could be simplified by using named variables instead of cell references, and information that is no longer relevant to the calculations could be removed. This should be done alongside the integration of the Canada Greener Homes Grant data and before the conversion into the new data management system.

**Table 16: 2021 Recommendations on Business, Non-profit,
and Institutional Program Components**

No.	Recommendation
BER – R1	The Evaluator recommends that EOne consider changes to the lighting measure worksheet to improve the accuracy of tracked parameters, notably the fields used to collect information on the hours of use, peak coincidence factors, and heating systems. The Evaluator provides examples of the types of changes recommended in Subsection 5.2.1 of 2021 BER Evaluation Report.
Custom – R1	For Retrofit and Building Optimization, on a priority basis review, improve and deploy M&V processes, savings calculation protocols, service requirements, as well as documentation and associated supporting materials to align these with best practices for custom programs. EOne should work on a priority basis to increase service requirements relating to the level of detail, quality, and accessibility of service documentation as well as internal review processes and practices related to M&V. These include M&V methods to capture energy and demand savings. Ideally, this recommendation would be actioned and implemented early in 2022 to the benefit of 2022 Custom participants.
OEM – R1	If operational demand programs are offered in the future, leverage pilot findings to deploy improved M&V and savings calculation protocol reviews. As for Retrofit and Building Optimization, detailed M&V guidance will be required to support this demand-focussed program. This guidance should be developed to include information about common demand response M&V methods that measure demand in the hours before the peak window and that compare results to those during the window. In addition, the guidance should be updated to include: › Information about M&V requirements and methods that capture the full effects of any load-shifting projects that may be submitted. › An emphasis on the fact that reductions must be well outside the margin of error of the M&V methodologies. This will be particularly important for any whole building approaches but could also be applicable to sub-metered approaches. › This guidance should be produced and published to make program materials accessible to participants. Where required, simple capability development strategies could be deployed, such as online workshops.
Retrofit – R1	Consider expanding the use of this type of structured pay-for-performance approach and encouraging larger return participants in Retrofit, Building Optimization, and Operational Demand Savings to participate in this offering. Custom Retrofit, Building Optimization, and Operational Demand Savings Participants may be considered in two groups: one-time participants with unique projects and returning participants applying multiple times for an ongoing stream of projects. For the latter group, it may make sense to consider an encompassing pay-for-performance approach. As seen in the 2021 evaluation results, this approach could potentially improve M&V practices, reduce adjustments, and reduce free-ridership while maintaining very high satisfaction levels and reducing administrative requirements for certain participants.

No.	Recommendation
Retrofit – R2	Develop and implement a process to identify project types more suited to quasi-prescriptive approaches (including solar PV, compressed air leaks, and possibly others such as domestic water booster pumps), and explicitly distinguish these project types from traditional custom projects within the Custom service. This should include developing appropriate protocols, documentation, and allowances for reviews of underlying savings determination methodologies as part of the annual evaluation plan. EOne should work with the Evaluator to determine savings methodologies, parameters, M&V documentation, and applicant requirements for these project types. For solar PV and compressed air leak projects, these should be accomplished on a priority basis given the popularity of such projects in Retrofit.
New Construction – R1	Interview participants shortly after having signed the CPA. › To do so, EOne could identify participants who have signed a CPA at the end of every quarter and ask a third party to interview them. The third party should safeguard the answers until the project closes and then transfer results directly to the Evaluator to maintain the confidentiality of responses. › To increase the likelihood that the third party conducting the interviews will be able to reach key project decision-makers, EOne should provide a second contact, if available, from within the participant organization from the start. › Reasonable efforts should be invested in contacting the provided contacts via phone interviews. If unsuccessful, the third party should send a web survey to the contacts who have not been interviewed by phone. › If the provided contacts remain unreachable through the phone interview and web survey, the free-ridership questionnaire should be administered once the project is completed at the time of evaluation.
SEM – R1	Develop guidelines on the usage of bottom-up approaches in SEM and ensure they are consistent with program objectives. These guidelines should define the conditions under which a bottom-up approach can be used and how the results will be used for multi-year reporting. They should include M&V requirements that are consistent with those of similar Custom Retrofit projects. These guidelines should also cover how the bottom-up approach will fit into an integrated energy management strategy at facility level, so that the focus is not entirely on individual measures, but also on overall energy performance improvement since it is a key SEM objective.

LIST OF APPENDICES

The following are presented in the 2021 DSM Programs Evaluation Executive Summary – Appendices document.

Appendix I: Bibliography

Appendix II: Calculation of Margins of Error

Appendix III: NTGR Calculations



2021 DSM PROGRAMS EVALUATION EXECUTIVE SUMMARY

EFFICIENCY

Appendix Report

March 17, 2022



NARRATIVE
RESEARCH



ANS DE SUCCÈS
YEARS OF SUCCESS



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TABLE OF CONTENTS

APPENDIX I BIBLIOGRAPHY	1
APPENDIX II CALCULATION OF MARGINS OF ERROR.....	11
APPENDIX III NTGR CALCULATIONS.....	16

APPENDIX I BIBLIOGRAPHY

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APPENDIX II

CALCULATION OF MARGINS OF ERROR

This appendix presents some examples of how the Evaluator established the margins of error for participant surveys, adjustment ratios, installation rates, and free-ridership levels. For participant survey margins of error, the example is drawn from the 2021 Green Heat evaluation. For the adjustment ratio margins of error, the example is drawn from the 2021 Business Energy Rebates (BER) Mail-in evaluation. No example specific to installation rates was included since the methodology is the same as the one for adjustment ratios. For the free-ridership level margins of error, the example is drawn from the 2021 Small Business Energy Solutions (SBES) evaluation.

Survey Margins of Error

The 2021 Green Heat survey margins of error were established by using the following formula, which corresponds to the margin of error calculation for a proportion (i.e. a value between 0% and 100%):

$$\text{Margin of Error } (e) = Z\alpha \times \sqrt{\frac{p \times (1 - p)}{n}} \times \sqrt{\frac{N - n}{N - 1}}$$

Where:

- › $Z\alpha$ is the coefficient used at a specific confidence level.
- › p is the proportion (typically established conservatively at 0.50, which yields the maximum error).
- › N is the population or, in this case, the total number of unique participants.
- › n is the sample size.

The sample size for this example is 140. Therefore, assuming a confidence level of 90%, a $Z\alpha$ coefficient of 1.645 is used, as presented in Table 1 below.

Table 1: Distribution of Coefficients t

Sample size	Confidence Level		
	95%	90%	80%
2	12.710	6.314	3.078
3	4.303	2.920	1.886
4	3.182	2.353	1.638
5	2.776	2.132	1.533
10	2.262	1.833	1.383
15	2.145	1.761	1.345
20	2.093	1.729	1.328
25	2.064	1.711	1.318
30	2.045	1.699	1.311
∞^*	1.960	1.645	1.282

* Coefficient z corresponds to the value of coefficient t for an infinite sample size and is used for samples larger than 30.

By using the formula presented above, and assuming a confidence level of 90%, a proportion of 0.50, and a total number of Instant Savings products equal to 3,186, the margin of error was established at 6.8%.

$$\text{Margin of Error} = 1.645 \times \sqrt{\frac{0.50 \times (1 - 0.50)}{140}} \times \sqrt{\frac{3,186 - 140}{3,186 - 1}} = 6.8\%$$

In 2021, this calculation was performed for all participant surveys.

Adjustment Ratio Margins of Error

Below is a description of the steps followed to calculate the margins of error for adjustment ratios applied to energy and peak demand savings, based on the example for energy savings from the 2021 BER Mail-in. The same calculation is used for installation rates, with the only difference being the use of installation rates instead of adjustment ratios in the equations.

Calculation of the Weighted Average of Adjustment Ratios

The weighted average was calculated by using the following formula and applying the adjustment ratios and tracked energy savings generated by Mail-in lighting measures:

$$\text{Weighted Average AR} = \frac{\sum_{i=1}^N \text{Adjustment Ratio}_i \times \text{Tracked Energy Savings}_i}{\text{Total Tracked Energy Savings}} = 0.993$$

In this calculation, N is the total number of evaluated projects (87) and i represents each individual project evaluated, the Evaluator established a weighted average adjustment ratio of 0.993.

Calculation of the Weighted Standard Deviation

Since the overall adjustment ratio is based on a weighted average, the Evaluator used the weighted standard deviation of the adjustment ratio for the calculation instead of the standard deviation. The following formula was used to calculate the weighted standard deviation.

Weighted Standard Deviation AR

$$= \sqrt{\frac{\sum_{i=1}^N \text{Tracked Energy Savings}_i \times (\text{Adjustment Ratio}_i - \text{Weighted Average AR})^2}{\frac{(N'-1) \sum_{i=1}^N \text{Tracked Energy Savings}_i}{N'}}} = 0.427$$

In this calculation, N represents the number of projects reviewed as part of the impact evaluation and N' represents the number of reviewed projects for which the tracked energy savings were higher than zero. In the case of BER Mail-in lighting projects, N is 87 and N' is 87. The weighted standard deviation for the adjustment ratio of energy savings for lighting measures was established at 0.427.

Calculation of the Margins of Error

The margins of error of the BER Mail-in lighting measures adjustment ratio were established by using the following formula that applies to samples drawn from a small population (defined as being less than 10 times the sample size):

$$\text{Margin of Error AR} = \frac{\text{Weighted Standard Deviation} \times t}{\sqrt{\frac{N(M-1)}{(M-N)}}} = \frac{0.427 \times 1.645}{\sqrt{\frac{87 \times (394-1)}{(394-87)}}} = \pm 6.7\%$$

In this calculation, M is the population size and the coefficient t was determined by using Table 1. Since N is larger than 30, the coefficient z was used instead of the coefficient t . By using the above formula and a population size of 394, the margin of error for the adjustment ratio applied to the energy savings generated by the BER Mail-in lighting measures was established at 6.7%.

In 2021, this calculation was performed for the savings adjustment ratios of BER Mail-in lighting measures. For other programs where an adjustment ratio was calculated in 2021, a census approach was used, meaning that all projects were reviewed. Therefore, calculating a margin of error on the adjustment ratio was unnecessary. This calculation was also used to establish Efficient Products Installation (EPI) installation rates.

Free-ridership Level Margin of Error

The Evaluator used the margin of error calculation of the free-ridership level for SBES do-it-yourself (DIY) path in 2021 as an example. Below are the steps followed to calculate this margin of error.

Calculation of the Weighted Average of Free-ridership Levels

The weighted average was calculated by using the following formula:

$$\text{Weighted Average FR} = \frac{\sum_{i=1}^N \text{Free-ridership Level}_i \times \text{Revised Gross Energy Savings}_i}{\text{Total Revised Gross Energy Savings}} = 15\%$$

In this calculation, N is the total number of surveyed participants who implemented energy efficiency measures and i represents each individual participant surveyed. The Evaluator established the weighted average free-ridership level at 15%.

Calculation of the Weighted Standard Deviation and Margin of Error

Since the free-ridership level is based on a weighted average, the Evaluator used the weighted standard deviation of the free-ridership for the calculation instead of the standard deviation. The following formula was used to calculate the weighted standard deviation.

Weighted Standard Deviation FR

$$= \sqrt{\frac{\sum_{i=1}^N \text{Revised Gross Energy Savings}_i \times (\text{Free-ridership}_i - \text{Weighted Average FR})^2}{\frac{(N'-1) \sum_{i=1}^N \text{Revised Gross Energy Savings}_i}{N'}}$$

$$\text{Margin of Error FR} = \frac{\text{Weighted Standard Deviation} \times t}{\sqrt{\frac{N(M-1)}{(M-N)}}$$

In this calculation, N is the sample size, N' represents the number of surveyed participants who had energy savings higher than zero, and M is the population size, while the coefficient t was determined by using Table 1 above.

Table 2 summarizes the calculation parameters and intermediary results used to establish the overall margin of error for the DIY path of the 2021 SBES evaluation.

Table 2: Summary of 2021 Margin of Error Calculation for SBES DIY Path

Parameter	Results
Population (M)	330
Sample Size (N)	49
Sampled Participants with Energy Savings Higher than Zero (N')	49
Coefficient t	1.68
Weighted Average Free-ridership	0.152
Weighted Standard Deviation on Free-ridership	0.165
Margin of Error on Free-ridership	0.037

The Weighted Standard Deviation FR equation was used for all program components whose free-ridership level was measured in 2021.

APPENDIX III NTGR CALCULATIONS

This appendix provides some examples to illustrate the Evaluator's calculations of free-ridership, participant spillover, and net-to-gross ratio values in the 2021 evaluation. To demonstrate how to apply the algorithm for calculating these values, this appendix provides an example from SBES, more specifically for lighting measures implemented through the do-it-yourself path. The Evaluator used a similar approach in assessing the free-ridership, participant spillover, and net-to-gross ratios of other program components. More details can be found in the evaluation reports of the individual program components. The following pages present screenshots of the attached Excel document.

NTGR Calculations



Appendix_NTGR_Fina
l.xlsx

How to open the Excel file in
Word, double click on the icon.

SBES NTGR

Free-ridership algorithm		Low Free-ridership Participant		High Free-ridership Participant		Average Free-ridership Participant	
Questions	Calculation Algorithm	Answer	Calc. Result	Answer	Calc. Result	Answer	Calc. Result
D3orD4. If your business had not received the rebate or the financing from ENS, would you have paid for the full cost of the lighting upgrades? (Scale 0 to 10)	D3orD4 = Answer x 10%	1	10%	10	100%	5	50%
	IF DK OR REF: D3orD4 = EMPTY						
D5. Were you aware that the lighting products rebated through the SBES program are premium products certified by Design Light Consortium or ENERGY STAR®?	IF 1. Yes: Use D6	1	0%	1	100%	2	0%
	IF 2. No OR DK OR REF: D6 = 0%						
D6. If there was no program rebate or financing, what is the likelihood that you would have installed the exact same model of lighting products? (Scale 0 to 10)	D6 =Answer x 10%	0		10		10	
	IF DK OR REF: D6 = EMPTY						
PA1 Score:	MEAN VALUE OF: (D3orD4; D6)	5%		100%		50%	
D1. Had your business already decided to install the energy-efficient lighting upgrades before learning about SBES?	IF 1. Yes: Use D2	2	0%	2	0%	2	0%
	IF 2. No OR DK OR REF: D1 = 0%						
D2. [IF D1=1] Just to confirm: before you learned about the SBES program and the rebates offered through the program, you had already made the decision to install the energy-efficient lighting upgrades?	IF 1. Yes: D1 = 100%	N/A		N/A		N/A	
	IF 2. No OR DK OR REF: D1 = 0%						
PA2 Score:	D1	0%		0%		0%	
D9. Level of influence– 5 factors (Scale 0 to 10)	D9 = MAX(a; b; c; d; e)	8	80%	0	0%	8	80%
PA3 Score:	(10 – D9) x 10%	20%		100%		20%	
D7. [IF TOTAL LIGHTING QTY >1] If there was no program rebate or financing, what is the likelihood that you would have installed exactly the same number of lighting products that you installed through the program? (Scale 0 to 10)	D7 = Answer x 10%	0	0%	10	100%	6	60%
	IF DK OR REF: D7 = EMPTY						
D8. [ASK IF D3 or D4 ≥5] If there was no program rebate or financing, what is the likelihood that you would have postponed installing the lighting upgrades by at least one year? (Scale 0 to 10)	D8 = (10 – Answer) x 10%	N/A		0	100%	4	60%
	IF DK OR REF: D7 = EMPTY						
PA4 Score:	Min (D7; D8)	0%		100%		60%	
Inconsistency Test PA1	IF ABS(D3orD4 – D6) ≥ 50% PA1 = MIN(D3orD4; D6)	5%		100%		50%	
Inconsistency Test PA2	IF D2 = 100% AND D3orD4 < 70%: PA2 = EMPTY	0%		0%		0%	
Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)	6%		67%		23%	
E2/E6. [Your business' previous participation in an ENS program] / [The promotion of energy efficiency carried out by ENS] was a major factor in your business' decision to install energy efficient upgrades in your facility.	IF(E2 OR E6 = Agree; 1) +	1	2	1	2	1	2
E3. Because of your business' previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, you had asked your contractor/distributor about different energy efficiency options before participating in SBES.	IF(E3 OR E7 = Agree; 1) +	0		0		0	
E7. The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to consider installing energy efficiency measures in your facility before participating in SBES.							
E4/E8. [Because of your business' previous participation in an ENS program and what was learned by participating in that program, you took] / [The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take] into account the cost-effectiveness of energy efficient upgrades when evaluating different options for the facility.	IF(E4 OR E8 = Agree; 1)	1		1		1	
Revised Free-Ridership	IF CI = 0 OR 1: Revised FR = FR IF CI = 2; Revised FR = FR*.75 IF CI = 3: Revised FR = FR*.50	5%		50%		18%	



Overall free-ridership level (%)
for the program component

$$FR = \frac{\sum_{i=1}^n (FR_i \times Gross\_Savings_i)}{\sum_{i=1}^n Gross\_Savings_i}$$

FR= 15%

Overall spillover level (%)
for the program component

$$SO_{total} = \frac{\sum_{i=1}^n SO\_Savings_i}{\sum_{i=1}^n Gross\_Savings_i}$$

SO_{total}= 0%

NTGR calculation

$$NTGR = 1 - FR_{total} + SO_{total}$$

NTGR= 85%



RESIDENTIAL EFFICIENT PRODUCT REBATES PROGRAM 2021 DSM EVALUATION

EFFICIENCYONE

Final Report

March 10, 2022



NARRATIVE
RESEARCH



ANS DE SUCCÈS
YEARS OF SUCCESS

ABBREVIATIONS

ARet	Appliance Retirement
BNI	Business, non-profit and institutional
DA	Delivery agent
DOE	Department of Energy
DSM	Demand-side management
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
EUL	Effective useful life
GHG	Greenhouse gas
LED	Light emitting diode
MA	Measure Assessment
MHEEP	Mi'kmaw Home Energy Efficiency Project
NS Power	Nova Scotia Power
NSUARB	Nova Scotia Utility and Review Board
NTGR	Net-to-gross ratio
RUL	Remaining useful life
SKU	Stock keeping unit
UARB	Utility and Review Board
UMP	Uniform Methods Project

DEFINITIONS

Accuracy	Reflects the proximity of measurements to the true value.
Adjustment ratio	The ratio of evaluated results to tracked results. This ratio expresses the adjustment made to tracked savings or other tracked values such as effective useful life.
Baseline	To determine gross savings, a baseline (or base case) is established providing detailed information about the reference (e.g. pre-existing or standard) measure or equipment chosen to be compared with the efficient measure or equipment. For the reference measure or equipment, the baseline may include such information as the hours of operation, wattage and the base consumption.
Bias	Systematic deviations of measurements from the true value.
Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
Displaced wattage	The displaced wattage is defined as the difference between the wattage values of the baseline equipment or product and the efficient equipment or product.
EnerGuide rating	An EnerGuide (official brand of Natural Resources Canada) rating is a standard measure of the home's energy performance. It is a measure of the efficiency of the building only and does not take into account occupant behaviour. It shows how energy efficient the home is through modelled heat losses of the home, based on several factors including building envelope characteristics, heated volume, heating systems and air leakage.
Effective useful life	The period a measure is expected to be in service and provide both energy and peak demand savings. This value combines the equipment life and the measure persistence, which includes factors such as business turnover or early retirement.
Equipment life	The number of years installed equipment will operate before it fails.
Equivalent CO ₂	A unit of measurement indicating the amount of carbon dioxide to which various kinds of emitted greenhouse gases are equivalent in terms of warming effects. In this report, the gases' global-warming potential is estimated over a timescale of 100 years.
Equivalent effective useful life	The number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. This value takes into account variations in annual energy savings throughout the effective useful life due to increased baselines.

Evaluated savings	Gross and net energy or peak demand savings calculated by the Evaluator using the parameters (unitary savings values, installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process. Unless otherwise specified, the evaluated savings are the first-year savings.
Evaluation plan	The evaluation plan summarizes the program description, objectives, base cases, documentation, evaluation methodology, budget and schedule.
First-year savings	The first full year of energy or peak demand savings generated by an energy efficiency measure.
Free-ridership	Percentage of gross savings attributable to participants who would have implemented the same or similar energy efficiency measures, with no change in timing, in the absence of the program.
Gross savings	Change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated.
Induced consumption	Energy consumption of appliances that would have been unplugged and not replaced by participants in the absence of the program.
Interactive effects	Effects on the energy consumption of other systems in the building (such as heating and cooling) due to the installation of an energy efficiency measure.
Participant spillover	Savings attributable to participants who continue to implement the energy efficiency measure introduced by a program after participating in it once, without participating in the program a second time.
In-service rate	The proportion of incentivized products that are installed and operating. This rate is usually applied to programs through which rebates are offered in-store and products are likely to be stored for a certain period before being installed, such as LED lamps.
Installation rate	The proportion of incentivized products reported as installed that remain installed and operating at the time of evaluation. This rate is usually applied to direct install or mail-in rebate programs through which measures are expected to be installed immediately at the time of participation.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for a measure's effective useful life and any increase in the baseline efficiency level (which reduces attributable annual savings) over its lifetime.
Line loss factor	The multiplier to convert savings at the customer meter to savings at the utility generator. It accounts for the electrical losses of the transmission and distribution system.
Margin of error	The amount of random sampling error.
Market effects	The impact of the program on the market (such as increased product availability, practices, and prices) that extends beyond changing the program participants' behaviour. This includes spillover among non-participants.

Net savings	Energy or peak demand savings that can be reliably attributed to a program. This includes effects, such as free-ridership and spillover, that negatively or positively affect the savings attributable to a program.
Net-to-gross ratio	The ratio of net energy savings to gross energy savings.
Non-sampling error	Errors arising during the course of all survey activities other than sampling. Non-sampling errors tend to lead to bias in measurements and are very difficult to quantify.
Peak coincidence factor	The percentage of measure demand savings that coincide in time with the annual peak demand of the entire electricity system.
Peak demand savings	The demand savings that coincide in time with the expected annual peak demand period of the entire electricity system.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	The error in measurement due to the fact that measurements are taken from a subset of the population and not the entire population.
Realization rate	The ratio of evaluated savings to tracked savings.
Sample size	The number of observations or replicates included in a statistical sample.
Secondary market impacts	Energy consumption of appliances that would have been transferred to the secondary market if said appliances had not been retired.
Tracked savings	Gross and net savings calculated based on various parameters such as number of participants or units installed or sold, unitary savings values, installation rates, interactive effects, and the net-to-gross ratio. Those parameters, with the exception of the number of participants or units installed or sold, are obtained from the previous evaluation.
Unitary savings	Energy or peak demand savings established on a unitary basis. This unit can either be a product (e.g., an 8 W LED lamp), a capacity (e.g., one-ton capacity of an air-source heat pump) or a participant (e.g., one participant taking part in a behaviour-based program).

TABLE OF CONTENTS

EXECUTIVE SUMMARY	X
Evaluation Approach.....	X
Program Performance.....	X
ARet Findings and Recommendations	xi
Instant Savings Findings and Recommendations	xiv
INTRODUCTION	1
1 ARET OVERVIEW.....	2
1.1 AREt Description	2
1.2 Follow-up on Past Evaluation Report Recommendations	3
1.3 Participation History.....	4
2 ARET EVALUATION APPROACH.....	6
3 ARET IMPACT EVALUATION	8
3.1 Tracking Sheet Audit.....	8
3.2 Gross Savings	8
3.2.1 Unitary Energy Savings.....	8
3.2.2 Unitary Peak Demand Savings	9
3.2.3 Interactive Effects	10
3.2.4 Effective Useful Life	11
3.2.5 Evaluated Gross Savings.....	12
3.3 Net Savings.....	16
3.3.1 Free-ridership and Secondary Market Impacts.....	16
3.3.2 Participant Spillover	17
3.3.3 Net-to-gross Ratio Calculation	17
3.3.4 Evaluated Net Savings.....	18
3.4 Realization Rate.....	21
4 ARET KEY FINDINGS AND RECOMMENDATIONS	22
5 INSTANT SAVINGS OVERVIEW	23
5.1 Instant Savings Description.....	23
5.2 Follow-up on Past Evaluation Report Recommendations	25
5.3 Participation History.....	25
6 INSTANT SAVINGS EVALUATION APPROACH	28

7	INSTANT SAVINGS PARTICIPANT AND PARTNER PERSPECTIVES	32
7.1	Participant Perspectives	32
7.2	Partner Perspectives	33
7.2.1	Satisfaction with Instant Savings	33
7.2.2	Influence of Instant Savings	34
8	INSTANT SAVINGS IMPACT EVALUATION.....	37
8.1	Tracking Sheet Audit.....	37
8.2	Gross Savings	37
8.2.1	Installation Rates	37
8.2.2	Unitary Energy Savings.....	37
8.2.3	Unitary Peak Demand Savings	39
8.2.4	Interactive Effects	41
8.2.5	Effective Useful Life	42
8.2.6	Evaluated Gross Savings.....	44
8.3	Net Savings.....	50
8.3.1	Free-ridership.....	50
8.3.2	Spillover	53
8.3.3	Net-to-gross Ratio Calculation	54
8.3.4	Evaluated Net Savings.....	54
8.4	Realization Rate.....	59
9	INSTANT SAVINGS MARKET EVOLUTION.....	61
9.1	Market Indicators – LED Lamps.....	61
9.1.1	Market Shares of Lamp Technologies in Atlantic Canada	61
9.1.2	LED Lamps Rebated by Instant Savings	63
9.1.3	Replacement Behaviour	64
9.1.4	Instant Savings Participating Retailer Outlook	65
9.1.5	LED Lamp Prices	65
9.1.6	Measured Free-ridership – LED Lamps	67
9.2	Market Indicators – LED Fixtures	67
9.2.1	Market Shares of Lighting Fixtures in Atlantic Canada.....	67
9.2.2	LED Fixtures Rebated by Instant Savings.....	69
9.2.3	Instant Savings Participating Retailer Outlook	70
9.2.4	LED Fixture Prices	70
9.2.5	Measured Free-ridership – LED Fixtures.....	71
9.3	Codes and Standards.....	72

9.4	Market Evolution Summary.....	73
10	INSTANT SAVINGS KEY FINDINGS AND RECOMMENDATIONS.....	76
	CONCLUSION.....	79

LIST OF TABLES

Table 1:	Summary of 2021 Residential Efficient Product Rebates Program Evaluation.....	x
Table 2:	Overall 2021 Residential Efficient Product Rebates Participation and Evaluated Savings	xi
Table 3:	Comparison of 2021 ARet Tracked and Evaluated Savings at the Generator.....	xiii
Table 4:	2021 Instant Savings, Free-ridership, Spillover, and Net-to-gross Ratios	xvi
Table 5:	Comparison of 2021 Instant Savings Tracked and Evaluated Savings at the Generator	xviii
Table 6:	Types of Evaluations Conducted for Each Program Component, 2021	1
Table 7:	Implementation Status of Past Recommendations for ARet	4
Table 8:	2021 ARet Evaluation Approach	6
Table 9:	2021 ARet Tracked and Evaluated Unitary Energy Savings.....	9
Table 10:	2021 ARet Tracked and Evaluated Unitary Peak Demand Savings.....	10
Table 11:	2021 ARet Equivalent Effective Useful Life Values.....	12
Table 12:	Evaluated 2021 ARet Gross Energy and Peak Demand Savings	13
Table 13:	2021 ARet Free-ridership and Secondary Market Impacts	16
Table 14:	2021 ARet Effects and NTGR	17
Table 15:	Evaluated 2021 ARet Net Energy and Peak Demand Savings	19
Table 16:	Evaluated 2021 ARet GHG Emission Reductions	21
Table 17:	Comparison of 2021 ARet Tracked and Evaluated Savings at the Generator.....	21
Table 18:	List of 2021 Rebates by Product.....	24
Table 19:	Implementation Status of Past Recommendations for Instant Savings	25
Table 20:	Number of Rebated Products Sold Through Instant Savings, 2020-2021	26
Table 21:	2021 Instant Savings Evaluation Approach	29
Table 22:	Retailer Satisfaction with Instant Savings, 2018-2021	33
Table 23:	Influence of Instant Savings on LED Lamps, 2018-2021	35
Table 24:	Influence of Instant Savings on LED Fixtures, 2019-2021	36
Table 25:	2021 Instant Savings Tracked and Evaluated Unitary Energy Savings.....	38
Table 26:	2021 Instant Savings Tracked and Evaluated Unitary Peak Demand Savings	40
Table 27:	2021 Instant Savings Interactive Effects Factors for Lighting Products.....	41
Table 28:	2021 Instant Savings Equivalent EUL Values.....	43
Table 29:	Evaluated 2021 Instant Savings Gross Energy and Peak Demand Savings.....	45
Table 30:	2021 Instant Savings Free-ridership Levels for Non-Costco Participants.....	51
Table 31 :	2019 Instant Savings Free-ridership Levels for Costco Participants	52
Table 32 :	2021 Instant Savings Free-ridership Levels for LED Lamps and Fixtures.....	52
Table 33:	2021 Instant Savings Free-ridership.....	53
Table 34:	2021 Instant Savings Spillover Levels	54
Table 35:	2021 Instant Savings Net-to-gross Ratios	54
Table 36:	Evaluated 2021 Instant Savings Net Energy and Peak Demand Savings.....	56
Table 37:	Evaluated 2021 Instant Savings GHG Emission Reductions	59
Table 38:	Comparison of 2021 Instant Savings Tracked and Evaluated Savings at the Generator	59
Table 39:	EOne Rebated LED Lamp Replacement Intention, 2015-2021.....	64
Table 40:	Average LED Prices by Lamp Type, 2016-2021.....	66
Table 41:	Free-ridership Level for LED Lamps 2015-2021	67

Table 42: Average LED Prices by Fixture Type, 2017-2021	71
Table 43: Free-ridership Level for LED Fixtures 2019-2021	72
Table 44: Overview of 2021 Key Factors in Program Planning.....	74
Table 45: Overall 2021 Residential Efficient Product Rebates Participation Level and Evaluated Savings	79

LIST OF FIGURES

Figure 1: 2021 ARet Targets and Evaluated Results.....	xii
Figure 2: Overview of ARet Participation, 2012-2021	xii
Figure 3: Evolution of ARet Net Savings, 2012-2021	xiii
Figure 4: 2021 Instant Savings Targets and Evaluated Results	xiv
Figure 5: Instant Savings Performance Overview, 2015-2021.....	xv
Figure 6: ARet Participation Process Summary	2
Figure 7: Overview of ARet Participation, 2012-2021	5
Figure 8: Evolution of ARet Gross Savings, 2012-2021.....	5
Figure 9: 2021 Tracked and Evaluated Gross Energy Savings	15
Figure 10: 2021 Tracked and Evaluated Gross Peak Demand Savings	15
Figure 11: Overview of Participation in Instant Savings, 2015–2021	27
Figure 12: 2021 Instant Savings Tracked and Evaluated Gross Savings	48
Figure 13: 2021 Instant Savings Tracked and Evaluated Gross Peak Demand Savings	49
Figure 14: Atlantic Canada Consumer Lighting Shipments by Type of Technology, 2012-2020	62
Figure 15: Atlantic Canada Consumer LED Shipments by Lamp Type, 2012-2020.....	63
Figure 16: EOne Instant Savings Rebated LED Lamps, 2013-2021.....	64
Figure 17: Average LED Lamp Prices in Instant Savings (All Lamp Types), 2012-2021.....	66
Figure 18: Proportion of Fixture Shipments – LED vs. Non-LED, 2018-2020	68
Figure 19: Atlantic Canada Residential/Commercial LED Fixture Shipments by Type, 2018-2020	69
Figure 20: EOne Instant Savings Rebated LED Fixtures, 2017-2021.....	70
Figure 21: Average LED Fixture Prices in Instant Savings, 2017-2021	71
Figure 22: 2021 Residential Market Evolution for LED Lighting.....	75
Figure 23: 2021 Residential Efficient Product Rebates Program Targeted and Evaluated Net Energy Savings	80
Figure 24: 2021 Residential Efficient Product Rebates Program Targeted and Evaluated Net Peak Demand Savings.....	80

EXECUTIVE SUMMARY

This report presents the 2021 demand-side management (DSM) evaluation results of the Residential Efficient Product Rebates program administered by EfficiencyOne (EOne). This program is comprised of two components: (1) Appliance Retirement (ARet); and (2) Instant Savings.

Evaluation Approach

The evaluation was aimed at calculating program component gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided greenhouse gas (GHG) emissions. Table 1 summarizes the type of evaluation conducted for each program component and the corresponding methodology.

Table 1: Summary of 2021 Residential Efficient Product Rebates Program Evaluation

Program Component	Evaluation Type			Methodology
	Impact	Process	Market	
Appliance Retirement	Condensed			› Tracking sheet audit › Measure Assessment (MA) update › Calculations using evaluation results › Use of 2018 participant survey results › GHG emission reduction calculations
Instant Savings	Comprehensive		X	› Tracking sheet audit › Measure Assessment (MA) update and Unitary savings review › Calculations using evaluation results › Participant online survey › Retailer interviews › EUL update › GHG emission reduction calculations

Program Performance

Table 2 below presents the participation levels, NTGRs, as well as evaluated gross and net savings at the generator for each program component and for the Residential Efficient Product Rebates program as a whole.

Table 2: Overall 2021 Residential Efficient Product Rebates Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
ARet							
Energy Savings	5,859	Appliances	4.462	GWh	0.55	2.474	GWh
Lifetime Energy Savings			17.849	GWh	0.56	9.925	GWh
Peak Demand Savings			0.640	MW	0.56	0.357	MW
Instant Savings							
Energy Savings	201,175	Products sold	15.792	GWh	0.91	14.314	GWh
Lifetime Energy Savings			128.201	GWh	0.94	121.022	GWh
Peak Demand Savings			1.819	MW	0.90	1.629	MW
Total							
Energy Savings			20.254	GWh		16.788	GWh
Lifetime Energy Savings			146.050	GWh		130.948	GWh
Peak Demand Savings			2.460	MW		1.987	MW

Residential Efficient Product Rebates was aimed at achieving 13.012 GWh in net electrical energy savings and 1.654 MW in net peak demand savings at the generator for 2021. The program achieved 16.788 GWh in net electrical energy savings and 1.987 MW in net peak demand savings at the generator in 2021. The program exceeded the net electrical energy savings target by 29% and peak demand savings target by 20%, mostly driven by Instant Savings, which remains the largest contributor to both total program net energy and peak demand savings.

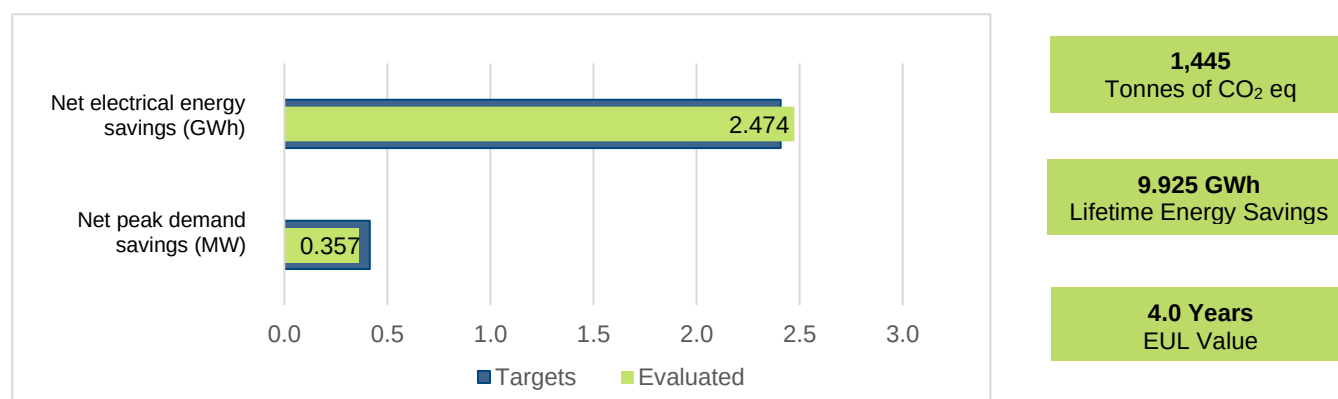
The following subsections present evaluation results at the program component level.

ARet Findings and Recommendations

This subsection presents the key findings and recommendations from the ARet evaluation.

2021 ARet-Finding: ARet achieved its net electrical energy savings targets but not its peak demand savings targets.

As outlined in Figure 1 below, ARet net electrical energy savings targets were exceeded by 2.7%, while net peak demand savings were 13.7% lower than the targets. The figure also presents the evaluated tonnes of CO₂ eq in annually avoided GHG emissions along with lifetime energy savings and the average EUL value.

Figure 1: 2021 ARet Targets and Evaluated Results


2021 ARet-Finding: ARet participation as well as energy and peak demand savings increased in 2021 partly because of the latent demand created by impacts from the COVID-19 pandemic in 2020, the expansion of public events in 2021, and the rebate increase for full-size appliances.

Figure 2 illustrates the evolution of ARet in terms of participation from 2012 to 2021, while Figure 3 further below illustrates the evolution of ARet net savings during the same period.

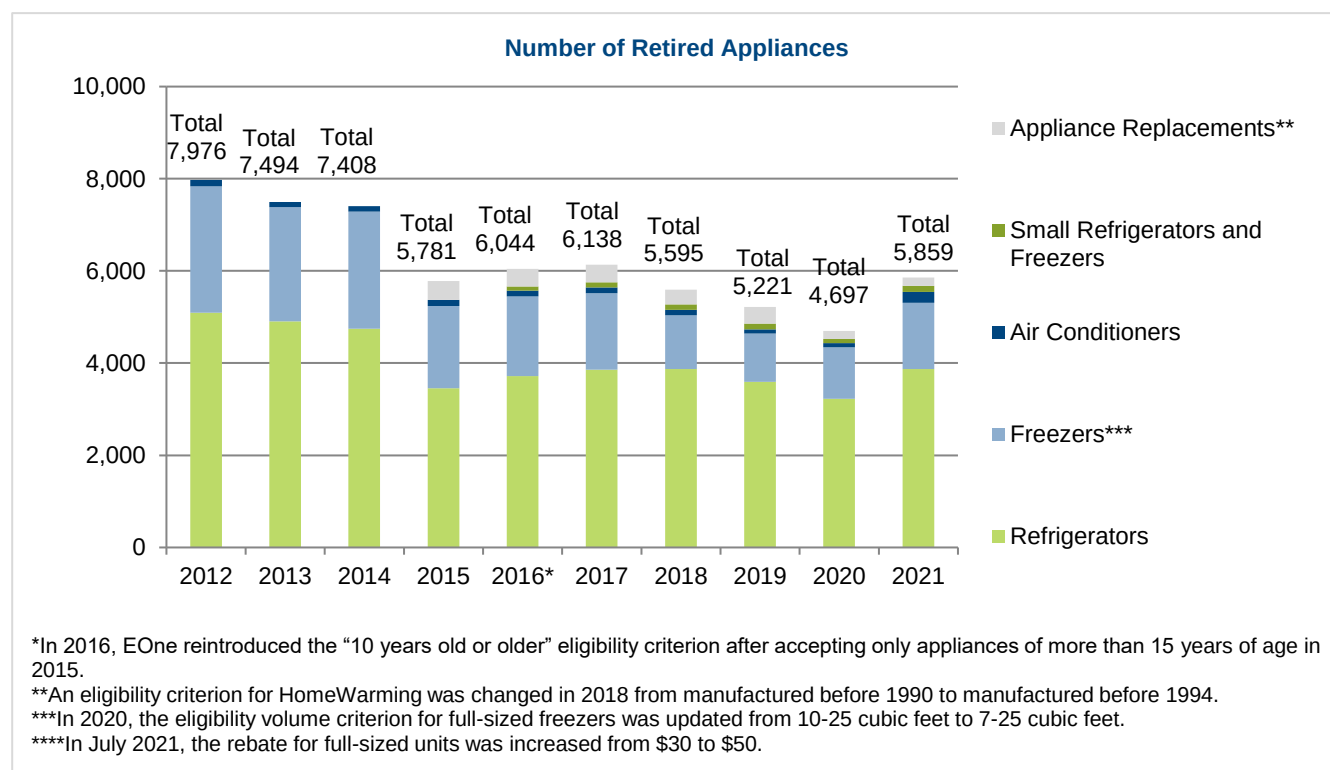
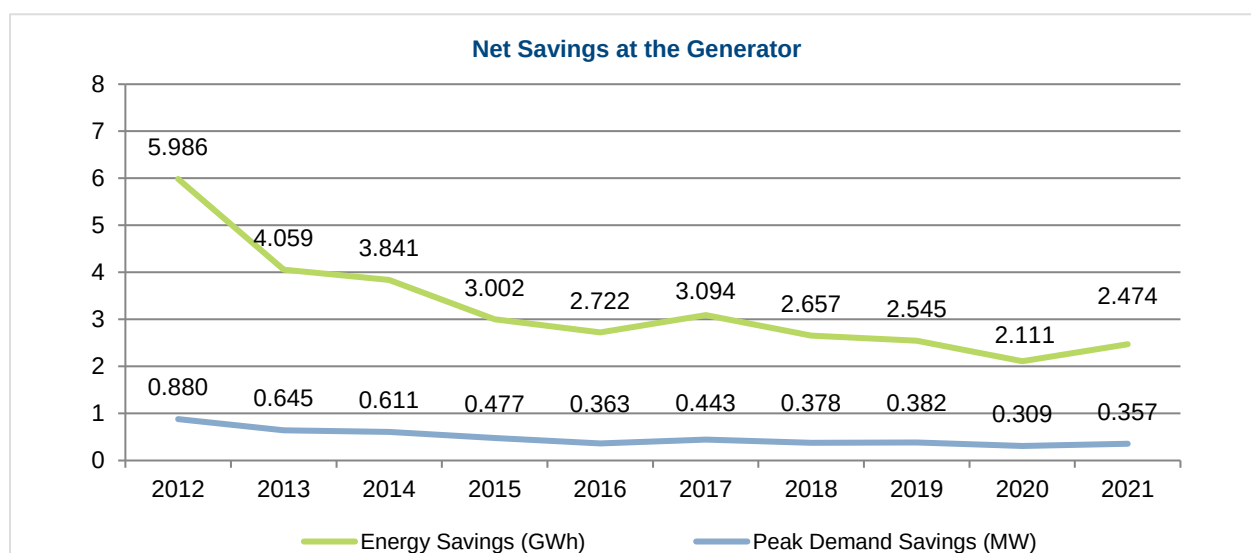
Figure 2: Overview of ARet Participation, 2012-2021


Figure 3: Evolution of ARet Net Savings, 2012-2021


2021 ARet-Finding: The differences between evaluated gross energy and peak demand savings determined by the Evaluator and the initial gross savings tracked by EOne are minimal.

Table 3 compares the tracked and evaluated results.

Table 3: Comparison of 2021 ARet Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	4.542	GWh	0.56	2.549	GWh	97%
Evaluation Results	4.462	GWh	0.55	2.474	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.652	MW	0.57	0.369	MW	97%
Evaluation Results	0.640	MW	0.56	0.357	MW	
*NTGRs vary for each type of appliance. The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by gross savings.						

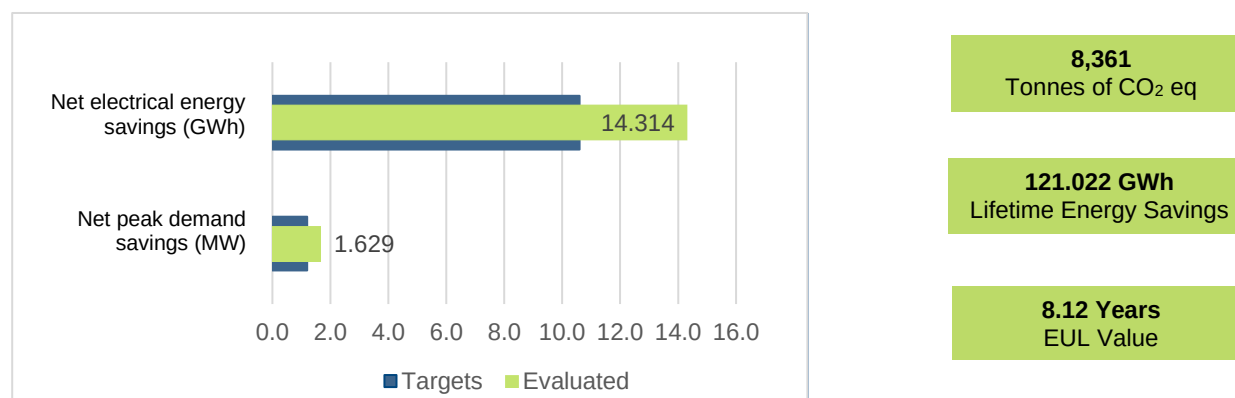
Instant Savings Findings and Recommendations

This subsection presents the key findings and recommendations from the Instant Savings evaluation.

2021 Instant Savings-Finding: Instant Savings net electrical energy savings and peak demand savings surpassed the targets.

As outlined in Figure 4 below, Instant Savings exceeded both net electrical energy target by 35% and peak demand savings target by 36%. The energy savings were over target largely due to increases in participation for products with high unitary savings, particularly from increases in the number of control products and appliances sold. The figure also includes the evaluated tonnes of CO² eq in annually avoided GHG emissions as well as lifetime energy savings and the EUL value.

Figure 4: 2021 Instant Savings Targets and Evaluated Results



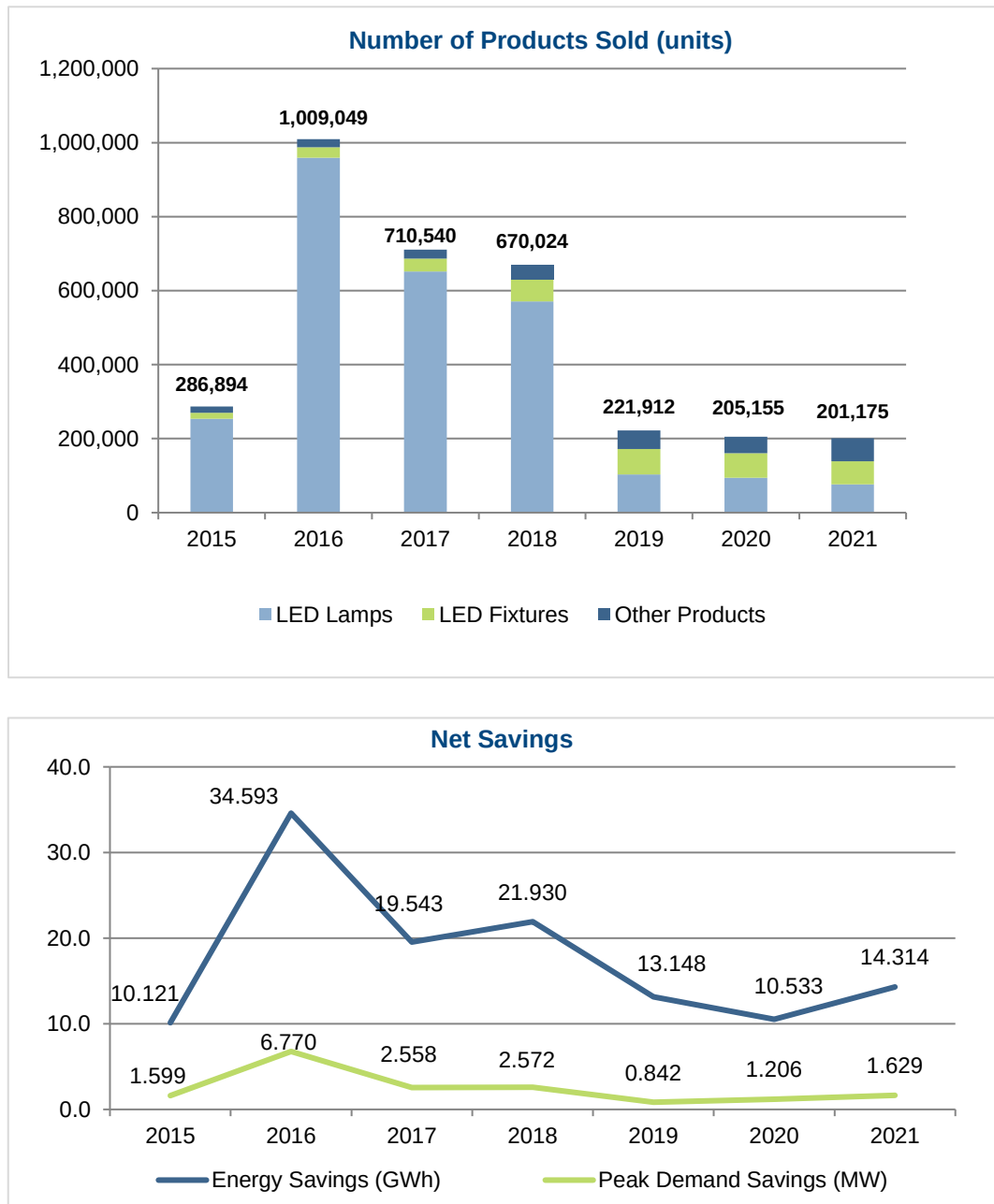
2021 Instant Savings-Finding: Instant Savings maintained a high participation level despite challenges from the COVID-19 pandemic, with a minimal decrease (2%) in overall products sold compared to 2020.

2021 Instant Savings-Finding: Efforts to diversify the program component led to strong gains in 2021, with non-lighting products providing the majority of gross savings. Gross savings from lighting products decreased by 9%, while savings from other products increased by 76% compared to 2020. Products other than lighting comprised 59% of gross energy savings, with ENERGY STAR® certified room air purifiers (17%), heavy-duty outdoor timers (14%), and programmable thermostats (7%) being the top drivers of non-lighting gross energy savings.

Figure 5 below illustrates the evolution of Instant Savings in terms of products sold as well as net energy and peak demand savings from 2015 to 2021.¹

¹ Rebates for ENERGY STAR certified LED A-types were removed in 2019 as part of EOne's exit strategy for this product, which explains the large decrease in the number of products sold from 2018 to 2019.

Figure 5: Instant Savings Performance Overview, 2015-2021



2021 Instant Savings-Finding: Retailers continue to be satisfied with Instant Savings overall and report moderate influence from the program component on consumer and staff knowledge as well as their stocking practices.

2021 Instant Savings-Finding: The free-ridership level for LED lamps increased significantly.

The free-ridership level for LED lamps was established at 64% compared to the 42% established in the 2020 evaluation. This result continues the increasing trend in free-ridership for LED lamps observed since 2019 and aligns with market evolution findings of continued and strong LED market growth in Atlantic Canada. As the online survey did not serve to collect sufficient responses from participants making purchases at Costco, 2021 results were combined with 2019 results from Costco participants for an overall free-ridership level of 46% for LED lamps.

2021 Instant Savings-Finding: The spillover for LED fixtures increased significantly.

Market effects were established at 32% for LED fixtures compared to 16% in 2020. This increase was driven by one large retailer that reported a sizable number of sales outside of the 2021 campaigns combined with attributing a relatively high influence to EOne's program, notably on the quantity of fixtures stocked in stores.

Table 4 summarizes the 2021 free-ridership, spillover, and net-to-gross ratios (NTGRs).

Table 4: 2021 Instant Savings, Free-ridership, Spillover, and Net-to-gross Ratios

Product Category	Free-ridership	Spillover	Net-to-gross Ratio
LED Lamps	46%	9%	0.63
LED Fixtures	41%	32%	0.91
All Other Products	-	-	1.00

2021 Instant Savings-Findings: LED lamps and fixtures represent the majority of new lighting shipments, thus compressing shares of other technologies, notably CFLs.

LED lamp shipments continued to grow and, based on Electrofed data, represented over 60% of Atlantic Canada consumer lamp shipments in 2020. CFLs made up an ever-decreasing share of the market with 5% of shipments in 2019. Shares of LED fixtures also continue to increase, and Electrofed data indicate that they represented almost the entirety of fixture shipments in 2020. The movement of the market toward LEDs and away from other technologies, including CFLs, echoes trends in the U.S. market.

2021 Instant Savings-Recommendation 1: Update the LED lamp and fixture baselines in the 2020-2022 Measure Assessment to reflect updates to regulations, the growing presence of LEDs in the market as well as the decreased market share of CFLs. The Evaluator currently applies a baseline for LED lamp and fixtures to establish their equivalent EUL values that are used to obtain lifetime savings. The current baseline uses a CFL equivalent for 2024 to the end of product life. This baseline should be updated to reflect market trends; given CFL market shares are becoming very small, it is highly likely that the upcoming U.S. regulation banning halogen lamps will effectively results in a complete shift to LEDs.

2021 Instant Savings-Findings: LED non-A-type lamps and fixtures are in a sustained growth phase, with LED non-A-type lamps being closer to maturity.

The market evolution analysis suggests that LED non-A-type lamps continue to be in a sustained growth phase and approaching maturity, with some growth in sales and shipments growing faster than A-type lamps that are considered a mature market. LED fixtures are similarly in a sustained growth phase, although less information specific to the residential market was available on this product.

2021 Instant Savings-Finding: The evaluated net energy and peak demand savings determined by the Evaluator are higher than the initial net savings tracked by EOne.

The evaluated net energy and peak demand savings are 4% higher than the values tracked by EOne. Those differences are mainly due to an increase in the spillover level and a decrease in the free-ridership level for LED fixtures, which resulted in a higher NTGR for this product category.

Table 5 compares the tracked and evaluated results.

Table 5: Comparison of 2021 Instant Savings Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	15.559	GWh	0.89	13.820	GWh	104%
Evaluation Results	15.792	GWh	0.91	14.314	GWh	
Peak Demand Savings						
Tracked Savings by EOne	1.790	MW	0.88	1.567	MW	104%
Evaluation Results	1.819	MW	0.90	1.629	MW	
*NTGRs varied for each type of product. The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by gross savings.						

INTRODUCTION

EfficiencyOne (EOne), an independent, non-profit organization, is responsible for helping Nova Scotians improve the energy efficiency of their homes and workplaces by designing, marketing, and delivering energy efficiency and conservation programs for Nova Scotians. EOne receives funding for its electricity demand-side management (DSM) activities from Nova Scotia Power (NS Power) ratepayers.

EOne has a DSM portfolio of three residential programs and three business, non-profit, and institutional (BNI) programs that are marketed to Nova Scotians through the Efficiency Nova Scotia (ENS) franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2021 DSM program portfolio. In addition, Econoler conducted research to inform EOne's approach to market transformation and treatment of codes and standards.

This evaluation report relates to the Residential Efficient Product Rebates program, which is comprised of two components: Appliance Retirement (ARet), and Instant Savings. Table 6 below lists the Residential Efficient Product Rebates program components and the types of evaluations conducted in 2021. A comprehensive impact evaluation involves reviewing the following four key elements: (1) the baseline definition; (2) the savings calculation methodology; (3) the values of the parameters used to calculate savings; and (4) net-to-gross ratios (NTGRs). A condensed impact evaluation involves using some or all of the previous year's impact evaluation parameters such as unitary savings values, adjustment ratios, installation rates, and NTGRs to provide evaluated results.

Table 6: Types of Evaluations Conducted for Each Program Component, 2021

Program	Program Component	2021		
		Process	Market	Impact
Residential Efficient Product Rebates	ARet			Condensed
	Instant Savings		X	Comprehensive

To carry out this evaluation, Econoler collaborated with Narrative Research. Econoler served as team leader and was involved in every aspect of the evaluation. Specifically, Econoler was in charge of coordinating and supervising all activities, conducting final reviews of all data-collection instruments, performing market evaluations and impact evaluation calculations, as well as preparing and reviewing evaluation reports. Narrative Research conducted interviews and surveys with participants and partners, as well as analyzed and reported on the data collected from those activities. Throughout this report, this team is referred to as the Evaluator.

Key findings, electrical first-year and lifetime energy savings, peak demand savings, and avoided greenhouse gas (GHG) emissions are presented in this report.

1 ARet OVERVIEW

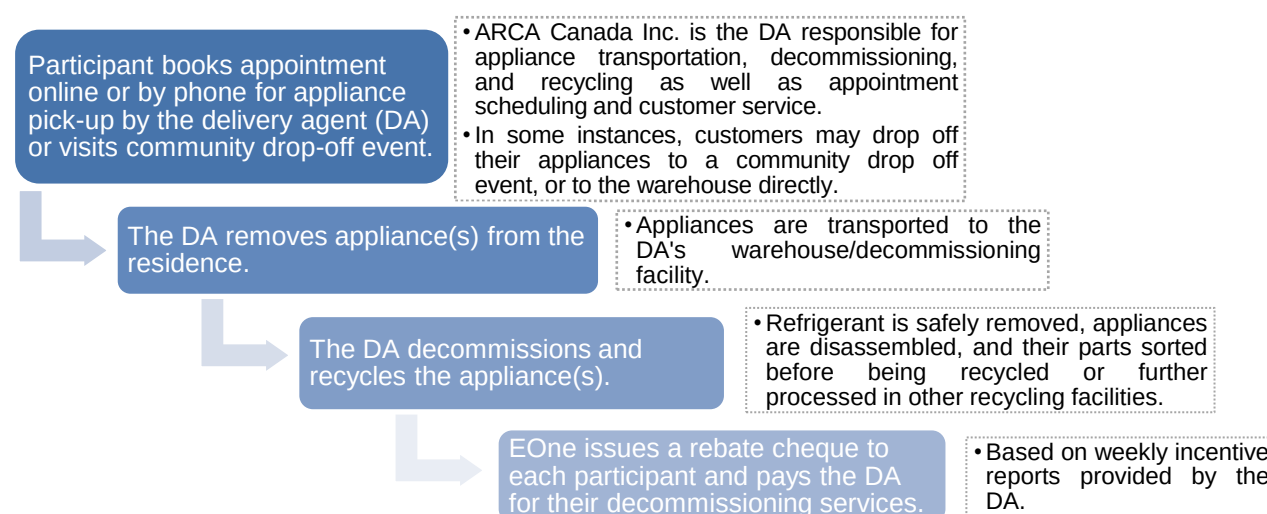
This section describes the ARet program component, follows up on past evaluation recommendations, and provides an overview of participation history.

1.1 ARet Description

Through ARet, EOne promotes the retirement of old, inefficient household appliances such as refrigerators, freezers, room air conditioners, dehumidifiers, and small refrigerators or freezers. ARet educates Nova Scotians about the cost of maintaining old and inefficient appliances, provides free appliance pick-ups from homes, delivers drop-off events in communities around the province, and offers a financial incentive for appliance retirements.

In addition to removing old appliances from participants' homes, ARet recycles the appliances by transporting them to a local recycling depot where over 95% of components are decommissioned and responsibly recycled. ARCA Canada Inc. is the delivery agent (DA) responsible for appliance transportation, decommissioning, and recycling. To have appliances picked up, participants must register by calling a toll-free number or register online using the booking portal available on the ENS website, both of which are managed by the DA. All website booking, scheduling, and maintenance activities are wholly the responsibility of the DA. Figure 6 outlines the main steps of the ARet participation process.

Figure 6: ARet Participation Process Summary



Eligible appliances must be in working condition and be 10 years of age or older. In 2021, this meant that eligible appliances had to be manufactured before 2011. In addition, full-sized refrigerators must have a standard size between 10 and 25 cubic feet, while full-sized freezers must be between seven and 25 cubic feet. For cost effectiveness, room air conditioners and small refrigerators and freezers are only picked up when a participant retires either one full-sized refrigerator or full-sized freezer at the same time. Also, dehumidifiers are only included as a drop-off appliance, either at a community event or at the warehouse directly. To participate in ARet, participants must own the appliance(s) to be retired.

The following rebates are offered through ARet:

- › \$30-\$50 for each retired full-sized refrigerator²
- › \$30-\$50 for each retired full-sized freezer
- › \$10 for each retired room air conditioner
- › \$10 for each retired small refrigerator or freezer
- › \$10 for each retired dehumidifier

In addition, replacements of inefficient dehumidifiers, refrigerators, freezers, and clothes dryers paid for by DSM funds under ARet are available to eligible participants of HomeWarming and the Mi'kmaw Home Energy Efficiency Project (MHEEP). Savings from these replacement services are claimed under ARet. HomeWarming and MHEEP provide energy efficiency upgrades at no cost to income-eligible owners and band-owned homes in Mi'kmaw communities respectively.

Due to public health and government directives regarding the COVID-19 pandemic, appliance replacement rates through HomeWarming and MHEEP continue to be slow. During the spring and in December 2021, appointments were limited to outdoor pick-ups for the safety of staff and customers. To increase participation, EOne hosted four community events in 2021 where participants could drop off old working appliances at a determined time and location within the community. Additionally, incentives for full-sized appliances were increased from \$30 to \$50 in July 2021 to increase participation.

ARet was aimed at achieving 2.41 GWh in net electricity energy savings and 0.414 MW in peak demand savings at the generator in 2021.

1.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated ARet in previous years and issued improvement recommendations. No major recommendations were made in 2020, and only one recommendation from 2018 remains under review. Table 7 provides a summary of the implementation status of the 2018 recommendation that has been carried forward.

² Incentives for full-size refrigerators and freezers were increased from \$30 to \$50 in July 2021 to increase participation.

Table 7: Implementation Status of Past Recommendations for ARet

#	Past Recommendations	Status	Comments
2018 ARet-R1	Continue to perform the metering activity and ensure the metering protocol is followed.	Deferred	EOne agrees with this recommendation although, due to facility restrictions, they were unable to perform a metering study in 2021. Results from 2017 metering activities were used for the 2021 evaluation because they comply with the Uniform Methods Protocol. EOne will continue to research for and develop a solution.

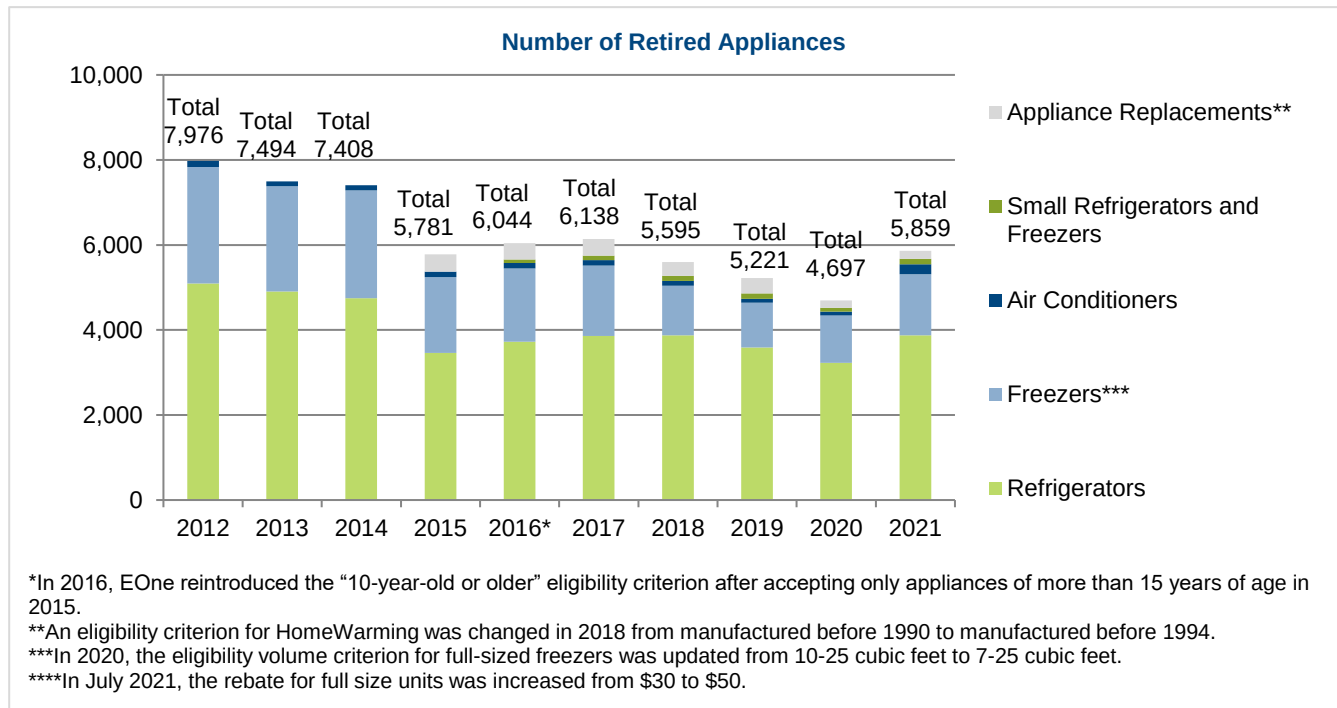
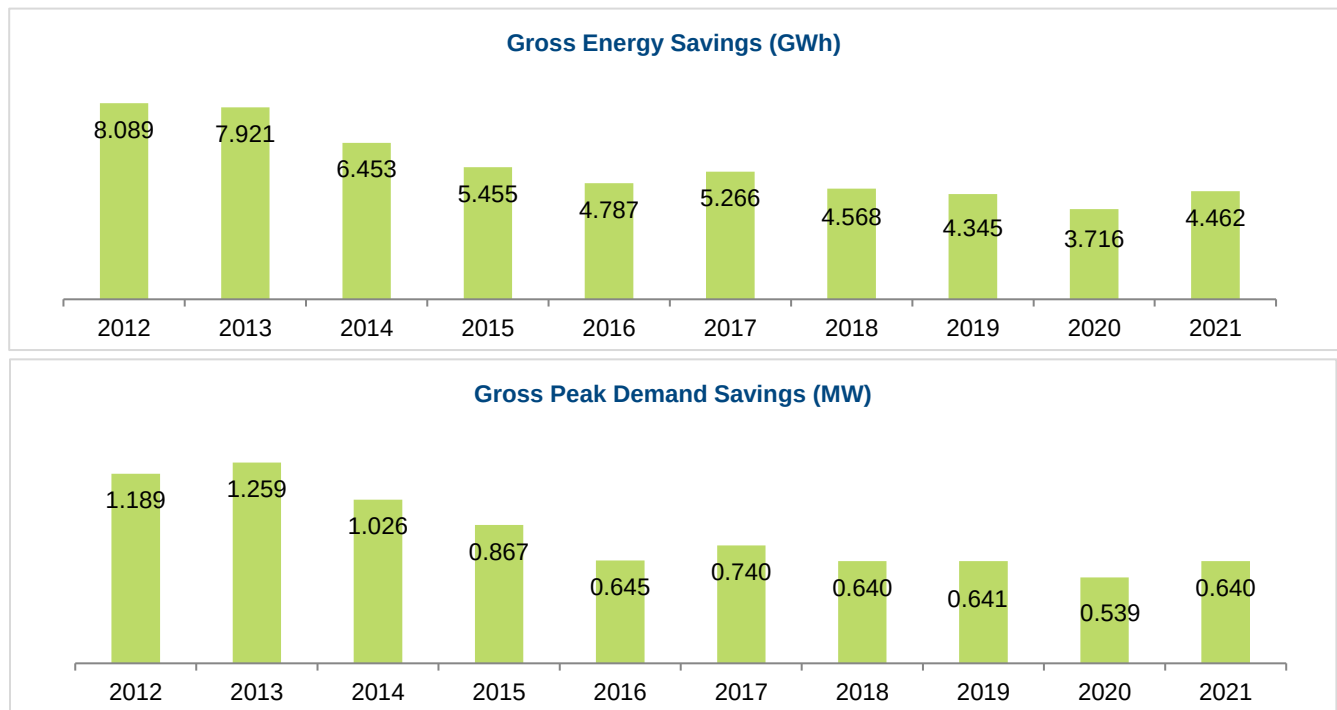
1.3 Participation History

Since 2012, ARet has retired or replaced a total of 62,213 old and inefficient appliances from homes and schools. These were recycled so that they could not be refurbished, sold second-hand, or left plugged in.

In 2021, 5,859 appliances were retired or replaced through ARet, HomeWarming, and MHEEP, as outlined in Figure 7 below. Specifically, 5,677 appliances were retired through ARet, for a total of 3,873 refrigerators, 1,437 freezers, 233 air conditioning units, and 134 small refrigerators or freezers. Additionally, 182 appliances were replaced through HomeWarming and MHEEP, for a total of 56 refrigerators, 90 freezers, and 36 dehumidifiers.

For the first time after three consecutive years of decreases, program participation increased. In 2021, 26% more appliance retirements and 5% more appliance replacements were recorded compared to 2020, for a combined 25% increase in participation. While participation returned to levels close to those before the COVID-19 pandemic, there was a slight increase compared to 2018-2019 levels, which could be explained by latent demand created by the pandemic in 2020, the expansion of public events where participants drop off their old appliances in 2021, and the rebate increase from \$30 to \$50 for full-sized appliances.

As illustrated in Figure 8 further below, ARet achieved 4.462 GWh in gross energy savings and 0.640 MW in gross peak demand savings in 2021. These results represent increases of 20% and 19% in gross energy and peak demand savings respectively compared to 2020.

Figure 7: Overview of ARet Participation, 2012-2021

Figure 8: Evolution of ARet Gross Savings, 2012-2021


2 ARET EVALUATION APPROACH

The 2021 AREt evaluation comprised a condensed impact evaluation. The main objectives of the 2021 AREt evaluation were as follows:

- › Calculate gross and net AREt results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions.³

The Evaluator identified key research questions aimed at achieving the main objectives. Table 8 outlines the evaluation objectives and maps them to the Evaluator's research questions and methods. Each method is described further below.

Table 8: 2021 AREt Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Measure Assessment (MA) update › Calculations using evaluation results
Calculate net results	› What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What are the net avoided GHG emissions in CO₂ eq?	› Use of 2018 participant survey results › Calculations using evaluation results › GHG emission reduction calculations

Tracking Sheet Audit

Prior to performing any savings calculations, the Evaluator conducted an audit of the final 2021 AREt tracking sheet to ensure it was complete and the entered data were consistent. The detailed protocol used for the tracking sheet audit and the results obtained are presented in Appendix I.

Unitary Savings Review

The Evaluator reviewed the unitary savings values of refrigerators and freezers to account for the evolving mix of manufacture year-class and average unit size, then updated the 2020-2022 Measure Assessment⁴ accordingly.

³ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

⁴ The 2020-2022 Measure Assessment is a reference document that provides an in-depth review of all parameters necessary to calculate the annual and lifetime gross energy and peak demand savings of most prescriptive measures and some semi-prescriptive measures offered through EOne's DSM program portfolio. In addition, the Measure Assessment includes effective useful life measures for all measures offered in EOne's program portfolio. For the evaluations conducted during the 2020-2022 DSM cycle, the Evaluator refers to the values presented in the 2020-2022 Measure Assessment.

Calculations Using Evaluation Results

Building on all the above methods and data collected, the Evaluator calculated the first-year and lifetime energy and peak demand savings as per the calculation methodology presented in Section 3 below.

GHG Emission Reduction Calculations

To obtain net avoided GHG emissions in CO₂ eq for ARet, the Evaluator multiplied the net energy savings by the latest Nova Scotia-specific factor for GHG emissions generated by electricity production. This factor was established using NS Power data.

3 ARET IMPACT EVALUATION

This section presents the findings of the 2021 impact evaluation aimed at determining gross and net electrical energy and peak demand savings.

3.1 Tracking Sheet Audit

To ensure program results are reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix I. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

3.2 Gross Savings

For ARet, gross savings correspond to the change in energy consumption resulting from the retirement of energy inefficient appliances in participants' homes, regardless of why they participated and what they would have done if the program was not available.⁵

As part of the 2021 evaluation, the Evaluator updated the unitary savings values for freezer and refrigerator retirements and replacements based on the proportion of units per manufacture-year class and average unit size found in the 2021 ARet tracking sheet. Detailed descriptions of the unitary savings calculations are presented in the 2020-2022 Measure Assessment.

3.2.1 Unitary Energy Savings

Table 9 below presents the tracked and evaluated energy savings for each type of appliance retired through ARet or replaced under HomeWarming and MHEEP in 2021.

For refrigerator and freezer retirements, variations in unitary savings values are due to changes in characteristics, namely age and size, of the appliances retired in 2021. Importantly, freezers and small freezers saw larger downward adjustments because of the change in eligibility criteria that began in 2020, which allowed seven ft³ freezers to be considered as full-size appliances compared to the prior 10 ft³ criterion.

Additionally, it should be noted that the change in eligibility criteria resulted in the inconsistent classification of 7 ft³ freezers, for which some units were tracked as small freezers and others as full-size freezers. Although it did not have a significant impact on savings since average sizes are considered, EOne should improve the tracking of those units to improve consistency.

⁵ Definition adapted from: National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

Table 9: 2021 ARet Tracked and Evaluated Unitary Energy Savings

Appliance	Tracked Unitary Energy Savings [kWh/year]	Evaluated Unitary Energy Savings [kWh/year]
ARet – Retirement		
Refrigerators	670	671
Freezers	896	862
Air Conditioners	257	257
Small Refrigerators	170	164
Small Freezers	266	240
Dehumidifiers	636	636
ARet – Replacement (HomeWarming and MHEEP)		
Refrigerators	678	660
Freezers	1,358	1,077
Dehumidifiers	636	636
Clothes Dryers	252	252

3.2.2 Unitary Peak Demand Savings

Peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The projected electricity peak demand period in Nova Scotia is between 5 p.m. and 7 p.m. in the months of December to February on non-holiday weekdays. The detailed unitary peak demand savings calculations are presented in the 2020-2022 Measure Assessment.

Table 10 below lists the tracked and evaluated unitary peak demand savings for each appliance retired through ARet or replaced under HomeWarming and MHEEP in 2021. The variations in unitary peak demand savings, such as variations in unitary energy savings, are due to changes in characteristics of appliances retired in 2021.

Table 10: 2021 ARet Tracked and Evaluated Unitary Peak Demand Savings

Appliance	Tracked Unitary Peak Demand Savings [W]	Evaluated Unitary Peak Demand Savings [W]
ARet – Retirement		
Refrigerators	92.5	92.6
Freezers	124	119
Air Conditioners	0	0
Small Refrigerators	23.5	22.6
Small Freezers	36.7	33.1
Dehumidifiers	213	213
ARet – Replacement (HomeWarming and MHEEP)		
Refrigerators	93.6	91.1
Freezers	187	149
Dehumidifiers	213	213
Clothes Dryers	34.8	34.8

3.2.3 Interactive Effects

Interactive effects occur when an implemented energy efficiency measure has an impact on the energy consumption of other elements such as heating and cooling equipment. For ARet, retiring old appliances causes an increase in the heating load in the winter and a decrease in the cooling load in the summer since the compressor of the old appliance releases significantly more waste heat than a newer, more efficient model. If an inefficient appliance is retired without being replaced, interactive effects are greater.

The heating load period in Nova Scotia lasts about eight months, while the cooling load period is relatively short, lasting approximately two months. Total annual interactive effects due to the retirement or replacement of old appliances are therefore expected to be negative, pushing the savings generated by such retirements or replacements downward.

Other factors can also affect the interactive effects of the program component including:

- › The focus of this ARet evaluation was on electricity savings. In Nova Scotia, fewer than 27% of households use electricity as their primary heating source.⁶ Therefore, the negative interactive effects on the heating load only affect approximately one third of participating households.
- › A significant number of appliances retired through ARet, such as refrigerators and freezers, are built into or leaned against an exterior wall. Rather than contributing to building heat loads, this results in more heat loss through the building envelope and through the appliance back wall, thereby reducing interactive effects.
- › In Nova Scotia, one third of households (36%)⁷ use air conditioning. For those households, positive interactive effects occur during the cooling period, which cancel a portion of the negative interactive effects.
- › Most jurisdictions that offer refrigerator and freezer retirement or replacement programs do not consider interactive effects for those appliances.⁸

After carefully considering all these factors, the Evaluator concluded that ARet interactive effects are negligible and therefore established the interactive effects factor at 0%.

3.2.4 Effective Useful Life

The effective useful life (EUL) values are used in the calculation of electrical energy savings that are expected to persist over time. For ARet, the lifetime energy savings and equivalent EUL of a unit are highly influenced by the remaining useful life (RUL) of old units; the latter corresponds to the remaining time that the old appliance would still have been used if it had not been replaced or retired.

For the 2021 evaluation, the Evaluator relied on the EUL values presented in the 2020-2022 Measure Assessment. Table 11 below summarizes the equivalent EUL values for each type of appliance. The equivalent EUL values were applied to each product gross and net first-year energy savings to obtain gross and net lifetime energy savings. As a result, the weighted average EUL values of gross and net savings differ (see Subsections 3.2.5 and 3.3.4).

⁶ Statistics Canada, *Residential Sector, Nova Scotia, Table 14: Total Households by Building Type and Energy Source*, <http://oee.rncan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=ns&rn=14&page=4> (Last accessed October 22, 2020).

⁷ Statistics Canada, *Table 38-10-0019-01 – Air conditioners*, <https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3810001901> (Last accessed November 25, 2021).

⁸ The technical reference manuals (TRMs) for California Municipal Utilities, Connecticut, Illinois, Maine, Massachusetts, Minnesota, Mid-Atlantic, New York, Northwest Power and Conservation Council, Ohio, Pennsylvania, Vermont, and Wisconsin were consulted. Only Northwest Power and Conservation Council and New York apply interactive effect factors for freezers and refrigerators (although only for new rebated appliances and not for recycled appliances).

Table 11: 2021 ARet Equivalent Effective Useful Life Values

Appliance	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]	Evaluated Gross Lifetime Unitary Savings [kWh]
ARet – Retirement			
Refrigerators	4	No change	2,684
Freezers	4	No change	3,448
Air Conditioners	3	No change	771
Small Refrigerators	4	No change	656
Small Freezers	4	No change	960
Dehumidifiers	5	No change	3,180
ARet – Replacement (HomeWarming and MHEEP)			
Refrigerators	5	No change	3,300
Freezers	4	No change	4,308
Dehumidifiers	5	No change	3,180
Clothes Dryers	5	No change	1,260

3.2.5 Evaluated Gross Savings

The gross energy and peak demand savings resulting from the retirement of old appliances through ARet and the appliance replacements through HomeWarming and MHEEP are listed in Table 12 below. The total gross energy and peak demand savings amount to 4.462 GWh and 0.640 MW respectively at the generator, which represents 17.849 GWh in lifetime energy savings. As a result, the average EUL value for gross energy savings is 4.0 years.

Line loss factors correspond to the values submitted to the Nova Scotia Utility and Review Board (UARB) as part of the 2014 Cost of Service Study Progress Update.⁹ The proportion of residential participants versus that of commercial participants was calculated using the 2021 tracking sheet data. For appliances retired through ARet, the gross savings at the generator were estimated by using a line loss factor of 1.094 and 1.145 for energy and peak demand savings respectively. For appliances replaced through HomeWarming and MHEEP, the gross savings at the generator were estimated by using a line loss factor of 1.095 and 1.147 for energy and peak demand savings respectively.

⁹ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 12: Evaluated 2021 ARet Gross Energy and Peak Demand Savings

Measure Category	Appliance Retirement					
	Refrigerators	Freezers	Room Air Conditioners	Small Refrigerators	Small Freezers	Dehumidifiers
Number of Units Retired or Replaced	3,873	1,437	233	105	29	0
Energy Savings						
Unitary Energy Savings (kWh)	671	862	257	164	240	636
Gross Energy Savings – at the Meter (GWh)	2.599	1.239	0.060	0.017	0.007	0
Line Loss Factor	1.094	1.094	1.094	1.094	1.094	1.094
Gross Energy Savings – at the Generator (GWh)	2.843	1.355	0.066	0.019	0.008	0
Equivalent Effective Useful Life (years)	4.0	4.0	3.0	4.0	4.0	5.0
Gross Lifetime Energy Savings – at the Generator (GWh)	11.373	5.421	0.197	0.075	0.030	0
Peak Demand Savings						
Unitary Peak Demand Savings (W)	92.6	119	0	22.6	33.1	213
Gross Peak Demand Savings – at the Meter (MW)	0.359	0.171	0.000	0.002	0.001	0
Line Loss Factor	1.145	1.145	1.145	1.145	1.145	1.145
Gross Peak Demand Savings – at the Generator (MW)	0.411	0.196	0.000	0.003	0.001	0

Evaluated 2021 ARet Gross Energy and Peak Demand Savings (Continued)

Measure Category	HomeWarming			MHEEP			Total
	Refrigerators	Freezers	Dehumidifiers	Refrigerators	Freezers	Dehumidifiers	
Number of Units Retired or Replaced	52	81	35	4	9	1	5,859
Energy Savings							
Unitary Energy Savings (kWh)	660	1,077	636	660	1,077	636	-
Gross Energy Savings – at the Meter (GWh)	0.034	0.087	0.022	0.003	0.010	0.001	4.078
Line Loss Factor	1.095	1.095	1.095	1.095	1.095	1.095	-
Gross Energy Savings – at the Generator (GWh)	0.038	0.095	0.024	0.003	0.011	0.001	4.462
Equivalent Effective Useful Life (years)	5.0	4.0	5.0	5.0	4.0	5.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	0.188	0.382	0.122	0.014	0.042	0.003	17.849
Peak Demand Savings							
Unitary Peak Demand Savings (W)	91.1	149	213	91.1	149	213	-
Gross Peak Demand Savings – at the Meter (MW)	0.005	0.012	0.007	0.000	0.001	0.000	0.559
Line Loss Factor	1.147	1.147	1.147	1.147	1.147	1.147	-
Gross Peak Demand Savings – at the Generator (MW)	0.005	0.014	0.009	0.000	0.002	0.000	0.640

Figure 9 compares the tracked and evaluated gross energy savings, while Figure 10 further below compares the tracked and evaluated gross peak demand energy savings.

Figure 9: 2021 Tracked and Evaluated Gross Energy Savings

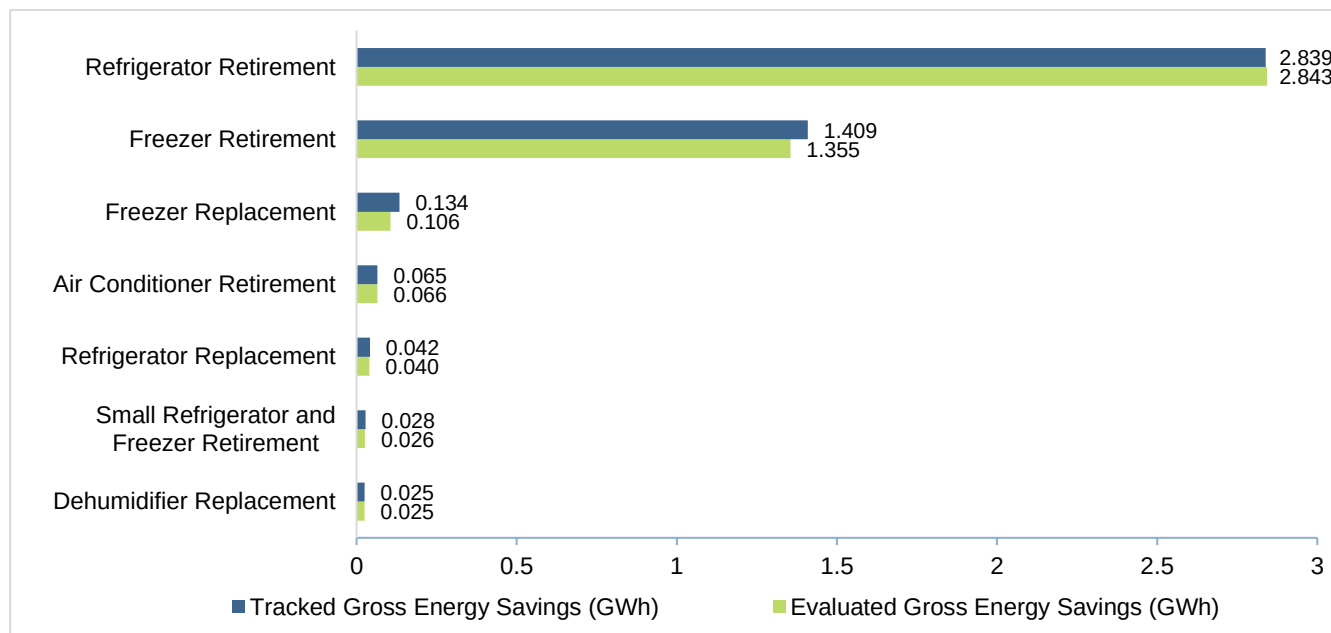
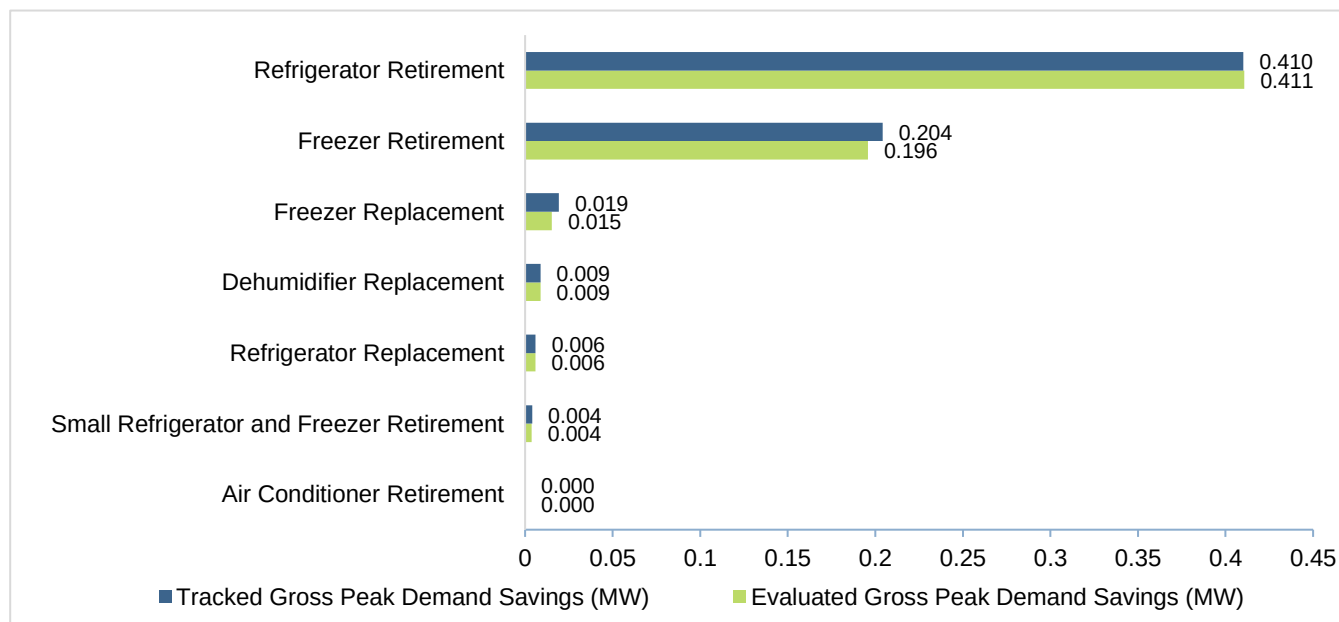


Figure 10: 2021 Tracked and Evaluated Gross Peak Demand Savings



3.3 Net Savings

The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the NTGR. In the case of ARet, the NTGR is established considering three effects that positively or negatively affect energy savings, namely free-ridership, secondary market impacts, and participant spillover. As for appliances replaced through HomeWarming and MHEEP, a NTGR of 1 was assumed given the replacement service eligibility criteria.

3.3.1 Free-ridership and Secondary Market Impacts

The free-ridership and secondary market impacts account for the fact that some participants would have disposed of their appliances (free-ridership) or would have transferred their old appliances to another user (secondary market impacts) in the absence of ARet. As required by the Uniform Methods Project (UMP) calculation methodology, the savings associated with various scenarios were calculated and the deduction in gross savings due to these effects depends on not only the percentage of the participants affected, but also the difference in savings associated with each scenario, as detailed in Appendix II.

The free-ridership levels were assessed during the 2018 evaluation using a self-report approach that involved asking non-low-income participants a set of questions during a telephone survey. No data collection aimed at updating the free-ridership levels was conducted in 2021. Therefore, the 2018 levels were used. Secondary market impacts are divided into two scenarios and were calculated using default proportions suggested by the UMP for cases where no general population survey is conducted. No free-ridership and secondary market impacts were applied to dehumidifier retirements since those units were not included in the 2018 survey and only represent a small portion of savings.

The free-ridership and secondary market impact calculation results are presented for each appliance type in Table 13.

Table 13: 2021 ARet Free-ridership and Secondary Market Impacts

Appliance	Gross Unitary Savings [kWh]	Free-ridership [kWh]	Secondary Market Impacts [kWh]
Refrigerators	671	234	58
Freezers	862	387	66
Air Conditioners	257	106	15
Small Refrigerators	164	44	7
Small Freezers	240	64	10
Dehumidifiers	636	-	-

3.3.2 Participant Spillover

For ARet, participant spillover occurs when participants decide to retire or replace other appliances pursuant to participating in the program component and due to its influence. The Evaluator also considered that participant spillover occurred when other appliances ineligible for a rebate were picked up when the DA came to retrieve the appliance to be retired.

Participant spillover was also assessed through a telephone survey during the 2018 evaluation and the results were used for the 2021 evaluation. Among the 200 participants surveyed in 2018, two reported that one or several additional appliances were picked up and that they would have sold them or given them away if they had not been retrieved under ARet, while none reported having retired an appliance that they would have kept if they had not participated in the program component. The total savings resulting from these additional retirements amounted to 770 kWh. This amount was divided by the total energy savings generated by all surveyed participants, resulting in a participant spillover level of 0%.

3.3.3 Net-to-gross Ratio Calculation

Given the methodology used to obtain net savings, the NTGR could not be calculated as a sum of the percentages of all effect values. To obtain an NTGR that takes into account both effects applied to unitary savings and the spillover applied to ARet overall gross savings, the following equation was used:

$$NTGR = \frac{\text{Gross Unitary Savings} - \text{Free-ridership} - \text{Secondary Market Impacts}}{\text{Gross Unitary Savings}} + \text{Spillover}\%$$

The detailed calculation results and NTGR, rounded to two decimal places, are presented for each appliance type in Table 14. A NTGR of 1.00 is used for dehumidifiers until there are sufficient data to estimate it.

Table 14: 2021 ARet Effects and NTGR

Appliance	Gross Unitary Savings [kWh]	Effects		Participant Spillover	NTGR	Net Unitary Savings [kWh]
		Free-ridership [kWh]	Secondary Market Impacts [kWh]			
Refrigerators	671	234	58	0%	0.56	379
Freezers	862	387	66		0.47	409
Air Conditioners	257	106	15		0.53	136
Small Refrigerators	164	44	7		0.69	113
Small Freezers	240	64	10		0.69	166
Dehumidifiers	636	-	-		1.00	636

3.3.4 Evaluated Net Savings

Net savings represent the savings that can be reliably attributed to a program component. For ARet, net savings are calculated by applying the NTGR values to gross savings as illustrated in the following equation:

$$\text{Net Savings} = \text{Gross Savings} \times \text{NTGR}$$

Overall, the total net energy and net peak demand savings for ARet amounted to 2.474 GWh and 0.357 MW at the generator respectively. The net lifetime energy savings were established at 9.925 GWh, which yields an average EUL value of 4.0 years for net energy savings.

The detailed savings results are outlined in Table 15 below.

Table 15: Evaluated 2021 ARet Net Energy and Peak Demand Savings

Measure Category	Appliance Retirement					
	Refrigerators	Freezers	Room Air Conditioners	Small Refrigerators	Small Freezers	Dehumidifiers
Energy Savings						
Gross Energy Savings – at the Meter (GWh)	2.599	1.239	0.060	0.017	0.007	0
NTGR	0.56	0.47	0.53	0.69	0.69	1.00
Net Energy Savings – at the Meter (GWh)	1.468	0.588	0.032	0.012	0.005	0
Line Loss Factor	1.094	1.094	1.094	1.094	1.094	1.094
Net Energy Savings – at the Generator (GWh)	1.606	0.643	0.035	0.013	0.005	0
Equivalent Effective Useful Life (years)	4.0	4.0	3.0	4.0	4.0	5.0
Net Lifetime Energy Savings – at the Generator (GWh)	6.424	2.572	0.104	0.052	0.021	0
Peak Demand Savings						
Gross Peak Demand Savings – at the Meter (MW)	0.359	0.171	0.000	0.002	0.001	0
NTGR	0.56	0.47	0.53	0.69	0.69	1.00
Net Peak Demand Savings – at the Meter (MW)	0.203	0.081	0.000	0.002	0.001	0
Line Loss Factor	1.145	1.145	1.145	1.145	1.1459	1.145
Net Peak Demand Savings – at the Generator (MW)	0.232	0.093	0.000	0.002	0.001	0

Evaluated 2021 ARet Net Energy and Peak Demand Savings (Continued)

Measure Category	HomeWarming			MHEEP			Total
	Refrigerators	Freezers	Dehumidifiers	Refrigerators	Freezers	Dehumidifiers	
Energy Savings							
Gross Energy Savings – at the Meter (GWh)	0.034	0.087	0.022	0.003	0.010	0.001	4.078
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	-
Net Energy Savings – at the Meter (GWh)	0.034	0.087	0.022	0.003	0.010	0.001	2.261
Line Loss Factor	1.095	1.095	1.095	1.095	1.095	1.095	-
Net Energy Savings – at the Generator (GWh)	0.038	0.095	0.024	0.003	0.011	0.001	2.474
Equivalent Effective Useful Life (years)	5.0	4.0	5.0	5.0	4.0	5.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	0.188	0.382	0.122	0.014	0.042	0.003	9.925
Peak Demand Savings							
Gross Peak Demand Savings – at the Meter (MW)	0.005	0.012	0.007	0.000	0.001	0.000	0.559
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	-
Net Peak Demand Savings – at the Meter (MW)	0.005	0.012	0.007	0.000	0.001	0.000	0.312
Line Loss Factor	1.147	1.147	1.147	1.147	1.147	1.147	-
Net Peak Demand Savings – at the Generator (MW)	0.005	0.014	0.009	0.000	0.002	0.000	0.357

As presented in Table 16, applying the Nova Scotia-specific factor¹⁰ for GHG emissions generated by electricity production, 0.5841 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 1,445 tonnes of annually avoided CO₂ eq.

Table 16: Evaluated 2021 ARet GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	2.474
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	1,445

3.4 Realization Rate

Table 17 compares ARet total tracked and evaluated savings. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 97% for both energy savings and peak demand savings.

Table 17: Comparison of 2021 ARet Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	4.542	GWh	0.56	2.549	GWh	97%
Evaluation Results	4.462	GWh	0.55	2.474	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.652	MW	0.57	0.369	MW	97%
Evaluation Results	0.640	MW	0.56	0.357	MW	
*NTGRs vary for each type of appliance. The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by gross savings.						

The evaluated gross and net energy savings as well as peak demand savings are 3% lower than the values tracked by EOne due to small variations in the unitary savings values of each appliance type after accounting for the characteristics (e.g. size and age) of the appliances retired in 2021.

¹⁰ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources: Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021), Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021 https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

4 ARET KEY FINDINGS AND RECOMMENDATIONS

As mentioned previously, the 2021 AREt evaluation comprised a condensed impact evaluation and its main objectives were as follows:

- › Calculate gross and net AREt results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions.

This section provides the Evaluator's key findings in relation to these objectives. The Evaluator has no specific recommendation for AREt.

2021 AREt-Finding: AREt achieved its net electrical energy savings targets but not its peak demand savings targets.

AREt achieved 2.473 GWh in net electrical energy savings and 0.357 MW in net peak demand savings at the generator in 2021, thus attaining the planned net electrical energy savings of 2.41 GWh. However, the net peak demand savings target of 0.414 MW was not achieved.

2021 AREt-Finding: AREt participation as well as energy and peak demand savings increased in 2021 partly because of the latent demand created by impacts from the COVID-19 pandemic in 2020, the expansion of public events in 2021, and the rebate increase for full-size appliance retirements.

For the first time after three consecutive years of decreases, program participation increased. In 2021, 26% more appliance retirements and 5% more appliance replacements were recorded compared to 2020, for a combined 25% increase in participation. While participation returned to levels close to those prior to the COVID-19 pandemic, there was a slight increase compared to 2018-2019 levels.

2021 AREt-Finding: The differences between evaluated gross energy and peak demand savings determined by the Evaluator and the initial gross savings tracked by EOne are minimal.

The evaluated gross and net energy savings as well as peak demand savings are 3% lower than the values tracked by EOne due to small variations in the unitary savings values of each appliance type after accounting for the characteristics (e.g. size and age) of the appliances retired in 2021.

5 INSTANT SAVINGS OVERVIEW

This section describes Instant Savings, follows up on past evaluation recommendations, and provides an overview of participation history.

5.1 Instant Savings Description

Instant Savings offers instant cash rebates to consumers who purchase eligible energy efficient products. Instant Savings is carried out with the help of one DA, Summerhill Group Inc. as well as national retailers and independent retailers that offer eligible products at over 180 locations across Nova Scotia. To respond to the online shopping trend, EOne introduced online retailers to their list of participating retailers in 2019.

Rebates on eligible products were offered during two campaigns that took place in the spring from April 9th to May 23rd, 2021, and in the fall from September 24th to November 14th, 2021. In addition, rebates are offered year-round on selected products.

Since the 2019 fall campaign, EOne has used a new rebate structure, which removes the price cap and provides options for either a 50% rebate on the package price or a flat rate per-unit rebate on selected products,¹¹ including non-A-type lamps, to allow for higher rebates based on the number of units per package. Starting May 24, 2021, Energy Star® certified LED fixtures (with and without motion sensors), outdoor clothesline kits and drying racks, which were rebated only during campaigns, are now rebated year-round. There were no other changes to the products rebated by Instant Savings in 2021.

Table 18 summarizes the energy efficient products offered through Instant Savings and their respective rebate amount. For each product category, a list of eligible stock keeping units (SKUs) is maintained and approved by EOne.

¹¹ The complete list of selected products (rebate up to 50% off the package price) is presented in Table 18 further below.

Table 18: List of 2021 Rebates by Product

Products Offered During Campaigns	Rebate
ENERGY STAR Certified Light Emitting Diode (LED) Non-A-type Lamps (single & multipacks)	\$7/unit or up to 50% off package price
Dimmer Switches or Wi-Fi Enabled Switches (single pack and multipack)	\$3/unit or up to 50% off package price
Indoor Motion Sensors	\$5
Outdoor Motion Sensors	\$8
Power Bars with Integrated Timers	\$5
Smart Power Strips (Load sensing power strips only)	\$10
Heavy-duty Outdoor Timers	\$10/unit** or up to 50% off package price
Programmable or Wi-Fi Enabled Thermostats for Electrical Baseboard Heaters (single packs, 2 packs, and packs of 3 or more)	\$20/unit** or up to 50% off package price
High Efficiency Showerheads (qualifying models must have a flow rate of 1.6 GMP or less)	\$8
Products Offered Year-round	Year-round Rebate
ENERGY STAR Certified Smart Thermostats for Non-electrical Heating	Up to \$100
ENERGY STAR Certified LED Fixtures Without Motion Sensors	\$12*
ENERGY STAR Certified LED Fixtures with Motion Sensors	\$20
Outdoor Clothesline Kits and Outdoor Drying Racks	\$5
ENERGY STAR Certified Recessed Downlight Fixtures (single & multipacks)	\$7/unit or up to 50% off package price
Select Smart Thermostats (with occupancy sensors) for Electrical Heating	\$35**
ENERGY STAR Certified Dehumidifiers	\$30
ENERGY STAR Certified Room Air Purifiers	Up to \$75
Clothes Washers (qualifying models are on the ENERGY STAR Most Efficient 2020 list)	\$75
Clothes Dryers (qualifying models must be ENERGY STAR certified and use less than 100 kWh per cubic foot of drum capacity)	\$75
ENERGY STAR Certified Variable Speed Pool Pumps	\$200
ENERGY STAR Certified Air-source Heat Pump Hot Water Heaters	\$400
* Represents a change in incentive from 2020	
** Represents a mid-year change that occurred at the beginning of the 2021 fall campaign	

Instant Savings is typically advertised through point-of-purchase materials and signage, the Efficiency Nova Scotia website, and other media including television commercials, social media, as well as print and online advertising. Where permitted, consumer engagement events were held in participating retail stores during the campaign periods to provide information about Instant Savings and cross-promote other EOne programs, components and services. Spring campaign events were held at most participating retailers; however, due to the COVID-19 pandemic, there were a limited number of events and marketing activities; with a return to lockdown in Nova Scotia in the spring, there was a freeze on marketing and a number of events ended up being cancelled. To boost sales in the fall campaign, EOne extended marketing efforts, held retailer events where approved and increased the rebates for LED fixtures (from 7\$ to 12\$), smart thermostats for electrical heat (from 25\$ to 35\$), programmable thermostats (from 15\$ to 20\$), and outdoor heavy-duty timers (from 8\$ to 10\$).

Instant Savings aimed to achieve 10.6 GWh in net electrical energy savings and 1.2 MW in net peak demand savings at the generator in 2021.

5.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated Instant Savings in previous years and issued recommendations for improvements. Table 19 below provides a summary of the implementation status for past recommendations that have been carried forward.

The Evaluator notes that only one recommendation from 2018 has not yet been implemented.

Table 19: Implementation Status of Past Recommendations for Instant Savings

#	Past Recommendations for Instant Savings	Status	Comments
2020 Instant-R1	Monitor market indicators and collect information to characterize the market for LED fixtures.	Completed	A market evolution study for LED fixtures is presented in this evaluation.
2018 Instant-R1	Perform a socket study through on-site visits to document energy savings potential related to lighting.	Deferred	EOne is considering a socket study as part of the 2023-2025 DSM plan.

5.3 Participation History

In 2021, a total of 201,175 eligible products were sold in participating stores across Nova Scotia, which represents a decrease of 2% compared to 2020. EOne reported that retailers noted that many, if not all, Instant Savings product categories were impacted in some form by supply chain issues in 2021.

As presented in Table 20 below, the sales of ENERGY STAR certified non-A-type LED lamps decreased by 19% compared to 2020. LED fixtures without motion sensors and LED recessed downlight fixtures both saw small decreases in sales (10% and 3% respectively) despite the fact that LED fixtures became year-round rebated products in May 2021. Conversely, there was a 31% increase in the number of control products sold, driven by the large increases in the number of heavy-duty outdoor timers and programmable thermostat sold, products that both benefited from increased incentives during the fall

campaign. Sales of clothesline kits and outdoor drying racks, whose sales increased significantly in 2020, decreased in 2021, returning closer to 2019 levels.

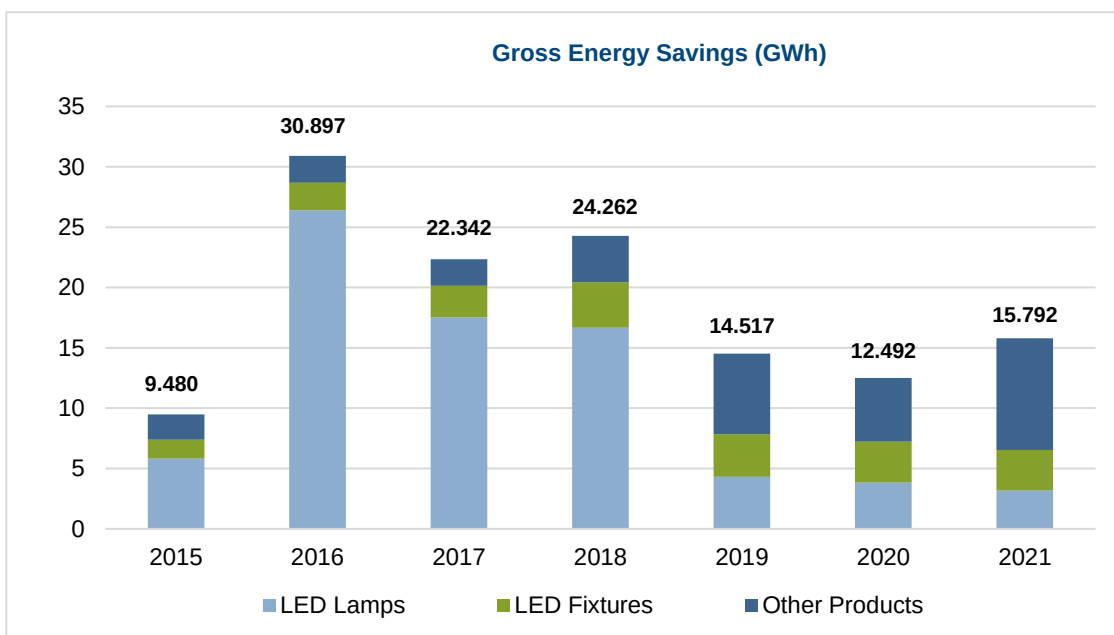
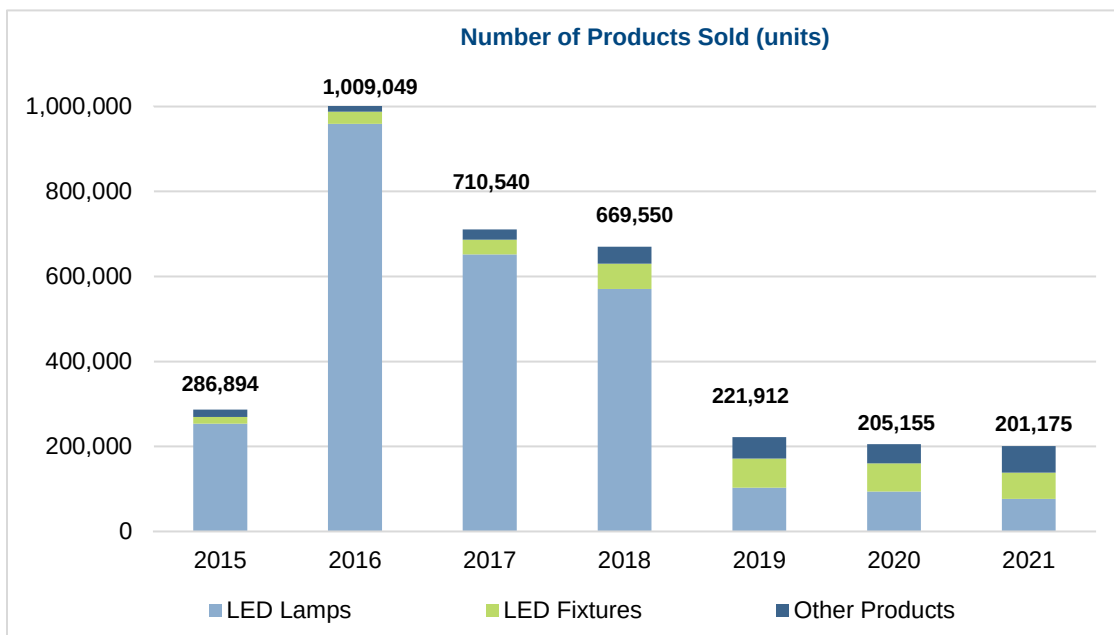
While remaining a low volume product, the sales of ENERGY STAR certified heat pump water heaters more than doubled from the previous year. There was also a significant sales increase for ENERGY STAR certified heat pump water heaters and variable speed pool pumps that were introduced in 2019. Sales in the appliance product category increased by 73% despite the removal of ENERGY STAR refrigerators in 2020; this was driven by a large increase in units sold for ENERGY STAR certified clothes dryers and ENERGY STAR room air purifiers.

Table 20: Number of Rebated Products Sold Through Instant Savings, 2020-2021

Product Category	2020	2021	Variation	
ENERGY STAR Certified Non-A-type LED Lamps	94,148	76,443	↓	19%
ENERGY STAR Certified LED Fixtures ^a	66,094	62,125	↓	6%
Controls ^b	25,046	32,801	↑	31%
Clothesline Kits and Outdoor Drying Racks	2,944	1,542	↓	48%
Appliances ^c	15,698	27,176	↑	73%
Energy Efficient Showerheads	669	903	↑	35%
Energy STAR Certified Air-source Heat Pump Hot Water Heaters	49	114	↑	133%
ENERGY STAR Certified Variable Speed Pool Pumps	51	71	↑	39%
Total	205,155	201,175	↓	2%
^a Including ENERGY STAR certified LED fixtures with and without motion sensors and ENERGY STAR certified LED recessed downlight fixtures.				
^b Including dimmer switches, indoor and outdoor motion sensors, heavy-duty outdoor timers, power bars with timers, programmable thermostats, smart thermostats, and smart power bars.				
^c ENERGY STAR certified clothes washers and dryers, ENERGY STAR certified dehumidifiers, and ENERGY STAR certified room air purifiers.				

As illustrated in Figure 11 below, LED lamps remain the highest selling product accounting for 38% of unit sales, with LED fixtures following at 31% of sales. Instant Savings achieved 15.792 GWh in gross energy savings in 2021, which represents a 26% increase compared to 2020 levels. Gross savings from lighting products decreased by 9%, while savings from other products increased by 76%. LED lamps and fixtures comprised 41% of gross savings. For the first time since its inception, LED lamps and fixtures did not represent the majority of gross energy savings for Instant Savings. Products other than LED lamps and fixtures constituted 59% of gross energy savings, with ENERGY STAR certified room air purifiers (17%), heavy-duty outdoor timers (14%), and programmable thermostats (7%) being top drivers of gross energy savings.

Figure 11: Overview of Participation in Instant Savings, 2015–2021



6 INSTANT SAVINGS EVALUATION APPROACH

The 2021 Instant Savings evaluation includes a market evaluation and a comprehensive impact evaluation. The main objectives of the 2021 Instant Savings evaluation are as follows:

- › Collect information on participant and partner perspectives
- › Calculate gross and net Instant Savings results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions¹²
- › Analyze the market evolution of LED lamps and fixtures

The Evaluator identified key research questions aimed at achieving these objectives. Table 21 outlines the evaluation objectives and maps them to the Evaluator's research questions, methods, and sample sizes (n). Each method is described further below.

¹² First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

Table 21: 2021 Instant Savings Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Collect information on participant and partner perspectives	› What is the awareness level about Instant Savings and how did participants learn about it? › What type of LED lamps and LED fixtures do participants purchase and what are their expected uses? › To what extent does Instant Savings influence staff and consumer knowledge and in-store product offerings? › How satisfied are retailers with Instant Savings?	› Participant online survey with in-store support (n=120) › Retailer interviews (n=8)
Calculate gross results	› Is the data in the tracking sheet complete, accurate, and consistent? › What are the unitary savings by product category? › What are the interactive effects factors for lighting and control products? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › MA update › Calculations using evaluation results
Calculate net results	› What is the Instant Savings free-ridership level for 2021? › What is the Instant Savings spillover level for 2021? › What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What are the Instant Savings' net avoided GHG emissions in terms of CO₂ eq?	› Participant online survey with in-store support (n=120) › Retailer interviews (n=8) › Calculations using evaluation results › GHG emission reduction calculations
Analyze the market evolution of LED lamps and fixtures	› How has the residential lighting market for LED lamps evolved since 2019? › How is the residential lighting market for LED fixtures evolving?	› Market evolution and characterization study

Participant Online Survey

Narrative Research staff conducted a participant online survey with 67 consumers who purchased qualifying non-A-type LED lamps, 15 who purchased recessed downlight fixtures, and 38 who purchased other LED fixtures during the fall campaign, for a total of 120 survey participants. The online survey was conducted throughout the 2021 fall campaign by distributing survey cards at 25 participating retail locations, with completed surveys being collected from a sampling of Canadian Tire, Kent, Home Hardware, and Home Depot stores. One completed survey was also collected from Costco. In some stores, Narrative Research staff also collected emails from consumers who bought eligible products to send them the link for completing the survey. The length of the survey was 11 minutes. The questionnaire is presented in Appendix IV, with complete participant survey results in Appendix V. The online survey sample of 120 participants yields a maximum margin of error of $\pm 7.6\%$ at a 90% confidence level.

Interviews with Retailers

In the fall of 2021, Narrative Research staff conducted in-depth interviews with six participating retailers. Instant Savings collaborates with 10 national retailers and the list of participating retailers was provided by EOne. The guide used for the interviews is provided in Appendix VI.

Tracking Sheet Audit

Prior to performing the unitary savings review, the Evaluator performed an audit of the final 2021 tracking sheet to ensure it was complete and the entered data was consistent. The detailed protocol used for the tracking sheet audit and the results obtained are presented in Appendix VII.

Unitary Savings Review

Given the rapid evolution of the lighting market, the unitary savings values of LED lights and fixtures were reviewed as part of the 2021 evaluation. The Evaluator conducted a literature review and reviewed tracking sheet data for all LED light and fixture products. The 2020–2022 Measure Assessment¹³ was updated accordingly.

EUL Update

The EUL values of lighting measures, for which baseline changes are anticipated during the measure lifetimes, were updated according to the 2021 tracking sheet. The 2020–2022 Measure Assessment was updated accordingly.

Calculations Using Evaluation Results

Building on all the above methods and collected data, the Evaluator calculated the first-year and lifetime energy and peak demand savings using the calculation methodology presented in Section 8 below.

¹³ The 2020–2022 Measure Assessment is a reference document that provides an in-depth review of all parameters necessary to calculate the annual and lifetime gross energy and peak demand savings of most prescriptive measures and some semi-prescriptive measures offered through EOne's DSM program portfolio. In addition, the Measure Assessment includes effective useful life measures for all measures offered in EOne's program portfolio. For the evaluations conducted during the 2020–2022 DSM cycle, the Evaluator refers to the values presented in the 2020–2022 Measure Assessment.

GHG Emission Reduction Calculations

To obtain net avoided GHG emissions in CO₂ eq for Instant Savings, the Evaluator multiplied the net energy savings by the latest Nova Scotia-specific factor for GHG emissions generated by electricity production. This factor was established using NS Power data.

Note on Margin of Error

For evaluation activities that yield quantitative results based on a sample, the Evaluator aimed to achieve a maximum margin of error of 10% at a confidence level of 90%. This means that if measurements were conducted many times with different samples, the data would be within 10 percentage points above or below the percentage reported 90% of the time. Thus, the margin of error indicates the relative level of precision¹⁴ of a measurement, while its associated confidence level indicates the probability of a measurement falling within the margin of error.¹⁵

As part of the Instant Savings evaluation, the Evaluator calculated the margins of error for free-ridership rates. The margins of error are listed alongside results in the applicable sections below. Examples of calculations used to establish margins of error are provided in Appendix II of the 2021 DSM Programs Evaluation Executive Summary.

¹⁴ Precision refers to how reproducible a set of measurements is. It does not take into account how close the measured values are to the true values since this would refer to accuracy.

¹⁵ As part of this evaluation, the confidence levels and the margins of error only take random sampling errors into account; they do not reflect non-sampling errors or biases such as data entry errors, inaccurate responses from respondents, or the inability to contact certain people.

7 INSTANT SAVINGS PARTICIPANT AND PARTNER PERSPECTIVES

This section presents the participant and partner perspectives on Instant Savings.

7.1 Participant Perspectives

An online participant survey was conducted as part of the Instant Savings evaluation. A total of 120 surveys were completed with LED purchasers during the 2021 fall campaign. A distinction was made between consumers who purchased non-A-type LED lamps (n=67), consumers who purchased recessed downlight fixtures (n = 15), and those who purchased LED fixtures (n=38).

More than half (58%) of respondents had heard of Instant Savings, which is a slight decrease from 2020 levels (68%). In-store promotions (46%) remain the main source of awareness, followed by store personnel (29%). One in seven (13%) found out about Instant Savings through the ENS website.

The average number of non-A-type lamps purchased was 4.3 lamps per person. Nearly eight in ten (79%) of those who purchased non-A-type LED lamps reported already having non-A-type LED lamps installed in their homes, which is on par with the 77% reported in 2020. Purchased non-A-type lamps were mainly intended to replace non-LED bulbs (51%), while others were purchased to be put into a new lamp or light fixture (28%) or to replace LEDs (25%). Participants who planned to replace existing LED lamps mostly did so to replace bulbs once they burn out (58%).

Among those who purchased LED fixtures, most had the intention of installing them inside their home (89%). The average number of LED fixtures purchased was 3.3 per person, with a higher average number of recessed downlight fixtures per person (4.9) compared to other LED fixtures (2.7). The reasons for fixture purchases were largely to install them in a place that did not have a fixture before (49%) or to replace an existing fixture that was still functional (45%). Most often, the existing fixtures being replaced used LED lamps (37%) or standard incandescent lamps (32%).

Just over one-half (52%) of non-A-type LED lamp purchasers were aware of the rebate before paying at the cash register, while two-thirds (66%) of LED fixture purchasers were aware of the rebate when paying at the cash register.

A small majority (58%) of respondents recalled seeing stickers, shelf signs, or posters promoting the LED rebates at the front of the store or in the light bulb section of the store, which is on par with the 59% in 2020. Recall of seeing the in-store signage was similar among LED bulb purchasers (55%) and LED fixture purchasers (62%).

7.2 Partner Perspectives

As part of the Instant Savings evaluation, six interviews were conducted with retailers. The following subsections present the results of those interviews.

7.2.1 Satisfaction with Instant Savings

Retailers are generally satisfied with Instant Savings overall, with an average satisfaction score of 8 on a 10-point scale where 1 means “Not at all satisfied” and 10 means “Completely satisfied”. Four retailers provided a score between 8 and 10 primarily due to the positive impact of Instant Savings on sales, the ease of program component delivery, and the prompt and courteous communications from program component staff. Despite more limited in-store visits from program component staff this year due to pandemic restrictions, one of those retailers identified this as an important and appreciated program component based on their experience in previous years.

The other two retailers provided moderately positive satisfaction scores of 6 and 7 on the 10-point scale. The main point of dissatisfaction for one retailer related to the difficulty in easily finding program component information on the website. The other retailer finds the SKU approval process cumbersome and time consuming and would like to see the Excel spreadsheet simplified. That retailer also noted difficulty in managing rebates in a national environment wherein provincial programs and rebate levels differ across the country. This retailer also feels that the SKU list could be expanded and include more rebated lighting product categories.

Retailers are highly satisfied with their interactions with the program component delivery representatives from Summerhill, with an average satisfaction score of 8.7 based on the same 10-point scale. Five retailers gave a score ranging from 8 to 10, with representatives being seen as responsive, attentive, helpful, and proactive in providing program component materials. The other retailer provided a slightly lower score of 7 with no areas noted for improvement.

Table 22 provides an overview of average satisfaction ratings with Instant Savings over the past four years.

Table 22: Retailer Satisfaction with Instant Savings, 2018-2021

	2018		2019		2020		2021	
	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size
Overall satisfaction with Instant Savings	8.6	8	8.0	7	8.8	8	8.0	6
Satisfaction with interactions with the program component delivery representatives from Summerhill	-	-	-	-	8.5	8	8.7	6
Scale: 1 = Not at all satisfied; 10 = Completely satisfied Base: Retailers who provided a rating								

Recommendations for improving Instant Savings primarily include streamlining the administrative process, with one retailer suggesting that an online portal should be developed to communicate with retailers and for administrative functions such as the SKU approval process.

7.2.2 Influence of Instant Savings

This subsection presents retailer opinions on the influence of Instant Savings on various factors relating to LED lamps and fixtures, such as consumer and staff knowledge about the products, as well as the quantity and variety of products stocked in-store. All retailers were asked to assess the influence of Instant Savings on a variety of factors, using a 0 to 10 scale where 0 indicates “No influence at all” and 10 indicates “A great deal of influence”.

LED Lamps

Overall, Instant Savings is seen as having a limited influence on enhancing both consumer and sales staff knowledge about LED lamps and their benefits (average influence rating of 5.7 and 4.7, respectively), although retailers generally find these factors difficult to assess given the increased prevalence of LED technology in recent years and the multiple existing sources of awareness. That said, retailers believe that knowledge has increased for both staff and consumers from year-over-year exposure to the campaign and due to the more broadly increased prevalence of information available on LED technology. Although retailers believe that the Instant Savings rebate is most attractive to consumers, the resulting interest in the product indirectly leads to increased consumer awareness and attention paid to LED lamps and their benefits.

There continues to be a decline in the perceived influence of Instant Savings on the variety of LED lamps stocked in-store, with the average influence rating being 3.4 on the 10-point scale. Retailers generally consider that Instant Savings has a minimal impact in this regard, with five retailers providing scores of 0 to 5, while one retailer was unable to provide a score. The choice of SKU is primarily driven by supplier recommendations, internal knowledge, and insights into consumer demand.

In terms of inventory levels, the perceived influence of Instant Savings stands at 5.5 on the 10-point scale. While three retailers provided an influence rating ranging from 7 to 10 as they need to bring in stock to respond to consumer demand during the campaign periods, the other three retailers provided lower scores of 0, 3, and 5. One of those retailers was left with unsold products from 2020, thus not requiring a larger order for the 2021 campaigns, while two retailers did not see a large increase in sales during the campaign periods.

Table 23 below provides an overview of the average ratings on each assessed influence factor.

Table 23: Influence of Instant Savings on LED Lamps, 2018-2021

Influence Factors	2018		2019		2020		2021	
	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size
Consumer knowledge about LED lamps and their benefits	8.0	8	6.7	7	6.4	8	5.7	6
Staff knowledge about LED lamps and their benefits	6.5	9	6.7	7	6.0	7	4.7	6
Quantity of LED lamps stocked in-store	7.4	8	6.3	7	5.9	8	5.5	6
Variety of LED lamps stocked in-store	7.4	9	3.7	7	2.4	8	3.4	5
Scale: 0 = Not at all influential; 10 = A great deal of influence Base: Retailers who provided a rating								

LED Fixtures

The perceived level of influence of Instant Savings on consumer and sales staff knowledge about LED fixtures and their benefits is moderate and has declined overall since 2020. The average influence rating for consumer knowledge is 5.8 while it stands at 4.7 for staff knowledge on the 10-point scale. As with the LED lamps, there is a general perception that knowledge has accumulated over time with the increased availability of and familiarity with these products. Three retailers provided a rating of 6 or 7 for the influence on staff knowledge given program component impacts on awareness over time. One retailer provided a rating of 5 because they noticed fewer questions from customers regarding this technology. The last two retailers provided a rating of 1 and 2 given increases in staff baseline knowledge about LED technology over time through various sources.

The influence of Instant Savings on consumer knowledge is moderate with an average influence score of 5.8. Three retailers provided an influence score ranging from 7 to 10 as the rebates elicit interest in the product, which then influences certain consumers to look for information to assist with their purchase decisions. The other three retailers provided a more moderate influence rating ranging from 2 to 5, primarily because Instant Savings is considered to have more of an impact on impulse purchases than on planned purchases.

Most retailers state that they choose the LED fixture SKU they carry in-store based on their own insights into consumer demand and market trends rather than aligning with Instant Savings (with the influence rating averaging 5.2). While three retailers offered influence ratings of 7 or 8, three others provided a score ranging from 0 to 5. Instant Savings is believed to have more influence on the quantity of LED fixtures retailers carry, notably during the campaign periods (influence score averaging 7.2). Four retailers provided a rating of 9 or 10 as they increase their supply levels during the campaign periods, while one retailer provided a rating of 4 because they believe that general interest in LED fixtures drives the increased sales more so than Instant Savings. The last retailer provided a score of 0 given their limited sales of LED fixtures even during the campaign periods.

Table 24 provides an overview of the average ratings on each assessed influence factor.

Table 24: Influence of Instant Savings on LED Fixtures, 2019-2021

Influence Factors	2019		2020		2021	
	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size
Consumer knowledge about LED fixtures and their benefits	6.4	7	6.5	8	5.8	6
Staff knowledge about LED fixtures and their benefits	6.4	7	5.9	8	4.7	6
Quantity of LED fixtures stocked in-store	6.3	7	6.6	8	7.2	6
Variety of LED fixtures stocked in-store	4.0	7	3.2	8	5.2	6
Scale: 0 = Not at all influential; 10 = A great deal of influence Base: Retailers who provided a rating						

2021 Instant Savings Participant and Partner Perspective Highlights

- › Awareness about the program component slightly decreased in 2021 (58%) compared to 2020 (68%). In-store promotion remains the main source of awareness for participants, with in-store personnel and the ENS website also being important sources of awareness for participants in 2021.
- › Retailers continue to be satisfied with Instant Savings overall, however satisfaction saw a decrease in 2021 (8.0 on a 10-point scale) compared to 2020 (8.8 on a 10-point scale). Retailers remain highly satisfied with their interactions with the program component delivery representatives from Summerhill (8.7 on a 10-point scale).
- › As reported by retailers and similarly to 2020, the average influence of the program component is moderate on LED products, with the highest influence being on consumer knowledge about LED products as well as the quantity of products stocked in-store, particularly for LED fixtures.

8 INSTANT SAVINGS IMPACT EVALUATION

The objective of the 2021 Instant Savings impact evaluation is to determine the gross and net electrical energy and peak demand savings.

8.1 Tracking Sheet Audit

To ensure program component results are reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix VII. Therefore, the tracked savings results presented in this report refer to the corrected tracked savings obtained by the Evaluator.

8.2 Gross Savings

For Instant Savings, gross savings correspond to the change in energy consumption resulting from eligible energy efficient products being purchased by participants, regardless of why they participated.¹⁶

8.2.1 Installation Rates

The installation rates of products sold under Instant Savings are assumed to be 100%. Please refer to the 2020-2022 Measure Assessment for details.

8.2.2 Unitary Energy Savings

The Evaluator validated the unitary savings values based on the 2020–2022 Measure Assessment and reviewed the unitary savings values for LED lamps and fixtures. Appendix VIII provides the detailed description of inputs, references, and unitary savings calculations for LED lamps and fixtures. Detailed descriptions of inputs, references, and unitary savings for all other products are provided in the 2020–2022 Measure Assessment.

The revised unitary savings values and the reasons for the changes were as follows:

- › For ENERGY STAR certified LED lamps and fixtures, the unitary savings values were updated to include the wattage values of the most popular products sold in 2021.
- › For heat pump water heaters, the unitary savings were updated to account for the percentage of electric water heaters by space heating type. The value was updated based on information from the 2018–2020 ARet tracking sheets.

¹⁶ Definition adapted from: National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

The unitary savings remain unchanged for all other products since their parameters have remained stable over the last 2-5 years and more recent or accurate sources for calculating such savings were not found in the literature. Table 25 below summarizes the tracked and revised energy savings values for each product category rebated through Instant Savings in 2021.

Table 25: 2021 Instant Savings Tracked and Evaluated Unitary Energy Savings

Product	Tracked Savings [kWh/year]	Evaluated Savings [kWh/year]
ENERGY STAR Certified LED Non-A-type Lamps (R, BR, and Decorative)	45.0	47.2
ENERGY STAR Certified LED Non-A-type Lamps (excluding R, BR, and Decorative)	45.7	No change
ENERGY STAR Certified LED Recessed Downlight Fixtures	51.3	55.3
ENERGY STAR Certified LED Fixtures	63.5	67.8
ENERGY STAR Certified LED Fixtures with Motion Sensors	137	128.3
Dimmer Switches	17.0	No change
Indoor Motion Sensors	45.8	No change
Indoor Motion Sensors with Dimmer Switches	53.6	No change
Outdoor Motion Sensors	159	No change
Power Bars with Integrated Timers	53.7	No change
Load Sensing Power Bars (smart strips)	53.8	No change
Heavy-duty Outdoor Timers	122	No change
Programmable Thermostats	221	No change
Smart Thermostats for Electrical Baseboards	348	No change
Clotheslines and Outdoor Drying Racks	104	No change
Efficient Clothes Washers	165	No change
Efficient Clothes Dryers	151	No change
ENERGY STAR Certified Room Air Purifiers	435	No change
ENERGY STAR Certified Dehumidifiers	45.2	No change
ENERGY STAR Certified Pool Pumps	530	No change
ENERGY STAR Certified Heat Pump Water Heaters	1026	907
High Efficiency Showerheads	134	No change

EOne identified the eligible products that are smart devices¹⁷ in the tracking sheet. Excluding smart thermostats, which are already tracked separately, 5,530 products were identified as smart devices. All product categories included products identified as smart devices, with programmable thermostats, ENERGY STAR LED fixtures and dimmer switches constituting the majority of the smart products sold. Since the number of smart devices is not significant among eligible products (3%), the Evaluator recommends applying the unitary savings value associated with the standard product and to keep tracking smart devices in the tracking sheet.

8.2.3 Unitary Peak Demand Savings

Peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The projected electricity peak demand period in Nova Scotia is between 5 p.m. and 7 p.m. from December to February on non-holiday weekdays. The Evaluator developed unitary peak demand savings for each measure for all other products and the differences between tracked and evaluated peak demand savings reflect updates made to the unitary energy savings of those products. The peak demand-to-energy ratios used are presented in the 2020–2022 Measure Assessment.

Table 26 summarizes the tracked and evaluated unitary peak demand savings values for each product installed through Instant Savings in 2021.

¹⁷ Smart devices are products that can be connected to other devices or networks using wireless protocols. It also includes products that use artificial intelligence to learn behavioral patterns.

Table 26: 2021 Instant Savings Tracked and Evaluated Unitary Peak Demand Savings

Product	Tracked Savings [W/year]	Evaluated Savings [W/year]
ENERGY STAR Certified LED Non-A-type Lamps (R, BR, and Decorative)	7.29	7.65
ENERGY STAR Certified LED Non-A-type Lamps (excluding R, BR, and Decorative)	7.40	No change
ENERGY STAR Certified LED Recessed Downlight Fixtures	8.31	8.96
ENERGY STAR Certified LED Fixtures	10.3	11.0
ENERGY STAR Certified LED Fixtures with Motion Sensors	22.2	20.8
Dimmer Switches	2.75	No change
Indoor Motion Sensors	0.00	No change
Indoor Motion Sensors with Dimmer Switches	0.00	No change
Outdoor Motion Sensors	0.00	No change
Power Bars with Integrated Timers	0.00	No change
Load Sensing Power Bars (smart strips)	0.00	No change
Heavy-duty Outdoor Timers	0.00	No change
Programmable Thermostats	0.00	No change
Smart Thermostats for Electrical Baseboards	0.00	No change
Clotheslines and Outdoor Drying Racks	0.00	No change
Efficient Clothes Washers	22.8	No change
Efficient Clothes Dryers	20.8	No change
ENERGY STAR Certified Room Air Purifiers	74.4	No change
ENERGY STAR Certified Dehumidifiers	15.1	No change
ENERGY STAR Certified Pool Pumps	0.00	No change
ENERGY STAR Certified Heat Pump Water Heaters	166	147
High Efficiency Showerheads	21.7	No change

8.2.4 Interactive Effects

In a home, interactive effects occur when implementing energy efficiency measures has an impact on the energy consumption of other elements such as heating and cooling. Interactive effects occur only when products are installed inside the house. In the case of Instant Savings, replacing incandescent lighting products with LED lamps results in an increase in the heating load during the winter and a decrease in the cooling load during the summer.

Lighting Products and Controls

The weighted interactive effects factors for lighting products were established as part of the 2020–2022 Measure Assessment activities and considered the various types of space heating and cooling found in Nova Scotia homes. Since ENERGY STAR certified LED lamps and ENERGY STAR certified LED fixtures purchased through the program component are also used for outdoor lighting, the interactive effects factors for these products were adjusted to take this into account.

Table 27 presents the interactive effects factors for LED products. The weighted interactive effects factors established in the 2020–2022 Measure Assessment for each lighting product were multiplied by an estimate of the proportion of the product installed indoors and outdoors to obtain an energy and peak demand interactive effect factor for each lighting product purchased through Instant Savings.

Table 27: 2021 Instant Savings Interactive Effects Factors for Lighting Products

Product Category - LED Lamps Fixtures and Other Indoor Devices	Weighted Energy Interactive Effects Factor	Weighted Peak Demand Interactive Effects Factor	Indoor %	Outdoor %	Energy Interactive Effects Factor	Peak Demand Interactive Effects Factor
ENERGY STAR Certified LED Non-A-type Lamps (R, BR, and Decorative)	-20.1%	-41.4%	92%	8%	-18.5%	-38.1%
ENERGY STAR Certified LED Non-A-type Lamps (excluding R, BR, and Decorative)			92%	8%	-18.5%	-38.1%
ENERGY STAR Certified LED Recessed Downlight Fixtures			100%	0%	-20.1%	-41.4%
ENERGY STAR Certified LED Fixtures			91%	9%	-18.3%	-37.7%
ENERGY STAR Certified LED Fixtures with Motion Sensors			2%	98%	-0.4%	-0.8%
Indoor Motion Sensors			100%	0%	-20.1%	-41.4%
Indoor Motion Sensors with Dimmers			100%	0%	-20.1%	-41.4%
Dimmer Switches			100%	0%	-20.1%	-41.4%

The proportions of LED lamps installed indoors and outdoors were determined using the 2016 Socket Study¹⁸ that surveyed 1,008 Nova Scotia residents. The proportions of ENERGY STAR certified LED fixtures installed indoors and outdoors were determined using the information provided in the 2021 tracking sheet for the most popular products (top 10 or more depending on the product) sold through Instant Savings, which respectively represent 83% and 65% of the total products sold for fixtures with motion sensors and fixtures without motions sensors.

For ENERGY STAR certified LED recessed downlight fixtures, the Evaluator assumed they were all installed indoors. Lighting controls sold through the program component, that is dimmer switches and indoor motion sensors, were also assumed to be all installed indoors.

Other Products

No interactive effects factors were calculated for power bars, outdoor devices, and thermostats sold through the program component. For clotheslines and outdoor drying racks, as well as large appliances, interactive effects were considered negligible.

8.2.5 Effective Useful Life

The Evaluator validated the EUL values based on the 2020–2022 Measure Assessment. The EUL values are used in the calculation of electrical energy savings that are expected to persist over time.

Table 28 summarizes the tracked and revised equivalent EUL values. The revised equivalent EUL values were applied to the gross and net first-year electrical energy savings of each product to obtain gross and net lifetime electrical energy savings. As a result, the weighted average EUL values of gross and net savings differ (see subsections 8.2.6 and 8.3.4 below).

¹⁸ Corporate Research Associates Inc., *2016 Socket Study*, Final Report prepared for Efficiency Nova Scotia, December 2016.

Table 28: 2021 Instant Savings Equivalent EUL Values

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]	Evaluated Gross Lifetime Unitary Savings [kWh]
ENERGY STAR Certified LED Non-A-type Lamps (R, BR, and Decorative)	5.1	4.2	198
ENERGY STAR Certified LED Non-A-type Lamps (Excluding R, BR, and Decorative)	5.5	5.0	229
ENERGY STAR Certified LED Recessed Downlight Fixtures	6.0	4.6	254
ENERGY STAR Certified LED Fixtures Without Motion Sensors	8.5	7.4	502
ENERGY STAR Certified LED Fixtures with Motion Sensors	9.7	8.1	1,037
Dimmer Switches	10.0	No change	170
Indoor Motion Sensors	10.0	No change	458
Indoor Motion Sensors with Dimmer Switches	10.0	No change	536
Outdoor Motion Sensors	10.0	No change	1,590
Power Bars with Integrated Timers	4.0	No change	215
Load Sensing Power Bars (smart strips)	4.0	No change	215
Heavy-duty Outdoor Timers	10.0	No change	1,220
Programmable Thermostats	10.0	No change	2,210
Smart Thermostats for Electrical Baseboards	10.0	No change	3480
Clotheslines and Outdoor Drying Racks	10.0	No change	1,040
Efficient Clothes Washers	11.0	No change	1,815
Efficient Clothes Dryers	12.0	No change	1,812
ENERGY STAR Certified Room Air Purifiers	9.0	No change	3,915
ENERGY STAR Certified Dehumidifiers	12.0	No change	542
ENERGY STAR Certified Variable Speed Pool Pumps	10.0	No change	5,300
ENERGY STAR Certified Heat Pump Water Heaters	10.0	No change	9,070
High Efficiency Showerheads	10.0	No change	1,340

8.2.6 Evaluated Gross Savings

The annual gross savings are based on the revised unitary savings values established for each product sold in 2021. The results are presented in Table 29 further below.

The gross savings at the generator were estimated by using a line loss factor of 1.095 and 1.147 for energy and peak demand savings respectively. The line loss factors correspond to the values submitted to the Nova Scotia Utility and Review Board (NSUARB) as part of the 2014 Cost of Service Study Progress Update.¹⁹ The gross energy savings at the generator were established at 15.792 GWh, which translates into 128.201 GWh in lifetime energy savings. As a result, the weighted average EUL value for gross energy savings is 8.12 years. The total gross peak demand savings were estimated at 1.819 MW at the generator.

¹⁹ Nova Scotia Utility and Review Board, *Matter M06555, 2014 Cost of Service Study Progress Update*, Exhibit N-2.09, Appendix I1.

Table 29: Evaluated 2021 Instant Savings Gross Energy and Peak Demand Savings

Product Category	LED Non-A-type Lamps		LED Recessed Downlight Fixtures	LED ENERGY STAR Fixtures		Dimmer Switches	Indoor Motion Sensors
	R, BR, and Decorative	Others		Without Motion Sensors	With Motion Sensors		
Number of Units							
Number of Units – Spring	17,000	13,240	-	-	-	4,262	100
Number of Units – Fall	25,382	20,821	-	-	-	4,715	184
Number of Units – Year-round	-	-	34,262	27,456	407	-	-
Total Number of Units	42,382	34,061	34,262	27,456	407	8,977	284
Energy Savings							
Unitary Energy Savings Value (kWh)	47.2	45.7	55.3	67.8	128	17.0	45.8
Energy Interactive Effects Factor	-18.5%	-18.5%	-20.1%	-18.3%	-0.4%	-20.1%	-20.1%
Gross Energy Savings - at the Meter (GWh)	1.630	1.269	1.514	1.521	0.052	0.122	0.010
Line Loss Factor	1.095	1.095	1.095	1.095	1.095	1.095	1.095
Gross Energy Savings - at the Generator (GWh)	1.785	1.389	1.657	1.665	0.057	0.133	0.011
Effective Useful Life (years)	4.2	5.0	4.6	7.4	8.1	10.0	10.0
Gross Lifetime Energy Savings - at the Generator (GWh)	7.496	6.944	7.623	12.320	0.460	1.335	0.114
Peak Demand Savings							
Unitary Peak Demand Savings (W)	7.65	7.40	8.96	11.00	20.80	2.75	0.00
Peak Demand Interactive Effects Factor	-38.1%	-38.1%	-41.4%	-37.7%	-0.8%	-41.4%	-41.4%
Gross Peak Demand Savings - at the Meter (MW)	0.201	0.156	0.180	0.188	0.008	0.014	0.000
Line Loss Factor	1.147	1.147	1.147	1.147	1.147	1.147	1.147
Gross Peak Demand Savings - at the Generator (MW)	0.230	0.179	0.206	0.216	0.010	0.017	0.000

Evaluated 2021 Instant Savings Gross Energy and Peak Demand Savings (Continued)

Product Category	Outdoor Motion Sensors	Power Bars with Timers	Smart Power Bars	Heavy-duty Outdoor Timers	Programmable Thermostats	Smart Thermostats for EBB	Clotheslines
Number of Units							
Number of Units – Spring	786	43	2	7,170	4,025	-	-
Number of Units – Fall	1,768	52	35	9,176	222	-	-
Number of Units – Year-round	-	-	-	-	-	261	1,542
Total Number of Units	2,554	95	37	16,346	4,247	261	1,542
Energy Savings							
Unitary Energy Savings Value (kWh)	159	53.7	53.8	122	221	348	104
Energy Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Gross Energy Savings - at the Meter (GWh)	0.406	0.005	0.002	1.994	0.939	0.091	0.160
Line Loss Factor	1.095	1.095	1.095	1.095	1.095	1.095	1.095
Gross Energy Savings - at the Generator (GWh)	0.445	0.006	0.002	2.183	1.027	0.099	0.176
Effective Useful Life (years)	10.0	4.0	4.0	10.0	10.0	10.0	10.0
Gross Lifetime Energy Savings - at the Generator (GWh)	4.445	0.022	0.009	21.831	10.275	0.994	1.756
Peak Demand Savings							
Unitary Peak Demand Savings (W)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Peak Demand Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Gross Peak Demand Savings - at the Meter (MW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Line Loss Factor	1.147	1.147	1.1476	1.147	1.147	1.147	1.147
Gross Peak Demand Savings - at the Generator (MW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Evaluated 2021 Instant Savings Gross Energy and Peak Demand Savings (Continued)

Product Category	Efficient Clothes Washers	Efficient Clothes Dryers	Room Air Purifiers	Dehumidifiers	Pool Pumps	Heat Pump Water Heaters	Showerheads	Total for All Products
Number of Units								
Number of Units – Spring	-	-	-	-	-	-	258	46,886
Number of Units – Fall	-	-	-	-	-	-	645	63,000
Number of Units – Year-round	4,215	5,106	5,581	12,274	71	114	-	91,289
Total Number of Units	4,215	5,106	5,581	12,274	71	114	903	201,175
Energy Savings								
Unitary Energy Savings Value (kWh)	165	151	435	45.2	530	907	134	-
Energy Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
Gross Energy Savings - at the Meter (GWh)	0.695	0.771	2.428	0.555	0.038	0.103	0.121	14.426
Line Loss Factor	1.095	1.095	1.095	1.095	1.095	1.095	1.095	-
Gross Energy Savings - at the Generator (GWh)	0.761	0.844	2.658	0.607	0.041	0.113	0.132	15.792
Effective Useful Life (years)	11.0	12.0	9.0	12.0	10.0	10.0	10.0	-
Gross Lifetime Energy Savings - at the Generator (GWh)	8.375	10.128	23.919	7.288	0.412	1.132	1.325	128.201
Peak Demand Savings								
Unitary Peak Demand Savings (W)	22.80	20.80	74.40	15.10	0.00	147.00	21.70	-
Peak Demand Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
Gross Peak Demand Savings - at the Meter (MW)	0.096	0.106	0.415	0.185	0.000	0.017	0.020	1.587
Line Loss Factor	1.147	1.147	1.147	1.147	1.147	1.147	1.147	-
Gross Peak Demand Savings - at the Generator (MW)	0.110	0.122	0.476	0.213	0.000	0.019	0.022	1.819

Figure 12 and Figure 13 below compare the tracked unitary electrical energy and peak demand savings to the evaluated gross savings. Both sets of savings values include adjustments to account for interactive effects. As outlined in Figure 12, the most significant difference in gross energy and peak demand savings came from the revision of the unitary savings and unitary peak demand savings value for LED lamps, LED fixtures, and ENERGY STAR certified heat pump water heaters.

Figure 12: 2021 Instant Savings Tracked and Evaluated Gross Savings

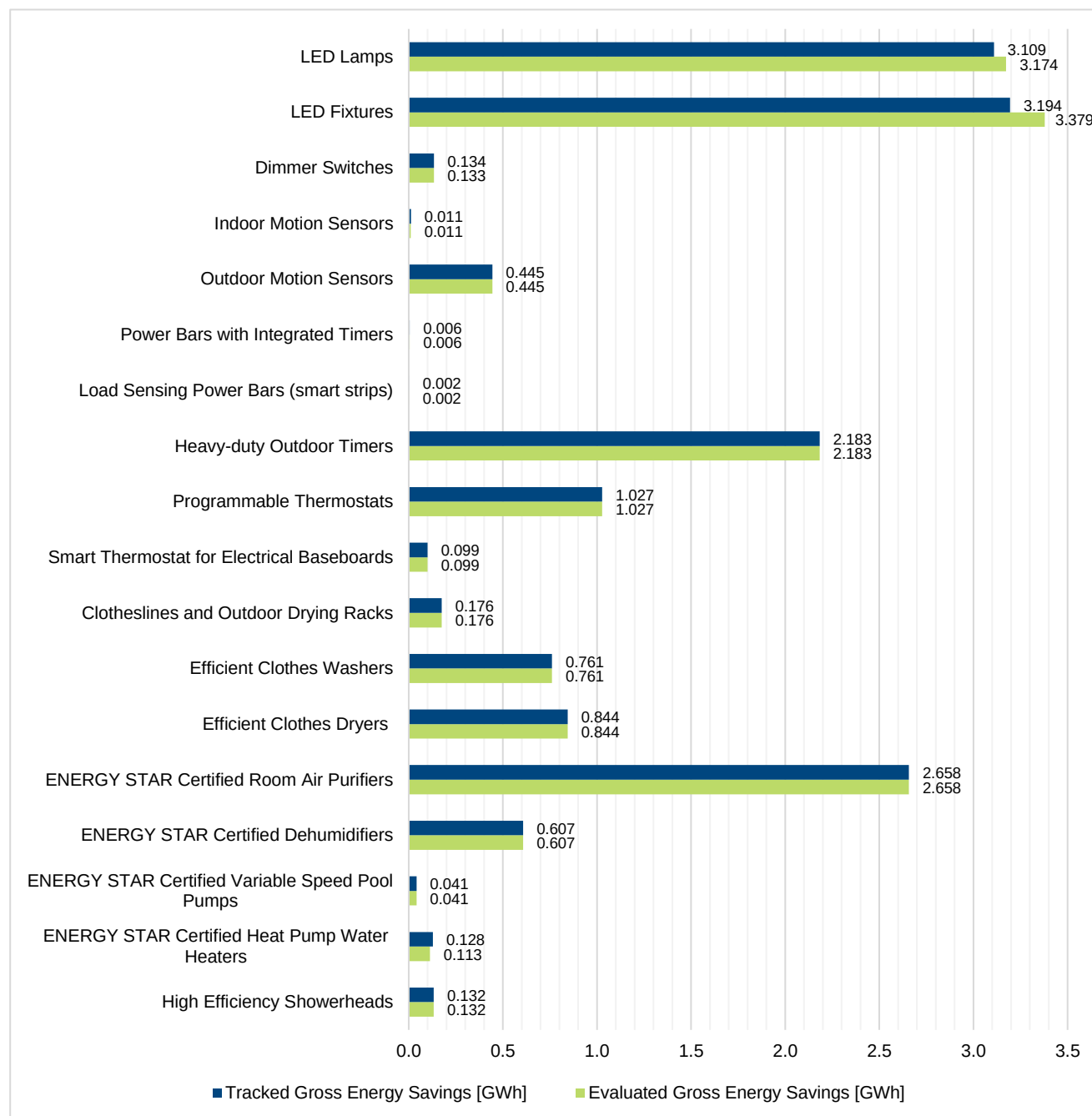
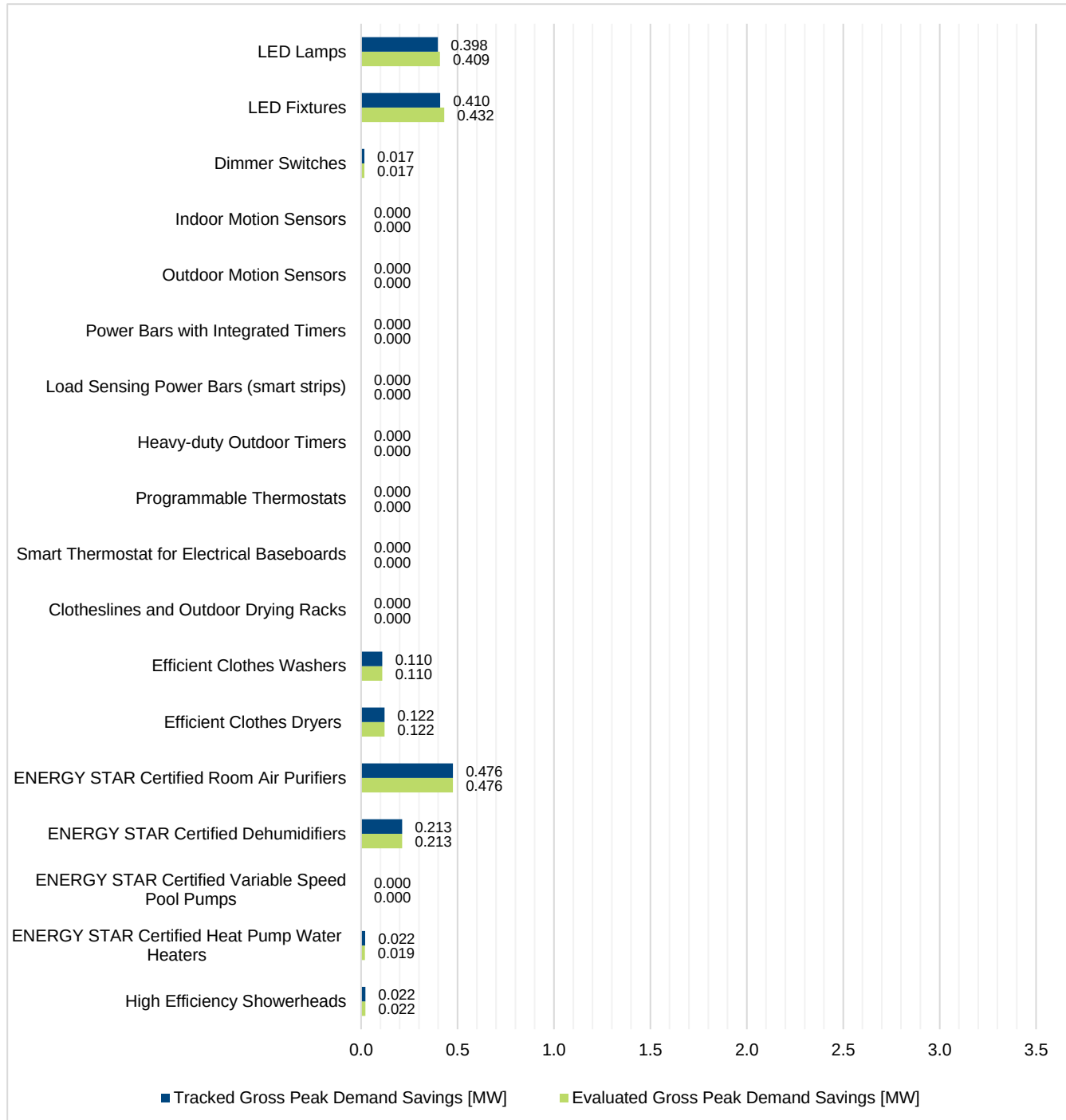


Figure 13: 2021 Instant Savings Tracked and Evaluated Gross Peak Demand Savings



8.3 Net Savings

The Evaluator determined the net energy and peak demand savings, that is the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the NTGR. In the case of Instant Savings, free-ridership and spillover are considered for two specific products – LED lamps and LED fixtures. These products were selected since they remain the best-selling product categories of the program component, accounting for 41% of total gross savings.

8.3.1 Free-ridership

The free-ridership level is calculated using algorithms that assess the likelihood for participants to have purchased LED lamps or fixtures without the discount offered through Instant Savings. The algorithms consider all applicable variables in the decision-making process, including awareness about the discount, cost, timing, and quantity. The algorithms underlying the free-ridership calculations is presented in Appendix IX.

The free-ridership level was assessed using a self-reporting approach that involved asking a series of questions through an online survey to participants who had purchased LED lamps, LED recessed downlight fixtures, or other LED fixtures. In response to continuing retailer social distancing requirements, the online survey approach was used instead of the intercept survey used in previous years.

Costco accounts for 34% of lighting product sales for Instant Savings; however, the 2021 online survey did not serve to collect sufficient responses from participants making purchases at Costco. Therefore, similar to 2020, the Evaluator decided to calculate a free-ridership level associated with non-Costco participants and use 2019 data to establish a free-ridership level associated with Costco purchasers. The following subsections present those results.

Measurement of Free-ridership for Non-Costco Participants

The free-ridership results for non-Costco participants are presented in Table 30 below. A specific free-ridership level was also calculated for LED recessed downlight fixtures and other LED fixtures, excluding recessed downlights, to understand if there are differences in consumer behaviour between these products, particularly with respect to the quantities purchased since recessed downlight fixtures are often purchased in multipacks, which is not the case for other LED fixtures.

Table 30: 2021 Instant Savings Free-ridership Levels for Non-Costco Participants

Product Category	Free-ridership	
	Level	Margin of Error
LED Lamps	64%	6.4%
LED Recessed Downlight Fixtures	56%	10.3%
Other LED Fixtures	33%	7.5%
All Other Products	-	-

For non-Costco participants, the survey revealed a free-ridership level of 64% for LED lamps. This level is higher than the 42% obtained during the 2020 evaluation. The online survey revealed that a larger proportion of participants were more likely to buy LED lamps in the absence of the discount offered through Instant Savings than in 2020. More participants were unaware of the discount before paying at the cash in 2021 or had the intention to buy LED lamps regardless of the discount. More precisely, 48% of surveyed participants purchasing LED lamps were unaware of the discount in 2021 compared to 35% in 2020. In addition, 89% of those participants who were aware of the discount stated that they would have purchased LEDs if the discount had not been offered, compared to 62% in 2020.

The free-ridership level obtained for LED recessed downlight fixtures is 56%, which is slightly lower than the 61% obtained during the 2020 evaluation.

The 2021 online survey revealed a free-ridership level of 33% for other LED fixtures, which is substantially lower than the 58% obtained in 2020. Conversely to LED lamps, the survey revealed that a smaller proportion of participants were likely to buy other LED fixtures in the absence of the discount than in 2020, with 37% of participants who were unaware of the discount before paying at the cash compared to 54% in 2020. Compared to 2020, among those aware of the discount, more participants in 2021 would not have made the purchase, would have put off their purchase, or purchased a lower quantity of the fixtures if the discount had not been offered.

When considered together, the free-ridership level for LED fixtures for non-Costco participants was 45% compared to the 59% established in the 2020 evaluation.

Treatment of Free-ridership for Costco Participants

Given the relatively large portion of lighting sales from Costco and indications based on 2019 data that Costco purchasers may have different behaviours than purchasers at other retailers, the Evaluator established a free-ridership level associated with Costco purchasers for LED lamps and LED fixtures based on 2019 data. The 2019 results are based on an intercept survey that used the same questions and algorithms for LED lamps and fixtures as in 2021, except for a small change made in 2021 to account for LED fixtures being rebated year-round. The results are presented in Table 31 below. Note that a specific free-ridership level for recessed downlight fixtures was not calculated in 2019; therefore, those products are included in the LED fixture product category.

Table 31 : 2019 Instant Savings Free-ridership Levels for Costco Participants

Product	Free-ridership	
	Level	Margin of Error
LED Lamps	11%	10.2%
LED Fixtures	34%	9.4%

The evaluator recommends updating the free-ridership level for Costco participants in the 2022 evaluation. If Costco data continue to be unavailable and considering changes in participant behaviour observed since 2020, particularly for LED lamps, the Evaluator recommends applying results obtained for the program based on non-Costco participants.

Overall 2021 Free-ridership Levels

The overall free-ridership levels for LED lamps and fixtures correspond to the average of the 2019 Costco free-ridership levels and the free-ridership of the other retailers obtained in 2021, weighted by the number of units sold in 2021 for each product category.

Table 32 outlines the free-ridership levels for LED lamps and fixtures.

Table 32 : 2021 Instant Savings Free-ridership Levels for LED Lamps and Fixtures

Product Category	Retailer	Evaluation Period	Free-ridership		Number of Units Sold in 2021	Weighted Average Free-ridership	
			Level	Margin of Error		Level	Margin of Error
LED Lamps	Costco	2019	11%	10.2%	25,877	46%	5.5%
	Non-Costco	2021	64%	6.4%	50,566		
LED Fixtures	Costco	2019	34%	9.4%	20,858	41%	5.3%
	Non-Costco	2021	45%	6.3%	41,267		

As for all other types of products rebated through Instant Savings, the Evaluator considered the free-ridership values to be nil. Table 33 below outlines the free-ridership levels for products sold through Instant Savings in 2021.

Table 33: 2021 Instant Savings Free-ridership

Product Category	Free-ridership	
	Level	Margin of Error
LED Lamps	46%	5.5%
LED Fixtures	41%	5.3%
All Other Products	-	-

8.3.2 Spillover

Throughout the year, sales of eligible products may have occurred due to the influence of Instant Savings even if no discount was offered. This influence is due to better knowledge and awareness about energy efficient products and changes in retailer offerings. These sales should be attributable to the program component as a form of market effect.

Retailer interviews were used to estimate the level of spillover by measuring the market effects attributable to the program component for non-A-type LED lamps and LED fixtures. For the 2021 evaluation, retailers were asked to provide their sales numbers for all ENERGY STAR certified LED lamps and fixtures sold throughout the year and not just the models selected for a rebate.

The methodology used to calculate the level of spillover is presented in Appendix X. It consists of estimating the number of LED lamps and fixtures sold without receiving a rebate from the Instant Savings campaigns and the proportion of those sales that can be attributed to the program component. The retailers from whom the Evaluator collected full or partial data account for 80% of non-A-type lamp sales and 72% of LED fixture sales.

A market effects level of 9% was measured for non-A-type LED lamps. This means that the portion of retailer sales outside of campaigns that are attributable to Instant Savings is equivalent to 9% of 2021 rebated LED non-A-type sales. The market effects level was estimated at 14% in 2020 for LED non-A-type sales.

A market effects level of 32% was measured for LED fixtures for 2021, up from the level established in 2020 (16%). The market effects were largely driven by one large retailer that reported a sizable number of sales outside of the campaigns in 2021 combined with attributing a relatively high influence to EOne's program, notably on the quantity of fixtures stocked in stores.

For each product, Table 34 below outlines the spillover level by product category. The Evaluator considered the spillover values for all other products rebated through Instant Savings to be nil.

Table 34: 2021 Instant Savings Spillover Levels

Product Category	Spillover Level
LED Lamps	9%
LED Fixtures	32%
All Other Products	-

8.3.3 Net-to-gross Ratio Calculation

The NTGR is calculated using the following equation:

$$NTGR = (1 - \% \text{ Free-ridership} + \% \text{ Spillover})$$

Using this equation, the NTGRs for LED lamps and fixtures were estimated at 0.63 and 0.91 respectively, as presented in Table 35 below. For all other products, an NTGR of 1.00 was used. The free-ridership and spillover levels for non-LED products could not be assessed through this evaluation. Units such as dimmer switches, occupancy sensors, and power bars with integrated timers are specialized products grouped into broader retail categories, which makes it difficult for retailers to estimate program component influence on product sales. Moreover, the population segments for these products are smaller, which makes it more difficult to reach these consumers through the online survey or general population survey. A margin of error is not presented for spillover since it is established by a census. Table 35 summarizes the NTGR of each product according to their respective free-ridership and spillover levels.

Table 35: 2021 Instant Savings Net-to-gross Ratios

Product Category	Free-ridership		Spillover	Net-to-gross Ratio
	Level	Margin of Error		
LED Lamps	46%	5.5%	9%	0.63
LED Fixtures	41%	5.3%	32%	0.91
All Other Products	-	-	-	1.00

8.3.4 Evaluated Net Savings

Net savings are defined as the changes in energy use that are attributable specifically to Instant Savings. Net program component impacts were estimated by applying the overall NTGR to gross savings, as exemplified in the following equation.

$$\text{Net Savings} = \text{Gross Savings} \times \text{NTGR}$$

This equation was used to calculate both net electrical energy savings and peak demand savings.

The Evaluator determined that Instant Savings achieved 14.314 GWh in net electrical energy savings and 1.629 MW in net peak demand savings at the generator. The net lifetime electrical energy savings were established at 121.022 GWh, which yields a weighted average EUL value of 8.4 years for net electrical energy savings. The detailed results are presented in Table 36 below.

Table 36: Evaluated 2021 Instant Savings Net Energy and Peak Demand Savings

Product Category	LED Non-A-type Lamps		LED Recessed Downlight Fixtures	LED ENERGY STAR Fixtures		Dimmer Switches	Indoor Motion Sensors
	R, BR, and Decorative	Others		Without Motion Sensors	With Motion Sensors		
Energy Savings							
Gross Energy Savings – at the Meter (GWh)	1.630	1.269	1.514	1.521	0.052	0.122	0.010
NTGR	0.63	0.63	0.91	0.91	0.91	1.00	1.00
Net Energy Savings – at the Meter (GWh)	1.027	0.799	1.378	1.384	0.047	0.122	0.010
Line Loss Factor	1.095	1.095	1.095	1.095	1.095	1.095	1.095
Net Energy Savings – at the Generator (GWh)	1.124	0.875	1.508	1.515	0.052	0.133	0.011
Effective Useful Life (years)	4.2	5.0	4.6	7.4	8.1	10.0	10.0
Net Lifetime Energy Savings – at the Generator (GWh)	4.722	4.375	6.937	11.211	0.419	1.335	0.114
Peak Demand Savings							
Gross Peak Demand Savings – at the Meter (MW)	0.201	0.156	0.180	0.188	0.008	0.014	0.000
NTGR	0.63	0.63	0.91	0.91	0.91	1.00	1.00
Net Peak Demand Savings – at the Meter (MW)	0.126	0.098	0.164	0.171	0.008	0.014	0.000
Line Loss Factor	1.147	1.147	1.147	1.147	1.147	1.147	1.147
Net Peak Demand Savings – at the Generator (MW)	0.145	0.113	0.188	0.196	0.009	0.017	0.000

Evaluated 2021 Instant Savings Net Energy and Peak Demand Savings (Continued)

Product Category	Outdoor Motion Sensors	Power Bars with Timers	Smart Power Bars	Heavy-duty Outdoor Timers	Programmable Thermostats	Smart Thermostats for EBB	Clotheslines
Energy Savings							
Gross Energy Savings – at the Meter (GWh)	0.406	0.005	0.002	1.994	0.939	0.091	0.160
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net Energy Savings – at the Meter (GWh)	0.406	0.005	0.002	1.994	0.939	0.091	0.160
Line Loss Factor	1.095	1.095	1.095	1.095	1.095	1.095	1.095
Net Energy Savings – at the Generator (GWh)	0.445	0.006	0.002	2.183	1.027	0.099	0.176
Effective Useful Life (years)	10.0	4.0	4.0	10.0	10.0	10.0	10.0
Net Lifetime Energy Savings – at the Generator (GWh)	4.445	0.022	0.009	21.831	10.275	0.994	1.756
Peak Demand Savings							
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Line Loss Factor	1.147	1.147	1.147	1.147	1.147	1.147	1.147
Net Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Evaluated 2021 Instant Savings Net Energy and Peak Demand Savings (Continued)

Product Category	Efficient Clothes Washers	Efficient Clothes Dryers	Room Air Purifiers	Dehumidifiers	Pool Pumps	Heat Pump Water Heaters	Showerheads	Total for All Products
Energy Savings								
Gross Energy Savings – at the Meter (GWh)	0.695	0.771	2.428	0.555	0.038	0.103	0.121	14.426
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-
Net Energy Savings – at the Meter (GWh)	0.695	0.771	2.428	0.555	0.038	0.103	0.121	13.076
Line Loss Factor	1.095	1.095	1.095	1.095	1.095	1.095	1.095	
Net Energy Savings – at the Generator (GWh)	0.761	0.844	2.658	0.607	0.041	0.113	0.132	14.314
Effective Useful Life (years)	11.0	12.0	9.0	12.0	10.0	10.0	10.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	8.375	10.128	23.919	7.288	0.412	1.132	1.325	121.022
Peak Demand Savings								
Gross Peak Demand Savings – at the Meter (MW)	0.096	0.106	0.415	0.185	0.000	0.017	0.020	1.587
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-
Net Peak Demand Savings – at the Meter (MW)	0.096	0.106	0.415	0.185	0.000	0.017	0.020	1.421
Line Loss Factor	1.147	1.147	1.147	1.147	1.147	1.147	1.147	-
Net Peak Demand Savings – at the Generator (MW)	0.110	0.122	0.476	0.213	0.000	0.019	0.022	1.629

As presented in Table 37, applying the Nova Scotia-specific factor²⁰ for GHG emissions generated by electricity production (0.5841 kg CO₂ eq/kWh), it was estimated that the annual net energy savings resulted in 8,361 tonnes of avoided CO₂ eq.

Table 37: Evaluated 2021 Instant Savings GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	14.314
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	8,361

8.4 Realization Rate

Table 38 compares the energy and peak demand savings established through this evaluation to those tracked by EOne. The realization rate representing the ratio of evaluated net savings to tracked net savings, was established at 104% for energy savings and at 104% for peak demand savings.

Table 38: Comparison of 2021 Instant Savings Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	15.559	GWh	0.89	13.820	GWh	104%
Evaluation Results	15.792	GWh	0.91	14.314	GWh	
Peak Demand Savings						
Tracked Savings by EOne	1.790	MW	0.88	1.567	MW	104%
Evaluation Results	1.819	MW	0.90	1.629	MW	
*NTGRs varied for each type of product. The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by gross savings.						

The evaluated net energy savings are 4% higher than the tracked net energy savings. This difference is mainly due to increases in spillover levels and decreases in the free-ridership level for LED fixtures, which resulted in a higher NTGR for this product category. Moreover, the increase in the unitary energy savings values of LED lamps, LED fixtures, and certified heat pump water heaters slightly contributed to the increase in energy savings.

²⁰ At the time of writing, 2021 data was not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:
 NS Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (last accessed November 8, 2021), Emera inc., *Management's Discussion & Analysis*, as at February 14, 2020 https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (last accessed November 8, 2021).

The evaluated net peak demand savings are 4% higher than those tracked by EOne, again due to the higher NTGR and increases in the unitary peak demand savings values of LED lamps, LED fixtures, and certified heat pump water heaters.

2021 Instant Savings Impact Evaluation Highlights

- › Instant Savings achieved 14.314 GWh in net electrical energy savings and 1.629 MW in net peak demand savings at the generator in 2021.
- › Free ridership for LED fixtures decreased in 2021, mostly due to the higher proportion of participants who were aware of the discount before paying at the cash in 2021 compared to 2020. Spillover for LED fixtures increased due to higher sales outside the rebate period for one large retailer.
- › Evaluated net energy savings and peak demand savings were both 4% higher than the tracked values mainly due to the higher spillover level and the lower free-ridership level for LED fixtures, which resulted in a higher NTGR.

9 INSTANT SAVINGS MARKET EVOLUTION

EOne has been active in the LED market since 2011 through Instant Savings. Market evolution assessments were completed as part of the 2017, 2018, and 2019 evaluations, the results of which served to analyze key market indicators and present a technology diffusion curve illustrating the market adoption of LED lighting in Nova Scotia. The aim of this section is to update the data collected as part of previous evaluations and provide up-to-date insights regarding the market transformation of LED lamps and LED fixtures in Nova Scotia. Given the LED market is rapidly evolving, regularly monitoring barriers to LED adoption is important to enable EOne to adapt the program component offer if needed.

In the following subsections herein, the Evaluator examines market shares, rebated products, retail prices, distributor outlooks, and free-ridership levels separately for LED lamps and LED fixtures. A section exploring codes and standards and a final market evolution overview is presented to complete the results of the analysis.

9.1 Market Indicators – LED Lamps

The Evaluator analyzed available market data and established key market indicators to understand the state of the LED lamp market in Nova Scotia.

9.1.1 Market Shares of Lamp Technologies in Atlantic Canada

The residential lighting market continues to be dominated by four main technologies, namely incandescent, halogen, CFL, and LED lamps. Secondary consumer data from Electro-Federation Canada available up to 2020²¹ as well as Electro-Federation market coverage assumptions were used to estimate lamp shipments and shares.

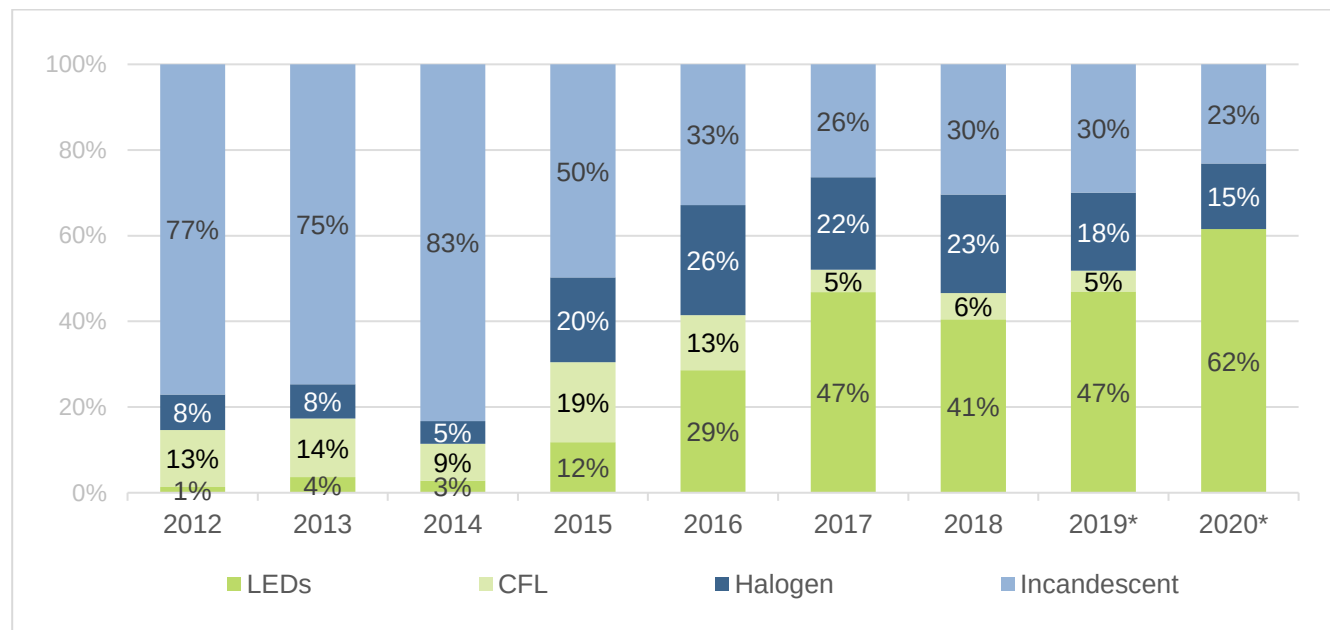
After remaining relatively flat between 2015 and 2017, the size of the consumer lighting market in Atlantic Canada decreased by 30% between 2017 and 2020 (and by 11% between 2019 and 2020). The drop in shipments can be seen mostly for incandescent and halogen lamps.²² These decreases are likely due to the introduction of alternatives to incandescent and halogen (CFLs, LEDs) lamps, which have longer product lives and thus require fewer replacement lamps. The COVID-19 pandemic also may have played a role in shipment decreases in 2020. That said, the consumer LED lamp market grew by 16% in 2020 compared to 2019. LEDs have been the lamp type with the most shipments in the residential lighting market since 2017.

²¹ Consumer Channel shipment data for Atlantic Canada and other regions were not available for 2019 and 2020; the Evaluator only had access to Total Canada data. The Evaluator estimated the 2019 and 2020 numbers by calculating the average of the ratios of Atlantic Canada to Total Canada sales for 2015-2018 inclusively and by applying this average to the Total Canada shipments for 2019 and 2020.

²² Data were not available for CFL lamps in 2020.

Figure 14 below illustrates shares for Atlantic Canada shipment data and reinforces the patterns described above. Shares for LED lamps increased to a new high at 62% of the consumer lighting market in 2020, thus compressing incandescent lamp shares to a low of 23% and reducing halogen lamp shares to 15%. Note that data for compact fluorescent lamp (CFL) lamps were not available for 2020, although the share of CFLs has hovered between 5-6% since 2017.

Figure 14: Atlantic Canada Consumer Lighting Shipments by Type of Technology, 2012-2020²³



Source: Electro-Federation Canada, Lamp Data - Consumer Channel 2018-2020 Revised.²⁴ *²⁵

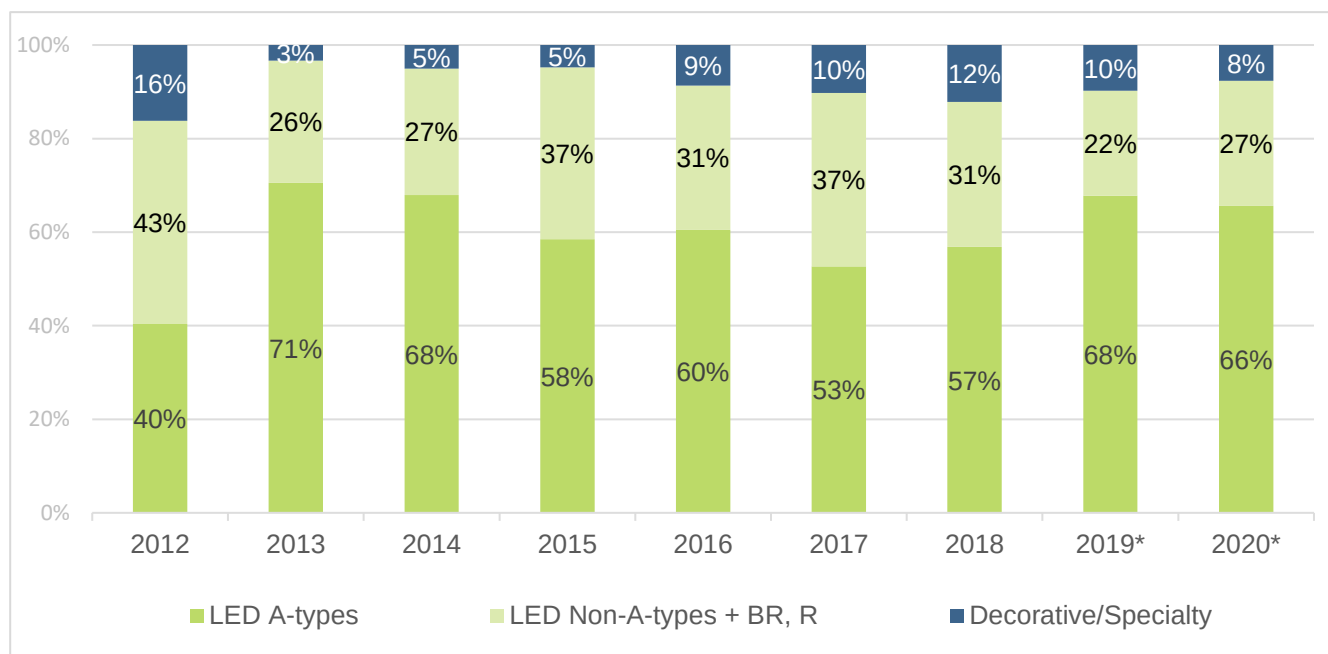
Figure 15 below breaks down LED shipments in the Atlantic region by lamp type. Non-A-type lamps are typically reflector lamps that replace halogen reflector lamps; BR and R lamps are also reflector lamps, although they primarily replace incandescent lamps. Since 2013, shares of LED shipments for A-type, non-A-type/BR/R, as well as decorative and specialty lamps have been fluctuating: A-types generally comprise over half to two-thirds of LED shipment shares, LED non-A-types/BR/R about one-quarter to one-third, and decorative and specialty lamps about 10% or less. It should be noted that shipments of LED non-A-type/BR/R lamps grew proportionally more than A-types (41% vs. 14% respectively) in 2020 compared to 2019.

²³ Data were not available for CFL lamps in 2020.

²⁴ Electro-Federation Canada revised the Consumer Channel shipment data for 2018 in its latest numbers. Numbers for 2018 may therefore differ slightly when comparing the 2021 and 2019 reports.

²⁵ Evaluator estimations for 2019 and 2020. Please refer to footnote 21.

Figure 15: Atlantic Canada Consumer LED Shipments by Lamp Type, 2012-2020



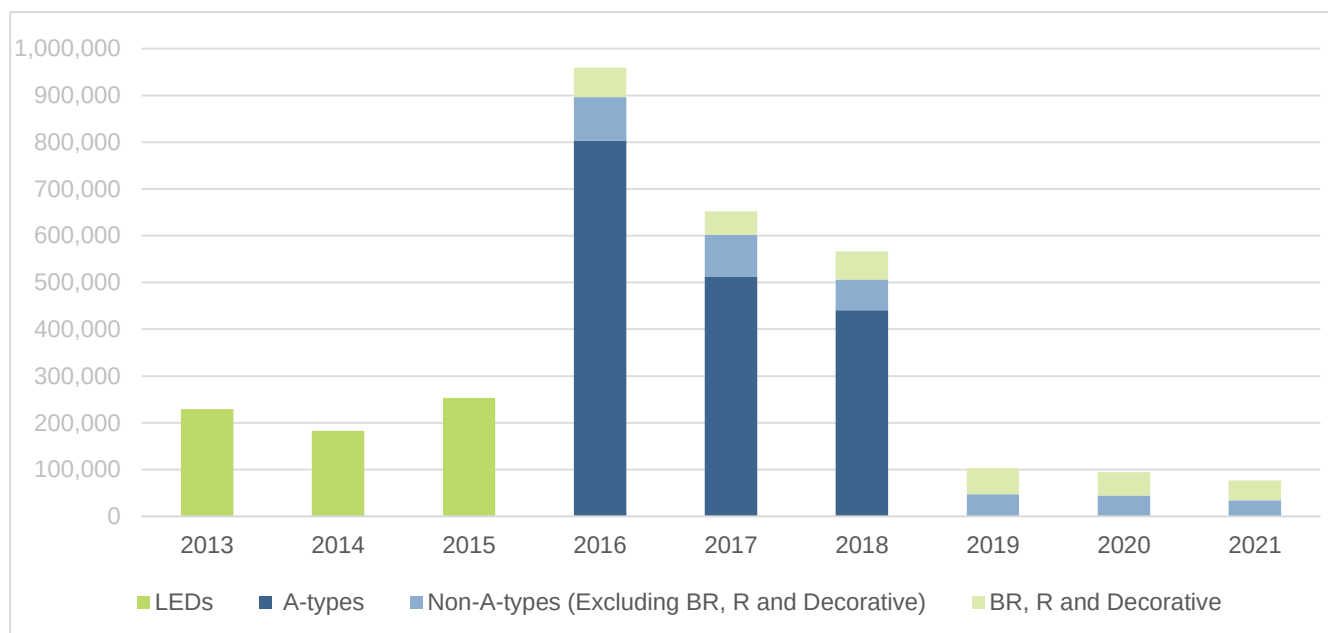
Source: Electro-Federation Canada, Lamp Data - Consumer Channel 2018-2020 Revised.²⁶ *²⁷

9.1.2 LED Lamps Rebated by Instant Savings

Figure 16 below illustrates the number of LED lamps rebated by Instant Savings since 2013, broken down by lamp type where data were available. Since A-type lamps were no longer rebated after 2018, the total number of rebated lamps has decreased significantly from 2019 onward. The downward trend in the number of non-A-type lamps (excluding BR, R and decorative) sold continued from 2016 through to 2021 and was 24% lower in 2021 than in 2020. The number of BR, R, and decorative lamps sold through the program component also decreased by 15% over the same period. The decrease in units sold from 2019 is counter to Electrofed data, indicating some growth in LED shipments during that period. However, given the uncertainty in 2020 Electrofed data as well as the market perturbations and retailer-reported supply chain delays/inventory issues caused by the COVID-19 pandemic, the Evaluator was not able to draw any conclusions from this observation. The Evaluator recommends monitoring this in future analyses.

²⁶ Electro-Federation Canada revised the Consumer Channel shipment data for 2018 in its latest numbers. Numbers for 2018 may therefore differ slightly when comparing the 2021 and 2019 reports.

²⁷ Evaluator estimations for 2019 and 2020. Please refer to footnote 21.

Figure 16: EOne Instant Savings Rebated LED Lamps, 2013-2021


Sources: 2013-2018 Instant Savings Evaluation Reports; 2019-2021 Instant Savings tracking sheets.

9.1.3 Replacement Behaviour

As part of the online participant survey described in Section 6, LED purchasers reported whether these lamps would be used for early replacement (i.e. to replace a lamp that has not burned out) or to replace a burned-out lamp. Table 39 below indicates a shift in replacement behaviour since 2020 as LED lamps are increasingly being installed in homes. The 2020 and 2021 survey results reveal a continued trend over the last several years, which indicate increasing proportions of LED lamps intended to replace burned-out lamps and the percentage of early replacements decreasing.

Table 39: EOne Rebated LED Lamp Replacement Intention,²⁸ 2015-2021

Replacement Intention	2015	2016	2017	2018	2019	2020	2021
Early Replacement	81%	77%	70%	59%	43%	27%	24%
Replace on Burn-out	19%	23%	30%	41%	57%	73%	79%

²⁸ 2015-2018 results include both A-type and non-A-type lamps; 2019-2021 results include non-A-types only.

9.1.4 Instant Savings Participating Retailer Outlook

A total of six retailers were asked about the impacts of COVID-19 on their lighting sales in 2021. They expressed mixed opinions. While two retailers reported increased consumer sales resulting from higher interest in home improvement, two others saw a decline in sales due to lower in-store foot traffic. One retailer did not see any impact. Two larger retailers also mentioned the supply issues affecting inventories across the lighting industry in general. Challenges with the supply chain in 2021 were also mentioned by the majority of retailers in their debrief interviews with EOne.

Retailers were asked about their predictions for 2022 non-A-type lamp sales. They primarily forecast that their sales of LED non-A-type and LED A-type lamps in 2022 will be consistent with 2021 levels. Only one small retailer forecast a decline in their sales of non-A-type LED lamps given that they perceive the market as saturated.

Retailers are divided in terms of where the residential market for LED non-A-type bulbs currently stands in Nova Scotia. Half of them are under the impression that it is in a sustained growth phase given increases in sales, and half of them believe that the category is levelling off as the market is becoming saturated.

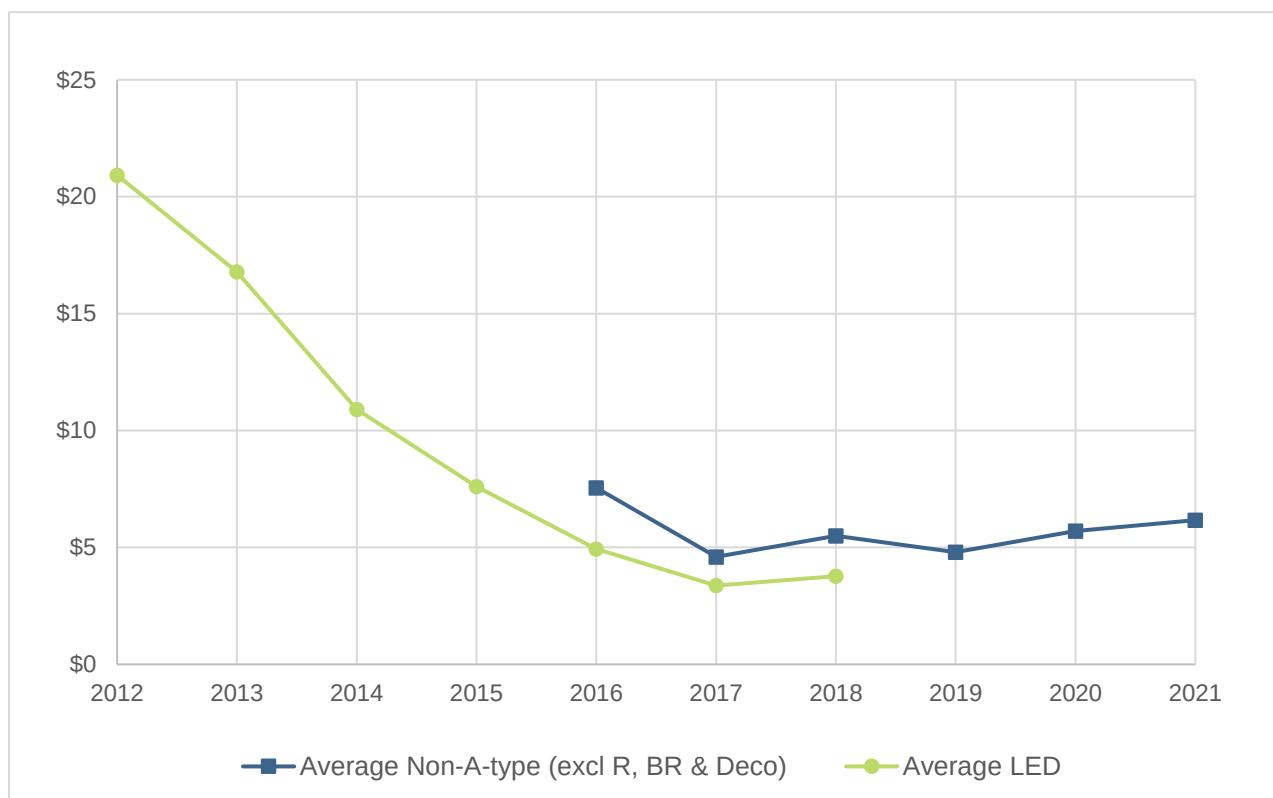
There are varying opinions with respect to LED A-type bulbs. For the most part, opinions are divided. There are those who believe the category is nearing product maturity and those who believe that product maturity has already been reached and demand is levelling off given the high conversion rate already achieved. One small retailer believes that LED A-type bulbs are gaining in popularity and still offer increased sales potential, while another large retailer considers that the category is in a sustained growth phase given their own observations of increased sales.

9.1.5 LED Lamp Prices

Figure 17 below illustrates the evolution in the unit price (before rebate) of eligible LED lamps sold through Instant Savings. Program component data for 2019, 2020 and 2021 are available only for non-A-type lamps. Since 2019, the average price of non-A-type lamps (excluding BR, R and decorative) is slowly rising, and was just over \$6 in 2021. Note that, after slower growth in 2020 (0.3%), the 2021 inflation rate in Nova Scotia rose to 4.1%, its highest level since 1991 (6.0%),²⁹ which is reflected in general price increases.

²⁹

<https://novascotia.ca/finance/statistics/topic.asp?fto=21u#:~:text=CPI%20inflation%20in%20Nova%20Scotia,the%20national%20rate%20of%203.4%25>.

Figure 17: Average LED Lamp Prices in Instant Savings (All Lamp Types), 2012-2021³⁰


Sources: 2012-2015 Instant Savings Evaluation Reports; 2016-2018 Instant Savings tracking sheets, 2019-2021 Instant Savings Product SKU list.

As outlined in Table 40, the average prices of non-A-type lamps (excluding BR, R, and decorative) as well as decorative lamps have increased since 2019, while those for BR and R lamps tend to fluctuate more over time.

Table 40: Average LED Prices by Lamp Type, 2016-2021³¹

Lamp Type	2016 (\$)	2017 (\$)	2018 (\$)	2019 (\$)	2020 (\$)	2021 (\$)
A-type	5.26	3.04	3.10	Not available	Not available	Not available
Non-A-type (excluding BR, R, Decorative)	7.55	4.60	5.50	4.80	5.70	6.14
BR	9.78	4.73	5.95	5.96	8.62	5.37
R	10.19	7.36	8.62	8.16	10.03	7.78
Decorative	7.81	4.12	4.98	4.96	5.32	5.44

³⁰ Due to multiple pricing errors by retailers in 2020, the data for that year should be interpreted with caution.

³¹ Refer to footnote 9 above.

The average incentive provided by Instant Savings in 2021 for LED non-A-type lamps (excluding BR, R, and decorative) was \$2.04. The incentives lower the average price of non-A-type LED lamps (excluding BR, R, and decorative) to approximately \$4.10 per lamp.

9.1.6 Measured Free-ridership – LED Lamps

The Evaluator analyzed the free-ridership level to gain insights into the evolution of LED lamp adoption in the Nova Scotia residential market. The 2021 survey revealed a free-ridership level of 46% for non-A-type lamps (see Table 41), which is higher than the values obtained in previous years. As discussed in Subsection 8.3.1, this result combines data from 2019 for Costco participants. Updated data are available for non-Costco participants and, for those participants, free-ridership indicates an even larger increase over time, going from 42% in 2020 to 64% in 2021.

The participant survey revealed that a larger proportion (89%) of 2021 participants than in 2020 (62%) would likely have bought LED lamps in the absence of the discount offered through Instant Savings.

Table 41: Free-ridership Level for LED Lamps³² 2015-2021

Free-ridership	2015	2016	2017	2018	2019	2020	2021
ENERGY STAR Certified LED Lamps	37%	33%	32%	39%	N/A	N/A	N/A
ENERGY STAR Non-A-type LED Lamps Only	N/A	N/A	N/A	N/A	28%	35%	46%

9.2 Market Indicators – LED Fixtures

As with LED lamps, the Evaluator relied on secondary data available for 2018 to 2020 from Electro-Federation Canada, data from Instant Rebates, and retailer interviews to understand the state of the Nova Scotia LED fixture market.

9.2.1 Market Shares of Lighting Fixtures in Atlantic Canada

The lighting fixture market includes many different categories of LED and non-LED products, including ceiling, surface, pendant, and wall fixtures, recessed downlights, striplights, and wraparounds, among others. Since data for the residential sector alone are not available, the Evaluator used data for the residential and commercial sectors combined³³ to estimate lighting fixture market sales and shares in Atlantic Canada. Note also that this data likely does not capture non-integrated fixtures (i.e. fixtures that are not sold with bulbs). The results should therefore be interpreted with caution.

³² 2015 to 2018 values include both A-type and non-A-type lamps, while 2019-2021 results include non-A-types only.

³³ Electro-Federation Canada is unable to separate the residential fixture data from the commercial fixture data; therefore, the data presented are for these two sectors combined. Hence, it is important to keep this in mind when interpreting the data in the context of the residential market only.

As reported by Electrofed, the residential/commercial LED fixtures market³⁴ grew four times faster between 2018 and 2019 than the total fixtures market (8% versus 2% respectively). Between 2019 and 2020, the total market contracted by 25%, including for LED fixtures (25%). This was likely due in some part to the impacts of COVID-19 on shipments and sales. Despite this, the share of LED fixtures continued to grow, representing almost the entirety (94%) of the total reported market in 2020 (an increase of 5% over 2018), as illustrated in Figure 18 below.

Figure 18: Proportion of Fixture Shipments – LED vs. Non-LED, 2018-2020

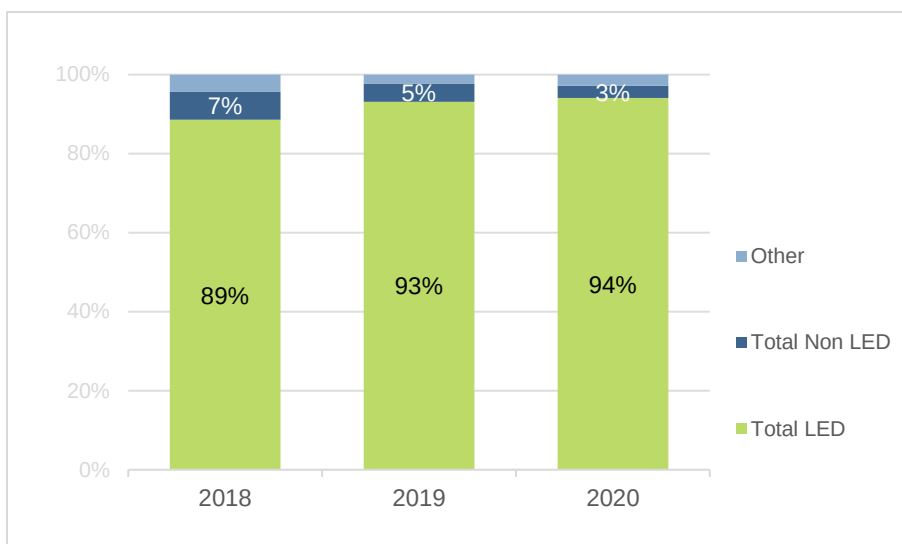
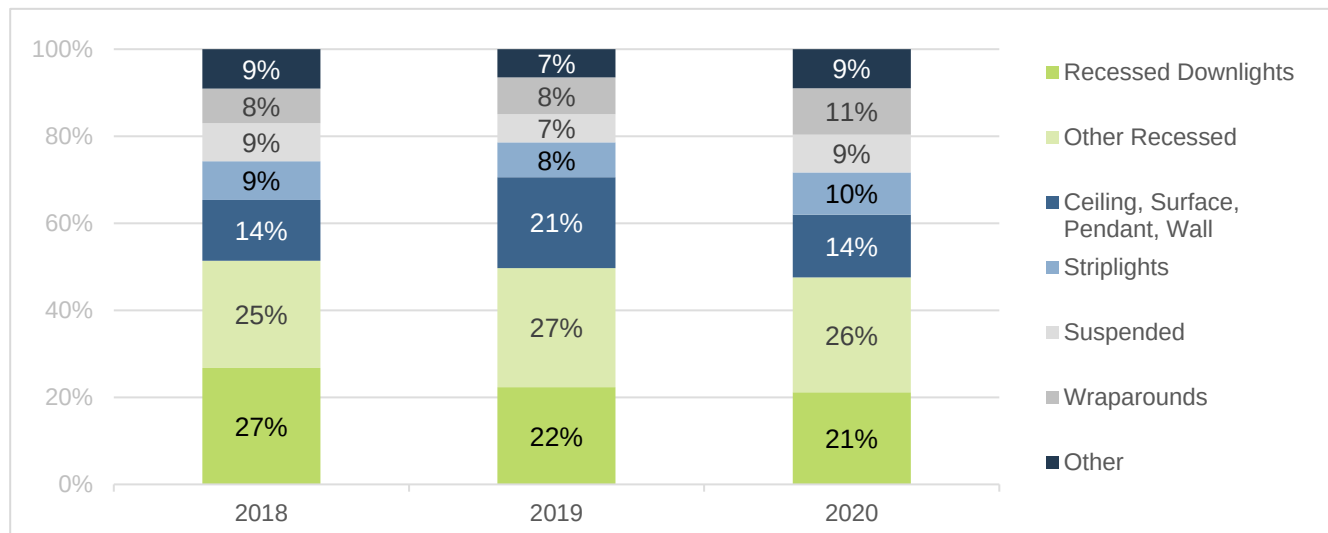


Figure 19 below indicates LED fixture shares between 2018 and 2020. There were no significant changes during that period regardless of fixture type. Shares of all recessed fixtures³⁵ continue to represent approximately half of the LED market, although there was some softening in recessed downlight shares over the 2018-2020 period. Ceiling, surface, pendant, and wall fixture shares rose temporarily in 2019 (21%) but returned to 2018 levels in 2020 (14%).

³⁴ The size of the market is estimated using sales amounts in \$.

³⁵ LED recessed fixtures include downlights, troffer parabolic lens louvers, baskets (direct and indirect), architectural linear fixtures, and housing-less fixtures.

Figure 19: Atlantic Canada Residential/Commercial LED Fixture Shipments by Type,³⁶ 2018-2020



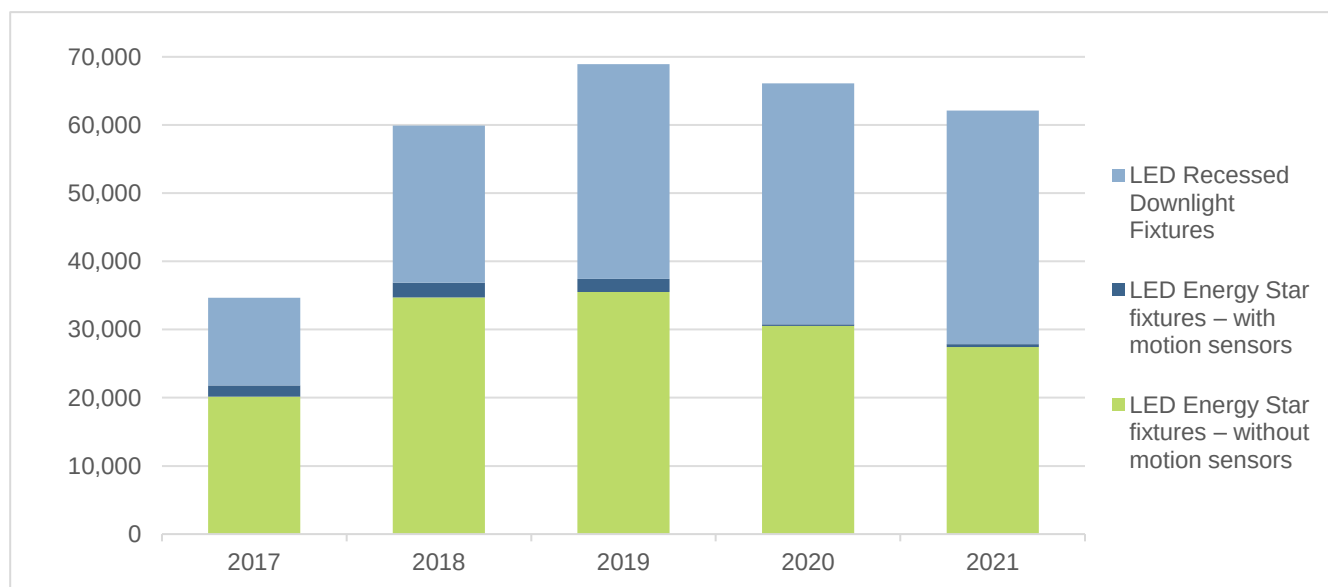
Source: Electro-Federation Canada, Lighting Fixtures Data - Residential/Consumer Channel 2018-2020.

9.2.2 LED Fixtures Rebated by Instant Savings

Figure 20 below illustrates the number of LED fixtures rebated through Instant Savings from 2017 to 2021, broken down by fixture type. Between 2017 and 2019, the number of rebated units increased significantly (by 99%), declined only slightly between 2019 and 2020 (by 4%), and declined again in 2021 (by 6%). In 2017 and 2018, LED ENERGY STAR fixtures without motion sensors comprised the majority of fixture types. Starting in 2020, that trend appeared to have been reversed with the majority of LED fixtures rebated being recessed downlights. Recessed downlights comprised 55% of rebated fixtures in 2021. ENERGY STAR fixtures with motion sensors have always constituted only a very small proportion of total rebated LED fixtures and reached their lowest level in 2021 (1% versus 5% in 2017).

³⁶ *Other Recessed* includes troffer parabolic lens louvers, baskets (direct and indirect), architectural linear, and housing-Less. *Other* includes: LED undercabinet, LED track lighting (units by heads only), LED coves and steps, and other LED parts and accessories.

Figure 20: EOne Instant Savings Rebated LED Fixtures, 2017-2021



Sources: 2017-2021 Instant Savings tracking sheets.

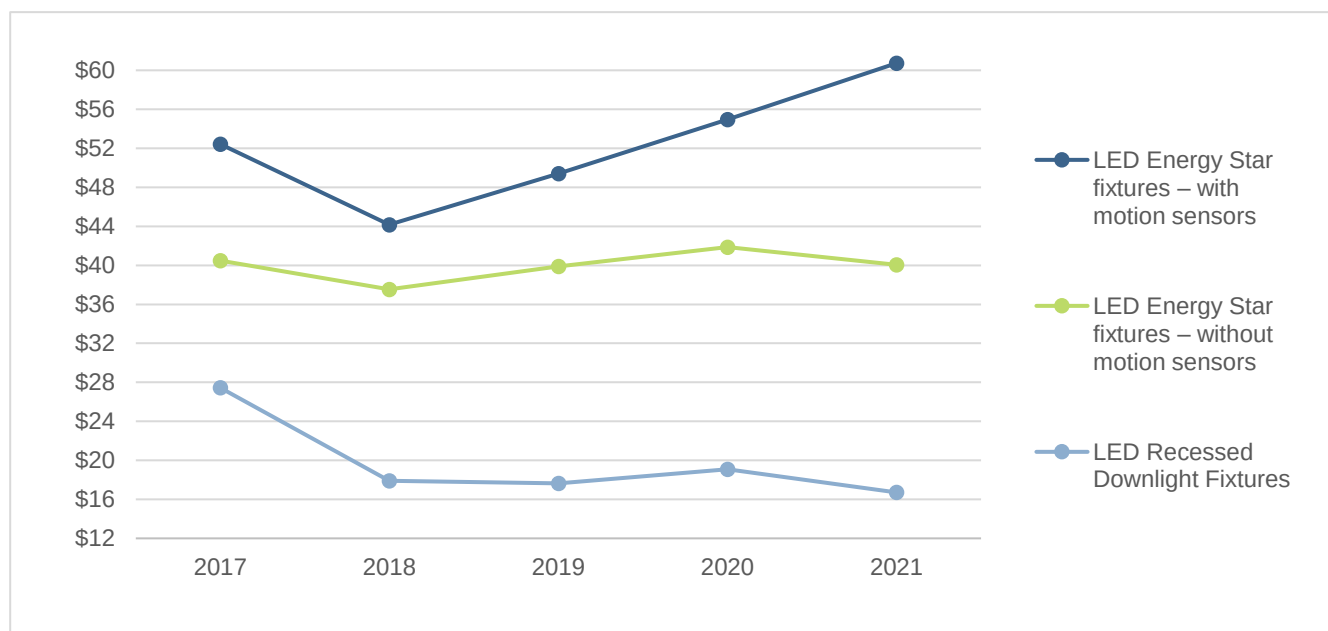
9.2.3 Instant Savings Participating Retailer Outlook

Instant Savings participating retailers were asked about their predictions for LED fixture sales in 2022. As with LED lamps, they primarily forecast that their LED fixture sales will be consistent with those in 2021.

There is more of a discrepancy among retailers as to where the market for LED fixtures stands, although there is a consensus that there remains potential for growth. While one larger and two smaller retailers believe that this product category is in a sustained growth phase given the products' popularity, two larger retailers consider it is nearing product maturity or close to levelling off given that sales have softened. One smaller retailer believes that the residential market for LED fixtures in Nova Scotia is gaining popularity given the relative novelty of such products.

9.2.4 LED Fixture Prices

Figure 21 below illustrates the prices (before a rebate is applied) of Instant Savings eligible LED fixtures sold through Instant Savings. Except for slight variations in 2020, the average prices of LED recessed downlight fixtures and LED ENERGY STAR fixtures without motion sensors have been hovering around the \$17 and the \$40 marks respectively over the past few years. Conversely, the average price of a LED ENERGY STAR fixture with a motion sensor has been increasing more significantly since 2018 (although it should be noted that the cost of these products varies greatly, which could affect the average results; for example, in 2021, the minimum price for fixtures with a motion sensor was \$22.99 while the maximum price was \$157.00, and the minimum price for fixtures without a motion sensor was \$12.50 while the maximum price was \$269.00).

Figure 21: Average LED Fixture Prices in Instant Savings, 2017-2021


Sources: 2017-2018 Instant Savings tracking sheets, 2019-2021 Instant Savings Product SKU list.

Table 42 below reiterates the findings mentioned above and presents the average prices of ENERGY STAR fixtures between 2017 and 2021.

Table 42: Average LED Prices by Fixture Type, 2017-2021

Fixture Type	2017 (\$)	2018 (\$)	2019 (\$)	2020 (\$)	2021 (\$)
LED Energy Star Fixtures – with Motion Sensors	\$52.43	\$44.17	\$49.42	\$54.96	\$60.73
LED Energy Star Fixtures – without Motion Sensors	\$40.48	\$37.54	\$39.88	\$41.87	\$40.07
LED Recessed Downlight Fixtures	\$27.44	\$17.89	\$17.64	\$19.07	\$16.71

The average incentive provided through Instant Savings in 2021 for both LED ENERGY STAR fixtures without motion sensors and for LED recessed downlights was \$9.70 and \$6.29 respectively. The incentives lower the average price of these fixtures to approximately \$30.37 and \$10.42 per fixture respectively.

9.2.5 Measured Free-ridership – LED Fixtures

The Evaluator analyzed the free-ridership level to gain insights into the evolution of LED fixture adoption in the Nova Scotia residential market. While 2020 saw a large increase in free-ridership levels, the 2021 results reveal a decrease in free-ridership for LED fixtures sold through Instant Savings (see Table 43 below).

Table 43: Free-ridership Level for LED Fixtures 2019-2021

Free-ridership	2019	2020	2021
LED Fixtures	32%	50%	41%

9.3 Codes and Standards

The ultimate indicator of market transformation is the adoption of more stringent codes and standards. Currently, general service lamps³⁷ are required to meet an efficiency level that corresponds to halogen incandescent lamps (for instance, a standard 60 W incandescent lamp is no longer allowed, and its equivalent is a 43 W halogen incandescent lamp). This minimum energy performance standard has been enforced since early 2014 or early 2015 depending on lamp wattages. As described in Appendix II of the 2020-2022 Measure Assessment, in terms of government regulations, the U.S. Energy Independence and Security Act continues to be a key consideration.³⁸ The previous U.S. administration decided to eliminate the EISA backstop on inefficient lighting products. However, six states passed their own state legislation to implement the efficient lighting standards on January 1, 2020 regardless of what happened nationally. In 2021, the Biden administration put general service lighting back on the regulatory agenda, and it was expected to restore the lighting standards for the extended definition of general service lamps (including decorative and reflector lamps) to the 45 lumens/W efficiency standard before the end of 2021.³⁹ As of December 2021, the regulation had not yet been adopted, but it should be imminently. The standards could still take some time to take effect, and there remains uncertainty as to the amount of time the Department of Energy (DOE) will allow between the adoption of the standards and compliance enforcement, with some observers estimating that the standard will come into effect in 2023.⁴⁰

In Canada, lighting is not currently on Natural Resources Canada's Forward Regulatory Plan for 2021-2023, although Canadian regulations typically follow the U.S. within approximately two years. While the upcoming regulation is set to establish a minimum efficiency level corresponding to a CFL, recent studies⁴¹ indicate that the U.S. market is rapidly moving away from CFL lamps and toward LED lamps.

³⁷ The Energy Efficiency Regulation on general service lamps covers most A-type lamps. Natural Resources Canada, *General Service Lamps and Modified Spectrum Incandescent Lamps*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869> (Last accessed January 26, 2018).

³⁸ Illinois Energy Efficiency Stakeholder Advisory Group, *Illinois Statewide Technical Reference Manual for Energy Efficiency Version 8.0, Volume 3*, October 2019, p. 258.

³⁹ Apex Analytics. *LED Market Update: LEDs Continue to Gain Market Share, Biden Administration Exploring Options for EISA Backstop*, August 26, 2021.

⁴⁰ Ibid.

⁴¹ Ibid.

9.4 Market Evolution Summary

Rosenburg and Hoefgen (2009) made recommendations on market transformation program planning and suggested analyzing certain factors, as outlined in Table 44 below, to identify whether program-based support should be withdrawn or reduced in light of changes observed in the market.⁴²

⁴² Rosenburg M. and Hoefgen L, *Market Effects and Market Transformation: Their Role in Energy Efficiency Program Design and Evaluation*, Prepared for the California Institute of Energy and the Environment, 2009.

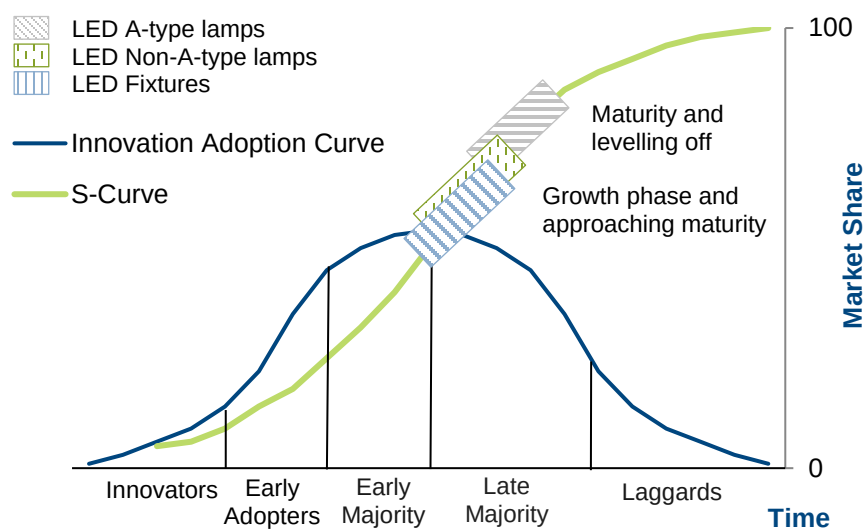
Table 44: Overview of 2021 Key Factors in Program Planning

Factor	Results
Market share of LED lamps	While overall residential lamp shipments have been decreasing since 2017, LED lamp shipments continued to grow in 2020 and now represent 62% of the market. CFLs have an ever-decreasing share of the market, with 5% reported in 2019. The movement of the market toward LEDs and away from other technologies, including CFLs, echoes trends in the U.S. market. LED shipments of non-A-type/BR/R lamps grew proportionally more than A-type lamps in 2020 compared to 2019, although A-types still have the largest share of LED shipments for now (66% in 2020). In terms of the market evolution of LED non-A-type lamps, retailer opinions are split: Half are under the impression that it is in a sustained growth phase given increases in sales, and half believe that the category is levelling off as the market is becoming saturated. Retailers are also divided in their experiences with respect to 2021 sales although they primarily forecast that 2022 LED lamp sales will be consistent with those in 2021 barring any COVID-19 related supply chain disruptions.
Market share of LED fixtures	While the volume of residential/commercial fixture (including LED fixtures) shipments contracted by 25% between 2019 and 2020, shares of LED fixtures continue to increase and represent almost the entirety of integrated fixture shipments reported by Electrofed. There is more of a discrepancy regarding retailers' perspectives as to where the residential market for LED fixtures stands, although there is a consensus that there remains potential for growth. Some believe that this product category is in a sustained growth phase given the products' popularity; others believe sales are nearing product maturity and are close to levelling off. As is the case for LED lamps, retailers predict 2022 LED fixture sales will be similar to those in 2021 barring any COVID-19 related supply chain disruptions.
Recent trends in prices of LED lamps and fixtures	The average price of non-A-type lamps (excluding BR, R, and decorative) continually increased between 2019 and 2021, and was just above \$6 in 2021. The average price of LED recessed downlight fixtures and fixtures without motion sensors have been hovering around the same price points over the past few years (\$17 and \$40 respectively). Conversely, the average prices of LED ENERGY STAR fixtures with motion sensors have been rising consistently over the past few years to reach a high point in 2021 (\$60). Price increases may be due in part to the general increase in inflation, which reached its highest point in 2021 (4.1%) since 1991 (6.0%).
Likelihood of inclusion in a near-term code or standard	The U.S. is imminently set to adopt a general service lamp minimum energy performance requirement. The update is expected to effectively ban halogen incandescent lamps from being manufactured or imported once the standard comes into force. In Canada, lighting is not currently in Natural Resources Canada's Forward Regulatory Plan for 2021-2023, although typically Canadian regulations follow the U.S. within approximately two years.
Market readiness for more efficient substitute technology	No substitute that is more efficient than LED lamps/fixtures has become available. Efficiency improvements in LED lamps and fixtures are likely, with organizations like the Design Light Consortium increasing their criteria for certification.

Figure 22 below provides a qualitative indication of the adoption stages of LED lamps and LED fixtures in the Nova Scotia residential sector. It demonstrates that, as successive groups of consumers adopt the new technology (identified in blue by the innovation adoption curve below),⁴³ the LED market share (as indicated by the S-curve in green) will eventually reach full saturation.

LED non-A-type lamps and fixtures continue to have a strong and growing presence in the Nova Scotia market. The Evaluator found that, in 2019, the LED A-type lamp market had reached maturity and maintains that conclusion (as indicated by the grey box in Figure 22). LED non-A-types (as identified by the green box) are in a sustained growth phase, approaching maturity with shipments growing faster than A-types between 2019 and 2020. LED fixtures (blue box) are in a similar state as LED non-A-type lamps, as suggested by a small but higher growth rate compared to total fixture sales and by the fact that 2021 fixture sales were composed almost entirely of LED products. An unknown in this analysis is how Atlantic LED shipment data translate to LED socket saturation in Nova Scotia; more recent socket information would help further refine this analysis.

Figure 22: 2021 Residential Market Evolution for LED Lighting



⁴³ Everett Rogers, *Diffusion of Innovations*, 1983.

10 INSTANT SAVINGS KEY FINDINGS AND RECOMMENDATIONS

As mentioned previously, the main objectives of the 2021 Instant Savings evaluation were as follows:

- › Collect information on participant and partner perspectives
- › Calculate gross and net Instant Savings results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions⁴⁴
- › Analyze the market evolution of LED lamps and fixtures

This section provides the Evaluator's key findings and recommendations in relation to these objectives. The following recommendation is also outlined in Appendix XI.

2021 Instant Savings-Finding: Instant Savings net electrical energy savings and peak demand savings surpassed the targets.

Instant Savings achieved 14.314 GWh in net electrical energy savings and 1.629 MW in net peak demand savings at the generator in 2021, thus surpassing the planned net electrical energy savings of 10.6 GWh and net peak demand savings of 1.2 MW. This is largely due to increases in participation in the controls and appliance product categories.

2021 Instant Savings-Finding: Instant Savings maintained a high level of participation despite challenges from the COVID-19 pandemic, with a minimal decrease (2%) in overall products sold compared to 2020.

Due to the COVID-19 pandemic, there were fewer events and marketing opportunities during the both the spring and fall campaigns. To boost sales in the fall campaign, EOne extended the length of the campaign and increased rebates for selected products, which allowed Instant Savings to maintain high participation. While LED lamps and fixtures still saw a decrease in participation, all other categories, except for clothesline kits and outdoor drying racks, saw increases in the number of products sold compared to 2020.

2021 Instant Savings-Finding: Efforts to diversify the program component showed strong gains in 2021, with non-lighting products providing the majority of the gross savings.

Gross savings from lighting products decreased by 10%, while savings from other products increased by 75%. For the first time since its inception, lighting (LED lamps and fixtures), at 41%, does not represent the majority of gross energy savings for Instant Savings. Products other than lighting made up 59% of the gross energy savings, with ENERGY STAR certified room air purifiers (17%), heavy-duty outdoor timers (14%) and programmable thermostats (7%) being the top drivers of non-lighting gross energy savings.

⁴⁴ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

2021 Instant Savings-Finding: Retailers continue to be satisfied with Instant Savings overall and report moderate influence from the program component on consumer and staff knowledge as well as their stocking practices.

Using a 10-point scale, retailers provided a score of 8.0 for their satisfaction with the program component and a score of 8.7 for their satisfaction with the program component delivery representatives from Summerhill. Overall, Instant Savings was seen by retailers as having a moderate influence on enhancing consumer and staff knowledge about LED lamps and LED fixtures as well influencing their stock of rebate-eligible products during the campaign periods. Influence scores for LED lamps slightly decreased and increased somewhat for LED fixtures from 2020.

2021 Instant Savings-Finding: The free-ridership for LED lamps increased significantly.

The free-ridership level for LED lamps was established at 64%, compared to 42% established in the 2020 evaluation. The increase is due to a higher proportion of participants who were unaware of the discount before paying for their products or had the intention to buy LED lamps regardless of the discount. This result continues the increasing trend in free-ridership for LED lamps observed since 2019 and aligns with market evolution findings of continued and strong market growth of LEDs in Atlantic Canada.

2021 Instant Savings-Finding: The spillover for LED fixtures increased significantly.

Market effects were established at 32% for LED fixtures compared to 16% in 2020. This increase was driven by one large retailer, who reported a sizable number of sales outside of the campaign in 2021 combined with attributing a relatively high influence to EOne's program, notably on the quantity of fixtures stocked in stores.

2021 Instant Savings-Findings: LED lamps and fixtures represent the majority of new lighting shipments, compressing shares of other technologies, notably CFLs.

LED lamp shipments continue to grow and based on Electrofed data, represented over 60% of Atlantic Canada consumer lamp shipments in 2020. CFLs make up an ever-decreasing share of the market, at 5% of shipments in 2019. Shares of LED fixtures also continue to increase and Electrofed data indicate that they represent almost the entirety of fixture shipments in 2020. The movement of the market towards LEDs and away from other technologies, including CFLs echoes trends in the U.S. market.

2021 Instant Savings-Recommendation 1: Update the LED lamp and fixture baselines in the 2020-2022 Measure Assessment to reflect updates to regulations, the growing presence of LEDs in the market as well as the decreased market share of CFLs. The Evaluator currently applies a baseline for LED lamp and fixtures to establish their equivalent EUL values that are used to obtain lifetime savings. The current baseline uses a CFL equivalent for 2024 to the end of product life. This baseline should be updated to reflect market trends; given CFL market shares are becoming very small, it is highly likely that the upcoming U.S. regulation banning halogen lamps will effectively results in a complete shift to LEDs.

2021 Instant Savings-Findings: LED non-A-type lamps and fixtures are in a sustained growth phase, with LED non-A-type lamps closer to maturity.

LED lamps and fixtures continue to have a strong and growing presence in the Nova Scotia market. The market evolution analysis suggests that LED non-A-type lamps continue to be in a sustained growth phase, approaching maturity, with some growth in sales, and shipments growing faster than A-type lamps, which are considered a mature market. LED fixtures are similarly in a sustained growth phase, although less information specific to the residential market was available on this product. Retailer feedback on both markets were mixed, between those that believe that the products are still in growth phases and those that believe that sales are close to levelling off.

2021 Instant Savings-Finding: The evaluated net energy and peak demand savings determined by the Evaluator are higher than the initial net savings tracked by EOne.

The evaluated net energy and peak demand savings are 4% higher than the values tracked by EOne. These differences are mainly due to the increase in spillover level and the decrease of the free-ridership level for LED fixtures, which resulted in higher NTGR for this product category. Moreover, the increase in the unitary energy savings values of LED lamps, LED fixtures and certified heat pump water heaters slightly contribute to the increase of energy savings.

CONCLUSION

Table 45 summarizes the participation level as well as the gross and net electrical energy savings for each Residential Efficient Product Rebates program component and for the program as a whole.

Table 45: Overall 2021 Residential Efficient Product Rebates Participation Level and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
ARet							
Energy Savings	5,859	Appliances	4.462	GWh	0.55	2.474	GWh
Lifetime Energy Savings			17.849	GWh	0.56	9.925	GWh
Peak Demand Savings			0.640	MW	0.56	0.357	MW
Instant Savings							
Energy Savings	201,175	Products sold	15.792	GWh	0.91	14.314	GWh
Lifetime Energy Savings			128.201	GWh	0.94	121.022	GWh
Peak Demand Savings			1.819	MW	0.90	1.629	MW
Total							
Energy Savings			20.254	GWh		16.788	GWh
Lifetime Energy Savings			146.050	GWh		130.948	GWh
Peak Demand Savings			2.460	MW		1.987	MW

Figure 23 and Figure 24 below illustrate the net electrical energy and peak demand savings targets respectively for each program component, for Residential Efficient Product Rebates as a whole, as well as whether targets were achieved in 2021. Residential Efficient Product Rebates was aimed at achieving 13.012 GWh in net electrical energy savings and 1.654 MW in net peak demand savings at the generator for 2021. It achieved 16.788 GWh in net electrical energy savings and 1.987 MW in net peak demand savings at the generator in 2021. The program exceeded the net electrical energy savings target by 29% and peak demand savings target by 20%, mostly driven by Instant Savings, which remains the largest contributor to both total program net energy and peak demand savings.

Figure 23: 2021 Residential Efficient Product Rebates Program Targeted and Evaluated Net Energy Savings

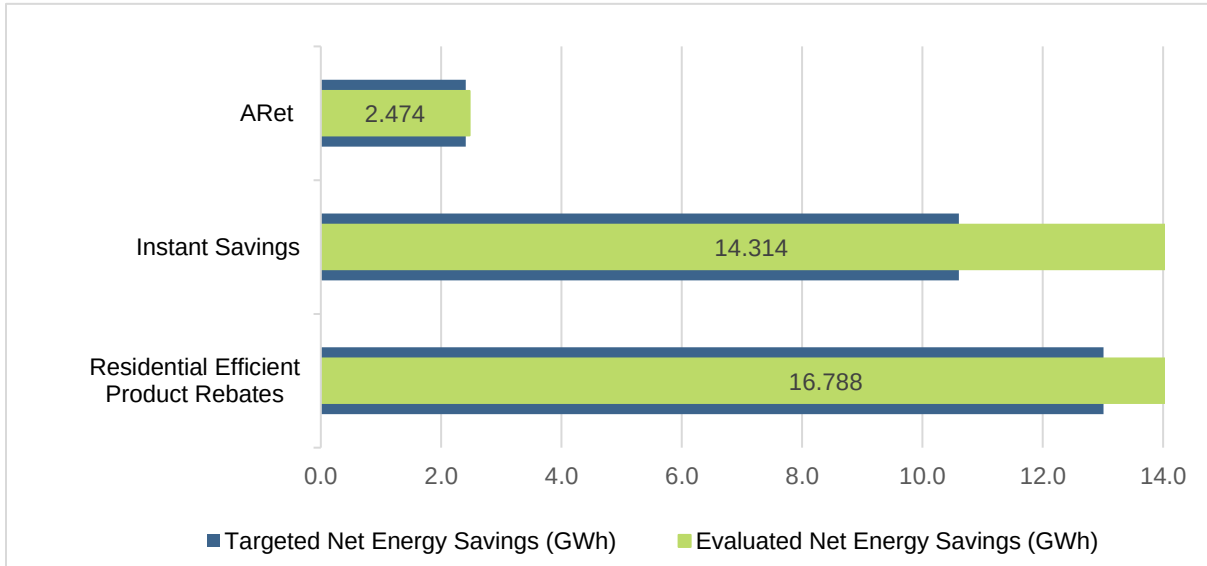
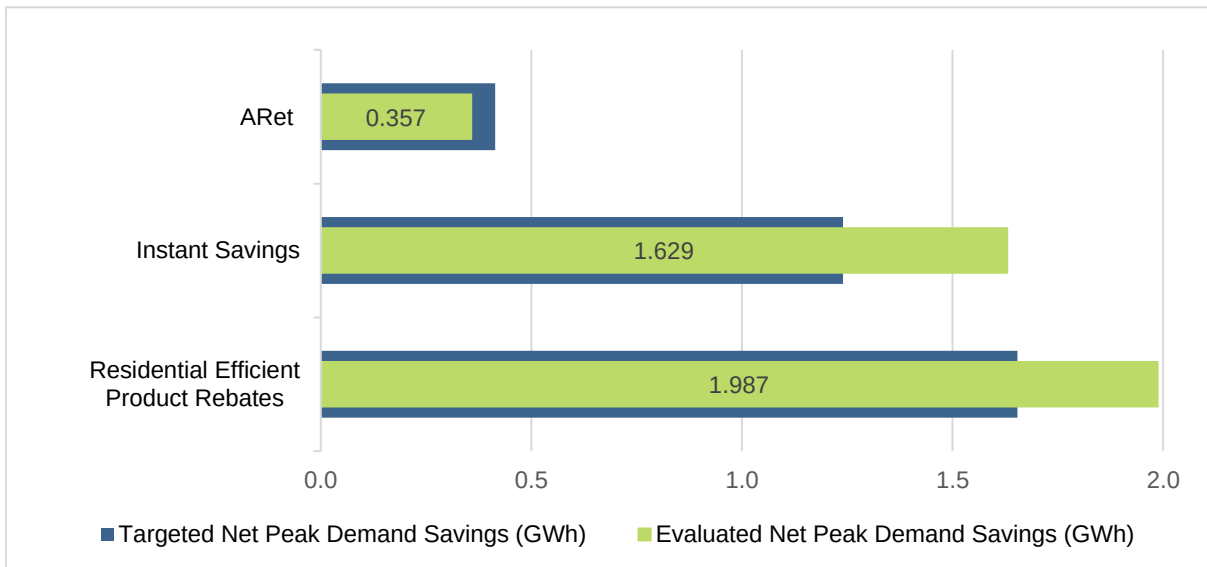


Figure 24: 2021 Residential Efficient Product Rebates Program Targeted and Evaluated Net Peak Demand Savings



LIST OF APPENDICES

The following are presented in the Residential Efficient Product Rebates Program – Appendices document.

Appliance Retirement

Appendix I ARet: Tracking Sheet Audit

Appendix II ARet: Free-ridership and Secondary Market Impact Calculations

Appendix III ARet: 2021 Recommendations

Instant Savings

Appendix IV IS: Participant Online Survey Questionnaire

Appendix V IS: Participant Survey Results

Appendix VI IS: Interview Guide with Retailer Partners

Appendix VII IS: Tracking Sheet Audit

Appendix VIII IS: Unitary Savings Calculations for Light-emitting Diode Lamps and Fixtures

Appendix IX IS: Algorithm for Free-ridership Calculation

Appendix X IS: Spillover Methodology

Appendix XI IS: 2021 Recommendations



RESIDENTIAL EFFICIENT PRODUCT REBATES PROGRAM 2021 DSM EVALUATION

EFFICIENCYONE

Appendix Report

March 10, 2022



TABLE OF CONTENTS

APPENDIX I ARET: TRACKING SHEET AUDIT.....	1
APPENDIX II ARET: FREE-RIDERSHIP AND SECONDARY MARKET IMPACT CALCULATIONS .	4
APPENDIX III ARET: 2021 RECOMMENDATIONS	9
APPENDIX IV IS: PARTICIPANT ONLINE SURVEY QUESTIONNAIRE.....	1
APPENDIX V IS: PARTICIPANT SURVEY RESULTS	17
APPENDIX VI IS: INTERVIEW GUIDE WITH RETAILER PARTNERS	35
APPENDIX VII IS: TRACKING SHEET AUDIT	54
APPENDIX VIII IS: UNITARY SAVINGS CALCULATIONS FOR LIGHT-EMITTING DIODE LAMPS AND FIXTURES	58
APPENDIX IX IS: ALGORITHM FOR FREE-RIDERSHIP CALCULATION.....	63
APPENDIX X IS: SPILLOVER METHODOLOGY	68
APPENDIX XI IS: 2021 RECOMMENDATIONS	70

APPENDIX I

ARET: TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying whether all the data fields required for the evaluation were included and filled out in the tracking sheet submitted by EfficiencyOne (EOne)
- › Ensuring that the tracked results are accurate by:
 - Verifying whether the parameters used to calculate the program results (the gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating whether all the calculation steps were performed consistently

EOne started using their new Integrated Customer Information System in 2021 for ARet; therefore, the format of the tracking sheet has changed from previous years.

Data Accuracy

Table 1 below lists all the parameters required for the Appliance Retirement (ARet) evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the table details the actions carried out by the Evaluator to adjust data where required.

Table 1: Verification of 2021 ARet Data Field Completeness and Accuracy

Data Field	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Savings at the Generator (Columns BP, BQ, BT, and BU)	Partial	N/A	Gross and net energy and peak demand savings at the generator were missing for two participants. Gross and net peak demand savings at the generator were missing for 17 other participants. Values were calculated using the line loss factors associated with their rate code.
Measure Name (Column BN)	Y	N/A	N/A
Appliance Size (Column CQ)	Y	N/A	N/A
Appliance Age (Column CP)	Y	N/A	N/A
Rate Code (Columns BD and BE)	Y	N/A	N/A

Data Field	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Reference Data			
Gross Unitary Savings	Y	Y	N/A
Equivalent Net-to-gross Ratios	Y	Y	N/A
Peak Demand-to-energy Ratio	Y	Y	N/A
Effective Useful Life	Y	Y	N/A

Data Consistency

The second step of the tracking sheet audit involved repeating the calculations and comparing the related data fields of the tracking sheet to identify any potential inconsistencies. Table 2 below lists the data fields of the ARet tracking sheet that were compared to ensure consistency.

Table 2: Verification of 2021 ARet Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Calculated Line Loss Factor (Gross Savings at the Generator / Gross Savings at the Meter)	Tracked Rate Codes	N	For 82 participants, incorrect line loss factors were applied, resulting in incorrect savings at the generator. Line loss factors from the official list were used to recalculate the savings at the generator. Also, line loss factors were missing for 17 projects although savings at the generator were correctly calculated, resulting in no impact on savings.
Calculated NTGR (Net Energy Savings at the Generator / Gross Energy Savings at the Generator)	Tracked NTGR	Y	N/A
Calculated Effective Useful Life (Net Lifetime Energy Savings at the Generator / Net Energy Savings at the Generator)	Tracked Effective Useful Life	Y	N/A
Verification of Duplicate IDs or Projects	-	Y	N/A

Equations and Compilation

After the correct values were established (as per Table 1), the Evaluator validated whether the equations in the tracking sheet correctly calculated each of the main program component results, the results of which are presented in Table 3.

Table 3: Verification of 2021 ARet Savings Compilation

Program Component Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	Y	N/A
Gross Peak Demand Savings at the Generator	Y	N/A
Net Energy Savings at the Generator	Y	N/A
Net Peak Demand Savings at the Generator	Y	N/A

Corrected Tracked Savings

Table 4 presents the corrected tracked savings values obtained as a result of all the changes made by the Evaluator, which are described in this appendix.

Table 4: 2021 ARet Corrected Tracked Savings

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
ARet					
Gross Energy Savings at the Generator	4.341	GWh	4.342	GWh	0.03%
Gross Peak Demand Savings at the Generator	0.616	MW	0.618	MW	0.37%
Net Energy Savings at the Generator	2.348	GWh	2.348	GWh	0.03%
Net Peak Demand Savings at the Generator	0.333	MW	0.335	MW	0.39%
HomeWarming and Mi'kmaw Home Energy Efficiency Project (MHEEP)					
Gross Energy Savings at the Generator	0.200	GWh	0.200	GWh	0.00%
Gross Peak Demand Savings at the Generator	0.034	MW	0.034	MW	0.00%
Net Energy Savings at the Generator	0.200	GWh	0.200	GWh	0.00%
Net Peak Demand Savings at the Generator	0.034	MW	0.034	MW	0.00%

APPENDIX II

ARET: FREE-RIDERSHIP AND SECONDARY MARKET IMPACT CALCULATIONS

This appendix presents the detailed calculations and assumptions used to establish the free-ridership and secondary market impacts for appliances retired through ARet.

For appliances replaced through HomeWarming and MHEEP, given the participant demographics, free-ridership and secondary market impact levels were assumed to be nil.

To determine the consumption level associated with free-ridership and secondary market impacts, the Evaluator used the 2018 participant survey results regarding the actions that participants would have taken in the absence of ARet, such as selling their appliance to a private party, giving it away to a charity organization or a family member, or transporting it to a landfill site or a recycling centre.

Free-ridership

Free-ridership corresponds to the energy consumption of appliances that would have been disposed of in the absence of ARet. It does not include the consumption of those appliances that would have been transferred to other owners; such transfers are assessed through the secondary market impacts.

Table 1 through Table 5 present the various discarding scenarios, relative proportions of participants, and free-ridership calculations.

Table 1: 2021 ARet Free-ridership Calculation per Refrigerator

Would Have Kept the Unit	Proportion (a)	Discard Scenario	Proportion (b)	Total Proportion (a*b)	Scenario Energy Consumption (kWh)	Scenario Gross Savings (kWh) (c)	Free-ridership (kWh) (a*b*c)
Yes	41%			41%	671	0	0
No	59%	Transferred	41%	24%	671	0	0
		Disposed	59%	35%	0	671	234
Total Free-ridership per Unit (kWh/unit)							234

Table 2: 2021 ARet Free-ridership Calculation per Freezer

Would Have Kept the Unit	Proportion (a)	Discard Scenario	Proportion (b)	Total Proportion (a*b)	Scenario Energy Consumption (kWh)	Scenario Gross Savings (kWh) (c)	Free-ridership (kWh) (a*b*c)
Yes	31%			31%	862	0	0
No	69%	Transferred	35%	24%	862	0	0
		Disposed	65%	45%	0	862	387
Total Free-ridership per Unit (kWh/unit)							387

Table 3: 2021 ARet Free-ridership Calculation per Room Air Conditioner

Would Have Kept the Unit	Proportion (a)	Discard Scenario	Proportion (b)	Total Proportion (a*b)	Scenario Energy Consumption (kWh)	Scenario Gross Savings (kWh) (c)	Free-ridership (kWh) (a*b*c)
Yes	45%			45%	257	0	0
No	55%	Transferred	25%	14%	257	0	0
		Disposed	75%	41%	0	257	106
Total Free-ridership per Unit (kWh/unit)							106

Table 4: 2021 ARet Free-ridership Calculation per Small Refrigerator

Would Have Kept the Unit	Proportion (a)	Discard Scenario	Proportion (b)	Total Proportion (a*b)	Scenario Energy Consumption (kWh)	Scenario Gross Savings (kWh) (c)	Free-ridership (kWh) (a*b*c)
Yes	60%			60%	164	0	0
No	40%	Transferred	33%	13%	164	0	0
		Disposed	67%	27%	0	164	44
Total Free-ridership per Unit (kWh/unit)							44

Table 5: 2021 ARet Free-ridership Calculation per Small Freezer

Would Have Kept the Unit	Proportion (a)	Discard Scenario	Proportion (b)	Total Proportion (a*b)	Scenario Energy Consumption (kWh)	Scenario Gross Savings (kWh) (c)	Free-ridership (kWh) (a*b*c)
Yes	60%			60%	240	0	0
No	40%	Transferred	33%	13%	240	0	0
		Disposed	67%	27%	0	240	64
Total Free-ridership per Unit (kWh/unit)							64

Secondary Market Impacts

For those participants who declared they would have transferred their old appliances, i.e. sold or given away their appliances in the absence of ARet, the net savings calculation takes into account the possible energy consumption of the appliances in the secondary market.

There are two possible scenarios:

Scenario 1

Would-be acquirers would have found another appliance if they had not received a second-hand appliance. Consequently, the total number of appliances connected to the grid is unchanged by ARet. There are two possibilities in this scenario: (1) another similarly used appliance would have been bought; or (2) a new standard-efficiency appliance would have been bought because of the reduced number of appliances available on the secondary market.

Scenario 2

Would-be acquirer in the secondary market would not have acquired another unit. The appliance is therefore used as a secondary unit by the acquirer who normally would not have sought the secondary unit. This means that there would be one more appliance operating on the grid. In this case, no secondary market impacts on energy consumption need to be removed from the gross savings.

Table 6 through Table 10 below present all the possible scenarios regarding appliances that would have been sold or given away to the secondary market, and their corresponding energy impacts. The proportions used for each of these scenarios are default values suggested by the UMP for cases where no general population survey is conducted. These assumptions could be refined in future evaluations based on further market research, but the cost of conducting such research should be taken into account in the decision-making process.

Table 6: 2021 ARet Secondary Market Impact Calculation per Refrigerator

Transfer Scenario Proportion (a)	Would-be Acquirer Finds an Alternative Unit	Proportion (b)	Alternative Type	Proportion (c)	Total Proportion (a*b*c)	Scenario Energy Consumption (kWh) (d)	Secondary Market Impact (kWh) (a*b*c*d)
24%	Yes	50%	Old Unit	50%	6%	671	40
			New Unit	50%	6%	302	18
	No	50%			12%	0	0
Total Secondary Market Impact (kWh/unit)							58

The energy consumption value for new standard efficiency refrigerators was established based on the maximum allowable energy consumption values of unit types that were equivalent to those sold through Instant Savings in 2019, in accordance with the effective Canadian energy efficiency standard.¹ This value was estimated at 431 kWh. After being multiplied by the part-use factor, the final annual energy consumption for new standard efficiency refrigerators was established at 302 kWh.

¹ Natural Resources Canada, *Refrigerators, Refrigerator-Freezers and Wine Chillers - Energy Efficiency Regulations*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6877> (Last accessed January 17, 2019).

Table 7: 2021 ARet Secondary Market Impact Calculation per Freezer

Transfer Scenario Proportion (a)	Would-be Acquirer Finds an Alternative Unit	Proportion (b)	Alternative Type	Proportion (c)	Total Proportion (a*b*c)	Scenario Energy Consumption (kWh) (d)	Secondary Market Impact (kWh) (a*b*c*d)
24%	Yes	50%	Old Unit	50%	6%	862	52
			New Unit	50%	6%	225	14
	No	50%			12%	0	0
Total Secondary Market Impact (kWh/unit)							66

To calculate the energy consumption value for new standard efficiency freezers, the Evaluator first calculated the maximum energy consumption of both chest and upright freezers by applying the Canadian standard² and then calculated the weighted average based on the proportion of each type of retired freezers as per the 2021 tracking sheet. After being multiplied by the part-use factor, the final annual energy consumption of new standard efficiency freezers was established at 225 kWh.

Table 8: 2021 ARet Secondary Market Impact Calculation per Room Air Conditioner

Transfer Scenario Proportion (a)	Would-be Acquirer Finds an Alternative Unit	Proportion (b)	Alternative Type	Proportion (c)	Total Proportion (a*b*c)	Scenario Energy Consumption (kWh) (d)	Secondary Market Impact (kWh) (a*b*c*d)
13%	Yes	50%	Old Unit	50%	3%	257	8
			New Unit	50%	3%	207	7
	No	50%			7%	0	0
Total Secondary Market Impact (kWh/unit)							15

To calculate the energy consumption value for new standard room air conditioners, the Evaluator assumed that the new units meet the current minimum energy efficiency level required by the federal energy efficiency regulations for ENERGY STAR[®] certified room air conditioners,³ which is a combined energy efficiency ratio (CEER) of 11.0 Btu/W·hr for louvered units without reverse cycle with a capacity below 8,000 Btu/hr. The Evaluator used the same equation as the one presented in the 2020 Measure Assessment for retired air conditioners as well as the capacity and hours of operation values and divided those by the aforementioned CEER, which resulted in an annual energy consumption value of 207 kWh for new standard room air conditioners.

² Natural Resources Canada, *Freezers Energy Efficiency Regulations*. <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6941> (Last accessed January 20, 2020).

³ Natural Resources Canada, *Room Air Conditioners Energy Efficiency Regulations*, <https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency/room-air-conditioners/6867> (Last accessed January 20, 2020).

Table 9: 2021 ARet Secondary Market Impact Calculation per Small Refrigerator

Transfer Scenario Proportion (a)	Would-be Acquirer Finds an Alternative Unit	Proportion (b)	Alternative Type	Proportion (c)	Total Proportion (a*b*c)	Scenario Energy Consumption (kWh) (d)	Secondary Market Impact (kWh) (a*b*c*d)
13%	Yes	50%	Old Unit	50%	3%	164	5
			New Unit	50%	3%	74	2
	No	50%			7%	0	0
Total Secondary Market Impact (kWh/unit)							7

Table 10: 2021 ARet Secondary Market Impact Calculation per Small Freezer

Transfer Scenario Proportion (a)	Would-be Acquirer Finds an Alternative Unit	Proportion (b)	Alternative Type	Proportion (c)	Total Proportion (a*b*c)	Scenario Energy Consumption (kWh) (d)	Secondary Market Impact (kWh) (a*b*c*d)
13%	Yes	50%	Old Unit	50%	3%	240	8
			New Unit	50%	3%	74	2
	No	50%			7%	0	0
Total Secondary Market Impact (kWh/unit)							10

The energy consumption values for new standard small appliances were established using the values for full-sized appliances. The Evaluator divided the annual energy consumption values of full-size appliances by their average cubic-foot volume and part-use factor, then multiplied those results by the average cubic-foot volume and part-use factor of small appliances. This resulted in annual energy consumption values of 74 kWh for both new standard small refrigerators and freezers.

APPENDIX III

ARET: 2021 RECOMMENDATIONS

The Evaluator made no specific recommendation as part of the 2021 evaluation of ARet. This appendix summarizes the previous evaluation recommendation that were not fully implemented or deferred.

Sections	Recommendations
2018 Recommendation (Deferred)	1. Continue to perform the metering activity and ensure the metering protocol is followed.

APPENDIX IV

IS: PARTICIPANT ONLINE SURVEY QUESTIONNAIRE

Table 5: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Online Survey
Estimated Time to Complete	5-10 minutes
Target Audience	Instant Savings participants who have purchased LED non-A type bulbs, OR LED fixtures during the fall 2021 campaign
Expected Number of Completions	n = 180: 60 for LED non-A type lamps, 60 for LED fixtures and 60 for recessed downlight fixtures
Fielding Firm	Narrative Research
Estimated Timeline for fielding	September 24 th – November 17 th , 2021

Table 6: Research Objectives and Associated Questions

Research Objectives	Section
Introduction and eligibility	A1, 0
Number of LED lamps / LED fixtures purchased and who is using them	B1-B3; E1-E3
Baseline definition	B4-B11; E4-E8
Free-Ridership for non-A type LED lamps	D1-D9
Free-Ridership for LED fixtures	G1-G8
Cross-Influence	H1-H6
Participant perspectives on Instant Savings awareness	C1-C3; F1-F3
Participant perspectives on LED penetration	B4, B11, E4
Demographics	I1 to I4

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Skip pattern or programming instructions **[LIKE THIS]**

Black text: instructions for interviewer **[NOTE: xxxx] / [PROBE: xxxx]**

A. Introduction and Eligibility

Thank you for taking the time to answer the following short survey about energy efficiency. We are gathering information from customers who purchased energy-efficient LED bulbs or LED fixtures between September 24th and November 17th. This survey should take about 5 minutes to complete.

A1. Where did you purchase your LED bulbs or LED fixtures?

1. Costco
2. Canadian Tire
3. The Home Depot
4. Kent

Please enter the SKU number for the LED bulbs or LED fixtures you recently purchased.

- › If you purchased both LED fixtures as well as LED bulbs, please enter the SKU number for a fixture.
 - › If you purchased more than one package of LED bulbs, please enter the SKU number for a package of non-pear-shaped LED bulbs, as illustrated below.
 - › If you purchased more than one LED fixture, please enter the SKU number for any one fixture.
- : _____

Pear-Shaped LED Bulbs		Non-Pear-Shaped LED Bulbs			
					
Pear-shaped bulb	Smart LED bulb	Bulb for pot-lights	Reflector bulb	Chandelier bulb	Globe bulb

[IF SKU = BULB, GO TO B SERIES, IF SKU = FIXTURE, GO TO E SERIES, IF SKU IS NOT ON LIST, THANK AND TERMINATE]

LED BULB SURVEY [ASK IF SKU = NON A-TYPE LED BULB]

B. Purchase – LED Bulbs

B1. How many non-pear-shaped LED bulbs did you purchase? Please enter the number of bulbs, not packages.

1. Enter number of LED bulbs bought: ____ **[NUMBER OF BULBS MUST BE ≥ 1].**
98. Don't know **[ASK RESPONDENT TO PROVIDE ESTIMATE TO CONTINUE SURVEY. IF UNABLE, THANK AND TERMINATE]**

- B2. [IN B1 IF NUMBER OF BULBS IS > 50 BULBS] You just entered that you purchased [ANSWER FROM B1] LED bulbs. Is that quantity correct?
1. Yes
 2. No **[CORRECT THE NUMBER OF BULBS FROM B1 ____CAN'T EXCEED 100 BULBS]**
 98. Don't know **[ASK RESPONDENT TO PROVIDE ESTIMATE TO CONTINUE SURVEY. IF UNABLE, THANK AND TERMINATE]**
- B3. Did you purchase these bulbs for your own use (for example, for your home or cottage), or are you a company or contractor purchasing products for a client or clients outside of your organization? **[ALLOW ONE RESPONSE ONLY]**
1. I purchased them for my own use
 2. I purchased them for a client or project outside of my organization
 3. **[SHOW IF B1 OR B2.2 > 1 BULB]** Both
 96. Other, please specify [_____]
- B4. Are there any non-pear-shaped LED bulbs currently installed in your home? **[CODE ONE ONLY]**
1. Yes
 2. No
 98. Don't know
- B5. **[ASK IF B1 OR B2.2= 1 BULB]** You bought one LED bulb. Do you plan on installing it... **[CODE ONLY ONE]**
1. To replace another LED bulb
 2. To replace a bulb that was not LED
 3. Into a new lamp or light fixture
 96. Other **[SPECIFY_____]**
- B6. **[ASK IF B5=1]** Do you plan on installing this LED bulb... **[ALLOW ONLY ONE CODE]**
1. To replace an LED bulb once it burns out
 2. To replace an LED bulb that is still working
 96. Other **[SPECIFY_____]**

- B7. **[ASK IF B5=2]** Do you plan on installing this LED bulb ... **[ALLOW ONLY ONE CODE]**
1. To replace a bulb once it burns out
 2. To replace a bulb that is still working
 96. Other [SPECIFY _____]
- B8. **[ASK IF B1 OR B2.2 > 1 (MORE THAN 1 BULB)]** You bought **[INSERT NUMBER OF LEDS FROM B1 OR B2.2]** LED bulbs. How many, if any, of these **[INSERT NUMBER OF LEDS FROM B1 OR B2.2]** LED bulbs will be installed... **[TOTAL NUMBER OF BULBS RECORDED CAN'T BE HIGHER THAN COUNT IN B1 OR B2.2] [ALL CATEGORIES NEED A NUMBER, ADD IN ZEROS FOR ANY THAT WERE NOT SELECTED; NON-OBLIGATORY]**
1. To replace another LED bulb: _____
 2. To replace a bulb that was not LED: _____
 3. Into a new lamp or light fixture: _____
 96. Other [SPECIFY _____]
- B9. **[ASK IF B8.1 >0]** Concerning the LED bulbs that you will use to replace existing LED bulbs: do you plan on installing these bulbs mostly ... **[ALLOW ONLY ONE CODE]**
1. To replace LED bulbs once they burn out
 2. To replace LED bulbs that are still working
 96. Other [SPECIFY _____]
 98. Don't know
- B10. **[ASK IF B8.2 >0]** Concerning the bulbs that you will use to replace existing non-LED bulbs: do you plan on installing these LED bulbs mostly ... **[ALLOW ONLY ONE CODE]**
1. To replace bulbs once they burn out
 2. To replace bulbs that are still working
 96. Other [SPECIFY _____]
 98. Don't know
- B11. **[ASK IF B6=2 OR B9=2]** Why do you plan on replacing LED bulbs that are still working?
ALLOW VERBATIM RESPONSE _____

C. Awareness of Program and Efficiency Nova Scotia – LED Bulbs

C1. Have you ever heard of the Efficiency Nova Scotia program that offers instant savings at the cash register for the purchase of energy-efficient lighting, controls or appliances? **[ALLOW ONLY ONE CODE]**

1. Yes
2. No

C2. **[ASK IF C1=1]** How did you find out about this program? **[ALLOW MULTIPLE RESPONSES; MAKE DON'T KNOW EXCLUSIVE]**

1. TV ads
2. Print ads
3. Radio ads
4. Radio remote – live radio personalities at a local store
5. In-store promotions
6. Store flyer
7. Store personnel
8. Efficiency Nova Scotia website
9. Facebook or other social media
10. Online advertisement on smart phone, computer or tablet
11. YouTube video
12. Billboards, digital billboards and other outdoor advertising
13. Word of mouth
14. Through an Efficiency Nova Scotia representative during an in-store engagement event
15. Through another Efficiency Nova Scotia program
96. Other [SPECIFY _____]
98. Don't know

C3. The day you recently bought the LED bulb(s), did you see the stickers, shelf signs or posters at the front of the store or in the light bulb section of the store promoting the discount offered on LED bulbs? **[ALLOW ONLY ONE CODE]**

1. Yes
2. No
98. Don't know

D. Free-Ridership - LED Bulbs

D1. Efficiency Nova Scotia offered a discount on non-pear-shaped LED bulbs. Before paying at the cash register, were you aware that a discount was offered on the purchase of LEDs? **[ALLOW ONLY ONE CODE]**

1. Yes **[GO TO D3]**
2. No **[GO TO D2]**
98. Don't know **[GO TO D2]**

D2. **[ASK IF NOT AWARE OF THE DISCOUNT (D1=2, DK)]** To confirm, you did not know about the discount on specific LED bulbs before paying at the register? **[CODE ONE ONLY]**

1. Yes, I knew about the discount
2. No, I did not know about the discount **[GO TO SECTION H]**

[ASK THE FOLLOWING QUESTIONS IF AWARE OF THE DISCOUNT (D1=1) OR (D2=1), OTHERWISE SKIP TO SECTION H]

D3. Before the beginning of the rebate campaign on September 24th, were you aware that discounts on LED bulbs would be offered this fall?

1. Yes
2. No **[SKIP TO D5]**

D4. **[ASK IF YES IN D3]** Did you postpone your purchase of LEDs to take advantage of the discount?

1. Yes
2. No

D5. If the discount on LEDs had NOT been offered, what would you have bought? Would you have... **[ALLOW ONLY ONE CODE]**

1. Bought LEDs anyway
2. Bought another type of bulb
3. Not bought any bulbs

D6. **[ASK IF D5=2]** Which type(s) of bulb would you have purchased instead? **[ALLOW MULTIPLE RESPONSES]**

1. Incandescent
2. Halogen
3. CFL
96. Other, SPECIFY: _____



D7. How likely would you have been to buy the LED bulbs that you purchased if you had to pay the full price? Please answer on a scale of 0 to 10, with a 0 indicating that you “Definitely Would Not Have Bought these LEDs” and a 10 indicating that you “Definitely Would Have Bought these LEDs.” **[DO NOT ACCEPT A RANGE]**

Definitely Would Not Have Bought LEDs 0	1	2	3	4	5	6	7	8	9	Definitely Would Have Bought LEDs 10

D8. If the discount had NOT been offered, when would you have purchased the LED bulbs that you did? **[ALLOW ONLY ONE CODE]**

1. **[INCLUDE IF D4=1]** Earlier
2. Definitely on the same day
3. Probably on the same day
4. Probably at a later date
5. Definitely at a later date
96. Would not have purchased them at all **[SKIP TO H SECTION]**

D9. **[ASK IF B1 OR B2.2 >1 (MORE THAN 1 BULB)]** Without the discount, would you have definitely purchased the same number of LED bulbs, probably purchased the same number, probably purchased fewer or definitely purchased fewer? **[ALLOW ONLY ONE CODE]**

1. Definitely the same number
2. Probably the same number
3. Probably fewer
4. Definitely fewer

[NOTE TO PROGRAMMER: CONTINUE TO SECTION H]

LED FIXTURE SURVEY [ASK IF SKU = LED FIXTURE]

E. Purchase – LED Fixtures

E1. How many LED fixtures did you purchase? Please enter the number of fixtures, not packages.

1. Enter number of LED fixtures bought: ____ **[NUMBER OF FIXTURES MUST BE ≥ 1].**
98. Don't know **[ASK RESPONDENT TO PROVIDE ESTIMATE TO CONTINUE SURVEY. IF UNABLE, THANK AND TERMINATE]**

E2. **[IN E1 IF NUMBER OF FIXTURES IS > 50 FIXTURES]** You entered that you purchased [ANSWER FROM E1] LED fixtures. Is that quantity correct?

1. Yes
2. No **[CORRECT THE NUMBER OF FIXTURES FROM E1 ____ CAN'T EXCEED 100 FIXTURES]**
98. Don't know **[ASK RESPONDENT TO PROVIDE ESTIMATE TO CONTINUE SURVEY. IF UNABLE, THANK AND TERMINATE]**

E3. Did you purchase these fixtures for your own use (for example, for your home or cottage), or are you a company or contractor purchasing products for a client or clients outside of your organization? **[ALLOW ONE RESPONSE ONLY]**

1. I purchased them for my own use
2. I purchased them for a client or project outside of my organization
3. **[SHOW IF E1 OR E2.2 >1 FIXTURE]** Both
96. Other, please specify [_____]

- E4. Are there any LED fixtures currently installed in your home? **[ALLOW ONLY ONE CODE]**
1. Yes
 2. No
 98. Don't know
- E5. Will the LED fixture(s) you bought be installed indoor or outdoor? **[ALLOW ONLY ONE CODE]**
1. Indoor
 2. Outdoor
 3. **[SHOW IF E1 OR E2.2 > 1 FIXTURE]** Both
 96. Other [SPECIFY _____]
- E6. **[IF E1 OR E2.2=1 FIXTURE]** For which of the following reasons did you buy this LED fixture?
[ALLOW ONLY ONE CODE]
1. To replace a fixture that was still functional
 2. To replace a fixture that was broken
 3. To install in a place that did not have a fixture before
 96. Other [SPECIFY _____]
- E7. **[ASK IF E1 OR E2.2 > 1 (MORE THAN 1 FIXTURE)]** You bought **[INSERT NUMBER FROM E1 OR E2.2]** LED fixtures. How many, if any, of these **[INSERT NUMBER FROM E1 OR E2.2]** LED fixtures will be installed... [TOTAL NUMBER OF FIXTURES RECORDED CAN'T BE HIGHER THAN COUNT IN **E1 OR E2.2**]

[NOTE TO PROGRAMMER: All categories need a number, code as zeros for any that were not selected].

1. To replace a fixture that was still functional
2. To replace a fixture that was broken
3. To install in a place that did not have a fixture before
96. Other [SPECIFY _____]

E8. **[DO NOT ASK IF E6=3 OR E7=3]** What types of bulbs were installed in the fixtures that you plan on replacing? [CODE AS MANY AS APPLY; SHOW BULB TYPES ON SCREEN]

1. LED bulbs
2. CFL bulbs
3. Halogen bulbs
4. Standard incandescent bulbs (those bulbs typically have wattages of 40 W, 60 W or 100 W).
5. Efficient incandescent bulbs (those bulbs look the same as incandescent bulbs but typically have wattages of 29 W, 43 W or 72 W)
96. Other [SPECIFY _____]

LED bulb	CFL bulb	Halogen bulb	Incandescent bulb	Efficient incandescent bulb
			 Typically have wattages of 40 W, 60 W or 100 W	 Typically have wattages of 29 W, 43 W or 72 W

F. Awareness of Program and Efficiency Nova Scotia – LED Fixtures

F1. Have you ever heard of the Efficiency Nova Scotia program that offers instant savings at the cash register for the purchase of energy-efficient lighting, controls or appliances? **[ALLOW ONLY ONE CODE]**

1. Yes
2. No

F2. **[ASK IF F1=1] How did you find out about this program? [ALLOW MULTIPLE RESPONSES; MAKE DON'T KNOW EXCLUSIVE]**

1. TV ads
2. Print ads
3. Radio ads
4. In-Store radio remote – live radio personalities at a local store
5. In-store promotions
6. Store flyer
7. Store personnel
8. Efficiency Nova Scotia website
9. Facebook or other social media
10. Online advertisement on smart phone, computer or tablet
11. YouTube video
12. Billboards, digital billboards and other outdoor advertising
13. Word of mouth
14. Through an Efficiency Nova Scotia representative during an in-store engagement event
15. Through another Efficiency Nova Scotia program
96. Other [SPECIFY _____]
98. Don't know

F3. The day you recently bought the LED light fixture(s), did you see the stickers, shelf signs or posters at the front of the store or in the light fixture section of the store promoting the discount offered on LED fixtures? **[ALLOW ONLY ONE CODE]**

1. Yes
2. No
98. Don't know

G. Free-Ridership – LED Fixtures

G1. Efficiency Nova Scotia offered a discount on LED fixtures. Before paying at the cash register, were you aware that a discount was offered on the purchase of LED fixtures? **[ALLOW ONLY ONE CODE]**

1. Yes **[GO TO G3]**
2. No **[GO TO G2]**
98. Don't know **[GO TO G2]**

- G2. **[ASK IF NOT AWARE OF THE DISCOUNT (G1=2, DK)]** To confirm, you did not know about the discount on specific LED fixtures before paying at the register? **[ALLOW ONLY ONE CODE]**
1. Yes, I knew about the discount
 2. No, I did not know about the discount
- G3. Thinking about your purchase of LED fixtures, what best describes your situation?
1. You were looking to purchase lighting fixtures but not specifically LED
 2. You were looking to purchase LED fixtures before you were aware of the discount offered by Efficiency Nova Scotia
 3. **[ASK IF G1 = 1 OR G2 = 1]** You came to the store to purchase LED fixtures because of the discount offered by Efficiency Nova Scotia
 96. You were not looking to purchase lighting fixtures
 98. Other, SPECIFY: _____

[ASK THE FOLLOWING QUESTIONS IF AWARE OF THE DISCOUNT (G1=1) OR (G2=1), OTHERWISE SKIP TO NEXT SECTION]

- G4. If the discount on LED fixtures had NOT been offered, what would you have bought? Would you have... **[ALLOW ONLY ONE CODE]**
1. Bought LED fixtures anyway
 2. Bought another type of fixture without LEDs
 3. Not bought any fixtures

G5. **[ASK IF G4=2]** If you were going to purchase a fixture without LED lighting, what type of bulbs would you have installed? **[ALLOW MULTIPLE RESPONSES]**

1. Incandescent
2. Halogen
3. CFL
96. Other, SPECIFY: _____



G6. How likely would you have been to buy the LED fixtures that you purchased if you had to pay the full price? Please answer on a scale of 0 to 10, with a 0 indicating that you “Definitely Would Not Have Bought these LED fixtures” and a 10 indicating that you “Definitely Would Have Bought these LED fixtures.” **[DO NOT ACCEPT RANGE]**

Definitely Would Not Have Bought LED Fixtures 0	1	2	3	4	5	6	7	8	9	Definitely Would Have Bought LED Fixtures 10

G7. If the discount had NOT been offered, when would you have purchased the LED fixtures that you did? **[ACCEPT ONLY ONE CODE]**

1. Earlier
2. Definitely on the same day
3. Probably on the same day
4. Probably at a later date
5. Definitely at a later date
96. Would not have purchased them at all **[SKIP TO H SECTION]**

G8. **[ASK IF E1 OR E2.2 > 1 (MORE THAN 1 FIXTURE)]** Without the discount, would you have definitely purchased the same number of LED fixtures, probably purchased the same number, probably purchased fewer or definitely purchased fewer? **[ACCEPT ONLY ONE CODE]**

1. Definitely the same number
2. Probably the same number
3. Probably fewer
4. Definitely fewer

[NOTE TO PROGRAMMER: CONTINUE TO SECTION H]

CROSS-CUTTING QUESTIONS [ASK ALL]

H. Cross-Influence

ROTATE (H1 + H2-H3) AND (H4 + H5-H6) SEQUENCES; SHOW H1 TO H3 ON SAME SCREEN AND H4 TO H6 ON SAME SCREEN

H1. Before your recent purchase, had you at any time in the past benefitted from a discount on energy efficient products or participated in any programs offered by Efficiency Nova Scotia? **[NON-OBLIGATORY]**

1. Yes
2. No

For the following statements, please indicate whether you agree or disagree.

H2. **[ASK IF H1=1]** Your previous experience with Efficiency Nova Scotia programs was a major factor in your decision to purchase **[LED BULBS/FIXTURES]**.

1. Agree
2. Disagree

H3. **[ASK IF H1=1]** Because of your previous experience with Efficiency Nova Scotia programs, you took into account the savings on your energy bill when choosing different lighting options for your home.

1. Agree
2. Disagree

- H4. Before your recent purchase, had you at any time in the past already seen Efficiency Nova Scotia promotional materials advertising the benefits of LED lighting?
1. Yes
 2. No
 98. Don't know

For the following statements, please indicate whether you agree or disagree.

- H5. **[ASK IF H4=1]** The Efficiency Nova Scotia promotional materials you saw were a major factor in your decision to purchase **[LED BULBS/FIXTURES]**.
1. Agree
 2. Disagree
- H6. **[ASK IF H4=1]** The Efficiency Nova Scotia promotional materials you saw prompted you to take into account the savings on your energy bill when choosing different lighting options for your home.
1. Agree
 2. Disagree

I. Demographics

These final questions are asked for statistical purposes only. The information collected is strictly confidential and will only be used in group results.

- I1. What type of residence do you live in? **[ACCEPT ONLY ONE CODE]**
1. Detached single-family house
 2. Semi-detached house
 3. Mobile home or house trailer
 4. Townhouse or duplex which share adjacent walls
 5. Row house (Single story apartment building)
 6. Apartment or condo building that has fewer than five stories
 7. Apartment or condo building that has five or more stories
 96. Another type [SPECIFY: _____]
 99. Prefer not to say

12. Do you own or rent this residence? **[ACCEPT ONLY ONE CODE]**
- 1. Own/buying **[GO TO I4]**
 - 2. Rent/lease **[GO TO I3]**
 - 96. Other (Describe)_____ **[GO TO I4]**
 - 99. Prefer not to say **[GO TO I4]**
13. Do you or does your landlord pay the electric bills for your residence? **[ACCEPT ONLY ONE CODE]**
- 1. I pay the electric bills
 - 2. My landlord pays the electric bills
 - 96. Other [Describe _____])
 - 97. Prefer not to say
14. What is your gender? **[ACCEPT ONLY ONE CODE]**
- 1. Male
 - 2. Female
 - 3. Gender diverse
 - 4. Other, please specify
 - 99. Prefer not to say
- END.
15. This concludes the survey. As a thank you for your time, we will provide you with a \$10 gift card. Please provide your full name and [email/home] address to receive the gift card. This information will be kept confidential.

Full name:

Email Address:

Mailing Address:

- 98. I don't wish to receive a gift card.

APPENDIX V

IS: PARTICIPANT SURVEY RESULTS

The participant survey results are presented in the following tables. Please note that the Instant Savings rebate structure was changed in 2019 with the removal of rebates for A-type LED lamps and again in May, 2021 with LED fixtures becoming rebated year-round. Caution should be taken when comparing results across years given the differing program component parameters. As a result, tracking is not provided for certain questions. The 2020 and 2021 results are based on an online survey, whereas an in-store intercept survey was used to collect results in previous years.

A1. Where did you purchase your LED bulbs or LED fixtures?

Products Purchased	2020	2021
Sample Size	184	120
The Home Depot	47%	55%
Canadian Tire	18%	25%
Kent	26%	16%
Costco	5%	3%
Home Hardware	4%	2%

A2. Please enter the SKU number for the LED bulbs or LED fixtures you recently purchased.

Type of LEDs Purchased	2020	2021
Sample Size	184	120
LED bulb(s)	46%	56%
LED fixture(s)	54%	44%

B1. How many non-pear-shaped LEDs did you purchase?

Number of Non-A-type LED Bulbs Purchased	2019	2020	2021
Sample Size	48	84	67
1-2	21%	21%	39%
3-4	29%	33%	24%
5-7	29%	29%	25%
8-10	8%	11%	7%
11 or more	13%	6%	4%
Average	5.3	5.0	4.3
Base: Respondents who purchased LED bulbs only Don't know/refused excluded from average calculations			

- B3. Did you purchase these bulbs for your own use (for example, for your home or cottage), or are you a company or contractor purchasing products for a client or clients outside of your organization?

Purchase Reason	2020	2021
Sample Size	84	67
I purchased them for my own use	95%	100%
I purchased them for a client or project outside of my organization	2%	-
Both	1%	-
Other	1%	-
Base: Respondents who purchased LED bulbs only		

- B4. Are there any non-pear-shaped LEDs currently installed in your home?

Non-A-type LED Bulbs Currently Installed	2019	2020	2021
Sample Size	48	84	67
Yes	63%	77%	79%
No	33%	18%	19%
Don't know	4%	5%	1%
Base: Respondents who purchased LED bulbs only			

- B5. You bought one LED bulb today. Do you plan on installing it ...?
- B8. You bought [NUMBER FROM B1] LED bulbs. How many, if any, of these [NUMBER FROM B1] LED bulbs will be installed ...?

Reason for Purchasing LED Bulbs	2020	2021
Sample Size	84	61
To replace a bulb that was not LED	46%	51%
Into a new lamp or light fixture	22%	28%
To replace another LED bulb	30%	25%
For some other reason	2%	2%
Base: Respondents who purchased LED bulbs only		

B6/B9. Concerning the LED bulbs that you will use to replace existing LED bulbs: do you plan on installing these LED bulbs mostly ...?

Existing LED Bulb Replacement Timing	2019	2020	2021
Sample Size	18 (#)	34	19 (#)
To replace LED bulbs once they burn out	16	71%	11
To replace LED bulbs that are still working	1	26%	8
Other	1	-	-
Don't know	-	3%	-
Base: Respondents who purchased LED bulbs to replace existing LED bulbs			

B7/B10. Concerning the bulbs that you will use to replace existing non-LED bulbs, do you plan on installing these bulbs mostly ...?

Non-LED Bulb Replacement Timing	2019	2020	2021
Sample Size	27	37	32
To replace non-LED bulbs that are still working	63%	84%	66%
To replace non-LED bulbs once they burn out	33%	16%	28%
Other	4%	-	6%
Base: Respondents who purchased LED bulbs to replace non-LEDs bulbs			

B11. Why do you plan on replacing LED bulbs that are still working?

Reason for Replacing Working LED Bulbs	2018	2019	2020	2021
Sample Size	16 (#)	1 (#)	9 (#)	8 (#)
Dislike lighting of these bulbs	6	1	3	7
Bulbs burn too fast	2	-	1	1
Dislike appearance of the bulbs	1	-	2	-
Bulbs flicker	-	-	1	-
Want bulbs that dim	-	-	1	-
Backup bulbs	4	-	-	-
Want bulbs to match	2	-	-	-
Other	-	-	1	-
Don't know	1	-	-	-
Base: Respondents who purchased LED bulbs to replace existing LED bulbs that are still working				

C1/F1. Have you ever heard of the Efficiency Nova Scotia program that offers instant savings at the cash register for the purchase of energy efficient lighting, controls, or appliances?

Instant Savings Awareness	2017	2018*	2019	2020	2021
Sample Size	100	194	111	184	120
Yes	63%	63%	70%	68%	58%
No	36%	37%	30%	32%	42%
Don't know	1%	-	-	-	-
*Question wording change in 2018					

C2/F2. How did you find out about this program?

Sources of Awareness	2017	2018	2019	2020	2021
Sample Size	63	123	78	125	70
In-store promotions	32%	37%	44%	46%	46%
Store personnel	-	5%	1%	32%	29%
ENS website	13%	5%	9%	10%	13%
Through an ENS representative during an in-store customer engagement event	10%	10%	4%	8%	11%
Word of mouth	13%	14%	18%	6%	9%
Store flyer	11%	15%	15%	4%	6%
Another ENS program	5%	-	1%	4%	6%
Radio ads	2%	15%	4%	5%	4%
Print ads	5%	9%	18%	5%	3%
Facebook or other social media	6%	3%	9%	4%	3%
Online advertising	5%	4%	6%	3%	3%
TV ads	16%	14%	13%	7%	1%
Billboards and other outdoor advertising	-	1%	-	2%	-
Radio remote – live radio personalities at a local store	-	4%	5%	1%	-
Someone visiting my home	-	3%	-	-	-
Through NS Power	-	2%	-	-	-
Others	3%	2%	1%	2%	1%
Don't know	-	1%	-	2%	1%
Base: Respondents who were aware of Instant Savings Multiple responses					

- C3. The day you recently bought the LED bulb(s), did you see the stickers, shelf signs, or posters at the front of the store or in the light bulb section of the store promoting the discount offered on LEDs?*

In-store Promotion Awareness	2017	2018	2019	2020	2021
Sample Size	94	152	48	84	67
Yes	94%	96%	81%	63%	55%
No	5%	4%	19%	37%	40%
Don't know	1%	-	-	-	4%
Base: Respondents who purchased LED bulbs (2017-2018) and respondents who purchased non-A-type LED bulbs (2019-2021) that were aware of discount prior to purchase					
*Wording change in 2021					

- F3. The day you recently bought the LED light fixture(s), did you see the stickers, shelf signs, or posters at the front of the store or in the light fixture section of the store promoting the discount offered on LED fixtures?*

In-store Promotion Awareness	2019	2020	2021
Sample Size	63	100	53
Yes	68%	55%	62%
No	29%	30%	30%
Don't know	3%	15%	8%
Base: Respondents who purchased LED fixtures			
*Wording change in 2021			

- C3/F3. The day you recently bought the LED [bulb(s)/light fixture(s)], did you see the stickers, shelf signs, or posters at the front of the store or in the [light bulb/light fixture] section of the store promoting the discount offered on LED [fixtures/bulbs]?*

In-store Promotion Awareness	2019	2020	2021
Sample Size	111	184	120
Yes	74%	59%	58%
No	24%	33%	36%
Don't know	2%	8%	6%
Base: Respondents who purchased LED bulbs and respondents who purchased LED fixtures			
*Wording change in 2021			

- D1. Efficiency Nova Scotia offered a discount on non-pear-shaped LED bulbs. Before paying at the register, were you aware that a discount was offered on the purchase of LEDs?
- D2. To confirm, you did not know about the discount on specific LED bulbs before paying at the register?* **[CODE ONE ONLY]**

Discount Awareness	2017	2018	2019	2020	2021
Sample Size	100	163	48	84	67
Yes, was aware of discount before paying	94%	91%	83%	63%	52%
No, was not aware of discount before paying	6%	9%	17%	37%	48%
Base: Respondents who purchased LED bulbs (2017-2018) and respondents who purchased non-A-type LED bulbs (2019-2021)					
*Slight wording change in 2020-2021					

- D3. Before the beginning of the rebate campaign on September 24th, were you aware that discounts on LED bulbs would be offered this fall?

Program Awareness	2017	2018	2019	2020	2021
Sample Size	94	152	40	53	35
Yes, aware that discounts would be offered this fall	15%	10%	18%	28%	6%
No, not aware that discounts would be offered this fall	82%	90%	83%	72%	94%
Don't know	3%	-	-	-	-
Base: Respondents who purchased LED bulbs (2017-2018) and respondents who purchased non-A-type LED bulbs (2019-2021) who were aware of discount prior to purchase					

- D4. Did you postpone your purchase of LEDs to take advantage of the discount?

Postponed Purchase of LEDs to Take Advantage of Rebate	2017 (#)	2018 (#)	2019 (#)	2020 (#)	2021 (#)
Sample Size	14	15	7	15	2
Yes	5	10	6	9	-
No	9	5	1	6	2
Base: Respondents who purchased LED bulbs (2017-2018) and respondents who purchased non-A-type LED bulbs (2019-2021) who were aware of discount prior to campaign beginning					

D5. If the discount on LEDs had NOT been offered, what would you have bought? Would you have...?

Purchases if Discount Had not Been Offered	2017	2018	2019	2020	2021
Sample Size	94	152	40	53	35
Bought LEDs anyway	38%	41%	45%	62%	89%
Bought another type of bulb	5%	2%	3%	21%	3%
Not bought any bulbs	55%	56%	50%	17%	9%
Don't know	1%	1%	3%	-	-
Base: Respondents who purchased LED bulbs (2017-2018) and respondents who purchased non-A-type LED bulbs (2019-2021) who were aware of discount					

D6. Which type(s) of bulb would you have purchased instead today?

Other Type of Bulb that Would Have Been Purchased	2017 (#)	2018 (#)	2019 (#)	2020 (#)	2021 (#)
Sample Size	5	3	1	11	1
CFL	-	-	-	1	1
Halogen	2	-	-	5	-
Incandescent	1	3	-	4	-
Others	1	-	-	-	-
Don't know	1	-	1	1	-
Base: Respondents who purchased LED bulbs (2017-2018) and respondents who purchased non-A-type LED bulbs (2019-2021) who would have purchased other bulbs instead					

D7. How likely would you have been to buy the LED bulbs that you purchased if you had to pay the full price? Please answer on a scale of 0 to 10, with a 0 indicating that you “Definitely would not have bought these LEDs” and a 10 indicating that you “Definitely would have bought these LEDs.”

Likelihood of Buying LEDs Without Discount	2017		2018		2019		2020		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Likelihood of buying LEDs if discount had not been offered	94	4.2	152	4.5	40	4.9	53	6.3	35	7.3
Base: Respondents who purchased LED bulbs (2017-2018) and respondents who purchased non-A-type LED bulbs (2019-2021) that were aware of discount prior to purchase Don't know/refused excluded from calculations										

D8. If the discount had NOT been offered, when would you have purchased the LEDs that you purchased today? Would it have been...?

Length of Time Before Purchasing LEDs	2017	2018	2019	2020	2021
Sample Size	94	152	40	53	35
Earlier	-	1%	-	2%	-
Definitely on the same day	21%	18%	25%	28%	60%
Probably on the same day	9%	15%	18%	25%	20%
Probably at a later date	32%	32%	20%	23%	11%
Definitely at a later date	34%	32%	33%	15%	6%
Would not have purchased them at all	4%	1%	5%	8%	3%
Don't know	-	1%	-	-	-
Base: Respondents who purchased LED bulbs (2017-2018) and respondents who purchased non-A-type LED bulbs (2019-2021) that were aware of discount prior to purchase					

D9. Without the discount, would you have definitely purchased the same number of LEDs, probably purchased the same number, probably purchased fewer, or definitely purchased fewer?

Number of Bulbs Likely to Purchase Without Discount	2017	2018	2019	2020	2021
Sample Size	90	150	35	45	32
Definitely the same number	24%	21%	23%	31%	50%
Probably the same number	18%	20%	43%	29%	31%
Probably fewer	30%	27%	9%	24%	13%
Definitely fewer	28%	29%	26%	16%	6%
Don't know	-	3%	-	-	-
Base: Respondents who purchased LED bulbs (2017-2018) and respondents who purchased non-A-type LED bulbs (2019-2021) that were aware of discount prior to purchase and would have purchased bulbs at some point without discount					

E1. How many LED fixtures did you purchase?

Number of LED Fixtures Purchased	2018	2019	2020	2021
Sample Size	26	63	100	53
1-2	58%	63%	70%	64%
3-4	35%	14%	16%	13%
5-7	8%	6%	3%	6%
8-10	-	6%	5%	9%
11 or more	-	10%	6%	8%
Average	2.4	4.1	3.0	3.3
Base: Respondents who purchased LED fixtures				

Number of LED Fixtures Purchased	2020		2021	
	Recessed Fixtures	Other LED Fixtures	Recessed Fixtures	Other LED Fixtures
Sample Size	30	70	15 (#)	38
1-2	60%	74%	7	71%
3-4	13%	17%	1	16%
5-7	3%	3%	2	3%
8-10	7%	4%	2	8%
11 or more	17%	1%	3	3%
Average	4.7	2.3	4.9	2.7
Base: Respondents who purchased LED fixtures				

E3. Did you purchase these fixtures for your own use (for example, for your home or cottage), or are you a company or contractor purchasing products for a client or clients outside of your organization?

Purchase Reason	2020	2021
Sample Size	100	53
I purchased them for my own use	98%	96%
I purchased them for a client or project outside of my organization	2%	2%
Other	-	2%
Base: Respondents who purchased LED fixtures		

E4. Are there any LED fixtures currently installed in your home?

LED Fixtures Currently Installed	2019	2020	2021
Sample Size	63	100	53
Yes	78%	76%	77%
No	22%	23%	17%
Don't know	-	1%	6%
Base: Respondents who purchased LED fixtures			

LED Fixtures Currently Installed	2020		2021	
	Recessed Fixtures	Other LED Fixtures	Recessed Fixtures	Other LED Fixtures
Sample Size	30	70	15 (#)	38
Yes	83%	73%	11	79%
No	17%	26%	3	16%
Don't know	-	1%	1	5%
Base: Respondents who purchased LED fixtures				

E5. Will the LED fixture(s) you bought be installed indoor or outdoor?

Intended Location of Fixtures	2018	2019	2020	2021
Sample Size	31	63	100	53
Indoor	94%	90%	88%	89%
Outdoor	3%	3%	6%	8%
Both	3%	6%	6%	4%
Base: Respondents who purchased LED fixtures Responses do not sum to 100% due to rounding				

Intended Location of Fixtures	2020		2021	
	Recessed Fixtures	Other LED Fixtures	Recessed Fixtures	Other LED Fixtures
Sample Size	30	70	15 (#)	38
Indoor	93%	86%	12	92%
Outdoor	3%	7%	2	5%
Both	3%	7%	1	3%
Base: Respondents who purchased LED fixtures Responses do not sum to 100% due to rounding				

E6. For which of the following reasons did you buy this LED fixture?

E7. You bought [NUMBER FROM E1] LED fixtures. How many, if any, of these [NUMBER FROM E1] LED fixtures will be installed...?

Reason for Purchasing LED Fixtures	2018	2019	2020	2021
Sample Size	31	63	100	120
To install in a place that did not have a fixture before	45%	46%	23%	49%
To replace a fixture that was still functional	49%	45%	71%	45%
To replace a fixture that was broken	5%	9%	3%	7%
Other	-	-	3%	-
Base: Respondents who purchased LED fixtures Responses do not sum to 100% due to rounding				

Reason for Purchasing LED Fixtures	2020		2021	
	Recessed Fixtures	Other LED Fixtures	Recessed Fixtures	Other LED Fixtures
Sample Size	30	70	15	38
To replace a fixture that was still functional	71%	72%	31%	60%
To install in a place that did not have a fixture before	28%	14%	62%	33%
To replace a fixture that was broken	1%	7%	7%	6%
Other	-	7%	-	-
Base: Respondents who purchased LED fixtures Responses do not sum to 100% due to rounding				

E8. What types of bulbs were installed in the fixtures that you plan on replacing?

Types of Bulbs in Replaced Fixtures	2018	2019	2020	2021
Sample Size	24	49	87	38
LED bulbs	25%	20%	49%	37%
Standard incandescent bulbs	42%	33%	30%	32%
Halogen bulbs	-	14%	14%	18%
CFL bulbs	29%	29%	10%	11%
Fluorescent tube		-	1%	3%
Efficient incandescent bulbs	4%	-	3%	-
Others	-	2%	-	5%
Don't know	4%	4%	-	-
Base: Respondents who replaced existing fixtures Multiple responses				

Types of Bulbs in Replaced Fixtures	2020		2021	
	Recessed Fixtures	Other LED Fixtures	Recessed Fixtures	Other LED Fixtures
Sample Size	24	63	9 (#)	29
LED bulbs	46%	51%	2	41%
Standard incandescent bulbs	29%	30%	2	34%
CFL bulbs	8%	11%	-	14%
Halogen bulbs	25%	10%	5	7%
Fluorescent tube	4%	-	-	3%
Efficient incandescent bulbs	-	5%	-	-
Others	.	.	.	7%
Base: Respondents who replaced existing fixtures Multiple responses				

- G1. Efficiency Nova Scotia offered a discount on LED fixtures. Before paying at the cash register, were you aware that a discount was offered on the purchase of LED fixtures?*
- G2 To confirm, you did not know about the discount on specific LED fixtures before paying at the register?*

Aware of Discount	2019	2020	2021
Sample Size	63	100	53
Yes	84%	49%	66%
No	14%	51%	34%
Don't know	2%	-	-
Base: Respondents who purchased LED fixtures *Slight change in wording in 2020			

Aware of Discount	2020		2021	
	Recessed Fixtures	Other LED Fixtures	Recessed Fixtures	Other LED Fixtures
Sample Size	30	70	15 (#)	38
Yes	57%	46%	11	63%
No	43%	54%	4	37%
Base: Respondents who purchased LED fixtures *Slight change in wording in 2020				

- G3. Thinking about your purchase of LED fixtures, what best describes your situation?*

LED Fixture Purchases	2019	2020	2021
Sample Size	63	100	53
You were looking to purchase LED fixtures before you were aware of the discount offered by ENS	37%	66%	55%
You were looking to purchase lighting fixtures but not specifically LEDs	21%	25%	25%
You came to the store to purchase LED fixtures because of the discount offered by ENS	21%	7%	19%
You were not looking to purchase lighting fixtures	22%	2%	-
Other	-	-	2%
Base: Respondents who purchased LED fixtures *Slight change in wording in 2020			

LED Fixture Purchases	2020		2021	
	Recessed Fixtures	Other LED Fixtures	Recessed Fixtures	Other LED Fixtures
Sample Size	30	70	15 (#)	38
You were looking to purchase LED fixtures before you were aware of the discount offered by ENS	80%	60%	12	45%
You were looking to purchase lighting fixtures but not specifically LEDs	7%	33%	1	32%
You came to the store to purchase LED fixtures because of the discount offered by ENS	10%	6%	1	24%
You were not looking to purchase lighting fixtures	3%	1%	-	-
Other	-	-	1	-
Base: Respondents who purchased LED fixtures *Slight change in wording in 2020				

- G4. If the discount on LED fixtures had NOT been offered, what would you have bought? Would you have ...? *

Purchases if Discount Had not Been Offered	2019	2020	2021
Sample Size	53	49	35
Bought LED fixtures anyway	51%	78%	57%
Bought other type of fixtures without LEDs	2%	6%	11%
Not bought any fixtures	45%	16%	31%
Don't know	2%	-	-
Base: Respondents who were aware of discount prior to purchase *Slight change in wording IN 2020-2021			

- G5. If you were going to purchase a fixture without LED lighting, what type of bulbs would you have installed?

Other Type of Bulb that Would Have Been Purchased	2019	2020	2021
Sample Size	1 (#)	3 (#)	4 (#)
Halogen	-	-	3
CFL	-	1	1
Incandescent	1	2	-
Base: Respondents who were aware of discount prior to purchase and who would have bought another type of fixture without LEDs if discount had not been offered			

- G6. How likely would you have been to buy the LED fixtures that you purchased if you had to pay the full price? Please answer on a scale of 0 to 10, with a 0 indicating that you “Definitely would not have bought these LED fixtures” and a 10 indicating you “Definitely would have bought these LED fixtures”.*

Likelihood of Buying LEDs Without Discount	2019		2020		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Likelihood of buying LED fixtures if discount had not been offered	53	5.0	49	7.5	35	6.2
Base: Respondents who purchased LED fixtures who were aware of discount prior to purchase Don't know/refused excluded from calculations *Slight change in wording in 2020						

- G7. If the discount had NOT been offered, when would you have purchased the LED fixtures that you did?*

Length of Time Before Purchasing LEDs	2019	2020	2021
Sample Size	53	49	35
Definitely today/definitely on the same day	34%	39%	20%
Probably today/probably on the same day	15%	27%	14%
Probably at a later date	17%	24%	37%
Definitely at a later date	26%	8%	14%
Would not have purchased them at all	4%	2%	14%
Don't know	4%	-	-
Base: Respondents who purchased LED fixtures who were aware of discount prior to purchase *Slight change in wording in 2020			

- G8. Without the discount, would you have definitely purchased the same number of LED fixtures, probably purchased the same number, probably purchased fewer, or definitely purchased fewer?

Number of Bulbs Likely to Purchase Without Discount	2019	2020	2021
Sample Size	35	29	20
Definitely the same number	31%	52%	25%
Probably the same number	29%	24%	15%
Probably fewer	14%	14%	45%
Definitely fewer	23%	10%	15%
Don't know	3%	-	-
Base: Respondents who purchased LED fixtures who were aware of discount prior to purchase and would have purchased bulbs at some point without discount			

- H1. Before your recent purchase, had you at any time in the past benefitted from a discount on energy efficient products or participated in other programs offered by Efficiency Nova Scotia?*

Benefitted from Other ENS Programs in the Past	2019	2020	2021
Sample Size	111	184	118
Yes	62%	62%	56%
No	35%	37%	44%
Don't know	3%	1%	-
Base: Respondents who purchased non-A-type LED bulbs or LED fixtures *Slight change in wording in 2020			

- H2. Your previous experience with Efficiency Nova Scotia programs was a major factor in your decision to purchase [LED BULBS/FIXTURES] today.

Previous Experience with ENS Programs Was Factor in Decision to Purchase	2019	2020	2021
Sample Size	69	114	66
Agree	80%	61%	70%
Disagree	20%	39%	30%
Base: Respondents who benefitted from ENS program in the past			

- H3. Because of your previous experience with Efficiency Nova Scotia programs, you took into account the savings on your energy bill when choosing different lighting options for your home.

Previous Experience with ENS Programs Influenced Decision About Lighting Options	2019	2020	2021
Sample Size	69	114	66
Agree	90%	82%	92%
Disagree	10%	18%	8%
Base: Respondents who benefitted from ENS program in the past			

- H4. Before your recent purchase, had you at any time in the past already seen Efficiency Nova Scotia promotional materials advertising the benefits of LED lighting?

Saw ENS Promotional Material Advertising Benefits of LEDs	2019	2020	2021
Sample Size	111	184	120
Yes	77%	68%	65%
No	16%	22%	24%
Don't know	6%	10%	11%
Base: Respondents who purchased LED bulbs or LED fixtures			

- H5. The Efficiency Nova Scotia promotional materials you saw were a major factor in your decision to purchase LED bulbs/fixtures.

Previous Experience with ENS Programs Was Factor in Decision to Purchase	2019	2020	2021
Sample Size	86	125	78
Agree	77%	59%	62%
Disagree	22%	41%	38%
Don't Know	1%	-	-
Base: Respondents who had previously seen ENS promotional materials			

- H6. The Efficiency Nova Scotia promotional materials you saw prompted you to take into account the savings on your energy bill when choosing different lighting options for your home.

Previous Experience with ENS Programs Was Factor in Decision to Purchase	2019	2020	2021
Sample Size	86	125	78
Agree	86%	79%	81%
Disagree	14%	21%	19%
Base: Respondents who had previously seen ENS promotional materials			

- I1. What type of residence do you live in?

Type of Home	2017	2018	2019	2020	2021
Sample Size	100	194	111	184	120
Detached single-family house	74%	89%	86%	87%	91%
Semi-detached house	10%	3%	4%	3%	3%
Townhouse or duplex that shares adjacent walls	4%	2%	5%	2%	3%
Apartment or condo building that has fewer than five stories	11%	2%	4%	2%	2%
Apartment or condo building that has five or more stories	-	3%	-	3%	1%
Mobile home or house trailer	1%	2%	2%	2%	-
Another type	-	-	-	-	1%
Prefer not to say	-	-	-	2%	-

12. Do you own or rent this residence?

Home Ownership	2017	2018	2019	2020	2021
Sample Size	100	194	111	184	120
Own/buying	87%	91%	96%	94%	95%
Rent/lease	13%	9%	4%	4%	3%
Other	-	-	-	1%	-
Prefer not to say	-	-	-	2%	2%

13. Do you or does your landlord pay the electric bills for your residence?

Who Pays Electric Bills	2017	2018	2019	2020	2021
Sample Size	13 (#)	17 (#)	4 (#)	7 (#)	4 (#)
I pay the electricity bill	9	14	3	6	3
My landlord pays the electricity bill	4	3	1	1	1
Base: Respondents who rent or lease their home					

14. Gender:

Gender	2017	2018	2019	2020	2021
Sample Size	100	194	111	184	120
Male	53%	54%	58%	55%	53%
Female	47%	46%	41%	42%	43%
Other	-	-	1%	3%	4%
Refused excluded from calculations					

APPENDIX VI

IS: INTERVIEW GUIDE WITH RETAILER PARTNERS

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview Guide
Estimated Time to Complete	25-30 minutes
Target Audience	Head office retailers
Expected Number of Completions	7
Contact List Source	EOne
Fielding Firm	Narrative Research
Estimated Timeline for fielding	November - December

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
COVID-19 Impact	A
Non A-Type LED Bulb Sales	B
Instant Savings Program's Impact on Non A-type LED Bulb	C
LED Fixtures Sales	D
Instant Savings Program's Impact on LED Fixtures	E
Market Evolution	F
Satisfaction	G

Import variables from database < **LIKE THIS** >

Skip pattern or programming instructions [**LIKE THIS**]

Black text: instructions for interviewer [**NOTE: xxxx**] / [**PROBE: xxxx**]

INTRODUCTION

Hello, may I please speak with _____?

Hello, my name is _____, from Narrative Research, an Atlantic Canadian research company. We are conducting an evaluation of the Instant Savings Program provided by Efficiency Nova Scotia.

A. Identification and Screening of Respondent

The information we received from Efficiency Nova Scotia show your company has participated in their Instant Savings program. Can I please speak with the person most responsible for managing inventory and sales of LED light bulbs and LED fixtures that received rebates through the Instant Savings program? This person may also be the person dealing with Efficiency Nova Scotia or their delivery partner, the Summerhill group. Would that person be you?

- › Person responsible available [CONTINUE]
- › Person responsible currently unavailable [ARRANGE CALL BACK WITH THE RIGHT PERSON]
- › No person responsible for stocking or management of products [CONTINUE INTERVIEW WITH CORPORATE MANAGER - CONTINUE]
- › Don't know [CONTINUE INTERVIEW WITH CORPORATE MANAGER - CONTINUE]
- › Refused [THANK AND TERMINATE]

Confidentiality

Your responses are for research purposes only. We will not share your information with any party in a way that could identify you or your company.

Recording of the Interview

I would like to record our interview so that I make sure I capture everything you say accurately. Is that all right with you?

Context

Since the beginning of 2021, Efficiency Nova Scotia has held two promotional campaigns for the Instant Savings program, where customers can get rebates for products including LED bulbs. The spring promotion was held from April 9 to May 23 and the fall promotion started on September 24 and will end on November 14. As of last May, LED fixtures were eligible for a year-round incentive. This means that LED fixtures were rebated from the beginning of the spring promotion in April onward. Again, this year, we understand that 2021 may not be a representative program year due to COVID-19, but we would still like to discuss your sales of LED bulbs and fixtures.

- A1. Before we begin, can you briefly explain the impact of COVID-19 on your 2021 lighting sales to date in Nova Scotia?
- A2. Do you expect the COVID-19 pandemic to have an impact on your Nova Scotia sales for the remainder of the year? If so, how will sales be impacted?
1. Yes – higher sales than a typical year
 2. Yes – lower sales than a typical year
 3. No – sales are returning back to a typical year
 4. No – COVID-19 has not really made a difference to sales
 98. Don't know

B. Non A-Type LED Bulbs

[ASK THIS SECTION IF NON A-TYPE LED BULBS RETAILER]

Now, let's look at your sales of **Non A-type** LED bulbs for this year in Nova Scotia. **Non-A-type** LED bulbs are those that do not have a pear-like shape; they can either have a screw-in or pin base. They are often used to replace halogens, reflector lamps or incandescent lamps for recessed fixtures.

For our discussion today, consider **all models** of Non A-type LED bulbs you carry, **not only the models eligible** for an Instant Savings rebate. Also consider only your Nova Scotia sales.

OPTION A [ASK IF TOTAL SALES = YES]

[ASK B1 TO B4 ONLY FOR COSTCO AND HOME DEPOT]

According to data you provided to Efficiency Nova Scotia, you sold **[TOTAL SALES - PACKAGES]** Non A-type LED packages of bulbs in Nova Scotia for the first three quarters of 2021. This represents about **[TOTAL SALES – UNITS]** Non-A-type LED bulbs.

- B1. Is this number a reasonable estimate of the number of all Non A-type LED bulbs that you sold for the first three quarters of 2021?
1. Yes
 2. No – I sold a lower number of bulbs
 3. No – I sold a higher number of bulbs

- B2. **[IF B1=2 OR B1 =3]** You said that you sold a [lower/higher] number of bulbs than our estimate. About how many Non A-type LED bulbs did you sell **in total** in Nova Scotia during the first three quarters of 2021?

_____ bulbs

[IF UNABLE TO PROVIDE AN ANSWER, USE OPTIONS BELOW FOR A RANGE]

Would you say that you sold ...?

1. Less than 10% lower/higher
2. Between 10%-20% lower/higher
3. Between 20%-30% lower/higher
4. Between 30%-40% lower/higher
5. About 50%
6. Between 50% and 60% lower/higher
7. Between 60% and 70% lower/higher
8. Between 70% and 80% lower/higher
9. More than 80%

- B3. **[IF B1 = YES]** Considering that you sold [TOTAL SALES - UNITS] NON A-TYPE LED BULBS IN THE FIRST THREE QUARTERS OF 2021. **Roughly what percentage of all Non-A-type LED bulbs you anticipate selling in 2021 does that number represent?**

_____ %

[IF UNABLE TO PROVIDE AN ANSWER, USE OPTIONS BELOW FOR A RANGE]

1. Less than 40%
2. Between 40 and 50%
3. About 50%
4. Between 50% and 60%
5. Between 60% and 70%
6. Between 70% and 80%
7. Between 80% and 90%
8. More than 90%

- B4. **[IF B1=2 OR B1 =3] Considering that you sold [ESTIMATE OF LED BULBS SOLD FOR THE FIRST THREE QUARTERS BASED ON RESPONSE TO B2] NON A-TYPE LED BULBS IN THE FIRST THREE QUARTERS OF 2021. Roughly what percentage of all Non-A-type LED bulbs you anticipate selling in 2021 does that number represent?**

_____ %

[IF UNABLE TO PROVIDE AN ANSWER, USE OPTIONS BELOW FOR A RANGE]

1. Less than 10%
2. Between 10%-20%
3. Between 20%-30%
4. Between 30%-40%
5. About 50%
6. Between 50% and 60%
7. Between 60% and 70%
8. Between 70% and 80%
9. Between 80% and 90%
10. More than 90%

[ASK B5 TO B10 ONLY IF HOME HARDWARE]

According to data you provided to Efficiency Nova Scotia for the first three quarters of 2021, **[TOTAL SALES - PACKAGES]** Non A-type LED packages of bulbs were shipped to the Home Hardware stores in Nova Scotia. This represents about all **[TOTAL SALES – UNITS]** Non A-type LED bulbs.

- B5. Is this number a reasonable estimate of the number of all Non A-type LED bulbs that you shipped for the first three quarters of 2021?
1. Yes
 2. No – I shipped a lower number of bulbs
 3. No – I shipped a higher number of bulbs

- B6. **[IF B5=2 OR B5 =3]** You said that you shipped a [lower/higher] number of bulbs than our estimate. About how many Non A-type LED bulbs did you shipped in total in Nova Scotia during the first three quarters of 2021?

_____ bulbs

[IF UNABLE TO PROVIDE AN ANSWER, USE OPTIONS BELOW FOR A RANGE]

Would you say that you shipped ...?

1. Less than 10% lower/higher
2. Between 10%-20% lower/higher
3. Between 20%-30% lower/higher
4. Between 30%-40% lower/higher
5. About 50%
6. Between 50% and 60% lower/higher
7. Between 60% and 70% lower/higher
8. Between 70% and 80% lower/higher
9. More than 80%

- B7. Are you expecting to ship additional Non A-type LED bulbs in the last three months of 2021?

1. Yes
2. No

- B8. **[IF B7=YES]** About how many Non A-type LED bulbs are you expecting to ship during the last three months of 2021?

_____ bulbs

[IF UNABLE TO PROVIDE AN ANSWER]

Would you say that you will ship ...?

1. 10% more
2. 10%-20% more
3. 20%-30% more
4. 30%-40% more
5. About 50% more
6. 50% and 60% more
7. 60% and 70% more
8. 70% and 80% more
9. 80% or higher more

- B9. **[IF B5 = YES OR NO AND B7= NO]** Considering that **[IF B5 = YES (use TOTAL SALES – UNITS)] OR [IF B5 = NO (use RESPONSE IN B6]** Non A-type LED bulbs were shipped to the Home Hardware stores for 2021, roughly what percentage of shipped units do you anticipate selling in 2021?

_____ %

[IF UNABLE TO PROVIDE AN ANSWER, USE OPTIONS BELOW FOR A RANGE]

1. Less than 50%
2. About 50%
3. Between 50% and 60%
4. Between 60% and 70%
5. Between 70% and 80%
6. Between 80%-90%
7. More than 90%

- B10. **[IF B5 = YES OR NO AND B7 = YES)]** Considering that **[IF YES IN B5 (use TOTAL SALES – UNITS) OR IF NO IN B5 (USE RESPONSE IN B6) + RESPONSE IN B8]** Non A-type LED bulbs will be shipped to the Home Hardware stores in 2021, roughly what percentage of shipped units do you anticipate selling in 2021?

_____ %

[IF UNABLE TO PROVIDE AN ANSWER, USE OPTIONS BELOW FOR A RANGE]

1. Less than 50%
2. About 50%
3. Between 50% and 60%
4. Between 60% and 70%
5. Between 70% and 80%
6. Between 80%-90%
7. More than 90%

OPTION B [ASK IF TOTAL SALES = NO AND IF REBATE ELIGIBLE TOTAL SALES = YES]

According to data you provided to Efficiency Nova Scotia, during the spring campaign, you sold **[REBATE ELIGIBLE TOTAL SALES - PACKAGES]** Non A-type LED packages of bulbs in Nova Scotia. This represents **[REBATE ELIGIBLE TOTAL SALES – UNITS]** Non A-type LED bulbs that received a rebate during the spring campaign.

- B11. Compared to the Non A-type LED bulbs sold during the spring campaign, are your sales of **Instant Savings rebate eligible Non A-type LED bulbs** during the fall campaign expected to be:
1. Lower than during the spring campaign
 2. About the same; or
 3. Higher
- B12. **[IF B11 = LOWER]** You said sales of Instant Savings rebate eligible Non A type LED bulbs will be lower during the fall than during the spring campaign. Would you say they will be:
1. Less than 10% lower
 2. Between 10%-30% lower
 3. Between 30-50% lower
 4. Between 50-70% lower
 5. Between 70-90% lower
 6. Between 90-99% lower
- B13. **[IF B11 = HIGHER]** You said sales of Instant Savings rebate eligible Non A type LED bulbs will be higher during the fall campaign than during the spring campaign. Would you say they will be:
1. Less than 10% higher
 2. Between 10%-30% higher
 3. Between 30-50% higher
 4. Between 50-70% higher
 5. Between 70-90% higher
 6. Between 90-99% higher
 7. Over 100% higher

- B14. So based on your forecast, you expect to sell **[ESTIMATE OF REBATE ELIGIBLE NON A-TYPE TOTAL SALES FOR 2021 BASED ON RESPONSE TO B12 OR B13] NON A-TYPE LED BULBS AS PART OF THE INSTANT SAVINGS FALL AND SPRING CAMPAIGNS IN 2021**. Roughly what proportion of the **total** number of Non A-type LED bulbs you expect to sell in 2021 does that number represent, across all SKUs (including both products that receive a rebate and those that do not)?

_____ %

[IF UNABLE TO PROVIDE AN ANSWER, USE OPTIONS BELOW FOR A RANGE]

1. Less than 40%
2. Between 40% and 50%
3. About 50%
4. Between 50% and 60%
5. Between 60% and 70%
6. Between 70% and 80%
7. Over 80%

OPTION C [ASK IF TOTAL SALES = NO AND REBATE ELIGIBLE TOTAL SALES=NO]

- B15. Thinking of all Non A-type LED bulbs, i.e. not only the Instant Savings rebate eligible products, approximately how many Non A-type LED bulbs did you sell **in total** in Nova Scotia during the first half of 2021? _____ bulbs
- B16. Roughly what percentage of Non A-type LED bulbs you anticipate selling in 2021 does that number represent?
1. Less than 40%
 2. Between 40% and 50%
 3. About 50% (about half)
 4. Between 50% and 60%
 5. More than 60%

C. Instant Savings Program's Impact – Non A-type LED Bulbs

[ASK THIS SECTION IF NON A-TYPE LED BULB RETAILER]

- C1. Efficiency Nova Scotia has promoted LED lighting and offered rebates through retailers on LED bulbs for a number of years. I would like to understand how your participation in the Instant Savings program has influenced staff and consumer knowledge, and your product offering, if at all. Using a 0-10 scale, where 0 means “not at all” and 10 means “a great deal”, to what extent has your participation in Instant Savings...
- a. Increased sales staff knowledge of LED bulbs and their benefits
Scale:
Please explain your response:
 - b. Increased consumers knowledge of LED bulbs and their benefits
Scale:
Please explain your response:
 - c. Influenced the variety of LED bulbs or models you carry in store
Scale:
Please explain your response:
 - d. Influenced the quantity of LED bulbs you stock in your stores
Scale:
Please explain your response:
- C2. As you know, the Instant Savings rebates on Non A-type LED bulbs are offered only during the spring and fall campaigns and only on selected products. Efficiency Nova Scotia has promoted energy efficient products and services year-round, through its advertising, website, and other energy efficiency programs for a number of years. The program and Efficiency Nova Scotia's other efforts may have an impact on Non A-type LED bulbs sales year-round **[NOTE TO INTERVIEWER – use the following if needed to get retailers talking:**
- › For instance, your salespeople may have a better knowledge of LEDs, thus being more apt to recommend these products to customers outside of the campaigns; or perhaps
 - › you may carry a wider variety of LED products or you may offer your own rebates throughout the year due to program influence; or maybe
 - › awareness of energy efficiency among customers may have increased due to Efficiency Nova Scotia's programs and general promotion of energy efficiency].

[READ VERBATIM] With this in mind, how much of an influence, either direct or indirect, do you think Efficiency Nova Scotia's programs and promotion will have had on the total number of Non A-type LED bulbs you will sell in 2021 outside of those that received a rebate?

Do you think that Efficiency Nova Scotia's programs and promotion will have ...

1. No influence at all on sales outside of rebate period this year (during months of January through March, June through mid-September, and December) or on non-rebate eligible Non A-type LED bulbs.
2. A slightly positive influence
3. A moderately positive influence
4. A very positive influence

C2a. **[IF POSITIVE IN C2– CODE 2-4]** What proportion of the number of Non A-type LED bulbs you will sell this year outside of those that received a rebate will be influenced at least in part by Efficiency Nova Scotia's programs and promotion? Would you say **[READ]**:

1. Less than 5%
2. Between 5% and 10%
3. Between 10% and 20%
4. Between 20% and 30%
5. More than 30% **[PLEASE ESTIMATE %: ____]**

Please explain your answer as best you can:

D. LED Fixtures

[ASK THIS SECTION IF LED FIXTURE RETAILER]

Now let's talk about the lighting fixtures you carry. As you may recall, the LED fixtures promoted by Instant Savings are ENERGY STAR certified, hard-wired, with integrated LED lighting, so the ones in which no bulb is screwed in. They include recessed fixtures as well as a variety of interior or exterior fixtures.

For this discussion, consider all models of LED fixtures you carry, **not only the models eligible** for an Instant Savings rebate. Also consider only your Nova Scotia sales.

OPTION A [ASK IF TOTAL SALES = YES]

[ASK B11 TO D4 ONLY FOR COSTCO AND HOME DEPOT]

According to data you provided to Efficiency Nova Scotia, you sold **[TOTAL SALES - PACKAGES]** packages of LED fixtures in Nova Scotia for the first three quarters of 2021. This represents **[TOTAL SALES - UNITS]** LED fixtures.

- D1. Is this number a reasonable estimate of the number of all LED fixtures that you sold for the first three quarters of 2021?
1. Yes
 2. No – I sold a lower number of fixtures
 3. No – I sold a higher number of fixtures
- D2. **[IF D1=2 OR D1 =3]** You said that you sold a [lower/higher] number of LED fixtures than our estimate. About how many LED fixtures did you sell in total in Nova Scotia during the first three quarters of 2021?

_____bulbs

[IF UNABLE TO PROVIDE AN ANSWER, USE OPTIONS BELOW FOR A RANGE]

Would you say that you sold ...?

1. Less than 10% lower/higher
2. Between 10%-20% lower/higher
3. Between 20%-30% lower/higher
4. Between 30%-40% lower/higher
5. About 50%
6. Between 50% and 60% lower/higher
7. Between 60% and 70% lower/higher
8. Between 70% and 80% lower/higher
9. More than 80%

- D3. **[IF D1 = YES]** Considering that you sold **[TOTAL SALES - UNITS]** LED fixtures in the first three quarters of 2021. Roughly what percentage of all LED fixtures you anticipate selling in 2021 does that number represent?

_____ %

[IF UNABLE TO PROVIDE AN ANSWER, USE OPTIONS BELOW FOR A RANGE]

1. Less than 40%
2. Between 40% and 50%
3. About 50%
4. Between 50% and 60%
5. Between 60% and 70%
6. Between 70% and 80%
7. Between 80% and 90%
8. More than 90%

- D4. **[IF D1=2 OR D1 =3]** Considering that you sold **[ESTIMATE OF LED FIXTURES SOLD FOR THE FIRST THREE QUARTERS BASED ON RESPONSE TO D2]** LED fixtures in the first three quarters of 2021. Roughly what percentage of all LED fixtures you anticipate selling in 2021 does that number represent?

_____ %

[IF UNABLE TO PROVIDE AN ANSWER, USE OPTIONS BELOW FOR A RANGE]

1. Less than 10%
2. Between 10%-20%
3. Between 20%-30%
4. Between 30%-40%
5. About 50%
6. Between 50% and 60%
7. Between 60% and 70%
8. Between 70% and 80%
9. Between 80% and 90%
10. More than 90%

OPTION B [ASK IF TOTAL SALES = NO AND IF REBATE ELIGIBLE TOTAL SALES = YES]

According to data you provided to Efficiency Nova Scotia, you sold **[REBATE ELIGIBLE TOTAL SALES - PACKAGES]** rebate eligible packages of LED fixtures in Nova Scotia for the first half of 2021. This represents **[REBATE ELIGIBLE SALES - UNITS]** LED fixtures that received a rebate.

- D5. Compared to the first half of 2021, are your sales of **Instant Savings rebate eligible LED fixtures** for the second half of the year expected to be:
1. Lower
 2. About the same
 3. Higher
- D6. **[IF D5 = LOWER]** You said sales of Instant Savings rebate eligible LED fixtures will be lower in the second half of the year than during the first half. Would you say they will be:
1. Less than 10% lower
 2. Between 10%-30% lower
 3. Between 30-50% lower
 4. Between 50-70% lower
 5. Between 70-90% lower
 6. Between 90-99% lower
- D7. **[IF D5 = HIGHER]** You said sales of Instant Savings rebate eligible LED fixtures will be higher in the second half of the year than during the first half. Would you say they will be:
1. Less than 10% higher
 2. Between 10%-30% higher
 3. Between 30-50% higher
 4. Between 50-70% higher
 5. Between 70-90% higher
 6. Between 90-99% higher
 7. Over 100% higher

- D8. So based on your forecast, you expect to sell **[ESTIMATE OF REBATE ELIGIBLE SALES FOR 2021 BASED ON RESPONSE TO D6 OR D7] REBATE ELIGIBLE LED fixtures IN 2021.** Roughly what proportion of the **total** number of LED fixtures you expect to sell in 2021 does that number represent?

_____ %

[IF UNABLE TO PROVIDE AN ANSWER, USE OPTIONS BELOW FOR A RANGE]

1. Less than 40%
2. Between 40% and 50%
3. About 50%
4. Between 50% and 60%
5. More than 60%

OPTION C [ASK IF TOTAL SALES = NO AND REBATE ELIGIBLE TOTAL SALES = NO]

- D9. Thinking of all LED fixtures, i.e. not only the Instant Savings rebate eligible products, how many LED fixtures did you sell in Nova Scotia during the first half of 2021?
_____ fixtures
- D10. Roughly what percentage of LED fixtures you anticipate selling in 2021 does that number represent? _____ %

E. Instant Savings Program’s Impact – LED Fixtures

[ASK THIS SECTION IF LED FIXTURES RETAILER]

- E1. Efficiency Nova Scotia has promoted LED lighting and offered rebates through retailers on LED fixtures for a number of years. I would like to understand how your participation in the Instant Savings program has influenced staff and consumer knowledge, and on your product offering, if at all. Using a 0-10 scale, where 0 means “not at all” and 10 means “a great deal”, to what extent has your participation in Instant Savings...
- a. Increased sales staff knowledge of LED fixtures and their benefits
Scale:
Please explain your response:
 - b. Increased consumers knowledge of LED fixtures and their benefits
Scale:
Please explain your response:
 - c. Influenced the variety of LED fixtures you carry in your stores
Scale:
Please explain your response:
 - d. Influenced the quantity of LED fixtures you stock in your stores
Scale:
Please explain your response:

E2. As you know, the Instant Savings rebates on LED fixtures are offered only on selected products and are now offered year-round. Efficiency Nova Scotia has promoted energy efficient products and services year-round, through its advertising, website, and other energy efficiency programs for a number of years. The program and Efficiency Nova Scotia's other efforts may have an impact on your sales of LED fixtures year-round **[NOTE TO INTERVIEWER – USE THE FOLLOWING IF NEEDED TO GET RETAILERS TALKING:**

- › For instance, your salespeople may have a better knowledge of LEDs, thus being more apt to recommend these products to customers outside of the campaigns; or perhaps
- › you may carry a wider variety of LED products or you may offer your own rebates throughout the year due to program influence; or maybe
- › awareness of energy efficiency among customers may have increased due to Efficiency Nova Scotia's programs and general promotion of energy efficiency].

[READ VERBATIM] With this in mind, how much of an influence, either direct or indirect, do you think Efficiency Nova Scotia's programs and promotion will have had on the total number of LED fixtures you will sell in 2021 outside of those that received a rebate?

Do you think that Efficiency Nova Scotia's programs and promotion will have ...

1. No influence at all on sales outside of rebate period this year (during months of January through March, June through mid-September, and December) or on non-rebate eligible LED fixtures.
2. A slightly positive influence
3. A moderately positive influence
4. A very positive influence

E2a **[IF POSITIVE IN E2– CODE 2-4]** What proportion of the number of LED fixtures you will sell this year outside of those that received a rebate will be influenced at least in part by Efficiency Nova Scotia's programs and promotion? Would you say **[READ]**:

1. Less than 5%
2. Between 5% and 10%
3. Between 10% and 20%
4. Between 20% and 30%
5. More than 30% **[PLEASE ESTIMATE %: _____]**

Please explain your answer as best you can:

F. Market Evolution – A-Type LED Bulbs

[ASK THIS SECTION TO ALL]

[NOTE TO INTERVIEWER: IN 2019, EFFICIENCY NOVA SCOTIA CHOSE TO REMOVE LED A-TYPE BULBS FROM INSTANT SAVINGS PRODUCT OFFER. F1 IS TO UNDERSTAND IMPACT OF THIS CHANGE ON 2021 SALES.]

The next questions are to understand the state of the market in Nova Scotia for residential LED lighting.

F1. Thinking about expected sales for 2022 compared to those forecasted for this year, do you anticipate selling more, about the same or fewer residential lighting products from the following categories in 2022 than in 2021:

- a. **[ASK IF NON A TYPE LED BULB RETAILER]** Non A-type LED bulbs
- b. **[ASK IF LED FIXTURE RETAILER]** LED fixtures
- c. **[ASK ALL]** A-type LED bulbs – that is bulbs that have a pear-like shape with a screw-in base, often used to replace incandescent or compact fluorescent lamps.
 1. More in 2022 than you anticipate for this year
 2. About the same number; or
 3. Fewer bulbs in 2022 than what you anticipate for this year

F2. For this question, please refer to the product adoption curve that was emailed to you before this interview. Thinking of the Nova Scotia residential lighting market, where on the product adoption curve would you place each of the following lighting products?

Lighting Products	2021 Letter on the Curve	Explanation
a. LED A-type bulbs		
b. LED Non A-type bulbs		
c. LED fixtures		

G. Satisfaction

[ASK TO ALL]

G1. On a scale of 1 to 10, where 1 is “not at all satisfied” and 10 is “completely satisfied” how satisfied are you overall with the Instant Savings program operated by Efficiency Nova Scotia.

a. Please explain the reason for your score.

[ASK IF ANSWER IS <5] Would you like someone from Efficiency Nova Scotia to follow up directly with you about your dissatisfaction with the Instant Savings program?

[IF YES] Do you agree for me to pass on your name and contact details to Efficiency Nova Scotia?

G2. On a scale of 1 to 10, where 1 is “not at all satisfied” and 10 is “completely satisfied”, how satisfied are you with your interactions with the program delivery representatives from Summerhill? _____

a. Please explain the reason for your score.

[ASK IF ANSWER IS <5] Would you like someone from Efficiency Nova Scotia to follow up directly with you about your dissatisfaction with your interactions with the program delivery representatives?

[IF YES] Do you agree for me to pass on your name and contact details to Efficiency Nova Scotia?

Those are all the questions I have for you today. Thank you for taking the time to take part in this interview.

APPENDIX VII

IS: TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying that all data fields required for the evaluation were included and filled out in the tracking sheet submitted by EOne
- › Ensuring that tracked results were accurate by:
 - Verifying that parameters used to calculate program results (gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating that all calculation steps were performed consistently

Data Accuracy

Table 1 lists all the parameters required for the Instant Savings evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the table details the actions carried out by the Evaluator to adjust data where required.

Table 1: Verification of 2021 Instant Savings Data Field Completeness and Accuracy

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Measure Code (Column D)	Y	N/A	N/A
Total Number of Units (Column K)	Y	N/A	N/A
Model Number (Column P)	Partial	N/A	817 missing model numbers. No action needed.
Wattage (where applicable) (Column Q)	Partial	N/A	2,961 missing wattage values. No action Needed.
Store ID (Column R-S)	Partial	N/A	6 items do not have a store ID. No action needed.
Reference Data			
Unitary Savings (2021 Measures & Codes: Column F)	Y	N	The unitary savings value for energy efficient showerheads used by EOne in the 2021 tracking sheet did not match those presented in the 2020 DSM Measure Assessment report. The Evaluator used the correct value in the calculations.
Unitary Peak Demand Savings (2021 Measures & Codes: Column G)	Y	N	The unitary savings values for energy efficient showerheads and heat pump water heaters used by EOne in the 2021 tracking sheet did not match those presented in the 2020 DSM Measure Assessment report. The Evaluator used the correct value in the calculations.
Installation/In-service Rates (2021 Measures & Codes: Cell B30)	Y	Y	N/A
Interactive Effects Factors (2021 Measures & Codes: Column G-H)	Y	Y	N/A
Net-to-gross Ratios (2021 Measures & Codes: Column P)	Y	Y	N/A
Effective Useful Life (2021 Measures & Codes: Column Y)	Partial	N	For efficient clothes washers, the value used in the 2021 tracking sheet was different than the one in the 2020 DSM Measure Assessment report. The Evaluator used the correct value in the calculations.

Data Consistency

The second step of the tracking sheet audit involved recreating calculations and comparing related tracking sheet data fields to identify any potential inconsistencies. Table 2 lists the tracking sheet data fields that were compared to ensure consistency.

Table 2: Verification of 2021 Instant Savings Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Calculated Line Loss Factor (Gross Energy Savings at the Generator / Gross Energy Savings at the Meter)	Tracked Rate Code Mix	Y	N/A
Product Type (Column O)	Product Technical Information	N	For one entry, representing one rebated product, the measure code associated with the product was incorrect. The evaluator used the product technical information to identify the correct measure code, which resulted in different savings for this entry.

Equations and Compilation

Once the correct values were established (as per Table 1), the Evaluator validated that the equations in the tracking sheet correctly calculated each of the main program component results, the results of which are presented in Table 3.

Table 3: Verification of 2021 Instant Savings Compilation of Savings

Program Component Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	N	An error was made in the calculation of the gross energy savings at the meter for ENERGY STAR certified clothes dryers. The Evaluator used the correct value from the 2020 DSM Measure Assessment report in the calculations.
Gross Peak Demand Savings at the Generator	Y	N/A
Net Energy Savings at the Generator	Y	N/A
Net Peak Demand Savings at the Generator	Y	N/A

Corrected Tracked Savings

Table 4 presents the corrected tracked savings resulting from all changes made by the Evaluator as described in this appendix.

Table 4: 2021 Instant Savings Corrected Tracked Savings

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
Instant Savings					
Gross Energy Savings at the Generator	15.512	GWh	15.559	GWh	0.30%
Gross Peak Demand Savings at the Generator	1.788	MW	1.790	MW	0.12%
Net Energy Savings at the Generator	13.773	GWh	13.820	GWh	0.34%
Net Peak Demand Savings at the Generator	1.565	MW	1.567	MW	0.14%

The difference in gross and net energy savings is due to the Evaluator using the unitary savings values in the 2020 DSM Measure Assessment report, which differed from those used by EOne in the 2021 tracking sheet for energy efficient showerheads and clothes dryers. Similarly, gross and net peak demand savings differed because EOne used incorrect unitary peak demand savings for energy efficient showerheads and heat pump water heaters.

One entry was also tracked in the wrong product category, which resulted in a minor adjustment to savings.

APPENDIX VIII

IS: UNITARY SAVINGS CALCULATIONS FOR LIGHT-EMITTING DIODE LAMPS AND FIXTURES

This appendix presents the detailed calculations and assumptions used to establish the unitary savings for light-emitting diode (LED) lamps and fixtures offered through Instant Savings. The baseline parameters for these products are updated annually since the residential lighting market is evolving rapidly. The 2020-2022 Measure Assessment was then updated accordingly.

LED Non-A-type Lamps

Unitary savings values were calculated for LED R, BR, and decorative lamps as well as other LED non-A-type lamps based on the assumption that R, BR, and decorative lamps replace incandescent lamps and other non-A-types replace halogen lamps. The two unitary savings values were determined using the following general lighting equation (Equation 1):

$$\text{Annual Unitary Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{\text{Displaced Wattage [W]} \times \text{HOU} \left[\frac{\text{h}}{\text{day}} \right] \times 365 \left[\frac{\text{day}}{\text{yr}} \right]}{1,000 \left[\frac{\text{W}}{\text{kW}} \right]} \quad (1)$$

As part of the 2021 evaluation, the Evaluator revised displaced wattage values and validated that the hours of operation value is still appropriate.

Displaced Wattage

The average displaced wattage values for the two product categories were established for two types of baselines, namely early replacement and replace-on-burn-out baselines. For the early replacement scenario, the lamps being replaced are the baseline, while the replace-on-burn-out scenario uses the energy efficiency regulation requirements as the baseline. This methodology is recommended in the principles of the Uniform Methods Project (UMP)⁴ to better represent the real baseline wattages for LED lamps.

Importantly, for non-A-type lamps, the baselines for both scenarios are the same. Since R, BR, and decorative lamps are only available in incandescent and LED, it was assumed that all LED R, BR, and decorative LED lamps replaced incandescent lamps. Since other non-A-type lamps are only available in halogen and LED, it was assumed that all LED lamps replaced halogen lamps for this product category.

The equivalent incandescent and halogen wattage values were obtained by researching the recommended equivalencies for the 10 most popular products for each category of LED lamps. The wattage calculation details are presented in Table 1.

⁴ National Renewable Energy Laboratory, *Uniform Methods Protocol Chapter 6: Residential Lighting Evaluation Protocol*, February 2014, pp. 6-20.

Table 1: 2021 Instant Savings Displaced Wattage Calculations

Purchased LED Lamps		Replaced Lamp Average Wattage	Displaced Wattage
LED Product Category	Average Wattage		
LED Non-A-type Lamps (R, BR, and Decorative) Replacing Incandescent	5.1	49.7	44.6
LED Non-A-type Lamps (excluding R, BR, and Decorative) Replacing Halogen	6.8	50.0	43.2

Based on the above methodology, the displaced wattages were established at 44.6 W for R, BR, and decorative lamps and 43.2 W for other LED non-A-type lamps.

Hours of Operation

The value for the daily hours of operation is based on the Northeast Residential Lighting Hours-of-Use (NERHOU) Study,⁵ which established an average use of 2.9 hours per day for efficient bulbs given the absence of a snapback effect.⁶

The UMP Residential Lighting Evaluation Protocol recommends that each jurisdiction conduct a metering study to determine specific hours of use (HOU). In 2016 and 2017, the Evaluator conducted a metering study among 75 households to assess daily hours of operation. The overall average daily HOU was established at 2.48 hours/day with a margin of error of ± 0.24 hours/day. Since the NERHOU Study was conducted on a much larger scale with 848 households and the study data and findings are closely aligned with the Evaluator's metering study margin of error, the Evaluator decided that the values established by the NERHOU Study are still the most appropriate for LED lamps installed through Instant Savings. Again for 2021, the Evaluator used the average hours of operation value for efficient lamps without a snapback value, which is 2.9 hours per day.

In-service Rate

The Evaluator decided not to apply an in-service rate to LED lamps and to claim all savings in the year during which LED lamps were purchased. For more details, please refer to the 2020-2022 Measure Assessment.

Unitary Savings

Unitary savings values were revised according to the displaced wattages of 44.6 W for R, BR, and decorative lamps and 43.2 W for other LED non-A-type lamps. The estimated hours of operation were maintained at 2.9 hours per day. Using the general lighting equation, the unitary savings values for LED R, BR, and decorative lamps and other LED non-A-type lamps were established at 47.2 kWh and 45.7 kWh respectively.

⁵ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

⁶ The snapback effect is defined as an increase in usage following the installation of an efficient product because the operating cost is lower.

LED Recessed Downlight Fixtures

The unitary savings value for recessed downlight fixtures sold through Instant Savings was obtained using the general lighting equation (Equation 1).

Displaced Wattages

To establish the displaced wattage of each category of lighting fixture offered under Instant Savings, the Evaluator identified the 10 best-selling models listed in the 2021 tracking sheet. Wattage value data as well as incandescent or halogen wattage equivalents for these models were then gathered from participating retailer websites (as recommended by manufacturers). These values were then converted into wattage values that meet the current Canadian energy efficiency regulation for general service lamps.

The 11 best-selling models of LED recessed downlight fixtures represent over 83% of all recessed LED lamps sold through the Instant Savings. For LED recessed downlight fixtures, analysis indicated that the average wattage value for new LED fixtures was 11.1 W and the average equivalent wattage was 63.3 W. Thus, the average displaced wattage was established at 52.2 W.

Hours of Operation

Similar to LED lamps, the Evaluator concluded that the hours of operation value for LED lamps (2.9 hrs/day) drawn from the 2014 NERHOU Study is still valid for LED recessed downlight fixtures and all other types of LED fixtures sold through Instant Savings with the exception of those equipped with motion sensors (two product categories that are covered in subsections further below).

Unitary Savings

Using the general lighting equation, the displaced wattage of 52.2 W, and the hours of operation value of 2.9 hours per day, the unitary savings value for LED recessed downlight fixtures was established to 55.3 kWh per year.

ENERGY STAR® Certified LED Fixtures Without a Motion Sensor

The unitary savings value associated with ENERGY STAR certified LED fixtures without a motion sensor is obtained using the general lighting equation (Equation 1).

Displaced Wattage

The Evaluator selected the 10 most popular models, which represent 65% of all 2021 sales for this product category. For some of these fixtures, information concerning the equivalent wattage was not available. The Evaluator therefore used the light output measured in lumens found on ENERGY STAR and manufacturer websites and used a table from the ENERGY STAR website to establish equivalent incandescent wattages (see Table 2 below). Then, the equivalent incandescent wattages were converted by using the current Canadian energy efficiency regulation requirements for general service lamps.

Table 2: 2021 ENERGY STAR Certified Lamp Light Output Equivalency to Incandescent Lamp Wattage⁷

Old Incandescent Lamps (W)	ENERGY STAR Certified Lamp Light Output (Lumens)
40	450
60	800
75	1,100
100	1,600
150	2,600

For LED fixtures without a motion sensor, analysis indicated that the average wattage value for new LED fixtures was 22.4 W and the average equivalent wattage was 86.5 W. Thus, the average displaced wattage was established at 64.1 W.

Unitary Savings

Using the displaced wattage of 64.1 W and hours of use of 2.9 hrs/day, the unitary savings value for ENERGY STAR certified LED fixtures without a motion sensor was established to 67.8 kWh per year.

ENERGY STAR Certified LED Fixtures with a Motion Sensor

The unitary savings value associated with ENERGY STAR certified LED fixtures with a motion sensor was determined using the general lighting equation (Equation 1).

Displaced Wattage

The Evaluator analyzed the twelve best-selling models of ENERGY STAR certified LED fixtures with a motion sensor sold through Instant Savings, which represent 83% of all 2021 sales for this product category. The Evaluator found that 96% of these fixtures housed lamps that replaced halogen lamps, while 4% of them replaced incandescent lamps. The methodology used to determine the equivalent wattage for this product category was the same as for ENERGY STAR certified LED fixtures without a motion sensor.

For LED fixtures with a motion sensor, analysis concluded that the average wattage value for new LED fixtures was 22.2 W and the average equivalent wattage was 88.3 W. Using these values, the average displaced wattage was established at 66.1 W.

Hours of Operation

The Evaluator did not identify any new metering study that reported the hours of use associated with residential motion sensors for outdoor or indoor usage. Hence, the Evaluator again applied the hours of use values recommended for the indoor and outdoor motion sensor products listed below.

⁷ ENERGY STAR, *Learn About Brightness*, https://www.energystar.gov/products/lighting_fans/light_bulbs/learn_about_brightness (Last accessed December 21, 2018).

For 2021, the Evaluator found that 98% of LED fixtures equipped with a motion sensor are designed for outdoor usage. For LED fixtures installed outdoors, the old and new hours of operation used are 4.72 and 2.92 hours per day respectively.

Unitary Savings

To establish the unitary savings for ENERGY STAR certified LED fixtures equipped with a motion sensor, the following formula (Equation 2) was used:

$$\text{Annual Unitary Savings} \left[\frac{kWh}{yr} \right] = \frac{(Wattage_{old} [W] \times HOU_{old} \left[\frac{hrs}{day} \right] - Wattage_{new} [W] \times HOU_{new} \left[\frac{hrs}{day} \right]) \times 365 \left[\frac{day}{yr} \right]}{1,000 \left[\frac{W}{kW} \right]} \quad (2)$$

Using the aforementioned wattage and hours of operation values, the unitary savings for ENERGY STAR certified LED fixtures equipped with a motion sensor was established at 128.3 kWh.

APPENDIX IX

IS: ALGORITHM FOR FREE-RIDERSHIP CALCULATION

The figures below present the algorithms for calculating the free-ridership levels of LED bulbs and LED fixtures. The participant survey questionnaire included questions designed to assess the planning, quantity, efficiency, period, cost, and influence of the program component. Each group of questions was transposed into a level of program component attribution that was used to calculate the free-ridership level associated with each participant.

Algorithm – LED Bulbs

Algorithm – LED Bulbs	
Section 1 – Free-ridership level for those who were unaware of discount before paying	
D1. Before paying at the cash register, were you aware that a discount was offered on the purchase of LEDs?	IF Yes: GO TO Section 2 IF No OR REF: GO TO D2
D2. [ASK IF D1=2, DK] To confirm – You did not know about the discount on specific packages of LED bulbs you purchased before paying at the register, is that correct?	IF Yes: GO TO Section 2 IF No OR REF: D2 = 100%
PA1 Score:	D2
Free-ridership level for those who were unaware of discount before paying	PA1 OTHERWISE: GO TO Section 2
Section 2 – Free-ridership level for those who postponed their purchase because of the program	
D3. Before the beginning of the campaign on September 24, were you aware that discounts on LED bulbs would be offered this fall?	IF Yes: GO TO D4 IF No OR REF: GO TO Section 3
D4. [ASK IF D3=1] Did you postpone your purchase of LEDs to take advantage of the discount?	IF Yes: D4 = GO TO D8 IF No OR REF: GO TO Section 3
D8. If the discount had NOT been offered, when would you have purchased the LEDs that you did? Would it have been...? 1. [ASK IF D4=1] Earlier 2. Definitely on the same day 3. Probably on the same day 4. Probably at a later date 5. Definitely at a later date 96. (Would not have purchased them at all) 99.(Don't know / Refused)	IF 1: D8 = 100% OTHERWISE: GO TO Section 3

Algorithm – LED Bulbs	
PA2 Score:	D8
D9. Without the discount, would you have definitely purchased the same number of LEDs? 1. Definitely the same number 2. Probably the same number 3. Probably fewer 4. Definitely fewer 99.(Don't know / Refused)	IF 1: D9 = 100% IF 2: D9 = 50% IF 3: D9 = 25% IF 4: D9 = 0% IF 99: D9 = 0%
PA3 Score:	D9
Free-ridership level for those who postponed their purchase because of the program	MEAN VALUE OF (PA2; PA3) OTHERWISE GO TO Section 3
Section 3 – Free-ridership level for regular participants (aware of discount, did not postpone purchase)	
D7. How likely is it that you would have bought the LEDs that you purchased today if you had to pay the full price? (Scale 0 to 10)	D7 = Answer x 10% IF 99: D7 = EMPTY
D5. If the discount on LEDs had NOT been offered, what would you have bought? 1. Bought LEDs anyway 2. Bought another type of bulb 3. Not bought any bulbs 99. (Don't know / Refused)	IF 1: D5 = 100% IF 2: D5 = Use D6 IF 3: D5 = 0% IF 99: D5 = EMPTY
D6. [ASK IF D5=2] Which type of bulb would you have purchased instead today? 1. Incandescent 2. Halogen 3. CFLs 96. Other 99.(Don't know / Refused)	IF 1 OR 2: D6 = 0% IF 3: D6 = 50% IF 96: D6 = EMPTY IF 99: D6 = EMPTY
PA4 Score:	MEAN VALUE OF (D7; D5-D6)
D8. If the discount had NOT been offered, when would you have purchased the LEDs that you did? Would it have been...? 2. Definitely today 3. Probably today 4. Probably at a later date 5. Definitely at a later date 96. (Would not have purchased them at all) 99. (Don't know / Refused)	IF 2: D8 = 100% IF 3: D8 = 50% IF 4: D8 = 25% IF 5: D8 = 0% IF 96: D8 = 0% IF 99: D8 = 0%

Algorithm – LED Bulbs	
PA5 Score:	D8
D9. Without the discount, would you have purchased the same number of LEDs? 1. Definitely the same number 2. Probably the same number 3. Probably fewer 4. Definitely fewer 99.(Don't know / Refused)	IF 1: D9 = 100% IF 2: D9 = 50% IF 3: D9 = 25% IF 4: D9 = 0% IF 99: D9 = 0%
PA6 Score:	D9
Inconsistency Test #1	IF D7 $\geq$ 70% AND D5-D6 = 0%: PA4 = EMPTY
Inconsistency Test #2	IF D7 $\leq$ 30% AND D9 $\geq$ 50%: PA6 = EMPTY
Free-ridership level (after inconsistency tests) for regular participants	MEAN VALUE OF: (PA4; PA5; PA6)
H2/H5. [Your previous participation in ENS programs]/[The ENS promotional materials you saw] was a major factor in your decision to purchase [LED BULBS] today? H3/H6. [Your previous experience with ENS programs]/[The ENS promotional materials you saw prompted] you to take into account the savings on your energy bill when choosing different lighting options for your home.	Cross-influence (CI) = IF (H2 OR H5 = Agree; 1) + IF (H3 OR H6 = Agree; 1)
Revised Free-ridership	IF CI=0, Revised FR = FR IF CI=1, Revised FR = FR*.75 IF CI=2, Revised FR = FR*.50

Algorithm – LED Fixtures

Algorithm – LED Fixtures	
Section 1 – Free-ridership level for those who were unaware of discount before paying	
G1. Before paying at the cash register, were you aware that a discount was offered on the purchase of LED fixtures?	IF Yes: GO TO Section 2 IF No OR REF: GO TO G2
G2. [ASK IF G1=2, DK] To confirm, is it correct that you did not know about the discount on specific LED fixtures before paying at the register?	IF Yes: GO TO Section 2 IF No OR REF: G2 = 100%
PA1 Score:	G2
Free-ridership level for those who were unaware of discount before paying	PA1 OTHERWISE: GO TO Section 2
Section 2 – Free-ridership level for regular participants (aware of discount)	
G6. How likely is it that you would have bought the LED fixtures that you purchased if you had to pay the full price? (Scale 0 to 10)	G6 = Answer x 10% IF 99: G6 = EMPTY
G4. If the discount on LED fixtures had NOT been offered, what would you have bought today? 1. Bought fixtures anyway 2. Bought another type of fixtures without LEDs 3. Not bought any fixtures 99. (Don't know / Refused)	IF 1: G4 = 100% IF 2: G4 = Use G5 IF 3: G4 = 0% IF 99: G4 = EMPTY
G5. [ASK IF G4=2] If you were going to purchase a fixture without LED lighting, what type of bulbs would you have installed? 1. Incandescent 2. Halogen 3. CFLs 96. Other 99. (Don't know / Refused)	IF 1 OR 2: G5 = 0% IF 3: G5= 50% IF 96: G5= EMPTY IF 99: G5 = EMPTY
PA4 Score:	MEAN VALUE OF (G6; G4-G5)
G7. If the discount had NOT been offered, when would you have purchased the LED fixtures that you did? Would it have been...? 1. Earlier 2. Definitely today 3. Probably today 4. Probably at a later date 5. Definitely at a later date 96. (Would not have purchased them at all) 99. (Don't know / Refused)	IF 1 OR 2: G7 = 100% IF 3: G7 = 50% IF 4: G7 = 25% IF 5: G7 = 0% IF 96: G7 = 0% IF 99: G7 = 0%
PA5 Score:	G7

Algorithm – LED Fixtures	
G8. Without the discount, would you have purchased the same number of LED fixtures? 1. Definitely the same number 2. Probably the same number 3. Probably fewer 4. Definitely fewer 99. (Don't know / Refused)	IF 1: G8 = 100% IF 2: G8 = 50% IF 3: G8 = 25% IF 4: G8 = 0% IF 99: G8 = 0%
PA6 Score:	G8
Inconsistency Test #1	IF G6 ≥ 70% AND G4-G5 = 0%: PA4 = EMPTY
Inconsistency Test #2	IF G6 ≤ 30% AND G8 ≥ 50% PA6 = EMPTY
Free-ridership level (after inconsistency tests) for regular participants	MEAN VALUE OF: (PA4; PA5; PA6)
H2/H5. [Your previous participation in ENS programs]/[The ENS promotional materials you saw] was a major factor in your decision to purchase [LED FIXTURES] today. H3/H6. [Your previous experience with ENS programs]/[The ENS promotional materials you saw prompted] you took into account the savings on your energy bill when choosing different lighting options for your home.	Cross-influence (CI) = IF(H2 OR H5=Agree; 1) + IF(H3 OR H6=Agree; 1)
Revised Free-ridership	IF CI=0, Revised FR = FR IF CI=1, Revised FR = FR*.75 IF CI=2, Revised FR = FR*.50

APPENDIX X

IS: SPILLOVER METHODOLOGY

Retailer interviews were used to estimate the level of spillover by measuring the market effects of LED lamps and LED fixtures attributable to the program component. Market effects were measured by estimating the number of LED lamps and fixtures sold without receiving a rebate during one of the campaigns and the proportion of those sales that can be attributed to Instant Savings. When retailers provided sales numbers, they were asked to consider all LED lamp and fixture models, not only the models selected for rebate. For retailers where sales data were unavailable, the number of LED lamps and fixtures sold throughout the year was established using their interview answers.

Algorithm – LED Bulbs

Retailers were asked to provide sales data for non-A type LED bulbs in advance of their interview. The data provided varied by retailer (e.g. time period, sales, or shipments). Therefore, depending on the data provided, each retailer was asked a series of questions to estimate the number of all non-A-type LED bulbs sold from January to December 2021 (**#LED_{Jan-Dec}**).

Algorithm – LED Bulbs	
Total Non-A Type Sales	
Non-A-type LED bulbs sold from January – December 2021 (extrapolated from retailer data and interview responses)	#LED_{Jan-Dec}
LED Sales During Instant Savings' Campaigns	
LED bulb sales during the Instant Savings Spring and Fall Campaigns (from the tracking sheet)	#LED_{IS}
Program Influence	
C2a. What proportion of the number of non-A type LED bulbs will you sell this year outside of those that received a rebate will be influenced at least in part by Efficiency Nova Scotia's programs and promotion?	%influence
Final Market Effects (LEDs) = ((#LED_{Jan-Dec} - #LED_{IS}) x %influence) / #LED_{IS}	

Algorithm – LED Fixtures

Retailers were asked to provide sales data for LED fixtures in advance of their interview. The data provided varied by retailer (e.g. time period, sales, or shipments). Therefore, depending on the data provided, each retailer was asked a series of questions to estimate the number of all the LED fixtures sold from January to December 2021 (**#LED fixtures_{Jan-Dec}**).

Algorithm – LED Fixtures	
Total LED Fixture Sales	
LED fixtures sold from January – December 2021 (extrapolated from retailer data and interview responses)	#LED fixtures_{Jan-Dec}
LED Fixture Sales During Instant Savings Campaigns	
LED fixture sales during the Instant Savings Spring and Fall Campaigns (from the tracking sheet)	#LED fixtures_{IS}
Program Influence	
E2a. What proportion of the number of LED fixtures will you sell this year outside of those that received a rebate will be influenced at least in part by Efficiency Nova Scotia's programs and promotion?	%influence
Final Market Effects (LED fixtures) = ((#LED fixture_{Jan-Dec} - #LED fixture_{IS}) x %influence) / #LED fixture_{IS}	

APPENDIX XI

IS: 2021 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2021 evaluation of Instant Savings, as well as all past evaluation recommendations that were not fully implemented or deferred.

Sections	2021 Recommendations
Executive Summary	1. Update the LED lamp and fixture baselines in the 2020-2022 Measure Assessment to reflect updates to regulations, the growing presence of LEDs in the market as well as the decreased market share of CFLs. The Evaluator currently applies a baseline for LED lamp and fixtures to establish their equivalent EUL values that are used to obtain lifetime savings. The current baseline uses a CFL equivalent for 2024 to the end of product life. This baseline should be updated to reflect market trends; given CFL market shares are becoming very small, it is highly likely that the upcoming U.S. regulation banning halogen lamps will effectively results in a complete shift to LEDs.
2018 Recommendation (Deferred)	2. Perform a socket study through on-site visits to document energy savings potential related to lighting.
Impact Evaluation	3. The evaluator recommends updating the free-ridership level for Costco participants in the 2022 evaluation. If Costco data continue to be unavailable and considering changes in participant behaviour observed since 2020, particularly for LED lamps, the Evaluator recommends applying results obtained for the program based on non-Costco participants.
Market Evolution	4. The decrease in units sold from 2019 is counter to Electrofed data, indicating some growth in LED shipments during that period. However, given the uncertainty in 2020 Electrofed data as well as the market perturbations and retailer reported supply chain delays/inventory issues caused by the COVID-19 pandemic, the Evaluator was not able to draw any conclusions from this observation. The Evaluator recommends monitoring this in future analyses.



EXISTING RESIDENTIAL PROGRAM 2021 DSM EVALUATION

EFFICIENCYONE

Final Report

March 10, 2022



ABBREVIATIONS

AMH	Affordable Multifamily Housing
BNI	Business, non-profit, and institutional
BOB	Black-out Bulbs
CASHP	Central air-source heat pump
COP	Coefficient of performance
DA	Delivery agent
DHW	Domestic hot water
DSM	Demand-side management
DWHR	Drain water heat recovery
EA	Energy auditor
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
EPI	Efficient Product Installation
ETS	Electric thermal storage
EUL	Effective useful life
GHG	Greenhouse gas
HEA	Home Energy Assessment
HM	Housing manager
HPWH	Heat pump water heater
HSPF	Heating seasonal performance factor
LCEF	Low Carbon Economy Fund
MHEEP	Mi'kmaw Home Energy Efficiency Project
MSHP	Mini-split heat pumps
NEEP	Northeast Energy Efficiency Partnerships
NRCan	Natural Resources Canada
NS Power	Nova Scotia Power
NSUARB	Nova Scotia Utility and Review Board
NTGR	Net-to-gross ratio
OR	Overestimation ratio
PNS	Province of Nova Scotia
SEER	Seasonal energy efficiency ratio

DEFINITIONS

Accuracy	Reflects the proximity of measurements to the true value.
Adjustment ratio	The ratio of evaluated results to tracked results. This ratio expresses the adjustment made to tracked savings or other tracked values such as effective useful life.
Baseline	To determine gross savings, a baseline (or base case) is established providing detailed information about the reference (e.g. pre-existing or standard) measure or equipment chosen to be compared with the efficient measure or equipment. For the reference measure or equipment, the baseline may include such information as the hours of operation, wattage and the base consumption.
Bias	Systematic deviations of measurements from the true value.
Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
Displaced wattage	The displaced wattage is defined as the difference between the wattage values of the baseline equipment or product and the efficient equipment or product.
EnerGuide rating	An EnerGuide (official brand of Natural Resources Canada) rating is a standard measure of the home's energy performance. It is a measure of the efficiency of the building only and does not take into account occupant behaviour. It shows how energy efficient the home is through modelled heat losses of the home, based on several factors including building envelope characteristics, heated volume, heating systems and air leakage.
Effective useful life	The period a measure is expected to be in service and provide both energy and peak demand savings. This value combines the equipment life and the measure persistence, which includes factors such as business turnover or early retirement.
Equipment life	The number of years installed equipment will operate before it fails.
Equivalent CO ₂	A unit of measurement indicating the amount of carbon dioxide to which various kinds of emitted greenhouse gases are equivalent in terms of warming effects. In this report, the gases' global-warming potential is estimated over a timescale of 100 years.
Equivalent effective useful life	The number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. This value takes into account variations in annual energy savings throughout the effective useful life due to increased baselines.

Evaluated savings	Gross and net energy or peak demand savings calculated by the Evaluator using the parameters (unitary savings values, installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process. Unless otherwise specified, the evaluated savings are the first-year savings.
Evaluation plan	The evaluation plan summarizes the program description, objectives, base cases, documentation, evaluation methodology, budget and schedule.
First-year savings	The first full year of energy or peak demand savings generated by an energy efficiency measure.
Free-ridership	Percentage of gross savings attributable to participants who would have implemented the same or similar energy efficiency measures, with no change in timing, in the absence of the program.
Gross savings	Change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated.
Induced consumption	Energy consumption of appliances that would have been unplugged and not replaced by participants in the absence of the program.
Interactive effects	Effects on the energy consumption of other systems in the building (such as heating and cooling) due to the installation of an energy efficiency measure.
Participant spillover	Savings attributable to participants who continue to implement the energy efficiency measure introduced by a program after participating in it once, without participating in the program a second time.
In-service rate	The proportion of incentivized products that are installed and operating. This rate is usually applied to programs through which rebates are offered in-store and products are likely to be stored for a certain period before being installed, such as LED lamps.
Installation rate	The proportion of incentivized products reported as installed that remain installed and operating at the time of evaluation. This rate is usually applied to direct install or mail-in rebate programs through which measures are expected to be installed immediately at the time of participation.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for a measure's effective useful life and any increase in the baseline efficiency level (which reduces attributable annual savings) over its lifetime.
Line loss factor	The multiplier to convert savings at the customer meter to savings at the utility generator. It accounts for the electrical losses of the transmission and distribution system.
Margin of error	The amount of random sampling error.
Market effects	The impact of the program on the market (such as increased product availability, practices, and prices) that extends beyond changing the program participants' behaviour. This includes spillover among non-participants.

Net savings	Energy or peak demand savings that can be reliably attributed to a program. This includes effects, such as free-ridership and spillover, that negatively or positively affect the savings attributable to a program.
Net-to-gross ratio	The ratio of net energy savings to gross energy savings.
Non-sampling error	Errors arising during the course of all survey activities other than sampling. Non-sampling errors tend to lead to bias in measurements and are very difficult to quantify.
Peak coincidence factor	The percentage of measure demand savings that coincide in time with the annual peak demand of the entire electricity system.
Peak demand savings	The demand savings that coincide in time with the expected annual peak demand period of the entire electricity system.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	The error in measurement due to the fact that measurements are taken from a subset of the population and not the entire population.
Realization rate	The ratio of evaluated savings to tracked savings.
Sample size	The number of observations or replicates included in a statistical sample.
Secondary market impacts	Energy consumption of appliances that would have been transferred to the secondary market if said appliances had not been retired.
Tracked savings	Gross and net savings calculated based on various parameters such as number of participants or units installed or sold, unitary savings values, installation rates, interactive effects, and the net-to-gross ratio. Those parameters, with the exception of the number of participants or units installed or sold, are obtained from the previous evaluation.
Unitary savings	Energy or peak demand savings established on a unitary basis. This unit can either be a product (e.g., an 8 W LED lamp), a capacity (e.g., one-ton capacity of an air-source heat pump) or a participant (e.g., one participant taking part in a behaviour-based program).

TABLE OF CONTENTS

EXECUTIVE SUMMARY	XII
INTRODUCTION	1
1 HEA OVERVIEW	3
1.1 HEA Description	3
1.2 Follow-up on Past Evaluation Report Recommendations	4
1.3 Participation History	6
2 HEA EVALUATION APPROACH	8
3 HEA IMPACT EVALUATION	10
3.1 Tracking Sheet Audit	10
3.2 Gross Savings	10
3.2.1 Installation Rates	11
3.2.2 Energy Savings	11
3.2.3 Peak Demand Savings	14
3.2.4 Interactive Effects	17
3.2.5 Effective Useful Life	17
3.2.6 Evaluated Gross Savings	18
3.3 Net Savings	21
3.3.1 Free-ridership	21
3.3.2 Participant Spillover	21
3.3.3 Net-to-gross Ratio Calculation	22
3.3.4 Unconverted Assessment Spillover	22
3.3.5 Green Heat and EPI Savings Deductions	23
3.3.6 Evaluated Net Savings	23
3.4 Realization Rate	25
4 HEA KEY FINDINGS AND RECOMMENDATIONS	26
5 GREEN HEAT OVERVIEW	28
5.1 Green Heat Description	28
5.2 Follow-up on Past Evaluation Report Recommendations	30
5.3 Participation History	31
6 GREEN HEAT EVALUATION APPROACH	33
7 GREEN HEAT PARTICIPANT PERSPECTIVES	36
8 GREEN HEAT IMPACT EVALUATION	38

8.1	Tracking Sheet Audit.....	38
8.2	Gross Savings	38
8.2.1	Installation Rates	38
8.2.2	Unitary Energy Savings.....	38
8.2.3	Unitary Peak Demand Savings	40
8.2.4	Interactive Effects	41
8.2.5	Effective Useful Life	42
8.2.6	Evaluated Gross Savings	42
8.3	Net Savings.....	46
8.3.1	Free-ridership.....	46
8.3.2	Net-to-gross Ratio Calculation	48
8.3.3	Evaluated Net Savings.....	48
8.4	Realization Rate.....	52
9	GREEN HEAT MARKET EVOLUTION.....	53
9.1	Market Indicators.....	53
9.1.1	Market Share of Heat Pumps	53
9.1.2	Green Heat Eligible Mini-split Heat Pumps.....	57
9.1.3	Mini-split Heat Pump Prices	58
9.1.4	Mini-split Heat Pump Market Outlook and Trends	59
9.1.5	Codes and Standards	60
9.1.6	Measured Free-ridership	61
9.2	Market Evolution Summary.....	61
10	GREEN HEAT KEY FINDINGS AND RECOMMENDATIONS.....	64
11	EPI OVERVIEW.....	66
11.1	EPI Description	66
11.2	Follow-up on Past Evaluation Report Recommendations	67
11.3	Participation History.....	67
12	EPI EVALUATION APPROACH.....	70
13	EPI PARTICIPANT PERSPECTIVES.....	72
14	EPI IMPACT EVALUATION	74
14.1	Tracking Sheet Audit.....	74
14.2	Gross Savings	74
14.2.1	Installation Rates	74
14.2.2	Unitary Energy Savings.....	76

14.2.3	Unitary Peak Demand Savings	80
14.2.4	Interactive Effects	82
14.2.5	Adjustment Ratio.....	83
14.2.6	Effective Useful Life	83
14.2.7	Evaluated Gross Savings.....	85
14.3	Net Savings.....	104
14.3.1	Free-ridership.....	104
14.3.2	Participant Spillover	104
14.3.3	Net-to-gross Ratio Calculation	105
14.3.4	Evaluated Net Savings.....	106
14.4	Realization Rate.....	115
15	EPI KEY FINDINGS AND RECOMMENDATIONS	117
16	MHEEP OVERVIEW.....	119
16.1	MHEEP Description	119
16.2	Follow-up on Past Evaluation Report Recommendations	120
16.3	Participant History.....	120
17	MHEEP EVALUATION APPROACH.....	122
18	MHEEP IMPACT EVALUATION	123
18.1	Tracking Sheet Audit.....	123
18.2	Gross Savings	123
18.2.1	Energy Savings.....	123
18.2.2	Peak Demand Savings.....	124
18.2.3	Interactive Effects	125
18.2.4	Effective Useful Life	125
18.2.5	Evaluated Gross Savings.....	126
18.3	Net Savings.....	127
18.3.1	Evaluated Net Savings.....	127
18.4	Realization Rate.....	127
19	MHEEP KEY FINDINGS AND RECOMMENDATIONS	129
20	AMH OVERVIEW	130
20.1	AMH Description.....	130
20.2	Follow-up on Past Evaluation Report Recommendations	131
20.3	Participation History.....	132
21	AMH EVALUATION APPROACH	134

22	AMH PARTICIPANT PERSPECTIVES.....	136
23	AMH IMPACT EVALUATION.....	137
23.1	Tracking Sheet Audit.....	137
23.2	Gross Savings	137
23.2.1	On-site Visits and Desk Review Findings	137
23.2.2	Interactive Effects	139
23.2.3	Effective Useful Life	140
23.2.4	Evaluated Gross Savings	140
23.3	Net Savings.....	141
23.3.1	Evaluated Net Savings.....	141
23.4	Realization Rate.....	142
24	AMH KEY FINDINGS AND RECOMMENDATIONS.....	143
	CONCLUSION.....	145

LIST OF TABLES

Table 1:	Summary of Existing Residential Program Evaluation	xii
Table 2:	Overall 2021 Existing Residential Participation and Evaluated Savings	xiv
Table 3:	Comparison of 2021 HEA Tracked and Evaluated Savings at the Generator	xvii
Table 4:	2021 Green Heat NTGRs.....	xix
Table 5:	Comparison of 2021 Green Heat Tracked and Evaluated Savings at the Generator	xix
Table 6:	Comparison of 2021 EPI Tracked and Evaluated Savings at the Generator	xxii
Table 7:	Comparison of 2021 MHEEP Tracked and Evaluated Savings at the Generator	xxiv
Table 8:	Comparison of 2021 AMH Tracked and Evaluated Savings at the Generator.....	xxvi
Table 9:	Types of Evaluations Conducted for Each Program Component, 2021	1
Table 10:	Implementation Status of Past Recommendations for HEA	5
Table 11:	2021 HEA Evaluation Approach	8
Table 12:	2021 HEA Overestimation Ratio Values	12
Table 13:	2021 HEA Tracked and Evaluated Unitary Energy Savings for Non-modelled Space Heating Measures.....	12
Table 14:	2021 HEA Tracked and Evaluated Unitary Energy Savings for DHW Measures.....	13
Table 15:	Unitary Peak Demand Savings Values for Space Heating Mini-split Heat Pumps	14
Table 16:	2021 HEA Tracked and Evaluated Peak Demand Savings.....	16
Table 17:	2021 HEA Equivalent Effective Useful Life Values	17
Table 18:	Evaluated 2021 HEA Gross Energy and Peak Demand Savings.....	19
Table 19:	HEA Average Free-ridership Level.....	21
Table 20:	HEA Average Participant Spillover Level.....	21
Table 21:	2021 HEA NTGR.....	22
Table 22:	2021 HEA Unconverted D Assessment Spillover	23
Table 23:	Evaluated 2021 HEA Net Energy and Peak Demand Savings.....	24

Table 24: Evaluated 2021 HEA GHG Emission Reductions	24
Table 25: Comparison of 2021 HEA Tracked and Evaluated Savings at the Generator	25
Table 26: 2021 Green Heat Incentives.....	29
Table 27: Implementation Status of Past Recommendations for Green Heat	30
Table 28: 2021 Green Heat Evaluation Approach	33
Table 29: 2021 Green Heat Survey Sample Sizes and Margins of Error	34
Table 30: 2021 Green Heat Tracked and Evaluated Unitary Energy Savings.....	39
Table 31: 2021 Green Heat Unitary Peak Demand Savings.....	41
Table 32: 2021 Green Heat Equivalent Effective Useful Life Values	42
Table 33: Evaluated 2021 Green Heat Gross Energy and Peak Demand Savings.....	43
Table 34: 2021 Green Heat Average Free-ridership Levels	48
Table 35: 2021 Green Heat NTGRs.....	48
Table 36: Evaluated 2021 Green Heat Net Energy and Peak Demand Savings.....	49
Table 37: Evaluated 2021 Green Heat GHG Emission Reductions	52
Table 38: Comparison of 2021 Green Heat Tracked and Evaluated Savings at the Generator	52
Table 39: Green Heat Incented High-efficiency Mini-split Heat Pump Systems, 2017-2021	56
Table 40: HEA Incented High-efficiency Mini-split Heat Pump Systems, 2015-2021	56
Table 41: Green Heat Average Costs and Incentives of Systems, 2017-2021	59
Table 42: Green Heat Free-ridership Levels for MSHPs, 2017-2021	61
Table 43: Analysis of 2021 Key Factors in Program Component Planning.....	62
Table 44: 2021 EPI List of Eligible Products.....	66
Table 45: Implementation Status of Past Recommendations for EPI.....	67
Table 46: 2021 EPI Evaluation Approach.....	70
Table 47: 2021 EPI Product Installation Rates	75
Table 48: 2021 EPI Tracked and Evaluated Unitary Energy Savings	78
Table 49: 2021 EPI Tracked and Evaluated Unitary Peak Demand Savings Values	80
Table 50: 2021 EPI Interactive Effects Calculation Results for LED Products Installed Indoors	82
Table 51: 2021 EPI Interactive Effects Factors for Pipe Insulation and Hot Water Tank Wraps.....	83
Table 52: 2021 EPI Equivalent Effective Useful Life Values.....	84
Table 53: Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Single-family Homes.....	86
Table 54: Evaluated 2021 EPI Gross Energy and Peak Demand Savings – Apartments	94
Table 55: 2021 EPI Free-ridership Level – Non-low-income Participants	104
Table 56: 2021 EPI Participant Spillover Level – Non-low-income Participants	104
Table 57: 2021 EPI Net-to-gross Ratios by Product Category.....	105
Table 58: Evaluated 2021 EPI Net Energy and Peak Demand Savings	107
Table 59: Evaluated 2021 EPI GHG Emission Reductions.....	115
Table 60: Comparison of 2021 EPI Tracked and Evaluated Savings at the Generator	115
Table 61: 2021 MHEEP Evaluation Approach.....	122
Table 62: Evaluated 2021 MHEEP Overestimation Ratios	124
Table 63: Tracked and Evaluated 2021 MHEEP Equivalent Effective Useful Life Values.....	125
Table 64: Evaluated 2021 MHEEP Gross Energy and Peak Demand Savings	126
Table 65: Evaluated 2021 MHEEP GHG Emission Reductions.....	127
Table 66: Comparison of 2021 MHEEP Tracked and Evaluated Savings at the Generator	128
Table 67: Implementation Status of Past Recommendations for AMH	131
Table 68: 2021 AMH Evaluation Approach.....	134
Table 69: 2021 AMH Adjustment Ratios	139
Table 70: 2021 AMH Revised Effective Useful Life	140
Table 71: Evaluated 2021 AMH Gross Energy and Peak Demand Savings	141

Table 72: Evaluated 2021 AMH GHG Emission Reductions	142
Table 73: Comparison of 2021 AMH Tracked and Evaluated Savings at the Generator	142
Table 74: Overall 2021 Existing Residential Participation and Evaluated Savings.....	145

LIST OF FIGURES

Figure 1: 2021 HEA Targets and Evaluated Results	xv
Figure 2: HEA Performance Overview, 2012-2021.....	xvi
Figure 3: 2021 Green Heat Targets and Evaluated Results	xvii
Figure 4: Green Heat Performance Overview, 2012-2021.....	xviii
Figure 5: 2021 EPI Targets and Evaluated Results.....	xx
Figure 6: EPI Performance Overview, 2012-2021	xxi
Figure 7: 2021 MHEEP Targets and Evaluated Results.....	xxiii
Figure 8: MHEEP Performance Overview, 2019-2021	xxiii
Figure 9: 2021 AMH Targets and Evaluated Results.....	xxv
Figure 10: AMH Performance Overview, 2018-2021	xxv
Figure 11: HEA Participation Process Summary	3
Figure 12: Overview of HEA Participation, 2012-2021	6
Figure 13: Evolution of HEA Gross Savings, 2012-2021	7
Figure 14: Green Heat Participation Process Summary	28
Figure 15: Overview of Green Heat Participation, 2012-2021.....	31
Figure 16: Evolution of Green Heat Gross Savings, 2012-2021	32
Figure 17: Barriers to the Installation of Energy Efficient Heating Equipment.....	36
Figure 18: 2021 Participant Satisfaction with Green Heat (10-point Scale)	37
Figure 19: 2021 Green Heat Tracked and Evaluated Gross Energy Savings	45
Figure 20: 2021 Green Heat Tracked and Evaluated Gross Peak Demand Savings	46
Figure 21: Incremental Homes with Heat Pump Systems Installed in Nova Scotia, 2013-2021.....	54
Figure 22: Homes with Heat Pump Systems (Cumulative), 2013-2021	55
Figure 23: Comparison of Incremental Existing Homes with Mini-split Heat Pump Systems with EOne Incented Systems, 2015-2021.....	57
Figure 24: Evolution of Green Heat Average Costs and Average Incentives – 2017-2021	58
Figure 25: 2021 Residential Market Evolution of Mini-split Heat Pumps.....	63
Figure 26: Overview of RDI, RP&C, and EPI Participation, 2016-2021	68
Figure 27: Evolution of RDI, RP&C, and EPI Gross Savings, 2012-2021	69
Figure 28: 2021 Participant Satisfaction with EPI (10-point Scale)	72
Figure 29: 2021 EPI Tracked and Evaluated Gross Savings.....	102
Figure 30: 2021 EPI Tracked and Evaluated Gross Peak Demand Savings.....	103
Figure 31: MHEEP Participation Process Summary	119
Figure 32: Overview of MHEEP Participation, 2019-2021	121
Figure 33: Evolution of MHEEP Gross Savings, 2019-2021	121
Figure 34: AMH Participation Process Summary.....	130
Figure 35: Overview of AMH Comprehensive Participant, 2018-2021	132
Figure 36: Evolution of AMH Gross Savings, 2018-2021.....	133
Figure 37: 2021 Existing Residential Program Targeted and Evaluated Net Energy Savings.....	146
Figure 38: 2021 Existing Residential Program Targeted and Evaluated Net Peak Demand Savings.....	146

EXECUTIVE SUMMARY

This report presents the 2021 demand-side management (DSM) results of the Existing Residential program administered by EfficiencyOne (EOne). This program is comprised of five components: (1) Home Energy Assessment (HEA); (2) Green Heat; (3) Efficient Product Installation (EPI); (4) Mi'kmaw Home Energy Efficiency Project (MHEEP); and Affordable Multifamily Housing (AMH). Combined, these program components encourage energy efficiency upgrades in existing residential homes, affordable housing, and non-profit organizations by providing financial incentives, technical information, and recommendations as well as free-of-charge direct installations of energy efficient products.

Evaluation Approach

The evaluation was aimed at calculating program component gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided greenhouse gas (GHG) emissions. For Green Heat, market evaluation was also conducted. Table 1 summarizes the types of evaluation conducted for each program component and the corresponding methodology.

Table 1: Summary of Existing Residential Program Evaluation

Program Component	Evaluation Type			Methodology
	Impact	Process	Market*	
HEA	Condensed			› Tracking sheet audit › Unitary savings review › Calculations using evaluation results › GHG emission reduction calculations
Green Heat	Condensed		X	› Participant survey › Tracking sheet audit › Unitary savings review › EUL update › Calculations using evaluation results › GHG emission reduction calculations › Heat pump distributor interviews › Market evolution and characterization study

Program Component	Evaluation Type			Methodology
	Impact	Process	Market*	
Efficient Product Installation	Comprehensive			› Participant survey › Tracking sheet audit › On-site visits › Measure Assessment update › Calculations using evaluation results › GHG emission reduction calculations
MHEEP	Condensed			› Tracking sheet audit › Measure Assessment update › Savings calculation review › Calculations using evaluation results › Calculations using a net-to-gross ratio of 1 › GHG emission reduction calculations
AMH	Comprehensive			› On-site visits and desk reviews › Tracking sheet audit › Effective useful life (EUL) update › Calculations using evaluation results › GHG emission reduction calculations
* Selected market evaluation themes, such as satisfaction and awareness, were added to impact evaluation activities for EPI and AMH				

Program Performance

Table 2 presents the participation levels, net-to-gross ratios (NTGRs), as well as evaluated gross and net savings at the generator for each program component and for the Existing Residential program as a whole.

Table 2: Overall 2021 Existing Residential Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
HEA							
Energy Savings	961	Participants	3.618	GWh	0.96	3.481	GWh
Lifetime Energy Savings			75.228	GWh	0.96	72.399	GWh
Peak Demand Savings			1.722	MW	0.87	1.495	MW
Green Heat							
Energy Savings	3,654	Measures installed	11.218	GWh	0.61	6.795	GWh
Lifetime Energy Savings			201.923	GWh	0.61	122.306	GWh
Peak Demand Savings			10.370	MW	0.62	6.451	MW
EPI							
Energy Savings	10,028 ¹	Participants	8.174	GWh	0.96	7.812	GWh
Lifetime Energy Savings			67.214	GWh	0.97	65.165	GWh
Peak Demand Savings			1.143	MW	0.96	1.098	MW
MHEEP							
Energy Savings	82	Participants	0.316	GWh	1.00	0.316	GWh
Lifetime Energy Savings			6.633	GWh	1.00	6.633	GWh
Peak Demand Savings			0.147	MW	1.00	0.147	MW
AMH							
Energy Savings	23	Projects	0.402	GWh	1.00	0.402	GWh
Lifetime Energy Savings			7.117	GWh	1.00	7.117	GWh
Peak Demand Savings			0.186	MW	1.00	0.186	MW
Total							
Energy Savings			23.728	GWh		18.806	GWh
Lifetime Energy Savings			358.115	GWh		273.620	GWh
Peak Demand Savings			13.568	MW		9.378	MW

¹ The number of participants is based on the number of unique reference numbers of participants that generated electricity savings.

Existing Residential was aimed at achieving 24.2 GWh in net electrical energy savings and 11.2 MW in net peak demand savings at the generator for 2021. It achieved 18.806 GWh in net electrical energy savings and 9.378 MW in net peak demand savings at the generator. Therefore, the program fell short of achieving planned energy and peak demand savings, with all program components being below target, with the exception of Green Heat. Despite the pandemic, Green Heat, MHEEP, and AMH participation levels were the highest ever in 2021. EPI was the largest contributor to total program net energy savings, while Green Heat was the greatest contributor to total net peak demand savings.

The following subsections present evaluation results at the program component level.

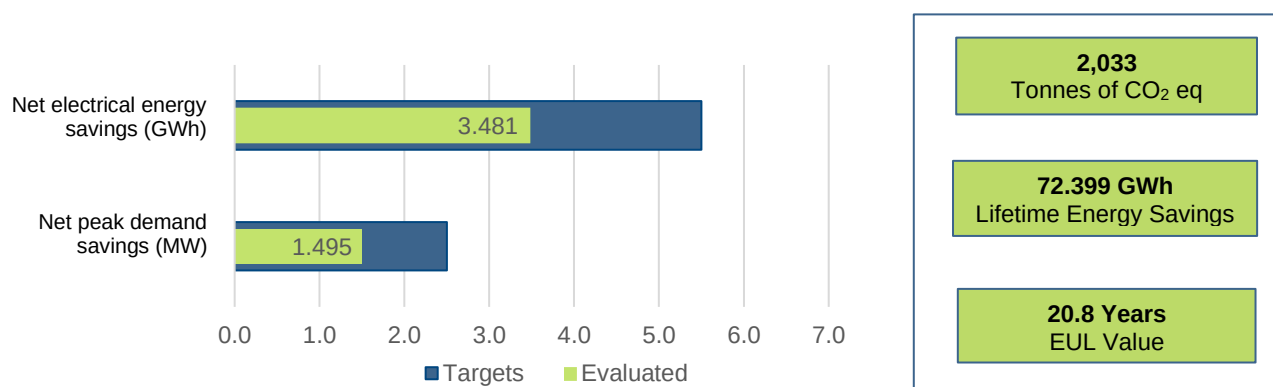
HEA Findings and Recommendations

This section presents the key findings and recommendations from the HEA evaluation.

2021 HEA-Finding: HEA net electrical energy and peak demand savings fell short of targets.

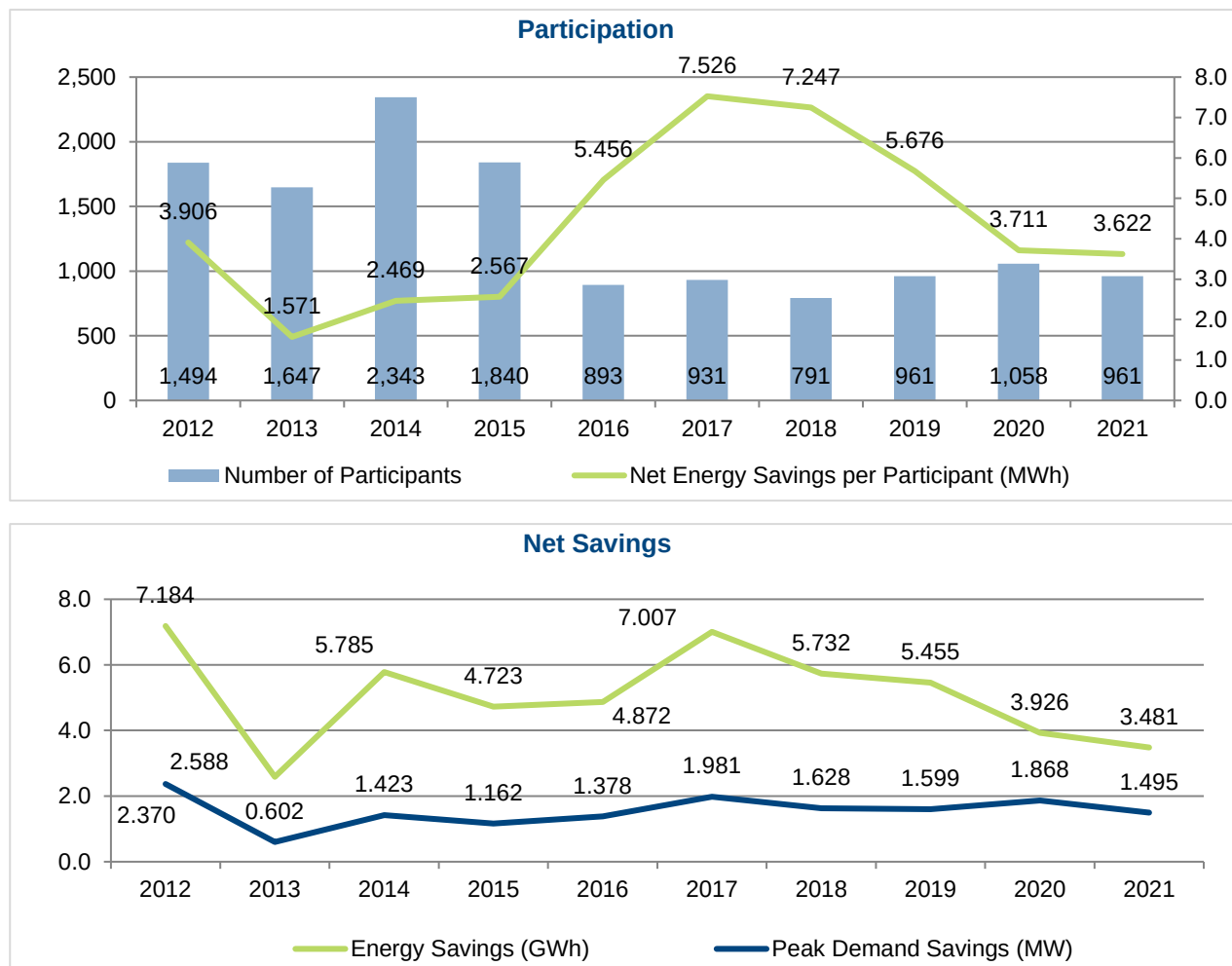
As outlined in Figure 1, HEA net electrical energy and peak demand savings fell short of targets by 37% and 40% respectively. The figure also includes the evaluated tonnes of CO₂ eq in annually GHG emissions, lifetime energy savings, and the EUL value.

Figure 1: 2021 HEA Targets and Evaluated Results



2021 HEA-Finding: Savings per home continued to decrease, but to a smaller extent than what has been observed since HEA has been open to both electrically and non-electrically heated homes. Indeed, the proportion of non-electrically-heated participants completing projects under HEA seems to have stabilized in 2021 (representing 51% compared to 48% in 2020), so the decrease in average savings per home is less significant (9% in 2021 compared to 2020 versus 36% in 2020 compared to 2019).

Figure 2 below illustrates the evolution of HEA in terms of participation, net energy and peak demand savings from 2012 to 2021, as well as the average savings per participant. The number of participants refers to those participants whose projects generated electrical savings regardless of whether their homes were primarily electrically heated.

Figure 2: HEA Performance Overview, 2012-2021


2021 HEA-Finding: The number of HEA tracking sheet fields has expanded a lot over the last few years with such additions as a new demand savings calculation approach. Tracking will further change in 2022 as HEA adapts its tools to co-deliver the federal Greener Homes program in Nova Scotia. Adding to an already extensive tracking tool increases the chances of calculation errors and other mistakes.

2021 HEA-Recommendation 1: Update and simplify the tracking sheet in time for next year's evaluation to minimize the risk of calculation errors. For instance, columns could be reorganized to follow the calculations steps from gross savings at meter to net savings at generator in that order. Also, formulas could be simplified by using named variables instead of cell references, and information that is no longer relevant to the calculations could be removed. This should be done alongside the integration of the Canada Greener Homes Grant data and before the conversion into the new data management system.

2021 HEA-Finding: The evaluated energy and peak demand savings were identical to the savings tracked by EOne.

Table 3 below compares the tracked and evaluated results.

Table 3: Comparison of 2021 HEA Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	3.618	GWh	0.96	3.481	GWh	100%
Evaluation Results	3.618	GWh	0.96	3.481	GWh	
Peak Demand Savings						
Tracked Savings by EOne	1.722	MW	0.87	1.495	MW	100%
Evaluation Results	1.722	MW	0.87	1.495	MW	
*NTGR values in this table include the impacts of unconverted D assessment spillover savings along with Green Heat and EPI savings deductions. The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by gross savings, which explains why the NTGR values are different from those presented in the above sections.						

Green Heat Findings and Recommendations

This subsection presents the key findings from the Green Heat evaluation. The Evaluator has no specific recommendation for Green Heat.

2021 GH-Finding: Green Heat net electrical energy and peak demand savings exceeded targets.

As outlined in Figure 3 below, Green Heat net electrical energy and peak demand savings exceeded targets by 22% and 13% respectively. The figure also includes the evaluated tonnes of CO₂ eq in annually avoided GHG emissions, lifetime energy savings, and the EUL value.

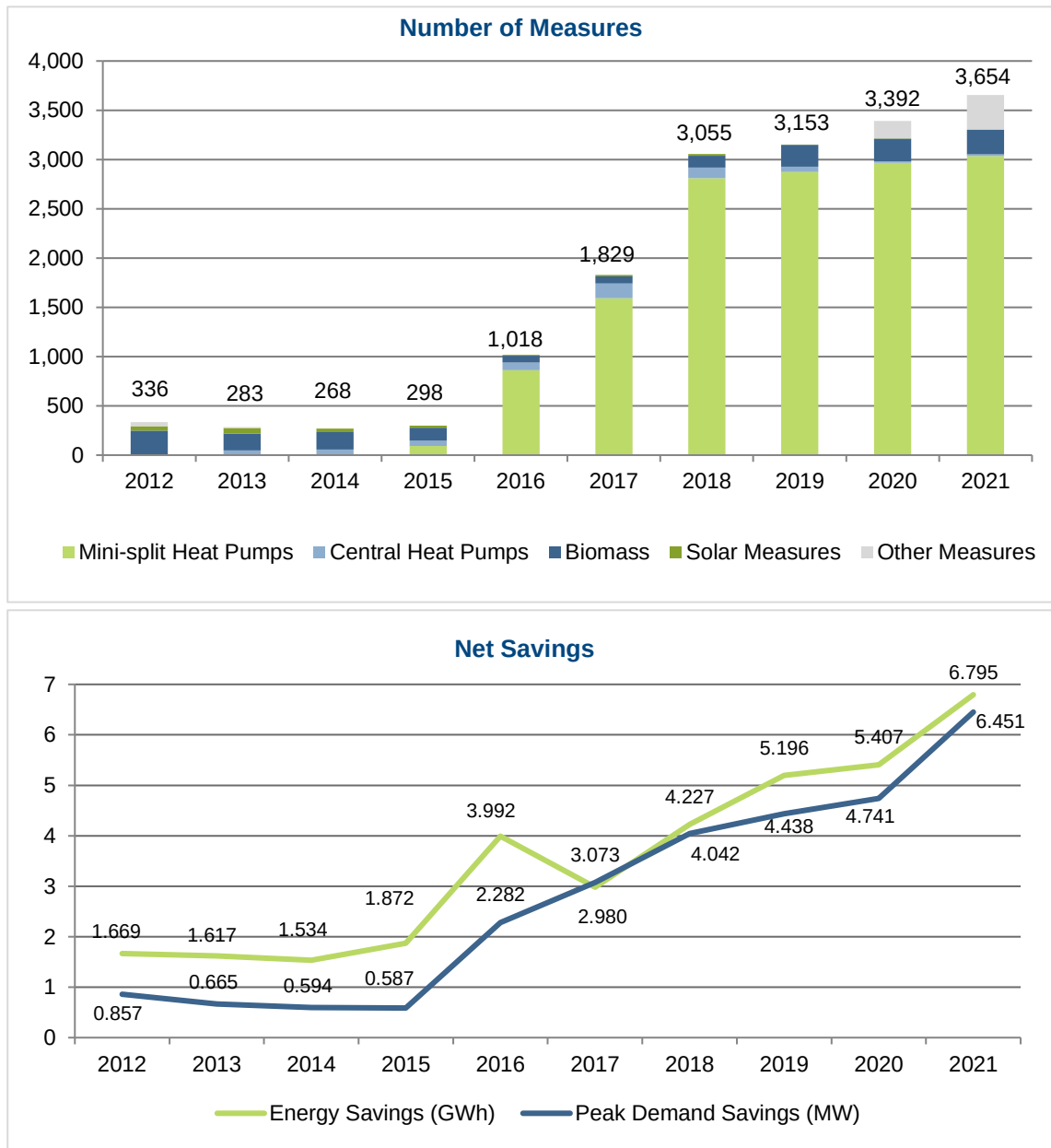
Figure 3: 2021 Green Heat Targets and Evaluated Results



2021 GH-Finding: Green Heat participation levels reached a new high in 2021, driven in large part by growth in demand reduction measures.

Figure 4 below illustrates the evolution of Green Heat in terms of the number of measures installed as well as net energy and peak demand savings from 2012 to 2021.

Figure 4: Green Heat Performance Overview, 2012-2021



2021 GH-Finding: Participant satisfaction with Green Heat remains high, with the rebate amounts being the only aspect of the program receiving a relatively lower satisfaction score.

2021 GH-Finding: Green Heat free-ridership levels for MSHPs decreased in 2021 mainly due to an update in how the timing variable of the decision-making process was accounted for in the algorithm; free-ridership remained stable for the other measure categories.

Table 4 below summarizes the NTGR values for Green Heat in 2021.

Table 4: 2021 Green Heat NTGRs

Measure	Free-ridership	NTGR
MSHPs	39%	0.61
CASHPs and GSHPs	33%	0.67
Biomass and Solar	41%	0.59
Demand Reduction	-	1.00

2021 GH-Finding: Both the evaluated net energy and peak demand savings determined by the Evaluator were significantly higher than the savings tracked by EOne due to new free-ridership level established in 2021 for MSHPs.

Table 5 compares the tracked and evaluated results.

Table 5: Comparison of 2021 Green Heat Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	11.218	GWh	0.50	5.580	GWh	122%
Evaluation Results	11.218	GWh	0.61	6.795	GWh	
Peak Demand Savings						
Tracked Savings by EOne	10.319	MW	0.50	5.179	MW	125%
Evaluation Results	10.370	MW	0.62	6.451	MW	
*NTGRs varied for each measure category. The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by gross savings.						

2021 GH-Finding: The annual number of MSHP systems that were incented by EOne slightly increased in 2020 and 2021, while their proportion compared to incremental households with MSHPs in Nova Scotia remained stable from 2019 to 2021.

2021 GH-Finding: Predictions of annual heat pump installations by NS Power as well as heat pump sales and consumer interest reported by distributors indicate that the MSHP market is in a sustained growth phase.

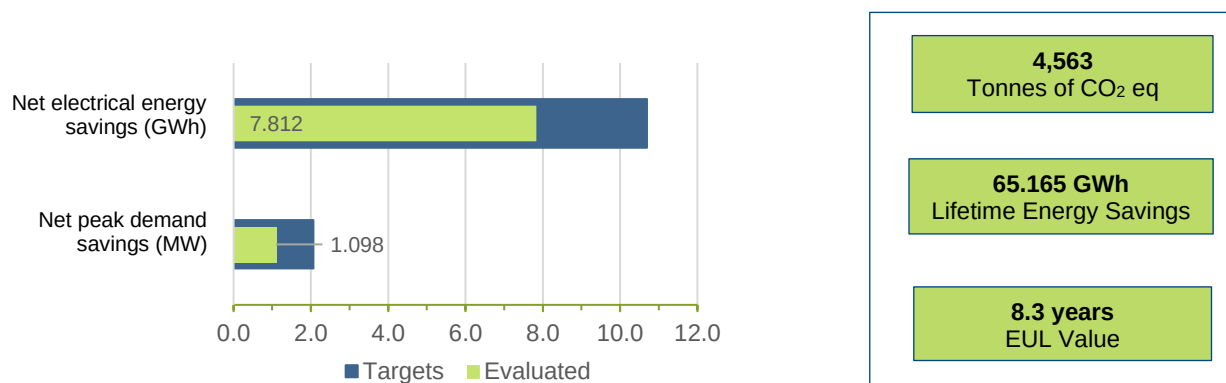
EPI Findings and Recommendations

This section presents the key findings from the EPI evaluation. The Evaluator has no specific recommendation for EPI. Deferred recommendations from the previous year are summarized in Appendix XVI.

2021 EPI-Finding: EPI net electrical energy and peak demand savings fell short of targets.

Based on the information outlined in Figure 9, EPI net electrical energy and peak demand savings fell short of targets by 27% and 47% respectively. The figure also includes the evaluated tonnes of CO₂ eq in annually avoided GHG emissions, lifetime energy savings, and the EUL value.

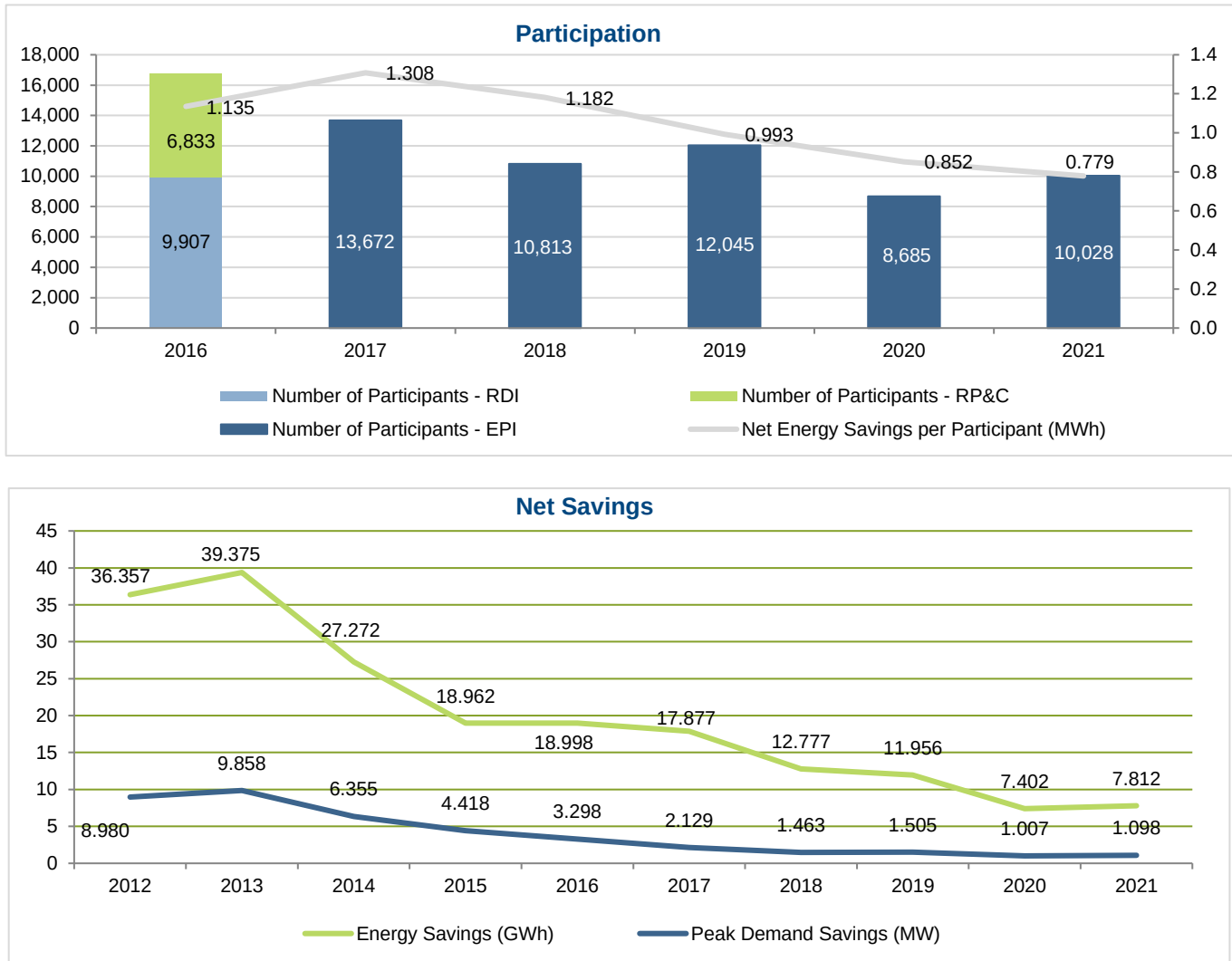
Figure 5: 2021 EPI Targets and Evaluated Results



2021 EPI-Finding: Savings per participant continued to decrease, driven by a further decrease in the number of LED lamps installed per household compared to 2020.

Figure 10 illustrates the evolution of EPI in terms of participation, average savings per participant, as well as net energy and peak demand savings from 2012 to 2021. Participation increased slightly in 2021 despite another temporary suspension of in-home activities in response to the COVID-19 pandemic.

Figure 6: EPI Performance Overview, 2012-2021



2021 EPI-Finding: The new installation rates established through the 2021 on-site visits resulted in a slight decrease in evaluated savings, notably due to a small decrease to the LED lamp installation rate.

2021 EPI-Finding: The Evaluator established free-ridership levels of 25% for LED lighting and 10% for low-flow showerheads, which indicates stable free-ridership compared to the 2019 levels of 23% for LED lighting and 9% for low-flow showerheads. The EPI average NTGR was evaluated at 0.96 in 2021.

2021 EPI-Finding: Overall satisfaction with EPI is high among participants.

2021 EPI-Finding: The differences between evaluated net energy and peak demand savings determined by the Evaluator and the net savings tracked by EOne were minimal.

Table 8 below compares the tracked and evaluated results. The small variation is due to the upward adjustment from the higher NTGR values established in 2021, which was somewhat offset by an overall downward adjustment resulting from the updated installation rates.

Table 6: Comparison of 2021 EPI Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
EOne Tracked Savings	8.347	GWh	0.91	7.621	GWh	103%
Evaluation Results	8.174	GWh	0.96	7.812	GWh	
Peak Demand Savings						
EOne Tracked Savings	1.157	MW	0.92	1.062	MW	103%
Evaluation Results	1.143	MW	0.96	1.098	MW	
*NTGRs varied for each type of product. The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by gross savings.						

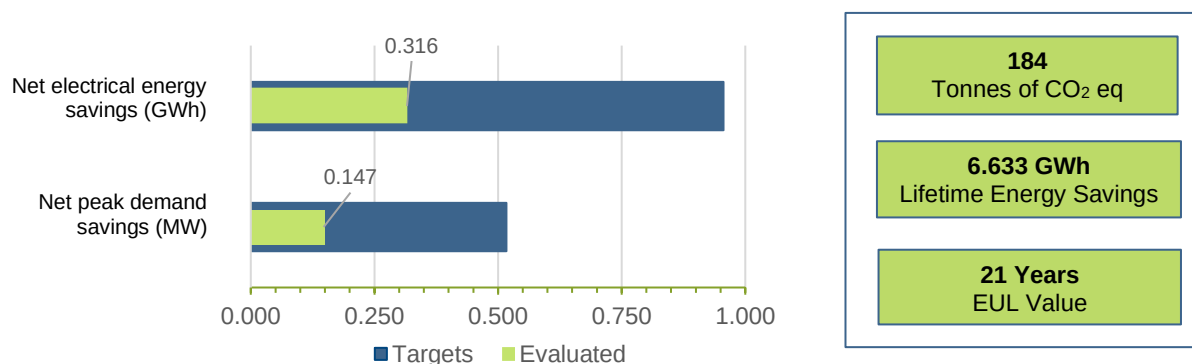
MHEEP Findings and Recommendations

This subsection presents the key findings from the MHEEP evaluation. The Evaluator has no specific recommendation for MHEEP.

2021 MHEEP-Finding: MHEEP net electrical energy and peak demand savings fell short of targets.

As outlined in Figure 7 below, MHEEP net electrical energy and peak demand savings fell short of targets by 67% and 71% respectively. While the rate of project completion picked up after a slow 2020 due to the COVID-19 pandemic, it was not sufficient to achieve targets that were higher than in 2020. The figure also includes the evaluated tonnes of CO₂ eq in annually avoided GHG emissions, lifetime energy savings, and the EUL value.

Figure 7: 2021 MHEEP Targets and Evaluated Results

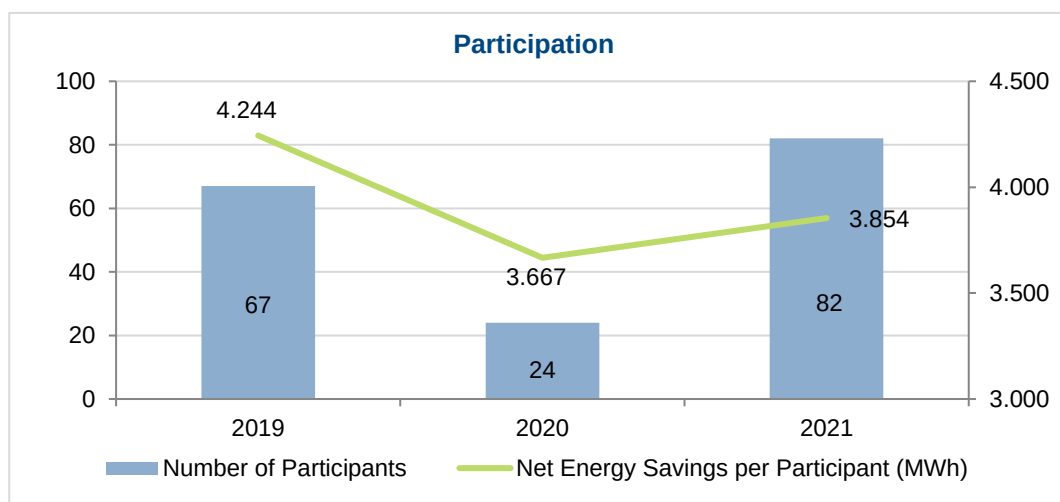


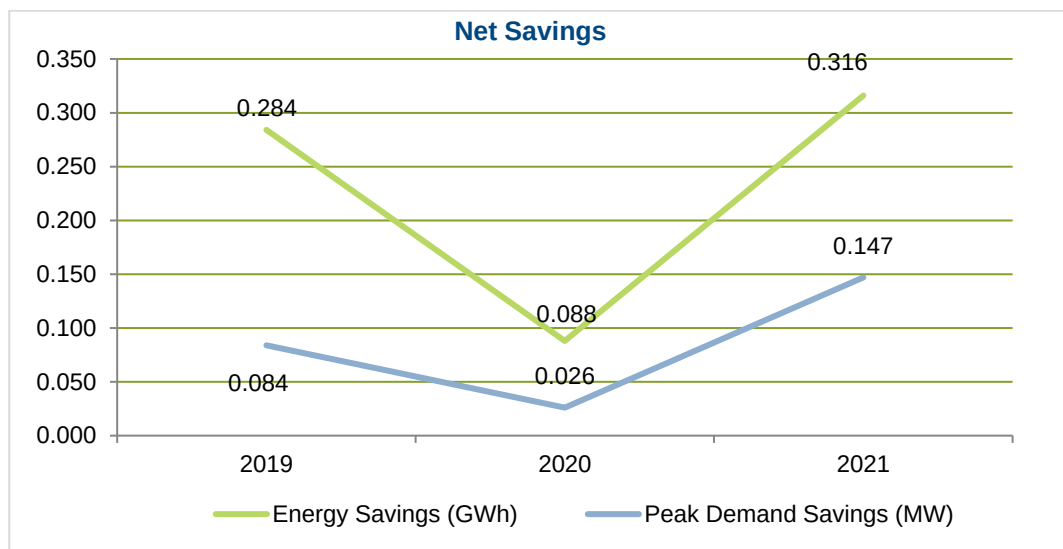
2021 MHEEP-Finding: Average electrical savings per participant increased in 2021, especially for peak demand savings.

The small increase in energy savings was driven by a lower proportion of homes with non-electrical heating participating in the program component compared to 2020. Conversely, peak demand savings were much higher due to a new and more precise calculation methodology for cold-climate heat pumps; as a result, peak demand savings per participant increased by 66%.

Figure 8 below illustrates the evolution of MHEEP in terms of participation, average savings per participant, as well as net energy and peak demand savings from 2019 to 2021.

Figure 8: MHEEP Performance Overview, 2019-2021





2021 MHEEP-Finding: The evaluated net energy and peak demand savings determined by the Evaluator were identical to the initial savings tracked by EOne.

Table 7 below compares the tracked and evaluated results.

Table 7: Comparison of 2021 MHEEP Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	0.316	GWh	1.00	0.316	GWh	100%
Evaluation Results	0.316	GWh	1.00	0.316	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.147	MW	1.00	0.147	MW	100%
Evaluation Results	0.147	MW	1.00	0.147	MW	

AMH Findings and Recommendations

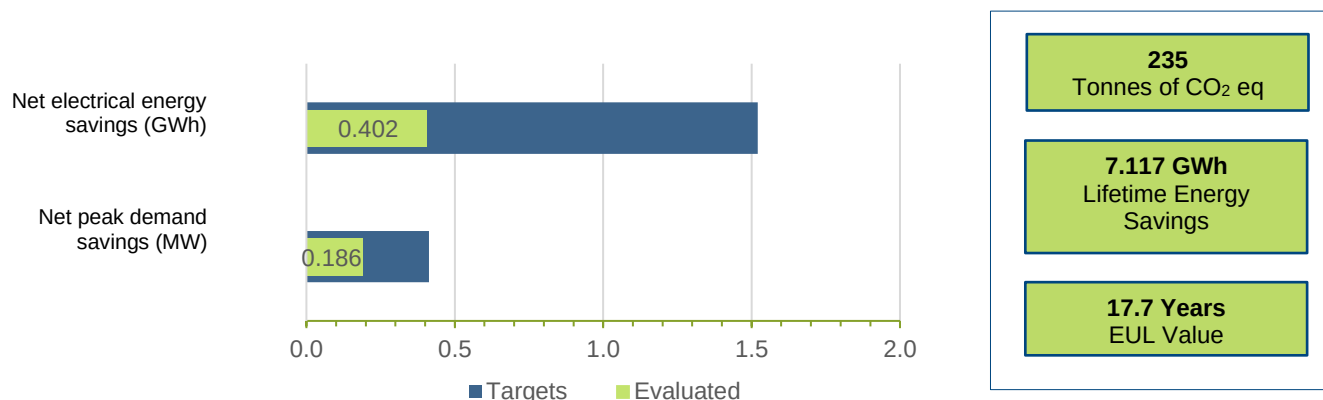
This section presents the key findings from the AMH evaluation.

2021 AMH-Finding: AMH net electrical energy and peak demand savings fell short of targets.

As outlined in Figure 9, AMH net electrical energy and peak demand savings fell short of targets by 74% and 55% respectively.

The figure also includes the evaluated tonnes of CO₂ eq in annually avoided GHG emissions, lifetime energy savings, and the EUL value.

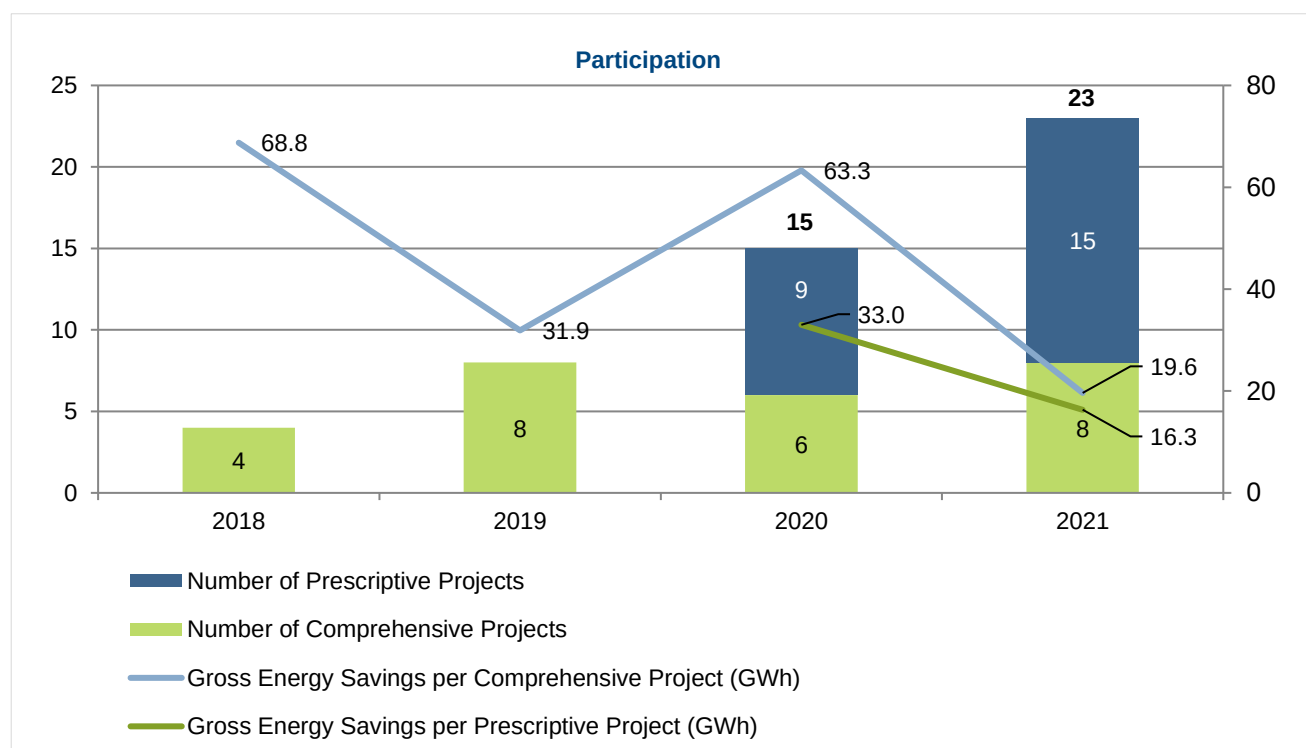
Figure 9: 2021 AMH Targets and Evaluated Results

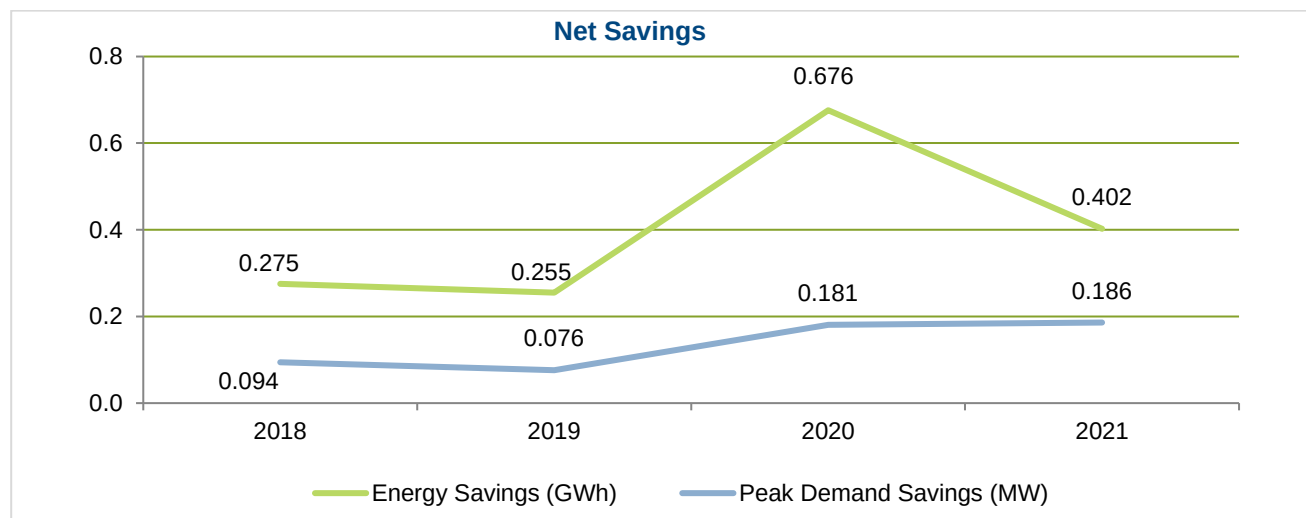


2021 AMH-Finding: AMH continued to grow and achieved its highest level of participation since its launch in 2018, largely driven by an increase in prescriptive projects. Despite an increase in the number of participants, a decrease in energy savings was observed due to lower energy savings per project in 2021 compared to 2020.

Figure 10 below illustrates the evolution of AMH in terms of participation, average net energy savings per participant, as well as net energy and peak demand savings from 2018 to 2021.

Figure 10: AMH Performance Overview, 2018-2021





2021 AMH-Finding: Following the project reviews, the Evaluator made downward adjustments to energy savings and upward adjustments to peak demand savings with the largest adjustments made to prescriptive projects, which resulted in overall adjustment ratios of 0.77 and 1.21 for energy and peak demand savings respectively.

2021 AMH-Finding: Participants are extremely satisfied with AMH and the recommended measures.

2021 AMH-Finding: The evaluated net energy savings determined by the Evaluator were lower than the savings tracked by EOne, while the evaluated net peak demand savings were higher than the savings tracked by EOne.

Table 8 compares the tracked and evaluated results. The differences between tracked and evaluated results are due to the adjustments made by the Evaluator following the project reviews.

Table 8: Comparison of 2021 AMH Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	0.522	GWh	1.00	0.522	GWh	77%
Evaluation Results	0.402	GWh	1.00	0.402	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.154	MW	1.00	0.154	MW	121%
Evaluation Results	0.186	MW	1.00	0.186	MW	

INTRODUCTION

EfficiencyOne (EOne), an independent, non-profit organization, is responsible for helping Nova Scotians improve the energy efficiency of their homes and workplaces by designing, marketing, and delivering energy efficiency and conservation programs for Nova Scotians. EOne receives funding for its electricity demand-side management (DSM) activities from Nova Scotia Power (NS Power) ratepayers.

EOne has a DSM portfolio of three residential programs and three business, non-profit, and institutional (BNI) programs that are marketed to Nova Scotians through the Efficiency Nova Scotia (ENS) franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2021 DSM program portfolio. In addition, Econoler conducted research to inform EOne's approach to market transformation and treatment of codes and standards.

This evaluation report relates to the Existing Residential program, which is comprised of five components: Home Energy Assessment (HEA); Green Heat; Efficient Product Installation (EPI); Mi'kmaw Home Energy Efficiency Project (MHEEP); and Affordable Multifamily Housing (AMH). Table 9 below lists the Existing Residential program components and the types of evaluations conducted in 2021. A comprehensive impact evaluation involves reviewing the following four key elements: (1) the baseline definition; (2) the savings calculation methodology; (3) the values of the parameters used to calculate savings; and (4) net-to-gross ratios (NTGRs). A condensed impact evaluation involves using some or all of the previous year's impact evaluation parameters such as unitary savings values, adjustment ratios, installation rates, and NTGRs to provide evaluated results.

Table 9: Types of Evaluations Conducted for Each Program Component, 2021

Program	Program Component	2021		
		Process	Market*	Impact
Existing Residential	HEA			Condensed
	Green Heat		X	Condensed
	EPI			Comprehensive
	MHEEP			Condensed
	AMH			Comprehensive
*Selected market evaluation themes, such as satisfaction and awareness, were added to impact evaluation activities for EPI and AMH				

To carry out this evaluation, Econoler collaborated with Equilibrium Engineering and Narrative Research. Econoler served as team leader and was involved in every aspect of the evaluation. Specifically, Econoler was in charge of coordinating and supervising all activities, conducting final reviews of all data-collection instruments, performing process and market evaluations and impact evaluation calculations, as well as preparing and reviewing evaluation reports. Equilibrium Engineering conducted desk reviews and on-site visits and also contributed to certain impact evaluation analyses.

Narrative Research conducted interviews and surveys with participants and partners, as well as analyzed and reported on the data collected from those activities. Throughout this report, this team is referred to as the Evaluator.

Key findings, electrical first-year and lifetime energy savings, peak demand savings, and avoided greenhouse gas (GHG) emissions are presented in this report for each program component.

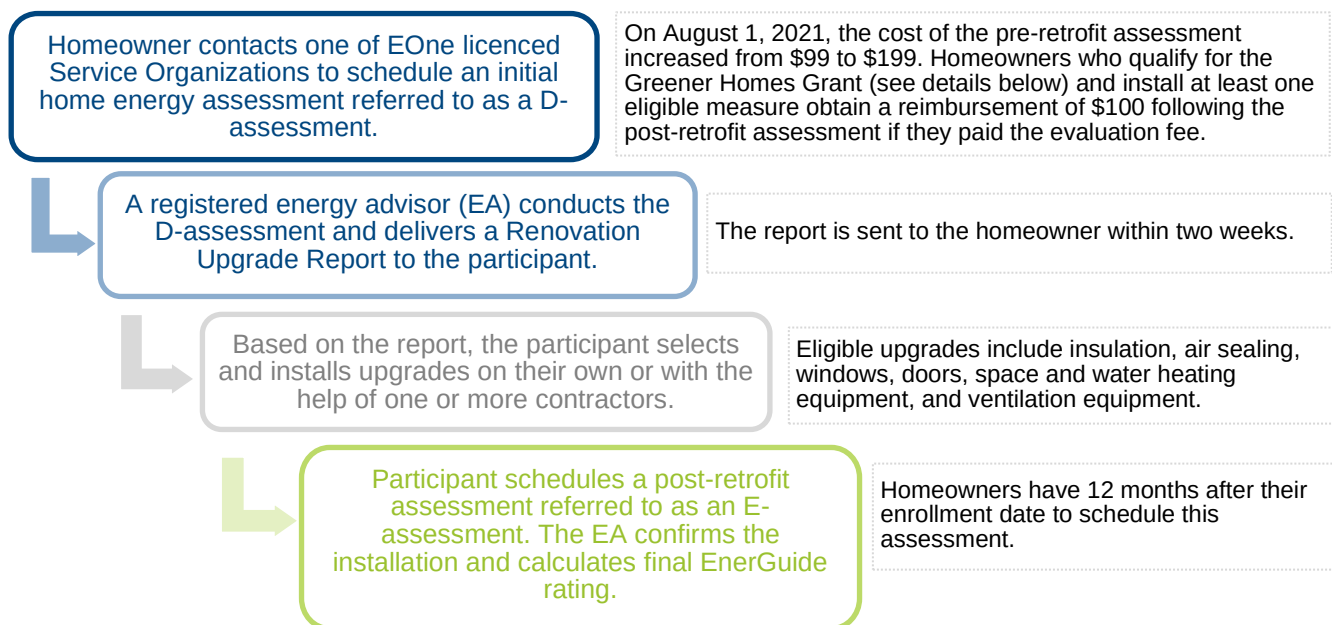
1 HEA OVERVIEW

This section describes Home Energy Assessment (HEA), follows up on past evaluation recommendations, and provides an overview of participation history.

1.1 HEA Description

HEA is a home energy evaluation-based program component that encourages homeowners to improve the energy efficiency and comfort of their home by providing them with related information and financial incentives in the form of rebates or low-interest financing. Participants receive a maximum incentive of \$5,000. HEA uses the EnerGuide home evaluation framework and is administered in collaboration with Natural Resources Canada (NRCan). The following figure illustrates the participation process along with details about the program component.

Figure 11: HEA Participation Process Summary



Through the addition of funds from the Low Carbon Economy Fund (LCEF) in July 2018 and from the province of Nova Scotia in October 2019, HEA offers the same services to non-electrically heated homes. This report presents the evaluation results for electrical measures only.

In 2020, EOne launched the Klondike pilot that involved enhanced incentives, awareness and, in some cases, new measures under EOne's existing services to homes and businesses serviced by the Klondike electrical substation. As part of the Klondike pilot, HEA increased incentives for heat pumps, biomass equipment, and domestic hot water (DHW) equipment. Demand reduction measures were also introduced in the form of electric thermal storage (ETS) units, three-element water heaters, and DHW heater timers. ETS and DHW heater timer incentives have since been made available to homeowners province wide. The Klondike pilot ended in March 2021, resulting in only a few participants taking part in this pilot in 2021.

In May 2021, the federal government announced the launch of the Canada Greener Homes Grant. The initiative offers grants of up to \$5,000 to help homeowners implement energy efficiency retrofits in their primary residence. In Nova Scotia, homeowners will have to register under HEA to receive this grant. To qualify, homeowners must verify that their home meets program eligibility requirements and have obtained a pre-retrofit assessment on or after April 1, 2020. Homeowners need to complete at least one of the retrofits that is both eligible and recommended in the assessment report to receive a federal grant. Only qualifying measures implemented on or after December 1, 2020, are eligible for rebates.

Due to public health and government directives regarding the COVID-19 pandemic, all in-home activities related to HEA were suspended in April and May 2021. All program activities were carried out as usual for the rest of the year, but the impacts of COVID-19 on HEA lingered in the form of some customers not wanting contractors in their homes and supply chain constraints that slowed home upgrades.

HEA aimed to achieve 5.5 GWh in net electrical energy savings and 2.5 MW in net peak demand savings at the generator in 2021.

1.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated HEA in previous years and issued improvement recommendations. Table 10 below provides a summary of the implementation status of each recommendation presented in the Executive Summary section of the 2020 Evaluation Report as well as past recommendations that have been carried forward.

The Evaluator notes that one recommendation out of the six listed has been partially implemented and most others are planned to be implemented in 2022.

Table 10: Implementation Status of Past Recommendations for HEA

#	Past Recommendations	Status	Comments
2018 HEA-R1	Conduct a billing analysis to review the overestimation ratio (OR) when a sufficient participant sample becomes available.	Deferred	A comprehensive evaluation, including a billing analysis, will be performed in 2022 to update overestimation ratios. Initially planned for 2020, this activity has been deferred to 2022 due to impacts from the COVID-19 pandemic and to allow for a sufficient sample size of version 11 HOT2000 participants.
2019 HEA-R1	Maximize the potential for deeper savings per home by encouraging EAs to recommend measures with high savings potential.	In Progress	EOne will investigate ways of encouraging EAs to recommend measures with high energy savings potential beyond those in which participants are interested. EOne will also consider opportunities to increase participant awareness about energy efficiency and its benefits. EOne is currently focused on working with EAs on elements of program delivery in light of ongoing COVID-19 impacts.
2019 HEA-R2	Develop and document a long-term strategy to improve contractor engagement with HEA.	Deferred	EOne will develop a strategy to engage contractors and educate them on the HEA program. EOne is currently focused on elements of program delivery in light of ongoing COVID-19 impacts. EOne expects strategy development to be completed in 2022.
2019 HEA-R3	Improve participant understanding of incentive levels.	Deferred	EOne will develop a strategy to improve participant understanding of incentive levels and customer feedback compilation. EOne is currently focused on elements of program delivery in light of ongoing COVID-19 impacts. With the launch of the Greener Homes Grant, EOne also plans on updating the HEA rebate guide, website, and other communication tools. EOne expects this recommendation to be implemented at the same time as these upcoming updates in 2022.
2020 HEA-R1	Update the unconverted D assessment spillover calculation assumptions to reflect the current participation mix and obtain more representative results.	Deferred	EOne will conduct data collection to update the unconverted D assessment spillover calculation. EOne has deferred implementation to 2022 due to impacts from the COVID-19 pandemic and limitations to conducting on-site visits. The launch of the Greener Homes Grant also resulted in resources not being available to carry out this assessment in 2021.
2020 HEA-R2	Consider tracking the parameters of heat pumps installed through HEA to increase the accuracy of the new heat pump peak demand savings calculation.	Partially Complete	EOne has updated heat pump information for 2021 projects using information from HOT2000 and is clarifying HOT2000 procedures for EAs to ensure this information is consistently tracked and shared with EOne moving forward. The tracked heat pump specifications do not, however, correspond to the ones required to perform the demand savings calculations. This information was corrected by the Evaluator during the tracking sheet audit although EOne should ensure that the right heat pump specifications are tracked going forward.

1.3 Participation History

As presented in Figure 12 below, 961 participants completed a project under HEA in 2021, representing an 8% decrease in participation compared to 2020. The number of participants refers to those participants whose projects generated electrical savings regardless of whether their homes are primarily electrically heated.

Figure 12 illustrates a slight decrease of 9% in average savings per participant compared to 2020. A decrease in average savings per participant is observed since HEA is open to both electrically and non-electrically heated homes. Typically, participants who generate both electrical and non-electrical savings have less electrical savings than homes with electrical savings only. Space heating being the main source of savings under HEA, having more non-electrically heated homes under HEA reduces the average potential electrical savings per participant. However, the proportion of DSM participants generating both non-electrical savings and electrical savings seems to have stabilized in 2021 (representing 51% compared to 48% in 2020), so the decrease in average savings per participant is less significant than it was in 2020 compared to 2019 (36%).

Figure 12: Overview of HEA Participation, 2012-2021

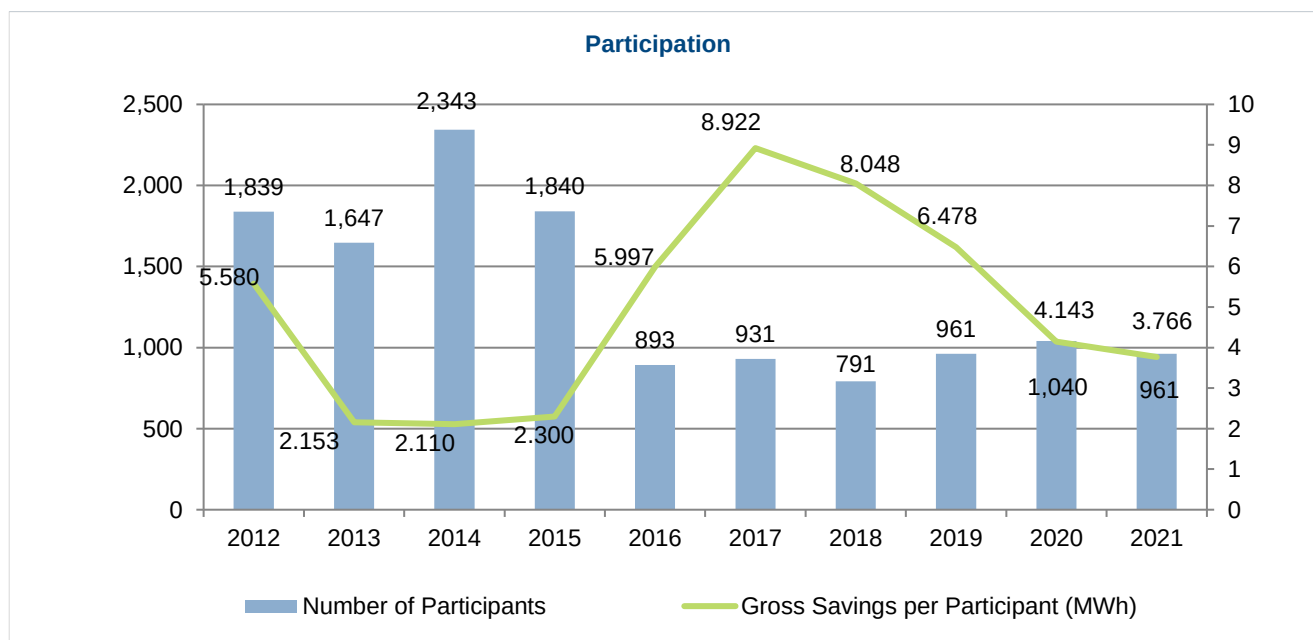
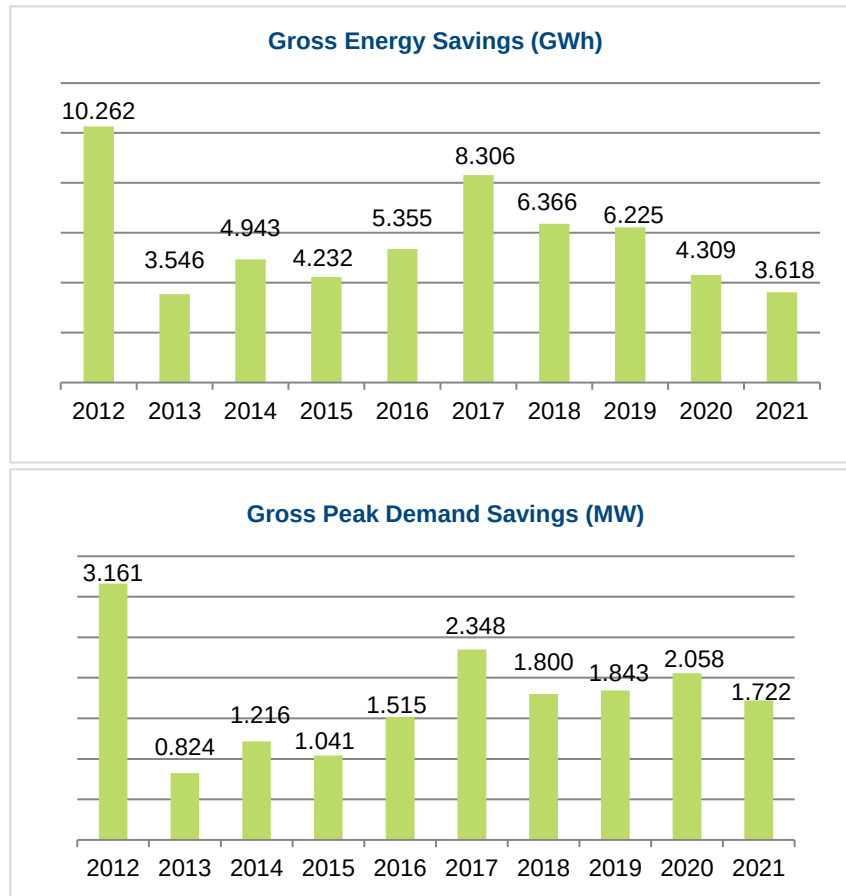


Figure 13 below provides an overview of the evolution of HEA gross energy and peak demand savings from 2012 to 2021. In 2021, HEA achieved 3.618 GWh in gross electrical energy savings and 1.722 MW in gross peak demand savings. A decrease of 16% was observed for both gross energy savings and peak demand savings compared to 2020.

Figure 13: Evolution of HEA Gross Savings, 2012-2021



2 HEA EVALUATION APPROACH

The 2021 HEA evaluation comprised a condensed impact evaluation. The main objective of the 2021 HEA evaluation was as follows:

- › Calculate gross and net HEA results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided greenhouse gas (GHG) emissions²

The Evaluator identified key research questions aimed at achieving the objectives. Table 11 outlines the evaluation objectives and maps them to the Evaluator's research questions, methods, and sample sizes (n). Each method is described further below.

Table 11: 2021 HEA Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › Have the savings been correctly and consistently calculated by applying the correct formulas and overestimation ratios (ORs) for heating and building envelope measures? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Measure Assessment update › Savings review calculation › Calculations using evaluation results
Calculate net results	› What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What are the net avoided GHG emissions in CO₂ eq for HEA?	› Use of net-to-gross ratio (NTGR) results from the 2020 participant survey › Calculations using evaluation results › GHG emission reduction calculations

Tracking Sheet Audit

Prior to conducting the savings calculation review, the Evaluator performed an audit of the final 2021 tracking sheet to ensure it was complete and the entered data were consistent. The detailed protocol used for the tracking sheet audit and the results obtained are presented in Appendix I.

Calculations Using Evaluation Results

Building on all the above methods and collected data, the Evaluator calculated the first-year and lifetime energy and peak demand savings as per the calculation methodology presented in Section 3 below.

² First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

GHG Emission Reduction Calculations

To obtain net avoided GHG emissions in CO₂ eq for HEA, the Evaluator multiplied the net energy savings by the latest Nova Scotia-specific factor of GHG emissions generated by electricity production. This factor was established using NS Power data.

3 HEA IMPACT EVALUATION

The objectives of the 2021 HEA impact evaluation were to determine gross and net electrical energy and peak demand savings, annually avoided GHG emissions, as well as effective useful life (EUL) values and associated lifetime energy savings.

3.1 Tracking Sheet Audit

To ensure program component results were reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix I. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

Most of the corrections made by the Evaluator were related to savings calculations notably to correct for prescriptive measures savings that had been overlooked as well as adjust both capping errors³ and Green Heat and EPI savings deduction values. The most significant correction relates to the heat pump demand savings calculation for which the Evaluator had to replace the tracked heat pump specifications for those relevant to this calculation.

The Evaluator notes that the corrections applied during the 2021 tracking sheet audit are similar to those made during the 2020 tracking sheet audit. The increasing size and complexity of the tracking sheet, mainly due to the changes made to HEA in the last few years, such as the new demand savings calculation approach, make manipulations difficult for both EOne and the Evaluator and increase the risk of errors. A reorganization of the tracking sheet is strongly recommended, especially in the context where the HEA tracking sheet will be converted into a new data management system and integrate new data for the Canada Greener Homes Grant.

3.2 Gross Savings

For HEA, gross savings correspond to the change in energy consumption resulting from measures implemented by HEA participants regardless of their reasons for participating.⁴ As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the installation rates, unitary energy and peak demand savings values, and interactive effects factors and applied the overestimation ratios (ORs) used to adjust modelled energy consumption to calculate space heating savings. The Evaluator also assessed the EUL values for HEA measures as part of Measure Assessment activities.

³ This term signifies changing negative values to zero.

⁴ Definition adapted from: National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

3.2.1 Installation Rates

Installation rates represent the proportion of products recorded in the tracking sheet that remain installed in participants' homes. Based on the 2020-2022 Measure Assessment, installation rates for all HEA measures are estimated at 100% due to their relatively high costs.

3.2.2 Energy Savings

Space Heating Energy Savings

The electrical energy savings for building envelope measures and space heating equipment (referred to as space heating savings) were calculated using the equation below.

$$\begin{aligned} \text{Gross Space Heating Savings (kWh)} = & \\ & \frac{[(Elec\_Heating_D(MJ) \times (1 - OR_D)) - (Elec\_Heating_E(MJ) \times (1 - OR_E))]}{3.6 \text{ MJ/kWh}} \\ & + \text{Non-modelled Space Heating Energy Savings (kWh)} \end{aligned}$$

Where:

- › $Elec\_Heating_D$ and $Elec\_Heating_E$ correspond to electrical space heating consumption levels during the D and E assessments respectively.
- › OR_D and OR_E correspond to the overestimation ratios used to adjust modelled energy consumption according to the space heating system in place during the D and E assessments respectively.
- › Non-modelled energy savings correspond to the electrical savings associated with the space heating measures that are not modelled in HOT2000, namely wood and pellet stoves, wood and pellet boilers and furnaces, as well as solar air equipment.

Overestimation Ratio Values

The savings calculation is mainly based on the difference (reduction) between D and E assessment electrical space heating consumption levels obtained in HOT2000, both of which were adjusted with an OR. The ORs were drawn from billing analyses conducted during the 2015 and 2018 HEA evaluations. The 2018 evaluation established distinct ORs depending on the space heating system in place. Table 12 presents the OR established for each scenario. The Evaluator considered these OR values to be still valid to adjust the modelled energy consumption of HEA participants. These ORs are expected to be updated next year to better represent HOT2000 version 11 changes, as almost all participants now use this version of the software.

Table 12: 2021 HEA Overestimation Ratio Values

Scenario	OR _D Assessment		OR _E Assessment	
	Tracked	Evaluated	Tracked	Evaluated
A participant who registered with a heat pump	0%	No change	0%	No change
A participant who registered without a heat pump and who did not install one	19%	No change	19%	No change
A participant who registered without a heat pump and then had one installed	19%	No change	0%	No change

Unitary Energy Savings Values for Non-modelled Space Heating Measures

Wood, pellet, and solar air space heating equipment is not modelled in HOT2000. Instead, energy savings are calculated based on unitary energy savings values. The detailed savings calculations are presented in the 2020-2022 Measure Assessment.

Table 13 below lists the tracked and evaluated unitary energy savings values for each non-modelled space heating measure implemented through HEA in 2021. As indicated, no changes were made to the tracked savings in 2021. Moreover, since no solar air equipment was installed under HEA in 2021, no unitary savings value was established for that measure.

**Table 13: 2021 HEA Tracked and Evaluated Unitary Energy Savings
for Non-modelled Space Heating Measures**

Measure	Tracked Savings [kWh/year]	Evaluated Savings [kWh/year]
Non-modelled Space Heating		
Wood Stove with Electric Resistance Baseline	10,443	No change
Wood Stove with Heat Pump Baseline	10,443 / Heat Pump Annual Coefficient of Performance (COP)	No change
Pellet Stove with Electric Resistance Baseline	8,959	No change
Pellet Stove with Heat Pump Baseline	8,959 / Heat Pump Annual COP	No change
Wood Furnace/Boiler with Electric Resistance Baseline	13,804 / Heat Pump Annual COP	No change
Wood Furnace/Boiler with Heat Pump Baseline		No change
Pellet Furnace/Boiler with Electric Resistance Baseline	13,765 / Heat Pump Annual COP	No change
Pellet Furnace/Boiler with Heat Pump Baseline		No change
Solar Air Equipment	N/A	N/A

Domestic Hot Water Energy Savings

Savings for DHW measures are calculated using a unitary savings value specific to each type of measure implemented. The unitary savings values were favoured over the simulation results from HOT2000 to ensure more accurate estimates of the energy savings associated with DHW measures. More precisely, the ORs for the values generated by the HOT2000 software were calculated using only space heating consumption values and, thus, could not be used to model DHW energy consumption.

Unitary Energy Savings Values for DHW Measures

Table 14 below lists the tracked and evaluated unitary energy savings values for each DHW measure implemented through HEA in 2021. The detailed savings calculations are presented in the 2020-2022 Measure Assessment. No changes were made to tracked savings in 2021.

Table 14: 2021 HEA Tracked and Evaluated Unitary Energy Savings for DHW Measures

Measure	Tracked Savings [kWh/year]	Evaluated Savings [kWh/year]
DHW Heating		
Drain Water Heat Recovery	805	No change
Solar DHW	2,736	No change
Heat Pump Water Heater – with Electric Resistance Baseline	865	No change
Heat Pump Water Heater – with Heat Pump Baseline	1,360	No change

As for the demand reduction measures introduced in HEA in 2021, only peak demand savings are calculated and the results are presented in Subsection 3.2.3 below.

Reporting Requirements

HEA incentives originate from two sources of funding and are thus reported to two different parties via the 2021 DSM evaluation and the 2021/22 PNS evaluation reports. The DSM evaluation is focused on reporting electrical savings achieved with electrical DSM investments, while the PNS evaluation is focused on energy savings achieved with government funding regardless of the type of fuel. To avoid double counting and determine the most appropriate way to report the associated savings, equations for each possible scenario were developed. The equations and their rationales are presented in Appendix II. The formulas were updated in 2019 to better reflect both the energy savings associated to fuel switching (i.e. from fossil fuel space heating energy sources to electrical heat pumps, wood or pellet stoves, or furnaces) and the distribution of savings between DSM-funded and PNS-funded programs for households that use multiple energy sources. The formulas established in the 2019 evaluation remained valid for the 2021 evaluation.

3.2.3 Peak Demand Savings

Peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The projected electricity demand peak period in Nova Scotia is defined as the coldest days (with an on-peak temperature estimated at -15 °C) between 5 p.m. and 7 p.m. in the months of December to February on non-holiday weekdays.

Space Heating Peak Demand Savings

For space heating measures modelled in HOT2000, peak demand savings calculations are obtained using a peak demand-to-energy ratio of 0.283 MW/GWh. This ratio (RES-Elect Space Heat&Cool) was set by Navigant in the 2016-2018 DSM Plan and was established based on the modelled system coincident peak demand savings and energy savings for a projected deployment of measures. Navigant used local data to establish the ratio. The Evaluator considered that the approach used by Navigant to establish the peak demand-to-energy ratio was still valid and was therefore used to estimate peak demand savings.

Starting in 2020, an exception was made for mini-split heat pumps for which unitary peak demand savings were calculated separately. In 2020, mini-split heat pump unitary peak demand savings were established by multiplying the average unitary peak demand savings per capacity obtained from the mini-split heat pump measures installed under Green Heat by the capacity of each system installed under HEA. Following a recommendation in the 2020 evaluation report, EOne started tracking the parameters of heat pumps installed through HEA to increase the accuracy of the new mini-split heat pump peak demand savings calculation and to match the calculation approach used for this type of measure in Green Heat. As a result, mini-split heat pump peak demand savings were calculated based on their tracked specifications as follows:

$$\text{Mini – Split Heat Pump Peak Demand Savings}_w = \frac{1,000}{3.412} \times HC_{min} \times \left(\frac{1}{COP_{base\_min}} - \frac{1}{COP_{ee\_min}} \right)$$

The parameters used in this equation are defined in Table 15 below.

Table 15: Unitary Peak Demand Savings Values for Space Heating Mini-split Heat Pumps

Variable	Symbol	Value
Rated heating capacity of the new heat pump at outdoor air temperature of -15 °C [kBTU/h]	HC_{min}	Specification data for each installed system
Coefficient of performance of the assumed baseline equipment (electric resistance) at -15 °C [kW/kW]	COP_{base_min}	1
Coefficient of performance of the new heat pump at -15 °C [kW/kW]	COP_{ee_min}	Specification data for each installed system
Conversion factor [BTU/W·h]	3.412	3.412
Conversion factor [W/kW]	1,000	1,000

For space heating measures that are not modelled in HOT2000, specific peak demand savings values were used for the 2021 evaluation (instead of applying a peak demand-to-energy ratio) to be consistent with Green Heat. The detailed calculations are presented in the 2020-2022 Measure Assessment.

Domestic Hot Water Peak Demand Savings

For DHW measures, the Evaluator used a peak demand-to-energy ratio of 0.162 MW/GWh, also obtained from the Navigant 2016-2018 DSM Plan, to develop unitary peak demand savings values. The peak demand-to-energy ratio and the resulting unitary peak demand savings are presented in the 2020-2022 Measure Assessment.

Demand Reduction Measures

As for demand reduction measures such as electric thermal storage units, three-element water heaters, and DHW heater timers, separate peak demand savings values were established. Their detailed calculations are presented in the 2020-2022 Measure Assessment.

Table 16 summarizes how the tracked and evaluated peak demand savings values were established for each category of measure installed through HEA in 2021.

Table 16: 2021 HEA Tracked and Evaluated Peak Demand Savings

Measure	Tracked Peak Demand Savings [W]	Evaluated Peak Demand Savings [W]
Space Heating		
Heat Pump Measures	Calculation based on specification data for each installed system	
Other Modelled Space Heating Measures*	$\left(\frac{[(Elec\_Heating_D(MJ) \times (1 - OR_D)) - (Elec\_Heating_E(MJ) \times (1 - OR_E))]}{3.6 \frac{MJ}{kWh}} - Heat\ Pump\ Measure\ Energy\ Savings\ (kWh) \right) \times 0.283 \frac{W}{kWh}$	
Wood Stove with Electric Resistance Baseline	4,000	No change
Wood Stove with ASHP Baseline	4,000	No change
Pellet Stove with Electric Resistance Baseline	4,000	No change
Pellet Stove with ASHP Baseline	4,000	No change
Wood Furnace/Boiler with Electric Resistance Baseline	7,660	No change
Wood Furnace/Boiler with ASHP Baseline	7,660	No change
Pellet Furnace/Boiler with Electric Resistance Baseline	7,750	No change
Pellet Furnace/Boiler with ASHP Baseline	7,750	No change
Solar Air Equipment	N/A	
Water Heating		
Drain Water Heat Recovery (DWHR)	130	No change
Solar Domestic Hot Water	0	No change
Heat Pump Water Heater – with Electric Resistance Baseline	140	No change
Heat Pump Water Heater – with Heat Pump Baseline	220	No change
Demand Reduction		
Electric Thermal Storage	Maximum Storage Capacity in 8 Hours / 16 Hours	No change
Three-element Water Heater	0.200	No change
DHW Heater Timer	0.500	No change
*Space heating heat pump energy savings are calculated using unitary savings values of 0.179 kWh/Btu/h and 0.060 kWh/Btu/h for fully and partially electrically heated households respectively.		

3.2.4 Interactive Effects

In a home, interactive effects occur when the implementation of energy efficiency measures has an impact on the energy consumption of other elements such as heating and cooling. Since HEA space heating measures target heating and cooling loads directly, the impact of these measures on heating and cooling is considered in the unitary savings. Therefore, no additional interactive effects factors were applied to the savings of these measures. As for water heating measures, interactive effects are considered to be nil with the exception of heat pump water heaters (HPWHs). For HPWH measures, interactive effects are already included in the engineering equation used to calculate the unitary savings value. Therefore, no additional interactive effects factor was applied to HPWH savings.

3.2.5 Effective Useful Life

As part of 2020-2022 Measure Assessment activities, the Evaluator reviewed the EUL values used in the calculation of electrical energy savings that are expected to persist over time. The EUL values established in the 2019 evaluation remain valid for the 2021 evaluation for water heating measures, although they were revised for space heating measures due to the evolution of the distribution of implemented measures.

Table 17 below summarizes the tracked and revised equivalent EUL values as well as the evaluated gross lifetime unitary savings. The revised equivalent EUL values are applied to the gross and net first-year electrical energy savings of each measure to obtain gross and net lifetime electrical energy savings. As a result, the weighted average EUL values of gross and net savings differ (see Subsections 3.2.6 and 3.3 below).

Table 17: 2021 HEA Equivalent Effective Useful Life Values

Measure	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]	Evaluated Gross Lifetime Unitary Savings [kWh]
Space Heating			
Building Envelope Measures	20	21	N/A
Space Heating Equipment			
Water Heating			
Drain Water Heat Recovery Equipment	20	No change	16,100
Solar Domestic Hot Water Systems	20	No change	54,720
Heat Pump Water Heater– with Electrical Baseboard Baseline	10	No change	8,650
Heat Pump Water Heater – with Heat Pump Baseline	10	No change	13,600

3.2.6 Evaluated Gross Savings

The annual gross savings for each category of measure installed through HEA in 2021 are listed in Table 18 below. Overall, total gross electrical energy and peak demand savings amounted to 3.618 GWh and 1.722 MW respectively at the generator,⁵ which represent 75.228 GWh in lifetime electrical energy savings. As a result, the weighted average EUL value for gross energy savings is 20.8 years.

The gross savings at the generator were estimated by using a line loss factor of 1.095 and 1.147 for energy and peak demand savings respectively. The line loss factors were updated for the purposes of the 2019 evaluation, and they correspond to the values submitted to the UARB as part of the 2014 Cost of Service Study Progress Update.⁶

⁵ The gross savings include 0.023 GWh and 0.025 MW generated by the Klondike pilot.

⁶ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 18: Evaluated 2021 HEA Gross Energy and Peak Demand Savings

Measure Category	Space Heating*	DWHR	Solar DHW	HPWH – Electric Resistance Baseline	HPWH – Heat Pump Baseline
Number of Participants/Units	961	1	1	0	2
Evaluated Energy Savings					
Unitary Energy Savings (kWh)	-	805	2,736	865	1,360
Gross Energy Savings Without Overestimation Ratio (OR) – at the Meter (GWh)	4.234	0.001	0.003	0.000	0.003
Gross Energy Savings with OR – at the Meter (GWh)	3.299	0.001	0.003	0.000	0.003
Line Loss Factor	1.095	1.095	1.095	1.095	1.095
Gross Energy Savings with OR – at the Generator (GWh)	3.612	0.001	0.003	0.000	0.003
Effective Useful Life (years)	20.8	20	20	10	10
Gross Lifetime Energy Savings – at the Generator (GWh)	75.121	0.018	0.060	0.000	0.030
Peak Demand Savings					
Unitary Peak Demand Savings Value (W)	-	130	0	140	220
Gross Peak Demand Savings – at the Meter (MW)	1.469	0.000	0.000	0.000	0.000
Line Loss Factor	1.147	1.147	1.147	1.147	1.147
Gross Peak Demand Savings – at the Generator (MW)	1.684	0.00	-	-	0.001
*Space heating includes building envelope and space heating equipment, including wood or pellet stoves, wood or pellet boilers/furnaces, and solar air equipment that are not modelled in HOT2000.					

Evaluated 2021 HEA Gross Energy and Peak Demand Savings (Continued)

Measure Category	Electric Thermal Storage	Three-element Water Heaters	DHW Heater Timers	Total
Number of Participants/Units	16	0	1	961
Evaluated Energy Savings				
Unitary Energy Savings (kWh)	N/A	N/A	N/A	-
Gross Energy Savings Without OR – at the Meter (GWh)	N/A	N/A	N/A	4.240
Gross Energy Savings with OR – at the Meter (GWh)	N/A	N/A	N/A	3.305
Line Loss Factor	1.095	1.095	1.095	1.095
Gross Energy Savings with OR – at the Generator (GWh)	N/A	N/A	N/A	3.618
Effective Useful Life (years)	18	12	15	20.8
Gross Lifetime Energy Savings – at the Generator (GWh)	N/A	N/A	N/A	75.228
Peak Demand Savings				
Unitary Peak Demand Savings Value (W)	-	0.200	0.500	
Gross Peak Demand Savings – at the Meter (MW)	0.031	0.000	0.001	1.502
Line Loss Factor	1.147	1.147	1.147	1.147
Gross Peak Demand Savings – at the Generator (MW)	0.036	-	0.001	1.722

3.3 Net Savings

The Evaluator determined net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the net-to-gross ratio (NTGR). In the case of HEA, the NTGR is established considering the effects, namely free-ridership and participant spillover that positively or negatively affect energy savings. In addition to the NTGR, unconverted D assessment spillover savings as well as Green Heat and EPI savings deductions are also accounted for in the net savings calculation.

3.3.1 Free-ridership

For HEA, free-ridership occurs when participants would have implemented energy efficiency upgrades and measures in the absence of the program component. Free-ridership was assessed in 2020 through a participant survey with HEA participants. Since no data-collection activities aimed at updating the free-ridership level were conducted, the 2020 level was used for the 2021 evaluation. Table 19 below outlines the measured free-ridership obtained in 2020.

Table 19: HEA Average Free-ridership Level

Average Free-ridership Level	Sample Size	Population Size	Margin of Error
26%	70	1,040	3.4%

3.3.2 Participant Spillover

For HEA, participant spillover occurs when participants implement additional energy efficiency measures recommended in their initial energy assessments after their participation in the program component, i.e. after having completed the final energy assessment, due to the influence of having participated in the program component and without receiving any additional support from the program component. Similarly to free-ridership, no data collection aimed at updating the 2020 participant spillover level was conducted in 2021. Therefore, the 2020 level was used as part of this evaluation. Table 20 outlines the measured participant spillover level obtained in 2020.

Table 20: HEA Average Participant Spillover Level

Average Participant Spillover Level	Sample Size	Population Size	Margin of Error
1%	70	1,040	1.3%

3.3.3 Net-to-gross Ratio Calculation

The NTGR is calculated using the following equation.

$$NTGR = (1 - \% \text{ Free-ridership} + \% \text{ Participant Spillover})$$

Based on the free-ridership and spillover levels established for HEA, the NTGR value was estimated at 0.75 as presented in Table 21.

Table 21: 2021 HEA NTGR

Free-ridership	Participant Spillover	NTGR
26%	1%	0.75

3.3.4 Unconverted Assessment Spillover

The unconverted D assessment savings spillover effect corresponds to the savings associated with those measures implemented by participants who did not complete an E assessment by the end of the allocated 12-month period (referred to as expired participants or unconverted D assessment participants). Those savings are added to gross savings as a form of spillover. Table 22 below outlines the parameters for unconverted D assessment spillover.

Based on a survey conducted in 2016, the Evaluator determined that 54% of unconverted participants installed at least one upgrade. The associated electrical energy savings that were influenced by EOne were determined to be 2,283 kWh per participant based on site visit results and HOT2000 simulations. The methodology and the parameters used in the 2016 evaluation were still considered appropriate for the 2021 evaluation. However, the higher number of non-electrically heated houses participating in HEA in recent years might affect the reliability of the current parameters, notably the average electrical energy savings that were influenced by EOne.

In total, 600 unconverted D assessment participants were identified in 2021. The total unconverted D assessment spillover savings were calculated by multiplying both the total number of unconverted D participants in 2021 by the proportion of participants who completed at least one upgrade (54%) and the associated savings (2,283 kWh). This resulted in unconverted D assessment spillover energy and peak demand savings estimated at 0.740 GWh and 0.209 MW at the meter for HEA. To better reflect what unconverted D assessment spillover savings represent and how they were tracked, the Evaluator decided to present the spillover savings in energy units rather than a percentage of annual gross savings.

Table 22: 2021 HEA Unconverted D Assessment Spillover

2021 Results	
Total Number of Unconverted D Assessment Participants	600
Ratio of Unconverted D Assessment Participants Who Implemented at Least One Measure	54%
Total Number of Unconverted D Assessment Participants Who Implemented at Least One Measure	324
Average Electrical Savings per Participant in kWh (with influence from EOne)	2,283
Total Unconverted D Assessment Spillover Energy Savings – at the Meter (GWh)	0.740
Demand-to-energy Ratio (MW/GWh)	0.283
Total Unconverted D Assessment Spillover Peak Demand Savings – at the Meter (MW)	0.209

3.3.5 Green Heat and EPI Savings Deductions

Several measures are offered under both HEA and Green Heat. In addition, Efficient Product Installation (EPI) introduced an air sealing pilot in 2019. To ensure that energy savings are not claimed twice for the same upgrade, the net electrical savings that were already claimed under Green Heat or EPI are deducted from HEA net electrical savings for those participants who participated in both HEA and Green Heat/EPI during the same period.

3.3.6 Evaluated Net Savings

Net savings are defined as the energy use reductions specifically attributable to HEA. Net savings were calculated by applying the NTGR value, adding unconverted D assessment spillover savings, and subtracting Green Heat and EPI savings, as illustrated in the following equation:

$$\text{Net Savings} = \text{Gross Savings} \times \text{NTGR} + \text{Unconverted D Assessment Spillover Savings} - \text{Green Heat Net Savings Deductions} - \text{EPI Net Savings Deductions}$$

This equation was used to calculate both electrical energy savings and peak demand savings.

The 2021 net energy savings for HEA were estimated at 3.481 GWh at the generator and the peak demand savings at 1.495 MW at the generator, as outlined in Table 23 below.⁷ The net lifetime energy savings were established at 72.399 GWh, which yield a weighted average EUL value of 20.8 years.

⁷ The net savings include 0.022 GWh and 0.024 MW in savings generated by the Klondike pilot.

Table 23: Evaluated 2021 HEA Net Energy and Peak Demand Savings

	Total
Energy Savings	
Gross Energy Savings – at the Meter (GWh)	3.305
NTGR	0.75
Unconverted D Assessment Spillover Energy Savings (GWh)	0.740
Net Energy Savings Without Savings Deductions – at the Meter (GWh)	3.219
Line Loss Factor	1.095
Green Heat and EPI Net Energy Savings Deductions (GWh)	0.043
Net Energy Savings with Savings Deductions – at the Generator (GWh)	3.481
Effective Useful Life (years)	20.8
Net Lifetime Energy Savings – at the Generator (GWh)	72.399
Peak Demand Savings	
Gross Peak Demand Savings – at the Meter (MW)	1.502
NTGR	0.75
Unconverted D Assessment Spillover Peak Demand Savings (MW)	0.209
Net Peak Demand Savings Without Savings Deductions – at the Meter (MW)	1.336
Line Loss Factor	1.147
Net Peak Demand Savings Without Savings Deductions – at the Generator (MW)	1.531
Green Heat and EPI Net Peak Demand Savings Deductions (MW)	0.036
Net Peak Demand Savings – at the Generator (MW)	1.495

As presented in Table 24, applying the Nova Scotia-specific factor⁸ for GHG emissions generated by electricity production to HEA net savings resulted in a total of 2,033 tonnes of annually avoided CO₂ eq.

Table 24: Evaluated 2021 HEA GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	3.481
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	2,033

⁸ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:
 Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),
 Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021
https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

3.4 Realization Rate

Table 25 below compares the energy and peak demand savings established through this evaluation to those calculated in the 2021 tracking sheet. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 100% for energy savings and peak demand savings.

Table 25: Comparison of 2021 HEA Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	3.618	GWh	0.96	3.481	GWh	100%
Evaluation Results	3.618	GWh	0.96	3.481	GWh	
Peak Demand Savings						
Tracked Savings by EOne	1.722	MW	0.87	1.495	MW	100%
Evaluation Results	1.722	MW	0.87	1.495	MW	
*NTGR values in this table include the impacts of unconverted D assessment spillover savings as well as Green Heat and EPI savings deductions. The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by gross savings, which explains why the NTGR values are different from those presented in the above sections.						

The net evaluated energy and peak demand savings determined by the Evaluator were identical to the net results tracked by EOne.

2021 HEA Impact Evaluation Highlights

- › HEA achieved 3.481 GWh in net electrical energy savings and 1.495 MW in net peak demand savings at the generator in 2021.
- › Evaluated net energy and peak demand savings were identical to the tracked results.

4 HEA KEY FINDINGS AND RECOMMENDATIONS

As mentioned previously, the main objectives of the 2021 HEA evaluation were as follows:

- › Calculate gross and net HEA results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided greenhouse gas (GHG) emissions

This section provides the Evaluator's key findings and recommendations in relation to these objectives. The following recommendations are also outlined in Appendix III.

2021 HEA-Finding: HEA net electrical energy and peak demand savings fell short of targets.

HEA achieved 3.481 GWh in net electrical energy savings and 1.495 MW in net peak demand savings at the generator in 2021, thus not attaining the planned net electrical energy savings of 5.53 GWh and net peak demand savings of 2.48 MW.

2021 HEA-Finding: Savings per home continued to decrease.

With 961 participants, the 2021 participation level decreased by 8% compared to 2020 and returned to the same level as in 2019. Gross energy and demand savings also decreased by 16%, which is attributable to not only a decrease in participation, but also the continuous decrease in savings per home. This decrease has been observed since HEA has been open to both electrically and non-electrically heated homes, but this situation seems to have stabilized with only a slight increase in the proportion of DSM participants generating both non-electrical savings and electrical savings from 48% in 2020 to 51% in 2021 and a much less significant drop in the average savings per home (9% observed in 2021 compared to 2020 versus 36% between 2020 and 2019).

2021 HEA-Finding: The HEA tracking sheet is becoming more prone to calculation errors and other mistakes.

The number of HEA tracking sheet fields has expanded a lot over the last few years with such additions as a new demand savings calculation approach. Tracking will further change in 2022 as HEA adapts its tools to co-deliver the federal Greener Homes program in Nova Scotia. Adding to an already extensive tracking tool increases the chances of calculation errors and other mistakes.

2021 HEA-Recommendation 1: Update and simplify the tracking sheet in time for next year's evaluation to minimize risks of calculation errors. For instance, columns could be reorganized to follow the calculations steps from gross savings at meter to net savings at generator in that order. Also, formulas could be simplified by using named variables instead of cell references, and information that is no longer relevant to the calculations could be removed. This should be done alongside the integration of the Canada Greener Homes Grant data and before the conversion into the new data management system.

2021 HEA-Finding: The evaluated energy and peak demand savings were identical to the savings tracked by EOne.

HEA underwent a condensed impact evaluation in 2021. No changes were made by the Evaluator to energy and peak demand savings parameters and calculations, hence resulting in evaluated results that are the same as the tracked values.

5 GREEN HEAT OVERVIEW

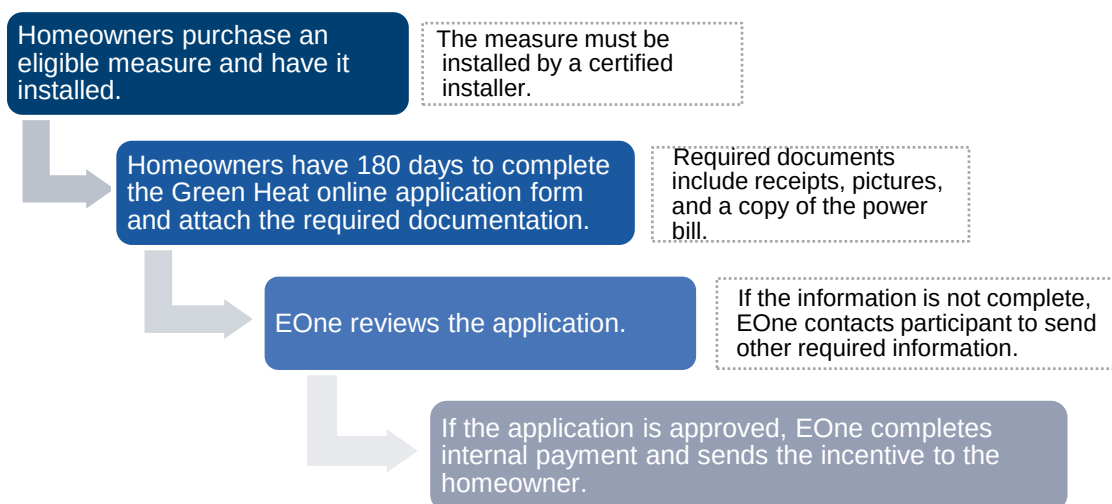
This section describes Green Heat, follows up on past evaluation recommendations, and provides an overview of participation history.

5.1 Green Heat Description

The Heating System Rebates Program, referred to as Green Heat, is aimed at encouraging the installation of energy efficient heating systems as well as heating systems for which fuel is provided from renewable resources in Nova Scotia homes. More specifically, Green Heat provides financial incentives to homeowners for high-efficiency heat pumps, biomass heating systems, solar space and water heating systems, and demand reduction measures.

EOne staff manages and administers Green Heat. Figure 14 outlines the main steps of the Green Heat participation process. In May 2021, a new online application system was implemented for the program component.

Figure 14: Green Heat Participation Process Summary



In addition, EOne works with Nova Scotia Power (NS Power) to cross-promote the on-bill financing option that NS Power offers to customers interested in installing heat pump systems.

In 2020, EOne launched the Klondike pilot that involved enhanced incentives, awareness and, in some cases, new measures under EOne's existing services to homes and businesses serviced by the Klondike electrical substation. As part of the Klondike pilot, Green Heat included increased incentives for most of its existing measures. Demand reduction measures were also introduced in the form of ETS units, three-element water heaters, and DHW heater timers. ETS and DHW heater timer incentives have since been made available to homeowners province wide. The Klondike pilot ended in March 2021, resulting in only a few participants taking part in the pilot in 2021.

In April 2021, the maximum time limit to apply to Green Heat after the purchase and installation of an eligible measure was increased from 90 to 180 days. The eligible model and incentives for three-element water heaters were also updated in April 2021.

Table 26 below summarizes current Green Heat incentives for each type of eligible system.

Table 26: 2021 Green Heat Incentives

Heat Pump	Incentive
Ductless Mini-split Heat Pumps	\$200/Refrigeration Ton
Centrally Ducted Air-source Heat Pumps	\$400/Refrigeration Ton
Air-to-water Heat Pumps	\$400/Refrigeration Ton
Ground-source Heat Pumps	\$500/Refrigeration Ton
Biomass	Incentive
Wood/Pellet Stoves or Fireplace Inserts	\$500/Unit
Wood/Pellet Boilers or Centrally Ducted Forced Air Furnaces	\$1,000/Unit
Solar	Incentive
Solar Thermal: Air Heating	\$400/Unit
Solar Domestic Hot Water (DHW)	\$1,000/Unit
Demand Reduction	Incentive
Electric Thermal Storage (ETS, listed room unit)	\$198-\$1,600/Unit*
Electric Thermal Storage (unlisted room unit)	\$25-\$40/kWh**
Electric Thermal Storage (central system)	\$2,000/Unit
Three-element Water Heaters (replacing electrical DHW)	\$400/Unit
Three-element Water Heaters (replacing oil-fired DHW)	\$650/Unit
DHW Heater Timers	\$20/Unit
* There were ten eligible ETS room units offered through Green Heat. The incentive level varied depending on the model. On October 1st, the incentive levels were raised from \$198-\$1,000 to \$316-\$1,600. ** On October 1st, the incentive level was raised from \$25/kWh to \$40/kWh.	

Since July 2018, through the addition of funds from the Low Carbon Economy Fund (LCEF), Green Heat has offered heating system rebates to non-electrically heated homes. The rebate amounts and criteria remain unchanged whether the home is electrically or non-electrically heated except for demand reduction measures. This report presents the evaluation results for electrical measures only. The savings associated with measures that displace non-electrical energy consumption are reported in the Province of Nova Scotia (PNS) Evaluation Report and are therefore not included herein.

Since the start of the COVID-19 pandemic, Green Heat has not been significantly impacted by public health and government directives. No notable impacts to Green Heat participation due to the COVID-19 pandemic were observed during 2021.

Green Heat was aimed at achieving net electrical energy savings of 5.56 GWh and 5.69 MW in net peak demand savings at the generator in 2021.

5.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated Green Heat in previous years and issued improvement recommendations. Table 27 provides a summary of the implementation status of each recommendation presented in the Executive Summary section of the 2020 Evaluation Report as well as past recommendations that have been carried forward.

Table 27: Implementation Status of Past Recommendations for Green Heat

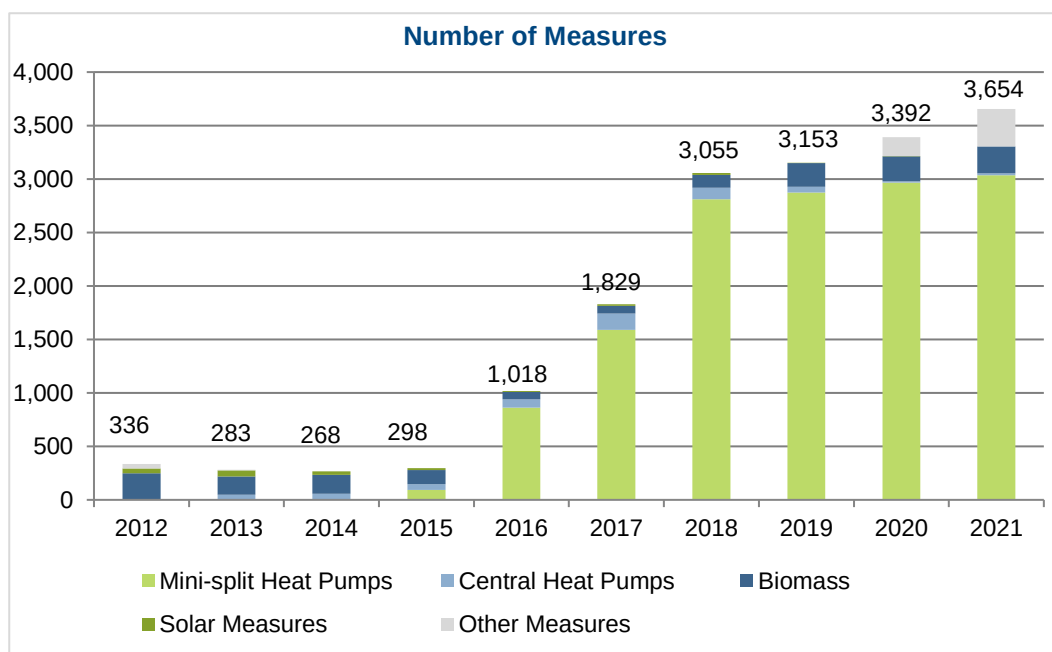
#	Past Recommendations	Status	Comments
2017-GH-R3	Improve the collection of technical information about central air-source heat pumps (CASHPs).	Not Recommended for Action	EOne does not intend, in the near future, to fully implement the Northeast Energy Efficiency Partnership (NEEP) list criteria for ASHPs since it would further reduce the number of models that are currently available and could result in less participation in the program component. Regardless, tracking of model and AHRI numbers has improved. In addition, it should be noted that this recommendation was made at a time when CASHPs were growing in popularity in the program component and represented a larger portion of participation.
2017 GH-R5	Develop a way for potential participants to better understand which CASHPs are eligible.	In Progress	This recommendation is tied to recommendation 2017 GH-R3. Since there are too many CASHP options or combinations, EOne no longer considers developing a list of eligible CASHPs a realistic option. EOne is considering a change in eligibility criteria to align with NRCAN requirements.

5.3 Participation History

In 2021, Green Heat had 3,654 measures installed, which represented an increase of 8% over 2020 levels. As illustrated in Figure 15 below, MSHPs were by far the most installed measure again in 2021 with 3,035 units. Since 2018, the numbers of MSHPs and biomass systems installed through Green Heat have been steady, although with a small increase each year. Conversely, the popularity of CASHPs and solar heating systems has continued to drop each year since 2018, notably without any solar heating systems installed in 2021.

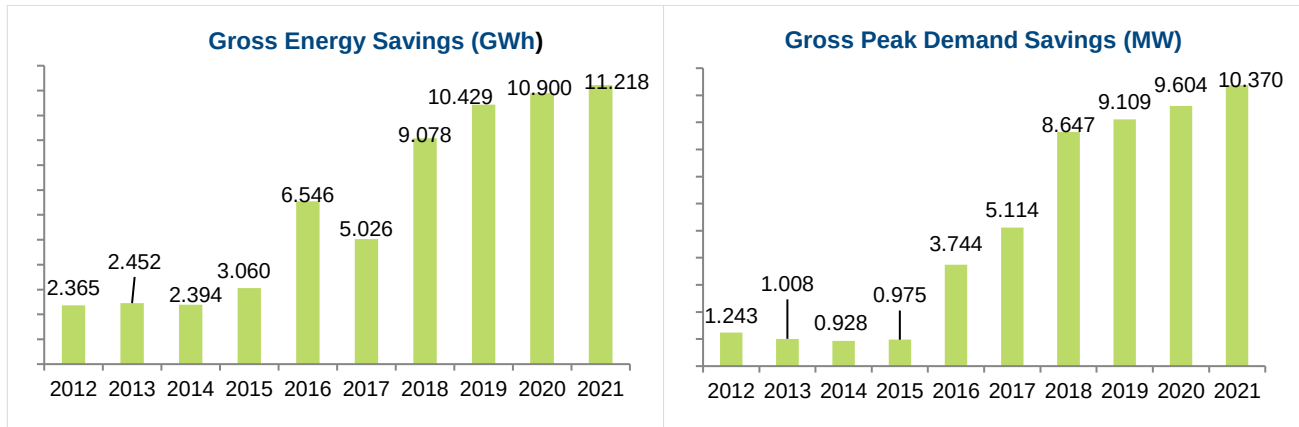
Having been introduced in Green Heat in 2020, demand reduction measures (listed as "Other Measures" in the figure below) continued to gain in popularity with nearly two times more of these measures being installed in 2021 than in 2020, including 235 electric thermal storage units, 71 domestic water heater timers, and 43 three-element water heaters.

Figure 15: Overview of Green Heat Participation, 2012-2021



As indicated in Figure 16, Green Heat achieved its highest savings levels so far with 11.218 GWh in gross energy savings and 10.370 MW in peak demand savings. This is mostly due to the higher number of measures installed, including MSHPs that represented 76% of gross energy savings in 2021 and demand reduction measures that largely contributed to the gross peak demand savings increase.

Figure 16: Evolution of Green Heat Gross Savings, 2012-2021



6 GREEN HEAT EVALUATION APPROACH

The 2021 Green Heat evaluation comprised a condensed impact evaluation and a market evaluation. The main objectives of the evaluation were as follows:

- › Collect information on participant perspectives
- › Calculate gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions⁹
- › Analyze the market evolution of mini-split heat pumps (MSHPs)

The Evaluator identified key research questions aimed at achieving the objectives. Table 28 outlines the evaluation objectives and maps them to the Evaluator's research questions, methods, and sample sizes (n). Each method is described further below.

Table 28: 2021 Green Heat Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Collect information on participant perspectives	› How did participants become aware of Green Heat? › Why did participants want to participate in Green Heat? › How satisfied are participants with Green Heat overall and its aspects?	› Participant survey (n=140)
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › What are the unitary savings for each measure category? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Measure Assessment Update › Calculations using evaluation results
Calculate net results	› What is the Green Heat free-ridership level for 2021? › What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What are the net avoided GHG emissions in CO₂ eq for Green Heat?	› Participant survey (n=140) › Calculations using evaluation results › GHG emission reduction calculations
Analyze the market evolution of MSHPs	› How has the residential MSHP market evolved since 2019?	› Heat pump distributor interviews (n=5) › Market evolution and characterization study

⁹ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

Participant Survey

In October and November 2021, Narrative Research conducted a telephone survey with 140 participants. The average length of the survey was 14 minutes. The survey questionnaire is presented in Appendix IV and the complete survey results are outlined in Appendix V.

Table 29 presents the total number of Green Heat participants and sample sizes as well as the corresponding margins of error at a 90% confidence level for the 2021 telephone survey.

Table 29: 2021 Green Heat Survey Sample Sizes and Margins of Error

Measure	Population	Sample Size	Sampling Margins of Error at 90% Confidence Level
MSHPs	2,902	97	±10.0%
CASHPs and GSHPs*	31	5	±40.8%
Biomass and Solar	253	38	±14.7%
Total	3,186	140	±8.3%
* The sample population for CASHPs and GSHPs included participants from both 2020 and 2021 since the number of participants with these measures was not sufficient to reach a sufficient sample size.			

Heat Pump Distributor Interviews

In November and December 2021, Narrative Research conducted five interviews with distributors who sell and install HVAC products in Nova Scotia to gain deeper understanding of high-efficiency and standard MSHP sales and trends in the market. The guide used for the distributor interviews is presented in Appendix VI.

Tracking Sheet Audit

Prior to performing the savings review, the Evaluator performed an audit of the final 2021 tracking sheet to ensure it was complete and the entered data were consistent. The detailed protocol used for the tracking sheet audit and the results obtained are presented in Appendix VII.

Unitary Savings Review

The Evaluator updated the unitary peak demand savings for CASHPs based on characteristics of the models installed in 2021. The 2020-2022 Measure Assessment¹⁰ was updated accordingly.

¹⁰ The 2020-2022 Measure Assessment is a reference document that provides an in-depth review of all parameters necessary to calculate the annual and lifetime gross energy and peak demand savings of most prescriptive measures and some semi-prescriptive measures offered through EOne's DSM program portfolio. In addition, the Measure Assessment includes effective useful life values for all measures offered in EOne's program portfolio. For the evaluations conducted during the 2020-2022 DSM cycle, the Evaluator refers to the values presented in the 2020-2022 Measure Assessment.

Calculations Using Evaluation Results

Building on all the above methods and collected data, the Evaluator calculated the first-year and lifetime energy and peak demand savings as per the calculation methodology presented in Section 8 below.

GHG Emission Reduction Calculations

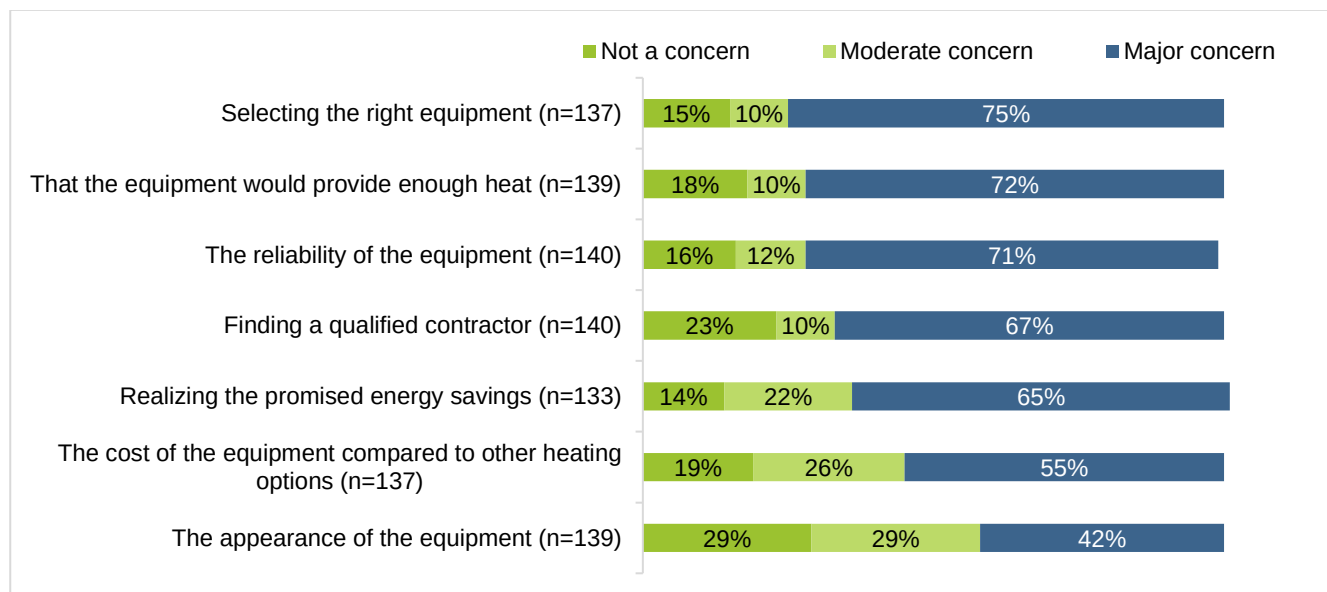
To obtain net avoided GHG emissions in CO₂ eq for Green Heat, the Evaluator multiplied net energy savings by the latest Nova Scotia-specific factor for GHG emissions generated by electricity production. This factor was established using NS Power data.

7 GREEN HEAT PARTICIPANT PERSPECTIVES

Awareness about Green Heat was driven largely by contractors, retailers, or distributors (34%) through word-of-mouth (19%) or online (14%). Sources of awareness are generally consistent with the previous evaluation. The main reasons for participating in Green Heat were to save on energy costs (56%) or to benefit from the rebate offered by ENS (30%). Other reasons provided were to make the home more energy efficient (17%), the environmental aspect (14%), or because they wanted air conditioning (13%).

Participants were primarily concerned with issues related to equipment, such as reliability and selecting the right equipment, when they were first considering the installation of energy efficient home heating equipment. Equipment costs and appearances were less of a concern. These results, which are outlined in Figure 17, are consistent with survey results from past evaluations.

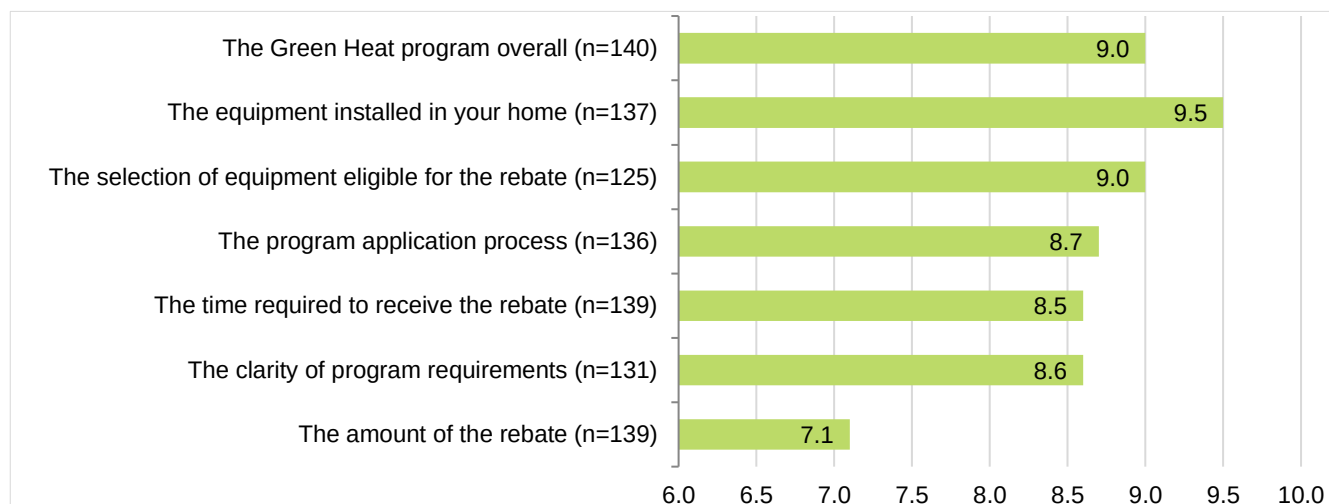
Figure 17: Barriers to the Installation of Energy Efficient Heating Equipment



Note: Ratings on a scale of 1-10, "A major concern" and "Moderate concern" are based on top three and middle three scale options. "Not a concern" is based on the bottom four scale options.

Satisfaction with Green Heat overall was high, with participating households providing an average score of 9.0 on a 10-point scale where 1 means "Not at all satisfied" and 10 means "Completely satisfied". Among the low number of participants who were less satisfied, the main reason reported was that the rebate amount was too low.

As illustrated in Figure 18 below, participants also provided high ratings for the equipment installed, selection of equipment eligible for rebate, program application process, time required to receive the rebate, and clarity of program requirements. There was somewhat less satisfaction with the rebate amount than with the other aspects of the program. Satisfaction levels from the 2021 evaluation were consistent with survey results from previous evaluations, with the exception of satisfaction with the rebate amount, which decreased from a score of 8.2 for 2019 to a score of 7.1 for the 2021 evaluation.

Figure 18: 2021 Participant Satisfaction with Green Heat (10-point Scale)


Note: Mean scores of ratings on a scale of 1 to 10 where 1 means "Not at all satisfied" and 10 means "Completely satisfied".

While many participants (50%) did not offer any recommendations on how to improve Green Heat, some respondents suggested increasing the rebate (24%). Other suggestions were mentioned by four percent or less of respondents.

2021 Green Heat Participant Perspective Highlights

- › Awareness about Green Heat is largely driven by contractors, retailers, and distributors.
- › The primary motivations for participating in Green Heat are to save on energy costs and benefit from the rebate.
- › Participants are mainly concerned with issues related to equipment, such as reliability and selecting the right equipment, when they first consider installing energy efficient home heating equipment.
- › Participants are very satisfied with Green Heat, with the rebate amount receiving somewhat lower satisfaction scores.

8 GREEN HEAT IMPACT EVALUATION

The objectives of the 2021 Green Heat impact evaluation were to determine the gross and net electrical energy and peak demand savings, annually avoided GHG emissions, as well as effective useful life (EUL) values and associated lifetime energy savings.

8.1 Tracking Sheet Audit

To ensure program component results were reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix VII. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

8.2 Gross Savings

For Green Heat, gross savings correspond to the change in energy consumption resulting from actions taken by participants regardless of their reasons for participating.¹¹ For the 2021 evaluation, the Evaluator relied on the values presented in the 2020-2022 Measure Assessment, except for the CASHP unitary peak demand savings value because it was revised based on the characteristics of CASHPs installed through Green Heat in 2021. As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the installation rates, unitary energy and peak demand savings values, and interactive effects factors as well as assessed the EUL values for Green Heat measures.

8.2.1 Installation Rates

Installation rates represent the proportion of measures recorded in the tracking sheet that remain installed in participants' homes. Installation rates for all energy efficient heating systems under Green Heat were estimated at 100% due to their relatively high cost.

8.2.2 Unitary Energy Savings

To establish Green Heat unitary savings, the Evaluator relied on a combination of billing analyses, energy models, engineering algorithms, and literature reviews. The 2020-2022 Measure Assessment provides a detailed description of inputs, references, and unitary savings calculations for all measure categories.

Table 30 further below summarizes the tracked and evaluated energy savings values for each measure installed through Green Heat in 2021.

¹¹ Definition adapted from National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

- › For heat pump measures, considering unitary savings values are established per capacity rather than per unit installed, the savings values per unit of heat pumps installed are presented for informational purposes only. The energy savings of heat pump measures correspond to the total savings obtained by multiplying the savings value per capacity by the capacity of each system installed divided by the number of heat pumps installed.
- › For biomass measures, average unitary energy savings values remained unchanged.
- › Since they are rarely installed, solar measures are not based on unitary savings values. Instead, energy savings are calculated using the RETScreen tool and parameters specific to each system installed. This is the same methodology as in past evaluations.

Table 30: 2021 Green Heat Tracked and Evaluated Unitary Energy Savings

Measure	Tracked Savings per Capacity [kWh/Btu/h]	Evaluated Savings per Capacity [kWh/Btu/h]	Tracked Savings [kWh/year]	Evaluated Savings [kWh/year]
Heat Pumps				
MSHPs – Fully Electrically Heated	0.179	No change	3,092*	No change
MSHPs – Mainly Electrically Heated	0.060	No change	1,040*	No change
CASHPs	0.101	No change	4,282*	No change
GSHPs	N/A	N/A	N/A	N/A
Biomass				
Wood Stoves or Fireplace Inserts with Electric Resistance Baseline	N/A	N/A	10,443	No change
Wood Stoves or Fireplace Inserts with Heat Pump Baseline	N/A	N/A	4,747	No change
Pellet Stoves or Fireplace Inserts with Electric Resistance Baseline	N/A	N/A	8,959	No change
Pellet Stoves or Fireplace Inserts with Heat Pump Baseline	N/A	N/A	4,072	No change
Wood Furnaces/Boilers with Electric Resistance Baseline	N/A	N/A	13,804	No change
Wood Furnaces/Boilers with Heat Pump Baseline	N/A	N/A	6,275	No change
Pellet Furnaces/Boilers with Electric Resistance Baseline	N/A	N/A	13,765	No change
Pellet Furnaces/Boilers with Heat Pump Baseline	N/A	N/A	6,257	No change
Solar				
Solar DHW	N/A	N/A	2,736**	No change
Solar Thermal Air Heating	N/A	N/A	594**	No change
*Presented for information purposes only and corresponding to the total savings obtained by multiplying the savings value per capacity by the capacity of each installed system divided by the number of installed heat pumps.				
**There were no new solar heating projects so the value from the 2020 DSM Evaluation Report was used for the 2021 evaluation.				

8.2.3 Unitary Peak Demand Savings

Peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The projected electricity demand peak period in Nova Scotia is defined as the coldest days (with an on-peak temperature estimated at -15 °C) between 5 p.m. and 7 p.m. in the months of December to February on non-holiday weekdays.

The detailed calculations for the unitary peak demand savings of each measure installed through Green Heat are presented in the 2020-2022 Measure Assessment.

- › For MSHPs and electric thermal storage units, unitary peak demand savings are calculated individually for each system installed. An average value corresponding to the sum of the peak demand savings for each system installed divided by the number of systems is presented for information purposes only.
- › For CASHPs, the average unitary peak demand savings value was revised based on the rated heating capacity and coefficient of performance (COP) at -15 °C of units installed through Green Heat in 2021.
- › For GSHP, biomass, solar, three-element water heater, and DHW heater timer measures, average unitary peak demand savings values remained unchanged.

Table 31 summarizes the tracked and evaluated unitary peak demand savings values for each measure.

Table 31: 2021 Green Heat Unitary Peak Demand Savings

Measure	Tracked Peak Demand Savings [W]	Evaluated Peak Demand Savings [W]
Heat Pumps		
MSHPs – Fully Electrically Heated	2,496*	No change
MSHPs – Mainly Electrically Heated	2,576*	No change
CASHPs	1,328	3,930
GSHPs	N/A	N/A
Biomass		
Wood Stoves or Fireplace Inserts with Electric Resistance Baseline	4,000	No change
Wood Stoves or Fireplace Inserts with Heat Pump Baseline	4,000	No change
Pellet Stoves or Fireplace Inserts with Electric Resistance Baseline	4,000	No change
Pellet Stoves or Fireplace Inserts with Heat Pump Baseline	4,000	No change
Wood Furnaces/Boilers with Electric Resistance Baseline	7,660	No change
Wood Furnaces/Boilers with Heat Pump Baseline	7,660	No change
Pellet Furnaces/Boilers with Electric Resistance Baseline	7,750	No change
Pellet Furnaces/Boilers with Heat Pump Baseline	7,750	No change
Solar		
Solar DHW	0	No change
Solar Thermal Air Heating	N/A	N/A
Demand Reduction		
Electric Thermal Storage	1,185*	No change
Three-element Water Heaters	200	No change
DHW Heater Timers	500	No change
*Presented for information purposes only. The average unitary peak demand savings were calculated based on the sum of the peak demand savings for each system installed divided by the number of systems installed. Peak demand savings were obtained based on specification data for each installed system (see 2020-2022 Measure Assessment for more details).		

8.2.4 Interactive Effects

In a home, interactive effects occur when the implementation of energy efficiency products has an impact on the energy consumption of other elements such as heating and cooling. Since Green Heat high-efficiency heating measures target heating and cooling loads directly, the impact of those measures on heating and cooling is considered in the unitary savings. Therefore, no additional interactive effects factor was applied to the savings of all measures because the interactive effects factors for each measure are assumed to be nil.

8.2.5 Effective Useful Life

As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the EUL values used in the calculations of electrical energy savings that are expected to persist over time. The EUL values established in the 2020 evaluation remain valid for the 2021 evaluation.

Table 32 below summarizes the EUL values as well as the evaluated gross lifetime unitary savings. The equivalent EUL values are applied to the gross and net first-year electrical energy savings of each measure to obtain the gross and net lifetime electrical energy savings. As a result, the weighted average EUL values of gross and net savings differ (see Subsections 8.2.6 and 8.3.3 below).

Table 32: 2021 Green Heat Equivalent Effective Useful Life Values

Measure	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]	Evaluated Gross Lifetime Unitary Savings [kWh]
MSHPs	18	No change	50,356
CASHPs	18	No change	84,383
GSHPs	25	No change	-
Wood and Pellet Stoves or Fireplace Inserts	18	No change	188,044
Wood and Pellet Furnaces/Boilers	18	No change	272,002
Solar DHW and Solar Air Space Heating	20	No change	-
Electric Thermal Storage	18	No change	N/A
Three-element Water Heaters	12	No change	N/A
DHW Heater Timers	15	No change	N/A

8.2.6 Evaluated Gross Savings

The annual gross savings for each category of measure installed through Green Heat in 2021 are listed in Table 33 below. Overall, total gross electrical energy and peak demand savings amounted to 11.218 GWh and 10.370 MW respectively at the generator,¹² which represent 201.923 GWh in lifetime electrical energy savings. As a result, the weighted average EUL value for gross energy savings is 18.0 years.

The gross savings at the generator were estimated by using a line loss factor of 1.095 and 1.147 for energy and peak demand savings respectively. The line loss factors were updated for the purposes of the 2019 evaluation, and they now correspond to the values submitted to the UARB as part of the 2014 Cost of Service Study Progress Update.¹³

¹² The gross savings include 0.071 GWh and 0.042 MW generated by the Klondike pilot.

¹³ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 33: Evaluated 2021 Green Heat Gross Energy and Peak Demand Savings

Measure	MSHPs		CASHPs	GSHPs
	Fully Electrical	Mainly Electrical		
Number of Units	2,242	793	17	-
Energy Savings				
Unitary Energy Savings (kWh)	3,092	1,040	4,282	-
Gross Energy Savings – at the Meter (GWh)	6.931	0.825	0.073	-
Line Loss Factor	1.095	1.095	1.095	1.095
Gross Energy Savings – at the Generator (GWh)	7.588	0.903	0.080	-
Effective Useful Life (years)	18	18	18	25
Gross Lifetime Energy Savings – at the Generator (GWh)	136.579	16.250	1.435	-
Peak Demand Savings				
Unitary Peak Demand Savings (W)	2,496	2,576	3,930	N/A
Gross Peak Demand Savings – at the Meter (MW)	5.596	2.043	0.067	-
Line Loss Factor	1.147	1.147	1.147	1.147
Gross Peak Demand Savings – at the Generator (MW)	6.416	2.343	0.077	-

Evaluated 2021 Green Heat Gross Energy and Peak Demand Savings (Continued)

Measure	Wood Stoves or Fireplace Inserts		Pellet Stoves or Fireplace Inserts		Wood Furnaces or Boilers		Pellet Furnaces or Boilers	
	Electric Resistance Baseline	Heat Pump Baseline	Electric Resistance Baseline	Heat Pump Baseline	Electric Resistance Baseline	Heat Pump Baseline	Electric Resistance Baseline	Heat Pump Baseline
Number of Units	189	27	32	4	1	-	-	-
Energy Savings								
Unitary Energy Savings (kWh)	10,443	4,747	8,959	4,072	13,804	6,275	13,765	6,257
Gross Energy Savings – at the Meter (GWh)	1.974	0.128	0.287	0.016	0.014	-	-	-
Line Loss Factor	1.095	1.095	1.095	1.095	1.095	1.095	1.095	1.095
Gross Energy Savings – at the Generator (GWh)	2.161	0.140	0.314	0.018	0.015	-	-	-
Effective Useful Life (years)	18	18	18	18	18	18	18	18
Gross Lifetime Energy Savings – at the Generator (GWh)	38.892	2.526	5.649	0.321	0.272	-	-	-
Peak Demand Savings								
Unitary Peak Demand Savings (W)	4,000	4,000	4,000	4,000	7,660	7,660	7,750	7,750
Gross Peak Demand Savings – at the Meter (MW)	0.756	0.108	0.128	0.016	0.008	-	-	-
Line Loss Factor	1.147	1.147	1.147	1.147	1.147	1.147	1.147	1.147
Gross Peak Demand Savings – at the Generator (MW)	0.867	0.124	0.147	0.018	0.009	-	-	-

Evaluated 2021 Green Heat Gross Energy and Peak Demand Savings (Continued)

Measure	Solar DHW	Solar Thermal Air Heating	Electric Thermal Storage	Three-element Water Heaters	DHW Heater Timers	Total
Number of Units	-	-	235	43	71	3,654
Energy Savings						
Unitary Energy Savings (kWh)	2,736	594	N/A	N/A	N/A	-
Gross Energy Savings – at the Meter (GWh)	-	-	N/A	N/A	N/A	10.248
Line Loss Factor	1.095	1.095	1.095	1.095	1.095	-
Gross Energy Savings – at the Generator (GWh)	-	N/A	N/A	N/A	N/A	11.218
Effective Useful Life (years)	20	20	18	12	15	-
Gross Lifetime Energy Savings – at the Generator (GWh)	-	N/A	N/A	N/A	N/A	201.923
Peak Demand Savings						
Unitary Peak Demand Savings (W)	N/A	N/A	1,185	200	500	-
Gross Peak Demand Savings – at the Meter (MW)	N/A	N/A	0.278	0.009	0.036	9.044
Line Loss Factor	1.147	1.147	1.147	1.147	1.147	-
Gross Peak Demand Savings – at the Generator (MW)	N/A	N/A	0.319	0.010	0.041	10.370

Figure 19 compares tracked gross energy savings to evaluated gross energy savings. As outlined in the figure, the tracked and evaluated energy savings are the same for all measures.

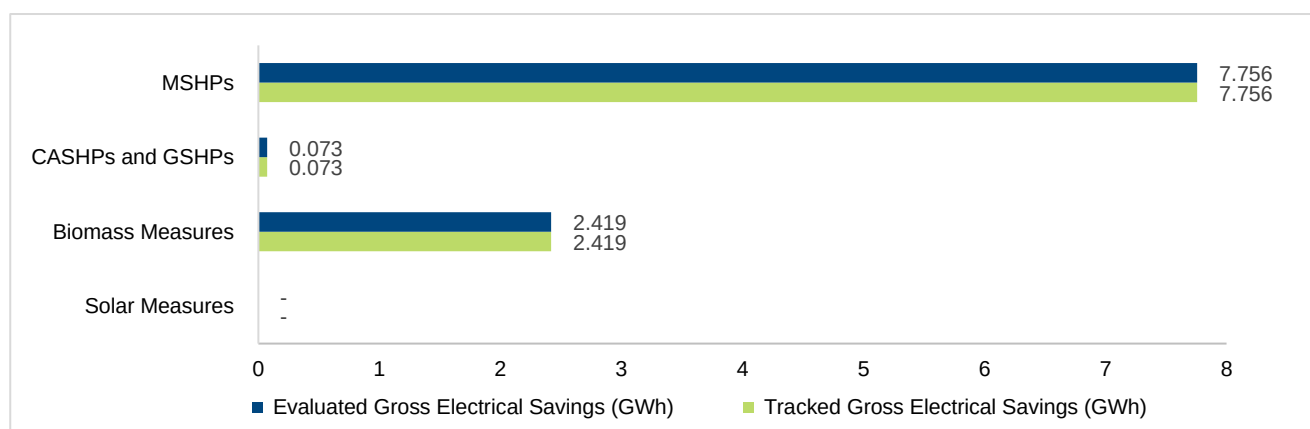
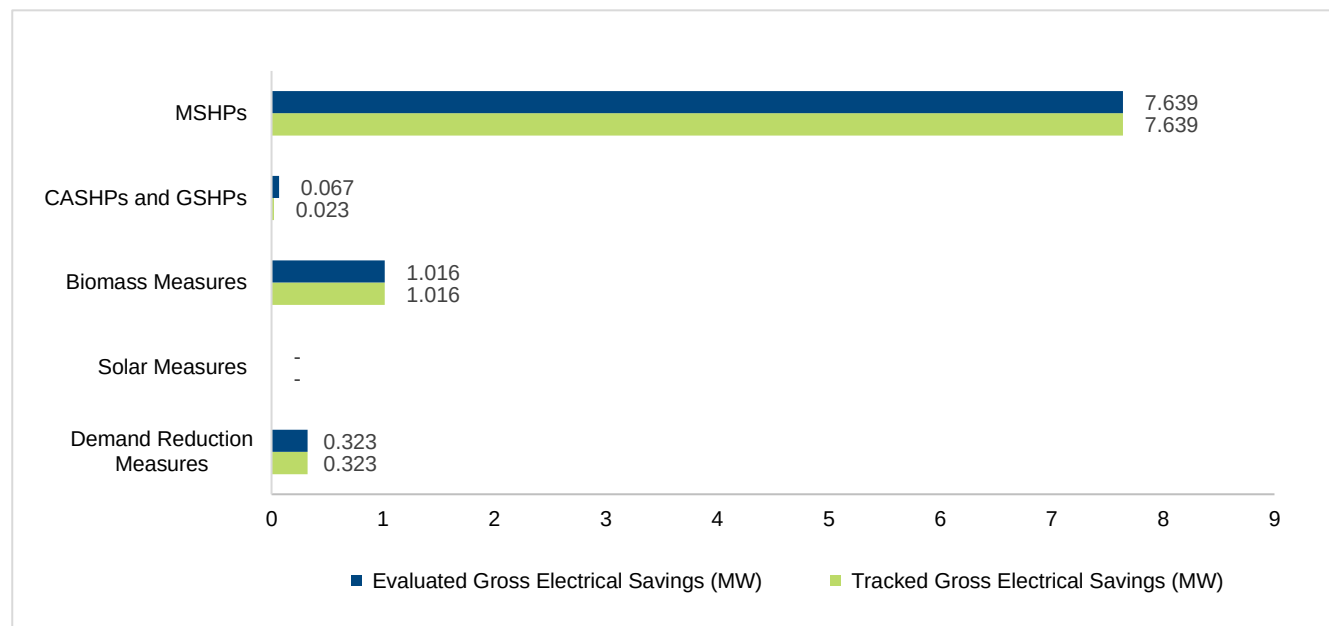
Figure 19: 2021 Green Heat Tracked and Evaluated Gross Energy Savings


Figure 20 below compares tracked gross peak demand savings to evaluated gross peak demand savings. As outlined in the figure, the tracked and evaluated peak demand savings are the same with the exception of CASHPs for which the unitary peak demand savings value was revised based on the rated heating capacity and COP at -15°C for the models installed through Green Heat in 2021.

Figure 20: 2021 Green Heat Tracked and Evaluated Gross Peak Demand Savings



8.3 Net Savings

The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the NTGR. More precisely, the NTGR includes effects such as free-ridership and spillover that positively or negatively affect both the energy savings and peak demand savings generated by a program component. In the case of Green Heat, only free-ridership is considered.

8.3.1 Free-ridership

For Green Heat, free-ridership occurs when participants would have still installed a new, more efficient heating system in the absence of the program component. The free-ridership levels were assessed using a self-reporting approach that involved asking sampled participants to respond to a set of questions during a telephone survey. Three different sets of questions were asked depending on the type of measures installed: (1) Biomass or solar heating systems; (2) centrally ducted heat pumps (including CASHPs, air-to-water heat pumps, and GSHPs); and (3) MSHPs. The questionnaire considers all applicable variables in the decision-making process, including planning, efficiency, timing, and cost.

The feedback collected from the participant survey was converted into an overall free-ridership level using the algorithms presented in Appendix VIII. For all measures, additional questions were used to determine whether participant decisions to install the measures had been influenced by previous participation in an EOne program component or EOne efforts to raise awareness about energy efficiency.

MSHP Measure

For MSHPs, which constitute by far the most popular Green Heat measure, the Evaluator assessed free-ridership by using two factors: (1) A series of questions regarding participants' decision to install a heat pump instead of another type of heating system or simply keeping the existing system (type-of-system factor); and (2) a series of questions regarding participants' decision to install a high-efficiency heat pump rather than a regular heat pump (high-efficiency factor).

When analyzing survey results, the Evaluator found that 71% of participants had already made the decision to install a MSHP before hearing about Green Heat. When factoring in the influence of the rebate on the project timeline as well as the high-efficiency and cross-influence factors, the free-ridership level was established at 39%, which represents a significant decrease compared to the last free-ridership results (53%) from 2019. This decrease was mainly due to an update in how the timing variable of the decision-making process was accounted for in the algorithm.

Centrally Ducted Heat Pump Measure

For centrally ducted heat pump measures, the questionnaire assessed the likelihood of participants replacing their electrical heating system with a centrally ducted heat pump of the same efficiency level in the absence of Green Heat.

Using this approach, the free-ridership level was evaluated at 35% for centrally ducted heat pumps with a margin of error of 21%. Since this result had a margin of error above 10% and the 2019 free-ridership level was similar (33%) with a margin of error below 10%, the Evaluator relied on the 2019 result for the 2021 evaluation.

Biomass and Solar Heating Systems

For biomass and solar heating systems, the questionnaire assessed the likelihood of participants replacing their electrical system with a biomass or solar heating system in the absence of the program component.

Using this approach, the free-ridership level was established at 41% for biomass and solar measures, which is similar to the latest result obtained in 2019 (42%).

Table 34 outlines the free-ridership level obtained for each measure category.

Table 34: 2021 Green Heat Average Free-ridership Levels

Measure	Average Free-ridership Level	Sample Size	Population Size	Margin of Error
MSHPs	39%	97	2,902	5.1%
CASHPs and GSHPs*	33%	30	54	7.6%
Biomass and Solar	41%	38	253	7.8%
* Results for centrally ducted heat pumps are those from the 2019 participant survey.				

No free-ridership was established for demand reduction measures since they were still fairly new to the program and only represent a small proportion of 2021 savings (3% of gross peak demand savings).

8.3.2 Net-to-gross Ratio Calculation

The NTGR was calculated using the following equation.

$$NTGR = (1 - \% \text{ Free-ridership})$$

Using the free-ridership level established for each measure category, the Evaluator calculated the NTGR values presented in Table 35.

Table 35: 2021 Green Heat NTGRs

Measure	Free-ridership	NTGR
MSHPs	39%	0.61
CASHPs and GSHPs	33%	0.67
Biomass and Solar	41%	0.59
Demand Reduction	-	1.00

8.3.3 Evaluated Net Savings

Net savings are defined as the energy use reductions specifically attributable to Green Heat. Net savings were estimated by applying the NTGRs listed above to the evaluated gross savings using the following equation:

$$\text{Net Savings} = \text{Gross Savings} \times \text{NTGR}$$

This equation was used to calculate both electrical energy savings and peak demand savings.

The net energy savings for Green Heat in 2021 were estimated at 6.795 GWh at the generator and the peak demand savings at 6.451 MW at the generator.¹⁴ The net lifetime energy savings were established at 122.306 GWh, which yield a weighted average EUL value of 18.0 years.

¹⁴ The net savings include 0.042 GWh and 0.025 MW generated by the Klondike pilot.

The detailed results are presented in Table 36.

Table 36: Evaluated 2021 Green Heat Net Energy and Peak Demand Savings

Measure	MSHPs		CASHPs	GSHPs
	Fully Electrical	Mainly Electrical		
Energy Savings				
Gross Energy Savings – at the Meter (GWh)	6.931	0.825	0.073	-
NTGR	0.61	0.61	0.67	0.67
Net Energy Savings – at the Meter (GWh)	4.228	0.503	0.049	-
Line Loss Factor	1.095	1.095	1.095	1.095
Net Energy Savings – at the Generator (GWh)	4.629	0.551	0.053	-
Effective Useful Life (years)	18	18	18	25
Net Lifetime Energy Savings – at the Generator (GWh)	83.313	9.913	0.961	-
Peak Demand Savings				
Gross Peak Demand Savings – at the Meter (MW)	5.596	2.043	0.067	-
NTGR	0.61	0.61	0.67	0.67
Net Peak Demand Savings – at the Meter (MW)	3.414	1.246	0.045	-
Line Loss Factor	1.147	1.147	1.147	1.147
Net Peak Demand Savings – at the Generator (MW)	3.914	1.429	0.051	-

Evaluated 2021 Green Heat Net Energy and Peak Demand Savings (Continued)

Measure	Wood Stoves or Fireplace Inserts		Pellet Stoves or Fireplace Inserts		Wood Furnaces or Boilers		Pellet Furnaces or Boilers	
	Electric Resistance Baseline	Heat Pump Baseline	Electric Resistance Baseline	Heat Pump Baseline	Electric Resistance Baseline	Heat Pump Baseline	Electric Resistance Baseline	Heat Pump Baseline
Energy Savings								
Gross Energy Savings – at the Meter (GWh)	1.974	0.128	0.287	0.016	0.014	-	-	-
NTGR	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Net Energy Savings – at the Meter (GWh)	1.164	0.076	0.169	0.010	0.008	-	-	-
Line Loss Factor	1.095	1.095	1.095	1.095	1.095	1.095	1.095	1.095
Net Energy Savings – at the Generator (GWh)	1.275	0.083	0.185	0.011	0.009	-	-	-
Effective Useful Life (years)	18	18	18	18	18	18	18	18
Net Lifetime Energy Savings – at the Generator (GWh)	22.946	1.490	3.333	0.189	0.160	-	-	-
Peak Demand Savings								
Gross Peak Demand Savings – at the Meter (MW)	0.756	0.108	0.128	0.016	0.008	-	-	-
NTGR	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Net Peak Demand Savings – at the Meter (MW)	0.446	0.064	0.076	0.009	0.005	-	-	-
Line Loss Factor	1.147	1.147	1.147	1.147	1.147	1.147	1.147	1.147
Net Peak Demand Savings – at the Generator (MW)	0.511	0.073	0.087	0.011	0.005	-	-	-

Evaluated 2021 Green Heat Gross Energy and Peak Demand Savings (Continued)

Measure	Solar DHW	Solar Thermal Air Heating	Electric Thermal Storage	Three- element Water Heaters	DHW Heater Timers	Total
Energy Savings						
Gross Energy Savings – at the Meter (GWh)	-	-	N/A	N/A	N/A	10.248
NTGR	0.59	0.59	1	1	1	-
Net Energy Savings – at the Meter (GWh)	-	-	N/A	N/A	N/A	6.207
Line Loss Factor	1.095	1.095	1.095	1.095	1.095	-
Net Energy Savings – at the Generator (GWh)	-	-	N/A	N/A	N/A	6.795
Effective Useful Life (years)	20	20	18	12	15	-
Net Lifetime Energy Savings – at the Generator (GWh)	-	-	N/A	N/A	N/A	122.306
Peak Demand Savings						
Gross Peak Demand Savings – at the Meter (MW)	N/A	N/A	0.278	0.009	0.036	9.044
NTGR	0.59	0.59	1	1	1	-
Net Peak Demand Savings – at the Meter (MW)	-	-	0.278	0.009	0.036	5.626
Line Loss Factor	1.147	1.147	1.147	1.147	1.147	-
Net Peak Demand Savings – at the Generator (MW)	-	-	0.319	0.010	0.041	6.451

As presented in Table 37, applying the Nova Scotia-specific factor¹⁵ for GHG emissions generated by electricity production to Green Heat net savings corresponds to a total of 3.969 tonnes of annually avoided CO₂ eq.

¹⁵ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:
Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),
Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021
https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

Table 37: Evaluated 2021 Green Heat GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	6.795
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	3.969

8.4 Realization Rate

Table 38 compares the energy and peak demand savings established through this evaluation to those calculated in the 2021 tracking sheet. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 122% for energy savings and 125% for peak demand savings.

Table 38: Comparison of 2021 Green Heat Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	11.218	GWh	0.50	5.580	GWh	122%
Evaluation Results	11.218	GWh	0.61	6.795	GWh	
Peak Demand Savings						
Tracked Savings by EOne	10.319	MW	0.50	5.179	MW	125%
Evaluation Results	10.370	MW	0.62	6.451	MW	
*NTGRs varied for each measure category. The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by gross savings.						

The evaluated gross energy savings determined by the Evaluator were identical to the initial gross savings tracked by EOne. As for gross peak demand savings, the slight difference was due to the adjustment to the unitary peak demand savings value for CASHPs.

Net energy and peak demand savings determined by the Evaluator were higher than the tracked savings by 22% and 25% respectively. These increases were due to the new free-ridership levels established in 2021. Notably, the free ridership for MSHPs decreased from 53% in 2020 to 39% in 2021, leading to a higher NTGR in 2021.

9 GREEN HEAT MARKET EVOLUTION

EOne has been active in the MSHP market through the Green Heat program since October 2015.¹⁶ A market evolution assessment was completed as part of the 2017, 2018, and 2019 evaluations, the results of which served to analyze key market indicators and present a technology diffusion curve illustrating the market adoption of MSHPs in Nova Scotia. The aim of this section is to update the data collected as part of the previous evaluations and provide up-to-date insights regarding the market transformation of MSHPs in Nova Scotia. Given the market for MSHPs is rapidly evolving in the province, regularly monitoring barriers to MSHP adoption is important to enable EOne to adapt the program component if needed.

9.1 Market Indicators

The Evaluator analyzed available market data and established key market indicators to understand the state of the MSHP market in Nova Scotia.

A key source of information used in this analysis was the heat pump data and assumptions included in the 2020 and 2021 NS Power load forecast and associated regulatory filings.^{17,18} NS Power uses a range of information including NS Power program component data, NRCAN data, residential consumer surveys, and heat pump distributor interviews to quantify heat pump use in the province. The NS Power load forecast information provides historical data up to 2019 and forecasts for 2020 and 2021.

9.1.1 Market Share of Heat Pumps

The data presented in this subsection are for all heat pumps, not just MSHPs. NS Power data indicates that, since 2013, over 90% of heat pumps installed through the NS Power on-bill financing program component have been MSHPs.¹⁹ This is echoed in Green Heat wherein 99% of incented heat pumps were MSHPs in 2021. Therefore, while this subsection presents information on heat pumps generally, the Evaluator concludes that this information is representative of the MSHP market in Nova Scotia.

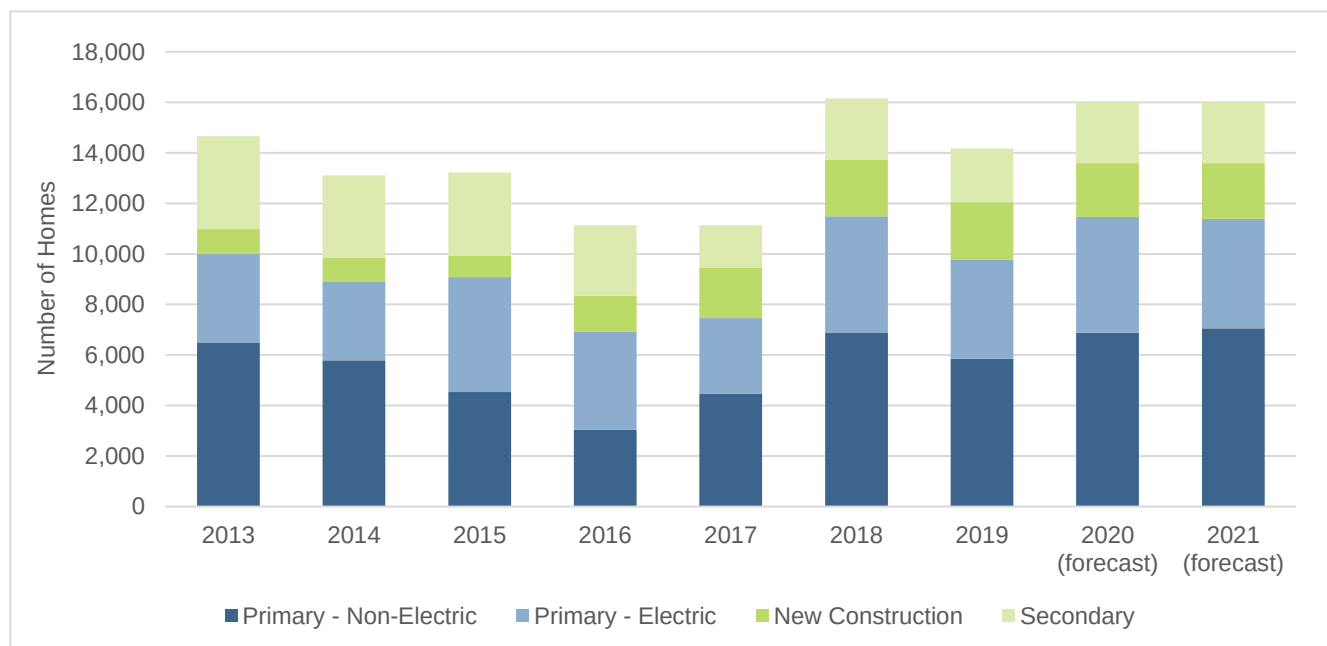
Figure 21 below depicts the number of incremental homes with heat pump systems installed annually in Nova Scotia since 2013, including new constructions. It was estimated that just over 14,000 homes had new heat pump systems installed in 2019, down from over 16,000 in 2018, with the bulk of those installations continuing to be in existing homes. The NS Power load forecast predicted a return to 2018 growth levels in 2020 with no changes expected in 2021.

¹⁶ Until 2012, EOne provided rebates for ductless MSHPs through EnerGuide for Existing Houses (currently known as HEA). In April 2012, EOne incentives on heating and cooling measures were transferred to a new program component called Fuel Substitution, and ductless MSHPs were no longer eligible for incentives. EOne continued to recommend the implementation of MSHPs without a rebate through some of its residential programs. Since August 2017, MSHP incentives have been offered to both electrically and non-electrically heated homes. Funding for non-electrically heated homes is provided under the federal government's LCEF through the Province of Nova Scotia since July 2018.

¹⁷ Nova Scotia Power 2020 Load Forecast Report Synapse IR-06 Att 5 ELECTRONIC.

¹⁸ Nova Scotia Power 2021 Load Forecast Report.

¹⁹ Nova Scotia Utility and Review Board, Matter M08087. NSP Response to E1 IR-4 Att 1.

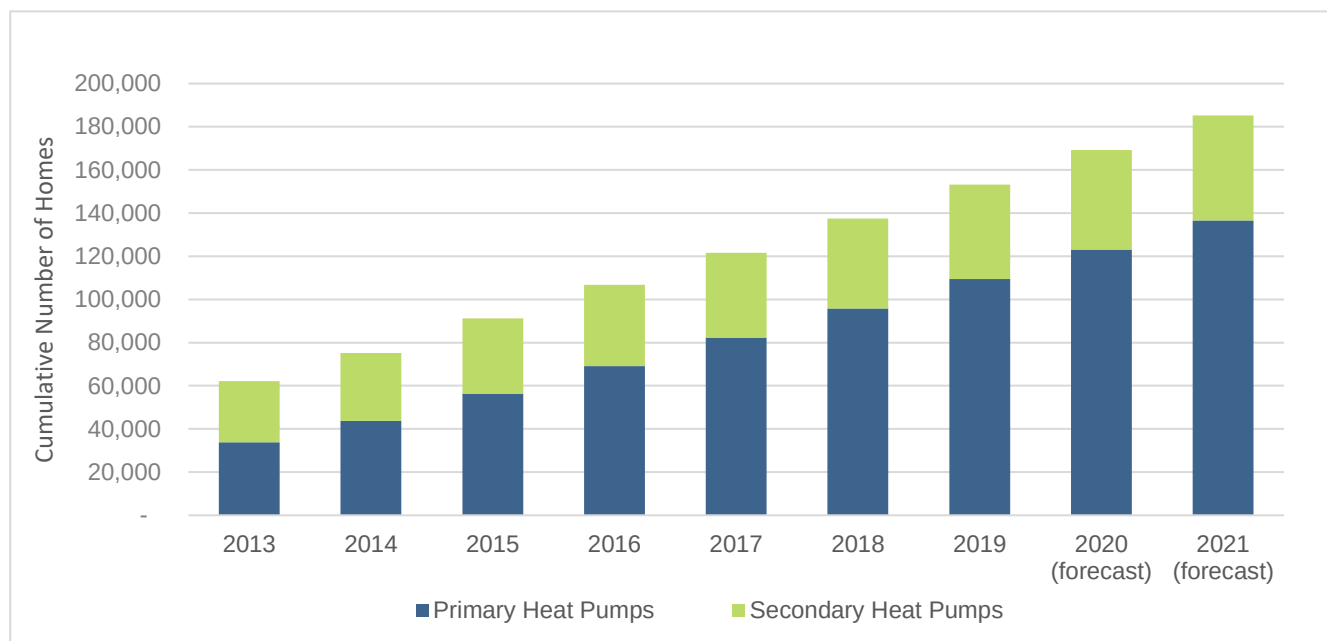
Figure 21: Incremental Homes with Heat Pump Systems Installed in Nova Scotia, 2013-2021


Sources: 2020 Load Forecast Report Synapse IR-06 Att 5 ELECTRONIC; 2021 Load Forecast Report

While Figure 21 above presents new annual heat pump installations, Figure 22 further below outlines the cumulative total number of homes with heat pumps in Nova Scotia. The number of homes with heat pumps has grown continually since 2013, with relatively high growth rates between 2012-2013 (31%) as well as between 2013-2014 and 2014-2015 (21%). From 2016 onward, the annual growth rate of new heat pump installations gradually declined, reaching 12% in 2019 and forecast for 9% in 2021.

As indicated in Figure 22 below, just over 150,000 homes had either a primary or secondary heat pump system in 2019. NS Power forecast a steady increase of about 16,000 homes with heat pumps per year for 2020 and 2021 (reaching just below 170,000 and just over 185,000 homes respectively in cumulative terms). NS Power estimated that 35% of households²⁰ would have used a heat pump for some or all their heating requirements in 2021.

²⁰ Nova Scotia Power 2021 Load Forecast Report (Section 4.4, p.32).

Figure 22: Homes with Heat Pump Systems (Cumulative), 2013-2021


Sources: 2020 Load Forecast Report Synapse IR-06 Att 5 ELECTRONIC; 2021 Load Forecast Report

Green Heat Mini-split Heat Pumps

Green Heat incents participants to purchase eligible high-performing cold climate MSHPs. From July 2017 to April 2021, only single-zone systems with a heating seasonal performance factor (HSPF) greater than 9.565 in Region V and multi-zone systems with an HSPF greater than 8.696 were eligible for Green Heat.²¹ Since January 2021, systems eligible for a Green Heat rebate must appear on the NEEP Cold Climate Air Source Heat Pump list, and HSPF, SEER, and COP variables are more stringent. Only single-zone systems with an HSPF of 11 or higher in Region V or multi-zone systems with an HSPF of 10 or higher that have a seasonal energy efficiency ratio (SEER) of 17 or more and a coefficient of performance (COP) greater than or equal to 1.75 at -15°C are eligible for Green Heat.²² By narrowing the eligibility criteria, the program component targets a subset of high-efficiency MSHPs that provide the greatest energy savings.

Table 39 below provides the number of Green Heat incented systems since 2017, including both DSM and PNS participants; in almost all cases, one MSHP system equates to one home. Since August 2017, participants with non-electrically heated homes have been eligible for the program component. The total number of incented systems increased significantly over the 2017-2021 period. The number more than doubled between 2017 and 2018 and grew 61% in 2019. Growth between 2019 and 2020 was relatively flat (-3% growth) but grew again in 2021 (7%) to reach a total of almost 6,000 incented systems.

²¹ Systems with an HSPF below 9.565 were still admitted to the program if equipped with a drain pan heater.

²² Heating Systems Rebate (Green Heat) Manual Revised April 29, 2021, p.14

Table 39: Green Heat Incented High-efficiency Mini-split Heat Pump Systems, 2017-2021

	2017		2018		2019		2020		2021	
	Electrical	Non-electrical	Electrical	Non-electrical	Electrical	Non-electrical	Electrical	Non-electrical	Electrical	Non-electrical
Number of MSHP Systems*	1,286	306**	2,117	1,442***	2,712	3,006	2,842	2,686	2,901	3,018
Average HSPF of Units	10.27		10.27		10.32		10.41		10.46	
*In almost all cases, one MSHP system incented by Green Heat equates to one home. **In 2017, MSHPs were only offered to non-electrically heated homes in the last five months of the year. *** In 2018, non-electrical participants were tracked as DSM participants prior to July 2018 and as PNS participants after July 2018. Thus, 2018 non-electrical includes both DSM and PNS participants.										

The efficiency of MSHP units remained relatively constant between 2017 and 2019 but increased in 2020 and 2021 from an average HSPF of 10.32 to 10.41 and 10.46 respectively. The maximum efficiency MSHP sold through Green Heat in 2020 increased, with an HSPF of 13.22 and rose to 14.50 in 2021, driven by the more stringent NEEP requirements.

HEA Mini-split Heat Pumps

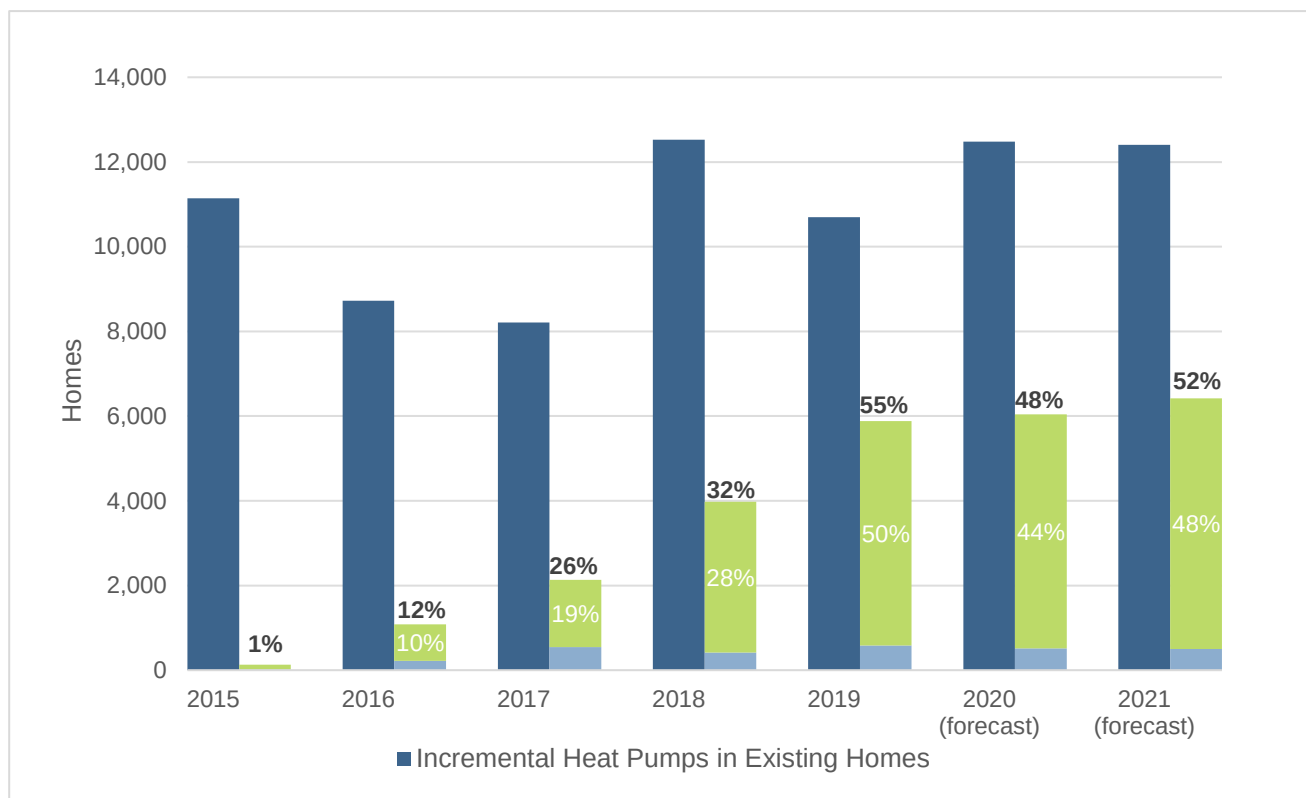
HEA also provides incentives for participants installing high-performing cold-climate MSHPs (i.e. same criteria as Green Heat) as part of a retrofit. As indicated in Table 40, HEA counted fewer MSHP system installations in 2020 and 2021 than in 2019.

Table 40: HEA Incented High-efficiency Mini-split Heat Pump Systems, 2015-2021

	2015	2016	2017	2018	2019	2020	2021
Number of MSHP Systems	16	220	542	420	585	514	503

Figure 23 below presents an evolution of the number of MSHP systems incented through Green Heat and HEA compared to an estimate of the incremental MSHP systems installed in existing homes in Nova Scotia, assuming that 90% of heat pump systems are MSHPs as per NS Power program component data. Based on the NS Power forecast for 2021, the number of incremental heat pumps should return to 2018 levels and the relative percentage of MSHPs incented by EOne will be more than half of that level (52%), the majority from the Green Heat program.

Figure 23: Comparison of Incremental Existing Homes with Mini-split Heat Pump Systems with EOne Incented Systems, 2015-2021²³



Note that the federal government announced the launch of the Canada Greener Homes Grant in May 2021. The initiative offers grants of up to \$5,000 to help homeowners implement energy efficiency retrofits in their primary residence, including the installation of MSHPs. In Nova Scotia, homeowners have to register under HEA to receive this grant.

9.1.2 Green Heat Eligible Mini-split Heat Pumps

The Evaluator interviewed five distributors of HVAC products, including MSHPs, in Nova Scotia to gain more in-depth understanding of MSHP market trends and sales of Green Heat-eligible high-performing cold-climate MSHPs. The list of interviewed distributors was the same as those interviewed as part of the 2019 evaluation. All interviewed distributors sell MSHPs wholesale to contractors and do not sell directly to homeowners.

The distributors interviewed all currently sell high-performing mini-split heat pumps. Four of the five distributors mentioned that at least 90% of the contractors to whom they sell MSHPs carry Green Heat eligible units.

²³ For 2020 and 2021, the number of incremental heat pumps in existing homes is based on an NS Power forecast; the numbers of incented MSHPs under the Green Heat and HEA programs are actuals, not forecasts.

9.1.3 Mini-split Heat Pump Prices

Figure 24 and Table 41 below provides the average cost of incented systems (excluding incentives) and the average incentive across nominal capacities based on the Green Heat tracking sheets from 2017 to 2021. This information indicates the general trend over time; the average cost values should be used with caution since large variations in system costs were observed in the tracking sheets and the cost data includes systems with multiple units. On average, the cost of MSHPs increased significantly in 2020 compared to 2019 for all nominal capacities but decreased in 2021. While average costs in 2021 were similar to those in 2019 for nominal capacities of 24,000 Btu/hr or below, they rose by 12% compared to 2019 levels for those above 24,000 Btu/hr. Over this same period, average incentive levels remained relatively stable. Distributors of Green Heat eligible MSHPs are of the opinion that prices have increased in general since 2019 or will do so soon due in part to increased production costs caused by COVID-19 market perturbations.

Figure 24: Evolution of Green Heat Average Costs and Average Incentives – 2017-2021

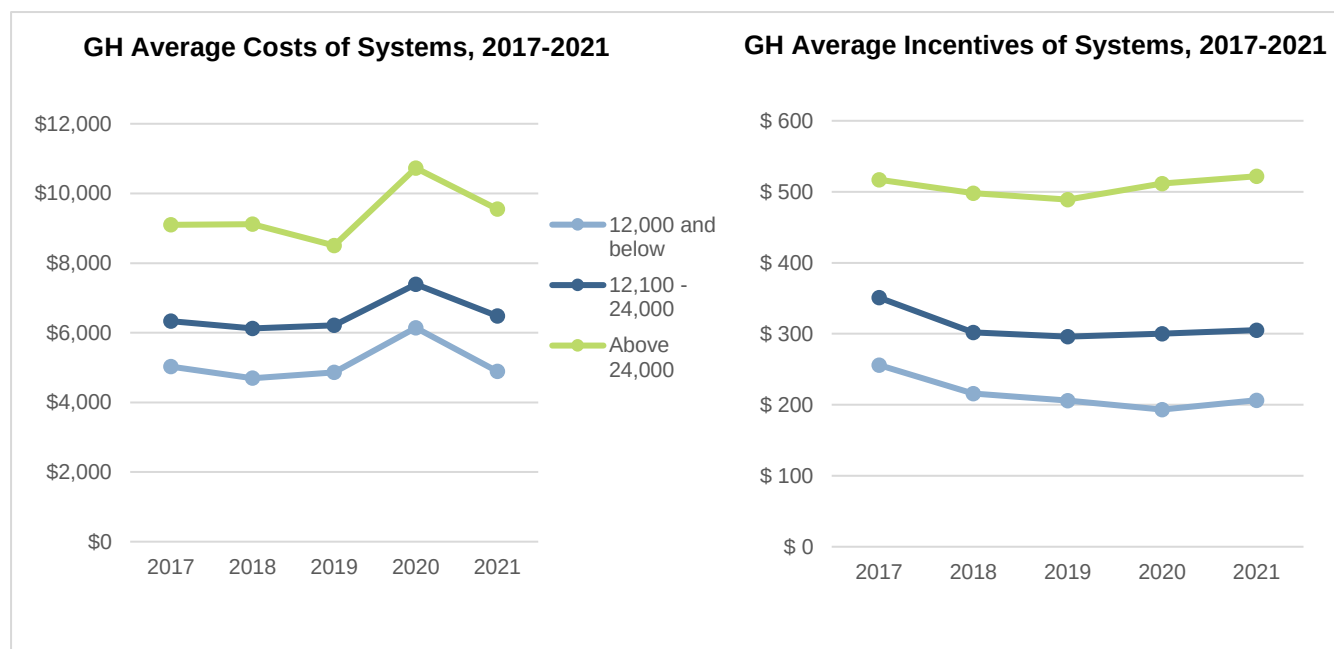


Table 41: Green Heat Average Costs and Incentives of Systems, 2017-2021

Nominal Capacity (Btu/hr)	2017		2018		2019		2020*		2021*	
	Average Cost	Average Incentive	Average Cost	Average Incentive	Average Cost	Average Incentive	Average Cost	Average Incentive	Average Cost	Average Incentive
12,000 and below	\$5,028	\$256	\$4,693	\$216	\$4,861	\$206	\$6,142	\$193	\$4,893	\$207
12,100 - 24,000	\$6,335	\$351	\$6,124	\$302	\$6,209	\$296	\$7,392	\$300	\$6,476	\$305
Above 24,000	\$9,095	\$517	\$9,116	\$498	\$8,505	\$489	\$10,729	\$511	\$9,545	\$522

*The average costs and incentives for 2020 and 2021 only take into account data from DSM participants. Based on past evaluations, no significant difference is expected between PNS and DSM average costs and incentives.

Distributors were asked about the price differential between a 12,000 BTU/hr standard MSHP and a Green Heat eligible MSHP in 2021. The differential provided ranges from \$200 to \$1,100, with an average of approximately \$570 or 13% of total cost, which is up slightly from the 10% of total cost estimated in 2019. The range varies due to the different costs, brands, and models carried by a given distributor.

9.1.4 Mini-split Heat Pump Market Outlook and Trends

To evaluate the evolution of MSHP sales over the past two years, the Evaluator asked for distributors' inputs.

From 2019 to 2020, four out of five distributors reported an increase in sales ranging from 15% to 31% (20% on average); the remaining distributor saw no change. The increases are primarily explained by more people working from home during the pandemic and looking to improve their home office environment as well as homeowners spending more on home improvements in general. Increased market demand for air conditioning also explains the higher sales.

All five distributors also experienced increased sales of MSHPs from 2020 to 2021, ranging from 10% to 35% (22% on average). Again, this was due to homeowners choosing to invest more in their homes and home improvement projects as opposed to spending it in other areas during the pandemic; it is also due to incentive programs such as Green Heat and Greener Homes.

The growth increases reported by the distributors are larger than those forecast by NS Power for 2020 and 2021 (see Figure 21 above).

The interviewed distributors report that between 70% and 90% of their MSHP sales in 2021 were high-performing cold climate units. Two distributors are under the impression that the vast majority of the high-performing MSHPs they sell to contractors are incented by ENS, while one distributor believes that the proportion is closer to 30% of sales. The two other distributors lacked sufficient knowledge to comment. Distributors are unsure of why there are not more purchasers of high-performing MSHPs applying for an incentive from ENS other than that the financial outlay is greater for the high-performing, higher-priced units, making them less attractive, and that customers lack interest in going through the application process.

Distributors have seen a few changes over the last two years in the MSHP market in Nova Scotia. Apart from the increased market demand, they also mention procurement issues, increased production costs resulting from the pandemic, and higher inflation. There is also higher consumer demand for installing multiple units throughout the home, including for outdoor units with multiple heads. One distributor mentioned the recent introduction of the Greener Homes program as having a potential impact on the level of interest in MSHPs going forward. From a technical standpoint, one distributor mentioned that MSHP technology is increasingly improving and becoming more energy efficient.

Distributors anticipate that sales will continue to increase into 2022 for the same reasons despite the procurement issues and increased production costs. One distributor mentioned that MSHPs became popular about a decade ago and that many owners are now looking for replacement units, thus explaining some of the increase in sales.

9.1.5 Codes and Standards

The ultimate indicator of market transformation is the adoption of more stringent codes and standards. Electric resistance heating remains the minimal efficiency level as per building codes for new small residential buildings and an update to the provincial building code is not planned in 2022. The Government of Canada is, however, planning to include a more stringent minimum energy performance standard for heat pumps as part of Amendment 17 to the Energy Efficiency Regulations, which is currently in the consultation phase and is expected to be published by 2023. This regulation is expected to modify the testing requirement so that performance ratings at -15°C are included in the HSPF calculations to better represent Canadian climatic conditions.²⁴ This change is an indication that the market is shifting toward heat pumps that perform better at low temperatures. While the proposed minimum HSPFs are lower than those in the current regulation, Natural Resources Canada indicates that they are more stringent – the reduction in value being due only to a change in the testing method.

²⁴ Natural Resources Canada, *Central Air Conditioners and Heat Pumps – May 2021 Technical Bulletin on Amending the Standards*, May 2021, available at <https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-regulations/planning-and-reporting/central-air-conditioners-and-heat-pumps/23613>.

9.1.6 Measured Free-ridership

The Evaluator analyzed the free-ridership level, as presented in Table 42 below, to gain insights into the evolution of MSHP adoption rates in Nova Scotia. The MSHP free-ridership level remained relatively stable from 2017 to 2020. In 2021, the free-ridership level was 39%. As discussed in Subsection 8.3.1, this decrease was mainly due to an update on how one variable was accounted for in the free-ridership algorithm.

Table 42: Green Heat Free-ridership Levels for MSHPs, 2017-2021

Free-ridership	2017	2018	2019	2020	2021
MSHPs	51%	54%	53%	53%	39%

9.2 Market Evolution Summary

In their recommendations on market transformation program planning, Rosenberg and Hoefgen (2009) identify a number of factors, presented in Table 43 below, to be analyzed to identify whether program component support should be withdrawn or reduced in light of changes observed in the market.²⁵

²⁵ Rosenberg M. and Hoefgen L., 2009. Market Effects and Market Transformation: Their Role in Energy Efficiency Program Design and Evaluation. Prepared for the California Institute of Energy and the Environment.

Table 43: Analysis of 2021 Key Factors in Program Component Planning

Factor	Results
Market share of heat pumps and efficient MSHPs	NS Power predicted a relatively flat market for MSHPs in 2020 and 2021. That said, distributors reported increased sales of MSHPs in 2021 and they believe that sales will continue to increase in 2022. An estimated 35% of households in Nova Scotia are forecast to have used a heat pump for some or all of their heating requirements in 2021. The efficiency of MSHP units sold through either Green Heat or HEA is increasing, driven by more stringent requirements and thus providing greater energy savings. The Evaluator estimates that 52% of incremental MSHPs installed in Nova Scotia received an incentive from EOne through either Green Heat or HEA.
Recent trends in prices and availability	On average, the 2021 costs of MSHPs for nominal capacities of 24,000 Btu/hr or less are similar to what they were in 2019; the average cost of higher capacities has risen 12% over 2019 levels. However, the majority of distributors of Green Heat eligible MSHPs say they have seen increases in 2020 and 2021 due, in part, to increased production costs. These price increases have not affected the average price differential between a 12,000 BTU/hr standard MSHP and a Green Heat eligible MSHP, although distributors provided a similar differential to that estimated in 2019. High-efficiency MSHPs remain accessible to consumers. Interviewed distributors again reported that almost all contractors with whom they work install Green Heat eligible MSHPs.
Likelihood of inclusion in a near-term code or standard	Electric resistance heating remains the minimal efficiency level as per building codes for small residential buildings. A new proposed regulation for heat pumps, expected in 2023, will require testing at -15°C and increase minimal HSPF values, which indicates that the market is moving toward more efficient heat pumps, including in cold conditions.
Market readiness of more efficient substitute technology	Not applicable.

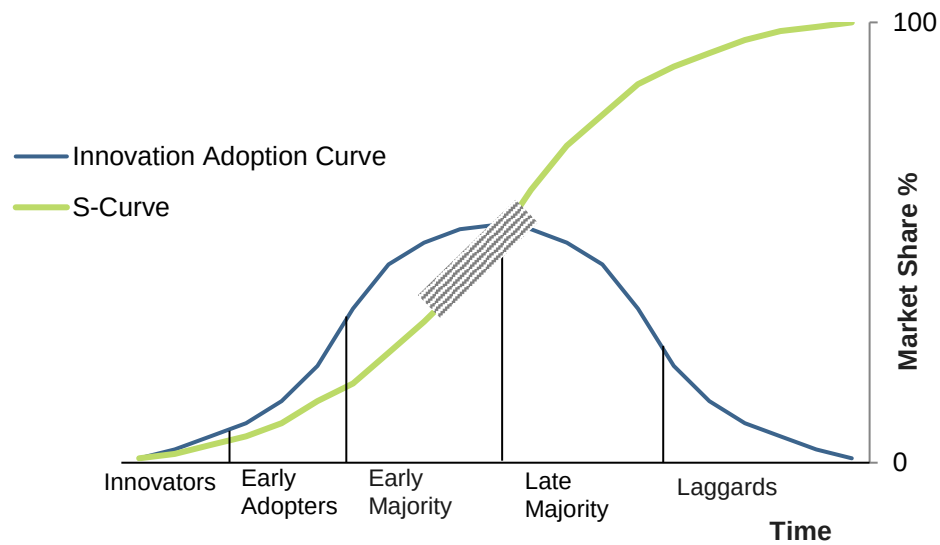
The above-listed market indicators demonstrate that the barriers to MSHP adoption continue to weaken and consumer interest remains high. Figure 25 below provides a qualitative indication of the adoption stages of MSHPs in Nova Scotia. It is not aimed at representing the exact market share of MSHPs, for which a more detailed analysis would be required.

The figure illustrates how, with successive groups of consumers adopting the new technology (depicted by the innovation adoption curve in blue),²⁶ the MSHP market share (depicted by the S-curve in grey) will eventually reach saturation. Sales will then level off, taper, and eventually phase out. Due to its qualitative nature, the intersection between the market share and adoption rate depicted in the chart should be interpreted with caution.

The Evaluator maintains the conclusion found in 2019 that the MSHP market remains in a slowing growth phase that is nearing product maturity. This is supported by the NS Power data estimating that 35% of households in Nova Scotia would use a heat pump for some or all of their heating requirements in 2021. Distributors affirm continued consumer interest and sales. The hatched box in Figure 25 below illustrates the MSHP placement on the product adoption curve.

²⁶ Everett Rogers, *Diffusion of Innovations*, 1983.

Figure 25: 2021 Residential Market Evolution of Mini-split Heat Pumps



10 GREEN HEAT KEY FINDINGS AND RECOMMENDATIONS

As mentioned previously, the main objectives of the 2021 Green Heat evaluation were as follows:

- › Collect information on participant perspectives
- › Calculate gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions²⁷
- › Analyze the market evolution of mini-split heat pumps (MSHPs)

This section provides the Evaluator's key findings in relation to these objectives. The Evaluator has no specific recommendation for Green Heat.

2021 GH-Finding: Green Heat net electrical energy and peak demand savings exceeded targets.

Green Heat achieved 6.795 GWh in net electrical energy savings and 6.451 MW in net peak demand savings at the generator in 2021, thus exceeding the planned net electrical energy savings of 5.56 GWh and net peak demand savings of 5.69 MW.

2021 GH-Finding: Green Heat participation levels reached a new high in 2021, driven in large part by growth in demand reduction measures.

With 3,654 measures installed, the 2021 participation level was the highest ever observed for Green Heat. The 2021 participation level was 8% higher than in 2020. In addition to mini-split heat pumps continuing to be very popular among participants, the increase in popularity of demand reduction measures, for which the participation levels nearly doubled compared to 2020, also contributed to this success.

2021 GH-Finding: Participant satisfaction with Green Heat remains high, with the rebate amounts being the only aspect of the program receiving a relatively lower satisfaction score.

Satisfaction with Green Heat overall was high in 2021 with participants providing an average score of 9.0 on a 10-point scale where 1 means "Not at all satisfied" and 10 means "Completely satisfied". In addition, all aspects of the program received satisfaction scores of 8.5 and above with the exception of the rebate amounts that received a somewhat lower satisfaction score of 7.1.

²⁷ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

2021 GH-Finding: Green Heat free-ridership levels for MSHPs decreased in 2021 and remained stable for other measure categories.

The 2021 free-ridership level for MSHPs was established at 39%, a decrease compared to the previous free-ridership result of 53% obtained in 2019. For biomass and solar measures, the 2021 level, evaluated at 41%, was similar to the result obtained in 2019 (42%). As for CASHPs and GSHPs, since the free-ridership level that was calculated based on 2021 survey results (35%) had a margin of error above 10% and the 2019 free-ridership level was similar (33%) with a margin of error below 10%, the Evaluator used the 2019 result for the 2021 evaluation. No free-ridership was established for demand reduction measures since they were still fairly new to the program and only represent a small proportion of 2021 savings. The decrease in the free-ridership level for MSHPs was mainly due to an update in how the timing variable of the decision-making process was accounted for in the algorithm.

2021 GH-Finding: The annual number of MSHP systems that were incented by EOne slightly increased in 2020 and 2021, while their proportion compared to incremental households with MSHPs in Nova Scotia remained stable from 2019 to 2021.

The annual number of incented MSHP systems has increased by 8% and 7% in 2020 and 2021 respectively. The Evaluator also estimated that, in 2020 and 2021 respectively, 48% and 52% of incremental MSHPs installed in existing Nova Scotia homes received an incentive from EOne through either Green Heat or HEA. These results are similar to the 2019 proportion of 55%.

2021 GH-Finding: The MSHP market is in a sustained growth phase.

NS Power predicted that annual incremental heat pump installations would remain relatively flat in 2020 and 2021 and that 35% of Nova Scotia households would use a heat pump in 2021. Heat pump distributors reported sales increases over the 2019-2021 period and agree that there is still strong consumer interest and sales potential in MSHPs moving forward.

2021 GH-Finding: Both the evaluated net energy and peak demand savings determined by the Evaluator were significantly higher than the savings tracked by EOne due to the new free-ridership level established in 2021 for MSHPs.

The evaluated gross energy and peak demand savings determined by the Evaluator were similar to the tracked gross savings, while the evaluated net energy and peak demand savings were higher than the tracked savings by 22% and 25% respectively. This increase was mainly due to the decrease in the free-ridership level of MSHPs, leading to a higher overall NTGR in 2021.

11 EPI OVERVIEW

This section describes the Efficient Product Installation (EPI) program component, follows up on past evaluation recommendations, and provides an overview of EPI participation history.

11.1 EPI Description

EPI provides participants with free-of-charge direct installations of energy efficient products. EOne contracts service providers to provide this service across the province. EPI is available to both homeowners and renters and encourages participants to also consider other EOne residential program components. Table 44 presents the products available for installation through EPI in 2021 and whether they were targeted at generating electrical savings, non-electrical savings, or both.

Table 44: 2021 EPI List of Eligible Products

Products	Electrical Savings	Non-electrical Savings
LED lamps including A-types, reflectors, and chandeliers	X	-
LED nightlights	X	-
Faucet aerators ²⁸	X	X
Low-flow showerheads ²⁹	X	X
Thermostatic shower valves ³⁰	X	X
Pipe insulation ³¹	X	X
Hot water tank wraps ³²	X	-
Smart thermostats (for non-electrically heated homes) ³³	-	X
Retractable clotheslines	X	-
Air sealing kits - foam gaskets	X	X
Air sealing kits - door sweeps	X	X
Air sealing kits - window air sealing	X	X
Air sealing kits - door weather stripping	X	X

²⁸ Since July 2018, through the addition of funds from the Low Carbon Economy Fund (LCEF), EPI has offered domestic hot water (DHW) products to both low-income and non-low-income homes with non-electrically heated hot water systems.

²⁹ Ibid.

³⁰ Thermostatic shower valves were removed in August 2019 and reintroduced in 2020.

³¹ Ibid.

³² Ibid.

³³ Since July 2019, smart thermostats are offered to all non-electrically heated households; prior to 2019, they were only offered to low-income households.

EPI funding comes from two sources: (1) Electricity ratepayer funding is used for upgrades that reduce electricity consumption; and (2) funding from the Government of Nova Scotia using, in part, funds from the federal government LCEF for upgrades that reduce the use of other fuels. This report presents the evaluation results for the electricity ratepayer portion of EPI only.

Due to public health and government directives regarding the COVID-19 pandemic, all in-home activities related to EPI were suspended from April 28, 2021 to June 1, 2021. Therefore, no installations were completed during that period.

EPI was aimed at achieving 10.7 GWh in net electrical energy savings and 2.07 MW in net peak demand savings at the generator in 2021.

11.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated EPI in previous years and issued improvement recommendations. Table 45 provides a summary of the implementation status of each recommendation presented in the Executive Summary section of the 2021 Evaluation Report as well as past recommendations that have been carried forward.

Table 45: Implementation Status of Past Recommendations for EPI

#	Past Recommendations for EPI	Status	Comments
2019 EPI-R2	Evaluate the market for EPI to quantify the residual potential for direct installations.	Deferred	EOne deferred the market evaluation to 2022.

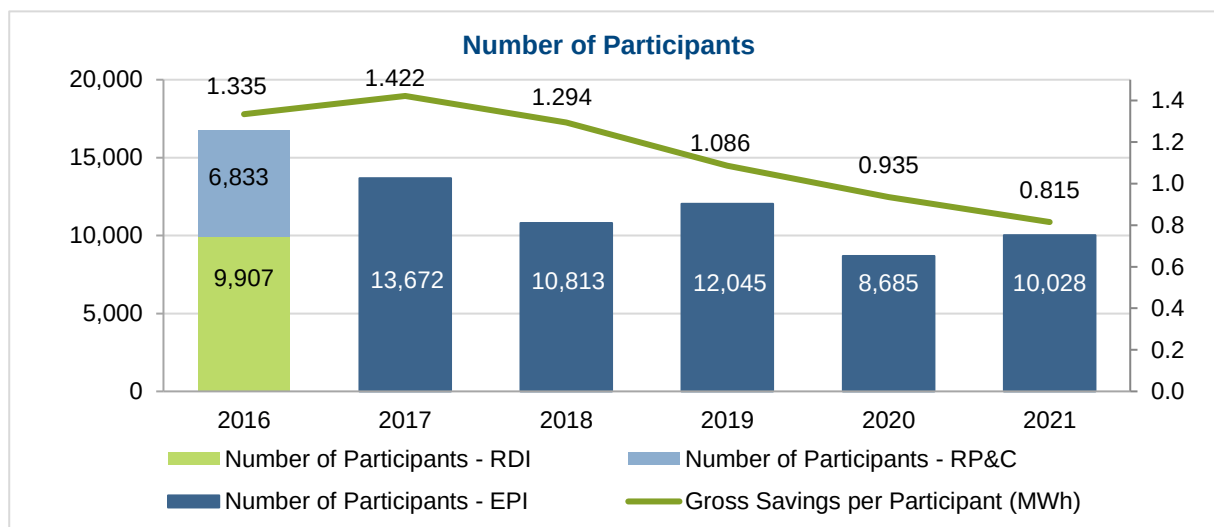
11.3 Participation History

As presented in Figure 26 below, EPI had 10,028 DSM participants, which represents a 15% increase in participation compared to 2020.³⁴ This can be explained in large part by a shorter suspension of in-home activities in response to the COVID-19 pandemic in 2021 compared to 2020.

In 2021, 155,935 efficient products were installed,³⁵ which represents a 2.5% increase compared to 2020. On average, 15.5 products were installed per household, down from the 17.5 products installed in 2020, despite the high proportion of participants living in single-family homes (86%) that typically offer many installation opportunities due to the size of such dwellings. Similarly, the average savings per participant decreased slightly by 13%. This follows the trend of declining savings per participant observed since 2017 due to a decreasing pool of opportunities per participant.

³⁴ The number of participants is based on the number of unique reference numbers of participants that generated electricity savings.

³⁵ The number of products only accounts for products generating electricity savings.

Figure 26: Overview of RDI,³⁶ RP&C,³⁷ and EPI Participation, 2016-2021


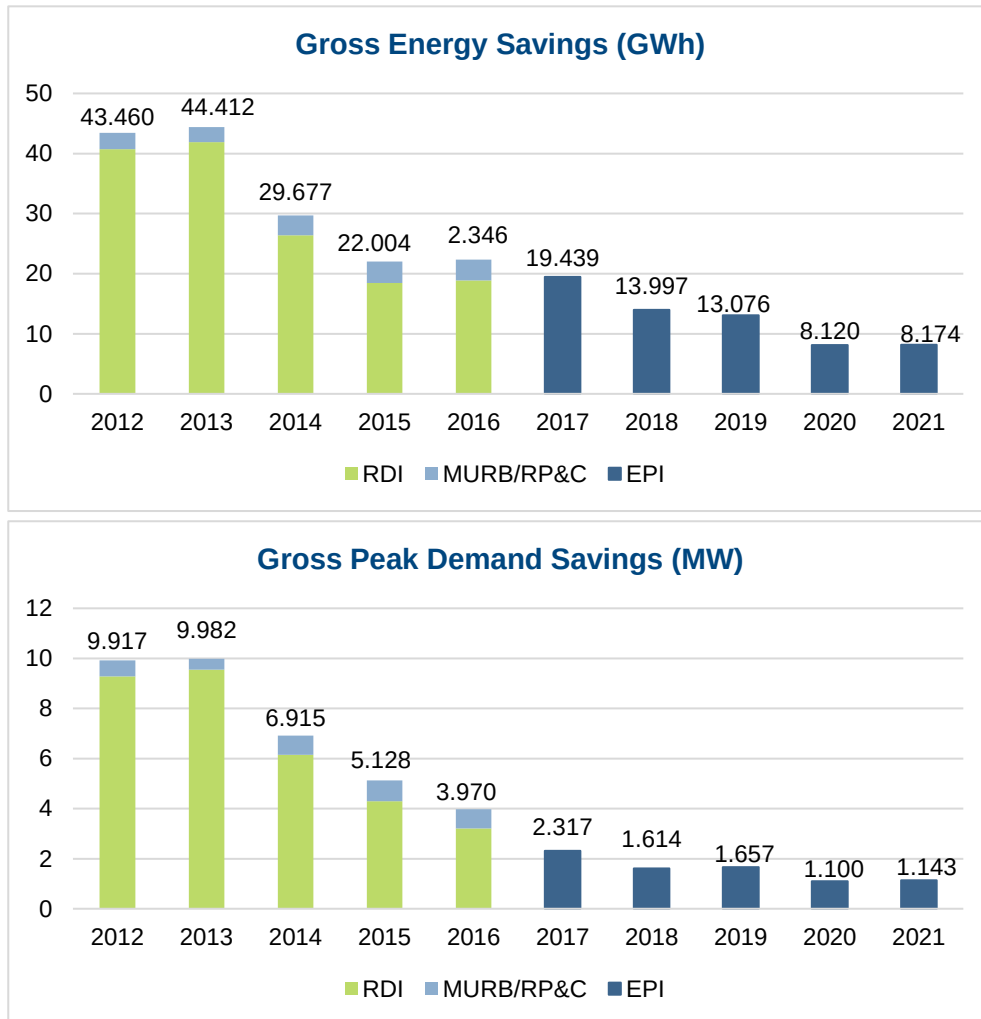
Furthermore, the number of A-type lamp replacements in single-family homes has continued to decrease. The average number of A-type lamps installed per single-family home decreased from 9.9 in 2020 to 8.0 in 2021. The decrease in the number of A-type lamp replacements explains in large part the decrease in the number of products per household discussed above. The average number of non-A-type lamp replacements per single-family home decreased slightly from 4.3 in 2020 to 3.4 in 2021. With 115,024 LED lamps generating 4.572 GWh in gross savings, LED lamps remain the most popular product type representing 74% of products installed in EPI and accounting for 56% of EPI gross savings.

³⁶ The number of 2016 RDI participants was revised to 9,907 to correct a transcription error made in the 2016 RDI Evaluation Report.

³⁷ The Multi-unit Residential Building program component became RP&C in 2014.

As illustrated in Figure 27 below, the 2021 gross energy and peak demand savings were similar to those generated in 2020 due to higher participation levels, although this was offset by lower savings per participant. In 2021, EPI achieved 8.174 GWh in gross electrical savings and 1.143 MW in gross peak demand savings.

Figure 27: Evolution of RDI, RP&C, and EPI Gross Savings, 2012-2021



12 EPI EVALUATION APPROACH

The 2021 EPI evaluation comprised a condensed impact evaluation. The main objectives of the 2021 EPI evaluation were as follows:

- › Calculate gross and net EPI results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions³⁸

The Evaluator identified key research questions aimed at achieving the main objectives. Table 46 outlines the evaluation objectives and maps them to the research questions and methods established by the Evaluator. Each method is described further below.

Table 46: 2021 EPI Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Collect information on participant perspectives	› How did participants become aware of EPI? › Why did participants want to participate in EPI? › What are participants' motivations for participating in program component? › How satisfied are participants with EPI overall and its aspects such as the products installed, quality of the work completed, and information received about the products installed?	› Participant survey
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › What are the unitary savings by product category? › What are the installation rates by product category? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › On-site visits › Measure Assessment update › Calculations using evaluation results
Calculate net results	› What is the EPI free-ridership level for 2021? › What is the EPI spillover level for 2021? › What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What are the net avoided GHG emissions in CO₂ eq for EPI?	› Participant survey › Calculations using evaluation results › GHG emission reduction calculations

³⁸ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

Participant Survey

In October and November 2021, Narrative Research conducted a telephone survey with a total of 100 participants. The average length of the survey was 15 minutes. The questionnaire is presented in Appendix X, while the complete survey results are outlined in Appendix XI. Drawing a random sample of 100 from a population of 10,028 yields a margin of error of 8.3% at a 90% confidence level.

Tracking Sheet Audit

Prior to performing the savings calculation review, the Evaluator audited the final 2021 tracking sheet to ensure it was complete and the entered data were consistent. The detailed protocol used for the tracking sheet audit and the results obtained are presented in Appendix XII.

On-site Visits

In the fall of 2021, Equilibrium performed on-site visits in 63 participant homes. The protocol for the on-site visits is presented in Appendix XIII.

Unitary Savings Review

The Evaluator reviewed the unitary savings of DHW measures based on the 2021 on-site visit findings and established unitary savings for one new lighting measure. The 2020-2022 Measure Assessment³⁹ was updated accordingly.

EUL Update

The Evaluator updated the EUL values of lighting products given the rapid evolution of the lighting market and established EUL values for the new lighting measure. The 2020-2022 Measure Assessment was updated accordingly.

Calculations Using Evaluation Results

Building on all the above methods and collected data, the Evaluator calculated the first-year and lifetime energy and peak demand savings as per the calculation methodology presented in Section 13 below.

GHG Emission Reduction Calculations

To obtain net avoided GHG emissions in CO₂ eq for EPI, the Evaluator multiplied net energy savings by the latest Nova Scotia-specific factor for GHG emissions generated by electricity production. This factor was established using NS Power data.

³⁹ The 2020-2022 Measure Assessment is a reference document that provides an in-depth review of all parameters necessary to calculate the annual and lifetime gross energy and peak demand savings of most prescriptive measures and some semi-prescriptive measures offered through EOne's DSM program portfolio. In addition, the Measure Assessment includes effective useful life measures for all measures offered in EOne's program portfolio. For the evaluations conducted during the 2020-2022 DSM cycle, the Evaluator refers to the values presented in the 2020-2022 Measure Assessment.

13 EPI PARTICIPANT PERSPECTIVES

A survey with 100 participating households was conducted as part of the EPI evaluation. Surveyed participants were asked questions regarding their awareness, motivations for participating, satisfaction and concerns about the services provided and their participation, and recommendations for program component improvements.

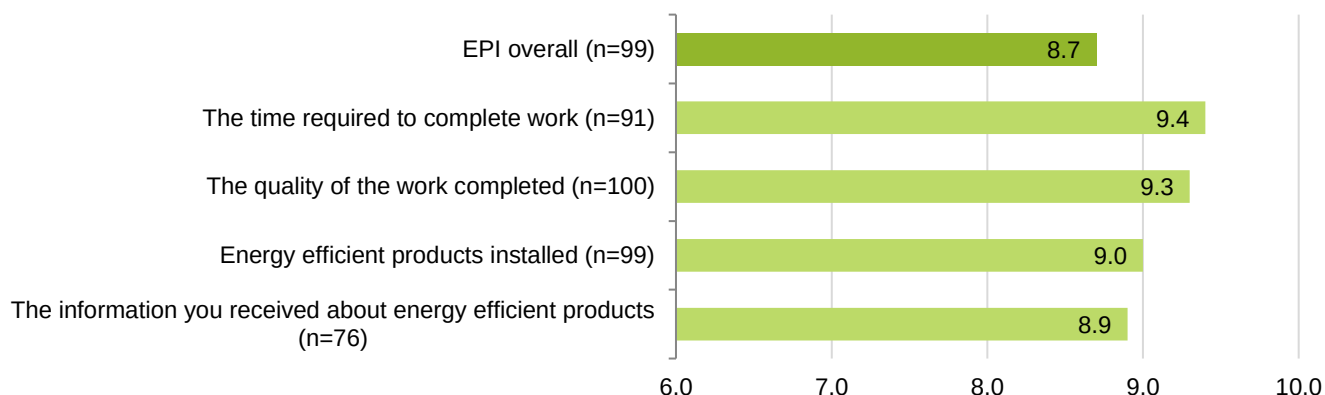
For the most part, participants first learned of EPI by word-of-mouth (32%), social media (13%) or information received by mail (11%). Participation in EPI was primarily motivated by a desire to save on energy costs (61%), although a small proportion (9%) were concerned that they would not save money or reduce their energy bill when they initially thought about participating in EPI. Wanting energy efficient upgrades was the second most cited motivation for participation (16%) despite concerns expressed by a few participants regarding product efficiency (5%) and EPI not providing an assessment on drafts in the house (5%). Overall, most participants (61%) reported having no concerns about participating in EPI.

Most participants (91%) were present when the energy efficient products were installed and most (84%) received information about energy efficient products during the installer visit. Seven of the 15 participants who did not receive this information expressed interest in it.

Satisfaction with EPI overall is very high and averages 8.7 on a scale of 1 to 10, where 1 means “Not at all satisfied” and 10 means “Completely satisfied”. Participants were mainly satisfied with the installer (26%), the information received (26%), and the good service provided in general (24%).

As outlined in Figure 28 below, participants also provided high satisfaction ratings for each aspect of the program component. The level of satisfaction is notably high with the time it took to complete the work and the quality of the work performed.

Figure 28: 2021 Participant Satisfaction with EPI (10-point Scale)



Note: Mean score of ratings on a scale of 1 to 10 where 1 means “Not at all satisfied” and 10 means “Completely satisfied”.

Two-thirds (66%) had no improvement recommendations, although a small proportion recommended offering more information on EPI and how to save energy (5%), offering more information on the products installed (5%), offering more products to be installed (5%), and improving advertising and awareness about the program component (4%).

2021 EPI Participant Perspective Highlights

- › Participants learned about EPI mainly through word-of-mouth, followed by social media or through the mail.
- › Satisfaction with EPI overall is very high among participants with an average rating of 8.7 on a 10-point scale. Participants were mainly satisfied with the installer, the information received, and the good service provided in general. They provided high ratings for the time required to complete the work (9.4 on a 10-point scale) and the quality of the work (9.3 on a 10-point scale)

14 EPI IMPACT EVALUATION

The objectives of the 2021 EPI impact evaluation were to determine the gross and net electrical energy and peak demand savings.

14.1 Tracking Sheet Audit

To ensure program component results are reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix XII. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

14.2 Gross Savings

For EPI, gross savings correspond to the change in energy consumption resulting from installing energy efficient products in participants' homes regardless of why they participated.⁴⁰ While the Evaluator relied on information from the 2020-2022 Measure Assessment to calculate EPI gross savings in 2021, the installation rates and certain assumptions were updated based on the 2021 EPI on-site visit findings. The Evaluator also applied an adjustment ratio determined as part of the 2019 evaluation to correct observed discrepancies in tracked lamp replacements.

In addition, the Evaluator updated the EUL values of lighting products, established EUL values for new products, and referred to the 2020-2022 Measure Assessment for the EUL values of all other products.

14.2.1 Installation Rates

Installation rates represent the proportion of products recorded in the tracking sheet that remain installed in participants' homes. In 2021, the Evaluator conducted 63 on-site visits that served to establish new installation rates for all products except for retractable clotheslines since there were no participants with this product in the sample. The installation rate from the previous on-site visits was used for retractable clotheslines.

Table 47 below lists the installation rates that the Evaluator applied to gross savings.

⁴⁰ Definition adapted from: National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

Table 47: 2021 EPI Product Installation Rates

Product	Installation Rate Applied to Gross Savings	Margin of Error	Source
LED Lamps	94%	2.1%	2021 EPI on-site visits
LED Nightlights	94%	2.1%	2021 EPI on-site visits
Faucet Aerators	85%	6.8%	2021 EPI on-site visits
Low-flow Showerheads	96%	5.1%	2021 EPI on-site visits
Thermostatic Shower Valves	88%	13.2%	2021 EPI on-site visits
Pipe Insulation (per ft)	100%	N/A	Assumption
Hot Water Tank Wraps	100%	0%	2021 EPI on-site visits
Retractable Clotheslines	86%	8.1%	EPI 2018 DSM and 2018/19 PNS Surveys
Air Sealing Kits – Foam Gaskets	31%	N/A	Assumption supported by 2021 EPI on-site visit findings (see details on the next page)
Air Sealing Kits – Door Sweeps	100%	0%	2021 EPI on-site visits
Air Sealing Kits – Window Air Sealing	84%	11.2%	2021 EPI on-site visits
Air Sealing Kits – Door Weather Stripping	84%	11.2%	2021 EPI on-site visits

The 2021 EPI site visits allowed the Evaluator to establish new installation rates with acceptable margins of error for most products. For products that had an installation rate with a margin of error higher than 10%, the Evaluator made the following assumptions:

- › While the margin of error obtained through the 2021 EPI site visits was above 10% for thermostatic shower valves, the installation rate established through the 2021 EPI site visits (88%) was used since it was close to the installation rate previously used (87% $\pm$ 9.5%) based on the 2018 DSM and 2018/19 PNS EPI surveys.
- › For pipe insulation, an installation rate of 100% was used since the 2021 EPI site visits did not result in an installation rate with an acceptable margin of error. The installation rate previously used (106%) was not maintained since the 2021 EPI site visits, despite resulting in a high margin of error, resulted in an installation rate of 92%, which did not support an installation rate above 100%.

- › For window air sealing and door weather stripping, a combined installation rate based on the 2021 EPI site visits was established to reduce the margin of error.⁴¹ It was considered acceptable to combine these two measures since their installation rates were similar and the reasons reported by participants for not having them installed at the time of the visits were similar. While the margin of error was above the 10% threshold despite combining these two measures, the installation ratio of 84% was used since the real installation rate is likely close to this value and using an assumption of 100% for the installation rate would overestimate savings.

In addition, the following assumptions were made for foam gaskets:

- › Visually confirming the installation of foam gaskets could not be accomplished within the time allotted for site visits. Instead, the Evaluator verbally confirmed if the participants received them and if they installed some or all of them. Among the visited participants that received foam gaskets based on the tracking sheet, 88% confirmed having receive this product. Participants had difficulties confirming if the foam gaskets were installed or how many were installed. The Evaluator assumed that seven foam gaskets (out of ten per package) would be installed on average based on the number of plugs and switches on exterior walls that were observed during the visits. The Evaluator also included an uncertainty factor of 50%. The equation below summarizes the calculation of the foam gasket installation rate.

Foam Gasket Installation Rate

$$\begin{aligned}
 &= \% \text{ of Participants that Confirmed Receiving Foam Gaskets} \\
 &\times \text{Uncertainty Factor} \times \frac{\text{Average Number Installed}}{\text{Number per Package}} \\
 &= 88\% \times 50\% \times 7/10 = 31\%
 \end{aligned}$$

14.2.2 Unitary Energy Savings

For EPI, EOne establishes separate unitary savings values for single-family homes and apartments. The Evaluator used the unitary savings values from the 2020-2022 Measure Assessment and revised them where necessary based on the 2021 EPI on-site visit findings. The 2020-2022 Measure Assessment document provides a detailed description of inputs, references, and unitary savings calculations for all product types offered through EPI.

⁴¹ Separately, the installation rate for window air sealing would have been 86% with a margin of error of 19% and 82% for door weather stripping with a margin of error of 13%.

The Evaluator made changes to the unitary savings values of DHW products, namely faucet aerators, low-flow showerheads, and thermostatic shower valves, to consider the average number of showerheads (from 1.5 to 1.6) and faucets (from 3.3 to 3.1) per household observed during the 2021 EPI on-site visits. Blackout bulbs were added to the 2020-2022 Measure Assessment since they were not included in that document previously; the evaluated unitary savings for this product were identical to the tracked values. The energy savings for other products, including lighting, were valid and required no adjustments.

Table 48 below summarizes the tracked and evaluated unitary energy savings for each product installed through EPI in 2021.

Table 48: 2021 EPI Tracked and Evaluated Unitary Energy Savings

Product	EPI – Single-family Homes		EPI – Apartments	
	Tracked Savings [kWh/yr]	Evaluated Savings [kWh/yr]	Tracked Savings [kWh/yr]	Evaluated Savings [kWh/yr]
LED Lamps				
9 W Replacing 25 W	15.8	No change	15.8	No change
9 W Replacing 29 W	19.7	No change	19.7	No change
9 W Replacing 40 W	30.6	No change	30.6	No change
9 W Replacing 43 W	33.5	No change	33.5	No change
9 W Replacing 60 W	50.3	No change	50.3	No change
9 W Replacing 72 W	62.1	No change	62.1	No change
9 W Replacing 100 W	89.7	No change	89.7	No change
9 W Replacing 150 W	139	No change	139	No change
9.5 W Replacing 29 W	19.2	No change	19.2	No change
9.5 W Replacing 40 W	30.1	No change	30.1	No change
9.5 W Replacing 43 W	33.0	No change	33.0	No change
9.5 W Replacing 60 W	49.8	No change	49.8	No change
9.5 W Replacing 72 W	61.6	No change	61.6	No change
9.5 W Replacing 100 W	89.2	No change	89.2	No change
9.5 W Replacing 150 W	138	No change	138	No change
18 W Replacing 100 W	80.8	No change	80.8	No change
7 W Black-out Bulbs (BOB) Replacing 60 W	52.2	No change	52.2	No change
PAR20 7 W Replacing 50 W	42.4	No change	42.4	No change
PAR30 8 W Replacing 53 W	44.3	No change	44.3	No change
PAR30 8 W Replacing 75 W	66.0	No change	66.0	No change
PAR38 15 W Replacing 90 W	73.9	No change	73.9	No change
PAR38 15 W Replacing 120 W	103	No change	103	No change
PAR38 15 W Replacing 150 W	133	No change	133	No change
GU10 7 W Replacing 35 W	27.6	No change	27.6	No change
GU10 7 W Replacing 50 W	42.4	No change	42.4	No change
7 W G25 Replacing 40 W	32.5	No change	32.5	No change
5 W Chandelier E12 Replacing 40 W	34.5	No change	34.5	No change

2021 EPI Tracked and Evaluated Unitary Energy Savings (Continued)

Product	EPI – Single-family Homes		EPI – Apartments	
	Tracked Savings [kWh/yr]	Evaluated Savings [kWh/yr]	Tracked Savings [kWh/yr]	Evaluated Savings [kWh/yr]
Air Sealing Products				
Air Sealing Kits – Foam Gaskets (Electric resistance heating)	90	No change	90	No change
Air Sealing Kits – Foam Gaskets (Heat pump heating)	40.9	No change	40.9	No change
Air Sealing Kits – Door Sweeps (Electric resistance heating)	173	No change	173	No change
Air Sealing Kits – Door Sweeps (Heat pump heating)	78.6	No change	78.6	No change
Air Sealing Kits – Window Air Sealing (Electric resistance heating)	149	No change	149	No change
Air Sealing Kits – Window Air Sealing (Heat pump heating)	67.7	No change	67.7	No change
Air Sealing Kits – Door Weather Stripping (Electric resistance heating)	196	No change	196	No change
Air Sealing Kits – Door Weather Stripping (Heat pump heating)	89.1	No change	89.1	No change
Other Products				
LED Nightlights	29.3	No change	29.3	No change
Faucet Aerators	103	110	130	No change
Low-flow Showerheads (0.5 gpm)	200	187	227	No change
Low-flow Showerheads (0.75 gpm)	299	281	341	No change
Low-flow Showerheads (1.0 gpm)	399	374	455	No change
Thermostatic Shower Valves (1.5 gpm)*	75	71	86	No change
Thermostatic Shower Valves (2.0 gpm)*	100	94	114	No change
Thermostatic Shower Valves (2.5 gpm)	125	118	143	No change
Pipe Insulation (per ft)	12.7	No change	12.7	No change
Hot Water Tank Wraps	159	No change	118	No change
Retractable Clotheslines	104	No change	104	No change
* Thermostatic shower valves of 1.5 or 2.0 gpm are no longer eligible but were included since a few were included in the tracking sheet.				

14.2.3 Unitary Peak Demand Savings

Peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The projected electricity demand peak period in Nova Scotia is between 5 p.m. and 7 p.m. in the months of December to February on non-holiday weekdays.

The Evaluator developed unitary peak demand savings for each product based on the peak demand-to-energy ratios presented in the 2020-2022 Measure Assessment. Differences between tracked and evaluated peak demand savings reflect updates made to the unitary energy savings of certain products. In addition, unitary peak demand savings for DHW direct load controls were established based on a literature review and added to the 2020-2022 Measure Assessment.

Table 49 summarizes the tracked and evaluated unitary peak demand savings for each product installed through EPI in 2021.

Table 49: 2021 EPI Tracked and Evaluated Unitary Peak Demand Savings Values

Product	EPI – Single-family Homes		EPI – Apartments	
	Tracked Savings [W/yr]	Evaluated Savings [W/yr]	Tracked Savings [W/yr]	Evaluated Savings [W/yr]
LED Lamps				
9 W Replacing 25 W	2.56	No change	2.56	No change
9 W Replacing 29 W	3.19	No change	3.19	No change
9 W Replacing 40 W	4.96	No change	4.96	No change
9 W Replacing 43 W	5.43	No change	5.43	No change
9 W Replacing 60 W	8.15	No change	8.15	No change
9 W Replacing 72 W	10.1	No change	10.1	No change
9 W Replacing 100 W	14.5	No change	14.5	No change
9 W Replacing 150 W	22.5	No change	22.5	No change
9.5 W Replacing 29 W	3.11	No change	3.11	No change
9.5 W Replacing 40 W	4.88	No change	4.88	No change
9.5 W Replacing 43 W	5.35	No change	5.35	No change
9.5 W Replacing 60 W	8.07	No change	8.07	No change
9.5 W Replacing 72 W	9.98	No change	9.98	No change
9.5 W Replacing 100 W	14.5	No change	14.5	No change
9.5 W Replacing 150 W	22.4	No change	22.4	No change
18 W Replacing 100 W	13.1	No change	13.1	No change
7 W Black-out Bulbs (BOB) Replacing 60 W	8.46	No change	8.46	No change
PAR20 7 W Replacing 50 W	6.87	No change	6.87	No change
PAR30 8 W Replacing 53 W	7.18	No change	7.18	No change
PAR30 8 W Replacing 75 W	10.7	No change	10.7	No change

Product	EPI – Single-family Homes		EPI – Apartments	
	Tracked Savings [W/yr]	Evaluated Savings [W/yr]	Tracked Savings [W/yr]	Evaluated Savings [W/yr]
PAR38 15 W Replacing 90 W	12.0	No change	12.0	No change
PAR38 15 W Replacing 120 W	16.7	No change	16.7	No change
PAR38 15 W Replacing 150 W	21.5	No change	21.5	No change
GU10 7 W Replacing 35 W	4.47	No change	4.47	No change
GU10 7 W Replacing 50 W	6.87	No change	6.87	No change
7 W G25 Replacing 40 W	5.27	No change	5.27	No change
5 W Chandelier E12 Replacing 40 W	5.59	No change	5.59	No change
Air Sealing Products				
Air Sealing Kits – Foam Gaskets (Electric resistance heating)	25.5	No change	25.5	No change
Air Sealing Kits – Foam Gaskets (Heat pump heating)	11.6	No change	11.6	No change
Air Sealing Kits – Door Sweeps (Electric resistance heating)	49.0	No change	49.0	No change
Air Sealing Kits – Door Sweeps (Heat pump heating)	22.2	No change	22.2	No change
Air Sealing Kits – Window Air Sealing (Electric resistance heating)	42.2	No change	42.2	No change
Air Sealing Kits – Window Air Sealing (Heat pump heating)	19.2	No change	19.2	No change
Air Sealing Kits – Door Weather Stripping (Electric resistance heating)	55.5	No change	55.5	No change
Air Sealing Kits – Door Weather Stripping (Heat pump heating)	25.2	No change	25.2	No change
Other Products				
LED Nightlights	4.75	No change	4.75	No change
Faucet Aerators	16.7	17.8	21.1	No change
Low-flow Showerheads (0.5 gpm)	32.4	30.3	36.8	No change
Low-flow Showerheads (0.75 gpm)	48.4	45.5	55.2	No change
Low-flow Showerheads (1.0 gpm)	64.6	60.6	73.7	No change
Thermostatic Shower Valves (1.5 gpm)*	12.2	11.5	13.9	No change
Thermostatic Shower Valves (2.0 gpm)*	16.2	15.2	18.5	No change
Thermostatic Shower Valves (2.5 gpm)	20.3	19.1	23.2	No change
Pipe Insulation (per ft)	2.06	No change	2.06	No change
Hot Water Tank Wraps	25.8	No change	19.1	No change
Retractable Clotheslines	0.00	No change	0.00	No change
* Thermostatic shower valves of 1.5 or 2.0 gpm are no longer eligible but were included since a few were included in the tracking sheet.				

14.2.4 Interactive Effects

In a home, interactive effects occur when the implementation of energy efficiency products has an impact on the energy consumption of other elements such as heating and cooling. In the case of EPI, replacing lighting products with LEDs causes an increase in the heating load during winter and a decrease in the cooling load during summer. The same effects occur for hot water insulation products.

For the 2021 evaluation, the Evaluator relied on the interactive effects factors presented in the 2020-2022 Measure Assessment with the exception of A-type and PAR38 lamps. The interactive effects factors were updated for LED A-type lamps to account for an update in the proportion of lamps installed inside versus outside (from 96% to 97%) based on the information in the 2021 EPI tracking sheet. Based on site visit observations, PAR38 lamps were assumed to be installed outdoors and the interactive effects factor was updated accordingly.

Table 50 and Table 51 below list the interactive effects factors for LED products installed indoors and hot water insulation products respectively.

Table 50: 2021 EPI Interactive Effects Calculation Results for LED Products Installed Indoors

Product	Type of Home	Energy Interactive Effects Factors	Peak Demand Interactive Effects Factors
LED A-type Lamps	Heat Pump Heating and Air Conditioning	-19.4%	-87.3%
	Electrical Heating with Air Conditioning	-53.3%	-87.3%
	Electrical Heating Without Air Conditioning	-56.3%	-87.3%
	No Electrical Heating with Air Conditioning	3.0%	0%
	With Neither Electrical Heating nor Air Conditioning	0%	0%
Reflector and Decorative LED Lamps and LED Nightlights (Except PAR38)	Heat Pump Heating and Air Conditioning	-20.0%	-90.0%
	Electrical Heating with Air Conditioning	-54.9%	-90.0%
	Electrical Heating Without Air Conditioning	-58.0%	-90.0%
	No Electrical Heating with Air Conditioning	3.1%	0%
	With Neither Electrical Heating nor Air Conditioning	0%	0%
PAR38 LED Lamps	Outdoor	0%	0%

Table 51: 2021 EPI Interactive Effects Factors for Pipe Insulation and Hot Water Tank Wraps

Parameter		Total Energy Interactive Effects	Peak Demand Interactive Effects
Single-family Homes	Heat Pump Heating	-13.0%	-90%
	Electrical Heating	-28.5%	-90%
	No Electrical Heating	0.0%	0%
Apartments	Heat Pump Heating and Cooling	-23.0%	-90%
	Electrical Heating with Air Conditioning	-54.8%	-90%
	Electrical Heating Without Air Conditioning	-60.0%	-90%
	No Electrical Heating with Air Conditioning	5.2%	0%
	With Neither Electrical Heating nor Air Conditioning	0.0%	0%

14.2.5 Adjustment Ratio

As part of the 2019 evaluation, the Evaluator conducted on-site visits (n = 28) to establish an overview of the types of lamps used in homes and verify that replaced A-type lamps were being properly tracked. The on-site visit results indicated that there are certain discrepancies in tracked savings.

Comparing the revised savings with tracked savings, the Evaluator determined an adjustment ratio of 96% with a margin of error of 5%. In an effort to track the replaced wattages of A-type lamps more accurately, EOne introduced new product categories to include a larger range of wattages. In 2021, 1,569 LED lamps were tracked under those new categories, which represent 2% of LED A-type lamps installed under EPI.

No data collection aimed at updating the adjustment ratio was conducted in 2021. Therefore, given the low number of LED lamps tracked under the new categories, as in the 2019 evaluation, this adjustment ratio was applied to the tracked savings for A-type incandescent lamp replacements to correct for observed discrepancies in tracked replaced lamps.

14.2.6 Effective Useful Life

As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the EUL values used in the calculation of electrical energy savings that are expected to persist over time. Apart from lighting products and pipe insulation, the EUL values established in the previous evaluation remain valid for the 2021 evaluation. For lighting products, EUL values were updated since baseline changes are anticipated during the measure lifetimes.

Table 52 below summarizes the tracked and revised equivalent EUL values. The revised equivalent EUL values are applied to each product gross and net first-year electrical energy savings to obtain gross and net lifetime electrical energy savings. As a result, the weighted average EUL values of gross and net savings differ (see Subsections 14.2.7 and 14.3.4).

Table 52: 2021 EPI Equivalent Effective Useful Life Values

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]	Evaluated Gross Lifetime Unitary Savings [kWh]	
			Single-family	Apartments
LED A19 Lamps				
9 W Replacing 25 W	4.0	3.0	47	
9 W Replacing 29 W	7.2	6.3	124	
9 W Replacing 40 W	5.0	4.4	135	
9 W Replacing 43 W	9.6	8.8	295	
9 W Replacing 60 W	6.7	6.2	312	
9 W Replacing 72 W	13.0	12.4	770	
9 W Replacing 100 W	9.3	8.9	798	
9 W Replacing 150 W	9.6	9.5	1,321	
9.5 W Replacing 29 W	7.2	6.3	121	
9.5 W Replacing 40 W	5.0	4.4	132	
9.5 W Replacing 43 W	9.6	8.8	290	
9.5 W Replacing 60 W	6.7	6.2	309	
9.5 W Replacing 72 W	13.0	12.4	764	
9.5 W Replacing 100 W	9.3	8.9	794	
9.5 W Replacing 150 W	9.6	9.5	847	
18 W Replacing 100 W	9.3	8.9	719	
7 W Black-out Bulbs (BOB) Replacing 60 W	8	6.2	324	
LED Reflector Lamps				
PAR20 7 W Replacing 50 W	5.5	4.5	191	
PAR30 8 W Replacing 53 W	4.9	4.0	177	
PAR30 8 W Replacing 75 W	6.5	5.6	370	
PAR38 15 W Replacing 90 W	6.0	5.1	377	
PAR38 15 W Replacing 120 W	7.2	6.4	659	
PAR38 15 W Replacing 150 W	6.8	5.9	785	
GU10 7 W Replacing 35 W	4.8	3.8	105	
GU10 7 W Replacing 50 W	5.5	4.5	191	
LED Decorative Lamps				
7 W G25 Replacing 40 W	4.0	3.0	98	
5 W Chandelier E12 Replacing 40 W	4.0	3.0	104	

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]	Evaluated Gross Lifetime Unitary Savings [kWh]	
			Single-family	Apartments
Air Sealing Products				
Air Sealing Kits – Foam Gaskets (Electric resistance heating)	15.0	No change	1,350	
Air Sealing Kits – Foam Gaskets (Heat pump heating)	15.0	No change	615	
Air Sealing Kits – Door Sweeps (Electric resistance heating)	15.0	No change	2,595	
Air Sealing Kits – Door Sweeps (Heat pump heating)	15.0	No change	1,179	
Air Sealing Kits – Window Air Sealing (Electric resistance heating)	15.0	No change	2,235	
Air Sealing Kits – Window Air Sealing (Heat pump heating)	15.0	No change	1,013	
Air Sealing Kits – Door Weather Stripping (Electric resistance heating)	15.0	No change	2,940	
Air Sealing Kits – Door Weather Stripping (Heat pump heating)	15.0	No change	1,326	
Other Products				
LED Nightlights	23.0	No change	674	
Faucet Aerators	10.0	No change	1,100	1,300
Low-flow Showerheads (0.5 gpm)	10.0	No change	1,870	2,270
Low-flow Showerheads (0.75 gpm)	10.0	No change	2,810	3,410
Low-flow Showerheads (1.0 gpm)	10.0	No change	3,740	4,550
Thermostatic Shower Valves (1.5 gpm)	10.0	No change	710	860
Thermostatic Shower Valves (2.0 gpm)	10.0	No change	940	1,140
Thermostatic Shower Valves (2.5 gpm)	10.0	No change	1,180	1,430
Pipe Insulation (per ft)	15.0	13.0	165	
Hot Water Tank Wraps	7.0	No change	1,113	826
Retractable Clotheslines	10.0	No change	1,040	

14.2.7 Evaluated Gross Savings

The annual gross savings for each category of products installed in 2021 through EPI are listed below. Table 53 and Table 54 below present the results for single-family homes and apartments respectively. Overall, the total gross energy and peak demand savings amounted to 8.174 GWh and 1.143 MW at the generator respectively, which represent 67.214 GWh in lifetime electrical energy savings. As a result, the weighted average EUL value for gross electrical energy savings was established at 8.2 years.

The gross savings at the generator were estimated using the appropriate line loss factors for each participant based on their rate code. The line loss factors correspond to the values submitted to the Nova Scotia Utility and Review Board (NSUARB) as part of the 2014 Cost of Service Study Progress Update.⁴²

⁴² Nova Scotia Utility and Review Board, *Matter M06555, 2014 Cost of Service Study Progress Update*, Exhibit N-2.09, Appendix I1.

Table 53: Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Single-family Homes

Product Category	LED Lamps							
	9 W Replacing							
	25 W	29 W	40 W	43 W	60 W	72 W	100 W	150 W
Number of Units								
Number of Units	359	847	7,652	670	59,700	110	5,414	6
Installation Rate (%)	94%	94%	94%	94%	94%	94%	94%	94%
Number of Units Installed	337	796	7,193	630	56,118	103	5,089	6
Energy Savings								
Unitary Energy Savings (kWh)	15.8	19.7	30.6	33.5	50.3	62.1	89.7	139
Energy Interactive Effects Factor*	-18.8%	-13.9%	-14.2%	-13.6%	-18.8%	-19.6%	-14.5%	-17.3%
Adjustment Ratio	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Gross Energy Savings – at the Meter (GWh)	0.004	0.013	0.181	0.017	2.200	0.005	0.375	0.001
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.005	0.014	0.199	0.019	2.408	0.005	0.410	0.001
Effective Useful Life (years)	3.0	6.3	4.4	8.8	6.2	12.4	8.9	9.5
Gross Lifetime Energy Savings – at the Generator (GWh)	0.014	0.089	0.873	0.169	14.929	0.067	3.652	0.006
Peak Demand Savings								
Unitary Peak Demand Savings (W)	2.56	3.19	4.96	5.43	8.15	10.1	14.5	22.5
Peak Demand Interactive Effects Factor*	-31.1%	-22.9%	-29.2%	-21.8%	-39.3%	-35.7%	-34.9%	-29.1%
Adjustment Ratio	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Gross Peak Demand Savings – at the Meter (MW)	0.001	0.002	0.024	0.003	0.267	0.001	0.046	0.000
Line Loss Factor*	1.1466	1.1466	1.1463	1.1462	1.1465	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.001	0.002	0.028	0.003	0.306	0.001	0.053	0.000
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.								

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Single-family Homes (Continued)

Product Category	LED Lamps						
	9.5 W Replacing						
	29 W	40 W	43 W	60 W	72 W	100 W	150 W
Number of Units							
Number of Units	0	0	0	0	0	0	2
Installation Rate (%)	94%	94%	94%	94%	94%	94%	94%
Number of Units Installed	0	0	0	0	0	0	2
Energy Savings							
Unitary Energy Savings (kWh)	19.2	30.1	33.0	49.8	61.6	89.2	138
Energy Interactive Effects Factor*	N/A	N/A	N/A	N/A	N/A	N/A	-27.6%
Adjustment Ratio	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Gross Energy Savings – at the Meter (GWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Effective Useful Life (years)	6.3	4.4	8.8	6.2	12.4	8.9	9.5
Gross Lifetime Energy Savings – at the Generator (GWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.002
Peak Demand Savings							
Unitary Peak Demand Savings (W)	3.11	4.88	5.35	8.07	9.98	14.5	22.4
Peak Demand Interactive Effects Factor*	N/A	N/A	N/A	N/A	N/A	N/A	-43.4%
Adjustment Ratio	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Line Loss Factor*	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.							

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Single-family Homes (Continued)

Product Category	LED Lamps					
	18 W Replacing 100 W	7 W BOB Replacing 60 W	PAR20 7 W Replacing 50 W	PAR30 8 W Replacing 53 W	PAR30 8 W Replacing 75 W	PAR38 15 W Replacing 90 W
Number of Units						
Number of Units	420	817	6,749	0	0	234
Installation Rate (%)	94%	94%	94%	94%	94%	94%
Number of Units Installed	395	768	6,344	0	0	220
Energy Savings						
Unitary Savings Value (kWh)	80.8	52.2	42.4	44.3	66	73.9
Interactive Effects Factor*	-13.7%	-22.6%	-22.0%	N/A	N/A	0.0%
Adjustment Ratio	0.96	0.96	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.026	0.030	0.210	0.000	0.000	0.016
Line Loss Factor*	1.0947	1.0946	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.029	0.033	0.230	0.000	0.000	0.018
Effective Useful Life (years)	8.9	6.2	4.5	4.0	5.6	5.1
Gross Lifetime Energy Savings – at the Generator (GWh)	0.258	0.202	1.033	0.000	0.000	0.091
Peak Demand Savings						
Unitary Peak Demand Savings (W)	13.1	8.46	6.87	7.18	10.7	12.0
Peak Demand Interactive Effects Factor*	-27.2%	-43.6%	-49.5%	N/A	N/A	0.0%
Adjustment Ratio	0.96	0.96	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.004	0.004	0.022	0.000	0.000	0.003
Line Loss Factor*	1.1464	1.1457	1.1464	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.004	0.004	0.025	0.000	0.000	0.003
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.						

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Single-family Homes (Continued)

Product Category	LED Lamps					
	PAR38 15 W Replacing 120 W	PAR38 15 W Replacing 150 W	GU10 7 W Replacing 35 W	GU10 7 W Replacing 50 W	G25 7 W Replacing 40 W	E12 5 W Chandelier Replacing 40 W
Number of Units						
Number of Units	551	1,595	762	5,056	4,070	14,524
Installation Rate (%)	94%	94%	94%	94%	94%	94%
Number of Units Installed	518	1,499	716	4,753	3,826	13,653
Energy Savings						
Unitary Savings Value (kWh)	103	133	27.6	42.4	32.5	34.5
Interactive Effects Factor*	0.0%	0.0%	-17.8%	-22.2%	-22.5%	-18.4%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.053	0.199	0.016	0.157	0.096	0.384
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.058	0.218	0.018	0.172	0.106	0.421
Effective Useful Life (years)	6.4	5.9	3.8	4.5	3.0	3.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.374	1.288	0.068	0.772	0.317	1.262
Peak Demand Savings						
Unitary Peak Demand Savings (W)	16.7	21.5	4.47	6.87	5.27	5.59
Peak Demand Interactive Effects Factor*	0.0%	0.0%	-42.4%	-46.4%	-46.3%	-40.1%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.009	0.032	0.002	0.018	0.011	0.046
Line Loss Factor*	1.1466	1.1466	1.1466	1.1464	1.1463	1.1465
Gross Peak Demand Savings – at the Generator (MW)	0.010	0.037	0.002	0.020	0.012	0.052
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.						

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Single-family Homes (Continued)

	LED Nightlights	Faucet Aerators	Low-flow Showerheads		
			0.5 gpm Reduction	0.75 gpm Reduction	1.0 gpm Reduction
Number of Units					
Number of Units	9,949	5,418	224	186	3,323
Installation Rate (%)	94%	85%	96%	96%	96%
Number of Units Installed	9,352	4,605	215	179	3,190
Energy Savings					
Unitary Savings Value (kWh)	29.3	110	187	281	374
Interactive Effects Factor*	-20.4%	0.0%	0.0%	0.0%	0.0%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.218	0.507	0.040	0.050	1.193
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.239	0.555	0.044	0.055	1.306
Effective Useful Life (years)	23.0	10.0	10.0	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	5.489	5.545	0.440	0.549	13.060
Peak Demand Savings					
Unitary Peak Demand Savings (W)	4.75	17.8	30.3	45.5	60.6
Peak Demand Interactive Effects Factor*	-42.3%	0.0%	0.0%	0.0%	0.0%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.026	0.082	0.007	0.008	0.193
Line Loss Factor*	1.1464	1.1463	1.1466	1.1466	1.1463
Gross Peak Demand Savings – at the Generator (MW)	0.029	0.094	0.007	0.009	0.222
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.					

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Single-family Homes (Continued)

Product Category	Thermostatic Shower Valves			Pipe Insulation (per foot)	Hot Water Tank Wraps
	1.5 gpm	2.0 gpm	2.5 gpm		
Number of Units					
Number of Units	3	4	1,349	6,936	2,139
Installation Rate (%)	88%	88%	88%	100%	100%
Number of Units Installed	3	4	1,187	6,936	2,139
Energy Savings					
Unitary Savings Value (kWh)	71.0	94.0	118	12.7	159
Interactive Effects Factor*	0.0%	0.0%	0.0%	-16.2%	-14.3%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.000	0.000	0.140	0.074	0.292
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.000	0.000	0.153	0.081	0.319
Effective Useful Life (years)	10.0	10.0	10.0	13.0	7.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.002	0.004	1.533	1.051	2.234
Peak Demand Savings					
Unitary Peak Demand Savings (W)	11.5	15.2	19.1	2.06	25.8
Peak Demand Interactive Effects Factor*	0.0%	0.0%	0.0%	-38.4%	-55.5%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.023	0.009	0.025
Line Loss Factor*	1.1466	1.1466	1.1463	1.1465	1.1463
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.026	0.010	0.028
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.					

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Single-family Homes (Continued)

Product Category	Retractable Clotheslines	Air Sealing Kits – Electric Resistance Heating			
		Foam Gaskets	Door Sweeps	Window Air Sealing	Door Weather Stripping
Number of Units					
Number of Units	2,475	2,052	115	281	448
Installation Rate (%)	86%	31%	100%	84%	84%
Number of Units Installed	2,129	636	115	236	376
Energy Savings					
Unitary Savings Value (kWh)	104	90.0	173	149	196
Interactive Effects Factor*	0.0%	0.0%	0.0%	0.0%	0.0%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.221	0.057	0.020	0.035	0.074
Line Loss Factor*	1.0946	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.242	0.063	0.022	0.039	0.081
Effective Useful Life (years)	10.0	15.0	15.0	15.0	15.0
Gross Lifetime Energy Savings – at the Generator (GWh)	2.423	0.940	0.327	0.578	1.211
Peak Demand Savings					
Unitary Peak Demand Savings (W)	0	25.5	49	42.2	55.5
Peak Demand Interactive Effects Factor*	0.0%	0.0%	0.0%	0.0%	0.0%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.016	0.006	0.010	0.021
Line Loss Factor*	1.1466	1.1462	1.1465	1.1466	1.1465
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.019	0.006	0.011	0.024
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.					

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Single-family Homes (Continued)

Product Category	Air Sealing Kits – Heat Pump Heating				Total for Single-family Homes
	Foam Gaskets	Door Sweeps	Window Air Sealing	Door Weather Stripping	
Number of Units					
Number of Units	1,347	88	185	333	146,393
Installation Rate (%)	31%	100%	84%	84%	-
Number of Units Installed	418	88	155	280	135,209
Energy Savings					
Unitary Savings Value (kWh)	40.9	78.6	67.7	89.1	-
Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	-
Adjustment Ratio	1.00	1.00	1.00	1.00	-
Gross Energy Savings – at the Meter (GWh)	0.017	0.007	0.011	0.025	6.966
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	-
Gross Energy Savings – at the Generator (GWh)	0.019	0.008	0.012	0.027	7.625
Effective Useful Life (years)	15.0	15.0	15.0	15.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	0.280	0.114	0.173	0.409	61.827
Peak Demand Savings					
Unitary Peak Demand Savings (W)	11.6	22.2	19.2	25.2	-
Peak Demand Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	-
Adjustment Ratio	1.00	1.00	1.00	1.00	-
Gross Peak Demand Savings – at the Meter (MW)	0.005	0.002	0.003	0.007	0.933
Line Loss Factor*	1.1464	1.1466	1.1461	1.1466	-
Gross Peak Demand Savings – at the Generator (MW)	0.006	0.002	0.003	0.008	1.069

* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.

Table 54: Evaluated 2021 EPI Gross Energy and Peak Demand Savings – Apartments

Product Category	LED Lamps							
	9 W Replacing							
	25 W	29 W	40 W	43 W	60 W	72 W	100 W	150 W
Number of Units								
Number of Units	14	19	122	16	4,135	0	90	1
Installation Rate (%)	94%	94%	94%	94%	94%	94%	94%	94%
Number of Units Installed	13	18	115	15	3,887	0	85	1
Energy Savings								
Unitary Energy Savings (kWh)	15.8	19.7	30.6	33.5	50.3	62.1	89.7	139
Energy Interactive Effects Factor*	-39.1%	-47.4%	-37.3%	-30.7%	-18.4%	N/A	-41.3%	-56.3%
Adjustment Ratio	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Gross Energy Savings – at the Meter (GWh)	0.000	0.000	0.002	0.000	0.153	0.000	0.004	0.000
Line Loss Factor*	1.0947	1.0945	1.0947	1.0947	1.0867	1.0947	1.0878	1.0947
Gross Energy Savings – at the Generator (GWh)	0.000	0.000	0.002	0.000	0.167	0.000	0.005	0.000
Effective Useful Life (years)	3.0	6.3	4.4	8.8	6.2	12.4	8.9	9.5
Gross Lifetime Energy Savings – at the Generator (GWh)	0.000	0.001	0.010	0.003	1.033	0.000	0.041	0.001
Peak Demand Savings								
Unitary Peak Demand Savings (W)	2.56	3.19	4.96	5.43	8.15	10.1	14.5	22.5
Peak Demand Interactive Effects Factor*	-62.4%	-73.5%	-60.1%	-49.1%	-29.3%	N/A	-64.0%	-87.3%
Adjustment Ratio	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.022	0.000	0.000	0.000
Line Loss Factor*	1.1466	1.1459	1.1465	1.1466	1.1153	1.1466	1.1121	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.000	0.024	0.000	0.000	0.000
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.								

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Apartments (Continued)

Product Category	LED Lamps						
	9.5 W Replacing						
	29 W	40 W	43 W	60 W	72 W	100 W	150 W
Number of Units							
Number of Units	0	0	0	0	0	0	1
Installation Rate (%)	94%	94%	94%	94%	94%	94%	94%
Number of Units Installed	0	0	0	0	0	0	1
Energy Savings							
Unitary Energy Savings (kWh)	19.2	30.1	33.0	49.8	61.6	89.2	138
Energy Interactive Effects Factor*	N/A	N/A	N/A	N/A	N/A	N/A	-56.0%
Adjustment Ratio	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Gross Energy Savings – at the Meter (GWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Effective Useful Life (years)	6.3	4.4	8.8	6.2	12.4	8.9	9.5
Gross Lifetime Energy Savings – at the Generator (GWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Peak Demand Savings							
Unitary Peak Demand Savings (W)	3.11	4.88	5.35	8.07	9.98	14.5	22.4
Peak Demand Interactive Effects Factor*	N/A	N/A	N/A	N/A	N/A	N/A	-87.2%
Adjustment Ratio	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Line Loss Factor*	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.							

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Apartments (Continued)

Product Category	LED Lamps					
	18 W Replacing 100 W	7 W BOB Replacing 60 W	PAR20 7 W Replacing 50 W	PAR30 8 W Replacing 53 W	PAR30 8 W Replacing 75 W	PAR38 15 W Replacing 90 W
Number of Units						
Number of Units	19	180	123	0	0	4
Installation Rate (%)	94%	94%	94%	94%	94%	94%
Number of Units Installed	18	169	116	0	0	4
Energy Savings						
Unitary Savings Value (kWh)	80.8	52.2	42.4	44.3	66.0	73.9
Interactive Effects Factor*	-47.4%	-15.1%	-12.1%	N/A	N/A	0.0%
Adjustment Ratio	0.96	0.96	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.001	0.007	0.004	0.000	0.000	0.000
Line Loss Factor*	1.0933	1.0740	1.0844	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.001	0.008	0.005	0.000	0.000	0.000
Effective Useful Life (years)	8.9	6.2	4.5	4.0	5.6	5.1
Gross Lifetime Energy Savings – at the Generator (GWh)	0.007	0.048	0.021	0.000	0.000	0.002
Peak Demand Savings						
Unitary Peak Demand Savings (W)	13.1	8.46	6.87	7.18	10.7	12
Peak Demand Interactive Effects Factor*	-73.5%	-23.8%	-25.6%	N/A	N/A	0.0%
Adjustment Ratio	0.96	0.96	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.001	0.001	0.000	0.000	0.000
Line Loss Factor*	1.1190	1.0855	1.1172	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.001	0.001	0.000	0.000	0.000
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.						

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Apartments (Continued)

Product Category	LED Lamps					
	PAR38 15 W Replacing 120 W	PAR38 15 W Replacing 150 W	GU10 7 W Replacing 35 W	GU10 7 W Replacing 50 W	G25 7 W Replacing 40 W	E12 5 W Chandelier Replacing 40 W
Number of Units						
Number of Units	0	9	0	192	191	370
Installation Rate (%)	94%	94%	94%	94%	94%	94%
Number of Units Installed	0	8	0	180	180	348
Energy Savings						
Unitary Savings Value (kWh)	103	133	27.6	42.4	32.5	34.5
Interactive Effects Factor*	0.0%	0.0%	N/A	-19.9%	-42.3%	-19.9%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.000	0.001	0.000	0.006	0.003	0.010
Line Loss Factor*	1.0947	1.0947	1.0947	1.0724	1.0944	1.0917
Gross Energy Savings – at the Generator (GWh)	0.000	0.001	0.000	0.007	0.004	0.010
Effective Useful Life (years)	6.4	5.9	3.8	4.5	3.0	3.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.000	0.007	0.000	0.030	0.011	0.031
Peak Demand Savings						
Unitary Peak Demand Savings (W)	16.7	21.5	4.47	6.87	5.27	5.59
Peak Demand Interactive Effects Factor*	0.0%	0.0%	N/A	-32.3%	-67.9%	-36.0%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.001	0.000	0.001
Line Loss Factor*	1.1466	1.1466	1.1466	1.0829	1.1413	1.1359
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.001	0.000	0.001
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.						

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Apartments (Continued)

	LED Nightlights	Faucet Aerators	Low-flow Showerheads		
			0.5 gpm Reduction	0.75 gpm Reduction	1.0 gpm Reduction
Number of Units					
Number of Units	1,996	515	8	5	243
Installation Rate (%)	94%	85%	96%	96%	96%
Number of Units Installed	1,876	438	8	5	233
Energy Savings					
Unitary Savings Value (kWh)	29.3	130	227	341	455
Interactive Effects Factor*	-8.2%	0.0%	0.0%	0.0%	0.0%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.050	0.057	0.002	0.002	0.106
Line Loss Factor*	1.0789	1.0868	1.0947	1.0947	1.0870
Gross Energy Savings – at the Generator (GWh)	0.054	0.062	0.002	0.002	0.115
Effective Useful Life (years)	23.0	10.0	10.0	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	1.252	0.618	0.019	0.018	1.154
Peak Demand Savings					
Unitary Peak Demand Savings (W)	4.75	21.1	36.8	55.2	73.7
Peak Demand Interactive Effects Factor*	-13.1%	0.0%	0.0%	0.0%	0.0%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.008	0.009	0.000	0.000	0.017
Line Loss Factor*	1.0934	1.1273	1.1466	1.1466	1.1279
Gross Peak Demand Savings – at the Generator (MW)	0.008	0.010	0.000	0.000	0.019
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.					

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Apartments (Continued)

Product Category	Thermostatic Shower Valves			Pipe Insulation (per foot)	Hot Water Tank Wraps
	1.5 gpm	2.0 gpm	2.5 gpm		
Number of Units					
Number of Units	0	0	73	85	103
Installation Rate (%)	88%	88%	88%	100%	100%
Number of Units Installed	0	0	64	85	103
Energy Savings					
Unitary Savings Value (kWh)	86.0	114	143	12.7	118
Interactive Effects Factor*	0.0%	0.0%	0.0%	-58.8%	-54.3%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.000	0.000	0.009	0.000	0.006
Line Loss Factor*	1.0947	1.0947	1.0943	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.000	0.000	0.010	0.000	0.006
Effective Useful Life (years)	10.0	10.0	10.0	13.0	7.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.000	0.000	0.101	0.006	0.043
Peak Demand Savings					
Unitary Peak Demand Savings (W)	13.9	18.5	23.2	2.06	19.1
Peak Demand Interactive Effects Factor*	0.0%	0.0%	0.0%	-85.0%	-83.0%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.001	0.000	0.000
Line Loss Factor*	1.1466	1.1466	1.1456	1.1466	1.1465
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.002	0.000	0.000
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.					

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Apartments (Continued)

Product Category	Retractable Clotheslines	Air Sealing Kits – Electric Resistance Heating			
		Foam Gaskets	Door Sweeps	Window Air Sealing	Door Weather Stripping
Number of Units					
Number of Units	778	206	7	11	14
Installation Rate (%)	86%	31%	100%	84%	84%
Number of Units Installed	669	64	7	9	12
Energy Savings					
Unitary Savings Value (kWh)	104	90.0	173	149	196
Interactive Effects Factor*	0.0%	0.0%	0.0%	0.0%	0.0%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.070	0.006	0.001	0.001	0.002
Line Loss Factor*	1.0772	1.0944	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.075	0.006	0.001	0.002	0.003
Effective Useful Life (years)	10.0	15.0	15.0	15.0	15.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.750	0.094	0.020	0.023	0.038
Peak Demand Savings					
Unitary Peak Demand Savings (W)	0	25.5	49	42.2	55.5
Peak Demand Interactive Effects Factor*	0.0%	0.0%	0.0%	0.0%	0.0%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.002	0.000	0.000	0.001
Line Loss Factor*	1.1466	1.1455	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.002	0.000	0.000	0.001
* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.					

Evaluated 2021 EPI Gross Energy and Peak Demand Savings - Apartments (Continued)

Product Category	Air Sealing Kits – Heat Pump Heating				Total for Single-family Homes
	Foam Gaskets	Door Sweeps	Window Air Sealing	Door Weather Stripping	
Number of Units					
Number of Units	9	0	0	2	9,541
Installation Rate (%)	31%	100%	84%	84%	-
Number of Units Installed	3	0	0	2	8,736
Energy Savings					
Unitary Savings Value (kWh)	40.9	78.6	67.7	89.1	-
Interactive Effects Factor*	0.0%	0.0%	0.0%	0.0%	-
Adjustment Ratio	1.00	1.00	1.00	1.00	-
Gross Energy Savings – at the Meter (GWh)	0.000	0.000	0.000	0.000	0.506
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	-
Gross Energy Savings – at the Generator (GWh)	0.000	0.000	0.000	0.000	0.549
Effective Useful Life (years)	15.0	15.0	15.0	15.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	0.002	0.000	0.000	0.002	5.387
Peak Demand Savings					
Unitary Peak Demand Savings (W)	11.6	22.2	19.2	25.2	-
Peak Demand Interactive Effects Factor*	0.0%	0.0%	0.0%	0.0%	-
Adjustment Ratio	1.00	1.00	1.00	1.00	-
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.066
Line Loss Factor*	1.1466	1.1466	1.1466	1.1466	-
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.000	0.074

* The interactive effects and line loss factors correspond to the average for each product weighted according to the proportion of each type of home and rate code respectively. The interactive effects factor is obtained by dividing gross savings at the meter by the unitary savings value, installation rate, number of units, and adjustment ratio when applicable. The line loss factor is obtained by dividing gross savings at the generator by gross savings at the meter.

Figure 29 below compares the tracked unitary electrical energy savings to the evaluated gross savings. As outlined in the figure, multiple measures had a small difference between the tracked and evaluated, which was due to the new installation rates established through the 2021 evaluation. The most significant difference in tracked savings compared to evaluated savings came from the adjustment to the LED lamps installation rate that was established at 94% in 2021 compared to the 98% value used for the tracked savings based on previous evaluation results. In addition, low-flow showerhead and thermostatic shower valve unitary savings were updated in 2021, which also contributed to the difference between the tracked and evaluated savings for these measures.

Figure 29: 2021 EPI Tracked and Evaluated Gross Savings

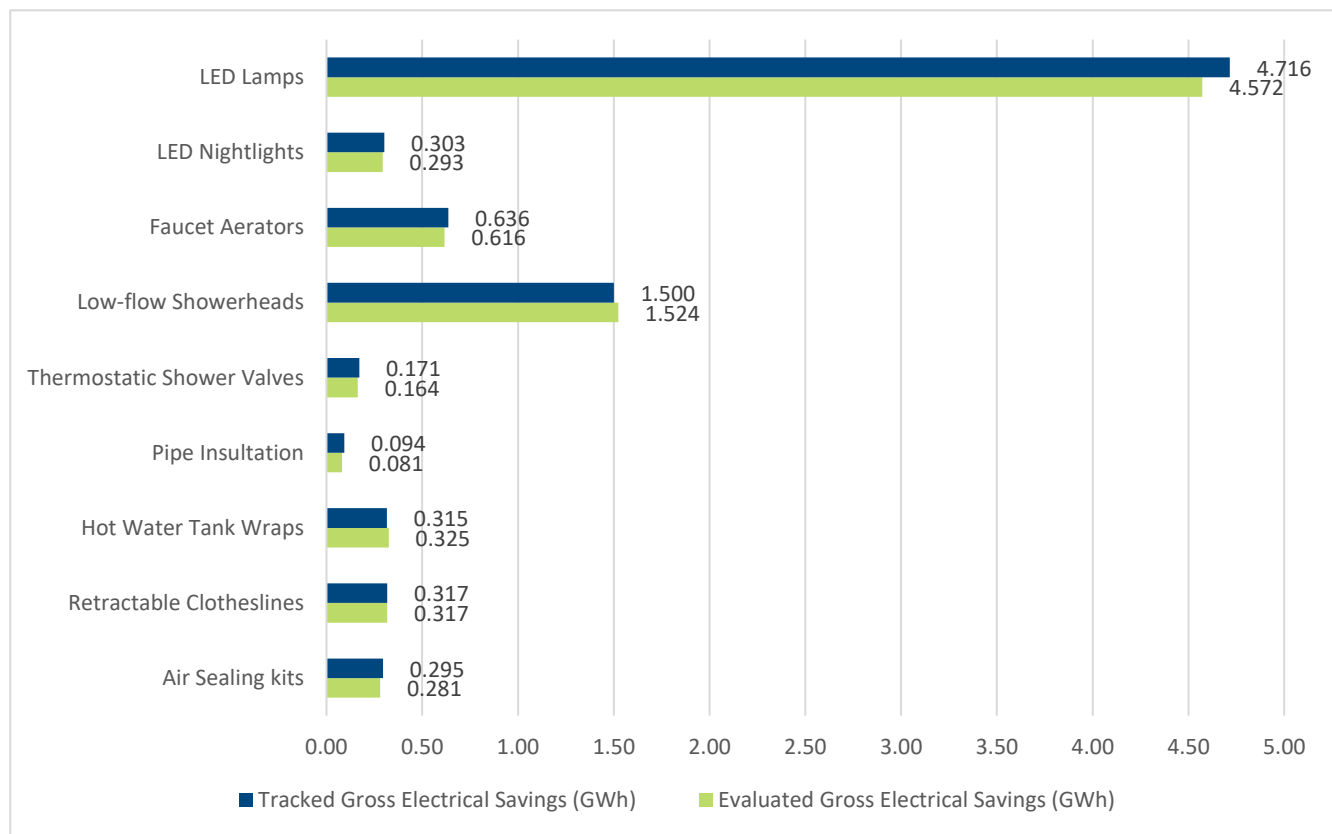
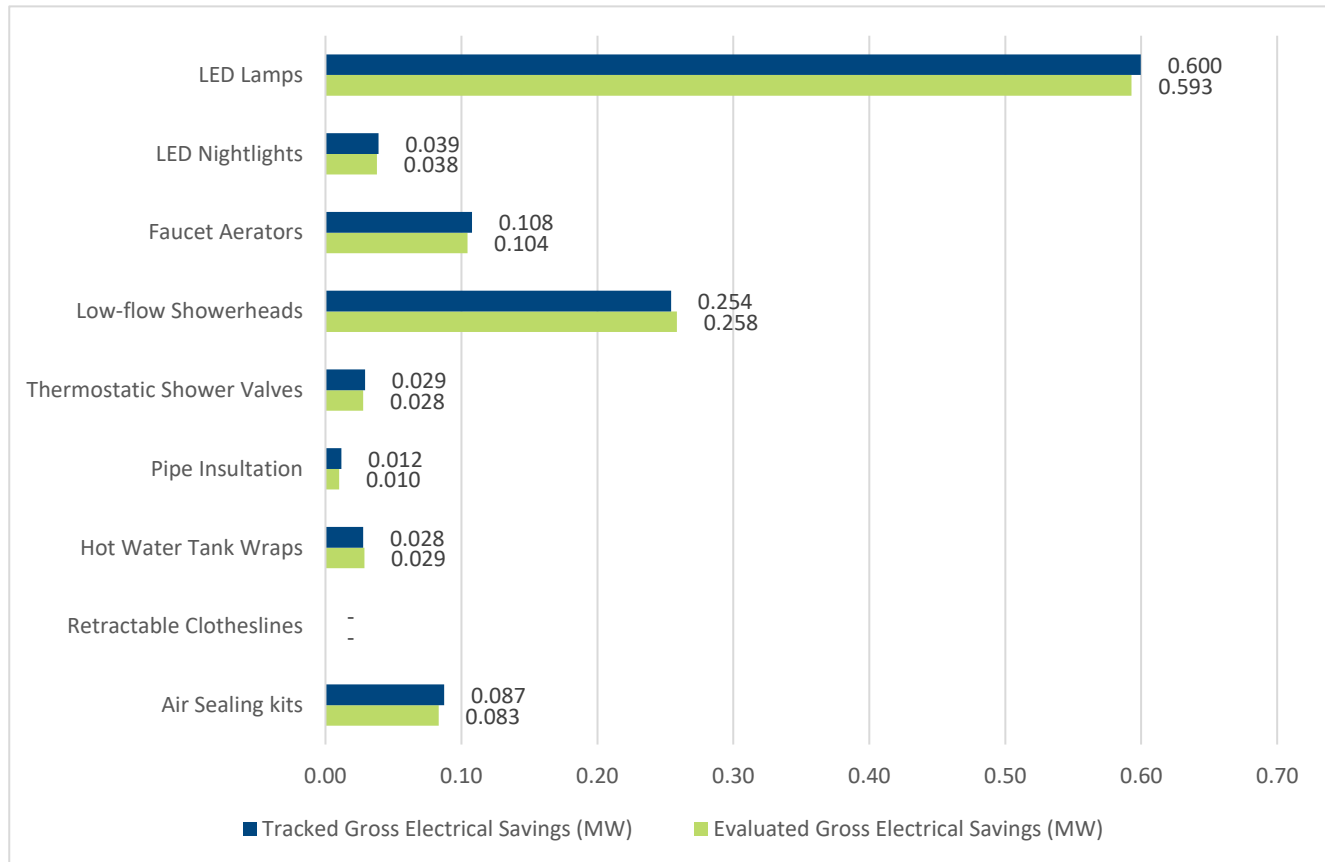


Figure 30 below compares the tracked unitary electrical peak demand savings to the evaluated gross savings. As for energy savings, the differences in tracked savings compared to evaluated savings mostly came from the new installation rates established in 2021.

Figure 30: 2021 EPI Tracked and Evaluated Gross Peak Demand Savings



14.3 Net Savings

The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the NTGR. In the case of EPI, the NTGR is established considering the free-ridership and participant spillover effects that positively or negatively affect energy savings.

14.3.1 Free-ridership

For EPI, free-ridership occurs when participants would have installed the same energy efficient products in the absence of the program component. The free-ridership level was assessed during the 2021 evaluation using a self-report approach that involved asking 100 non-low-income participants that received at least LED lamps or a low-flow showerhead a set of questions during a telephone survey. Table 55 outlines the free-ridership level results for the 2021 evaluation.

Table 55: 2021 EPI Free-ridership Level – Non-low-income Participants

	Average Free-ridership Level	Margin of Error
LED Lighting	25%	3.6%
Low-flow Showerheads	10%	3.0%
Other Products	0%	N/A

The Evaluator established free-ridership levels of 25% for LED lighting and 10% for low-flow showerheads, which indicates stable free-ridership compared to the 2019 levels⁴³ of 23% for LED lighting and 9% for low-flow showerheads.

14.3.2 Participant Spillover

For EPI, participant spillover occurs when participants purchase and install additional energy efficient products due to the influence of having participated in the program component without receiving any additional support from an EOne program. Similar to free-ridership, the spillover level was assessed through the participant survey. Table 56 outlines the participant spillover level results for the 2021 evaluation.

Table 56: 2021 EPI Participant Spillover Level – Non-low-income Participants

	Average Participant Spillover Level	Margin of Error
All Products	10%	7.5%

⁴³ The 2019 values for owners were used as a comparison point since owners and tenants were not differentiated in 2021.

Among the 100 surveyed participants, 17 indicated having installed efficient products after participating in EPI and for which their participation had an influence. These additional products resulted in a spillover level of 10%, which represents a noticeable increase compared to the 2019 level of 3%.⁴⁴ This increase is in large part explained by the lower savings per participant compared to 2019 as discussed in Subsection 11.3 above since the spillover level is inversely proportional with respondent program savings. In addition, 2021 respondents attributed more influence from EPI on their additional product installations with an average attribution score of 79% in 2021 compared to 58% in 2019.

The spillover methodology did not include space heating and building envelope measures. A number of respondents noted that they installed “Other” measures, including heat pumps and building envelope improvements since their participation in EPI. Estimating potential spillover savings from these measures would require additional information from respondents. However, given these measures have the potential for sizable savings, future spillover research should consider including how EPI influences the installation of space heating and building envelope measures.

14.3.3 Net-to-gross Ratio Calculation

The NTGR was calculated using the following equation:

$$NTGR = (1 - \% \text{ Free-ridership} + \% \text{ Internal Spillover})$$

The NTGR for low-income participants is assumed to be 1.00. Using both the free-ridership and participant spillover levels established for non-low-income participants and the proportions of the savings associated with low-income and non-low-income participants, the overall NTGR values were established at 0.90 for LED lamps, 1.00 for low-flow showerheads, and 1.07 for other products, as listed in Table 57 below. Overall, the weighted average NTGR for low-income and non-low-income participants combined was established at 0.96.

Table 57: 2021 EPI Net-to-gross Ratios by Product Category

	LED Lamps		Low-flow Showerheads		Other Products	
	Non-low-income Participants	Low-income Participants	Non-low-income Participants	Low-income Participants	Non-low-income Participants	Low-income Participants
NTGR	0.90	1.00	1.00	1.00	1.10	1.00
Proportion of Product Category Gross Savings by Participant Type	66%	34%	69%	31%	65%	35
NTGR for All Participants by Product Category	0.90		1.00		1.07	

⁴⁴ The 2019 value for owners was used as a comparison point since owners and tenants were not differentiated in 2021.

14.3.4 Evaluated Net Savings

Net savings are defined as the energy use reductions that are specifically attributable to EPI. Net savings were estimated by applying the overall NTGR to gross savings as exemplified in the following equation:

$$\text{Net Savings} = \text{Gross Savings} \times \text{NTGR}$$

This equation was used to calculate both electrical energy savings and peak demand savings.

The net energy savings for EPI in 2021 were estimated at 7.812 GWh at the generator and the peak demand savings at 1.098 MW at the generator. The net lifetime energy savings were established at 65.165 GWh, which yields a weighted average EUL value of 8.3 years.

The detailed results for all building types combined are presented in Table 58 below.

Table 58: Evaluated 2021 EPI Net Energy and Peak Demand Savings

Product Category	LED Lamps							
	9 W Replacing							
	25 W	29 W	40 W	43 W	60 W	72 W	100 W	150 W
Energy Savings								
Gross Energy Savings – at the Meter (GWh)	0.004	0.013	0.183	0.018	2.353	0.005	0.379	0.001
NTGR	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Net Energy Savings – at the Meter (GWh)	0.004	0.012	0.165	0.016	2.118	0.004	0.341	0.001
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0942	1.0947	1.0946	1.0947
Net Energy Savings – at the Generator (GWh)	0.004	0.013	0.181	0.018	2.317	0.005	0.373	0.001
Effective Useful Life (years)	3.0	6.3	4.4	8.8	6.2	12.4	8.9	9.5
Net Lifetime Energy Savings – at the Generator (GWh)	0.013	0.082	0.795	0.155	14.365	0.061	3.324	0.006
Peak Demand Savings								
Gross Peak Demand Savings – at the Meter (MW)	0.001	0.002	0.024	0.003	0.288	0.001	0.047	0.000
NTGR	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Net Peak Demand Savings – at the Meter (MW)	0.001	0.002	0.022	0.002	0.259	0.001	0.042	0.000
Line Loss Factor*	1.1466	1.1466	1.1463	1.1462	1.1442	1.1466	1.1463	1.1466
Net Peak Demand Savings – at the Generator (MW)	0.001	0.002	0.025	0.003	0.297	0.001	0.048	0.000
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. The factor is obtained by dividing gross savings at the generator by gross savings at the meter.								

Evaluated 2021 EPI Net Energy and Peak Demand Savings (Continued)

Product Category	LED Lamps						
	9.5 W Replacing						
	29 W	40 W	43 W	60 W	72 W	100 W	150 W
Energy Savings							
Gross Energy Savings – at the Meter (GWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NTGR	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Net Energy Savings – at the Meter (GWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947
Net Energy Savings – at the Generator (GWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Effective Useful Life (years)	6.3	4.4	8.8	6.2	12.4	8.9	9.5
Net Lifetime Energy Savings – at the Generator (GWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.002
Peak Demand Savings							
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NTGR	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Net Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Line Loss Factor*	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466
Net Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. The factor is obtained by dividing gross savings at the generator by gross savings at the meter.							

Evaluated 2021 EPI Net Energy and Peak Demand Savings (Continued)

Product Category	LED Lamps					
	18 W Replacing 100 W	7 W BOB Replacing 60 W	PAR20 7 W Replacing 50 W	PAR30 8 W Replacing 53 W	PAR30 8 W Replacing 75 W	PAR38 15 W Replacing 90 W
Energy Savings						
Gross Energy Savings – at the Meter (GWh)	0.027	0.037	0.214	0.000	0.000	0.017
NTGR	0.90	0.90	0.90	0.90	0.90	0.90
Net Energy Savings – at the Meter (GWh)	0.024	0.033	0.193	0.000	0.000	0.015
Line Loss Factor*	1.0946	1.0906	1.0945	1.0947	1.0947	1.0947
Net Energy Savings – at the Generator (GWh)	0.027	0.036	0.211	0.000	0.000	0.016
Effective Useful Life (years)	8.9	6.2	4.5	4.0	5.6	5.1
Net Lifetime Energy Savings – at the Generator (GWh)	0.238	0.225	0.949	0.000	0.000	0.083
Peak Demand Savings						
Gross Peak Demand Savings – at the Meter (MW)	0.004	0.005	0.023	0.000	0.000	0.003
NTGR	0.90	0.90	0.90	0.90	0.90	0.90
Net Peak Demand Savings – at the Meter (MW)	0.003	0.004	0.020	0.000	0.000	0.002
Line Loss Factor*	1.1460	1.1319	1.1456	1.1466	1.1466	1.1466
Net Peak Demand Savings – at the Generator (MW)	0.004	0.005	0.023	0.000	0.000	0.003
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. The factor is obtained by dividing gross savings at the generator by gross savings at the meter.						

Evaluated 2021 EPI Net Energy and Peak Demand Savings (Continued)

Product Category	LED Lamps					
	PAR38 15 W Replacing 120 W	PAR38 15 W Replacing 150 W	GU10 7 W Replacing 35 W	GU10 7 W Replacing 50 W	G25 7 W Replacing 40 W	E12 5 W Chandelier Replacing 40 W
Energy Savings						
Gross Energy Savings – at the Meter (GWh)	0.053	0.201	0.016	0.163	0.100	0.394
NTGR	0.90	0.90	0.90	0.90	0.90	0.90
Net Energy Savings – at the Meter (GWh)	0.048	0.180	0.015	0.147	0.090	0.354
Line Loss Factor*	1.0947	1.0947	1.0947	1.0938	1.0947	1.0946
Net Energy Savings – at the Generator (GWh)	0.053	0.198	0.016	0.160	0.098	0.388
Effective Useful Life (years)	6.4	5.9	3.8	4.5	3.0	3.0
Net Lifetime Energy Savings – at the Generator (GWh)	0.336	1.166	0.061	0.721	0.295	1.164
Peak Demand Savings						
Gross Peak Demand Savings – at the Meter (MW)	0.009	0.032	0.002	0.018	0.011	0.047
NTGR	0.90	0.90	0.90	0.90	0.90	0.90
Net Peak Demand Savings – at the Meter (MW)	0.008	0.029	0.002	0.017	0.010	0.042
Line Loss Factor*	1.1466	1.1466	1.1466	1.1435	1.1462	1.1462
Net Peak Demand Savings – at the Generator (MW)	0.009	0.033	0.002	0.019	0.011	0.048
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. The factor is obtained by dividing gross savings at the generator by gross savings at the meter.						

Evaluated 2021 EPI Net Energy and Peak Demand Savings (Continued)

	LED Nightlights	Faucet Aerators	Low-flow Showerheads		
			0.5 gpm Reduction	0.75 gpm Reduction	1.0 gpm Reduction
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.268	0.563	0.042	0.052	1.299
NTGR	0.90	1.07	1.00	1.00	1.00
Net Energy Savings – at the Meter (GWh)	0.242	0.603	0.042	0.052	1.299
Line Loss Factor*	1.0917	1.0939	1.0947	1.0947	1.0940
Net Energy Savings – at the Generator (GWh)	0.264	0.660	0.046	0.057	1.421
Effective Useful Life (years)	23.0	10.0	10.0	10.0	10.0
Net Lifetime Energy Savings – at the Generator (GWh)	6.067	6.595	0.459	0.567	14.214
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.033	0.091	0.007	0.008	0.211
NTGR	0.90	1.07	1.00	1.00	1.00
Net Peak Demand Savings – at the Meter (MW)	0.030	0.098	0.007	0.008	0.211
Line Loss Factor*	1.1341	1.1444	1.1466	1.1466	1.1448
Net Peak Demand Savings – at the Generator (MW)	0.034	0.112	0.008	0.010	0.241
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. The factor is obtained by dividing gross savings at the generator by gross savings at the meter.					

Evaluated 2021 EPI Net Energy and Peak Demand Savings (Continued)

Product Category	Thermostatic Shower Valves			Pipe Insulation (per foot)	Hot Water Tank Wraps
	1.5 gpm	2.0 gpm	2.5 gpm		
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.000	0.000	0.149	0.074	0.297
NTGR	1.07	1.07	1.07	1.07	1.07
Net Energy Savings – at the Meter (GWh)	0.000	0.000	0.160	0.079	0.318
Line Loss Factor*	1.0947	1.0947	1.0946	1.0947	1.0947
Net Energy Savings – at the Generator (GWh)	0.000	0.000	0.175	0.087	0.348
Effective Useful Life (years)	10.0	10.0	10.0	13.0	7.0
Net Lifetime Energy Savings – at the Generator (GWh)	0.002	0.004	1.748	1.131	2.436
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.024	0.009	0.025
NTGR	1.07	1.07	1.07	1.07	1.07
Net Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.026	0.009	0.027
Line Loss Factor*	1.1466	1.1466	1.1463	1.1465	1.1464
Net Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.030	0.011	0.031
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. The factor is obtained by dividing gross savings at the generator by gross savings at the meter.					

Evaluated 2021 EPI Net Energy and Peak Demand Savings (Continued)

Product Category	Retractable Clotheslines	Air Sealing Kits – Electric Resistance Heating			
		Foam Gaskets	Door Sweeps	Window Air Sealing	Door Weather Stripping
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.291	0.063	0.021	0.037	0.076
NTGR	1.07	1.07	1.07	1.07	1.07
Net Energy Savings – at the Meter (GWh)	0.311	0.067	0.023	0.039	0.081
Line Loss Factor*	1.0905	1.0946	1.0947	1.0947	1.0947
Net Energy Savings – at the Generator (GWh)	0.339	0.074	0.025	0.043	0.089
Effective Useful Life (years)	10.0	15.0	15.0	15.0	15.0
Net Lifetime Energy Savings – at the Generator (GWh)	3.395	1.107	0.371	0.642	1.336
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.018	0.006	0.010	0.022
NTGR	1.07	1.07	1.07	1.07	1.07
Net Peak Demand Savings – at the Meter (MW)	0.000	0.019	0.006	0.011	0.023
Line Loss Factor*	1.1466	1.1462	1.1465	1.1466	1.1465
Net Peak Demand Savings – at the Generator (MW)	0.000	0.022	0.007	0.013	0.026
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. The factor is obtained by dividing gross savings at the generator by gross savings at the meter.					

Evaluated 2021 EPI Net Energy and Peak Demand Savings (Continued)

Product Category	Air Sealing Kits – Heat Pump Heating				Total for Single-family Homes
	Foam Gaskets	Door Sweeps	Window Air Sealing	Door Weather Stripping	
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.017	0.007	0.011	0.025	7.471
NTGR	1.07	1.07	1.07	1.07	-
Net Energy Savings – at the Meter (GWh)	0.018	0.007	0.011	0.027	7.141
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	-
Net Energy Savings – at the Generator (GWh)	0.020	0.008	0.012	0.029	7.812
Effective Useful Life (years)	15.0	15.0	15.0	15.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	0.302	0.122	0.185	0.441	65.165
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.005	0.002	0.003	0.007	0.999
NTGR	1.07	1.07	1.07	1.07	-
Net Peak Demand Savings – at the Meter (MW)	0.005	0.002	0.003	0.008	0.959
Line Loss Factor*	1.1464	1.1466	1.1461	1.1466	-
Net Peak Demand Savings – at the Generator (MW)	0.006	0.002	0.004	0.009	1.098
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. The factor is obtained by dividing gross savings at the generator by gross savings at the meter.					

As presented in Table 59, applying the Nova Scotia-specific factor⁴⁵ for GHG emissions generated by electricity production to EPI net savings corresponds to a total of 4,563 tonnes of annually avoided CO₂ eq.

Table 59: Evaluated 2021 EPI GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	7.812
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	4,563

14.4 Realization Rate

Table 60 compares the energy and peak demand savings established through this evaluation to those tracked in the 2021 tracking sheet. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 103% for energy savings and 103% for peak demand savings.

Table 60: Comparison of 2021 EPI Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate Value
	Value	Unit	Value	Value	Unit	
Energy Savings						
Tracked Savings by EOne	8.347	GWh	0.91	7.621	GWh	103%
Evaluation Results	8.174	GWh	0.96	7.812	GWh	
Peak Demand Savings						
Tracked Savings by EOne	1.157	MW	0.92	1.062	MW	103%
Evaluation Results	1.143	MW	0.96	1.098	MW	
*NTGRs varied for each type of product. The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by gross savings.						

⁴⁵ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:
 Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),
 Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021
https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

The evaluated net energy and peak demand savings were 3% higher than the values tracked by EOne. While the new installation rates resulted in slightly lower evaluated gross savings than the tracked savings, the higher NTGR values established in 2021 more than compensated for that reduction.

2021 EPI Impact Evaluation Highlights

- › EPI achieved 7.812 GWh in net electrical energy savings and 1.098 MW in net peak demand savings at the generator in 2021.
- › Updating the installation rates based on the 2021 on-site visit findings resulted in a slight reduction in gross savings, notably since the LED lamp installation rate decreased from 98% to 94%.
- › While free-ridership levels established in 2021 were similar to those from 2019, spillover increased from 3% in 2019 to 10% in 2021.
- › Evaluated net energy and peak demand savings were 3% higher than the tracked values due to the increase to the NTGR values.

15 EPI KEY FINDINGS AND RECOMMENDATIONS

As mentioned previously, the main objectives of the 2021 EPI evaluation were as follows:

- › Calculate gross and net EPI results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions

This section provides the Evaluator's key findings in relation to these objectives. The Evaluator has no specific recommendation for EPI. Deferred recommendations from the previous year are summarized in Appendix XVI.

2021 EPI-Finding: EPI net electrical energy and peak demand savings fell short of targets.

EPI achieved 7.812 GWh in net electrical energy savings and 1.098 MW in net peak demand savings at the generator in 2021, thus not attaining the planned net electrical energy savings of 10.7 GWh and net peak demand savings of 2.07 MW. Participation increased slightly in 2021 despite another temporary suspension of in-home activities in response to the COVID-19 pandemic.

2021 EPI-Finding: Savings per participant continued to decrease, driven by a further decrease in the number of LED lamps installed per household compared to 2020.

The residential lighting market is evolving quickly, resulting in fewer opportunities for LED lamp replacements. In 2021, the average number of A-type lamp replacements decreased from 9.9 to 8.0. In addition, there was a significant decrease in the number of non-A type lamps going from 4.3 in 2020 to 3.4 in 2021. LED lighting accounted for 60% of EPI gross savings in 2021; therefore, the evolution of the lighting market will continue to present challenges for the program component to maintain savings.

2021 EPI-Finding: The new installation rates established through the 2021 on-site visits resulted in a slight decrease in evaluated savings, notably due to a small decrease to the LED lamp installation rate.

While the installation rates of a few measures increased or remained unchanged in 2021 compared to those used in 2020, the installation rates of most measures were adjusted downward, which resulted in 2% lower gross evaluated energy savings compared to the savings tracked by EOne. The decrease from 98% to 94% for the LED lamps installation rate had the largest impact.

2021 EPI-Finding: Free-ridership levels for EPI remains similar to the previous levels established in 2019, while spillover increased.

The NTGR was evaluated at 0.96 in 2021 compared to 0.91 in 2020. The Evaluator established free-ridership levels of 25% for LED lighting and 10% for low-flow showerheads, which indicate stable free-ridership compared to the 2019 levels of 23% for LED lighting and 9% for low-flow showerheads. For spillover, the Evaluator established a level of 10%, which represents a noticeable increase compared to the 2019 level of 3%; since spillover is inversely proportional to respondent program savings, this increase can be largely explained by the lower savings per participant compared to 2019.⁴⁶

2021 EPI-Finding: Overall satisfaction with EPI is high among participants.

Using a 10-point scale, participants provided an average score of 8.7 for their satisfaction with EPI. Participants were mainly satisfied with the installer (26%), the information received (26%), and the good service provided in general (24%). Similarly, participants were also generally pleased with the time required to complete the work (9.4 on a 10-point scale) and the quality of the work (9.3 on a 10-point scale).

2021 EPI-Finding: The differences between evaluated net energy and peak demand savings determined by the Evaluator and the net savings tracked by EOne were minimal.

The evaluated net energy and peak demand savings are 3% higher than the values tracked by EOne. This small variation is due to an upward adjustment resulting from the higher NTGR values established in 2021, which was somewhat offset by an overall downward adjustment resulting from the updated installation rates.

⁴⁶ The 2019 values for owners were used as a comparison point since owners and tenants were not differentiated in 2021.

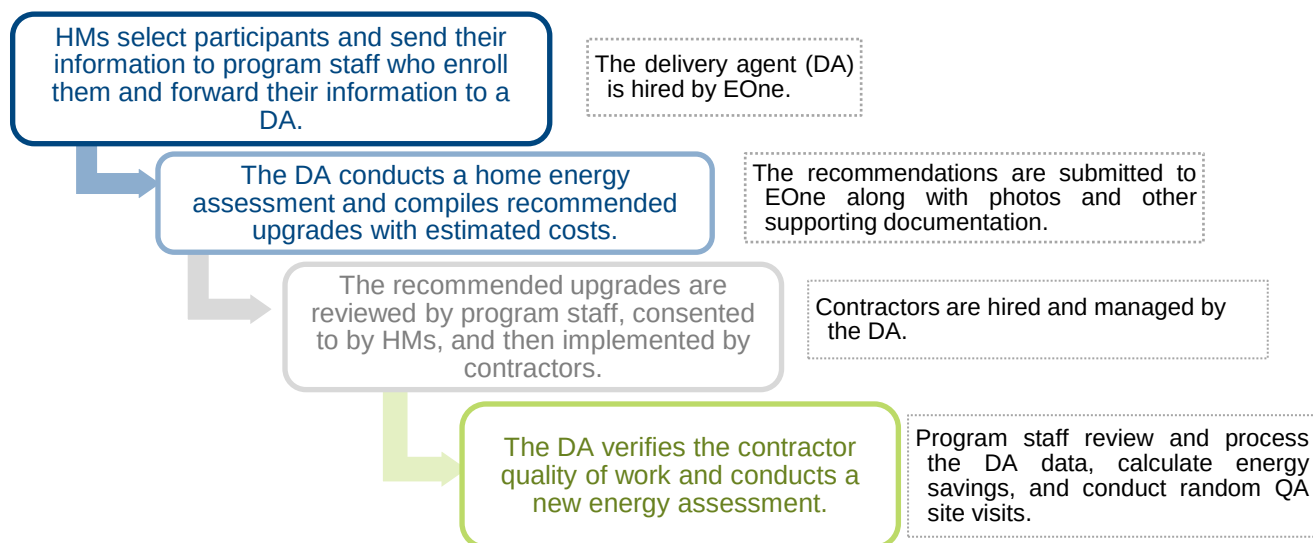
16 MHEEP OVERVIEW

This section describes the Mi'kmaw Home Energy Efficiency Project (MHEEP) program component, follows up on past evaluation recommendations, and provides an overview of MHEEP participation history.

16.1 MHEEP Description

MHEEP provides energy efficiency upgrades to band-owned homes in Mi'kmaw communities at no cost to participants or the community. EOne works with community housing managers (HMs), two delivery agents (DA), and Mi'kmaw-preferred contractors to deliver the Project across all 13 Mi'kmaw communities in Nova Scotia. Figure 31 illustrates the participation process along with details about the program component.

Figure 31: MHEEP Participation Process Summary



MHEEP consists of conducting home energy assessments using the EnerGuide home evaluation framework, and each participating home receives an EnerGuide rating upon completion. The Project also provides building envelope upgrades such as draft-proofing and insulation as well as upgrades for space heating equipment, programmable and smart thermostats, and water heating equipment. Moisture management measures such as bathroom fans, heat recovery ventilation, and carbon monoxide detectors may also be provided.

MHEEP also serves to identify opportunities to replace old appliances (dehumidifiers, refrigerators, freezers, clothes washers, and dryers) with energy efficient models and facilitates those replacements internally through the EOne Appliance Retirement program component. Appliance replacements and their electrical savings are presented in the 2021 Residential Efficient Product Rebates Evaluation Report.

HMs identify and enroll participants and assist with program component requirements. DAs conduct pre-retrofit assessments (D assessments), recommend energy saving measures, assign the work to contractors, and perform post-retrofit assessments (E assessments) to ensure that measures were implemented according to industry standards and that residents understand how to operate any new equipment.

MHEEP was launched in June 2018 as the First Nations Home Energy Efficiency Pilot. After the pilot stage in early 2019, MHEEP began work in participating homes in June 2019 and communications materials were developed to better inform HMs and participants.

MHEEP funding comes from two sources: (1) Electricity ratepayer funding is used for upgrades that reduce electricity consumption; and (2) funding from the Province of Nova Scotia is used for upgrades that reduce non-electrical fuel consumption as well as a portion of upgrades that reduce electricity consumption. This report presents all electrical savings achieved by MHEEP.

Due to public health and government directives regarding the COVID-19 pandemic, all in-home activities related to MHEEP were suspended from April 28 to June 9, 2021. Therefore, no in-home assessments and upgrades were completed during that period.

MHEEP was aimed at achieving 0.956 GWh in net electrical energy savings and 0.517 MW in net peak demand savings at the generator in 2021.

16.2 Follow-up on Past Evaluation Report Recommendations

No major improvement recommendations were made for MHEEP in 2020.

16.3 Participant History

As presented in Figure 32 below, 82 participants completed projects and achieved electrical energy savings in 2021 under MHEEP, representing a 242% increase in participation compared to 2020. Participation is now back to levels slightly higher than those prior to the COVID-19 pandemic. Although the MHEEP team tried to catch up on projects that were delayed in 2020, there were still concerns due to the pandemic among the communities served by the program component and the team could not entirely make up for the lower participation of the previous year.

Figure 32 also illustrates a 5% increase in average savings per participant compared to 2020, which is partly due to a lower proportion of participants with non-electrical heating. In 2021, 50% of DSM participants generated non-electrical savings, whereas 71% did so in 2020. Participants who generate both electrical and non-electrical savings have less electrical savings than homes with electrical savings only.

Figure 32: Overview of MHEEP Participation, 2019-2021

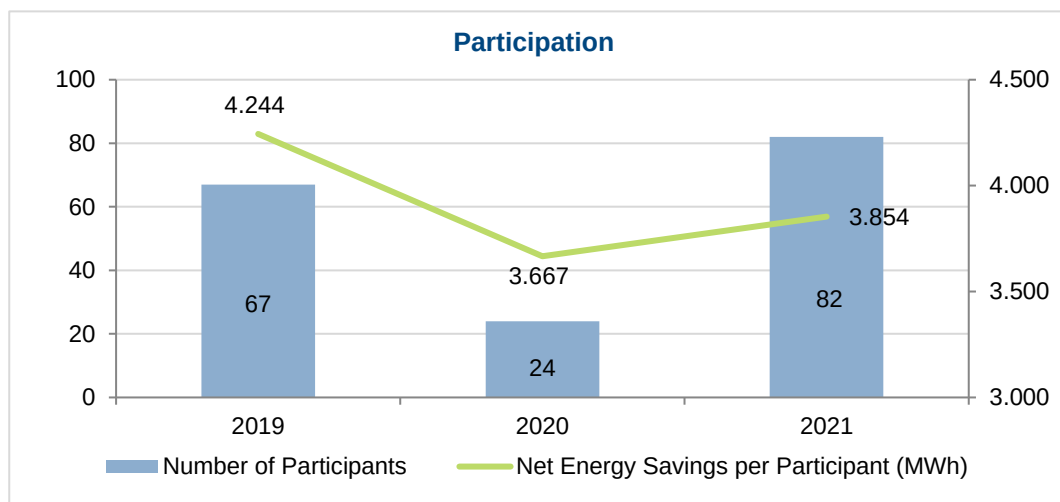
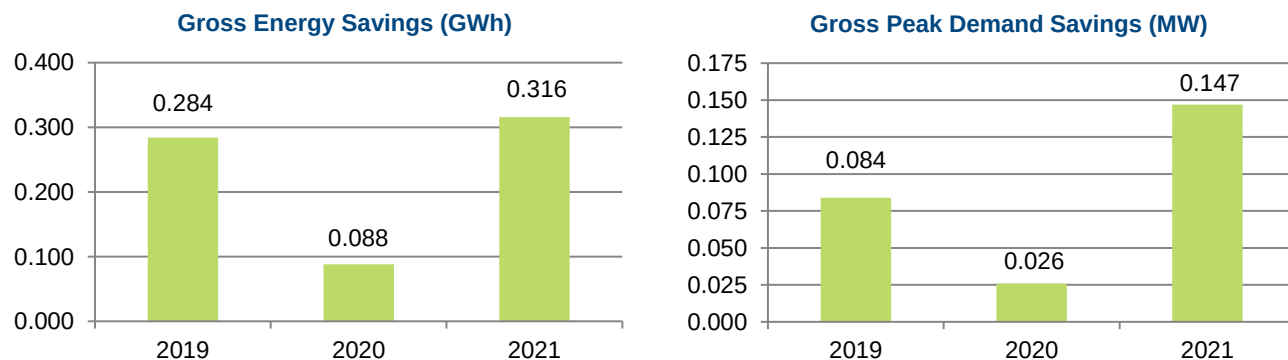


Figure 33 below provides an overview of the evolution of MHEEP gross energy and peak demand savings from 2019 and 2021. MHEEP total gross energy and peak demand savings were higher than in 2020 due to higher participation levels. In 2021, MHEEP achieved 0.316 GWh in gross electrical energy savings and 0.147 MW in gross peak demand savings.

Figure 33: Evolution of MHEEP Gross Savings, 2019-2021



Based on the tracking sheet, the mix of measures generating electrical savings in MHEEP is composed mainly of heat pump retrofits as well as building envelope and air sealing measures. Nearly all (93%) participants who achieved electrical energy savings received a heat pump.

17 MHEEP EVALUATION APPROACH

The 2021 MHEEP evaluation comprised a condensed impact evaluation. The main objective of the 2021 MHEEP evaluation was as follows:

- › Calculate gross and net MHEEP results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions⁴⁷

Table 61 outlines the evaluation objectives and maps them to the research questions and methods established by the Evaluator.

Table 61: 2021 MHEEP Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › Have the savings been correctly and consistently calculated by applying the correct Overestimation Ratios (ORs) for heating and building envelope measures? › What are the unitary savings by measure category? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Measure Assessment update › Savings calculation review › Calculations using evaluation results
Calculate net results	› What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What are the net avoided GHG emissions in CO₂ eq for the program component?	› Calculations using a net-to-gross ratio of 1 › GHG emission reduction calculations

Tracking Sheet Audit

Prior to performing the savings review, the Evaluator performed an audit of the final 2021 tracking sheet to ensure it was complete and the entered data were consistent. The detailed protocol used for the tracking sheet audit and the results obtained are presented in Appendix XVII.

Calculations Using Evaluation Results

The Evaluator calculated the first-year and lifetime energy and peak demand savings as per the calculation methodology presented in Section 18 below.

GHG Emission Reduction Calculations

To obtain net avoided GHG emissions in CO₂ eq for MHEEP, the Evaluator multiplied the net energy savings by the latest Nova Scotia-specific factor for GHG emissions generated by electricity production. This factor was established using NS Power data.

⁴⁷ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

18 MHEEP IMPACT EVALUATION

The objectives of the 2021 MHEEP impact evaluation were to determine gross and net electrical energy and peak demand savings, annually avoided GHG emissions, as well as effective useful life (EUL) values and associated lifetime energy savings. While the measures installed under MHEEP generate both electrical and non-electrical energy savings, only the electrical portion is covered in this report.

18.1 Tracking Sheet Audit

To ensure project results are reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix XVII. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

18.2 Gross Savings

MHEEP gross savings correspond to the change in energy consumption resulting from the measures implemented by participants regardless of why they participated.⁴⁸ In 2021, MHEEP participants received building envelope and/or space heating upgrades that generated electrical savings. The savings associated with those upgrades are obtained through HOT2000 modelling. One measure that included electrical unitary savings calculations was installed.

The methodologies used for evaluating the gross savings are described in the following subsections.

18.2.1 Energy Savings

The savings from building envelope and space heating measures are estimated using pre-retrofit (D assessment) and post-retrofit (E assessment) energy models from HOT2000 simulations.

Electrical savings are calculated using the following equation.

$$\text{Gross Space Heating Savings (kWh)} = \frac{\% \text{ Electrical Heating}_D \times [(SHC_D(MJ) \times (1 - OR_D)) - (SHC_E(MJ) \times (1 - OR_E))]}{3.6}$$

⁴⁸ Definition adapted from: National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

Where:

- › % *Electrical Heating_D* corresponds to the proportion of space heating covered by electrical heating systems during the D assessment.
- › SHC corresponds to total space heating consumption (all fuel types combined).
- › OR corresponds to the overestimation ratio used to adjust modelled energy consumption (according to the space heating system in place during the D and E assessments).

The savings calculations were based on the difference between the D assessment and E assessment space heating consumption values, both of which were adjusted with an OR. The ORs were drawn from billing analyses conducted in 2015 and 2018 as part of the HEA evaluations, and the results are presented in Table 62. These ORs will be updated during the next evaluation year to better represent changes made to HOT2000 version 11 since all homes are now modelled in this version of the software.

Table 62: Evaluated 2021 MHEEP Overestimation Ratios

Scenario	OR _D	OR _E
A participant who registered with a heat pump	0%	0%
A participant who registered without a heat pump and who did not have one implemented	19%	19%
A participant who registered without a heat pump and then had one implemented	19%	0%

Participants with non-electrical space heating are eligible for the program component, meaning participants can generate both electrical and non-electrical savings. As indicated in the equation above, the proportion of electrical savings for each participant is determined by multiplying total space heating savings by the proportion of space heating covered by electrical heating systems during the D assessment.

Programmable and smart thermostats, drain water heat recovery systems, and heat pump water heaters are not modelled in HOT2000. Instead, energy savings are calculated based on unitary energy savings values. Only one of the measures was installed through MHEEP in 2021, a programmable thermostat. For this measure, the Evaluator selected the unitary savings value of 221 kWh for a programmable thermostat installed in a single-family home, as described in the 2020-2022 Measure Assessment.

18.2.2 Peak Demand Savings

Peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The projected electricity peak demand period in Nova Scotia is between 5 p.m. and 7 p.m. in the months of December to February on non-holiday weekdays.

For MHEEP, peak demand savings were calculated using the peak demand-to-energy ratio of 0.283 MW/GWh for space heating savings (RES-Elect Space Heat&Cool) set by Navigant in the 2016-2018 DSM Plan. This ratio was established based on the modelled system coincident peak demand savings and energy savings for a projected deployment of measures. Navigant used local data

to establish the ratios. The Evaluator considered that the approach used by Navigant to establish the peak demand-to-energy ratios was still valid and therefore used it to estimate peak demand savings.

An exception was made for heat pump measures. Starting in 2021, unitary peak demand savings were calculated separately for heat pump measures. Heat pump unitary peak demand savings were established by multiplying the average unitary peak demand savings per capacity obtained from the heat pump measures installed under Green Heat in 2020 by the capacity of each system installed under MHEEP. This new methodology significantly increased the average peak demand savings per participant, which were 1.79 kW per participant in 2021 compared to 1.08 kW in 2020. A small proportion of that increase is, however, due to other changes in the mix of participants, such as a slightly higher proportion of participants with electrical space heating.

In future years, if EOne wishes to increase the accuracy of heat pump peak demand savings, specific parameters for space heating heat pumps could be documented in the tracking sheet. Instead of using the average unitary peak demand savings per capacity obtained from Green Heat, the unitary peak demand savings of each heat pump installed could be calculated based on their heating capacity and coefficient of performance (COP) at -15 °C.

18.2.3 Interactive Effects

In a home, interactive effects occur when the implementation of energy efficiency measures has an impact on the energy consumption of other factors such as heating and cooling. The interactive effects of the space heating measures modelled in HOT2000 were already considered in the savings calculations since the simulation models encompass the total energy consumption of a house.

18.2.4 Effective Useful Life

As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the EUL values used in the calculation of electrical energy savings that are expected to persist over time. The EUL for building envelope upgrades and space heating equipment was revised based on the measures installed by HEA participants in 2021 since HEA and MHEEP participants install similar measures.

Table 63: Tracked and Evaluated 2021 MHEEP Equivalent Effective Useful Life Values

Measure	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]	Evaluated Lifetime Gross Energy Savings per Unit [kWh]
Building Envelope	20	21	-
Space Heating Equipment			

18.2.5 Evaluated Gross Savings

The annual gross savings at the generator are presented in Table 64 below. Overall, the annual gross energy and peak demand savings at the generator amounted to 0.316 GWh and 0.147 MW respectively, which represent 6.633 GWh in lifetime energy savings. As a result, the weighted average EUL value for gross energy savings is 21 years.

The gross savings at the generator were estimated by using a line loss factor of 1.0947 for energy savings and 1.1466 for peak demand savings between the meter and the generator. These line loss factors were provided by NS Power and correspond to the values used for residential consumers. The line loss factors correspond to the values submitted to the UARB as part of the 2014 Cost of Service Study Progress Update.⁴⁹

Table 64: Evaluated 2021 MHEEP Gross Energy and Peak Demand Savings

	Total
Number of Participants	82
Energy Savings	
Gross Energy Savings Without Overestimation Ratio (OR) – at the Meter (GWh)	0.425
Gross Energy Savings with OR – at the Meter (GWh)	0.289
Line Loss Factor	1.0947
Gross Energy Savings with OR – at the Generator (GWh)	0.316
Effective Useful Life (years)	21
Gross Lifetime Energy Savings – at the Generator (GWh)	6.633
Peak Demand Savings	
Peak Demand-to-energy Ratio (MW/GWh)*	0.445
Gross Peak Demand Savings – at the Meter (MW)	0.129
Line Loss Factor	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.147
* Corresponds to the equivalent peak demand-to-energy ratio obtained by dividing gross peak demand savings by gross energy savings. This value is different from the peak demand-to-energy ratio that was used in the past (0.283 MW/GWh) because of the new calculation methodology applied for heat pumps.	

⁴⁹ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

18.3 Net Savings

The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the NTGR. More precisely, the NTGR represents the positive or negative impacts of spillover and free-ridership effects on gross savings. A NTGR of 1.00 was used since participating homes are owned by Mi'kmaw communities that traditionally have small housing budgets spread across many competing housing priorities.

18.3.1 Evaluated Net Savings

Net savings are defined as the energy savings specifically attributable to MHEEP. Since spillover and free-ridership effects were considered nil, the net MHEEP impacts are equal to the gross savings generated by the Project. Overall, total net energy and peak demand savings amounted to 0.316 GWh and 0.147 MW at the generator respectively.

As presented in Table 65 below, applying the Nova Scotia-specific factor⁵⁰ for GHG emissions generated by electricity production, 0.5841 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 184 tonnes of annually avoided CO₂ eq.

Table 65: Evaluated 2021 MHEEP GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	0.316
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Net Annual GHG Emission Reductions (tonnes of CO₂ eq)	184

18.4 Realization Rate

A comparison of the energy and peak demand savings values established through this evaluation and those tracked by EOne is presented in Table 66. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 100% for energy savings and 100% for peak demand savings.

⁵⁰ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:

Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021), Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021 https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

Table 66: Comparison of 2021 MHEEP Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	0.316	GWh	1.00	0.316	GWh	100%
Evaluation Results	0.316	GWh	1.00	0.316	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.147	MW	1.00	0.147	MW	100%
Evaluation Results	0.147	MW	1.00	0.147	MW	

Both the energy and peak demand savings determined by the Evaluator were identical to the initial savings tracked by EOne.

19 MHEEP KEY FINDINGS AND RECOMMENDATIONS

As mentioned previously, the main objectives of the 2021 MHEEP evaluation were as follows:

- › Calculate gross and net MHEEP results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions.

This section provides the Evaluator's key findings in relation to these objectives. The Evaluator has no specific recommendation for MHEEP.

2021 MHEEP-Finding: MHEEP net electrical energy and peak demand savings fell short of targets.

MHEEP achieved 0.316 GWh in net electrical energy savings and 0.147 MW in net peak demand savings at the generator in 2021, thus not attaining the planned net electrical energy savings of 0.956 GWh and net peak demand savings of 0.517 MW. MHEEP fulfilled 33% of the energy savings targets in 2021 compared to 14% in 2020. Although the participation level was higher than in pre-pandemic years, it was not sufficient to reach increased targets compared to the 2020 level.

2021 MHEEP-Finding: Average electrical savings per participant increased in 2021, especially for peak demand savings.

Compared to 2020, the average savings per participant increased by 5%, which was due to a lower proportion of participants with non-electrical heating. Space heating being the main source of savings under MHEEP, having less non-electrically heated homes under MHEEP increases the potential for average electrical savings per participant. Conversely, peak demand savings were much higher due to a new and more precise calculation methodology for cold-climate heat pumps; as a result, peak demand savings per participant increased by 66%.

2021 MHEEP-Finding: The evaluated net energy and peak demand savings determined by the Evaluator were identical to the initial net savings tracked by EOne.

Both the energy and peak demand savings determined by the Evaluator were identical to the initial savings tracked by EOne. Therefore, the Evaluator made no adjustments to savings.

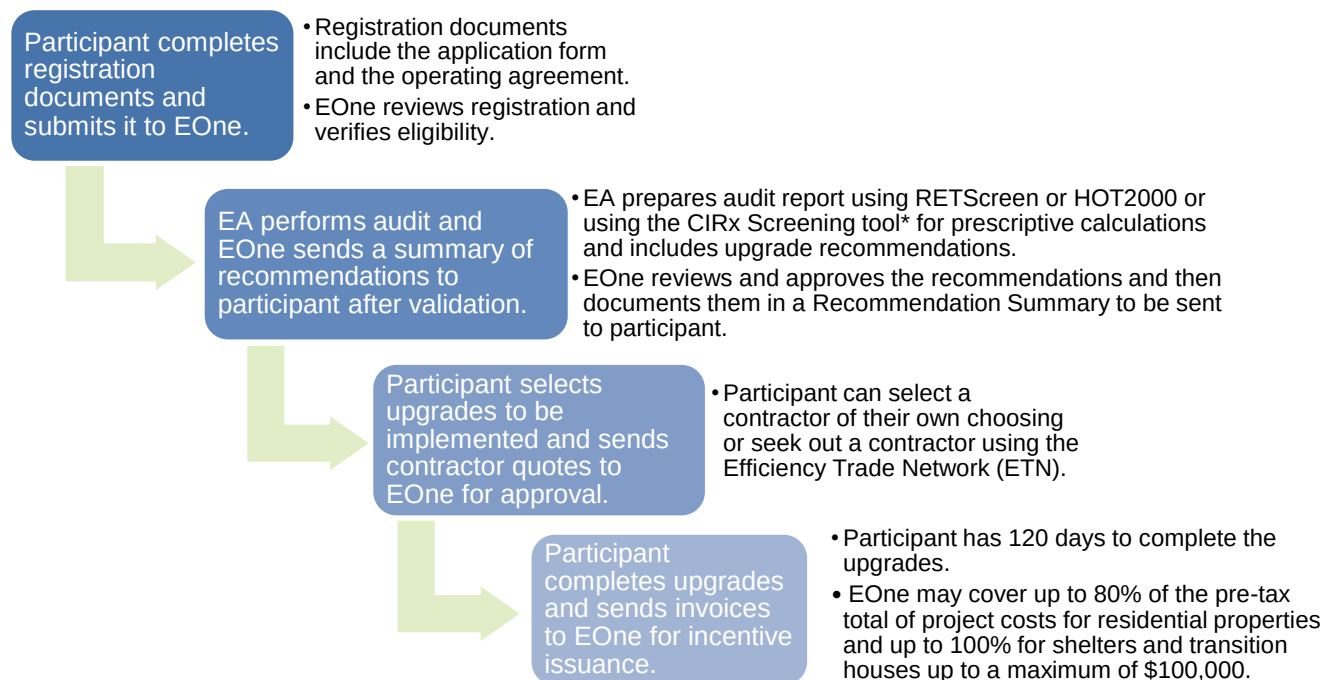
20 AMH OVERVIEW

This section describes Affordable Multifamily Housing (AMH), follows up on past evaluation recommendations, and provides an overview of participation history.

20.1 AMH Description

AMH provides affordable housing owners and non-profit organizations, such as rehabilitation or transition houses, with incentives for building-wide energy retrofit projects with the intent of reducing electrical and non-electrical energy consumption in Nova Scotia. Unless they follow a prescriptive path to install specific measures, AMH projects must undergo a complimentary audit at the beginning of the participation process to identify eligible energy efficiency measures such as water and space heating systems and building envelope measures. This audit is conducted by one of five AMH-approved energy auditors (EAs). Further details about the AMH participation process are provided in Figure 34.

Figure 34: AMH Participation Process Summary



* The CIRx Screening Tool is an EOne tool presenting the savings calculation methodologies, assumptions, and equipment parameters specific to each project.

Since May 2021, the maximum incentive amounts were changed to \$15,000 per affordable unit (MURBs and cooperatives) and \$5,000 per affordable room (rooming houses). The maximum of \$100,000 was kept for shelters, transition houses, and non-bed facilities such as food banks.

AMH funding comes from two sources: (1) Electricity ratepayer funding is used for measures that reduce electricity consumption; and (2) funding from the Province of Nova Scotia (PNS) is used for measures that reduce non-electrical fuel consumption as well as a portion of upgrades that reduce electricity consumption. Since April 2021, additional funding from PNS through the Green Fund allowed for an increase in the incentive amount up to 80% of costs for electrical projects. This report presents all electrical savings achieved by AMH.

Due to public health and government directives regarding the COVID-19 pandemic, all in-home activities related to AMH were suspended from April 28, 2021 to June 1, 2021. Therefore, no energy audits were completed during that period. Certain participants continued to move forward with projects at that time and remote walkthrough visits were performed for some participants to close out their projects, although fewer completions were achieved due to contractor delays and access restrictions.

AMH was aimed at achieving 1.52 GWh in net electrical energy savings and 0.413 MW in net peak demand savings at the generator in 2021.

20.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated AMH in previous years and issued improvement recommendations. Table 67 provides a summary of the implementation status of each recommendation presented in the Executive Summary section of the 2021 Evaluation Report.

Table 67: Implementation Status of Past Recommendations for AMH

#	Past Recommendations for AMH	Status	Comments
2020 AMH-R1	Assess ways to simplify the audit report template while ensuring it meets the need for EOne to populate the recommendation summary template.	Complete	A new audit report template has been developed to align with program component expectations, including standard language to ensure minimum program requirements are being met.
2020 AMH-R2	Encourage EAs to include insulation measures in their audit reports and ensure that such measures are recommended to participants in the recommendation summaries.	Complete	EOne has implemented changes to the audit report that now emphasizes building envelope upgrades, including insulation.

20.3 Participation History

Since 2020, AMH savings are generated by two types of projects: comprehensive and prescriptive projects. In 2021, 23 projects generating electrical savings were completed under AMH, including eight comprehensive and 15 prescriptive projects, which resulted in 0.402 GWh in gross energy savings and 0.186 MW in peak demand savings. One of the comprehensive projects also included non-electrical savings.

As illustrated in Figure 35 below, the number of projects increased by 53% in 2021 compared to 2020, with the number of comprehensive projects increasing from 6 to 8 in 2021 and the number of prescriptive projects increasing from 9 to 15.

Energy savings per project were lower in 2021 than in 2020. Gross energy savings per comprehensive project dropped by 68%, notably due to a decrease in the average building size of participating projects in 2021 compared to 2020. Gross energy savings per prescriptive project also decreased substantially (-52%) from 2020, due in part to the downward adjustment made by the Evaluator.

Although this report is focused on projects that generated electrical savings, it should be noted that, when considering AMH participation globally, most participants are not electrically heated.

Figure 35: Overview of AMH Comprehensive Participant, 2018-2021

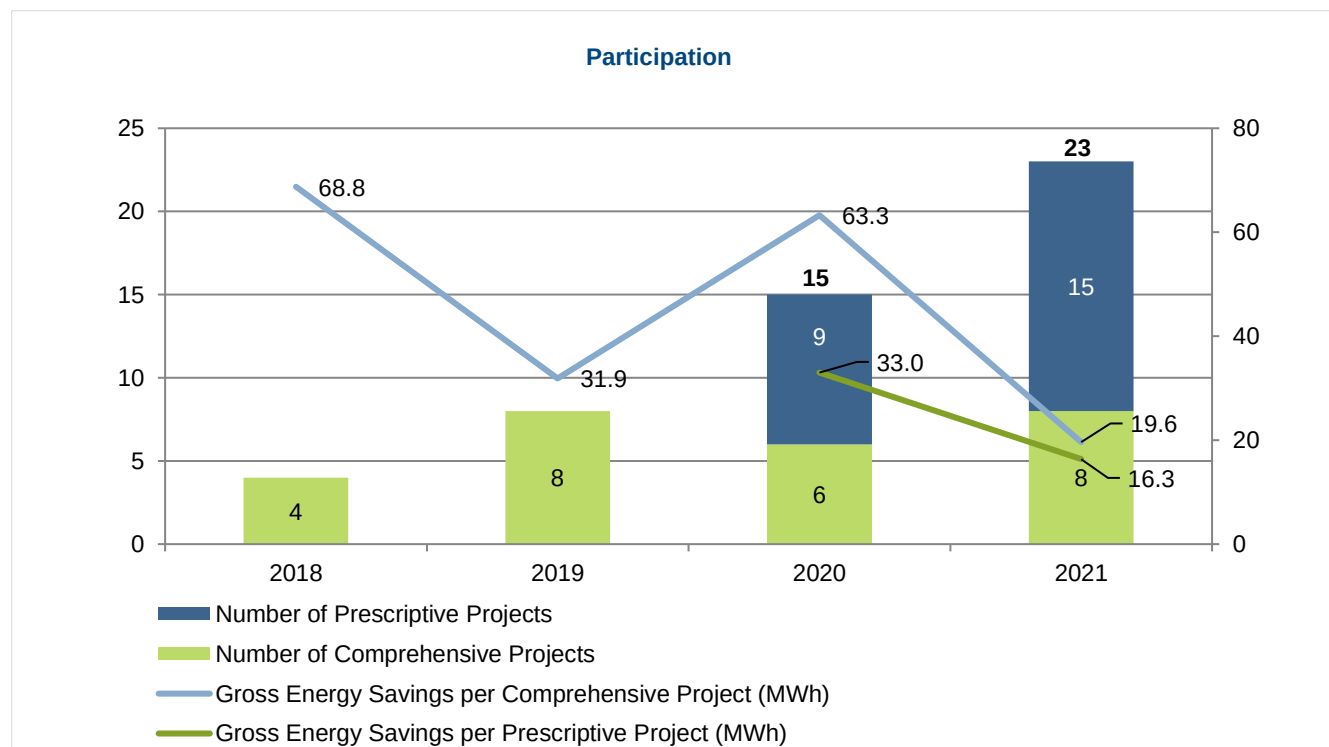
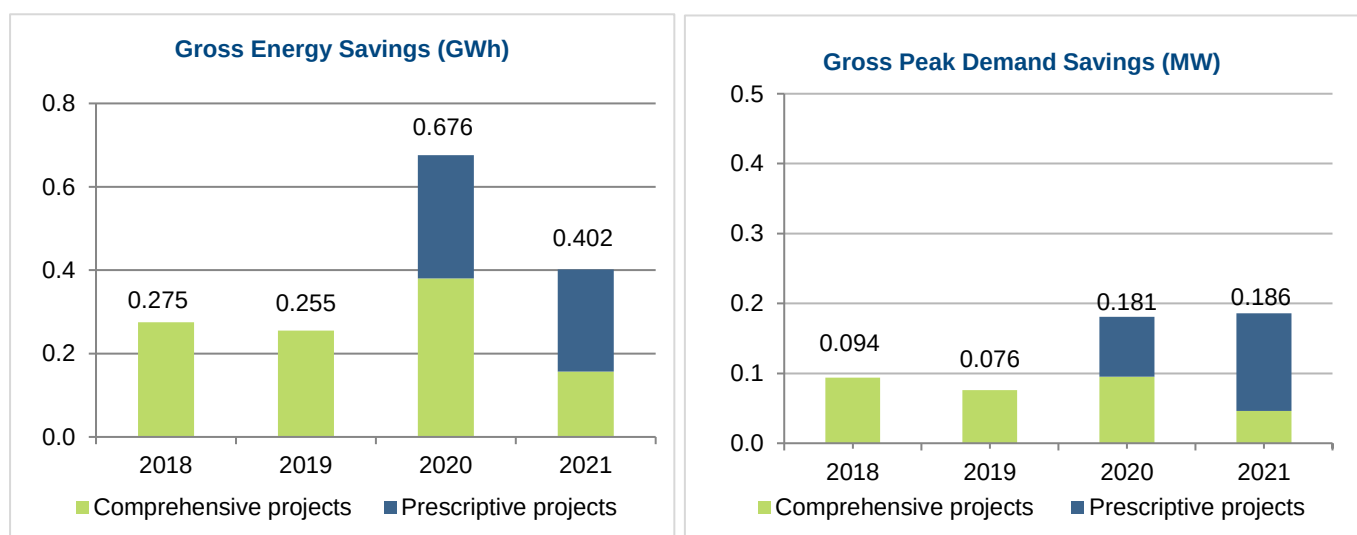


Figure 36 below presents the evolution of AMH gross savings since 2018. In 2021, prescriptive projects generated the majority of energy and peak demand savings (61% and 75% respectively), which can be explained by the higher number of participants with these projects in 2021 compared to 2020.

Despite the increase in participation, the gross energy savings decreased by 41% compared to 2020 due to the lower energy savings per participant. In contrast to energy savings, peak demand savings slightly increased (+3%) compared to the 2020 level. The reason why energy savings decreased while peak demand savings increased is the adjustments made by the Evaluator through the project reviews, which resulted in a downward adjustment to energy savings and an upward adjustment to peak demand savings.

Figure 36: Evolution of AMH Gross Savings, 2018-2021



21 AMH EVALUATION APPROACH

The 2021 evaluation consisted of a comprehensive impact evaluation. The main objectives of the 2021 AMH evaluation were as follows:

- › Collect information on AMH participant perspectives
- › Calculate gross and net AMH results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions⁵¹

The Evaluator identified key research questions aimed at achieving the above objectives. Table 68 outlines the evaluation objectives and maps them to the Evaluator's research questions, methods, and sample sizes (n). Each method is described further below.

Table 68: 2021 AMH Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Collect information on participant perspectives	› How satisfied are participants with AMH? › What challenges or barriers, if any, have participants experienced with AMH?	› On-site visits and desk reviews
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › Are the gross savings calculated for a sample of projects consistent with EOne tracking, savings calculation methods, and the measures observed in project documentation? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › On-site visits and desk reviews › Calculations using evaluation results
Calculate net results	› What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What are the net avoided GHG emissions in CO₂ eq for AMH?	› Calculations using a net-to-gross ratio of 1 › GHG emission reduction calculations

Tracking Sheet Audit

Prior to conducting the savings calculation review, the Evaluator performed an audit of the final 2020 tracking sheet to ensure it was complete and the entered data were consistent. The detailed protocol used for the tracking sheet audit and the results obtained are presented in Appendix XIX.

On-Site Visits and Desk Reviews

In the fall of 2021, Equilibrium performed on-site visits and simulation model reviews for three comprehensive projects and reviewed the documentation of four prescriptive projects.

⁵¹ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

The on-site visits and simulation model reviews were aimed at validating that the inputs used in the simulation model were appropriate and the savings tracked by EOne were consistent with the simulation outputs. The desk reviews were aimed at validating the consistency of the savings tracked by EOne with the calculations, photos, and invoices included in project files.

Information on participant perspectives was also collected during the on-site visits and through follow-up phone interviews for non-visited projects.

The protocol for the on-site visits and desk reviews is presented in Appendix XX.

Effective Useful Life Update

Using the Effective Useful Life (EUL) values for common measures presented in the 2020-2022 Measure Assessment⁵² and the proportion of measures implemented through AMH in 2021, the Evaluator calculated the EUL of the program component as a whole.

Calculations Using Evaluation Results

Building on all the above methods and collected data, the Evaluator calculated the first-year and lifetime energy and peak demand savings as per the calculation methodology presented in Section 23 below.

GHG Emission Reduction Calculations

To obtain net avoided GHG emissions in CO₂ eq for AMH, the Evaluator multiplied the net energy savings by the latest Nova Scotia-specific factor for GHG emissions generated by electricity production. This factor was established using NS Power data.

⁵² The 2020-2022 Measure Assessment is a reference document that provides an in-depth review of all parameters necessary to calculate the annual and lifetime gross energy and peak demand savings of most prescriptive measures and some semi-prescriptive measures offered through EOne's DSM portfolio. In addition, the Measure Assessment includes effective useful life measures for all measures offered in EOne's program portfolio. For the evaluations conducted during the 2020-2022 DSM cycle, the Evaluator refers to the values presented in the 2020-2022 Measure Assessment.

22 AMH PARTICIPANT PERSPECTIVES

As part of the AMH on-site visits, desk reviews, and follow-up phone interviews with participants, six respondents commented on their experience and satisfaction with AMH.

Overall satisfaction with AMH was very high among participants. All participants provided a rating of 10 on a 10-point scale (with 1 indicating “Not at all satisfied” and 10 indicating “Completely satisfied”). The main reasons reported for being satisfied were as follows:

- › The process was easy, not cumbersome. (2 mentions)
- › The incentives allowed participants to implement their project. (2 mentions)
- › AMH criteria allowed upgrades to proceed in old buildings. (1 mention)
- › AMH creates great value for tenants. (1 mention)
- › Participants were satisfied with the work done by the contractor. (2 mentions)

Two respondents said they faced challenges when implementing their project. One participant discovered asbestos during construction, which triggered unplanned abatement work. The other participant had some back and forth with vendors to receive all the data and information needed to send to EOne. The latter participant mentioned that they encountered no challenges when dealing with EOne or when the work was being completed.

2021 AMH Participant Perspective Highlights

- › Overall satisfaction with AMH was very high among participants. All participants provided a rating of 10 on a 10-point scale.
- › Participants were satisfied with the easy process, work performed by the contractor, and incentives received.

23 AMH IMPACT EVALUATION

The objectives of the 2021 AMH impact evaluation were to determine gross and net electrical energy and peak demand savings, annually avoided GHG emissions, as well as EUL and associated lifetime energy savings.

23.1 Tracking Sheet Audit

To ensure program component results were reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix XIX. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

23.2 Gross Savings

Gross savings correspond to the change in energy consumption resulting from custom electrical energy saving upgrades such as building envelope measures, space heating measures, and DHW measures implemented by AMH participants.

Since 2020, AMH savings are generated by two types of projects: Comprehensive and prescriptive projects.

- › Comprehensive projects are projects for which the implemented measures are modelled by software such as HOT2000 or RETScreen. The energy savings of these projects are calculated by comparing the energy model of the base case and the proposed case. Calculations are performed with project-specific parameters.
- › Prescriptive projects are not modelled and have their energy savings calculated using the CIRx Screening Tool provided by EOne, which is a tool presenting the savings calculation methodologies, assumptions, and calculation parameters for measures implemented under AMH.

This subsection describes the methodology used to review the AMH projects that generated savings in 2021 and summarizes the review findings. Interactive effects and EUL values were also assessed.

23.2.1 On-site Visits and Desk Review Findings

The Evaluator conducted a desk review for four prescriptive projects and on-site visits accompanied by simulation model reviews for three comprehensive projects. Reviewed projects were randomly selected among those that were completed at the time of sampling. Among the selected projects, two had twin projects⁵³ for which the Evaluator applied the same adjustments as the reviewed twin projects.

⁵³ The term “twin projects” refers to projects with the same measure in an identical building, thus with the same savings.

The desk reviews and on-site visits were aimed at validating the consistency of the savings tracked by EOne. More specifically, the Evaluator verified that:

- › Supporting documentation, including photos and invoices of installed measures, were complete and matched the measures for which savings were reported in the tracking sheet
- › Savings calculated through engineering calculations or obtained through simulations matched the savings reported in the tracking sheet
- › Baseline and efficient equipment performance levels, such as R-values or efficiency levels of heating and cooling equipment, and building characteristics were reasonable and correctly entered in the engineering calculations or simulation models

Among the three comprehensive projects, the Evaluator adjusted the savings of one project because an incorrect heat pump capacity value was used in the simulation model. This adjustment had a small upward impact on both the energy savings and peak demand savings of that project. No adjustments were made for the other two projects.

While it did not result in an adjustment, the Evaluator noted that the building usage of one comprehensive project was not appropriately modelled. Indeed, the building was observed to be a food bank with commercial food refrigerators, freezers and cooking equipment, but was simulated in HOT2000, software used to simulate only residential buildings and equipment. Using RETScreen would be more appropriate for modelling projects operating commercial equipment since it would account for the commercial equipment impact on the building energy consumption, thus on the savings. The Evaluator did not adjust the savings since it was assumed that they would be of similar magnitude. Going forward, the Evaluator recommends that EOne ensure that the right building usage is modelled for each project.

For the four prescriptive projects reviewed, the Evaluator noted that the tracked peak demand savings were calculated using a peak demand-to-energy ratio for a whole-house developed by Navigant. Energy savings for prescriptive projects are based on CIRx Screening tool equations.⁵⁴ The tool also includes peak demand savings equations and, given that the tool equations use parameters specific for each measure, it provides more accurate peak demand savings. Therefore, the Evaluator revised the demand savings of all prescriptive projects by applying the CIRx Screening tool equations. Going forward, the Evaluator recommends using the CIRx Screening tool equations to calculate peak demand savings when this tool is used to estimate energy savings.

⁵⁴ The CIRx Screening tool is an EOne tool presenting the savings calculation methodologies, assumptions, and equipment parameters specific to each commercial measure.

The Evaluator observed that the heat pump full-load hours for one of the prescriptive projects was lower than for the other three reviewed prescriptive projects. Currently, no full-load hour value was established specifically for AMH; hence, EOne was using the value for multifamily in the CIRx Screening tool. Following an internal review, EOne selected a new value based on a billing analysis for Green Heat from 2017. While this value is for buildings with similar usage as AMH participant buildings, it should be noted that it was developed for single-family homes and not multi-unit residential buildings (MURBs). Nevertheless, the Evaluator agrees with using this value until a value specific to AMH can be established. Therefore, the heat pump full-load hours of all reviewed prescriptive projects were adjusted to the billing analysis value, which resulted in a downward adjustment for three projects. In addition, the Evaluator recommends that a heat pump full-load hour value for AMH be established.

Considering all the adjustments discussed above, the Evaluator decreased the tracked energy savings by 110 MWh and increased the peak demand savings by 81.9 kW, which resulted in adjustment ratios of 0.62 for energy savings and 1.35 for peak demand savings for the reviewed projects. Since the adjustments made by the Evaluator did not result in adjustment factors with margin of errors below 10%, no adjustment ratio was applied to the non-reviewed project savings. Overall, the Evaluator adjustments resulted in adjustment ratios of 0.77 for energy savings and 1.21 for peak demand savings for the program as a whole. Table 69 outlines the adjustment ratios obtained through the project reviews and the overall adjustment ratios.

Table 69: 2021 AMH Adjustment Ratios

	Comprehensive	Prescriptive	Total
Energy Savings			
Adjustment Ratio for Reviewed Projects	1.017	0.445	0.622
Overall Adjustment Ratio	1.011	0.669	0.772
Peak Demand Savings			
Adjustment Ratio for Reviewed Projects	1.017	1.493	1.346
Overall Adjustment Ratio	1.011	1.294	1.209

23.2.2 Interactive Effects

In a home, interactive effects occur when the implementation of energy efficiency measures has an impact on the energy consumption of other factors such as heating and cooling. The interactive effects of space heating and DHW measures were already considered in the savings calculations since the engineering calculations or the simulation models encompass those effects.

23.2.3 Effective Useful Life

Using the EUL values presented in the 2020-2022 Measure Assessment and the proportion of measures implemented through AMH in 2021, the Evaluator revised the program component EUL value. Table 70 below outlines the shares of savings and the equivalent EUL value for the three most implemented measure categories used to calculate the weighted average EUL.

Table 70: 2021 AMH Revised Effective Useful Life

Measure Category	Share of Savings [%]	Evaluated Equivalent EUL [years]	Source
Heating Systems	86%	18	GDS, 2007 ⁵⁵ – Heat Pumps
Building Envelopes	7%	25	GDS, 2007 – Insulation
Lighting	7%	5.7	Lifetime of 50,000 hours based on model specifications. Assumption that lamps are in common zones and turned on 24/7.
Weighted Average EUL	-	17.7	Calculation

23.2.4 Evaluated Gross Savings

The annual gross savings at the generator are presented in Table 71 below. Overall, the annual gross energy and peak demand savings at the generator amounted to 0.402 GWh and 0.186 MW respectively, which represents 7.117 GWh in lifetime energy savings. As a result, the weighted average EUL value for gross energy savings is 17.7 years.

The gross energy savings at the generator were estimated by using different line loss factors for each participant based on their rate code. This resulted in average line loss factors of 1.086 for energy savings and 1.134 for peak demand savings. The line loss factors correspond to the values submitted to the NSUARB as part of Nova Scotia Power 2014 Cost of Service Study Progress Update.⁵⁶

⁵⁵ GDS Associates. *Measure Life Report Residential and Commercial/Industrial Lighting and HVAC Measures*, June 2007.

⁵⁶ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix 1.

Table 71: Evaluated 2021 AMH Gross Energy and Peak Demand Savings

	Comprehensive	Prescriptive	Total
Number of Projects	8	15	23
Energy Savings			
Tracked Gross Energy Savings – at the Meter (GWh)	0.145	0.335	0.480
Adjustment Ratio for Energy Savings	1.011	0.669	0.772
Gross Energy Savings – at the Meter (GWh)	0.146	0.224	0.370
Line Loss Factor	1.076	1.093	1.086
Gross Energy Savings – at the Generator (GWh)	0.157	0.245	0.402
Equivalent Effective Useful Life (years)	17.7	17.7	17.7
Gross Lifetime Energy Savings – at the Generator (GWh)	2.784	4.333	7.117
Peak Demand Savings			
Tracked Gross Peak Demand Savings – at the Meter (MW)	0.041	0.095	0.136
Adjustment Ratio for Peak Demand Savings	1.011	1.294	1.209
Gross Peak Demand Savings – at the Meter (MW)	0.041	0.123	0.164
Line Loss Factor	1.104	1.145	1.134
Gross Peak Demand Savings – at the Generator (MW)	0.046	0.140	0.186

23.3 Net Savings

The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the net-to-gross ratio (NTGR). More precisely, the NTGR represents the positive or negative impacts of spillover and free-ridership effects on gross savings. For AMH, free-ridership and spillover effects were considered to be nil since participants are non-profits or low-income housing owners with limited budgets for building improvements. Therefore, a NTGR of 1.00 was applied.

23.3.1 Evaluated Net Savings

Net savings are defined as the changes in energy use that are specifically attributable to AMH. Since spillover and free-ridership effects were considered nil, the net energy savings are equal to the gross savings generated by the program component. Overall, total net electrical energy and peak demand savings amounted to 0.402 GWh and 0.186 MW at the generator respectively.

As presented in Table 72, applying the Nova Scotia-specific factor⁵⁷ for GHG emissions generated by electricity production to AMH net savings corresponds to a total of 235 tonnes of annually avoided CO₂ eq.

Table 72: Evaluated 2021 AMH GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	0.402
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	235

23.4 Realization Rate

Table 73 below compares the energy and peak demand savings established through this evaluation to those calculated in the 2021 tracking sheet. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 77% for energy savings and at 121% for peak demand savings.

Table 73: Comparison of 2021 AMH Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	0.522	GWh	1.00	0.522	GWh	77%
Evaluation Results	0.402	GWh	1.00	0.402	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.154	MW	1.00	0.154	MW	121%
Evaluation Results	0.186	MW	1.00	0.186	MW	

The net evaluated energy savings were 33% lower than the value tracked by EOne and, conversely, net evaluated peak demand savings were 21% higher than the value tracked by EOne. These differences are due to the adjustments made by the Evaluator following the project reviews.

⁵⁷ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:
Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),
Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021
https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf
(Last accessed November 8, 2021).

24 AMH KEY FINDINGS AND RECOMMENDATIONS

As mentioned previously, the main objectives of the 2021 AMH evaluation were as follows:

- › Collect information on AMH participant perspectives
- › Calculate gross and net AMH results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions

This section provides the Evaluator's key findings and recommendations in relation to these objectives. The following recommendations are also outlined in Appendix XXI.

2021 AMH-Finding: AMH net electrical energy and peak demand savings fell short of targets in 2021.

AMH achieved 0.402 GWh in net electrical energy savings and 0.186 MW in net peak demand savings at the generator in 2021, thus not attaining the planned net electrical energy savings of 1.52 GWh and net peak demand savings of 0.413 MW.

2021 AMH-Finding: AMH continued to grow and achieved its highest level of participation since its launch in 2018, largely driven by an increase in prescriptive projects.

AMH reached its highest participation rate with 23 projects generating electrical savings being completed in 2021. Among the 23 projects, 15 projects were prescriptive projects, and they generated more than half of the savings (61%). Despite the increase in the number of participants, energy savings decreased by 41% compared to the 2020 due to lower savings per participant. In contrast to the energy savings, peak demand savings increased slightly (3%) compared to 2020.

2021 AMH-Finding: Following the project reviews, the Evaluator made downward adjustments to energy savings and upward adjustment to peak demand savings, with the largest adjustments made to prescriptive projects.

The project reviews led to an overall adjustment ratio of 0.77 for energy savings due mostly to a change to the full-load hour value for heat pumps in prescriptive projects; the Evaluator opted to use a full-load hour value for the residential sector established through a billing analysis for Green Heat until a value specific to AMH can be established.

For peak demand savings, the project reviews led to an overall adjustment ratio of 1.21 due to a change in methodology for the prescriptive project peak demand savings calculation. While EOne used a peak demand-to-energy ratio to calculate prescriptive project peak demand savings, the Evaluator used the peak demand savings equations from the EOne calculation tool and that rely on parameters specific to each measure.

2021 AMH-Finding: Participants are extremely satisfied with AMH and the recommended measures.

Satisfaction with AMH overall is extremely high among participants, with all participants providing a rating of 10 on a 10-point scale.

2021 AMH-Finding: The evaluated net energy savings determined by the Evaluator were lower than the savings tracked by EOne, while the evaluated net peak demand savings were higher than the savings tracked by EOne.

The net evaluated energy savings were 33% lower than the value tracked by EOne and, conversely, net evaluated peak demand savings were 21% higher than the value tracked by EOne. These differences are due to the adjustments made by the Evaluator following the project reviews.

CONCLUSION

Table 74 presents the participation levels as well as evaluated gross and net savings at the generator for each Existing Residential program component and for the program as a whole.

Table 74: Overall 2021 Existing Residential Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
HEA							
Energy Savings	961	Participants	3.618	GWh	0.96	3.481	GWh
Lifetime Energy Savings			75.228	GWh	0.96	72.399	GWh
Peak Demand Savings			1.722	MW	0.87	1.495	MW
Green Heat							
Energy Savings	3,654	Measures installed	11.218	GWh	0.61	6.795	GWh
Lifetime Energy Savings			201.923	GWh	0.61	122.306	GWh
Peak Demand Savings			10.370	MW	0.62	6.451	MW
EPI							
Energy Savings	10,028 ⁵⁸	Participants	8.174	GWh	0.96	7.812	GWh
Lifetime Energy Savings			67.214	GWh	0.97	65.165	GWh
Peak Demand Savings			1.143	MW	0.96	1.098	MW
MHEEP							
Energy Savings	82	Participants	0.316	GWh	1.00	0.316	GWh
Lifetime Energy Savings			6.633	GWh	1.00	6.633	GWh
Peak Demand Savings			0.147	MW	1.00	0.147	MW
AMH							
Energy Savings	23	Projects	0.402	GWh	1.00	0.402	GWh
Lifetime Energy Savings			7.117	GWh	1.00	7.117	GWh
Peak Demand Savings			0.186	MW	1.00	0.186	MW
Total							
Energy Savings			23.728	GWh		18.806	GWh
Lifetime Energy Savings			358.115	GWh		273.62	GWh
Peak Demand Savings			13.568	MW		9.378	MW

⁵⁸ The number of participants is based on the number of unique reference numbers of participants that generated electricity savings.

Figure 37 and Figure 38 below respectively illustrate the net energy and peak demand savings targets for each program component, Existing Residential as a whole, as well as whether targets were achieved in 2021. Existing Residential was aimed at achieving 24.2 GWh in net electrical energy savings and 11.2 MW in net peak demand savings at the generator for 2021. It achieved 18.806 GWh in net electrical energy savings and 9.378 MW in net peak demand savings at the generator. Therefore, the program fell short of achieving planned energy and peak demand savings, with all program components being below target, with the exception of Green Heat. Despite the pandemic, Green Heat, MHEEP, and AMH participation levels were the highest ever in 2021. EPI was the largest contributor to total program net energy savings, while Green Heat was the greatest contributor to total net peak demand savings.

Figure 37: 2021 Existing Residential Program Targeted and Evaluated Net Energy Savings

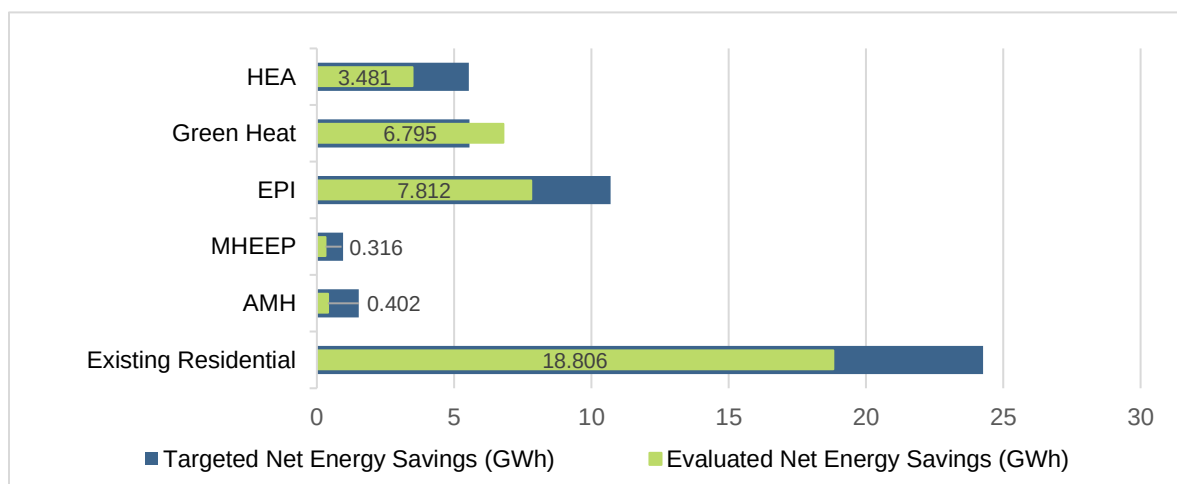
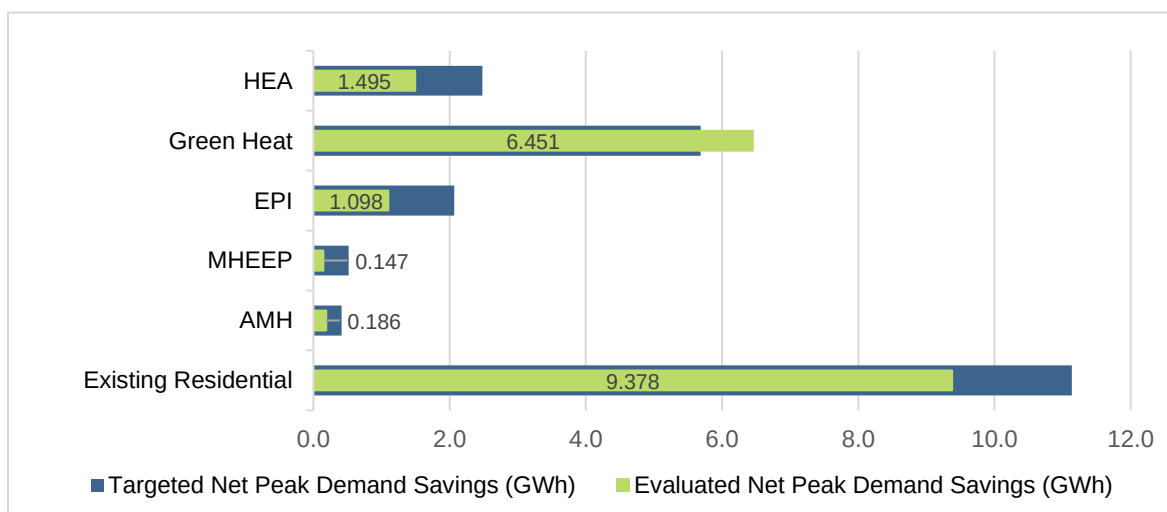


Figure 38: 2021 Existing Residential Program Targeted and Evaluated Net Peak Demand Savings



LIST OF APPENDICES

The following are presented in the Existing Residential Program – Appendices document.

Home Energy Assessment

- Appendix I HEA: Tracking Sheet Audit
- Appendix II HEA: Reporting Requirements
- Appendix III HEA: 2021 Recommendations

Green Heat

- Appendix IV Green Heat: Participant Survey Questionnaire
- Appendix V Green Heat: Participant Survey Results
- Appendix VI Green Heat: Distributors Interview Guide
- Appendix VII Green Heat: Tracking Sheet Audit
- Appendix VIII Green Heat: Algorithm for Free-ridership Calculation
- Appendix IX Green Heat: 2021 Recommendations

Efficient Product Installation

- Appendix X EPI: Participant Survey Questionnaire
- Appendix XI EPI: Participant Survey Results
- Appendix XII EPI: Tracking Sheet Audit
- Appendix XIII EPI: On-site Visit Sampling Methodology and Protocol
- Appendix XIV EPI: Algorithm for Free-ridership Calculation
- Appendix XV EPI: Algorithm for Participant Spillover Calculation
- Appendix XVI EPI: 2021 Recommendations

Mi'kmaw Home Energy Efficiency Project

- Appendix XVII MHEEP: Tracking Sheet Audit
- Appendix XVIII MHEEP: 2021 Recommendations

Affordable Multifamily Housing

Appendix XIX AMH: Tracking Sheet Audit

Appendix XX AMH: Protocol for Desk Reviews and On-site Visits

Appendix XXI AMH: 2021 Recommendations



EXISTING RESIDENTIAL PROGRAM 2021 DSM EVALUATION

EFFICIENCYONE

Appendix Report

March 14, 2022



NARRATIVE
RESEARCH



TABLE OF CONTENTS

APPENDIX I HEA: TRACKING SHEET AUDIT	1
APPENDIX II HEA: REPORTING REQUIREMENTS	7
APPENDIX III HEA: 2021 RECOMMENDATIONS	9
APPENDIX IV GREEN HEAT: PARTICIPANT SURVEY QUESTIONNAIRE	10
APPENDIX V GREEN HEAT: PARTICIPANT SURVEY RESULTS	30
APPENDIX VI GREEN HEAT: DISTRIBUTORS INTERVIEW GUIDE.....	57
APPENDIX VII GREEN HEAT: TRACKING SHEET AUDIT	63
APPENDIX VIII GREEN HEAT: ALGORITHM FOR FREE-RIDERSHIP CALCULATION	67
APPENDIX IX GREEN HEAT: 2021 RECOMMENDATIONS	72
APPENDIX X EPI: PARTICIPANT SURVEY QUESTIONNAIRE.....	73
APPENDIX XI EPI: PARTICIPANT SURVEY RESULTS.....	96
APPENDIX XII EPI: TRACKING SHEET AUDIT	115
APPENDIX XIII EPI: ON-SITE VISIT SAMPLING METHODOLOGY AND PROTOCOL	120
APPENDIX XIV EPI: ALGORITHM FOR FREE-RIDERSHIP CALCULATION	124
APPENDIX XV EPI: ALGORITHM FOR PARTICIPANT SPILLOVER CALCULATION	127
APPENDIX XVI EPI: 2021 RECOMMENDATIONS	129
APPENDIX XVII MHEEP: TRACKING SHEET AUDIT	130
APPENDIX XVIII MHEEP: 2021 RECOMMENDATIONS	133
APPENDIX XIX AMH: TRACKING SHEET AUDIT	134
APPENDIX XX AMH: PROTOCOL FOR DESK REVIEWS AND ON-SITE VISITS	137
APPENDIX XXI AMH: 2021 RECOMMENDATIONS	140

APPENDIX I

HEA: TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying that all data fields required for the evaluation were included and filled out in the tracking sheet submitted by EOne
- › Ensuring that tracked results were accurate by:
 - Verifying that parameters used to calculate program results (gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating that all calculation steps were performed consistently

Data Accuracy

Table 1 lists all the parameters required for the HEA evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the table details the actions carried out by the Evaluator to adjust data where required.

Table 1: Verification of 2021 HEA Data Field Completeness and Accuracy

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluations	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Gross Energy Savings at the Meter	Y	N/A	N/A
Net Energy Savings at the Generator	Y	N/A	N/A
Net Peak Demand Savings at the Generator	Y	N/A	N/A
Heating System Type	Y	N/A	N/A
DHW System Fuel	Y	N/A	N/A
D Assessment Energy Consumption for Electrical Heating	Y	N/A	N/A
E Assessment Energy Consumption for Electrical Heating	Y	N/A	N/A
Heat Pump COP at D Assessment	Y	N/A	N/A
Heat Pump COP at E Assessment	Y	N/A	N/A
Rate Code	Y	N/A	N/A
Green Heat and EPI Energy Savings Deductions	Y	Partial	› The Evaluator checked the current and past tracking sheets for Green Heat (2019, 2020, and 2021) and EPI (2019, 2020, and 2021) to ensure that the savings deductions were correctly applied. – Among the 59 participants for whom deductions were applied, only three participants could not be found in previous tracking sheets. As a result, the Evaluator did not apply any deductions for those participants. The Evaluator adjusted the savings for some of the remaining 56 participants based on the net evaluated energy savings values found in the past tracking sheets.
Green Heat and EPI Peak Demand Savings Deductions	Y	Partial	› The Evaluator did not apply any savings deductions to the three participants for whom savings deductions were removed. The Evaluator adjusted the savings for some of the remaining 56 participants based on the net evaluated demand savings values found in the past tracking sheets.

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluations	If Incomplete or Inconsistent, Action Taken by the Evaluator
Reference Data			
Unitary Savings	Partial	N/A	The Evaluator added and used the unitary savings values to calculate peak demand saving values for space heating (wood/pellet furnaces, boilers, stoves) and domestic hot water prescriptive measures (Heat pump water heaters, DHWR).
Overestimation Ratios	Y	Y	N/A
Net-to-gross Ratios	Y	Partial	EOne calculated net energy savings using the free-ridership and participant spillover levels but without considering the unconverted D assessment spillover level established in 2020. Although different from the 2020 NTGR value, the Evaluator agrees with this approach as explained below (see details below the table).
Peak Demand-to-energy Ratio	Y	Partial	EOne applied the space heating savings peak demand-to-energy ratio, i.e. 0.283 MW/GWh, to calculate non-HP demand savings without considering domestic hot water measures for which specific unitary savings values should be used. The Evaluator corrected the equation so that the 0.283 MW/GWh only applies to non-HP modelled space heating energy savings (see correction in Column KV).
Effective Useful Life (EUL)	No	N/A	The EUL values were missing for all measures as well as lifetime energy savings. The Evaluator added the EUL values recommended in the 2020 evaluation for each measure.
Number of Participants with Unconverted D Assessments	Yes	No	In the expired participant list, 16 expired participants claimed in 2020 completed an E assessment in 2021. The Evaluator reduced the number of expired participants by 16.
Energy Savings for Unconverted D Assessments	Yes	Yes	N/A
Peak Demand Savings for Unconverted D Assessments	Yes	Yes	N/A

The Evaluator understands that, instead of using the unconverted D assessment spillover effect (i.e. 14%) established in 2020, EOne used the information tracked about expired participants in 2021 to directly account for the savings related to these unconverted D assessments. Although different from the NTGR established in 2020, the Evaluator did not make any adjustment to the way EOne calculated and tracked the net energy savings.

Data Consistency

The second step of the tracking sheet audit involved recreating calculations and comparing related tracking sheet data fields to identify any potential inconsistencies in the calculations and correct them in the tracked values. Table 2 lists all the HEA tracking sheet data fields that were compared to ensure consistency.

Table 2: Verification of 2021 HEA Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Calculated Line Loss Factor (Gross Energy Savings at the Generator / Gross Energy Savings at the Meter)	Tracked Rate Codes	Y	N/A
Verification of Duplicate IDs or Projects	-	Y (except in one case)	The Evaluator found one supplemental participant for whom the space heating savings were double counted (only the wood stove savings should have been considered). The non-wood stove savings value was changed to zero in that case.
Verification of Negative Savings	-	N	Total demand savings had negative values in 14 cases because of the Green Heat/EPI deductions. The Evaluator capped the demand savings at 0 in those cases (see Column JC).
Verification of Manual Entries	-	Y	N/A
Verification of Savings Capped at 0 kWh Before Applying the Non-modelled Savings for DHW Measures	-		EOne capped savings at 0 kWh after the addition of prescriptive measure savings. The Evaluator adjusted the calculation to cap savings at 0 kWh only for space heating measures (see Column IT). This situation occurred 25 times in the 2021 HEA tracking sheet.

Equations and Compilation

Once the correct values were established (as per Table 1), the Evaluator validated that the equations in the tracking sheet correctly calculated each of the main program component results, the results of which are presented in Table 3.

Table 3: Verification of 2021 HEA Savings Compilation

Program Component Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	Partial	The savings calculation for gross energy savings at the meter is consistent. However, the calculation for gross energy savings at the generator is missing. The Evaluator added a column to calculate gross energy savings at the generator.
Gross Peak Demand Savings at the Generator	Partial	Similarly to the gross energy savings, the Evaluator added a column to calculate gross peak demand savings at the generator. As for the gross peak demand savings at the meter, the calculations were consistent with the new methodology developed in 2020 to calculate heat pump demand savings separately from other modelled space heating measure demand savings. However, given that heat pump specifications are now tracked, a slightly different calculation approach can be used. See details below in Table 3.
Net Energy Savings at the Generator	Y	N/A
Net Peak Demand Savings at the Generator	Partial	The total net peak demand savings at the generator did not consider demand response measure savings (ETS room, hot water timer, and ETS central). The Evaluator added a new column to also account for those savings.

Instead of using the average unitary peak demand savings per capacity obtained from Green Heat to calculate heat pump demand savings, this calculation was refined by the Evaluator based on the tracked heat pump specifications. This new calculation considers, as explained in Subsection 3.2.3 herein, the heat pump rated heating capacity and COP at -15°C. In applying this new approach, the Evaluator realized that the rated heating capacity at 8°C and not -15°C was the value tracked in the tracking sheet. Moreover, in cases where more than one heat pump was installed, the specifications of all heat pumps were aggregated into one single value instead of being considered individually. The Evaluator corrected this situation by looking up the correct specifications of each heat pump in the CCHP Master List and in the NEEP HP List using their AHRI number and model number. For cases where the specifications could not be found in those databases, the Evaluator used the previous method based on the average unitary peak demand savings per capacity obtained from Green Heat to calculate the heat pump demand savings.

Corrected Tracked Savings

Table 4 presents the corrected tracked savings resulting from all the changes made by the Evaluator as described in this appendix.

Table 4: 2021 HEA Corrected Tracked Savings

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
HEA					
Gross Energy Savings at the Generator	3.533	GWh	3.618	GWh	2.45%
Gross Peak Demand Savings at the Generator	1.927	MW	1.722	MW	-10.64%
Net Energy Savings at the Generator	3.362	GWh	3.481	GWh	3.53%
Net Peak Demand Savings at the Generator	1.637	MW	1.495	MW	-8.68%

The differences between the tracked and corrected values are mainly explained by the following corrections made by the Evaluator:

- › For the differences in energy savings
 - Capping the energy savings at 0 kWh for space heating measures before, not after, the addition of prescriptive measures. Before this correction, prescriptive measure savings were also capped at 0 when modelled space heating savings were negative.
 - The adjustments made to Green Heat and EPI savings deduction values based on the information found in current and past tracking sheets (removal of deductions for three participants and adjustment of energy and demand savings for some of the remaining 56 participants)
 - The reduction in the number of expired participants from 616 to 600.
- › For the differences in demand savings
 - The use of cold climate heat pump specifications (when this information was available) to calculate peak demand savings instead of using the average unitary peak demand savings per capacity obtained from Green Heat.
 - The inclusion of demand response measures (ETS, water heater timers) in the total peak demand savings calculation.
 - Capping the total peak demand savings at 0 kW when this value was negative due to Green Heat/EPI deductions.
 - The use of unitary values to calculate hot water measure demand savings instead of using a peak demand-to-energy ratio of 0.283 MW/GWh that only applies to space heating measures.

APPENDIX II

HEA: REPORTING REQUIREMENTS

HEA incentives originate from two sources of funding and are thus reported to two different parties via the 2021 DSM evaluation and 2021/22 Province of Nova Scotia (PNS) evaluation reports. The DSM evaluation is focused on reporting electrical savings funded by electric DSM investment, while the PNS evaluation is focused on energy savings funded by government funding regardless of the type of fuel. To avoid double counting and determine the most appropriate way to report savings, EOne developed the equations and rationales presented in Table 1 below.

The equations presented below were used in the tracking sheet for all participants who implemented building envelope measures or installed new space heating equipment.

The equations were updated in 2019 to better reflect both the energy savings associated to fuel switching (i.e. from fossil fuel space heating energy sources to electrical heat pump, wood or pellet stoves, and furnaces) and the distribution of savings between DSM-funded and PNS-funded programs for households that use multiple energy sources.

When a fuel switch occurred from a non-electrical heating system in the D assessment to an electrical heating system in the E assessment, electrical savings were capped at 0 kWh and the overall savings, taking into account the increase in electrical consumption, were claimed as non-electrical savings.

The equations reference the following parameters:

- › Electrical space heating energy consumption (Elect_Heating_D and Elec_Heating_E) obtained from HOT2000 during the D and E assessments
- › Total space heating energy consumption (Total_Heating_D and Total_Heating_E) obtained from HOT2000 during the D and E assessments
- › Savings from space heating equipment that are not modelled in HOT2000 (Non-modelled Heating Savings)

Table 1: Reporting Requirements for Different Energy Saving Scenarios¹

Scenarios	1	2	3	4
Change in Overall Electrical Energy Consumption	Increase	Increase	Decrease	Decrease
Change in Overall Non-electrical Energy Consumption	Increase	Decrease	Decrease	Increase
Reporting	N/A	PNS Report	DSM and PNS Reports	DSM Reports
Equation Used to Calculate DSM Savings	N/A	N/A	$\text{Electric\_Heating}_D - \text{Electric\_Heating}_E + \text{Non-modelled Heating Savings}$	$\text{Electric\_Heating}_D - \text{Electric\_Heating}_E + \text{Non-modelled Heating Savings}$
Equation Used to Calculate PNS Savings	N/A	$\text{Total\_Heating}_D - \text{Total\_Heating}_E - (\text{Electric\_Heating}_E - \text{Electric\_Heating}_E) + \text{Non-modelled Heating Savings}$	$\text{Total\_Heating}_D - \text{Total\_Heating}_E - \text{DSM Savings} + \text{Non-modelled Heating Savings}$	N/A
Rationale	This situation never occurs in HEA.	These projects are entirely PNS funded.	The savings are allocated to the appropriate report based on the equations above. DSM savings are subtracted from PNS savings to avoid double counting.	These projects are entirely DSM-funded.

¹ To simplify the equations in Table 1, overestimation ratios are omitted.

APPENDIX III

HEA: 2021 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2021 HEA evaluation as well as all past evaluation recommendations that were not fully implemented or deferred.

Sections	Recommendations
Executive Summary	1. Update and simplify the tracking sheet in time for next year’s evaluation to minimize the risk of calculation errors. For instance, columns could be reorganized to follow the calculations steps from gross savings at meter to net savings at generator in that order. Also, formulas could be simplified by using named variables instead of cell references, and information that is no longer relevant to the calculations could be removed. This should be done alongside the integration of the Canada Greener Homes Grant data and before the conversion into the new data management system.
2020 Recommendations (Deferred or partially implemented)	2. Update the unconverted D assessment spillover calculation assumptions to reflect the current participation mix and obtain more representative results.
	3. Consider tracking the parameters of heat pumps installed through HEA to increase the accuracy of the new heat pump peak demand savings calculation.
2019 Recommendations (Deferred or in progress)	4. Maximize the potential for deeper savings per home by encouraging EAs to recommend measures with high savings potential.
	5. Develop and document a long-term strategy to improve contractor engagement with HEA.
	6. Improve participant understanding of incentive levels.
2018 Recommendation (Deferred)	7. Conduct a billing analysis to review the overestimation (OR) ratio when a sufficient participant sample becomes available.

APPENDIX IV

GREEN HEAT: PARTICIPANT SURVEY QUESTIONNAIRE

Table 5: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Participant Survey
Estimated Time to Complete	15 minutes
Target Audience	Participants who purchased a solar systems or home heating equipment
Expected Number of Completions	140 (70 MSHP, 30 central heat pumps (CASHP), 40 solar and biomass)
Contact List Source	EfficiencyOne
Fielding Firm	Narrative Research
Estimated Timeline for fielding	October - November

Table 6: Research Objectives and Associated Questions

Research Objectives	Section
Verification	A
Awareness and Motivations for Participating	B
Free-ridership – Mini-split Heat Pumps	C
Free-ridership – Central Heat Pumps	D
Free-ridership – Solar and Biomass	E
Cross-influence	F
Satisfaction	G
Barriers	H
Recommendations for Program Improvements	I
Demographics	J

To be adapted by Econoler **[Blue text]**

Import variables from database < **LIKE THIS** >

Skip pattern or programming instructions **[LIKE THIS]**

Black text: instructions for interviewer **[NOTE: xxxx] / [PROBE: xxxx]**

INTRODUCTION

Could I speak with <INSERT NAME>?

1. Yes **[CONTINUE]**
2. No **[SAY “PERHAPS YOU CAN HELP ME ANYWAY.” CONTINUE]**

Hello, my name is _____ from Narrative Research, a Halifax-based survey research company. We are performing an evaluation of energy efficiency services provided by Efficiency Nova Scotia. Our records indicate that you or your household recently participated in the Green Heat program, now called the Heating System Rebates program.

We would appreciate your help in answering questions about this program. The information you provide will be used to help Efficiency Nova Scotia improve the program. Is this a good time for you?

[IF NEEDED: The program provides a rebate for the installation of solar systems or home heating equipment, such as heat pumps, furnaces, and boilers.]

[IF NEEDED: You may have recently been contacted by Narrative Research and Efficiency Nova Scotia about your experience with the program. This survey is different as it focuses on other aspects of your participation in the program.]

[IF NEEDED: The survey will take about 15 minutes.]

A. Verification

[READ A1 IF ONE EQUIPMENT (EQUIPMENT #1 ONLY) IN THE DATABASE]

A1. Our records indicate that your household installed a <EQUIPMENT 1> through the Green Heat program. Is this correct?

1. Yes **[CONTINUE TO B1]**
2. No, does not recall participating **[PROBE:** Are you sure? According to our records, you would have received a rebate from Efficiency Nova Scotia for installing a <EQUIPMENT 1>. **[IF PERSIST AS NO, THANK, TERMINATE, RECORD AND KEEP DATA]**
99. Don't know/Refused **[PROBE:** “Is there someone else in your household who would know about having participated in the Green Heat program?”] **[IF NO, ASK TO SPEAK TO THE APPROPRIATE PERSON AND RESTART AT INTRODUCTION. IF PERSISTS AS NO, THANK, TERMINATE, RECORD AND KEEP DATA.]**

[IF REFUSED, ASK “CAN WE SCHEDULE A MORE CONVENIENT TIME FOR YOU TO CONDUCT THIS SURVEY?”]

[SCHEDULED, IF NECESSARY, FOR: _____]

[READ A2 IF MORE THAN ONE EQUIPMENT (EQUIPMENT #1 AND #2) IN THE DATABASE]

- A2. Our records indicate that your household installed a <EQUIPMENT 1> and a <EQUIPMENT 2> through the Green Heat program. Is this correct?
1. Yes **[CONTINUE TO A3]**
 2. No, does not recall participating **[PROBE: Are you sure? According to our records, you would have received a rebate from Efficiency Nova Scotia for installing a <EQUIPMENT 1> and <EQUIPMENT 2>. [IF YES GO TO A3. IF PERSIST AS NO, THANK, TERMINATE, RECORD AND KEEP DATA]**
 3. No, I only installed a <EQUIPMENT 1> **[CONTINUE TO B1]**
 4. No, I only installed a <EQUIPMENT 2> **[CONTINUE TO B1]**
 99. Don't know/Refused **[PROBE: "Is there someone else in your household who would know about having participated in the Green Heat program?"] [IF NO, ASK TO SPEAK TO THE APPROPRIATE PERSON AND RESTART AT INTRODUCTION. IF PERSISTS AS NO, THANK, TERMINATE, RECORD AND KEEP DATA.]**

[IF REFUSED, ASK "CAN WE SCHEDULE A MORE CONVENIENT TIME FOR YOU TO CONDUCT THIS SURVEY?"]

[SCHEDULED, IF NECESSARY, FOR: _____]

- A3. **[ASK IF A2 = 1 OR 2]** For purposes of this survey, keep only the <EQUIPMENT 1> clearly in your mind as you answer the next few questions.

FOR THE REMAINDER OF THE INTERVIEW, CONSIDER "EQUIPMENT" TO REFER TO EQUIPMENT 2 IF A2=4, OTHERWISE, CONSIDER "EQUIPMENT" TO REFER TO EQUIPMENT 1 FOR ALL OTHERS. REFER TO THE CORRESPONDING INCENTIVE 1 OR 2.

B. Awareness and Motivations for Participating

B1. How did you first become aware of the Green Heat program? **[DO NOT READ. SINGLE RESPONSE]**

1. Radio ads
2. Print ads (magazine or newspaper)
3. In-store signage
4. Retailer flyer
5. Email
6. Through a contractor, retailer, or distributor
7. Efficiency Nova Scotia website
8. Word of mouth
9. Online advertisement on smart phone, computer or tablet
10. Saw an advertisement - general
11. Online
12. Social Media (e.g., Facebook, Twitter, Instagram, Snapchat, TikTok, Youtube, etc.)
13. Through another Efficiency Nova Scotia program
96. (Other) [SPECIFY _____]
98. Don't know
99. Refused

B2. What was the SINGLE most important reason you were interested in participating in Green Heat? **[SINGLE RESPONSE] [DO NOT READ]**

1. To save on energy/to save on energy costs
2. For better comfort
3. To make home more energy efficient
4. Wanted air conditioning
5. To have a backup heating source
6. Wanted wood stove/Like wood heat
7. Old system wasn't working properly
8. To reduce my energy bill
9. To get the rebate offered by Efficiency Nova Scotia
10. The environmental aspect
11. Wanted a better solar systems or home heating equipment
96. Other [SPECIFY _____])
98. Don't know **[GO TO C1]**
99. Refused **[GO TO C1]**

B3. Were there any other reasons? **[DO NOT READ. ACCEPT MULTIPLE KEEPING CODE 97, 98 AND 99 EXCLUSIVE; DO NOT SHOW RESPONSE FROM B2]**

12. To save on energy/to save on energy costs
13. For better comfort
14. To make home more energy efficient
15. Wanted air conditioning
16. To have a backup heating source
17. Wanted wood stove/Like wood heat
18. Old system wasn't working properly
19. To reduce my energy bill
20. To get the rebate offered by Efficiency Nova Scotia
21. The environmental aspect
22. Wanted a better solar systems or home heating equipment
97. (Other) [SPECIFY _____])
97. None/no other reasons
98. Don't know
99. Refused

C. Free-Ridership – Mini-split Heat Pumps

[ASK C1 TO C8 IF EQUIPMENT = MINI-SPLIT HEAT PUMPS (MSHP) IN SAMPLE]

Moving along to another topic... I would like to ask you a series of questions regarding your decision to install a high efficiency heat pump instead of installing another type of heating system or simply keeping your existing system.

Series A: Questions on the decision to install a heat pump

C1. Had you **already** decided to install a heat pump **before** you heard about the Green Heat program?

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused

C2. **[IF C1=1]** Just to confirm: **before** you learned about the Green Heat program, you had already made the decision to install a heat pump?

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused

C3. **[IF C1=2, 98, 99 OR C2=2, 98, 99]** If there was no Green Heat program, which of the following actions would you have taken? **[READ IN ORDER, CODE ONE ONLY]**

1. Kept your existing heating system **[GO TO G SECTION]**
2. Purchased a new electric heating system other than a heat pump **[GO TO G SECTION]**
3. Purchased a new non-electric heating system (e.g. oil or gas system) **[GO TO G SECTION]**
4. Purchased a heat pump

[VOLUNTEERED]

98. Don't know **[GO TO G SECTION]**
99. Refused **[GO TO G SECTION]**

- C4. **[IF C2=1 OR C3=4]** If there was no Green Heat program, what is the likelihood that you would have postponed the purchase of a heat pump by at least one year? Please answer on a scale of 0 to 10, where 0 is “Very unlikely” and 10 is “Very likely.” **[PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]**

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don’t Know
- 99. Refused

Series B: Questions on the decision to install a high-efficiency heat pump

Only high-efficiency heat pump models are eligible for a rebate under the Green Heat program, so the heat pump you have installed is much more efficient than the standard heat pump models on the market, especially at low temperatures of -15°C or less. Now, we will discuss your decision to install a high-efficiency heat pump model rather than a less efficient and less expensive model.

- C5. Were you aware that high efficiency heat pumps that operate at temperatures below -15°C were available before you heard about the Green Heat program?

- 1. Yes
- 2. No

[VOLUNTEERED]

- 98. Don’t know
- 99. Refused

- C6. **[IF C5=1]** Before you heard about the Green Heat program, had you already made the decision to install a **high-efficiency** heat pump model?

- 1. Yes
- 2. No

[VOLUNTEERED]

- 98. Don’t know
- 99. Refused

- C7. Efficiency Nova Scotia gave a rebate of \$<INCENTIVE> for your new high-efficiency heat pump. If you had not received the rebate from Efficiency Nova Scotia, would you have paid the total cost of your high-efficiency heat pump? Please answer on a scale of 0 to 10, where 0 means that you “Definitely **Would Not Have Paid**” and 10 means that you “Definitely **Would Have Paid**.” **[PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]**

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know
99. Refused

- C8. I would like you to rate the influence of the following three factors in your decision to install a high-efficiency heat pump. Use a scale from 0 to 10 where 0 is “No influence” and 10 is “Great influence”. The first factor is... **[READ AND ROTATE FACTORS; DO NOT ACCEPT A RANGE]**

Factor (READ AND RANDOMIZE)	Responses
a. The program rebate	___ Response ___98 Don't Know ___99 Refused
b. Information on the benefits of high efficiency heat pumps provided by Efficiency Nova Scotia	___ Response ___98 Don't Know ___99 Refused
c. Information on the benefits of high efficiency heat pumps provided by the retailers or contractors	___ Response ___98 Don't Know ___99 Refused

D. Free-Ridership – Central Heat Pumps

[ASK D1 TO D7 IF EQUIPMENT = Central heat pump IN SAMPLE]

- D1. Moving along to another topic... Had you **already** decided to install a high efficiency <EQUIPMENT> **before** you heard about the Green Heat program?

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused

D2. **[IF D1=1]** Just to confirm: **before** you decided to participate in the Green Heat program, you had already made the decision to install a high efficiency **<EQUIPMENT>**?

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused

D3. Efficiency Nova Scotia gave a rebate of \$**<INCENTIVE>** for your new **<EQUIPMENT>**. If you had not received the rebate from Efficiency Nova Scotia, would you have paid the entire cost of your **<EQUIPMENT>**? Please answer on a scale of 0 to 10, where 0 means that you "Definitely **Would Not** Have Paid" and 10 means that you "Definitely **Would Have** Paid."
[PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know
99. Refused

[READ FIRST TIME THROUGH ONLY; REPEAT SCALE AS NEEDED] I would like you to consider what actions you would have taken if there was no Green Heat program. For the next questions, answer on a scale of 0 to 10, where 0 is "Very Unlikely" and 10 is "Very Likely."

[DO NOT ACCEPT A RANGE – ASK D4 TO D6 SEQUENCE IN ORDER/DO NOT RANDOMIZE]

D4. If there was no Green Heat program, what is the likelihood that you would have installed a less efficient and less expensive heat pump?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know
99. Refused

- D5. If there was no Green Heat program, what is the likelihood that you would have kept your old heating system instead of installing a new one?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know

99. Refused

- D6. If there was no Green Heat program, what is the likelihood that you would have postponed installing the **<EQUIPMENT>** by at least one year?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know

99. Refused

- D7. I would like you to rate the influence of the following three factors in your decision to install [a/an] **<EQUIPMENT>**. Use a scale from 0 to 10 where 0 is “No influence” and 10 is “Great influence”. The first factor is... **[READ AND ROTATE FACTORS; DO NOT ACCEPT A RANGE]**

Factor (READ AND RANDOMIZE)	Responses
a. The program rebate	___ Response ___98 Don't Know ___99 Refused
b. Information provided by Efficiency Nova Scotia	___ Response ___98 Don't Know ___99 Refused
c. Information on the benefits of high efficiency equipment provided by the retailers or contractors	___ Response ___98 Don't Know ___99 Refused

E. Free-Ridership – Solar and Biomass

[ASK E1 TO E7 IF EQUIPMENT = WOOD STOVE, PELLET STOVE, WOOD FURNACE OR WOOD FIREPLACE IN SAMPLE]

E1. Moving along to another topic... Had you **already** decided to install a **<EQUIPMENT>** before you heard about the Green Heat program?

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused

E2. **[IF E1=1]** Just to confirm: **before** you decided to participate in the Green Heat program, you had already made the decision to install a **<EQUIPMENT>**?

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused

E3. Efficiency Nova Scotia gave a rebate of \$**<INCENTIVE>** for your new **<EQUIPMENT>**. If you had not received the rebate from Efficiency Nova Scotia, would you have paid the entire cost of your **<EQUIPMENT>**? Please answer on a scale of 0 to 10, where 0 means that you "Definitely **Would Not** Have Paid" and 10 means that you "Definitely **Would Have** Paid."
[PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know
99. Refused

[READ FIRST TIME THROUGH ONLY; REPEAT SCALE AS NEEDED] I would like you to consider what actions you would have taken if there was no Green Heat program. For the next questions, answer on a scale of 0 to 10, where 0 is "Very Unlikely" and 10 is "Very Likely."

[DO NOT ACCEPT A RANGE – ASK E4 TO E6 SEQUENCE IN ORDER/DO NOT RANDOMIZE]

- E4. If there was no Green Heat program, what is the likelihood that you would have installed an electrical heating system instead of the **<EQUIPMENT>** you installed through the program?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know

99. Refused

- E5. If there was no Green Heat program, what is the likelihood that you would have kept your old heating system instead of installing a new one?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know

99. Refused

- E6. If there was no Green Heat program, what is the likelihood that you would have postponed installing the **<EQUIPMENT>** by at least one year?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know

99. Refused

- E7. I would like you to rate the influence of the following two factors in your decision to install a **<EQUIPMENT>**. Use a scale from 0 to 10 where 0 is “No influence” and 10 is “Great influence”. The first factor is... **[READ AND ROTATE FACTORS; DO NOT ACCEPT A RANGE]**

Factor (READ AND RANDOMIZE)	Responses
a. The program rebate	___ Response ___98 Don't Know ___99 Refused
b. Information provided by Efficiency Nova Scotia	___ Response ___98 Don't Know ___99 Refused

F. Cross-Influence

[READ AND ROTATE (F1 + F2 TO F4) AND (F5 + F6 TO F8) SEQUENCES]

F1. Before participating in the Green Heat program in 2021, had you at any time in the past participated in any Efficiency Nova Scotia program or service?

1. Yes
2. No

[VOLUNTEERED]

98. Don't know)
99. Refused

For the following statements, please indicate whether you agree or disagree.

F2. **[IF F1=1]** Your previous participation in an Efficiency Nova Scotia program was a major factor in your decision to install [a/an] **<EQUIPMENT>** in your home.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

F3. **[IF F1=1]** Because of your previous participation in an Efficiency Nova Scotia program and what you learned by participating in this program, you asked a contractor or a distributor about energy efficient heating systems for your home.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

F4. **[IF F1=1]** Because of your previous participation in another Efficiency Nova Scotia program and what you learned by participating in this program, you took into account the savings on your energy bill when evaluating different heating systems for your home.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

F5. Before participating in the Green Heat program in 2021, had you at any time in the past seen Efficiency Nova Scotia advertisements or information discussing the benefits of energy efficiency?

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused

For the following statements, please indicate whether you agree or disagree.

F6. **[IF F5=1]** The promotion of energy efficiency carried out by Efficiency Nova Scotia was a major factor in your decision to install [a/an] **<EQUIPMENT>** in your home.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

F7. **[IF F5=1]** The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to ask a contractor or a distributor about energy efficient heating systems for your home.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

F8. **[IF F5=1]** The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take into account the savings on your energy bill when evaluating different heating systems for your home.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

G. Satisfaction

G1. Using a scale from 1 to 10 where 1 is "not at all satisfied" and 10 is "completely satisfied" how would you rate your satisfaction with the program overall? **[RECORD NUMBER, 98=DON'T KNOW, 99 REFUSED] [DO NOT ACCEPT A RANGE].**

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know
99. Refused

G2. **[IF G1<8]** What was the most important reason you were not more satisfied with the program overall? **[PROBE FOR SPECIFIC REASON. ACCEPT MULTIPLE RESPONSE KEEPING CODE 98 EXCLUSIVE]**

RECORD VERBATIM: _____

[VOLUNTEERED]

98. Don't know

G3. On a scale of 1 to 10, where 1 is “not at all satisfied” and 10 is “completely satisfied,” how satisfied were you with each of the following aspects of the Green Heat program? Please indicate if any are not applicable to you. **[DO NOT RANDOMIZE]**

- a. The clarity of program requirements
- b. The program application process
- c. The amount of the rebate
- d. Time required to receive rebate
- e. The equipment installed in your home
- f. The selection of equipment eligible for the rebate

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 97. Not applicable
- 98. Don't Know/Don't recall
- 99. Refused

H. Barriers

H1. For the next few statements, I'd like you to think back to the time when you started to consider installing [a/an] **<EQUIPMENT>**. On a scale of 1 to 10 where 1 means “not at all a concern” and 10 means “a major concern,” how much of a concern was... **[READ AND ROTATE ORDER]**

- a. Selecting the right equipment
- b. The appearance of the equipment
- c. Finding a qualified contractor
- d. The reliability of the equipment
- e. That the equipment would provide enough heat
- f. Realizing the promised energy savings
- g. The cost of the equipment compared to other heating options

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't Know
- 99. Refused

H2. What other concerns, if any, did you have with installing [a/an] **<EQUIPMENT>**?

RECORD VERBATIM

[VOLUNTEERED]

97. None/no concerns

98. Don't know

99. Refused

I. Recommendations for Program Improvements

I1. What was the most helpful aspect of the Green Heat program? **[SINGLE RESPONSE, DO NOT READ]**

1. Rebate/Lowering the cost of the installation

2. Assistance in finding an installer

3. Providing energy savings/efficient equipment

4. Providing information about efficient equipment

5. Easy application process

6. Good/knowledgeable representatives

96. Other [SPECIFY _____]

98. Don't know

99. Refused

I2. Do you have any recommendations for improving the Green Heat program? PROBE: Anything else? **[DO NOT READ. ACCEPT MULTIPLE KEEPING CODE 98 AND 99 EXCLUSIVE]**

1. Increase the rebate

2. Offer additional equipment eligible for rebates

3. Offer more information on the equipment recommended

4. Simplify program application, forms, and associated paperwork

5. Speed up the process

6. Increase the time given to complete the upgrades

7. Advertise the program more or in a better way

97. No recommendation

96. Other [SPECIFY _____]

98. Don't know

99. Refused

J. Demographics

These final questions are asked for statistical purposes only. The information collected is strictly confidential.

J1. What type of residence do you live in? **[READ RESPONSES 1-5, THEN 96; SELECT ONE RESPONSE]**

1. Detached single-family home
2. Semi-detached house
3. Mobile home or house trailer
4. Townhouse or duplex which share adjacent walls
5. Row house
96. Or Another type [SPECIFY: ____]

[VOLUNTEERED]

98. Don't know
99. Refused

J2. How many bedrooms are in your home? **[RECORD NUMBER, DO NOT ACCEPT RANGE; ENTER ZERO FOR A STUDIO APARTMENT WITH NO BEDROOMS]**

RECORD NUMBER: ____

98. Don't know

J3. Including yourself, how many people live in this residence on a full-time basis?

Number of people: _____ **[NOTE: DON'T ALLOW ZERO FOR A RESPONSE]**

[VOLUNTEERED]

97. Nobody lives in the house on a full-time basis
99. Refused

- J4. Please stop me when I reach your age group. Are you...: **[READ; STOP WHEN ANSWER IS VOLUNTEERED]**
1. 18 to 24
 2. 25 to 34
 3. 35 to 44
 4. 45 to 54
 5. 55 to 64
 6. 65 or over
- [VOLUNTEERED]**
99. Refused
- J5. What is the highest level of education you have completed? **[READ IF NECESSARY]**
1. Less than high school graduation diploma
 2. High school graduation diploma and/or some post-secondary
 3. Trades certificate or diploma
 4. College certificate or diploma
 5. University degree, certificate or diploma
 96. Other (SPECIFY:___)
- [VOLUNTEERED]**
99. Refused
- J6. Which of the following income categories best describes your total annual household income before taxes in 2020? Stop me when I reach the right category. **[READ LIST; SELECT ONE RESPONSE]**
1. Less than \$25,000
 2. At least \$25,000 but less than \$40,000
 3. At least \$40,000 but less than \$60,000
 4. At least \$60,000 but less than \$80,000
 5. At least \$80,000 but less than \$100,000
 6. At least \$100,000 but less than \$125,000
 7. At least \$125,000 or more
- [VOLUNTEERED]**
99. Refused

J7. **[DO NOT READ; BY OBSERVATION]** Gender:

1. Male
2. Female
3. Other

END: Those are all the questions I have for you. I thank you very much for your time and cooperation and have a nice day

APPENDIX V

GREEN HEAT: PARTICIPANT SURVEY RESULTS

The participant survey results are presented in the following tables.

Note that for 2019 air-to-water heat pumps are included in the “Central Heat Pump” category. Consideration should be taken when comparing results across years for this category. As well, some questions in 2018 utilized a “0 to 10” scale, while in 2019 and 2021 these questions used a “1 to 10” scale. Caution should be taken when comparing results across years for these questions.

B. Awareness and Motivations for Participating

B1. How did you first become aware of the Green Heat program?

Source of Awareness	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	90	45	22	23	120	50	30	40	140	97	5 (#)	38
Through a contractor, retailer or distributor	39%	29%	59%	39%	37%	38%	43%	30%	34%	36%	2	26%
Via a friend, acquaintance, or family member, word of mouth	23%	40%	-	13%	14%	20%	7%	13%	19%	20%	1	16%
Online	12%	7%	14%	22%	16%	12%	20%	18%	14%	13%	2	11%
Social media	-	-	-	-	3%	2%	-	8%	8%	7%	-	11%
ENS website	-	-	-	-	-	-	-	-	6%	4%	-	13%
Saw an advertisement - general	9%	9%	5%	13%	8%	6%	10%	8%	3%	4%	-	-
Print ads (magazine or newspaper)	2%	2%	5%	-	-	-	-	-	3%	3%	-	3%
My own research	-	-	-	-	-	-	-	-	2%	3%	-	-
In-store signage	-	-	-	-	6%	2%	3%	13%	1%	-	-	5%
Radio ads	3%	7%	-	-	3%	6%	-	-	1%	1%	-	-
Retailer flyer	2%	2%	-	4%	3%	2%	-	5%	1%	-	-	5%
Online advertisement on smart phone, computer or tablet	-	-	-	-	-	-	-	-	1%	1%	-	3%
Through another ENS program	-	-	-	-	-	-	-	-	1%	-	-	3%
Had a heat pump before	2%	-	9%	-	-	-	-	-	-	-	-	-
Others	4%	2%	9%	4%	6%	6%	7%	5%	5%	5%	-	5%
Don't know	2%	2%	-	4%	6%	6%	10%	3%	1%	2%	-	-

B2. What was the SINGLE most important reason you were interested in participating in Green Heat?*

Most Important Reason for Participating	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	90	45	22	23	120	50	30	40	140	97	5 (#)	38
Save on energy/ energy costs	49%	62%	36%	35%	33%	36%	33%	30%	41%	46%	4	24%
To get the rebate offered by ENS	-	-	-	-	-	-	-	-	22%	13%	1	45%
To reduce my energy bill	-	-	-	-	-	-	-	-	6%	6%	-	5%
To make home more energy efficient	7%	4%	9%	9%	6%	10%	7%	-	5%	6%	-	3%
Wanted air conditioning	3%	7%	-	-	14%	28%	10%	-	4%	5%	-	-
For better comfort	10%	11%	9%	9%	8%	10%	-	10%	4%	4%	-	3%
Old system wasn't working properly	11%	2%	32%	9%	15%	6%	23%	20%	3%	3%	-	3%
To replace another heating source	1%	-	5%	-	5%	2%	13%	3%	2%	3%	-	-
Wanted wood stove/ like wood heat	6%	-	9%	13%	3%	-	-	10%	2%	-	-	8%
To help the environment/The environmental aspect	1%	-	-	4%	1%	2%	0%	0%	2%	1%	-	5%
Wanted a better solar systems or home heating equipment	-	-	-	-	-	-	-	-	2%	2%	-	3%
To have a backup heating source	6%	4%	-	13%	8%	2%	-	23%	1%	1%	-	3%
Convenience/ease of use/maintenance	2%	4%	-	-	4%	4%	3%	5%	1%	2%	-	-
To heat the basement	2%	4%	-	-	-	-	-	-	-	-	-	-
Others	2%	-	-	9%	3%	0%	10%	0%	4%	6%	-	-
*Wording change in 2021												

B3. Were there any other reasons?

Other Important Reasons for Participating	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	90	45	22	23	120	50	30	40	140	97	5 (#)	38
Save on energy/ energy costs	23%	22%	36%	13%	18%	20%	17%	15%	18%	20%	-	16%
To make home more energy efficient	10%	7%	9%	17%	8%	8%	17%	-	12%	13%	-	11%
To help the environment/ The environmental aspect	4%	2%	9%	4%	8%	8%	13%	3%	11%	13%	-	8%
Wanted air conditioning	17%	27%	14%	-	12%	22%	10%	-	9%	13%	-	-
To get the rebate offered by ENS	-	-	-	-	-	-	-	-	8%	7%	-	11%
For better comfort	8%	7%	9%	9%	13%	14%	13%	13%	6%	5%	1	5%
To reduce my energy bill	-	-	-	-	-	-	-	-	4%	3%	1	3%
Wanted wood stove/ like wood heat	8%	-	-	30%	3%	-	-	10%	3%	1%	-	8%
Convenience/ease of use/maintenance	4%	9%	-	-	1%	-	-	3%	2%	2%	1	-
Wanted a better solar systems or home heating equipment	-	-	-	-	-	-	-	1	1%	2%	-	-
Old system wasn't working properly	3%	2%	5%	4%	4%	4%	7%	3%	1%	-	-	5%
To have a backup heating source	6%	9%	5%	-	3%	6%	-	3%	1%	1%	-	3%
To replace another heating source	3%	-	14%	-	3%	2%	7%	3%	1%	-	-	3%
Rebate/Financing	-	-	-	-	1%	-	-	3%	-	-	-	-
Others	6%	7%	9%	-	5%	4%	-	10%	4%	5%	-	-
None/No other reasons	21%	22%	9%	30%	30%	22%	33%	38%	38%	36%	3	39%
Don't know/Refused	3%	4%	5%	-	1%	-	-	3%	1%	2%	-	-
Multiple Responses												

B2/B3. What was the SINGLE most important reason you were interested in participating in Green Heat? Were there any other reasons?

Important Reasons for Participating (All Mentions)	2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	140	97	5 (#)	38
To save on energy/to save on energy costs	56%	61%	4	39%
To get the rebate offered by Efficiency Nova Scotia	30%	21%	1	55%
To make home more energy efficient	17%	20%	0	13%
The environmental aspect	14%	14%	0	13%
Wanted air conditioning	13%	19%	0	0%
To reduce my energy bill	9%	9%	1	8%
For better comfort	8%	8%	1	5%
Wanted wood stove/Like wood heat	5%	1%	0	16%
Old system wasn't working properly	4%	3%	0	8%
Convenience/Ease of use/maintain	4%	4%	1	0%
Wanted a better solar systems or home heating equipment	4%	4%	0	3%
To replace another heat source	3%	3%	0	3%
To have a backup heating source	3%	2%	0	5%
Other	7%	10%	0	0%

C. Free-Ridership – Mini-split Heat Pumps

[ASK C1 TO C8 IF EQUIPMENT = MINI-SPLIT HEAT PUMPS (MSHP) IN SAMPLE]

Moving along to another topic... I would like to ask you a series of questions regarding your decision to install a high efficiency heat pump instead of installing another type of heating system or simply keeping your existing system.

Series A: Questions on the decision to install a heat pump

- C1. Had you already decided to install a heat pump before you heard about the Green Heat Program?
- C2. Just to confirm: before you learned about the Green Heat Program, you had already made the decision to install a heat pump?*

Already Made Decision to Install Heat Pump Prior to Green Heat	2018	2019	2021
Sample Size	45	50	97
Yes	71%	70%	73%
No	27%	28%	26%
Don't know	2%	2%	1%
Base: Respondents who had previously decided to install a mini-split heat pump before participating in the program component			
*Wording change in 2021			

- C3. If there was no Green Heat program, which of the following actions would you have taken?*

Actions Taken in Absence of Green Heat	2018 (#)	2019 (#)	2021 (%)
Sample Size	13	15	26
Purchased a heat pump	11	10	38%
Kept your existing heating system	1	3	35%
Purchased a new non-electric heating system (e.g., oil or gas system)	-	1	12%
Don't know	1	1	15%
Base: Respondents who had not previously decided to install a mini-split heat pump before participating in the program component			
*Wording change in 2021			

- C4. If there was no Green Heat program, what is the likelihood that you would have postponed the purchase of a heat pump by at least one year? Please answer on a scale of 0 to 10, where 0 is "Very unlikely" and 10 is "Very likely."*

Actions Taken in Absence of Green Heat	2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Postponed the purchase of a heat pump by at least one year	43	2.5	45	4.5	81	3.5
Don't know/refused excluded from calculation						
Base: Respondents who previously decided to install a mini-split heat pump prior to hearing about Green Heat, or were likely to purchase a heat pump without the program component						

Series B: Questions on the decision to install a high-efficiency heat pump

Only high-efficiency heat pump models are eligible for a rebate under the Green Heat program, so the heat pump you have installed is much more efficient than the standard heat pump models on the market, especially at low temperatures of -15°C or less. Now, we will discuss your decision to install a high-efficiency heat pump model rather than a less efficient and less expensive model.

- C5. Were you aware of the availability of high efficiency heat pumps that operate at temperatures below -15°C were available before you heard about the Green Heat Program?

Aware of High Efficiency Heat Pumps	2018	2019	2021
Sample Size	44	46	81
Yes	59%	65%	65%
No	41%	33%	32%
Don't know	-	2%	2%
Base: Respondents who previously decided to install a mini-split heat pump prior to hearing about Green Heat, or were likely to purchase a heat pump without the program component			

- C6. Before you heard about the Green Heat Program, had you already made the decision to install a high-efficiency heat pump model?

Previously Decided to Install High Efficiency Heat Pump	2018	2019	2021
Sample Size	26	30	53
Yes	81%	93%	79%
No	15%	7%	17%
Don't know	4%	-	4%
Base: Respondents who were aware of high efficiency heat pumps prior to participating in the program component			

- C7. Efficiency Nova Scotia gave a rebate of \$<INCENTIVE> for your new high-efficiency heat pump. If you had not received the rebate from Efficiency Nova Scotia, would you have paid the total cost of your high-efficiency heat pump? Please answer on a scale of 0 to 10, where 0 means that you “Definitely Would Not Have Paid” and 10 means that you “Definitely Would Have Paid.”*

Would Have Paid Full Cost of High Efficiency Heat Pump	2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Would have paid/financed full cost of heat pump	44	9.0	46	9.0	80	8.7
Don't know/Refused excluded from calculations Base: Respondents who previously decided to install a mini-split heat pump prior to hearing about Green Heat, or were likely to purchase a heat pump without the program component *Wording change in 2021						

- C8. I WOULD LIKE YOU TO RATE THE INFLUENCE OF THE FOLLOWING THREE FACTORS IN YOUR DECISION TO install a high-efficiency heat pump. USE A SCALE FROM 0 TO 10 WHERE 0 IS “NO INFLUENCE” AND 10 IS “GREAT INFLUENCE”. THE FIRST FACTOR IS...

Influence of Factors on Decision to Have High Efficiency Heat Pump Installed	2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Information on the benefits of high efficiency heat pumps provided by the retailers or contractors	44	8.4	45	7.8	81	7.5
Information on the benefits of high efficiency heat pumps provided by ENS	43	5.7	45	5.9	77	6.1
The program rebate*	44	4.9	46	5.4	81	5.7
Don't know/Refused excluded from calculations Base: Respondents who previously decided to install a mini-split heat pump prior to hearing about Green Heat, or were likely to purchase a heat pump without the program component *Wording change in 2019 and in 2021						

D. Free-Ridership – Central Heat Pumps

[ASK D1 TO D7 IF EQUIPMENT = Central heat pump IN SAMPLE]

- D1. Moving along to another topic... Had you already decided to install a high efficiency [EQUIPMENT] before you heard about the Green Heat program?
- D2. Just to confirm: **before** you decided to participate in the Green Heat program, you had already made the decision to install a high efficiency [EQUIPMENT]?*

Already Made Decision to Install Equipment Prior to Green Heat	2018	2019	2021 (#)
Sample Size	22	30	5
Yes	64%	87%	2
No	32%	13%	3
Don't know	5%	-	-
Base: Respondents who had previously decided to install an air-source heat pump or ground-source heat pump or air-to-water heat pump before participating in the program component *Wording change in 2021			

- D3. Efficiency Nova Scotia gave a rebate of \$<INCENTIVE> for your new [EQUIPMENT]. If you had not received the rebate from Efficiency Nova Scotia, would you have paid the entire cost of your [EQUIPMENT]? Please answer on a scale of 0 to 10, where 0 means that you “Definitely Would Not Have Paid” and 10 means that you “Definitely Would Have Paid.”*

Would Have Paid Full Cost Heat Pump	2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Would have paid/financed full cost of air-source heat pump or ground-source heat pump	20	8.1	30	8.2	5	8.0
Don't know/Refused excluded from calculations Base: Respondents who had previously decided to install an air-source heat pump or ground-source heat pump or air-to-water heat pump before participating in the program component *Wording change in 2021						

- D4-D6. I would like you to consider what actions you would have taken if there was no Green Heat program. For the next questions, answer on a scale of 0 to 10, where 0 is “Very Unlikely” and 10 is “Very Likely.” If there was no Green Heat program, what is the likelihood that you would have...*

Likelihood of Actions If Program Not Available	2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Installed a less efficient and less expensive heat pump	22	5.1	30	4.5	5	5.2
Postponed installing equipment by at least one year	22	3.7	30	3.9	5	4.0
Kept your old heating system instead of installing a new one	21	3.0	30	3.2	5	1.6
Don't know/Refused excluded from calculations Base: Respondents who had previously decided to install an air-source heat pump or ground-source heat pump or air-to-water heat pump before participating in the program component *Wording change in 2021						

- D7. I WOULD LIKE YOU TO RATE THE INFLUENCE OF THE FOLLOWING THREE FACTORS IN YOUR DECISION TO install [a/an] [EQUIPMENT]. USE A SCALE FROM 0 TO 10 WHERE 0 IS “NO INFLUENCE” AND 10 IS “GREAT INFLUENCE”. THE FIRST FACTOR IS...*

Influence of Factors on Decision to Have Heat Pump Installed	2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
The program rebate*	21	5.2	30	6.4	5	6.8
Information on the benefits of high efficiency equipment provided by the retailers or contractors*	22	7.9	30	7.7	5	6.2
Information provided by Efficiency Nova Scotia*	21	5.0	30	5.9	5	4.6
Don't know/Refused excluded from calculations Base: Respondents who had previously decided to install an air-source heat pump or ground-source heat pump or air-to-water heat pump before participating in the program component *Wording change in 2019 and in 2021						

E. Free-Ridership – Solar and Biomass

[ASK E1 TO E7 IF EQUIPMENT = WOOD STOVE, PELLET STOVE, WOOD FURNACE OR WOOD FIREPLACE IN SAMPLE]

- E1. Moving along to another topic... Had you already decided to install a [EQUIPMENT] before you heard about the Green Heat program?
- E2. Just to confirm: **before** you decided to participate in the Green Heat program, you had already made the decision to install a [EQUIPMENT]?*

Already Made Decision to Install Equipment Prior to Green Heat	2018	2019	2021
Sample Size	23	40	38
Yes	87%	75%	76%
No	9%	23%	24%
Don't know	4%	3%	-
Base: Respondents who had previously decided to install a Wood/Pellet Stove/Boiler/Furnace/Solar Heating System before participating in the program component *Wording change in 2021			

- E3. Efficiency Nova Scotia gave a rebate of \$<INCENTIVE> for your new [EQUIPMENT]. If you had not received the rebate from Efficiency Nova Scotia, would you have paid the entire cost of your [EQUIPMENT]? Please answer on a scale of 0 to 10, where 0 means that you “Definitely Would Not Have Paid” and 10 means that you “Definitely Would Have Paid.”*

Would Have Paid Full Equipment	2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Would have paid/financed full cost of solar water heating, wood stove, pellet stove or wood boiler/furnace	23	8.8	39	7.9	38	8.5
Don't know/Refused excluded from calculations Base: Respondents who had previously decided to install a Wood/Pellet Stove/Boiler/Furnace/Solar Heating System before participating in the program component *Wording change in 2021						

- E4-E6. I would like you to consider what actions you would have taken if there was no Green Heat program. For the next questions, answer on a scale of 0 to 10, where 0 is “Very Unlikely” and 10 is “Very Likely.” If there was no Green Heat program, what is the likelihood that you would have...*

Likelihood of Actions If Program Not Available	2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Postponed installing the equipment by at least one year	22	3.6	39	4.4	38	4.2
Kept your old heating system instead of installing a new one	20	3.0	39	4.4	35	3.4
Installed an electrical heating system instead of the equipment installed through the program	21	1.8	39	1.5	38	2.5
Don't know/Refused excluded from calculations Base: Respondents who had previously decided to install a Wood/Pellet Stove/Boiler/Furnace/Solar Heating System prior to the program component *Wording change in 2021						

E7. I WOULD LIKE YOU TO RATE THE INFLUENCE OF THE FOLLOWING TWO FACTORS IN YOUR DECISION TO install a <EQUIPMENT>. USE A SCALE FROM 0 TO 10 WHERE 0 IS “NO INFLUENCE” AND 10 IS “GREAT INFLUENCE”. THE FIRST FACTOR IS...*

Influence of Factors on Decision to Solar or Biomass Equipment Installed	2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
The program rebate*	23	4.4	40	5.9	38	5.3
Information provided by ENS	23	3.7	40	4.9	38	5.2
Don't know/Refused excluded from calculations Base: Respondents who had previously decided to install a Wood/Pellet Stove/Boiler/Furnace/Solar Heating System before participating in the program component *Wording change in 2021						

F. Cross-Influence

[READ AND ROTATE (F1 + F2 TO F4) AND (F5 + F6 TO F8) SEQUENCES]

F1. Before participating in the Green Heat program in 2021, had you at any time in the past participated in any Efficiency Nova Scotia program or service?**

Previous Participation in Another ENS Program Component	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/ Biomass	Total	MSHP	Central Heat Pump	Solar/ Biomass	Total	MSHP	Central Heat Pump	Solar/ Biomass
Sample Size	89	44	22	23	116	46*	30	40	124	81	5 (#)	38
Yes	39%	39%	45%	35%	34%	28%	27%	48%	40%	42%	1	37%
No	61%	61%	55%	65%	65%	70%	73%	53%	58%	54%	4	63%
Don't know	-	-	-	-	1%	2%	-	-	2%	4%	-	-

*Base: Excludes respondents who would have kept their existing heating system or purchased a different heating system if the program rebate had not been offered.

**Wording change in 2021

F2. Your previous participation in an Efficiency Nova Scotia program was a major factor in your decision to install [EQUIPMENT] in your home.

Previous Participation in Another ENS Program Component was Factor in Decision to Install	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	35	17 (#)	10 (#)	8 (#)	40	13 (#)*	8 (#)	19 (#)	49	34	1 (#)	14 (#)
Agree	43%	6	6	3	48%	4	5	10	41%	35%	0	8
Disagree	54%	10	4	5	53%	9	3	9	59%	65%	1	6
Don't know	3%	1	-	-	-	-	-	-	-	-	-	-
Base: Respondents who previously participated in another ENS program component												
*Base: Excludes respondents who would have kept their existing heating system or purchased a different heating system if the program rebate had not been offered.												

F3. Because of your previous participation in an Efficiency Nova Scotia program and what you learned by participating in this program, you asked a contractor or a distributor about energy efficient heating systems for your home.

Previous Participation in Another ENS Program Component Influenced Decision to Ask About Energy Efficient Heating Systems	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	35	17 (#)	10 (#)	8 (#)	40	13 (#)*	8 (#)	19 (#)	49	34	1 (#)	14 (#)
Agree	69%	11	9	4	73%	11	6	12	67%	68%	0	10
Disagree	31%	6	1	4	28%	2	2	7	33%	32%	1	4
Base: Respondents who previously participated in another ENS program component												
*Base: Excludes respondents who would have kept their existing heating system or purchased a different heating system if the program rebate had not been offered.												

- F4. Because of your previous participation in another Efficiency Nova Scotia program and what you learned by participating in this program, you took into account the savings on your energy bill when evaluating different heating systems for your home.

Influenced Decision to Account for Energy Bill Savings When Evaluating Heating Systems	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	35	17 (#)	10 (#)	8 (#)	40	13 (#)*	8 (#)	19 (#)	49	34	1 (#)	14 (#)
Agree	89%	16	9	6	75%	10	6	14	84%	82%	1	12
Disagree	9%	-	1	2	23%	2	2	5	14%	15%	-	2
Don't know	3%	1	-	-	3%	1	-	-	2%	3%	-	-
Base: Respondents who previously participated in another ENS program component												
*Base: Excludes respondents who would have kept their existing heating system or purchased a different heating system if the program rebate had not been offered.												

- F5. Before participating in the Green Heat program in 2021, had you at any time in the past already seen Efficiency Nova Scotia advertisements or information discussing the benefits of energy efficiency?*

Previously Saw Energy Efficiency Promotional Materials Distributed by ENS	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	89	44	22	23	116	46**	30	40	124	81	5 (#)	38
Yes	74%	80%	73%	65%	79%	78%	73%	85%	82%	85%	4	76%
No	25%	18%	27%	35%	20%	22%	23%	15%	17%	15%	1	21%
Don't know	1%	2%	-	-	1%	-	3%	-	1%	-	-	3%
*Slight wording change in 2019												
**Base: Excludes respondents who would have kept their existing heating system or purchased a different heating system if the program rebate had not been offered.												

F6. The promotion of energy efficiency carried out by Efficiency Nova Scotia was a major factor in your decision to install [equipment] in your home.*

Promotional Materials Distributed by ENS Were a Major Factor In Decision to Install	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	66	35	16 (#)	15 (#)	92	36**	22	34	102	69	4 (#)	29
Agree	44%	49%	7	5	63%	61%	68%	62%	50%	48%	2	55%
Disagree	53%	49%	8	10	37%	39%	32%	38%	50%	52%	2	45%
Don't know	3%	3%	1	-	-	-	-	-	-	-	-	-
Base: Respondents who had previously seen ENS promotional materials												
*Change in wording in 2019												
**Base: Excludes respondents who would have kept their existing heating system or purchased a different heating system if the program rebate had not been offered.												

F7. The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to ask a contractor or a distributor about energy efficient heating systems for your home.*

Promotion of Energy Efficiency Carried Out by ENS Prompted Asking About Efficient Heating Systems for Home	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	66	35	16 (#)	15 (#)	92	36**	22	34	102	69	4 (#)	29
Agree	59%	60%	10	8	61%	67%	59%	56%	57%	55%	3	59%
Disagree	41%	40%	6	7	39%	33%	41%	44%	42%	43%	1	41%
Don't know	-	-	-	-	-	-	-	-	1%	1%	-	-
Base: Respondents who had previously seen ENS promotional materials												
*Change in wording in 2019												
**Base: Excludes respondents who would have kept their existing heating system or purchased a different heating system if the program rebate had not been offered.												

- F8. The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take into account the savings on your energy bill when evaluating different heating systems for your home.*

Promotion of Energy Efficiency Carried out by ENS Prompted Asking About Efficient Heating Systems for Home	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/ Biomass	Total	MSHP	Central Heat Pump	Solar/ Biomass	Total	MSHP	Central Heat Pump	Solar/ Biomass
Sample Size	66	35	16 (#)	15 (#)	92	36**	22	34	102	69	4 (#)	29
Agree	70%	69%	11	11	82%	86%	82%	76%	79%	77%	3	86%
Disagree	30%	31%	5	4	16%	11%	18%	21%	21%	23%	1	14%
Don't know	-	-	-	-	2%	3%	-	3%	-	-	-	-
Base: Respondents who had previously seen ENS promotional materials												
*Change in wording in 2019												
**Base: Excludes respondents who would have kept their existing heating system or purchased a different heating system if the program rebate had not been offered.												

G. Satisfaction

- G1. Using a scale from 1 to 10 where 1 is “not at all satisfied” and 10 is “completely satisfied” how would you rate your satisfaction with the program overall?*

Satisfaction With Green Heat Overall	2018								2019								2021							
	Total		MSHP		Central Heat Pump		Solar/ Biomass		Total		MSHP		Central Heat Pump		Solar/ Biomass		Total		MSHP		Central Heat Pump		Solar/ Biomass	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Overall satisfaction	89	9.0	45	9.0	21	9.3	23	9.0	118	9.1	48	9.2	30	8.7	40	9.2	140	9.0	97	8.7	5	8.0	38	9.7
Don't know/Refused excluded from calculations																								
*Note that a 0-10 scale was used in 2018, caution should be taken when interpreting differences across years																								

G2. What was the most important reason you were not more satisfied with the program overall?

Most Important Reason Not More Satisfied With Green Heat Overall	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	10 (#)	5 (#)	2 (#)	3 (#)	16 (#)	4 (#)	7 (#)	5 (#)	17 (#)	15 (#)	1 (#)	1 (#)
The rebate amount is too small	2	2	-	-	7	3	4	-	7	6	1	-
Program too hard to understand	1	-	-	-	1	-	-	1	2	2	-	-
Information is too vague/ Didn't receive any/ enough information	-	-	-	-	-	-	-	-	2	2	-	-
Too long to get the energy audit done	-	-	-	-	-	-	-	-	2	2	-	-
Poor communication	1	1	-	-	2	1	-	1	1	1	-	-
The rebate application form is too long or complicated to complete	-	-	-	-	1	1	-	-	1	1	-	-
Never received paperwork/report	1	-	-	1	-	-	-	-	1	1	-	-
Had issues when submitting the application	-	-	-	-	-	-	-	-	1	-	-	1
It is too long to receive the rebate amount	2	1	-	1	1	-	-	1	-	-	-	-
Energy efficient equipment didn't qualify	1	-	1	-	1	-	1	-	-	-	-	-
Administration was slow	-	-	-	-	1	-	-	1	-	-	-	-
Service was not organized	-	-	-	-	1	-	1	-	-	-	-	-
Lack of time to do the repairs suggested	-	-	-	-	1	-	-	1	-	-	-	-
They didn't do anything the first time they came	1	1	-	-	-	-	-	-	-	-	-	-
Others	1	-	-	1	2	1	1	-	1	1	-	-
Don't know	-	-	-	-	-	-	-	-	1	1	-	-
Base: Respondents who provided an overall satisfaction score of 7 or lower												

G3. On a scale of 1 to 10, where 1 is 'not at all satisfied' and 10 is 'completely satisfied', how satisfied were you with each of the following aspects of the Green Heat program?*

Satisfaction With Green Heat	2018								2019								2021							
	Total		MSHP		Central Heat Pump		Solar/Biomass		Total		MSHP		Central Heat Pump		Solar/Biomass		Total		MSHP		Central Heat Pump		Solar/Biomass	
Sample Size	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
The equipment installed in your home	87	9.3	44	9.4	20	8.9	23	9.4	119	9.1	50	9.2	29	8.9	40	9.2	137	9.5	96	9.4	5	8.8	36	9.7
The selection of equipment eligible for the rebate**	73	8.2	35	8.1	21	8.3	17	8.4	106	8.5	42	8.7	27	8.0	37	8.5	125	9.0	87	8.8	3	8.3	35	9.6
The program application processes	85	8.8	43	8.9	21	8.6	21	8.6	-	-	-	-	-	-	-	-	136	8.7	93	8.5	5	7.6	38	9.2
The clarity of program requirements	85	8.6	42	8.6	21	8.3	22	8.6	115	8.7	47	8.9	30	8.4	38	8.6	131	8.6	89	8.6	5	6.6	37	9.0
The time required to receive the rebate	89	8.4	44	8.6	22	7.9	23	8.3	119	8.1	49	8.0	30	8.1	40	8.4	139	8.6	96	8.3	5	7.8	38	9.3
The amount of the rebate	89	7.8	44	7.3	22	8.3	23	8.2	120	8.2	50	7.9	30	8.0	40	8.9	139	7.1	96	6.6	5	6.6	38	8.6
Don't know/Refused/Not applicable excluded from calculations																								
*Note that a 0-10 scale was used in 2018, caution should be taken when interpreting differences across years																								
**Wording change in 2021																								

H. Cross-Influence

H1. For the next few statements, I'd like you to think back to the time when you started to consider installing [a/an] [EQUIPMENT]. On a scale of 1 to 10 where 1 means "not at all a concern" and 10 means "a major concern", how much of a concern was...*

Satisfaction With Green Heat	2018								2019								2021							
	Total		MSHP		Central Heat Pump		Solar/Biomass		Total		MSHP		Central Heat Pump		Solar/Biomass		Total		MSHP		Central Heat Pump		Solar/Biomass	
Sample Size	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
The reliability of the equipment	88	8.4	44	8.6	21	8.7	23	7.7	119	7.6	50	7.1	30	8.2	39	7.9	140	7.9	97	7.9	5	9.4	38	7.8
Selecting the right equipment	87	7.7	43	8.3	21	7.1	23	6.9	120	7.7	50	7.2	30	8.2	40	8.0	137	7.8	94	7.7	5	9.4	38	8.0
That the equipment would provide enough heat	89	7.6	44	8.3	22	7.2	23	6.5	117	7.7	48	7.2	30	8.3	39	7.9	139	7.8	96	7.6	5	9.6	38	7.9
Realizing the promised energy savings	83	7.3	41	8.0	20	7.4	22	6.0	115	7.3	47	6.6	29	8.3	39	7.4	133	7.6	94	7.4	5	9.4	34	7.8
Finding a qualified contractor	90	7.3	45	7.4	22	7.0	23	6.0	118	7.4	50	6.9	29	8.4	39	7.2	140	7.3	97	7.3	5	9.4	38	7.0
The cost of the equipment compared to other heating options*	87	6.9	44	6.8	20	7.6	23	6.6	117	7.0	48	6.9	30	7.6	39	6.6	137	7.0	96	6.8	5	9.2	36	7.0
The appearance of the equipment	89	5.6	45	5.6	21	5.6	23	5.3	120	6.1	50	5.9	30	5.6	40	6.7	139	6.2	97	6.1	5	3.8	37	6.9
Don't know/Refused excluded from calculations																								
Note that a 0-10 scale was used in 2018, caution should be taken when interpreting differences across years																								
*Slight change to wording in 2019 and in 2021																								

H2. What other concerns, if any, did you have with installing [a/an] [EQUIPMENT]?

Other Concerns With Installation of Equipment	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	90	45	22	23	120	50	30	40	140	97	5 (#)	38
The location of the installed unit or space limitation	2%	4%	-	-	6%	8%	3%	5%	6%	7%	-	3%
It wouldn't provide enough heat	10%	20%	-	-	3%	6%	-	-	4%	4%	-	5%
The appearance of the unit	1%	2%	-	-	2%	4%	-	-	4%	3%	-	5%
The reliability of the equipment and how to properly use it	8%	7%	14%	4%	1%	2%	-	-	4%	4%	1	-
Quality of contractor/Having equipment installed properly	4%	4%	5%	4%	3%	4%	3%	3%	3%	2%	1	3%
Safety of the equipment/ Fire safety	2%	-	-	9%	-	-	-	-	3%	1%	1	5%
It would increase home insurance	2%	-	-	9%	-	-	-	-	3%	-	1	8%
Cost of the equipment/ Whether we could afford it	-	-	-	-	-	-	-	-	3%	3%	-	3%
Warranty/The length of the warranty	-	-	-	-	-	-	-	-	2%	3%	-	-
Cooling ability/Whether it would keep house cool	-	-	-	-	-	-	-	-	2%	3%	-	-
Buying and storing wood/ Availability of pellets	-	-	-	-	-	-	-	-	2%	-	-	8%
The ongoing maintenance required	-	-	-	-	-	-	-	-	1%	2%	-	-
Efficiency of the equipment/ It wouldn't be efficient	-	-	-	-	-	-	-	-	1%	2%	-	-
Impact on the environment	-	-	-	-	-	-	-	-	1%	1%	-	3%
The noise of the unit	-	-	-	-	3%	6%	-	-	1%	1%	-	-
It wouldn't work the way it was supposed to	1%	-	5%	-	1%	-	3%	-	1%	1%	-	-
Whether it will save money	2%	2%	-	4%	5%	6%	7%	3%	1%	1%	-	-
Buying and storing wood/ Availability of pellets	-	-	-	-	3%	-	-	8%	-	-	-	-
Others	11%	11%	14%	9%	10%	12%	3%	13%	9%	9%	-	11%
None/No concerns	59%	58%	59%	61%	68%	60%	73%	73%	59%	57%	3	63%
Don't know	1%	-	5%	-	1%	-	3%	-	-	-	-	-
Multiple responses												

I. Recommendations for Program Improvements

I1. What was the most helpful aspect of the Green Heat program?

Helpful Aspects of Green Heat	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	90	45	22	23	120	50	30	40	140	97	5 (#)	38
The rebate/Lowering the cost of the installation*	47%	33%	50%	70%	49%	30%	50%	73%	49%	40%	4	66%
Providing information about efficient equipment	8%	11%	5%	4%	12%	10%	23%	5%	6%	6%	1	3%
Providing energy savings/ efficient equipment	7%	9%	5%	4%	8%	16%	3%	3%	6%	8%	-	-
Easy application process	6%	7%	9%	-	1%	-	-	3%	6%	3%	-	16%
Good/knowledgeable representatives	10%	7%	14%	13%	6%	8%	7%	3%	4%	4%	-	5%
Information provided	3%	7%	-	-	3%	4%	3%	-	4%	5%	-	-
More environmentally friendly	1%	2%	-	-	1%	2%	-	-	3%	4%	-	-
Assistance in finding an installer	2%	2%	5%	-	3%	4%	3%	-	2%	3%	-	-
Financing option	1%	2%	-	-	-	-	-	-	1%	1%	-	-
ENS Website	-	-	-	-	2%	2%	3%	-	-	-	-	-
Providing a better heating system than previous system	1%	2%	-	-	-	-	-	-	-	-	-	-
Others	7%	2%	-	-	9%	12%	3%	10%	11%	15%	-	3%
Nothing	-	-	-	-	2%	2%	-	3%	1%	1%	-	-
Don't know/Refused	8%	11%	5%	-	6%	10%	3%	3%	8%	8%	-	8%
Multiple responses												

12. Do you have any recommendations for improving the Green Heat program? PROBE: Anything

Recommendations to Improve Green Heat	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	90	45	22	23	120	50	30	40	140	97	5 (#)	38
Increase the rebates	2%	2%	-	4%	12%	10%	13%	13%	24%	30%	1	11%
Advertise the program more or in a better way	14%	11%	18%	17%	3%	4%	3%	3%	4%	4%	-	5%
Improve communication/ Better support	-	-	-	-	4%	6%	3%	3%	3%	2%	2	-
Simplify application, forms and associated paperwork	6%	4%	5%	9%	2%	2%	3%	-	3%	3%	-	3%
Offer more information on the equipment recommended	9%	11%	5%	9%	2%	-	-	5%	2%	2%	-	3%
Offer more information on the requirements of the program	-	-	-	-	1%	-	-	3%	2%	3%	-	-
Offer additional equipment eligible for rebates	8%	4%	9%	13%	6%	4%	7%	8%	1%	1%	-	-
Speed up process	2%	2%	-	4%	5%	4%	10%	3%	1%	2%	-	-
Information on qualified contractors	3%	2%	9%	-	3%	-	7%	3%	1%	1%	1	-
More knowledgeable people	-	-	-	-	1%	2%	-	-	1%	1%	-	-
Increase the time given to complete the upgrades	1%	-	-	4%	1%	-	-	3%	-	-	-	-
Others	9%	11%	-	13%	9%	8%	10%	10%	9%	6%	-	16%
No recommendations	30%	38%	18%	26%	59%	70%	53%	50%	50%	46%	1	63%
Don't know	19%	16%	36%	9%	3%	4%	-	3%	3%	2%	1	3%
Multiple responses												

J. Demographics

J1. What type of residence do you live in?

Type of Residence	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	90	45	22	23	120	50	30	40	140	97	5 (#)	38
Detached single-family home	80%	78%	82%	83%	85%	86%	93%	78%	84%	78%	5	97%
Semi-detached house	3%	4%	5%	-	7%	8%	-	10%	7%	10%	-	-
Mobile home or house trailer	10%	16%	-	9%	7%	6%	-	13%	4%	6%	-	-
Townhouse or duplex which share adjacent walls	1%	-	5%	-	-	-	-	-	1%	2%	-	-
Another type	6%	2%	9%	9%	1%	-	3%	-	2%	3%	-	-
Refused	-	-	-	-	1%	-	3%	-	1%	-	-	3%

J2. How many bedrooms are in your home?

Number of Bedrooms	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	90	45	22	23	120	50	30	40	140	97	5 (#)	38
0	-	-	-	-	1%	2%	-	-	-	-	-	-
1	4%	4%	-	9%	2%	4%	-	-	1%	2%	-	-
2	9%	7%	5%	17%	17%	16%	3%	28%	16%	13%	-	26%
3	59%	58%	68%	52%	49%	42%	57%	53%	49%	51%	2	47%
4+	28%	31%	28%	22%	30%	32%	40%	20%	33%	34%	3	26%
Don't know	-	-	-	-	2%	4%	-	-	-	-	-	-

J3. Including yourself, how many people live in this residence on a full-time basis?

Number of People in Household	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	90	45	22	23	120	50	30	40	140	97	5 (#)	38
1	14%	11%	18%	17%	23%	16%	13%	38%	14%	15%	-	11%
2	56%	58%	59%	48%	47%	42%	57%	45%	50%	49%	4	47%
3	12%	13%	14%	9%	13%	18%	10%	10%	20%	20%	-	24%
4+	17%	18%	9%	26%	16%	20%	20%	8%	16%	15%	1	18%
Refused	-	-	-	-	2%	4%	-	-	-	-	-	-

J4. Please stop me when I reach your age group. Are you...:*

Age	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	90	45	22	23	120	50	30	40	140	97	5 (#)	38
18-24	-	-	-	-	1%	-	3%	-	1%	1%	-	-
25-34	9%	9%	-	17%	9%	8%	13%	8%	10%	9%	1	11%
35-44	9%	9%	-	17%	13%	12%	10%	18%	15%	14%	-	18%
45-54	14%	11%	14%	22%	19%	22%	13%	20%	17%	13%	2	24%
55-64	38%	40%	36%	35%	28%	18%	40%	30%	32%	33%	1	32%
65+	30%	31%	50%	9%	28%	38%	17%	25%	25%	29%	1	16%
Refused	-	-	-	-	2%	2%	3%	-	-	-	-	-
*Wording change in 2021												

J5. What is the highest level of education you have completed?

Education	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	90	45	22	23	120	50	30	40	140	97	5 (#)	38
Less than high school graduation diploma	3%	-	5%	9%	4%	6%	-	5%	4%	5%	-	3%
High school graduation diploma and/or some post-secondary	28%	27%	27%	30%	24%	20%	23%	30%	16%	20%	-	11%
Trades certificate or diploma	11%	9%	14%	13%	7%	10%	-	8%	1%	1%	-	-
College certificate or diploma	13%	16%	5%	17%	20%	14%	23%	25%	31%	30%	2	32%
University degree, certificate or diploma	44%	49%	50%	30%	43%	46%	53%	30%	44%	40%	3	50%
Other	-	-	-	-	-	-	-	-	3%	2%	-	5%
Refused	-	-	-	-	3%	4%	-	3%	1%	2%	-	-

J6. Which of the following income categories best describes your total annual household income before taxes in 2020?

Income	2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	140	97	5 (#)	38
Less than \$25,000	5%	4%	-	8%
At least \$25,000 but less than \$40,000	5%	5%	-	5%
At least \$40,000 but less than \$60,000	6%	7%	-	3%
At least \$60,000 but less than \$80,000	15%	15%	-	16%
At least \$80,000 but less than \$100,000	21%	19%	1	26%
At least \$100,000 but less than \$125,000	12%	12%	-	13%
At least \$125,000 or more	23%	21%	3	24%
Refused	14%	16%	1	5%

J7. Gender :

Gender	2018				2019				2021			
	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass	Total	MSHP	Central Heat Pump	Solar/Biomass
Sample Size	90	45	22	23	120	50	30	40	140	97	5 (#)	38
Male	62%	58%	73%	61%	57%	46%	63%	65%	59%	61%	3	53%
Female	38%	42%	27%	39%	43%	54%	37%	35%	41%	39%	2	47%

APPENDIX VI

GREEN HEAT: DISTRIBUTORS INTERVIEW GUIDE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview Guide
Estimated Time to Complete	15 min.
Target Audience	Distributors of mini-split heat pumps
Expected Number of Completions	n = 5
Contact List Source	Internet Research and Discussion with Distributors
Fielding Firm	Econoler
Estimated Timeline for fielding	November-December

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
Role	A
Efficiency and price of MSHPs	B
Market size of MSHPs	C
Product Adoption Curve	D

To be adapted by Econoler **[Blue text]**

Import variables from database < **LIKE THIS** >

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Black text: instructions for interviewer **[NOTE: xxxx] / [PROBE: xxxx]**

INTRODUCTION

Thank you for taking the time to speak with me. As part of the 2021 evaluation of their Green Heat program, which provides financial incentives for the purchase of high-efficiency mini-split heat pumps (MSHPs), Efficiency Nova Scotia wants to understand the state of the province-wide MSHP market. I very much appreciate your taking the time to participate in this interview.

As someone involved in the MSHP market, your input is very important to help Efficiency Nova Scotia better understand the evolution of this market. Your comments will be summarized and combined with the answers from other people who participate in the interview. Neither your name nor your organization will be identified with your answers.

Our discussion should last approximately 15 minutes.

Do you have any questions before we begin?

A. Role

[ASK A1 – A4 IF NEW CONTACT (I.E. DIDN'T SPEAK TO THEM IN 2019)]

First, I would like to get a little background information about you.

- A1. **[IF DISTRIBUTOR/MANUFACTURER]** My understanding is that your company is a **[DISTRIBUTOR/MANUFACTURER]** of heating and cooling equipment, such as MSHPs. Is this correct? **[GO TO A3]**
- A2. **[IF PROFESSIONAL ASSOCIATION]** My understanding is that your organization is a professional association comprising of distributors and manufacturers of heating and cooling equipment. Is this correct **[GO TO A4]**
- A3. Do you sell MSHPs to contractors or directly to homeowners?
- A4. For how many years have you worked in or had contact with the MSHP market? **[GO TO SECTION B]**

[ASK A5 IF OLD CONTACT (I.E. WE SPOKE TO THEM IN 2019 OR 2020)]

- A5. I understand from your past interview that your company is a **[DISTRIBUTOR/MANUFACTURER]** of heating and cooling equipment, such as MSHPs that sells to contractors but not homeowners directly. Is this still correct for 2021? **[IF NO RECORD THE CHANGE]**

B. Efficiency and Price of MSHPs

First, I want to discuss with you the characteristics of the MSHPs that you sell.

Efficiency Nova Scotia's Green Heat program provides incentives to high-performance cold climate MSHPs; that is MSHPs that have a HSPF (high seasonal performance factor) of over 10 or higher in Region V as well as a COP (coefficient of performance) at -15 degrees Celsius that is greater than 1.75 and that appear on the NEEP Cold Climate Air Source Heat Pump list. For the purposes of the interview, I will refer to Green Heat eligible MSHPs as high-performing cold climate MSHPs. Please keep in mind that Green Heat eligible MSHPs are higher performing and more energy-efficient than most ENERGY STAR certified MSHPs.

- B1. Do you (still) sell high-performing cold climate MSHPs?
- a. Yes
 - b. No
- B2. **[ASK IF NO AT B1]** Please confirm that you do not currently sell high-performing cold climate MSHPs.
- a. I **do not** sell high-performing cold climate MSHPs **[THANK AND TERMINATE]**
 - b. I do sell high-performing cold climate MSHPs **[CONTINUE]**
- B3. What percentage of the contractors that you sell MSHPs to carry high-performing cold climate MSHPs?
- a. **[IF LOWER THAN 90% ASK]** Our estimate from 2019 is that on average 90% of contractors carry high-performing cold climate MSHPs. Why do you think fewer of the contractors you do business with carry high-performing MSHPs?
- B4. Moving on to pricing, how have the prices of MSHPs in general evolved since 2019? Have they increased/decreased/stayed the same?
- a. **[IF INCREASED/DECREASED ASK]** What are the reasons for this in your opinion?
- B5. What is the average price of a standard MSHP with a 12,000 Btu/hour cooling capacity?

RECORD (\$):

[PROBE: Please think of your most popular standard model. What is this model and what is its current selling price?]

- B6. And what would be the average price of a high-performing cold climate MSHP with a 12,000 Btu/hour cooling capacity?

RECORD (\$):

[PROBE: Please think of your most popular standard model. What is this model and what is its current selling price?]

- B7. To confirm, the average price differential between a standard efficiency MSHP and a high-performing cold climate MSHP with a 12,000 Btu/hour cooling capacity would be about **[\$B6-\$B5]**. Is that correct?

- B8. **[ASK IF B7<\$550 OR >\$650]** Our estimate from 2019 was an average price differential of \$590 or that the price of a high-performing cold climate MHSP is about 10% higher than a standard efficiency MSHP. You estimated it at **[\$B6-\$B5]**. Can you help us understand why there might be a difference? **[PROBE:** Has the price evolved? Was our 2019 estimate off?]

C. Market Size of Mini-Split Heat Pumps

Now, I would like to specifically discuss your sales of MSHPs, and here we are talking about all MSHP sales not just high-performing MSHPs.

- C1. To the best of your knowledge, did your overall sales of MSHP increase, decrease or stay the same from 2019 to 2020? By what percentage an [increase/decrease]? Why do you think they have [increased/decreased/stayed the same]? **[PROBE:** Impact of COVID, supply chain, demand for renovations]

Increase	No change	Decrease
☐ %	☐	☐ %

Explanation: _____

- C2. To the best of your knowledge, have your overall sales of MSHP increased, decreased or stayed the same from 2020 to 2021? By what percentage an [increase/decrease]? Why do you think they have [increased/decreased/stayed the same]? **[PROBE:** Impact of COVID, supply chain, demand for renovations, Federal Government incentives from the Greener Homes program]

Increase	No change	Decrease
☐ %	☐	☐ %

Explanation: _____

- C3. Do you expect your sales of MSHPs to increase, decrease or stay the same in 2022?
- a. Why do you say that?
- C4. Now turning to your sales of high-performing MSHPs. Based on your best estimate, what proportion of your MSHP sales in 2021 were high-performing cold climate MSHPs?

RECORD (%):

- C5. In your interactions with contractors, do you have a sense of the number of high-performance MSHPs you sell that are incented by **Efficiency Nova Scotia**? **[IF NO GO TO SECTION D]**
- C6. **[IF C5 = YES]** Our data shows that half of total MSHP sales in Nova Scotia, including standard and high-performing MSHPs, go through an Efficiency Nova Scotia program. Does our estimate seem reasonable? Why or why not?
- C7. **[IF C5 = YES AND 50% IS REASONABLE IN C6]** Why do you think there aren't more purchasers of high-performing MSHPs that apply for an incentive from Efficiency Nova Scotia's programs?

D. Product Adoption Curve

Now, I am interested in hearing your thoughts on how the market for MSHPs has changed over the last two years. **[SEND FIGURE BY EMAIL AHEAD OF INTERVIEW]**

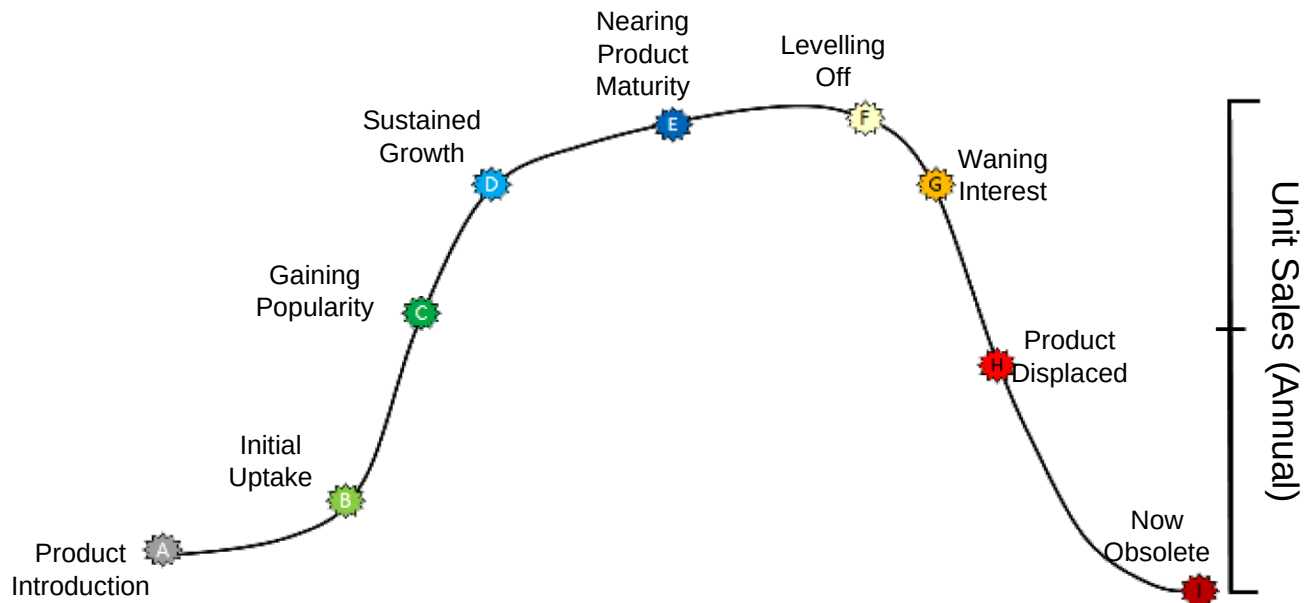
- D1. What changes in the MSHP market, if any, have you seen over the last two years in Nova Scotia? **[IF NEEDED PROBE FOR:** changes related to COVID, the efficiency, materials, incentive programs, or prices of MSHP installed in Nova Scotia homes.]
- a. In your opinion, what explains these changes?

For the next question, please refer to the product adoption curve that was sent to you via email before this interview. The product adoption curve illustrates the typical lifecycle for a product in the market.

- D2. **[IF 2019 CURVE IS NOT AVAILABLE] WHERE ON THE PRODUCT ADOPTION CURVE WOULD YOU PLACE MSHPs?**

[IF 2019 CURVE IS AVAILABLE] Where on the product adoption curve would you place MSHPs this year? Last year, your response was... **[NOTE: USE 2019 LETTER CURVE TO REMIND RESPONDENTS WHAT THEY ANSWERED IN 2019.]**

	Last Year's Response (if available)	2021 Letter on the Curve	Why do you think that?
Mini Split Heat Pumps			



E. Closing

E1. Those are all the questions I have for you today. Do you have anything to add regarding the program or this interview?

Thank you for your collaboration and the time you took to answer our questions.

APPENDIX VII

GREEN HEAT: TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying that all data fields required for the evaluation were included and filled out in the tracking sheet submitted by EOne
- › Ensuring that tracked results were accurate by:
 - Verifying that parameters used to calculate program results (gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating that all calculation steps were performed consistently

EOne started using their new Integrated Customer Information System in 2021 for ARet; therefore, the format of the tracking sheet has been changed compared to previous years.

Data Accuracy

Table Table lists all the parameters required for the Green Heat evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the table details the actions carried out by the Evaluator to adjust data where required.

Table 1: Verification of 2021 Green Heat Data Field Completeness and Accuracy

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Heating System Type	Partial	N/A	Primary heating systems were missing for 114 participants, and they are unknown for 28 participants. Those missing were considered to be electrical heating systems. For those unknown, the heating sources were available, so they were considered fully or partially electrically-heated depending on the secondary heating source.

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Unitary Savings	Partial	N/A	The unitary savings values are the same as those outlined in the 2020 Evaluation Report. For tracked unitary energy savings, the Evaluator corrected them for five pellet stove projects and 32 wood stove projects. - For pellet stoves, the Evaluator corrected the savings values to correspond to values for fully electrically heated houses, i.e. 8,959 kWh instead of 4,072 kWh. - For wood stoves, the Evaluator corrected the savings values to correspond to values for fully electrically heated houses, i.e. 10,443 kWh instead of 4,747 kWh. The correct tracked unitary peak demand savings were used for all measures, except for four electric thermal storage (ETS) measures. - The Evaluator adjusted the unitary peak demand savings for four of the installed models. Also, two ETS systems had only energy savings and no information to calculate peak demand savings. No savings were attributed to those units.
Heating Seasonal Performance Factor (HSPF)	Partial	N/A	For 13 participants, the Evaluator adjusted the HSPF based on information from specification sheets found online, although this did not impact savings. 11 of them were missing, all corresponding to centrally-ducted heat pump system measures. As for the two other participants, the Evaluator corrected the values.
Heating Capacity at Rated Condition	Partial	N/A	For 402 participants, the Evaluator corrected the rated heating capacity using the values from the NEEP list.
Heating Capacity at -15°C	Partial	N/A	For 651 participants, the Evaluator corrected the heating capacity at -15°C based on information from the NEEP list.
COP at -15°C	Partial	N/A	For 757 participants, the Evaluator corrected the COP at -15°C based on information from the NEEP list.
Rate Code	Partial	N/A	For 76 participants, the rate class (residential) does not correspond to the rate code name (municipal). Residential rate codes are unknown for 25 participants. A residential rate code was used for those participants.
Net-to-gross Ratios	Y	N/A	N/A
Effective Useful Life	Y	Partial	All effective useful life (EUL) values were correct except for one three-element water heater project. The Evaluator corrected the EUL value from 10 to 12 years.

Data Consistency

The second step of the tracking sheet audit involved recreating calculations and comparing related tracking sheet data fields to identify any potential inconsistencies in the calculations and correct them in the tracked values. Table lists all the tracking sheet data fields that were compared to ensure consistency.

Table 2: Verification of 2021 Green Heat Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Tracked Line Loss Factor	Tracked Rate Codes	Y	N/A
Verification of Duplicate IDs or Projects	-	Y	See text below in Table .

The Evaluator verified that no projects were claimed multiple times. A total of 415 participants were found with multiple entries. The Evaluator ensured that there was no double counting for those participants. For all of them, energy savings, AHRI certificate numbers, outdoor unit models, indoor unit models, PM external ID, or measure names were different.

Equations and Compilation

Once the correct values were established (as per Table), the Evaluator validated that the equations in the tracking sheet correctly calculated each of the main program component results, the results of which are presented in Table .

Table 3: Verification of 2021 Green Heat Savings Compilation

Program Component Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	Y	N/A
Gross Peak Demand Savings at the Generator	Y	N/A
Net Energy Savings at the Generator	Y	N/A
Net Peak Demand Savings at the Generator	Y	N/A

Corrected Tracked Savings

Table below presents the corrected tracked savings values resulting from all the changes made by the Evaluator as described in this appendix.

Table 4: 2021 Green Heat Corrected Tracked Savings

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
Green Heat					
Gross Energy Savings at the Generator	11.095	GWh	11.218	GWh	1.11%
Gross Peak Demand Savings at the Generator	10.011	MW	10.319	MW	3.08%
Net Energy Savings at the Generator	5.496	GWh	5.580	GWh	1.52%
Net Peak Demand Savings at the Generator	5.032	MW	5.179	MW	2.92%

The main differences between the tracked and corrected values are found in the peak demand savings results. They are mainly explained by the adjustment to the heating capacity and COP at -15°C used for mini-split heat pumps to determine peak demand savings.

The following other corrections made by the Evaluator had a lower impact on results, especially because some were downward and other upward adjustments:

- › An adjustment to the nominal heating capacity used for mini-split heat pumps for the determination of energy savings.
- › The adjustment to the baseline for several wood and pellet stove models from a heat pump baseline to an electrical resistance baseline according to their primary and secondary heating sources.

APPENDIX VIII

GREEN HEAT: ALGORITHM FOR FREE- RIDERSHIP CALCULATION

The tables below present the free-ridership calculation algorithms for biomass and solar measures, central heat pumps, and MSHPs. The participant survey questionnaire included questions designed to assess the planning, quantity, efficiency, period, cost, and influence of the program component. A set of questions was also asked to assess cross-influence, which refers to the level of influence that participants' previous participation in one of EOne's program components or energy efficiency awareness campaigns had on their decisions to implement energy efficiency measures. Participants' responses to each group of questions were converted into a value indicating the level of program component attribution, and this value was used to calculate the free-ridership level associated with each participant.

For those participants who installed an MSHP, the algorithm consisted of two portions. The first portion served to assess a participant's decision to install a heat pump. The second served to assess a participant's decision to purchase a high-efficiency heat pump. The portion for assessing the decision to install a heat pump was given a weight of 75% since the savings associated with the efficiency increase provided by an electric resistance system (with an HSPF of 3.412) compared to a standard heat pump (usually with an HSPF of 7.1 according to federal energy efficiency regulations) represents about 75% of the total savings attributable to a high-efficiency MSHP. Also, the portion of free-ridership linked to the decision to purchase a high-efficiency heat pump (the remaining 25%) was considered only if the free-ridership level of the first portion was higher than 50%. It was assumed that, if the probability of purchasing a heat pump was lower than or equal to 50%, the probability of purchasing a high-efficiency heat pump was close to nil.

Table 1: Free-Ridership Algorithm for Biomass and Solar Measures

E3. If you had not received the rebate from Efficiency Nova Scotia, would you have paid the entire cost of your <EQUIPMENT> ? (Scale 0 to 10)	E3 = Answer x 10% IF DK OR REF: E3 = EMPTY
E4. If there was no Green Heat program, what is the likelihood that you would have installed an electrical heating system instead of the <EQUIPMENT> you installed through the program? (Scale 0 to 10)	E4 = (10 – Answer) x 10% IF DK OR REF: E4 = EMPTY
E5. If there was no Green Heat program, what is the likelihood that you would have kept your old heating system instead of installing a new one? (Scale 0 to 10)	E5 = (10 – Answer) x 10% IF DK OR REF: E5 = EMPTY
PA1 Score:	MEAN VALUE OF: (E3; MIN(E4; E5))
E1. Had you already decided to install a <EQUIPMENT> before you heard about the Green Heat program?	IF 1. Yes: Use E2 IF 2. No OR DK OR REF: E2 = 0%

E2. [IF E1=1] Just to confirm: before you decided to participate in the Green Heat program, you had already made the decision to install a <EQUIPMENT> ?	IF 1. Yes: E2 = 100% IF 2. No OR DK OR REF: E2 = 0%
PA2 Score:	E2
E7. Level of influence (Scale 0 to 10)	E7 = MAX(E7a; E7b)
PA3 Score:	(10 – E7) x 10%
E6. If there was no Green Heat program, what is the likelihood that you would have postponed installing the <EQUIPMENT> by at least one year?	E6 = (10 – Answer) x 10% IF DK OR REF: E6 = EMPTY
PA4 Score:	E6
Inconsistency Test PA1	IF ABS (E3 – MIN (E4; E5)) ≥ 50% PA1 = MIN (E3; E4; E5)
Inconsistency Test PA2	IF E2 = 100% and E3 < 70% PA2 = EMPTY
Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)
Cross-Influence	
F2/F6. [Your previous participation in an Efficiency Nova Scotia program / The promotion of energy efficiency carried out by Efficiency Nova Scotia] was a major factor in your decision to install [a/an] <EQUIPMENT> in your home. F3/F7. [Because of your previous participation in an Efficiency Nova Scotia program and what you learned by participating in this program, you asked / The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to ask] a contractor or a distributor about energy efficient heating systems for your home. F4/F8. [Because of your previous participation in another Efficiency Nova Scotia program and what you learned by participating in this program, you took / The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take] into account the savings on your energy bill when evaluating different heating systems for your home.	Cross-influence (CI) = IF(F2 OR F6=Agree; 1) + IF(F3 OR F7=Agree; 1) + IF(F4 OR F8=Agree; 1)
Revised Free-Ridership	IF CI=0 OR 1, Revised FR = FR IF CI=2, Revised FR = FR*.75 IF CI=3, Revised FR = FR*.50

Table 2: Free-Ridership Algorithm for Central Heat Pumps

D3. If you had not received the rebate from Efficiency Nova Scotia, would you have paid the entire cost of your <EQUIPMENT> ? (Scale 0 to 10)	D3= Answer x 10% IF DK OR REF: D3 = EMPTY
D4. If there was no Green Heat program, what is the likelihood that you would have installed a less efficient and less expensive heat pump? (Scale 0 to 10)	D4 = (10 – Answer) x 10% IF DK OR REF: D4 = EMPTY
D5. If there was no Green Heat program, what is the likelihood that you would have kept your old heating system instead of installing a new one? (Scale 0 to 10)	D5 = (10 – Answer) x 10% IF DK OR REF: D5 = EMPTY
PA1 Score:	MEAN VALUE OF: (D3; MIN(D4; D5))
D1. Had you <i>already</i> decided to install a high efficiency <EQUIPMENT> <i>before</i> you heard about the Green Heat program?	IF 1. Yes: Use D2 IF 2. No OR DK OR REF: D2 = 0%
D2. [IF D1=1] Just to confirm: <i>before</i> you decided to participate in the Green Heat program, you had already made the decision to install a high efficiency <EQUIPMENT> ?	IF 1. Yes: D2 = 100% IF 2. No OR DK OR REF: D2 = 0%
PA2 Score:	D2
D7. Level of influence (Scale 0 to 10)	D7 = MAX(D7a; D7b)
PA3 Score:	(10 – D7) x 10%
D6. If there was no Green Heat program, what is the likelihood that you would have postponed installing the <EQUIPMENT> by at least one year? (Scale 0 to 10)	D6 = (10 – Answer) x 10% IF DK OR REF: D6 = EMPTY
PA4 Score:	D6
Inconsistency Test PA1	IF ABS (D3 – MIN (D4; D5)) ≥ 50% PA1 = MIN (D3; D4; D5)
Inconsistency Test PA2	IF D2 = 100% AND D3 < 70% PA2 = EMPTY

Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)
Cross-Influence	
F2/F6. [Your previous participation in an Efficiency Nova Scotia program / The promotion of energy efficiency carried out by Efficiency Nova Scotia] was a major factor in your decision to install [a/an] <EQUIPMENT> in your home. F3/F7. [Because of your previous participation in an Efficiency Nova Scotia program and what you learned by participating in this program, you asked / The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to ask] a contractor or a distributor about energy efficient heating systems for your home. F4/F8. [Because of your previous participation in another Efficiency Nova Scotia program and what you learned by participating in this program, you took / The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take] into account the savings on your energy bill when evaluating different heating systems for your home.	Cross-influence (CI) = IF(F2 OR F6=Agree; 1) + IF(F3 OR F7=Agree; 1) + IF(F4 OR F8=Agree; 1)
Revised Free-Ridership	IF CI=0 OR 1, Revised FR = FR IF CI=2, Revised FR = FR*.75 IF CI=3, Revised FR = FR*.50

Table 3: Free-Ridership Algorithm for MSHPs

Series A: Decision to install a HP	
C1. Had you already decided to install a heat pump before you heard about the Green Heat program?	IF 1. Yes: Use C2 IF 2. No OR DK OR REF: C2 = 0%
C2. [IF C1=1] Just to confirm: before you learned about the Green Heat program, you had already made the decision to install a heat pump?	IF 1. Yes: C2 = 100% IF 2. No OR DK OR REF: C2 = 0%
C3. [IF C1=2, 98, 99 OR C2=2, 98, 99] If there was no Green Heat program, which of the following actions would you have taken? 1. Kept your existing heating system 2. Purchased a new electric heating system other than a heat pump 3. Purchased a new non-electric heating system (e.g. oil or gas system) 4. Purchased a heat pump	IF 1, 2 or 3: END IF 4: ASK C4
C4. [IF C2=1 OR C3=4] If there was no Green Heat program, what is the likelihood that you would have postponed the purchase of a heat pump by at least one year? (Scale 0 to 10)	C4 = (10 – Answer) x 10% IF DK OR REF: C4 = EMPTY
PA1 Score (Series A)	MEAN VALUE OF: (C2; C4)

Series B: Decision to install a high-efficiency HP	
C5. Were you aware that high efficiency heat pumps that operate at temperatures below -15°C were available before you heard about the Green Heat program?	IF 1. Yes: Use C6 IF 2. No, DK OR REF: C6 = 0% and END
C6. [IF C5=1] Before you heard about the Green Heat program, had you already made the decision to install a high-efficiency heat pump model?	IF 1. Yes: C6 = 100% IF 2. No, DK OR REF: C6 = 0%
C7. If you had not received the rebate from Efficiency Nova Scotia, would you have paid the total cost of your high-efficiency heat pump? (Scale 0 to 10)	C7 = Answer x 10% IF DK OR REF: C7 = EMPTY
C8. Level of influence (Scale 0 to 10)	C8 = (10 - MAX(C8a;C8b;C8c))*10%
PA2 Score (Series B)	IF PA1<=50% OR C5<>1 PA2 = 0%, OTHERWISE MEAN VALUE OF: (C6; C7; C8)
Inconsistency Test #1	IF C6 = 100% and C7 < 70% C6 = EMPTY
Free-Ridership	0.75xPA1+0.25xPA2
Cross-Influence	
F2/F6. [Your previous participation in an Efficiency Nova Scotia program / The promotion of energy efficiency carried out by Efficiency Nova Scotia] was a major factor in your decision to install [a/an] <EQUIPMENT> in your home. F3/F7. [Because of your previous participation in an Efficiency Nova Scotia program and what you learned by participating in this program, you asked / The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to ask] a contractor or a distributor about energy efficient heating systems for your home. F4/F8. [Because of your previous participation in another Efficiency Nova Scotia program and what you learned by participating in this program, you took / The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take] into account the savings on your energy bill when evaluating different heating systems for your home.	Cross-influence (CI) = IF(F2 OR F6=Agree; 1) + IF(F3 OR F7=Agree; 1) + IF(F4 OR F8=Agree; 1)
Revised Free-Ridership	IF CI=0 OR 1, Revised FR = FR IF CI=2, Revised FR = FR*.75 IF CI=3, Revised FR = FR*.50

APPENDIX IX

GREEN HEAT: 2021 RECOMMENDATIONS

The Evaluator has no specific recommendation for Green Heat. This appendix summarizes the previous evaluation recommendations that were not fully implemented or deferred.

Section	Recommendations
2017-GH-R3 (not recommended for action)	Improve the collection of technical information about central air-source heat pumps (CASHPs).
2017 GH-R5 (in progress)	Develop a way for potential participants to better understand which CASHPs are eligible.

APPENDIX X

EPI: PARTICIPANT SURVEY QUESTIONNAIRE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Participant Survey
Estimated Time to Complete	15 minutes
Target Audience	Non-Low-income participants
Expected Number of Completions	100
Contact List Source	EfficiencyOne
Fielding Firm	Narrative Research
Estimated Timeline for fielding	October - November

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
Verification	A
Awareness and Motivations for Participating	B
Satisfaction	C
Barriers	D
Recommendations for Program Improvement	E
Demographics	F

To be adapted by Econoler **[Blue text]**

Import variables from database < **LIKE THIS** >

Skip pattern or programming instructions **[LIKE THIS]**

Black text: instructions for interviewer **[NOTE: xxxx] / [PROBE: xxxx]**

INTRODUCTION

Could I speak with <INSERT NAME>?

1. Yes **[CONTINUE]**
2. No **[SAY “PERHAPS YOU CAN HELP ME ANYWAY.” CONTINUE]**

Hello, my name is _____ and I am with Narrative Research, and we are performing an evaluation of energy efficiency services provided by Efficiency Nova Scotia. Our records indicate that you or your household recently participated in the Efficient Product Installation Service. Are you the person who was most involved with this service?

(IF NEEDED: As part of this service, someone would have come to your house and installed new lighting or a product to use hot water more efficiently, such as LED light bulbs and faucet aerators, at no charge, as well as offered advice on ways your house can save energy).

[IF NO, ASK TO SPEAK TO THE APPROPRIATE PERSON]: “May I please speak to the person who knows the most about this service?”]

We would appreciate your help in answering questions related to your participation in this service. The information you provide will be used to help Efficiency Nova Scotia evaluate and improve the service. Is this a good time for you?

(IF NEEDED: You may have recently been contacted by Narrative Research and Efficiency Nova Scotia about your experience with the service. This survey is different as it focuses on other aspects of your participation in the service.)

(IF NEEDED: The survey will take about 12 minutes.)

1. Yes **[CONTINUE]**
2. No, I don’t remember the service / Don’t know **[PROMPT: “Are you sure? Someone would have come to your house and installed energy-efficient products, at no charge, for you to save energy and money?” RECODE AS “YES” IF THE PROMPT WORKS; IF RESPONDENT STILL SAYS NO: Is there someone else in the household who would know about having participated in this Efficiency Nova Scotia service? [IF YES: ASK TO SPEAK TO THEM AND REPEAT INTRODUCTION]**
3. No, but they came to my previous home **[CONTINUE]**
4. No **[THANK, TERMINATE, RECORD, AND KEEP DATA]**
99. Refused **[THANK, TERMINATE, RECORD, AND KEEP DATA]**

[IF REFUSED, ASK “Can we schedule a more convenient time for you to conduct this survey?”

[SCHEDULED, IF NECESSARY, FOR: _____]

A. Verification

- A1. I am going to read you a list of energy-efficient products that, according to our records, were installed in your home by the Efficient Product Installation Service. For each one, can you please confirm that this product was in fact installed through the service? **[READ WHAT IS ON RECORD (MEASURE#0 IN THE DATABASE)]. [NOTE FOR PROGRAMMER: DO NOT PUT THE NUMBER OF EACH MEASURE]**
- a. LED bulbs
 - b. LED nightlights
 - c. Pipe insulation
 - d. Hot water tank wrap
 - e. Low-flow showerheads or showerwands
 - f. Thermostatic shut-off valve for showers [IF NEEDED: This valve shuts off the water once hot water is flowing. You then have to open the valve to begin showering.]
 - g. Air sealing kit (including foam gaskets, door sweeps, window air sealing, and door weather stripping)
 - h. Bathroom and/or kitchen faucet aerators
 - i. Nest thermostat (IF NECESSARY: Nest thermostats can be controlled by a smartphone, tablet or computer)
 - j. Retractable clotheslines
- 5. Yes, installed through the service
 - 6. No, not installed through the service
 - 98. Don't know
 - 99. Refused

[THANK, TERMINATE, RECORD AND KEEP DATA IF RESPONDENT SAYS “NO”, “DK” OR “REFUSED” TO ALL QUESTIONS FROM A1]

B. Awareness and Motivations for Participating

B1. How did you first learn about the Efficient Product Installation Service? **[ACCEPT ONE RESPONSE] [DO NOT READ]**

1. TV ads
2. Print ads (magazine or newspaper)
3. Radio ads
4. Through a third party contractor or service provider (other than Efficiency Nova Scotia)
5. Email
6. Efficiency Nova Scotia website
7. Social media (e.g., Facebook, Twitter, Instagram, Snapchat, TikTok, Youtube, etc.)
8. Online advertisement on smart phone, computer or tablet
9. Word of mouth
10. Through another Efficiency Nova Scotia program
96. Other [SPECIFY _____]
98. Don't know

B2. What was the SINGLE most important reason you were interested in participating in the Efficient Product Installation Service? **[ACCEPT ONE RESPONSE] [DO NOT READ]**

1. To save on energy/to save on energy costs
2. For better comfort
3. To receive LED bulbs
4. To help protect the environment
5. No cost for services/service was free of charge
6. To reduce my water consumption
7. Wanted energy-efficient upgrades
96. Other [SPECIFY _____]
98. Don't know **[GO TO B4]**
99. Refused **[GO TO B4]**

- B3. Were there any other reasons? **[DO NOT READ. ACCEPT MULTIPLE KEEPING CODE 97, 98 AND 99 EXCLUSIVE; DO NOT SHOW RESPONSE FROM B2]**
1. To save on energy/to save on energy costs
 2. For better comfort
 3. To receive LED bulbs
 4. To help protect the environment
 5. No cost for services/service was free of charge
 6. To reduce my water consumption
 7. Wanted energy-efficient upgrades
 96. Other [SPECIFY _____]
 97. None/no other reasons
 98. Don't know
 99. Refused
- B4. Were you present when these energy-efficient products were installed? **[DO NOT READ, CODE ONE ONLY]**
1. Yes
 2. No
 98. Don't know
 99. Refused
- B5. **[ASK IF B4 = YES]** Did you receive information about these energy-efficient products during the visit from the installer? **[DO NOT READ, CODE ONE ONLY]**
1. Yes, received some information
 2. No, did not receive any information
 98. Don't recall
- B6. **[ASK IF NO OR DON'T RECALL IN B5]** Would you have liked to receive information about energy-efficient products from the installer? **[DO NOT READ, CODE ONE ONLY]**
1. Yes
 2. No
 98. Don't know
 99. Refused

C. Satisfaction

- C1. Using a scale from 1 to 10 where 1 is “not at all satisfied” and 10 is “completely satisfied,” how satisfied are you with the Efficient Product Installation Service overall? **[DO NOT ACCEPT A RANGE]**

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't know

99. Refused

- C2. **[ASK IF C1 < 8, DO NOT ASK IF DK OR REFUSED IN C1]** What was the most important reason you were not more satisfied with the service overall? **[DO NOT READ. PROBE FOR SPECIFIC REASON. ACCEPT MULTIPLE RESPONSE KEEPING CODE 98 AND 99 EXCLUSIVE]**

1. I expected more

2. Did not like the products installed

3. I did not like the installer who came to my home

4. I did not notice any savings on my energy bill

5. The process was complicated

96. Other - Specify : ____

98. Don't know

99. Refused

C3. **[IF C1 ≥ 8]** What was the most important reason you were satisfied with the service overall?
**[PROBE FOR SPECIFIC REASON. DO NOT READ – ACCEPT MULTIPLE RESPONSE
KEEPING CODE 98 AND 99 EXCLUSIVE]**

1. Lowered energy bill
2. Good service
3. Saves energy
4. Better lights/lighting
5. Informative/Information received
6. I like the installer who visited the home
7. Service was free
8. Everything went smooth
9. Reasonable time frame
10. Products/services offered through service
96. Other: Please specify :_____
98. Don't know
99. Refused

C4. Using a scale from 1 to 10, where 1 is “not at all satisfied” and 10 is “completely satisfied,” how satisfied are you with each of the following aspects of the Efficient Product Installation Service.
[DO NOT RANDOMIZE; DO NOT ACCEPT A RANGE; REPEAT SCALE AS NEEDED ONLY]

- a. **[ASK IF YES IN B4]** The time required to complete work
- b. The energy-efficient products installed
- c. The quality of the work completed
- d. **[ASK IF YES IN B5]** The information you received about energy-efficient products

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

97. Not applicable
98. Don't know/Don't recall
99. Refused

D. Barriers

- D1. When you initially thought about participating in the Efficient Product Installation Service, what were your concerns, if any?

RECORD VERBATIM: _____

[VOLUNTEERED]

- 97. No concerns
- 98. Don't know
- 99. Refused

E. Free-Ridership

INSTRUCTION: FREE-RIDERSHIP SERIES SHOULD BE ASKED ONLY TO RESPONDENTS WHO INDICATED:

“YES” IN A1A (LED BULBS) – ASK FR LED BULBS SECTION

AND/OR

“YES” IN A1E (LOW FLOW SHOWERHEADS) – ASK FR LOW FLOW SHOWERHEADS SECTION

OTHERWISE SKIP TO G SECTION

FR - LED BULBS [ASK IF YES IN A1A]

The next questions will be about the LED bulbs that were installed through the service, excluding night lights.

- E1. Had you already decided to purchase and install the LED bulbs that were installed through the Efficient Product Installation Service before learning about this Service? **[CODE ONE ONLY]**

- 1. Yes
- 2. No

[VOLUNTEERED]

- 98. Don't know
- 99. Refused

E2. **[IF E1=YES]** Just to confirm: before you learned about the Efficient Product Installation Service, you had already made the decision to purchase and install LED bulbs in your home?

1. Yes, I had already made the decision to purchase and install LED bulbs
2. No, I had not already made the decision

[VOLUNTEERED]

98. Don't know
99. Refused

E3. If Efficiency Nova Scotia had not installed these LED bulbs at no charge as part of the Efficient Product Installation Service, how likely would you have been to purchase and pay for those LED bulbs, knowing that the cost is about \$4 per bulb?

Please use a scale of 0-10 where 0 is "Very Unlikely" and 10 is "Very Likely".

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER -

[VOLUNTEERED]

98. Don't know
99. Refused

[READ FIRST TIME THROUGH ONLY] I would like you to consider actions you would have taken if there was no Efficient Product Installation Service. For the next questions, again answer on a scale of 0 to 10, where 0 is "Very Unlikely," and 10 is "Very Likely."

[DO NOT ACCEPT A RANGE – ASK E4, E5, E6 SEQUENCE IN ORDER/DO NOT RANDOMIZE; REPEAT SCALE IF NECESSARY]

E4. If there was no Efficient Product Installation Service, how likely would you have been to take the initiative to purchase LED bulbs at a store and install them yourself in your home?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't know
99. Refused

- E5. **[IF E4>=5]** If there was no Efficient Product Installation Service, how likely would you have been to postpone by at least one year replacing your bulbs with LEDs?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't know
- 99. Refused

- E6. **[ASK IF LED BULBS QUANTITY>1]** If there was no Efficient Product Installation service, how likely would you have been to purchase and install all **[QUANTITY]** LED bulbs that were installed through the Efficient Product Installation Service?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't know
- 99. Refused

[IF ONLY LED BULBS A1A=YES, GO TO C8. OTHERWISE GO TO E7]

FR - LOW FLOW SHOWERHEADS [ASK IF YES IN A1E]

The next questions will be about the Low flow showerheads you had installed through the service.

- E7. Had you already decided to purchase and install the low flow showerheads that were installed through the Efficient Product Installation Service before learning about this Service? **[CODE ONE ONLY]**

- 1. Yes
- 2. No

[VOLUNTEERED]

- 98. Don't know
- 99. Refused

E8. **[IF E7=YES]** Just to confirm: before you learned about the Efficient Product Installation Service, you had already made the decision to purchase and install low flow showerheads?

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused

E9. If Efficiency Nova Scotia had not installed these low flow showerheads at no charge as part of the Efficient Product Installation Service, how likely would you have been to purchase and pay for the low flow showerheads, knowing that the cost is about \$30 per unit?

Please use a scale of 0-10 where 0 is "Very Unlikely" and 10 is "Very Likely".

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't know
99. Refused

[READ FIRST TIME THROUGH ONLY] I would like you to consider actions you would have taken if there was no Efficient Product Installation Service. For the next questions, answer on a scale of 0 to 10, where 0 is "Very Unlikely," and 10 is "Very Likely."

[DO NOT ACCEPT A RANGE – ASK ERREUR ! SOURCE DU RENVOI INTROUVABLE., E11, E12 SEQUENCE IN ORDER/DO NOT RANDOMIZE; REPEAT SCALE IF NECESSARY]

E10. **IF THERE WAS NO EFFICIENT PRODUCT INSTALLATION SERVICE, HOW LIKELY WOULD YOU HAVE BEEN TO TAKE THE INITIATIVE TO PURCHASE LOW FLOW SHOWERHEADS AT A STORE AND INSTALL THEM YOURSELF, OR HAVE THEM INSTALLED BY SOMEONE ELSE, IN YOUR HOME?**

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER -

[VOLUNTEERED]

98. Don't know
99. Refused

E11. **[IF E10>=5]** If there was no **EFFICIENT PRODUCT INSTALLATION SERVICE**, how likely would you have been to delay by at least one year replacing your showerheads?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't know

99. Refused

E12. **[ASK IF LOW FLOW SHOWERHEADS AND/OR SHOWERWANDS QUANTITY>1]** If there was no **EFFICIENT PRODUCT INSTALLATION SERVICE**, how likely would you have been to purchase and install the **[QUANTITY]** low flow showerheads that were installed through the Efficient Product Installation Service?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't know

99. Refused

[ASK C8 ONCE, NOT FOR EACH PRODUCT (A1A OR A1E)]

E13. I would like you to rate the influence of the following two factors in your decision to have the energy-efficient products installed in your home. Use a scale from 0 to 10 where 0 is "No influence" and 10 is "Great influence". The first factor is... **[READ AND ROTATE FACTORS; DO NOT ACCEPT A RANGE]**

Factor (READ AND RANDOMIZE)	Responses
a. The installation of energy-efficient products, at no charge, offered by the service	___ Response ___ 98 Don't Know ___ 99 Refused ___ 97 Not applicable
b. Information or advice provided by the service staff	___ Response ___ 98 Don't Know ___ 99 Refused ___ 97 Not applicable

F. Cross-Influence

INSTRUCTION: CROSS-INFLUENCE SERIES SHOULD BE ASKED ONLY TO RESPONDENTS WHO INDICATED

“YES” IN A1A (LED BULBS) AND/OR “YES” IN A1E (LOW FLOW SHOWERHEADS).

OTHERWISE SKIP TO G SERIES.

READ AND ROTATE (F1 + F2-F4) AND (F5 + F6-F8) SEQUENCES

F1. Before participating in the Efficient Product Installation Service in **[MONTH/YEAR]**, had you at any time in the past participated in any Efficiency Nova Scotia program or Service?

1. Yes

2. No

[VOLUNTEERED]

98. Don't know

99. Refused

For the following three statements, please indicate whether you agree or disagree.

F2. **[IF F1=1]** Your previous participation in an Efficiency Nova Scotia program or Service was a major factor in your decision to have energy-efficient products installed in your home.

1. Agree

2. Disagree

[VOLUNTEERED]

98. Don't know

99. Refused

F3. **[IF F1=1]** Because of your previous participation in an Efficiency Nova Scotia program or Service and what you learned by participating in the Service, you requested the installation of energy-efficient products at no cost in your home.

1. Agree

2. Disagree

[VOLUNTEERED]

98. Don't know

99. Refused

F4. **[IF F1=1]** Because of your previous participation in another Efficiency Nova Scotia program or Service and what you learned by participating in this program, you took into account the savings on your energy bill when evaluating different energy-efficient products for your home.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

F5. Before participating in the Efficient Product Installation Service in <MONTH/YEAR>, had you at any time in the past seen Efficiency Nova Scotia advertisement or information discussing the benefits of energy efficiency?

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused

For the following three statements, please indicate whether you agree or disagree.

F6. **[IF F5=1]** The promotion of energy efficiency carried out by Efficiency Nova Scotia was a major factor in your decision to have energy-efficient products installed in your home.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

F7. **[IF F5=1]** The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to ask for the installation of energy-efficient products at no cost in your home.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

F8. **[IF F5=1]** The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take into account the savings on your energy bill when evaluating different energy-efficient products for your home.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

G. Spillover

G1. **[ASK ALL]** Since participating in the Efficient Product Installation Service, have you installed any additional efficient products in your home?

1. Yes
2. No **[GO TO 0]**

[VOLUNTEERED]

98. Don't know/Don't recall **[GO TO 0]**
- 99. Refused [GO TO 0]**

G2. **[IF G1= YES]** What energy-efficient products have you installed in your home since participating in the Efficient Product Installation Service? **[DO NOT READ, ALLOW MULTIPLE KEEPING CODE 97 AND 98 EXCLUSIVE]** Probe: Any others?

1. LED bulbs
2. Low flow showerheads
3. Smart power strip/smart power bar
4. Energy Star refrigerator
5. Energy Star clothes washer
6. LED fixtures
7. NEST or smart thermostats
8. Programmable thermostats
9. Dehumidifiers
10. Air purifiers
11. Clothesline
12. Variable speed pool pumps
13. Air source heat pump hot water heaters
14. Faucet aerators
15. Pipe insulation
16. Tank wrap
17. Thermostatic shut-off valves
18. Door sweeps
19. Window air sealing kits
20. Door weather stripping kits
21. Other [SPECIFY_____]
97. None **[GO TO 0]**
98. Don't know **[GO TO 0]**

G3. **[IF ANY OF CODE 1-20 AND/OR 96 IN G2; ASK FOR EACH RESPONSE IN G2] How many [INSERT ANSWER FROM G2] [FOR STATEMENT O (CODE 15 IN G2): FEET OF PIPE INSULATION] did you purchase and install?**

- a. LED bulbs
- b. Low flow showerheads
- c. Smart power strip/smart power bar
- d. Energy Star refrigerator
- e. Energy Star clothes washer
- f. LED fixtures
- g. NEST or smart thermostats
- h. Programmable thermostats
- i. Dehumidifiers
- j. Air purifiers
- k. Clothesline
- l. Variable speed pool pumps
- m. Air source heat pump hot water heaters
- n. Faucet aerators
- o. Pipe insulation
- p. Tank wrap
- q. Thermostatic shut-off valves
- r. Door sweeps
- s. Window air sealing kits
- t. Door weather stripping kits
- u. Other [SPECIFY_____]

RECORD NUMBER IN QUANTITY OR NUMBER OF FEET OF PIPE INSULATION

[VOLUNTEERED]

- 98. Don't know
- 99. Refused

G4. **[IF ANY OF G3 A TO M > 0; SHOW ONLY PRODUCTS FROM G3 IF > 0]** Did you receive an instant rebate at the cashier for the **[INSERT PRODUCT FROM G2]** you purchased? **[REPEAT FOR EACH PRODUCT AT G2 IF > 0]**

- a. LED bulbs
- b. Low flow showerheads
- c. Smart power strip/smart power bar
- d. Energy Star refrigerator
- e. Energy Star clothes washer
- f. LED fixtures
- g. NEST or smart thermostats
- h. Programmable thermostats
- i. Dehumidifiers
- j. Air purifiers
- k. Clothesline
- l. Variable speed pool pumps
- m. Air source heat pump hot water heaters

- 1. Yes
- 2. No

[VOLUNTEERED]

- 98. Don't know
- 99. Refused

G5. **[ASK ALL]** Since participating in the Efficient Product Installation Service, have you retired any old appliances in your home?

- 1. Yes
- 2. No

[VOLUNTEERED]

- 98. Don't know/Don't recall
- 99. Refused

- G6. **[IF 0=1]** What appliances have you retired since participating in the Efficient Product Installation Service? **[DO NOT READ, ALLOW MULTIPLE KEEPING CODE 97 AND 98 EXCLUSIVE]**
Probe: Any others?
1. Refrigerators
 2. Freezers
 3. Room air conditioning units
 4. Dehumidifiers
 5. Other [SPECIFY_____]
 97. None
 98. Don't know
- G7. **[ASK FOR EACH RESPONSE 1-4 AND 96 IN G5]** How many **[INSERT RESPONSE IN G5]** have you retired?
- a. Refrigerators
 - b. Freezers
 - c. Room air conditioning units
 - d. Dehumidifiers
 - e. Other [SPECIFY_____]
- RECORD NUMBER IN QUANTITY**
[VOLUNTEERED]
98. Don't know
 99. Refused
- G8. **[IF ANY OF G7A TO D > 0; SHOW ONLY PRODUCTS FROM G7 IF > 0]** Did you receive a rebate or assistance from a program for the **[INSERT APPLIANCE FROM G7 > 0]** you retired?
[REPEAT FOR EACH PRODUCT TO G7 IF > 0]
- a. Refrigerators
 - b. Freezers
 - c. Room air conditioning units
 - d. Dehumidifiers
1. Yes
 2. No
- [VOLUNTEERED]**
98. Don't know
 99. Refused

- G9. **[ASK IF ANY OF G3A-T AND/OR ANY OF G7A-D > 0]** How influential was your experience with the Efficient Product Installation Service in your decision to install these additional energy-efficient products or retire these appliances in your home? Use a scale of 0 to 10, where 0 means that your experience with the Efficient Product Installation Service “had no influence at all on your decision,” and 10 means that it was “extremely influential”. **[DO NOT ACCEPT A RANGE]**

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't know

99. Refused

H. Recommendations for Program Improvements

- H1. Do you have any recommendations to help improve the Efficient Product Installation Service?
PROBE: Anything else? **[DO NOT READ, RECORD VERBATIM]**

RECORD VERBATIM: _____

97. None

98. Don't know

99. Refused

I. Demographics

[ASK ALL] These final questions are asked for statistical purposes only. The information collected is strictly confidential.

11. What type of residence do you live in? **[READ RESPONSES 1-7, THEN 96; SELECT ONE RESPONSE]**

1. Apartment building that has fewer than five stories
2. Apartment building that has five or more stories
3. Row house (Single story apartment building)
4. Detached single-family home
5. Semi-detached house
6. Mobile home or house trailer
7. Townhouse or duplex with shared adjacent walls
8. Or some other type [SPECIFY: ____]

[VOLUNTEERED]

98. Don't know
99. Refused

12. How many bedrooms are in your home? **[RECORD NUMBER, DO NOT ACCEPT RANGE; ENTER ZERO FOR A STUDIO APARTMENT WITH NO BEDROOMS]**

RECORD NUMBER: ____

1. DON'T KNOW

13. Do you own or rent this home? **[DO NOT READ; CODE ONE ONLY]**

1. Own/buying
2. Rent/lease
3. Other – Specify: _____
99. Refused

14. Do you pay the electric bills for your home, either on your own or shared with someone else?
[DO NOT READ; CODE ONE ONLY]
1. Yes, on your own or shared with someone else
 2. No
 3. Other - Specify _____
 98. Don't Know
 99. Refused
15. Including yourself, how many people live in this residence on a full-time basis?
- Number of people: ____ **[DO NOT ALLOW ZERO FOR A RESPONSE]**
[VOLUNTEERED]
97. Nobody lives in the house on a full-time basis
 99. Refused
16. Please stop me when I reach your age group. Are you: **[READ; STOP WHEN ANSWER IS VOLUNTEERED]**
1. 18 to 24
 2. 25 to 34
 3. 35 to 44
 4. 45 to 54
 5. 55 to 64
 6. 65 or over
- [VOLUNTEERED]**
99. Refused
17. What is the highest level of education you have completed? **[READ IF NECESSARY]**
1. Less than high school graduation diploma
 2. High school graduation diploma and/or some post secondary
 3. Trades certificate or diploma
 4. College certificate or diploma
 5. University degree, certificate or diploma
 6. Other (SPECIFY: _____)
- [VOLUNTEERED]**
99. Refused

18. **[DO NOT READ; BY OBSERVATION]** Gender:

1. Male
2. Female; or
3. Gender diverse

[VOLUNTEERED]

99. Refused

Those are all the questions I have for you. Thank you for your time and assistance and have a nice day.

APPENDIX XI

EPI: PARTICIPANT SURVEY RESULTS

The participant survey results are presented in the following tables.

B1. How did you first learn about the Efficient Product Installation Service?

First Learned About EPI Service	2021
Sample Size	100
Word-of-mouth	32%
Social media (e.g., Facebook, Twitter, Instagram, Snapchat, TikTok, Youtube, etc.)	13%
Through the mail/Received card in the mail	11%
Online advertisement on smart phone, computer or tablet	8%
Through a third party contractor or service provider (other than Efficiency Nova Scotia)	7%
Internet/Google search	6%
Efficiency Nova Scotia website	4%
Print ads (magazine or newspaper)	4%
TV ads	4%
Email	3%
Others	7%
Don't know	1%

B2. What was the SINGLE most important reason you were interested in participating in the Efficient Product Installation Service? *

B3. Were there any other reasons?

Reasons for Participating	2018		2021	
	Most Important Motivation	Other Important Motivations**	Most Important Motivation	Other Important Motivations**
Sample Size	100	100	100	100
To save on energy/energy costs	77%	16%	61%	18%
Wanted energy efficient upgrades	4%	11%	16%	13%
To help protect the environment	3%	10%	5%	15%
To get my home more energy efficient	-	-	4%	6%
No cost for services/service was free of charge	2%	10%	3%	5%
To receive LED bulbs	13%	4%	3%	1%
For better comfort	-	-	2%	3%
To reduce my water consumption	-	1%	-	1%
Others	2%	1%	6%	2%
None/no other reasons	-	55%	-	46%
Don't know	-	-	-	1%
*Wording change in 2021				
**Multiple Responses; B3 was not asked of those who responded 'Don't Know' or Refused in B2				

B4. Were you present when these energy efficient products were installed? *

Was Present During Installation	2018	2021
Sample Size	100	100
Yes	92%	91%
No	8%	8%
Refused	-	1%
*Wording change in 2021		

B5. Did you receive information about these energy efficient products during the visit from the installer? *

Received Information from Installer	2018	2021
Sample Size	92	91
Yes, received some information	62%	84%
No, did not receive any information	17%	14%
Don't recall	21%	2%
Base: Respondents who were home/present during the installation *Wording change in 2021		

B6. Would you have liked to receive information about energy efficient products from the installer? *

Interested in Receiving Information	2018	2021 (#)
Sample Size	34	15
Yes	68%	7
No	28%	6
Don't know	4%	2
Base: Respondents who did not receive information during the visit *Wording change in 2021		

C1. Using a scale from 1 to 10 where 1 is 'not at all satisfied' and 10 is 'completely satisfied', how satisfied are you with the Efficient Product Installation Service overall? *

Satisfaction with EPI Overall	2018	2021
Sample Size	99	99
Mean	9.3	8.7
Don't know/Refused excluded from calculations *Wording change in 2021		

C2. What was the most important reason you were not more satisfied with the service overall?

Key Reasons Not More Satisfied with EPI Overall	2018 (#)	2021 (#)
Sample Size	5	19
I expected more	3	13
I did not receive any information	-	2
Unsure if program is worthwhile/Waste of tax payers money	-	2
Installation process was too short/quick	-	2
Product was not set properly	-	1
I did not like the installer who visited the home	-	1
I don't like the light bulbs I received/I did not like the products installed	2	-
Others	-	1
Base: Respondents who were not satisfied with the service (as indicated by a rating of less than 8) Multiple Responses		

C3. What was the most important reason you were satisfied with the service overall?

Key Reasons Satisfied with EPI Overall	2018	2021
Sample Size	94	80
I like the installer who visited the home	38%	26%
Informative/Information received	19%	26%
Good service	24%	24%
Reasonable time frame	24%	18%
Products/services offered through service	12%	13%
Everything went smooth	14%	13%
Lowered energy bill	6%	8%
Better lights/lighting	4%	5%
Service was free	5%	5%
Saves energy/Improved energy efficiency	8%	4%
Service met my expectations	1%	4%
Improved the house/house is warmer/more comfortable	-	1%
Better for the environment	-	1%
Others	4%	8%
Don't know/Refused	4%	-
Base: Respondents who were satisfied with the service (as indicated by a rating of '8 or more') Multiple responses		

C4. Using a scale from 1 to 10, where 1 is “not at all satisfied” and 10 is “completely satisfied,” how satisfied are you with each of the following aspects of the Efficient Product Installation Service? *

Satisfaction with Aspects of EPI	2018		2021	
	Sample Size	Mean	Sample Size	Mean
The time required to complete work**	92	9.5	91	9.4
The quality of the work completed	100	9.5	100	9.3
Energy efficient products installed	99	8.9	99	9.0
The information you received about energy efficient products***	62	9.3	76	8.9
Not applicable, Don't know/Don't recall and Refused excluded from calculations *Wording change in 2021 **Base: Respondents who were home/present during the installation ***Base: Respondents who received information during the visit from the installer about energy efficient products				

D1. When you initially thought about participating in the Efficiency product Installation Service, what were your concerns, if any? *

Concerns About the Service	2018	2021
Sample Size	100	100
Wouldn't save money/reduce energy bill	-	9%
Products wouldn't be efficient	-	5%
Wouldn't assess my house for drafts	-	5%
Length of time it takes	-	4%
The service wouldn't be good	-	3%
If it was free/who would pay for it	2%	2%
Wouldn't qualify	-	2%
Scheduling issues/Had to be done during weekdays	-	2%
Wouldn't like the products installed	3%	1%
Others	-	7%
No concerns	96%	61%
*Wording change in 2021		

- E1. Had you already decided to purchase and install the LED bulbs that were installed through the Efficient Product Installation Service before learning about this Service?

Already Decided to Purchase and Install LED Bulbs Installed Through EPI Before Learning About This Service	2021
Sample Size	92
Yes	66%
No	32%
Don't know	2%
Base: Respondents who had LED bulbs installed through EPI	

- E2. Just to confirm: before you learned about the Efficient Product Installation Service, you had already made the decision to purchase and install LED bulbs in your home?

To Confirm: Already Decided to Purchase and Install LED Bulbs Before Learning About EPI	2021
Sample Size	61
Yes	97%
No	3%
Base: Respondents who had LED bulbs installed through EPI and had decided to purchase and install LED bulbs through EPI before learning about this service (yes in E1)	

- E1/E2 Combined. Had you already decided to purchase and install the LED bulbs that were installed through the Efficient Product Installation Service before learning about this Service? Just to confirm: before you learned about the Efficient Product Installation Service, you had already made the decision to purchase and install LED bulbs in your home?

Already Decided to Purchase and Install LED Bulbs Before Learning About EPI	2021
Sample Size	92
Yes	64%
No	34%
Don't know	2%
Base: Respondents who had LED bulbs installed through EPI	

- E3. If Efficiency Nova Scotia had not installed these LED bulbs at no charge as part of the Efficient Product Installation Service, how likely would you have been to purchase and pay for those LED bulbs, knowing that the cost is about \$4 per bulb? Please use a scale of 0-10 where 0 is “Very Unlikely” and 10 is “Very Likely”.

If ENS Had Not Installed LED Bulbs at No Charge as Part of EPI, Likelihood of Purchasing LED Bulbs at \$4 per Bulb	2021
Sample Size	91
Mean	7.0
Base: Respondents who had LED bulbs installed through EPI Don't know and Refused excluded from calculations	

- E4. If there was no Efficient Product Installation Service, how likely would you have been to take the initiative to purchase LED bulbs at a store and install them yourself in your home? Answer on a scale of 0 to 10, where 0 is “Very Unlikely” and 10 is “Very Likely”.

If No EPI, Likelihood of Taking Initiative to Purchase LED Bulbs and Self-install in Home	2021
Sample Size	92
Mean	7.2
Base: Respondents who had LED bulbs installed through EPI Don't know and Refused excluded from calculations	

- E5. If there was no Efficient Product Installation Service, how likely would you have been to postpone by at least one year replacing your bulbs with LEDs? Answer on a scale of 0 to 10, where 0 is “Very Unlikely” and 10 is “Very Likely”.

If No EPI, Likelihood of Postponing by at Least One Year, Replacement of Bulbs with LEDs	2021
Sample Size	77
Mean	6.8
Base: Respondents who had LED bulbs installed through EPI, and if no EPI service, likelihood of taking initiative to purchase LED bulbs and self-install in home is ≥ 5 Don't know and Refused excluded from calculations	

- E6. If there was no Efficient Product Installation Service, how likely would you have been to purchase and install all [QUANTITY] LED bulbs that were installed through the Efficient Product Installation Service?

If No EPI, Likelihood of Purchasing and Installing Same Quantity of LED Bulbs Installed Through EPI	2021
Sample Size	84
Mean	5.6
Base: Respondents who had >1 LED bulb installed through EPI Don't know and Refused excluded from calculations	

- E7. Had you already decided to purchase and install the low flow showerheads that were installed through the Efficient Product Installation Service before learning about this Service?

Already Decided to Purchase and Install Low-flow Showerheads Installed Through EPI Before Learning About This Service	2021
Sample Size	39
Yes	18%
No	82%
Base: Respondents who had low flow showerheads installed through EPI	

- E8. Just to confirm: before you learned about the Efficient Product Installation Service, you had already made the decision to purchase and install low flow showerheads?

To Confirm: Already Decided to Purchase and Install Low-flow Showerheads Before Learning About EPI	2021 (#)
Sample Size	7
Yes	6
No	1
Base: Respondents who had low flow showerheads installed through EPI and had decided to purchase and install low flow showerheads through EPI before learning about this service	

- E7/E8 Combined. Had you already decided to purchase and install the low flow showerheads that were installed through the Efficient Product Installation Service before learning about this Service? Just to confirm: before you learned about the Efficient Product Installation Service, you had already made the decision to purchase and install low flow showerheads?

Already Decided to Purchase and Install Low-flow Showerheads Installed Through EPI Before Learning About this Service	2021
Sample Size	39
Yes	15%
No	85%
Base: Respondents who had low flow showerheads installed through EPI	

- E9. If Efficiency Nova Scotia had not installed these low flow showerheads at no charge as part of the Efficient Product Installation Service, how likely would you have been to purchase and pay for the low flow showerheads, knowing that the cost is about \$30 per unit?

If ENS Had Not Installed Low-flow Showerheads at No Charge as Part of EPI, Likelihood of Purchasing Low-flow Showerheads at \$30 per Unit	2021
Sample Size	39
Mean	3.0
Base: Respondents who had low flow showerheads installed through EPI Don't know and Refused excluded from calculations	

- E10. If there was no Efficient Product Installation Service, how likely would you have been to take the initiative to purchase low flow showerheads at a store and install them yourself, or have them installed by someone else, in your home?

If No EPI, Likelihood of Taking Initiative to Purchase and Install Low-flow Showerheads in Home	2021
Sample Size	39
Mean	3.3
Base: Respondents who had low flow showerheads installed through EPI Don't know and Refused excluded from calculations	

- E11. If there was no Efficient Product Installation Service, how likely would you have been to delay by at least one year replacing your showerheads?

If No EPI, Likelihood of Delaying by at Least One Year Replacement of Low-flow Showerheads	2021
Sample Size	13
Mean	3.9
Base: Respondents who had low flow showerheads installed through EPI and if no EPI service, likelihood of taking initiative to purchase and install low flow showerheads in home is ≥ 5 Don't know and Refused excluded from calculations	

- E12. [If there was no Efficient Product Installation Service, how likely would you have been to purchase and install the [QUANTITY] low flow showerheads that were installed through the Efficient Product Installation Service?

If No EPI, Likelihood of Purchasing and Installing the Same Quantity of Low-flow Showerheads Installed Through EPI	2021
Sample Size	11
Mean	3.3
Base: Respondents who had >1 low flow showerheads and/or showerwands installed through EPI Don't know and Refused excluded from calculations	

- E13. I would like you to rate the influence of the following two factors in your decision to have the energy efficient products installed in your home. Use a scale from 0 to 10 where 0 is “No influence” and 10 is “Great influence”.

Influence on Decision to Have the Energy Efficient Products Installed in Home	2021	
	Sample Size	Mean
The installation of energy efficient products, at no charge, offered by the service	96	8.8
Information or advice provided by the service staff	97	7.1
Base: Respondents who had LED bulbs or low flow showerheads and/or showerwands installed through EPI Don't know and Refused excluded from calculations		

- F1. Before participating in the Efficient Product Installation Service in [MONTH/YEAR], had you at any time in the past participated in any Efficiency Nova Scotia program or Service?

Prior Participation in ENS Program or Service	2021
Sample Size	98
Yes	35%
No	62%
Don't know	3%
Base: Respondents who had LED bulbs and/or low flow showerheads and/or showerwands installed through EPI	

- F2. Your previous participation in an Efficiency Nova Scotia program or Service was a major factor in your decision to have energy efficient products installed in your home.

Previous Participation in an ENS Program or Service Was a Major Factor in Decision to Have Energy Efficient Products Installed in Home	2021
Sample Size	34
Agree	79%
Disagree	21%
Base: Respondents who had LED bulbs and/or low flow showerheads and/or showerwands installed through EPI and had previously participated in ENS program or service	

- F3. Because of your previous participation in an Efficiency Nova Scotia program or Service and what you learned by participating in the Service, you requested the installation of energy efficient products at no cost in your home.

Requested Installation of Energy Efficient Products Because of Previous ENS Program or Service Participation	2021
Sample Size	34
Agree	94%
Disagree	6%
Base: Respondents who had LED bulbs and/or low flow showerheads and/or showerwands installed through EPI and had previously participated in ENS program or service	

- F4. Because of your previous participation in another Efficiency Nova Scotia program or Service and what you learned by participating in this program, you took into account the savings on your energy bill when evaluating different energy efficient products for your home.

Took into Account the Savings on Energy Bill When Evaluating Different Energy Efficient Products Because of Previous ENS Program or Service Participation	2021
Sample Size	34
Agree	82%
Disagree	18%
Base: Respondents who had LED bulbs and/or low flow showerheads and/or showerwands installed through EPI and had previously participated in ENS program or service	

- F5. Before participating in the Efficient Product Installation Service in <MONTH/YEAR>, had you at any time in the past seen Efficiency Nova Scotia advertisement or information discussing the benefits of energy efficiency?

Seen ENS Advertisement or Information Discussing Benefits of Energy Efficiency Prior to Participating in EPI	2021
Sample Size	98
Yes	78%
No	20%
Don't know	2%
Base: Respondents who had LED bulbs and/or low flow showerheads and/or showerwands installed through EPI	

- F6. The promotion of energy efficiency carried out by Efficiency Nova Scotia was a major factor in your decision to have energy efficient products installed in your home.

Promotion of Energy Efficiency Carried Out by ENS Was a Major Factor in Decision to Have Energy Efficient Products Installed in Home	2021
Sample Size	76
Agree	79%
Disagree	20%
Don't know	1%
Base: Respondents who had LED bulbs and/or low flow showerheads and/or showerwands installed through EPI and had previously seen ENS advertisement or information discussing benefits of energy efficiency	

- F7. The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to ask for the installation of energy efficient products at no cost in your home.

Promotion of Energy Efficiency Carried Out by ENS Prompted to Ask for Installation of Energy Efficient Products at No Cost in Home	2021
Sample Size	76
Agree	96%
Disagree	3%
Refused	1%
Base: Respondents who had LED bulbs and/or low flow showerheads and/or showerwands installed through EPI and had previously seen ENS advertisement or information discussing benefits of energy efficiency	

- F8. The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take into account the savings on your energy bill when evaluating different energy efficient products for your home.

Promotion of Energy Efficiency Carried Out by ENS Prompted Taking into Account the Savings on Energy Bill When Evaluating Different Energy Efficient Products for Home	2021
Sample Size	76
Agree	88%
Disagree	11%
Refused	1%
Base: Respondents who had LED bulbs and/or low flow showerheads and/or showerwands installed through EPI and had previously seen ENS advertisement or information discussing benefits of energy efficiency	

- G1. Since participating in the Efficient Product Installation Service, have you installed any additional efficient products in your home?

Installed Additional Efficient Products Since Participating in EPI	2021
Sample Size	100
Yes	32%
No	66%
Don't know/Don't recall	2%

G2. What energy efficient products have you installed in your home since participating in the Efficient Product Installation Service? Any others?

Energy Efficient Products Installed in Home Since Participating in EPI	2021
Sample Size	32
LED bulbs	28%
Heat pump	19%
Insulation	13%
Door weather stripping kits	13%
Doors	9%
Windows	9%
Air source heat pump hot water heaters	6%
Siding	3%
Solar panels	3%
Low flush toilet	3%
Window air sealing kits	3%
Pipe insulation	3%
Dehumidifiers	3%
LED fixtures	3%
Energy Star refrigerator	3%
Smart power strip/smart power bar	3%
Others	16%
None	3%
Don't know	-
Base: Respondents who installed any additional efficient products in home since participating in EPI Multiple responses	

G3. How many did you purchase and install?

Number of Energy Efficient Products Installed Since Participating in EPI	2021	
	Sample Size	Mean
LED bulbs	9	8.9
Door weather stripping kits	4	1.8
Air source heat pump hot water heaters	2	2.0
LED fixtures	1	3.0
Dehumidifiers	1	1.0
Pipe insulation	1	20.0*
Others	17	6.4
Base: Respondents who installed efficient product in home since participating in EPI		
*Average number of ft		

G4. Did you receive an instant rebate at the cashier for the [energy efficient product] you purchased?

Received Instant Rebate at the Cashier for Energy Efficient Products Installed Since Participating in EPI	2021 (#)			
	Sample Size	Yes	No	Don't Know
LED bulbs	9	-	7	2
Air source heat pump hot water heaters	2	-	2	-
LED fixtures	1	-	1	-
Dehumidifiers	1	-	1	-
Base: Respondents who purchased >0				

G5. Since participating in the Efficient Product Installation Service, have you retired any old appliances in your home?

Retired Old Appliance in Home Since Participating in EPI	2021
Sample Size	100
Yes	30%
No	70%

- G6. What appliances have you retired since participating in the Efficient Product Installation Service? Any others?

Appliances Retired Since Participating in EPI	2021
Sample Size	30
Refrigerators	47%
Laundry machines/Washer/Dryer	20%
Dishwasher	17%
Stove	13%
Freezers	13%
Small appliances (toaster, kettle)	10%
Microwave	7%
Dehumidifiers	7%
Others	10%
Base: Respondents who retired old appliances since participating in EPI Multiple Response	

- G7. How many appliances have you retired?

Number of Old Appliances Retired Since Participating in EPI	2021	
	Sample Size	Mean
Refrigerators	13	1.7
Freezers	3	1.3
Dehumidifiers	2	1.0
Others	19	1.3
Base: Respondents who retired old appliances since participating in EPI		

- G8. Did you receive a rebate or assistance from a program for the appliances you retired?

Received Rebate or Assistance From a Program for Appliances Retired	2021 (#)		
	Sample Size	Yes	No
Refrigerators	13	4	9
Freezers	3	2	1
Dehumidifiers	2	-	2
Base: Respondents who retired >0			

- G9. How influential was your experience with the Efficient Product Installation Service in your decision to install these additional energy efficient products or retire these appliances in your home? Use a scale of 0 to 10, where 0 means that your experience with the Efficient Product Installation Service “had no influence at all on your decision,” and 10 means that it was “extremely influential”.

Influence of EPI Experience on Decision to Install Additional Energy Efficient Products or Retire Appliances in Home		2021
Sample Size		29
Mean		6.6
Base: Respondents who installed additional energy efficient products or retired appliances in home Don't know and Refused excluded from calculations		

- H1. Do you have any recommendations to help improve the Efficient Product Installation Service? Anything else? *

Participant Suggestions to Improve EPI	2018	2021
Sample Size	100	100
Offer more products to be installed	12%	5%
Offer more information on the products installed	8%	5%
Offer more information on EPI/on how to save energy	-	5%
Better advertising/More awareness of the program	3%	4%
Improve communication	3%	3%
Better/brighter light bulbs	-	2%
Improve quality of work	2%	1%
Complete work faster	2%	1%
Replace a higher number of light bulbs	1%	-
Issues with faucet aerator	1%	-
Others	4%	10%
No recommendations	67%	66%
Multiple responses *Wording change in 2021		

11. What type of residence do you live in?

Type of Home	2018	2021
Sample Size	100	100
Detached single-family home	76%	80%
Townhouse or duplex with shared adjacent walls	6%	4%
Semi-detached house	10%	4%
Mobile home or house trailer	6%	2%
Row house or Single story apartment building	-	2%
Apartment building that has five to twenty stories (2021)/ five or more stories (2018) *	1%	1%
Apartment building that has fewer than five stories*	-	1%
Some other type	-	4%
Refused	-	1%
Don't know	-	1%
*Wording change in 2021		

12. How many bedrooms are in your home?

Number of Bedrooms	2018	2021
Sample Size	100	100
1	2%	-
2	10%	23%
3	56%	42%
4 or more	30%	35%
Don't know	1%	-

13. Do you own or rent this home?

Own or Rent Home	2021
Sample Size	100
Own/buying	93%
Rent/lease	7%
Other	-
Refused	-

14. Do you pay the electric bills for your home, either on your own or shared with someone else? *

Pay Electricity Bills	2018	2021
Sample Size	100	100
Yes – On own or shared with someone else	100%	98%
No	-	2%
Refused	-	-
*Wording change in 2021		

15. Including yourself, how many people live in this residence on a full-time basis?

People in Household	2018	2021
Sample Size	100	100
1	18%	22%
2	48%	49%
3	12%	10%
4+	20%	16%
Nobody lives in the house on a full-time basis	-	1%
Refused	1%	2%

16. What is your age group? Are you ...?

Age of Respondent	2018	2021
Sample Size	100	100
18 to 24	1%	3%
25 to 34	10%	15%
35 to 44	15%	12%
45 to 54	18%	14%
55 to 64	22%	19%
65 or over	34%	37%
Refused	-	-

17. What is the highest level of education you have completed?

Level of Education	2018	2021
Sample Size	100	100
Less than high school graduation diploma	4%	4%
High school graduate diploma and/or some post-secondary education	18%	18%
Trades certificate/diploma	2%	7%
College certificate/diploma	22%	15%
University degree/certificate/diploma	51%	53%
Refused	3%	3%

18. Gender?

Gender	2018	2021
Sample Size	100	100
Male	48%	47%
Female	52%	52%
Refused	-	1%

APPENDIX XII

EPI: TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying that all data fields required for the evaluation were included and filled out in the tracking sheet submitted by EOne
- › Ensuring that tracked results were accurate by:
 - Verifying that parameters used to calculate program results (gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating that all calculation steps were performed consistently

EOne started using their new Integrated Customer Information System in 2021 for EPI; therefore, the format of the tracking sheet has been changed compared to that of previous years.

Data Accuracy

Table 1 lists all the parameters required for the EPI evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the table details the actions carried out by the Evaluator to adjust data when required.

Table 1: Verification of 2021 EPI Data Field Completeness and Accuracy

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Gross Energy Savings at the Meter	Partial	N/A	1,929 rows had zero or empty gross energy savings at the meter while such savings should have been claimed.
Gross Peak Demand Savings at the Meter	Partial	N/A	1,108 rows had zero or empty gross peak demand savings at the meter while such savings should have been claimed. The Evaluator calculated savings for those rows based on the measure, space heating source, and DHW source. While no explanation was found for most occurrences, 4 rows were identified as having inconsistent heating sources and systems, more precisely that the heating source was non-electrical while the heating system was a heat pump. Those 4 rows were attributed electrical savings while EOne tracked non-electrical savings.

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Tenant Type/Building Type (Columns AQ/CQ)	Partial	N/A	The ownership type was missing for 33,832 rows. This is mainly useful for process evaluation purposes, so no adjustment was needed. The building type was missing for 30 rows. The Evaluator considered them as single-family homes since the majority of participants live in this type of home.
Heating Source/System Type (Columns BX to CA)	Partial	N/A	The primary heating source was missing for 3,254 rows. All except one were for clotheslines for which savings are not impacted by space heating type, so no adjustment was needed. The one that was not for a clothesline measure was identified based on the heating system. 15 other rows had empty or unknown primary heating systems, although they were all for non-electrical heating sources, so no adjustment was needed. In addition, EOne considered both primary and secondary heating systems when identifying the presence of a heat pump, while the Evaluator only considers the primary heating system, which resulted in 792 changes to unitary savings or interactive effects factors.
DHW System Source (Column CB)	Partial	N/A	The DHW system source was missing for 23,819 rows. However, none of those rows were for DHW, so no adjustment was needed.
Rate Code (Column AL)	Y	N/A	None
Reference Data			
Due to the transfer to the CIS tracking system that occurred during the year, two sets of data were merged, which resulted in multiple columns not having been properly populated in the old tracking sheet. The findings below focused on the information used in the CIS system because it will be used in the future.			
Unitary Savings (Column AO, reference table: H, I)	Y	Partial	EOne used demand savings for door weatherstripping in apartments of 0.0306kW while the value in the 2020 DSM Measure Assessment (MA) was 0.0555 kW.
Installation/In-service Rates (Reference table: U)	Y	Y	N/A
Interactive Effects Factors (Reference table: L-T, X-AI)	Partial		The Evaluator found discrepancies for the IE factor of “Light-Elec resist heat-with AC-Energy” for “LED E12 Chandeliers” compared to the value from the 2020 DSM MA, which was corrected. Similarly, the Evaluator used the value for LED lamps from the MA for “BOB 7 W Replacing 60 W”, which differed from the value used by EOne.

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Net-to-gross Ratios (Column BC; Reference table: V, W)	N		All the NTGRs used by EOne were slightly different from those from the 2020 evaluation. For lighting measures, a value of 0.8 was used by EOne while the 2020 evaluation value was 0.86. For low-flow showerheads, a value of 0.94 was used by EOne while the 2020 evaluation value was 0.96. For all the other measures, a value of 1.03 was used by EOne while the 2020 evaluation value was 1.02.
Effective Useful Life (Reference table: K)	Partial		The EUL values used by EOne were different from those of the 2020 DSM MA for the following measures: - LED 9 W replacing 150 W - LED 9 W replacing 25 W - LED 9.5 W replacing 150 W - LED 9.5 W replacing 25 W
Adjustment Ratio (Column BR)	Y	Y	N/A

Data Consistency

The second step of the tracking sheet audit involved recreating calculations and comparing related tracking sheet data fields to identify any potential inconsistencies. Table 2 lists the data fields of the EPI tracking sheet that were compared to ensure consistency.

Table 2: Verification of 2021 EPI Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Calculated Line Loss Factor (Gross Energy Savings at the Generator / Gross Energy Savings at the Meter)	Tracked Rate Codes	N	Different rounding figures were used by EOne and the Evaluator. This resulted in 1,025 rows with different energy line loss factors and 18,032 rows with different demand line loss factors.
Verification of Duplicate IDs or Projects	-	N	27 projects were identified as potential duplicates. EOne confirmed that 25 of them were duplicates. Hence, the duplicates were excluded from the evaluation results.

Equations and Compilation

Once the correct values were established (as per Table 1), the Evaluator validated that the equations in the tracking sheet correctly calculated each of the main program component results, the results of which are presented in Table 3.

Table 3: Verification of 2021 EPI Savings Compilation

Service Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	Partial	Multiple rows had nil or empty gross energy and/or peak demand savings at the generator. As mentioned in Table 1, many had no value in the savings at the meter column, which resulted in no savings at the generator. In addition, 1,345 other rows did not have energy savings at the generator, and 1,374 had no value for peak demand savings, although they had savings at the meter. The Evaluator recalculated the savings at the generator using the corrected savings at the meter and the line loss factor associated with each participant rate code. For space heating measures, EOne divides the savings by a COP, which results in slightly different savings than those presented in the 2020 DSM MA document. Also, the Evaluator identified multiple instances wherein a COP of 2.1 was applied by EOne instead of the value of 2.2 used in the MA. Furthermore, EOne did not apply this COP adjustment to multiple peak demand savings, which also resulted in different values than those presented in the MA. Aside from the inconsistencies mentioned above, the tracked line loss factors were correctly applied by EOne to obtain the savings at the generator.
Gross Peak Demand Savings at the Generator	Partial	
Net Energy Savings at the Generator	Y	Aside from the inconsistencies mentioned for gross savings at the generator and the use of incorrect NTGRs as mentioned in Table 1, the tracked NTGRs were correctly applied to obtain the net energy savings at the generator.
Net Peak Demand Savings at the Generator	Y	

Corrected Tracked Savings

Table 4 presents the corrected tracked savings resulting from all changes made by the Evaluator. More details are described in this appendix.

Table 4: 2021 EPI Corrected Tracked Savings

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
EPI					
Gross Energy Savings at the Generator	7.833	GWh	8.347	GWh	6.6%
Gross Peak Demand Savings at the Generator	1.105	MW	1.157	MW	4.7%
Net Energy Savings at the Generator	7.260	GWh	7.621	GWh	5.0%
Net Peak Demand Savings at the Generator	1.033	MW	1.062	MW	2.8%

The difference between the tracked and corrected tracked savings is mainly explained by the many rows (about 5%) for which no savings were tracked by EOne and for which the Evaluator calculated savings. This impacted energy and peak demand savings as well as gross and net savings.

While it had a lesser impact, the Evaluator also corrected certain unitary savings values, interactive effects factors, and COPs. Additionally, many values were rounded differently by the Evaluator since they were drawn from the 2020 DSM MA. Furthermore, a few heating systems were considered differently by the Evaluator and a few duplicates were removed.

APPENDIX XIII

EPI: ON-SITE VISIT SAMPLING METHODOLOGY AND PROTOCOL

Sampling Methodology

For the 2021 EPI evaluation, the Evaluator visited 63 EPI participants based on the July 2021 tracking sheet. To improve the chances that all products could be observed in a large enough number of houses and that reliable installation rates could be established, the sample was composed of participants that had at least five different products installed. The sample was verified to be representative of the population within $\pm 10\%$ of the proportion of participants served by a delivery agent (DA) and a representative mix of product installations.

On-site Visit Protocol

The on-site visits were conducted to verify the number of products installed and recorded in the tracking sheet as well as verify house characteristics needed for impact calculations.

The on-site visit protocol was developed to serve two main purposes: (1) Establish the installation rates of products; and (2) determine whether any products had been removed and, if any, the reasons for their removal. The Evaluator then validated the assumptions used to calculate the unitary savings value of each product type by collecting the following information during the visits:

- › The locations of the new lamps (indoors or outdoors)
- › The domestic hot water (DHW) heating source and tank size
- › The number of faucets and showerheads in a home
- › The faucet aerator locations

On-site Visit Data-collection Form

Prior to the visit, fields in light gray are filled in based on the information in the tracking sheet. Other fields are filled in during the site visit based on on-site observations and the contact's statements.

1 General Information

Date of Visit:

Tracking Number:

Delivery Agent ID:

Address:

Contact Name:

Telephone:

Type of Dwelling:

Owner or Tenant:

	From Tracking Sheet				Confirmed On-site			
Main Heat Type:								
Secondary Heat Type								
AC Used in Home	Yes	☐	No	☐	Yes	☐	No	☐
DHW Heat Type:								

2 Product Installation Information

Lighting Products

Product	Quantity in Tracking Sheet	Quantity On Site	Explanation, If Different	Indoors or Outdoors
9 W LED				
9.5 W LED				
18 W LED				
7 W PAR20 LED				
8 W PAR30 LED				
15 W PAR38 LED				
7 W GU10 LED				
7 W G25 LED				
5 W E12 LED Chandelier				
LED Nightlight				
BOB Emergency LED				

Notes:

Domestic Hot Water (DHW) Related Products

Total number of faucets in the house: _____

Total number of showerheads in the house: _____

Product	Quantity in Tracking Sheet	Quantity On Site	Explanation, If Different	Tank Size (Gal.) or Flow Rate
Hot Water Tank Wrap				
Pipe Insulation				N/A
Kitchen Faucet Aerators				N/A
Bathroom Faucet Aerators				N/A
Low-flow Showerheads				
Thermostatic Shower Valves				

Notes:

Air Sealing Kit

Number of Switch and Plug on exterior walls: _____

Product	Quantity in Tracking Sheet	Quantity On Site	Explanation, If Different	Installed by the Delivery Agent or Left Behind?
Door Sweep				
Door Weatherstripping				
Window Air Sealing				
Switch and Plug Insulator				

Notes:

Thermostats

Product	Quantity in Tracking Sheet	Quantity On Site	Explanation, If Different	Type of Controlled Equipment
Smart Thermostat				

Notes:

Others

Product	Quantity in Tracking Sheet	Quantity On Site	Explanation, If Different
Retractable Clothesline			

Notes:

APPENDIX XIV

EPI: ALGORITHM FOR FREE-RIDERSHIP CALCULATION

The figure below presents the algorithm for calculating the free-ridership level. The participant survey questionnaire included questions designed to assess the planning, quantity, efficiency, period, cost, and influence of the program component. Questions were also asked to quantify cross-influence. This corresponds to the level of influence that previous participation in one of ENS's energy efficiency program components or ENS efforts to raise energy efficiency awareness had on the decision to implement the energy efficiency measure. Each group of questions was transposed into a level of program component attribution, which was used to calculate the free-ridership level associated with each participant.

Table 1: Free-ridership Algorithm for LED lamps

E1. Had you already decided to purchase and install LED bulbs before learning about the Efficient Product Installation Service?	IF Yes: Use E2 IF No OR DK OR REF: E1 = 0%
E2. Just to confirm: before you learned about the Efficient Product Installation Service, you had already made the decision to purchase and install LED bulbs in your home?	IF Yes: E1 = 100% IF No OR DK OR REF: E1 = 0%
PA1 Score	E1
E3. If Efficiency Nova Scotia had not installed these LED bulbs at no charge as part of the Efficient Product Installation Service, how likely would you have been to purchase and pay for those LED bulbs, knowing that the cost is about \$4 per bulb? (Scale 0 to 10)	E3 = Answer x 10% IF DK OR REF: E3 = EMPTY
E4. If there was no Efficient Product Installation Service, how likely would you have been to take the initiative to purchase LED bulbs at a store and install them yourself in your home?	E4 = Answer x 10% IF DK OR REF: E4 = EMPTY
PA2 Score	MEAN VALUE OF (E3; E4)
E5. [IF E4 ≥ 5] If there was no Efficient Product Installation Service, how likely would you have been to postpone by at least one year replacing your bulbs with LEDs? (Scale 0 to 10)	E5 = (10 – Answer) x 10% IF DK OR REF: E5 = EMPTY
PA3 Score	E5
E6. [ASK IF LED BULBS QUANTITY>1] If there was no Efficient Product Installation service, how likely would you have been to purchase and install all [QUANTITY] LED bulbs that were installed through the Efficient Product Installation Service?	E6 = Answer x 10% IF DK OR REF: E6 = EMPTY
PA4 Score	E6
E13. Level of influence (Scale 0 to 10)	E13 = MAX(a; b)

PA5 Score	(10 – E13) x 10%
Inconsistency Test PA1	IF E1 = 100% AND IF E3 < 70% OR E4 < 70%: PA1 = EMPTY
Inconsistency Test PA2	IF ABS(E3 – E4) ≥ 50%: PA2 = MIN (E3; E4)
Free-Ridership (FR)	MEAN VALUE OF: (PA1; PA2; PA3; PA4; PA5)
Cross-Influence	
F2/F6. [Your previous participation in an Efficiency Nova Scotia program or Service/ The promotion of energy efficiency carried out by Efficiency Nova Scotia] was a major factor in your decision to have energy-efficient products installed in your home. F3/F7. [Because of your previous participation in an Efficiency Nova Scotia program or Service and what you learned by participating in the Service, you requested/ The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to ask for] the installation of energy-efficient products at no cost in your home. F4/F8. [Because of your previous participation in another Efficiency Nova Scotia program or Service and what you learned by participating in this program, you took/ The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to took] into account the savings on your energy bill when evaluating different energy-efficient products for your home.	Cross-influence (CI) = IF(F2 OR F6 = Agree; 1) + IF(F3 OR F7 = Agree; 1) + IF(F4 OR F8 = Agree; 1)
Revised Free-Ridership	IF CI = 0 OR 1: Revised FR = FR IF CI = 2: Revised FR = FR*.75 IF CI = 3: Revised FR = FR*.50

Table 2: Free-ridership Algorithm for Low Flow Showerhead

E7. Had you already decided to purchase and install low flow showerheads (LFSH) before learning about the Efficient Product Installation Service?	IF Yes: Use E8 IF No OR DK OR REF: E7 = 0%
E8. Just to confirm: before you learned about the Efficient Product Installation Service, you had already made the decision to purchase and install LFSH?	IF Yes: E7 = 100% IF No OR DK OR REF: E7 = 0%
PA1 Score	E8
E9. If Efficiency Nova Scotia had not installed these LFSH at no charge as part of the Efficient Product Installation Service, how likely would you have been to purchase and pay for the LFSH, knowing that the cost is about \$30 per unit? (Scale 0 to 10)	E9 = Answer x 10% IF DK OR REF: E9 = EMPTY

E10. If there was no Efficient Product Installation Service, how likely would you have been to take the initiative to purchase LFSH at a store and install them yourself, or have them installed by someone else, in your home? (Scale 0 to 10)	E10 = Answer x 10% IF DK OR REF: E10 = EMPTY
PA2 Score	MEAN VALUE OF (E9; E10)
E11. [IF E4 ≥ 5] If there was no Efficient Product Installation Service, how likely would you have been to delay by at least one year replacing your showerheads?	E11 = (10 – Answer) x 10% IF DK OR REF: E11 = EMPTY
PA3 Score	E11
E12. [ASK IF LFSH QUANTITY>1] If there was no Efficient Product Installation Service, how likely would you have been to purchase and install the [QUANTITY] LFSH that were installed through the Efficient Product Installation Service?	E12 = Answer x 10% IF DK OR REF: E12 = EMPTY
PA4 Score	E12
E13. Level of influence (Scale 0 to 10)	E13 = MAX(a ; b)
PA5 Score	(10 – E13) x 10%
Inconsistency Test PA1	IF E7 = 100% AND IF E9< 70% OR E10 < 70%: PA1 = EMPTY
Inconsistency Test PA2	IF ABS(E9 – E10) ≥ 50%: PA2 = MIN (E9; E10)
Free-Ridership (FR)	MEAN VALUE OF: (PA1; PA2; PA3; PA4; PA5)
Cross-Influence	
F2/F6. [Your previous participation in an Efficiency Nova Scotia program or Service/ The promotion of energy efficiency carried out by Efficiency Nova Scotia] was a major factor in your decision to have energy-efficient products installed in your home. F3/F7. [Because of your previous participation in an Efficiency Nova Scotia program or Service and what you learned by participating in the Service, you requested/ The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to ask for] the installation of energy-efficient products at no cost in your home. F4/F8. [Because of your previous participation in another Efficiency Nova Scotia program or Service and what you learned by participating in this program, you took/ The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to took] into account the savings on your energy bill when evaluating different energy-efficient products for your home.	Cross-influence (CI) = IF(F2 OR F6 = Agree; 1) + IF(F3 OR F7 = Agree; 1) + IF(F4 OR F8 = Agree; 1)
Revised Free-Ridership	IF CI = 0 OR 1: Revised FR = FR IF CI = 2: Revised FR = FR*.75 IF CI = 3: Revised FR = FR*.50

APPENDIX XV

EPI: ALGORITHM FOR PARTICIPANT SPILLOVER CALCULATION

Participant spillover was measured using a participant survey. Participants were asked, pursuant to participating in EPI, whether they implemented any additional energy efficiency measures without benefitting from any rebates offered by EOne program components. If a participant did have additional measures implemented, they were asked the type of measure and quantity installed. Subsequently, another question was asked to quantify the level of influence the program component had on the participant's decision to implement the additional measures. The value established regarding this level of influence was used to determine the portion of additional savings attributable to the program component.

Then, the level of participant spillover was established by dividing the total quantity of additional savings attributable to the program component by the total quantity of savings achieved by the program component for all survey respondents.

The table below illustrates the methodology used to calculate the participant spillover level.

Table 3: Participant Spillover Algorithm

G1. Since participating in the Efficient Product Installation Service, have you installed any additional efficient products in your home?	IF Yes: CONTINUE IF No OR DK OR REF : GO TO G5
G2. What energy-efficient products have you installed in your home since participating in the Efficient Product Installation Service? G3. How many (item) did you purchase and install?	SO1 = SUM (energy savings associated with each upgrade)
G4. Did you receive an instant rebate at the cashier for the [INSERT PRODUCT FROM G2] you purchased?	IF 1. Yes: SO2 = 0 for the measure IF 2. No OR DK OR REF : SO2 = 1
G5. Since participating in the Efficient Product Installation Service, have you retired any old appliances in your home?	IF 1. Yes: CONTINUE IF 2. No OR DK OR REF : G7
G6. What appliances have you retired since participating in the Efficient Product Installation Service? G7. How many [INSERT RESPONSE IN G6] have you retired?	SO3 = SUM (energy savings associated with each retired appliance)
G8. Did you receive a rebate or assistance from a program for the [INSERT APPLIANCE FROM G7] you retired?	IF 1. Yes: SO4 = 0 for the measure IF 2. No OR DK OR REF : SO4 = 1
Additional Products and Retirement Savings	SO5 = SO1 x SO2 + SO3 x SO4
Attribution Level G9. How influential was your experience with the Efficient Product Installation Service in your decision to install these additional energy-efficient products or retire these appliances in your home? (Scale 0 to 10)	SO6 = Answer x 10% IF DK or REF: SO6 = EMPTY
Final Spillover Level = $\frac{\text{SUM of (SO5 x SO6) for All Respondents}}{\text{SUM of Program Savings for All Respondents}}$	

APPENDIX XVI

EPI: 2021 RECOMMENDATIONS

The Evaluator has no specific recommendation for EPI. This appendix summarizes the past evaluation recommendations that were not fully implemented or deferred at the time of the 2021 evaluation.

Section	Recommendations
2019 EPI-R2 (deferred)	1. Evaluate the market for EPI to quantify the residual potential for direct installations.

APPENDIX XVII

MHEEP: TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying that all data fields required for the evaluation were included and filled out in the tracking sheet submitted by EOne
- › Ensuring that tracked results were accurate by:
 - Verifying that parameters used to calculate program results (gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating that all calculation steps were performed consistently

Data Accuracy

Table 1 lists all the parameters required for the MHEEP evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the table details the actions carried out by the Evaluator to adjust data when required.

Table 1: Verification of 2021 MHEEP Data Field Completeness and Accuracy

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluations	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Proportion of Space Heating Covered by Electrical Heating Systems (Contractor Savings Tab - Column O)	Y	N/A	
D Assessment Total Space Heating Consumption (All Fuels) (Contractor Savings Tab - Column W)	Y	N/A	
E Assessment Total Space Heating Consumption (Contractor Savings Tab - Column Y)	Y	N/A	
Presence of Heat Pump at D Assessment (Participant Tab - Column Y)	Y	N/A	
Presence of Heat Pump at E Assessment (Contractor Savings Tab - Column Q)	Y	N/A	
Rate Code (Contractor Savings Tab - Column P)	Y	N/A	

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluations	If Incomplete or Inconsistent, Action Taken by the Evaluator
Reference Data			
Unitary Savings	Y	Y	
Overestimation Ratios	Y	Y	
Net-to-gross Ratios	Y	Y	
Peak Demand-to-energy Ratios	Y	Y	
Effective Useful Life	Y	Y	

Data Consistency

The second step of the tracking sheet audit involved recreating calculations and comparing related tracking sheet data fields to identify any potential inconsistencies. Table 2 lists the data fields of the MHEEP tracking sheet that were compared to ensure consistency.

Table 2: Verification of 2021 MHEEP Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Calculated Line Loss Factor (Gross Energy Savings at the Generator / Gross Energy Savings at the Meter)	Tracked Rate Codes	Y	
Verification of Duplicate IDs or Projects	-	Y	

Equations and Compilation

Once the correct values were used (as per **Erreur ! Source du renvoi introuvable.**), the Evaluator validated that the equations in the tracking sheet correctly calculated each of the main program component results, the results of which are presented in Table 3.

Table 3: Verification of 2021 MHEEP Savings Compilation

Program Component Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	Y	
Gross Peak Demand Savings at the Generator	Y	
Net Energy Savings at the Generator	Y	
Net Peak Demand Savings at the Generator	Y	

Corrected Tracked Savings

Table 4 presents the corrected tracked savings, which are identical to the tracked values, as the Evaluator made no changes.

Table 4: 2021 MHEEP Corrected Tracked Savings

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
MHEEP					
Gross Energy Savings at the Generator	0.316	GWh	0.316	GWh	0.00%
Gross Peak Demand Savings at the Generator	0.147	MW	0.147	MW	0.00%
Net Energy Savings at the Generator ²	0.316	GWh	0.316	GWh	0.00%
Net Peak Demand Savings at the Generator ³	0.147	MW	0.147	MW	0.00%

² Net savings are not included as a separate value in the tracking sheet since net savings are equal to gross savings.

³ Ibid.

APPENDIX XVIII

MHEEP: 2021 RECOMMENDATIONS

The Evaluator has no specific recommendation for MHEEP. No major improvement recommendations were made for MHEEP in previous years.

APPENDIX XIX AMH: TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying that all data fields required for the evaluation were included and filled out in the tracking sheet submitted by EOne
- › Ensuring that tracked results were accurate by:
 - Verifying that parameters used to calculate program results (gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating that all calculation steps were performed consistently

Data Completeness and Accuracy

Table 1 lists all the parameters required for the AMH evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the table details the actions carried out by the Evaluator to obtain or adjust data where required.

Table 1: Verification of 2021 AMH Data Field Completeness and Accuracy

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Gross Energy Savings at the Meter (Column HO)	Y	N/A	N/A
Gross Peak Demand Savings at the Meter (Column HR)	Y	N/A	N/A
Rate Code (Column BY)	Partial	Y	The rate codes of two DSM participants were missing. The Evaluator assigned codes based on the address and type of organization.
Reference Data			
Equivalent Net-to-gross Ratio	Y	Y	N/A
Peak Demand-to-energy Ratio	Y	Y	N/A
Line Loss Factors	Y	Y	N/A
Effective Useful Life	Y	Y	N/A

Data Consistency

The second step of the tracking sheet audit involved recreating calculations and comparing related tracking sheet data fields to identify any potential inconsistencies. Table 2 lists the data fields that were compared to ensure consistency.

Table 2: Verification of 2021 AMH Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Meter at Measure Level (Column HN)	Gross Energy Savings at the Meter at Project Level (Column HO)	N	Two DSM participants did not have any savings at the measure level, although they had savings at the project level. The Evaluator used the value of the project-level savings as the measure-level savings. In addition, similarly to previous years, measure savings and project savings differ because of interactive effects only being considered at the project level for audit participants. No action was needed since the explanation was already accepted by the Evaluator.
Verification of Duplicate IDs or Projects	-	Y	N/A

Equations and Compilation

Once the correct values were established (as per **Erreur ! Source du renvoi introuvable.**), the Evaluator validated that the equations in the tracking sheet correctly calculated each of the main program component results as presented in Table 3 below.

Table 3: Verification of 2021 AMH Data Field Consistency

Program Component Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	N	The values for the gross energy and peak demand savings at the generator do not appear in the tracking sheet. Regardless, the Evaluator was able to obtain them using the net savings at the generator; gross and net savings are identical for AMH and the net savings were included in the tracking sheet.
Gross Peak Demand Savings at the Generator	N	
Net Energy Savings at the Generator	Y	While the equation was appropriate, the net savings at the generator of one participant were not calculated because the rate code was not the same as in the reference table. The Evaluator calculated the net savings at the generator for that participant.
Net Peak Demand Savings at the Generator	Y	

Corrected Tracked Savings

Table 4 presents the corrected tracked savings resulting from all changes made by the Evaluator as described in this appendix.

Table 4: 2021 AMH Corrected Tracked Savings

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
AMH					
Gross Energy Savings at the Generator	0.494	GWh	0.522	GWh	6%
Gross Peak Demand Savings at the Generator	0.145	MW	0.154	MW	6%
Net Energy Savings at the Generator	0.494	GWh	0.522	GWh	6%
Net Peak Demand Savings at the Generator	0.145	MW	0.154	MW	6%

The difference between the tracked and corrected savings is due to the omission of the calculation of said savings for one of the participants.

APPENDIX XX

AMH: PROTOCOL FOR DESK REVIEWS AND ON-SITE VISITS

On-site visits and desk reviews were conducted to verify the building characteristics and measure information as well as validate if this information was correctly modelled or used in savings calculations. Table 1 presents the protocol used during on-site visits and project reviews.

Table 1: Site Visit and Desk Review Protocol

1. General Information			
On-site Visit Date:		Company Name:	
Project ID:		Facility Contact Name:	
Facility Name:		Contact Title:	
Address:		Contact Phone:	
		Email:	
List of people participating in the On-site visit:			
2. Building information and Construction Details			
	Tracking Sheet Data	Validated Data	Notes
Primary Heating Fuel			
Primary Heating System			
Water Heating Fuel			
Water Heating System			
Building Type			
Square Footage			
Wall Thickness			
Wall Insulation Type			
Sliding Type			
Window Type			
Roof Type			

3. TRACKED Energy Savings and Peak Demand Savings			
Energy Savings	Measure #1	Measure #N	Total
Methodology used for calculating savings (RETScreen, Engineering Calculation, HOT2000)			
Is the calculation method reasonable?			
Does the calculation account for heating/cooling efficiency?			
Do invoices attest to work completion?			
Claimed savings in tracking sheet (kWh)			
Claimed savings in audit report (kWh)			
Claimed savings in simulation file/calculation sheet (kWh)			
Are claimed savings consistent among documentation files?			
Discrepancy Descriptions			
Peak Demand Savings	Measure #1	Measure #N	Total
Peak demand savings in tracking sheet (kW)			
Peak demand to energy ratio applied (W/kWh)			
Peak demand savings in calculation sheet (kW)			
Are peak demand savings consistent?			
4. Site Visit/Call Notes and Comments			
	Measure #1	Measure #N	Total
Notes and questions before the visit:			
Comments and responses:			
General Notes (not about the measures themselves, but on the simulation, the building, etc.)			
Notes and questions before the visit:			
Comments and responses:			

5. EVALUATED Savings and Adjustments made by the Evaluator			
	Measure #1	Measure #N	Total
Corrected energy savings (kWh)			
Energy savings adjustment (kWh)			
Corrected peak demand savings (kW)			
Peak demand savings adjustment (kW)			
What was adjusted?			
Why?			
6. Market Questions			
We would appreciate your help in answering questions about the Affordable Multifamily Housing program component.			
S1. Using a scale from 1 to 10 where 1 means “Not at all satisfied” and 10 means “Completely satisfied”, how would you rate your satisfaction with the program overall?			
S2. [IF S1<8] What is the most important reason you are not more satisfied with the program overall?			
S3. [IF S1>8] What is the most important reason you are satisfied with the program overall?			
S4. Did you face any challenges or barriers when implementing your project?			
S5. [IF S4 = YES, then ask:] What was the most important challenge or barrier?			
S6. Do you have any suggestions to improve the Affordable Multifamily Housing program component? Consider all aspects of the component: Participation process, program forms, marketing, interactions with ENS staff or contractors, etc.			

APPENDIX XXI

AMH: 2021 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2021 AMH evaluation.

Sections	Recommendations
Impact Evaluation	1. The Evaluator recommends that EOne ensure that the right building usage is modelled for each project.
	2. The Evaluator revised the demand savings of all prescriptive projects by applying the CIRx Screening tool equations. Going forward, the Evaluator recommends using the CIRx Screening tool equations to calculate peak demand savings when this tool is used to estimate energy savings.
	3. Currently, no heat pump full-load hour value was established specifically for AMH; hence, EOne and the Evaluator used a value based on a billing analysis for Green Heat from 2017. While this value is for buildings with similar usage as AMH participant buildings, it should be noted that it was developed for single-family homes and not multi-unit residential buildings (MURBs). Thus, the Evaluator recommends that a heat pump full-load hour value for AMH be established.



NEW RESIDENTIAL PROGRAM 2021 DSM EVALUATION

EFFICIENCYONE

Final Report

March 16, 2022



ABBREVIATIONS

BNI	Business, non-profit and institutional
CCHP	Cold climate air-source heat pump
DNM	Did not meet
DSM	Demand-side management
EA	Energy advisor
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
EUL	Effective useful life
GHG	Greenhouse gas
MSHP	Mini-split Heat Pump
NBC	National Building Code
NHC	New Home Construction
NS Power	Nova Scotia Power
NTGR	Net-to-gross ratio
OR	Overestimation ratio
SO	Service Organization

DEFINITIONS

Accuracy	Reflects the proximity of measurements to the true value.
Adjustment ratio	The ratio of evaluated results to tracked results. This ratio expresses the adjustment made to tracked savings or other tracked values such as effective useful life.
Baseline	To determine gross savings, a baseline (or base case) is established providing detailed information about the reference (e.g. pre-existing or standard) measure or equipment chosen to be compared with the efficient measure or equipment. For the reference measure or equipment, the baseline may include such information as the hours of operation, wattage and the base consumption.
Bias	Systematic deviations of measurements from the true value.
Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
Displaced wattage	The displaced wattage is defined as the difference between the wattage values of the baseline equipment or product and the efficient equipment or product.
EnerGuide rating	An EnerGuide (official brand of Natural Resources Canada) rating is a standard measure of the home's energy performance. It is a measure of the efficiency of the building only and does not take into account occupant behaviour. It shows how energy efficient the home is through modelled heat losses of the home, based on several factors including building envelope characteristics, heated volume, heating systems and air leakage.
Effective useful life	The period a measure is expected to be in service and provide both energy and peak demand savings. This value combines the equipment life and the measure persistence, which includes factors such as business turnover or early retirement.
Equipment life	The number of years installed equipment will operate before it fails.
Equivalent CO ₂	A unit of measurement indicating the amount of carbon dioxide to which various kinds of emitted greenhouse gases are equivalent in terms of warming effects. In this report, the gases' global-warming potential is estimated over a timescale of 100 years.
Equivalent effective useful life	The number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. This value takes into account variations in annual energy savings throughout the effective useful life due to increased baselines.

Evaluated savings	Gross and net energy or peak demand savings calculated by the Evaluator using the parameters (unitary savings values, installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process. Unless otherwise specified, the evaluated savings are the first-year savings.
Evaluation plan	The evaluation plan summarizes the program description, objectives, base cases, documentation, evaluation methodology, budget and schedule.
First-year savings	The first full year of energy or peak demand savings generated by an energy efficiency measure.
Free-ridership	Percentage of gross savings attributable to participants who would have implemented the same or similar energy efficiency measures, with no change in timing, in the absence of the program.
Gross savings	Change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated.
Induced consumption	Energy consumption of appliances that would have been unplugged and not replaced by participants in the absence of the program.
Interactive effects	Effects on the energy consumption of other systems in the building (such as heating and cooling) due to the installation of an energy efficiency measure.
Participant spillover	Savings attributable to participants who continue to implement the energy efficiency measure introduced by a program after participating in it once, without participating in the program a second time.
In-service rate	The proportion of incentivized products that are installed and operating. This rate is usually applied to programs through which rebates are offered in-store and products are likely to be stored for a certain period before being installed, such as LED lamps.
Installation rate	The proportion of incentivized products reported as installed that remain installed and operating at the time of evaluation. This rate is usually applied to direct install or mail-in rebate programs through which measures are expected to be installed immediately at the time of participation.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for a measure's effective useful life and any increase in the baseline efficiency level (which reduces attributable annual savings) over its lifetime.
Line loss factor	The multiplier to convert savings at the customer meter to savings at the utility generator. It accounts for the electrical losses of the transmission and distribution system.
Margin of error	The amount of random sampling error.
Market effects	The impact of the program on the market (such as increased product availability, practices, and prices) that extends beyond changing the program participants' behaviour. This includes spillover among non-participants.

Net savings	Energy or peak demand savings that can be reliably attributed to a program. This includes effects, such as free-ridership and spillover, that negatively or positively affect the savings attributable to a program.
Net-to-gross ratio	The ratio of net energy savings to gross energy savings.
Non-sampling error	Errors arising during the course of all survey activities other than sampling. Non-sampling errors tend to lead to bias in measurements and are very difficult to quantify.
Peak coincidence factor	The percentage of measure demand savings that coincide in time with the annual peak demand of the entire electricity system.
Peak demand savings	The demand savings that coincide in time with the expected annual peak demand period of the entire electricity system.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	The error in measurement due to the fact that measurements are taken from a subset of the population and not the entire population.
Realization rate	The ratio of evaluated savings to tracked savings.
Sample size	The number of observations or replicates included in a statistical sample.
Secondary market impacts	Energy consumption of appliances that would have been transferred to the secondary market if said appliances had not been retired.
Tracked savings	Gross and net savings calculated based on various parameters such as number of participants or units installed or sold, unitary savings values, installation rates, interactive effects, and the net-to-gross ratio. Those parameters, with the exception of the number of participants or units installed or sold, are obtained from the previous evaluation.
Unitary savings	Energy or peak demand savings established on a unitary basis. This unit can either be a product (e.g., an 8 W LED lamp), a capacity (e.g., one-ton capacity of an air-source heat pump) or a participant (e.g., one participant taking part in a behaviour-based program).

TABLE OF CONTENTS

EXECUTIVE SUMMARY	VIII
INTRODUCTION	1
1 NHC OVERVIEW.....	2
1.1 NHC Description	2
1.2 Follow-up on Past Evaluation Report Recommendations	4
1.3 Participation History.....	5
2 NHC EVALUATION APPROACH.....	7
3 NHC IMPACT EVALUATION	8
3.1 Tracking Sheet Audit.....	8
3.2 Gross Savings	8
3.2.1 Gross Energy Savings Calculations	8
3.2.2 Peak Demand Savings.....	9
3.2.3 Interactive Effects	10
3.2.4 Effective Useful Life	10
3.2.5 Evaluated Gross Savings	11
3.3 Net Savings.....	12
3.3.1 Free-ridership.....	12
3.3.2 Spillover (Market Effects)	12
3.3.3 Net-to-gross Ratio Calculation	13
3.3.4 Evaluated Net Savings.....	13
3.4 Realization Rate.....	15
4 NHC KEY FINDINGS AND RECOMMENDATIONS	16
CONCLUSION.....	17

LIST OF TABLES

Table 1: Summary of 2021 New Residential Program Evaluation	viii
Table 2: Overall 2021 New Residential Participation and Evaluated Savings.....	viii
Table 3: Comparison of 2021 NHC Tracked and Evaluated Savings at the Generator	xi
Table 4: Types of Evaluations Conducted for Each Program Component, 2021	1
Table 5: 2021 NHC Incentive Structure, Valid Post-November 2019.....	3
Table 6: Implementation Status of Past Recommendations for NHC.....	4
Table 7: 2021 NHC Evaluation Approach.....	7
Table 8: 2021 NHC Overestimation Ratio Values.....	9
Table 9: Unitary Peak Demand Savings Values for CCHPs	10
Table 10: Summary of 2021 NHC EUL Values.....	11
Table 11: Evaluated 2021 NHC Gross Energy and Peak Demand Savings	11
Table 12: 2021 NHC Overall Free-ridership Level.....	12
Table 13: 2021 NHC NTGR	13
Table 14: Evaluated 2021 NHC Net Energy and Peak Demand Savings	14
Table 15: Evaluated 2021 NHC GHG Emission Reductions.....	15
Table 16: Comparison of 2021 NHC Tracked and Evaluated Savings at the Generator	15
Table 17: Overall 2021 New Residential Participation and Savings	17

LIST OF FIGURES

Figure 1: 2021 NHC Targets and Evaluated Results.....	ix
Figure 2: NHC Performance Overview, 2012-2021	x
Figure 3: NHC Net Energy and Peak Demand Savings, 2012-2021.....	x
Figure 4: NHC Participation Process Summary.....	2
Figure 5: Overview of NHC Participation, 2012-2021	6
Figure 6: Evolution of NHC Gross Savings, 2012-2021.....	6
Figure 7: 2021 NHC Targets and Evaluated Results.....	17

EXECUTIVE SUMMARY

This report presents the 2021 demand-side management (DSM) results of the New Residential program administered by EfficiencyOne (EOne). This program is comprised of one component, New Home Construction (NHC). NHC encourages homeowners and builders to exceed energy efficiency building code requirements in new homes by providing energy efficiency recommendations and financial incentives.

Evaluation Approach

The evaluation was aimed at calculating program component gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided greenhouse gas (GHG) emissions. The evaluation also served to assess market questions. Table 1 summarizes the types of evaluation conducted along with the corresponding methodology.

Table 1: Summary of 2021 New Residential Program Evaluation

Program Component	Evaluation Type			Methodology
	Impact	Process	Market	
NHC	Condensed	-	-	› Tracking sheet audit › Use of the net-to-gross ratio (NTGR) results from 2020 › Calculations using evaluation results › GHG emission reduction calculations

Program Performance

Table 2 presents the participation level, net-to-gross ratios (NTGRs), as well as evaluated gross and net savings at the generator for the New Residential program.

Table 2: Overall 2021 New Residential Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
NHC							
Energy Savings	853	Participants	6.245	GWh	0.91	5.683	GWh
Lifetime Energy Savings			190.712	GWh	0.91	173.548	GWh
Peak Demand Savings			2.511	MW	0.91	2.285	MW

The following subsection presents the evaluation results.

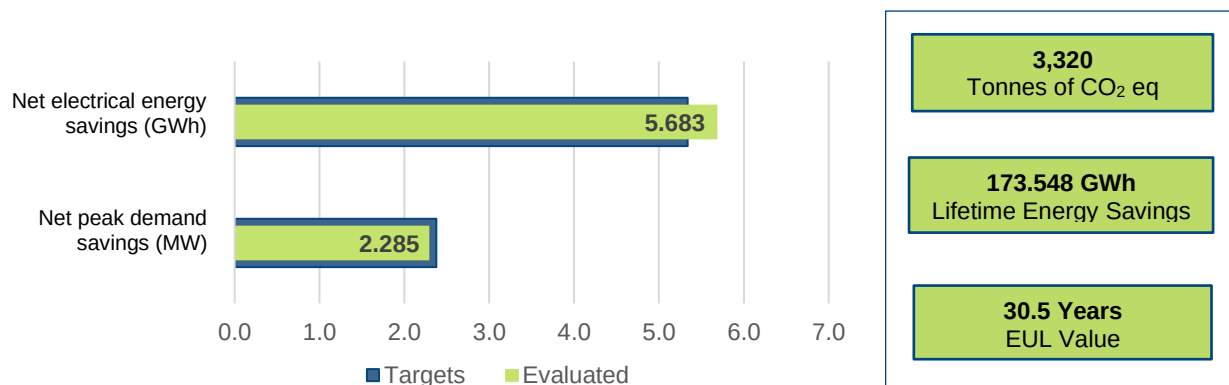
NHC Findings and Recommendations

This subsection presents the key findings and recommendations from the NHC evaluation.

2021 NHC-Finding: NHC net electrical energy savings surpassed targets but net peak demand savings fell short of targets.

As outlined in Figure 1 below, NHC net electrical energy savings surpassed targets by 6% and net peak demand savings fell short of targets by 4%. The figure also includes the evaluated tonnes of CO₂ eq in annually avoided GHG emissions, lifetime energy savings, and the EUL value.

Figure 1: 2021 NHC Targets and Evaluated Results



2021 NHC-Finding: In 2021, NHC participation levels were lower than in 2020.

The 2021 participation levels fell by 6% compared to 2020 levels with a total of 853 completed houses despite a 7% increase in house completions in Nova Scotia. This resulted in a reduction of the share of the province's total number of new homes participating in NHC (32% in 2021 versus 37% in 2020). Fewer opportunities to promote NHC in 2020 and 2021 due to the COVID-19 pandemic and longer delays in project completion might explain the decrease in participation. Moreover, houses that did not meet (DNM) the minimum requirement to qualify for the final rebate decreased by 40% to 75 compared to 124 houses in 2020.

Figure 2 below illustrates the evolution of NHC in terms of participation and net energy savings per home from 2012 to 2021, while Figure 3 further below illustrates the evolution of net energy and peak demand savings over the same period. The number of homes refers to those homes that generated electrical savings.

Figure 2: NHC Performance Overview, 2012-2021

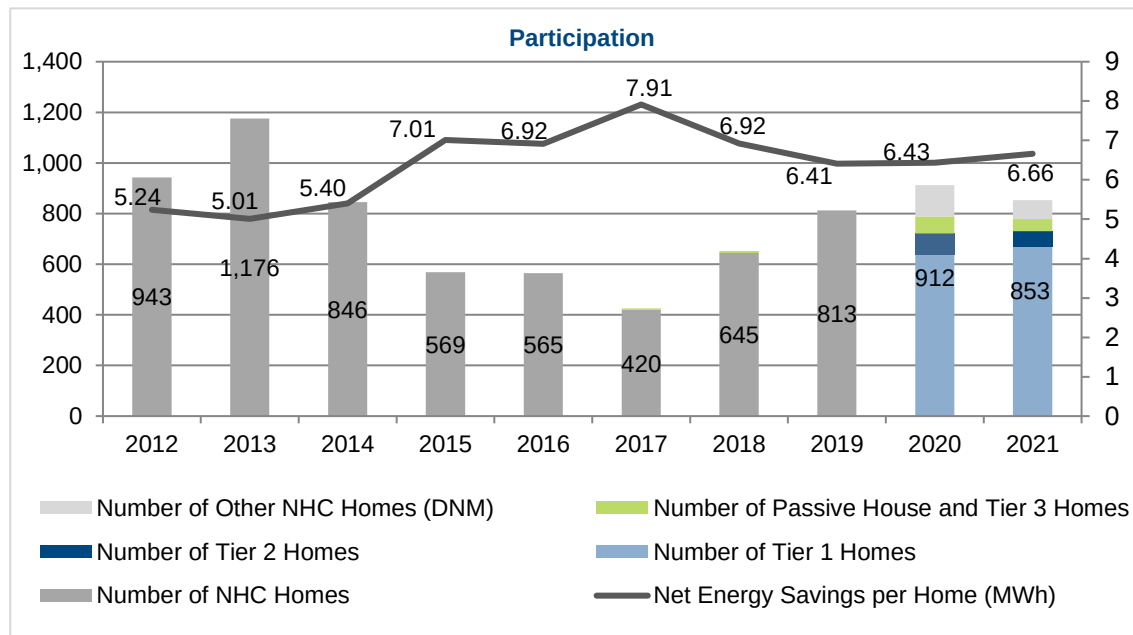
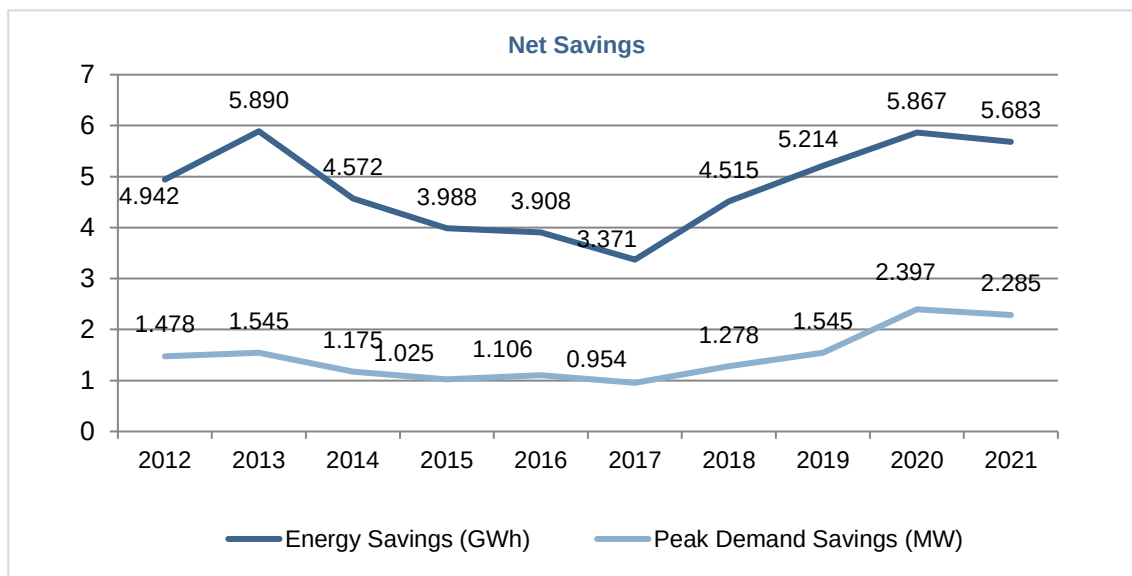


Figure 3: NHC Net Energy and Peak Demand Savings, 2012-2021



2021 NHC-Finding: Evaluated gross savings were identical to the savings tracked by EOne, while net evaluated savings were slightly higher.

The net evaluated energy and peak demand savings determined by the Evaluator were both 3% higher than the net results tracked by EOne due to the slight increase to the NTGR value.

Table 3 compares the tracked and evaluated results.

Table 3: Comparison of 2021 NHC Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	6.245	GWh	0.88	5.496	GWh	103%
Evaluation Results	6.245	GWh	0.91	5.683	GWh	
Peak Demand Savings						
Tracked Savings by EOne	2.511	MW	0.88	2.210	MW	103%
Evaluation Results	2.511	MW	0.91	2.285	MW	

INTRODUCTION

EfficiencyOne (EOne), an independent, non-profit organization, is responsible for helping Nova Scotians improve the energy efficiency of their homes and workplaces by designing, marketing, and delivering energy efficiency and conservation programs for Nova Scotians. EOne receives funding for its electricity demand-side management (DSM) activities from Nova Scotia Power (NS Power) ratepayers.

EOne has a DSM portfolio of three residential programs and three business, non-profit, and institutional (BNI) programs that are marketed to Nova Scotians through the Efficiency Nova Scotia (ENS) franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2021 DSM program portfolio. In addition, Econoler conducted research to inform EOne's approach to market transformation and treatment of codes and standards.

This evaluation report relates to the New Residential program, which is comprised of one component: New Home Construction (NHC). Table 4 below lists the New Residential program component and the type of evaluation conducted in 2021. A condensed impact evaluation involves using some or all of the previous year's impact evaluation parameters such as unitary savings values, adjustment ratios, installation rates, and net-to-gross ratios (NTGRs) to provide evaluated results. Econoler carried out this evaluation, throughout this report Econoler is referred to as the Evaluator.

Table 4: Types of Evaluations Conducted for Each Program Component, 2021

Program	Program Component	2021		
		Process	Market	Impact
New Residential	New Home Construction	-	-	Condensed

Key findings, electrical first-year and lifetime energy savings, peak demand savings, and avoided greenhouse gas (GHG) emissions are presented in this report.

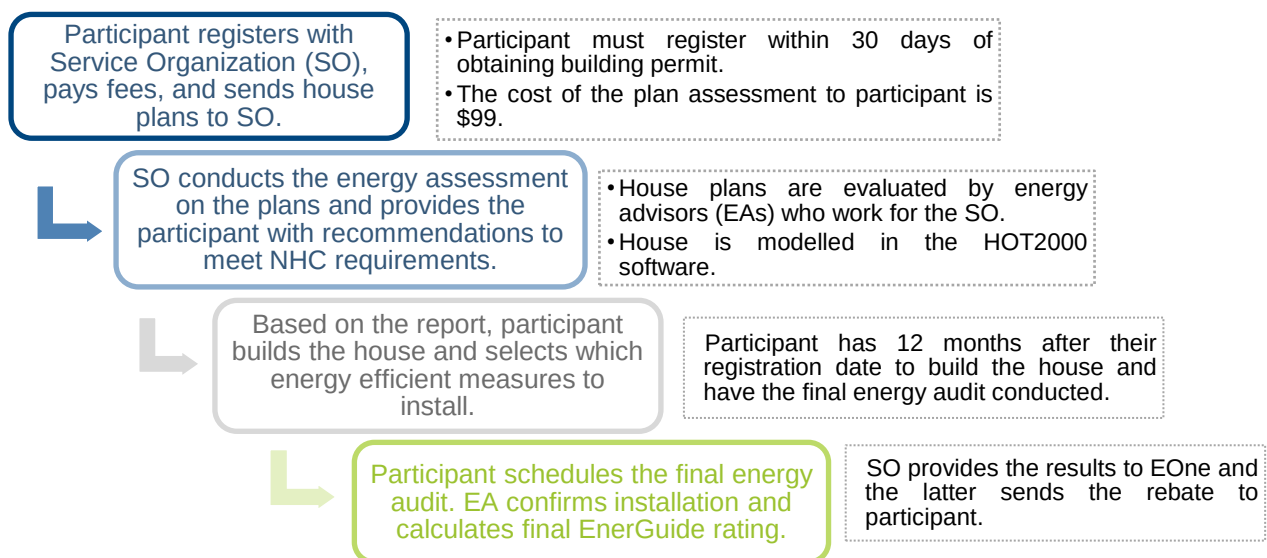
1 NHC OVERVIEW

This section describes New Home Construction (NHC), follows up on past evaluation recommendations, and provides an overview of participation history.

1.1 NHC Description

NHC is meant to encourage homeowners and builders to exceed energy efficiency building code requirements in new homes, thereby increasing the number of energy efficient dwellings in Nova Scotia. Since October 2015, NHC has been fully funded through DSM funds, and only electrically heated households have been eligible.¹ Figure 4 illustrates the participation process along with details about the program component.

Figure 4: NHC Participation Process Summary



Changes were made to the NHC incentive structure over the last few years. On 1 October 2017, NHC transitioned to version 15 of the EnerGuide rating system to estimate annual energy use in gigajoules.² The incentive structure was adapted to accommodate this change, although the rebate amounts remained the same. Version 15 of the rating system is meant to provide homeowners with more useful information about their new home energy performance.

¹ EOne considers a home to be electrically heated when the participant plans to install a heating system that provides all or most of the heating from electricity.

² Projects that obtain incentives by reaching ENERGY STAR® certification are still assessed using the 0-100 EnerGuide rating system.

On 3 December 2018, Eone added a third tier to the incentive structure and removed ENERGY STAR® or R2000 certifications for new registrations. The following incentives were available to NHC participants who registered between 3 December 2018 and 4 November 2019:

- › Tier 1 – An incentive of \$2,000 was provided for homes that achieve: (1) An energy use level 30% better than required by the National Building Code (NBC) for homes no larger than 1,200 ft²; or (2) an energy use level 45% better than required by the NBC for homes larger than 1,200 ft²;
- › Tier 2 – An incentive of \$5,000 was provided for homes that achieve: (1) An energy use level 45% better than required by the NBC for homes no larger than 1,200 ft²; or (2) an energy use level 65% better than required by the NBC for homes larger than 1,200 ft²;
- › Tier 3 – An incentive of \$7,000 was provided for homes that achieve: (1) An energy use level 65% better than required by the NBC for homes no larger than 1,200 ft²; or (2) an energy use level 75% better than required by the NBC for homes larger than 1,200 ft²;
- › An additional incentive of \$2,000 was provided for homes that achieve Net Zero Ready, Net Zero, or Passive House certification.

On 4 November 2019, Eone removed home size requirements from its incentive structure and subdivided the incentive according to home type. Table 5 presents the incentives available to NHC participants who have registered since 4 November 2019.³

Table 5: 2021 NHC Incentive Structure, Valid Post-November 2019

Home Type	Tier	Rebate	Target
Single-family Detached Homes	1	\$2,000	40% better than code
	2	\$5,000	65% better than code
	3	\$7,000 + \$2,000	75% better than code Net Zero Ready, Net Zero, or Passive House certification
Multi-unit Homes	1	\$1,000	30% better than code
	2	\$2,000	65% better than code
	3	\$3,000 + \$2,000	75% better than code Net Zero Ready, Net Zero, or Passive House certification

On 1 December 2020, EOne changed the requirement for homes under 1,000 square feet. They now need to achieve 70% better than code to qualify for the Tier 3 incentive. This change was made as it was found that homes under this size have difficulty meeting 75% better than code requirements.

NHC has not been significantly impacted by public health and government directives regarding the COVID-19 pandemic. Although some site visits were postponed, initial energy assessments and construction have occurred as normal and final energy assessments were completed in unoccupied houses.

³ For participants who registered before this date, the incentive structure for which they were originally registered applies.

For 2021, NHC was aimed at achieving 5.3 GWh in net electricity savings and 2.4 MW in net peak demand savings at the generator.

1.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated NHC in previous years and issued improvement recommendations. Table 6 below provides a summary of the implementation status of each recommendation. All three recommendations, one from the 2018 evaluation and two from the 2020 evaluation, have been deferred for implementation in the next few years.

Table 6: Implementation Status of Past Recommendations for NHC

#	Recommendations for NHC	Status	Comments
2018 NHC-R4	Conduct a billing analysis to review overestimation ratios (Ors) when a sufficient NHC participant sample becomes available.	Deferred	The scope of the 2021 New Residential evaluation was changed from a comprehensive to a condensed evaluation. The billing analysis has therefore been postponed to 2022.
2020 NHC-R1	Consider ways to increase the uptake of measures other than the installation of mini-split heat pumps (MHSPs) for participants to achieve program tiers.	Deferred	Eone will work with the service organizations and engineering and planning departments to determine ways to encourage participants to build higher performance homes and implement measures beyond heat pumps that are in line with code changes. This recommendation will be implemented over the next few years in line with code and other changes.
2020 NHC-R2	Review the data-collection strategy among builders	Deferred	The scope of the 2021 New Residential evaluation was changed from a comprehensive billing analysis to a condensed evaluation. As a result, builder interviews were not conducted in 2021. Eone will continue to work with the Evaluator to discuss approaches for conducting these surveys in future years to achieve greater uptake.

1.3 Participation History

The evolution of NHC participation levels as well as that of gross energy and peak demand savings from 2012 to 2021 is presented in Figure 5 and Figure 6 below respectively. A total of 853⁴ houses were completed in 2021, which represents a decrease of 6% over 2020 levels yet remains the second best year since 2014. This decrease in participation was also accompanied by a smaller share of the province's total number of new homes participating in NHC in 2021 compared to the previous year (32% in 2021 versus 37% in 2020). Conversely, the number of housing completions in Nova Scotia increased by 7%. Fewer opportunities to promote NHC in 2020 and 2021 due to the COVID-19 pandemic and longer delays in project completion might explain the decrease in participation. In terms of the number of participating homes that qualified under the different tiers in 2021, 668 homes qualified under Tier 1, 62 under Tier 2, and 48 under Tier 3. A total of 75 houses did not meet (DNM) the minimum requirement to qualify for the final rebate, which is significantly less than in 2020 when 124 homes did not meet the minimum requirement. Each year, savings are claimed for such houses because they received an assessment of their house plans and were influenced by NHC to improve their energy performance even if they do not reach the minimum required.

In 2021, NHC achieved 6.245 GWh and 2.511 MW in gross energy and peak demand savings at the generator respectively.

⁴ This value includes 14 participants who did not receive a rebate due to having a non-electrical primary heating system. These participants would typically have changed their heating system during the design or construction process, although NHC still had an influence on the other features of their homes, so electrical savings were claimed.

Figure 5: Overview of NHC Participation, 2012-2021⁵

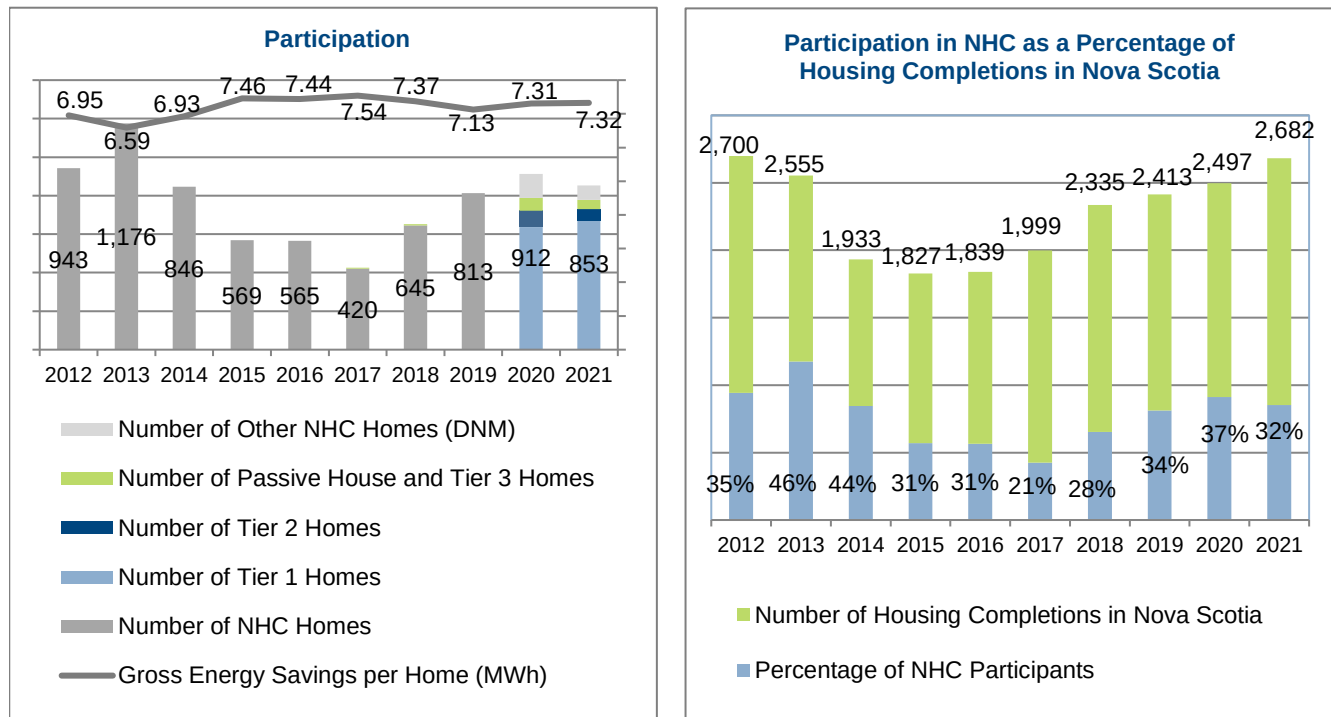
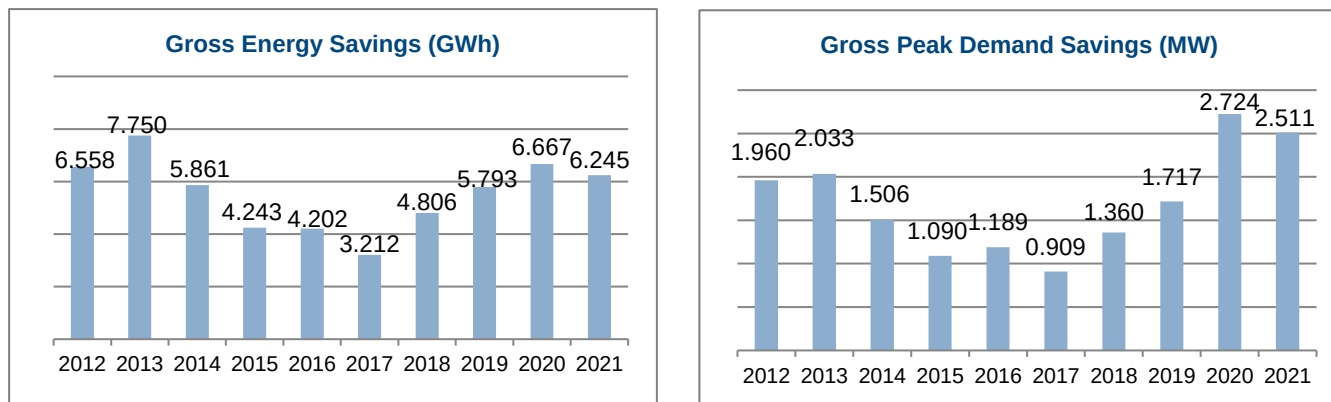


Figure 6: Evolution of NHC Gross Savings, 2012-2021



⁵ The numbers of participants indicated in the figures refer to participants who generated electrical savings and, if they registered before October 2015, whose homes were electrically heated. The housing completion numbers were drawn from the Canada Mortgage and Housing Corporation website using the Housing Market Information Portal at: <https://www03.cmhc-schl.gc.ca/hmip-pimh/#TableMapChart/1/1/Canada>, (Consulted January 31, 2021).

2 NHC EVALUATION APPROACH

The 2021 NHC evaluation comprised a condensed impact evaluation. The main objectives of the 2021 NHC evaluation were as follows:

- › Calculate NHC gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions⁶

The Evaluator identified key research questions aimed at achieving the objectives. Table 7 outlines the evaluation objectives and maps them to the Evaluator's research questions, methods, and sample sizes (n). Each method is described further below.

Table 7: 2021 NHC Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › Have the savings been correctly and consistently calculated by applying the correct formulas and ORs for heating and building envelope measures? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Calculations using evaluation results
Calculate net results	› What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What are the net avoided GHG emissions in CO₂ eq for NHC?	› Use of the NTGR results from 2020 › Calculations using evaluation results › GHG emission reduction calculations

Tracking Sheet Audit

Prior to performing the savings calculation review, the Evaluator performed an audit of the final 2021 tracking sheet to ensure it was complete and the entered data were consistent. The detailed protocol used for the tracking sheet audit and the results obtained are presented in Appendix I.

Calculations Using Evaluation Results

The Evaluator calculated first-year and lifetime energy and peak demand savings as per the calculation methodology presented in Section 3 below.

GHG Emission Reduction Calculations

To obtain net avoided GHG emissions in CO₂ eq for NHC, the Evaluator multiplied the net energy savings by the latest Nova Scotia-specific factor for GHG emissions generated by electricity production. This factor was established using NS Power data.

⁶ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

3 NHC IMPACT EVALUATION

The objectives of the 2021 NHC impact evaluation were to determine NHC gross and net electrical energy and peak demand savings.

3.1 Tracking Sheet Audit

To ensure program component results were reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix I. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

3.2 Gross Savings

Gross savings correspond to the change in energy consumption resulting from the energy efficiency performance achieved in new homes under NHC. The Evaluator reviewed the gross energy savings calculations, peak demand-to-energy ratios, and effective useful life values.

The methodologies used for evaluating those elements are described in the following subsections.

3.2.1 Gross Energy Savings Calculations

$$\text{Gross Energy Savings} = (EC_{\text{To-code}} - BC) \times (1 - OR_{\text{To-code}}) - (EC_{\text{As-built}} - BC) \times (1 - OR_{\text{As-built}})$$

Modelled Energy Consumption

For each participant, HOT2000 simulations are used to model as-built energy consumption levels, i.e. the energy consumption of a new house as built, and the to-code energy consumption level representing the value of the baseline, i.e. the energy consumption of the same house built with characteristics corresponding to the current building code.

Baseload Consumption

Baseload consumption is a fixed value of 8,760 kWh for HOT2000 version 10.5 and of 7,118 kWh for HOT2000 version 11. The baseload consumption is removed from the savings calculation since it is not affected by energy efficient upgrades.

Overestimation Ratio

ORs are used to adjust the modelled energy consumption values generated by HOT2000 because the software tends to slightly overestimate savings. The Evaluator considered the OR values established as part of the 2018 HEA evaluation still valid to adjust the modelled energy consumption of NHC participants. Table 8 presents the OR established for each scenario. These ORs will be updated during the next evaluation year to better represent changes made to HOT2000 version 11 as almost all participants now use this version of the software.

Table 8: 2021 NHC Overestimation Ratio Values

Scenario	OR
To-code Model – with Neither Heat Pump nor Wood/Pellet Stove	9%
As-built Model – with Heat Pump	0%
As-built Model – Without Heat Pump	19%

Non-electrical Heating System Used as Backup

For NHC, the baseline heating system modelled in the to-code simulation corresponds to 100% electric baseboards. The total as-built modelled energy consumption level is subtracted from this baseline scenario even if a portion of energy consumption is non-electrical. This ensures a conservative estimate in the savings calculations and avoids accounting for fuel-switching savings. Only 11% of 2021 participant homes had a non-electrical backup heating system installed.⁷

3.2.2 Peak Demand Savings

Peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The projected electricity demand peak period in Nova Scotia is between 5 p.m. and 7 p.m. from December to February on non-holiday weekdays.

For NHC, peak demand savings were calculated using the peak demand-to-energy ratio of 0.283 MW/GWh established by Navigant in the 2016-2018 DSM Plan. This ratio was established using modelled system-coincident peak demand savings and energy savings for a projected deployment of measures. Navigant used local data to establish this ratio. The Evaluator considered that the approach used by Navigant was still valid and therefore used it to estimate peak demand savings for NHC.

An exception was made for new homes with cold climate air-source heat pumps (CCHPs). Starting in 2020, peak demand savings were calculated separately for this type of heat pump based on specifications for each installed system and using the following equation.

$$CCHP \text{ Peak Demand Savings}_w = \frac{1,000}{3.412} \times HC_{min} \times \left(\frac{1}{COP_{base\_min}} - \frac{1}{COP_{ee\_min}} \right)$$

⁷ Including 2% that did not receive a rebate because their non-electrical heating system was actually their primary system.

Table 9: Unitary Peak Demand Savings Values for CCHPs

Variable	Symbol	Value
Rated heating capacity of the new CCHP at outdoor air temperature of -15 °C [kBTU/h]	HC_{min}	Specification data for each installed system
Coefficient of performance of the assumed baseline equipment (electric resistance) at -15 °C [kW/kW]	COP_{base_min}	1
Coefficient of performance of the new heat pump at -15 °C [kW/kW]	COP_{ee_min}	Specification data for each installed system
Conversion factor [BTU/W·h]	3.412	3.412
Conversion factor [W/kW]	1,000	1,000

The peak demand savings associated to all other non-CCHP measures were calculated using the following equation based on the peak demand-to-energy ratio:

$$\begin{aligned}
 \text{Non - CCHP Peak Demand Savings}_W & \\
 &= (\text{Gross Energy Savings} - \text{CCHP Energy Savings}) \times 0.283 \frac{W}{kWh}
 \end{aligned}$$

CCHP energy savings are calculated using a unitary value of 0.179 kWh/BTU/h based on the billing analysis results of the 2017 Green Heat evaluation for fully electrically heated households, as detailed in the 2020-2022 Measure Assessment report. It is to be noted that, since NHC is a performance-based program component, the Evaluator assumed that CCHPs are always implemented with other measures in new qualifying homes to be able to reach the required minimum energy performance level. Based on this assumption, non-CCHP peak demand savings were systematically calculated for all participants.

3.2.3 Interactive Effects

The Evaluator added no interactive effects to the savings calculations since they were already taken into account in the HOT2000 simulations.

3.2.4 Effective Useful Life

As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the EUL values used in the calculation of electrical energy savings that are expected to persist over time. The EUL values established in the 2019 evaluation remained valid for the 2021 evaluation.

Table 10 below presents the EUL values established for NHC. An EUL value of 36 years was used for all Tier 3 participants. For all other NHC participants, an EUL value of 30 years was used.

Table 10: Summary of 2021 NHC EUL Values

	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]
Tier 3 Participants	36	No change
All Other NHC Participants	30	No change

3.2.5 Evaluated Gross Savings

Table 11 below presents the annual gross savings for NHC. Overall, the total gross energy and peak demand savings amounted to 6.245 GWh and 2.511 MW at the generator respectively. Based on EUL values of 36 years for Tier 3 participants and 30 years for all other NHC participants, the lifetime gross energy savings amount to 190.712 GWh.

The gross savings at the generator were calculated using a line loss factor between the meter and the generator of 1.095 for energy savings and 1.147 for peak demand savings. The line loss factors were updated in the 2019 evaluation and correspond to the values submitted to the Nova Scotia Utility and Review Board as part of the 2014 Cost of Service Study Progress Update.⁸

Table 11: Evaluated 2021 NHC Gross Energy and Peak Demand Savings

	Total
Number of Participants	853
Energy Savings	
Gross Energy Savings Without Overestimation Ratio (OR) – at the Meter (GWh)	6.978
Gross Energy Savings with OR – at the Meter (GWh)	5.705
Line Loss Factor	1.095
Gross Energy Savings with OR – at the Generator (GWh)	6.245
Effective Useful Life (years)	30.5
Gross Lifetime Energy Savings – at the Generator (GWh)	190.712
Peak Demand Savings	
Peak Demand-to-energy Ratio (MW/GWh)	0.384**
Gross Peak Demand Savings – at the Meter (MW)	2.190
Line Loss Factor	1.147
Gross Peak Demand Savings – at the Generator (MW)	2.511
* An EUL value of 30 years was applied to Tier 1 and Tier 2 participants while an EUL value of 36 years was applied to Tier 3 participants. The weighted average EUL value for gross energy savings was 30.5 years. ** Corresponds to the equivalent peak demand-to-energy ratio obtained by dividing gross peak demand savings by gross energy savings. This value is not equal to 0.283 MW/GWh because of the new calculation methodology applied to CCHPs.	

⁸ Nova Scotia Utility and Review Board, *Matter M06555, 2014 Cost of Service Study Progress Update*, Exhibit N-2.09, Appendix I1.

3.3 Net Savings

The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the net-to-gross ratio (NTGR). The NTGR represents the positive or negative effects on gross savings. Two effects are considered for NHC: Free-ridership and spillover in the form of market effects.

3.3.1 Free-ridership

Free-ridership occurs when participant homeowners or participant builders would have implemented energy efficiency measures in the absence of the program component. The assessment of the NHC free-ridership level is based on a self-report approach that involves asking participant homeowners and participant builders a set of questions during telephone surveys. The questions serve to assess the likelihood for participants to have built houses beyond the energy building code requirements in the absence of the program component.

For the 2021 evaluation, the free-ridership level for participating homeowners and builders from the 2019 evaluation were used, and the overall free-ridership level was calculated using the proportion of homeowner and builder applicants in NHC in 2021, as outlined in Table 12 below.

Table 12: 2021 NHC Overall Free-ridership Level

	Free-ridership Level from 2019	Margin of Error	Participation Proportion in 2021	2021 Overall Free-ridership Level (Homeowners and Builders Combined)
Participant Homeowners	28%	7.6%	22%	24%
Participant Builders	23%	5.3%	78%	

3.3.2 Spillover (Market Effects)

Spillover occurs when participants decide to implement energy efficiency measures in new construction projects without participating in the program component. For NHC, this is measured in the form of market effects based on builder perspectives, housing market information, and data from the tracking sheet as exemplified in the following equation.

$$Spillover\ Level = \frac{Total\ \#\ of\ N - P\ Houses \times \%N - P\ Houses_{EE} \times \%Attrib \times \%Elect}{Total\ \#\ of\ Participating\ Houses}$$

The total number of non-participating houses (Total # of N-P Houses) was obtained by subtracting the number of new houses that participated in NHC (as per the 2021 tracking sheet) from the total number of houses built in Nova Scotia in 2021.⁹ The result was multiplied by the percentage of non-participating houses that would have met the NHC energy efficiency criteria (%N-P Houses_{EE}) and by the percentage of attribution (%Attrib) that corresponds to the influence of NHC on the residential new home construction market. These two percentages, established at 88% and 9% respectively, were obtained from the builder survey conducted as part of the 2019 evaluation. These two percentages were then multiplied by the percentage of new houses that are primarily electrically heated (%Elect). This value was established at 90% during the 2016 evaluation by calculating the average proportion of participants who used electricity as their main heating source and who participated in NHC between 2012 and 2015, a period when NHC was also offered to participants with non-electrical heating systems. Finally, the spillover level was obtained by dividing the resulting value by the total number of participating houses in 2021 (Total # of Participating Houses) obtained from the 2021 tracking sheet. The measured spillover level for 2021 was established at 15% compared to 12% in 2020.

3.3.3 Net-to-gross Ratio Calculation

The NHC NTGR is calculated using the following equation.

$$NTGR = (1 - \% \text{ Free-ridership} + \% \text{ Spillover} [\text{Market Effects}])$$

By applying the free-ridership and spillover levels discussed in the previous subsections, the NHC NTGR value was estimated at 0.91 as presented in Table 13 below.

Table 13: 2021 NHC NTGR

Free-ridership	Participant Spillover	NTGR
24%	15%	0.91

3.3.4 Evaluated Net Savings

Net savings represent the savings that can be reliably attributed to a program component. For NHC, net savings are calculated by applying the NTGR value calculation above to the evaluated gross savings, as exemplified in the following equation.

$$\text{Net Savings} = \text{Gross Savings} \times \text{NTGR}$$

This equation was used to calculate both energy and peak demand savings.

⁹ Canada Mortgage and Housing Corporation data. *Housing Market Information Portal*. <https://www03.cmhc-schl.gc.ca> (Last accessed January 31, 2021).

The NHC net energy and peak demand savings were established at 5.683 GWh and 2.285 MW respectively at the generator. Based on the EUL values of 36 years for Tier 3 participants and 30 years for all other NHC participants, the net lifetime energy savings were established at 173.548 GWh. Detailed results are presented in Table 14 below.

Table 14: Evaluated 2021 NHC Net Energy and Peak Demand Savings

	Total
Energy Savings	
Gross Energy Savings – at the Meter (GWh)	5.705
NTGR	0.91
Net Energy Savings – at the Meter (GWh)	5.192
Line Loss Factor	1.095
Net Energy Savings – at the Generator (GWh)	5.683
Effective Useful Life (years)*	30.5
Net Lifetime Energy Savings – at the Generator (GWh)	173.548
Peak Demand Savings	
Gross Peak Demand Savings – at the Meter (MW)	2.190
NTGR	0.91
Net Peak Demand Savings – at the Meter (MW)	1.993
Line Loss Factor	1.147
Net Peak Demand Savings – at the Generator (MW)	2.285
* An EUL value of 30 years was applied to Tier 1 and Tier 2 participants while an EUL value of 36 years was applied to Tier 3 participants. The weighted average EUL value for net energy savings was 30.5 years.	

As presented in Table 15, applying the Nova Scotia-specific factor¹⁰ for GHG emissions generated by electricity production, 0.5841 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 3,320 tonnes of annually avoided CO₂ eq.

¹⁰ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:
 Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),
 Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021
https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

Table 15: Evaluated 2021 NHC GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	5.683
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Net Annual GHG Emission Reductions (tonnes of CO₂ eq)	3,320

3.4 Realization Rate

A comparison of the energy and peak demand savings values established through the 2021 evaluation to those tracked by EOne is presented in Table 16. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 103% for both energy and peak demand savings.

Table 16: Comparison of 2021 NHC Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	6.245	GWh	0.88	5.496	GWh	103%
Evaluation Results	6.245	GWh	0.91	5.683	GWh	
Peak Demand Savings						
Tracked Savings by EOne	2.511	MW	0.88	2.210	MW	103%
Evaluation Results	2.511	MW	0.91	2.285	MW	

Both the evaluated gross energy and peak demand savings determined by the Evaluator were identical to the initial gross savings tracked by EOne. The net evaluated energy and peak demand savings determined by the Evaluator were both 3% above the net results tracked by EOne due to the slight increase to the NTGR value.

4 NHC KEY FINDINGS AND RECOMMENDATIONS

As mentioned previously, the main objectives of the 2021 NHC evaluation were as follows:

- › Calculate NHC gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions¹¹

This section provides the Evaluator's key findings in relation to these objectives. The Evaluator had no recommendations as part of the 2021 NHC evaluation. Past recommendations are outlined in Appendix II.

2021 NHC-Finding: NHC net electrical energy savings surpassed targets but net peak demand savings fell short of targets.

NHC achieved 5.683 GWh in net electrical energy savings and 2.285 MW in net peak demand savings at the generator in 2021, thus attaining the planned net electrical energy savings of 5.338 GWh and slightly missing the target of 2.377 MW for net peak demand savings.

2021 NHC-Finding: In 2021, NHC participation levels were lower than in 2020.

The 2021 participation levels decreased by 6% compared to 2020 levels with a total of 853 completed houses despite a 7% increase in house completions in Nova Scotia. This resulted in a reduction in the share of the province's total number of new homes participating in NHC (32% in 2021 versus 37% in 2020). Fewer opportunities to promote NHC in 2020 and 2021 due to the COVID-19 pandemic and longer delays in project completion might explain the decrease in participation. Moreover, houses that did not meet (DNM) the minimum requirement to qualify for the final rebate decreased by 40% to 75 compared to 124 houses in 2020.

2021 NHC-Finding: Evaluated gross savings were identical to the savings tracked by EOne, while net evaluated savings were slightly higher.

The net evaluated energy and peak demand savings determined by the Evaluator were both 3% higher than the net results tracked by EOne due to the slight increase to the NTGR value.

¹¹ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

CONCLUSION

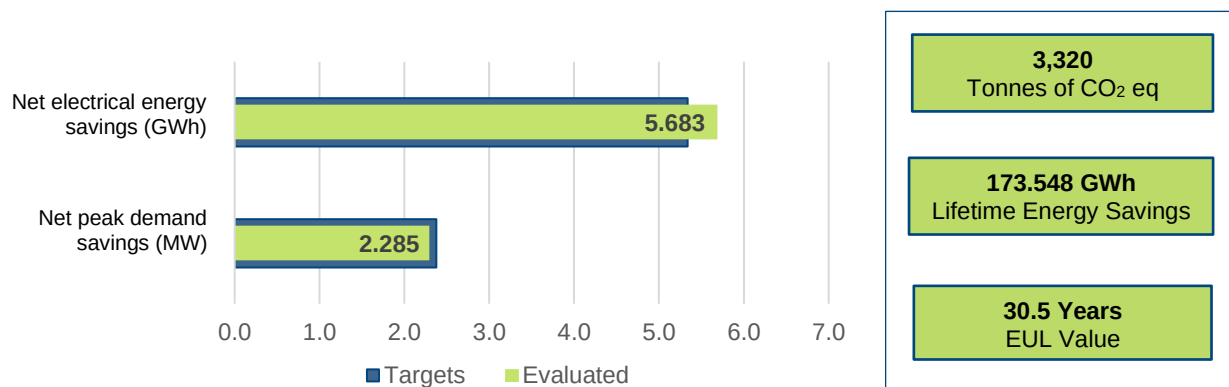
Table 17 summarizes the participation level, as well as the gross and net savings for the New Residential program that is comprised of one component: New Home Construction (NHC).

Table 17: Overall 2021 New Residential Participation and Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
NHC							
Energy Savings	853	Participants	6.245	GWh	0.91	5.683	GWh
Lifetime Energy Savings			190.712	GWh	0.91	173.548	GWh
Peak Demand Savings			2.511	MW	0.91	2.285	MW

Figure 7 below illustrates the net energy and peak demand savings targets for the New Residential program and indicates whether they were met in 2021. New Residential was aimed at achieving 5.34 GWh in net electrical energy savings and 2.38 MW in net peak demand savings at the generator for 2021. It achieved 5.683 GWh in net electrical energy savings and 2.285 MW in net peak demand savings at the generator in 2021. The program therefore surpassed its net energy savings targets by 6% but net peak demand savings fell short of targets by 4%.

Figure 7: 2021 NHC Targets and Evaluated Results



LIST OF APPENDICES

The following are presented in the New Residential Program – Appendices document.

New Home Construction

Appendix I: Tracking Sheet Audit

Appendix II: 2021 Recommendations



NEW RESIDENTIAL PROGRAM 2021 DSM EVALUATION

EFFICIENCYONE

Appendix Report

March 16, 2022



TABLE OF CONTENTS

APPENDIX I TRACKING SHEET AUDIT	1
APPENDIX II 2021 RECOMMENDATIONS.....	5

APPENDIX I TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying that all data fields required for the evaluation were included and filled out in the tracking sheet submitted by EfficiencyOne (EOne)
- › Ensuring that tracked results were accurate by:
 - Verifying that parameters used to calculate program results (gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating that all calculation steps were performed consistently

Data Accuracy

Table 1 below lists all the parameters required for the New Home Construction (NHC) evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the table details the actions carried out by the Evaluator to adjust data when required.

Table 1: Verification of 2021 NHC Data Field Completeness and Accuracy

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Heating System Type (Column AT)	Y	Y	
Date Complete (Columns A and B)	Y	Y	
As-built Modelled Energy Consumption (Column BH) and Baseload Consumption (Column BG)	Y	Y	
To-code Modelled Energy Consumption (Column AA)	Y	Y	
Heat Pump Source (Column AR)	Y	Y	
Overestimation Ratios for the To-code Scenario (Column BE) and As-built Scenario (Column BF)	Y	Y	
Cold Climate Heat Pump Capacity (Column CM)	Y	N/A	
Cold Climate Heat Pump COP at -15°C (Column CN)	Y	N/A	
Cold Climate Heat Pump Heating Capacity at -15°C (Column CO)	Y	N/A	
Reference Data			
Net-to-gross Ratios	Y	Y	
Peak Demand-to-energy Ratio	Y	Y	
Effective Useful Life	Y	Y	
Line Loss Factor	Y	Y	
Average Gross Energy Savings per Installed Btu/hr for CCHPs as Observed in Green Heat	Y	Y	This value is not presented in the Reference tab, although the correct value of 0.179 kWh/Btu/h is used in Column CR.

Data Consistency

The second step of the tracking sheet audit involved recreating calculations and comparing related tracking sheet data fields to identify any potential inconsistencies. Table 2 below lists the data fields that were compared to ensure consistency.

Table 2: Verification of NHC 2021 Data Field Consistency

Consistency Verification	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Verification of Duplicate IDs or Projects	Y	
Verification of Negative As-built Modelled Energy Consumption Values	N	Nine participants had negative as-built consumption levels most probably due to their solar system (non-zero solar generation in Column AW). Their as-built consumption was capped at 0 in Column BJ.
Verification of Negative Savings Against Incentives and Notes	N	The verification of negative savings (Column BN) revealed three participants with negative savings. Two of them did not receive a rebate while the other one did. No notes were left in the tracking sheet to explain why this participant was given an incentive in that case. These participants were removed from the tracking sheet.
Verification of Savings Claimed for Non-electrical Heating Systems	Y	In total, 16 participants had non-electrical heating systems yet had all their savings claimed as electrical and did not receive the final rebate; the Evaluator validated that the savings claimed for those participants were only for end uses other than heating. EOne claims savings for these participants since their non-electrical heating system might have changed during the design or construction phase, although they still implement some energy efficiency measures as a result of the program; they, however, do not receive an incentive. Another participant received a rebate although they also had a non-electrical system; this was a case where a mini-split heat pump with indoor heads in every room had been installed; in this case, EOne considers that this acts as a main electrical heating system and the participant is eligible for the rebate. The Evaluator made no change to the tracked savings and notes the rationale behind this decision.

Equations and Compilation

The Evaluator validated that, once the correct values were used (as per Table 1), the equations in the tracking sheet correctly calculated each of the main program component results.

Table 3: Verification of 2021 NHC Savings Compilation

Program Component Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator (Column BO)	Y	
Gross Peak Demand Savings at the Generator (Column BQ)	N	While the new approach to the peak demand savings calculation is carried out properly in Columns CM to CZ, the gross peak demand savings at the generator are only presented in Column BQ, and it uses the old peak demand savings approach. The Evaluator calculated the tracked gross peak demand savings

Program Component Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
		from the correctly calculated net peak demand savings at generator.
Net Energy Savings at the Generator (Column BM)	Y	
Net Peak Demand Savings at the Generator (Column BS)	Y	

Corrected Tracked Savings

Table 4 below presents the corrected tracked savings resulting from all changes made by the Evaluator, as described in this appendix.

Table 4: 2021 NHC Corrected Tracked Savings

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
NHC					
Gross Energy Savings at the Generator	6.278	GWh	6.245	GWh	-0.52%
Gross Peak Demand Savings at the Generator	1.861	MW	2.511	MW	34.94%
Net Energy Savings at the Generator	5.525	GWh	5.496	GWh	-0.52%
Net Peak Demand Savings at the Generator	2.221	MW	2.210	MW	-0.51%

The small downward adjustments to gross and net energy savings and to net peak demand savings are due to the few participants that were either removed from the tracking sheet because of negative savings or for which savings were reduced, as described in Table 2 above. Moreover, the corrected tracked value for gross peak demand savings was increased by almost 35% because the tracked value for gross savings did not use the new calculation methodology for peak demand savings to provide a more accurate and higher estimate of peak demand savings for cold-climate heat pumps.

APPENDIX II 2021 RECOMMENDATIONS

The Evaluator had no recommendations as part of the 2021 NHC evaluation. This appendix summarizes all the past evaluation recommendations that were not fully implemented or deferred.

#	Recommendations for NHC
2018 NHC-R4 (deferred)	Conduct a billing analysis to review overestimation ratios (ORs) when a sufficient NHC participant sample becomes available.
2020 NHC-R1 (deferred)	Consider ways to increase the uptake of measures other than the installation of mini-split heat pumps (MHSPs) for participants to achieve program tiers.
2020 NHC-R2 (deferred)	Review the data-collection strategy among builders.



EFFICIENT PRODUCT REBATES PROGRAM 2021 DSM EVALUATION

EFFICIENCYONE

Final Report

March 17, 2022



NARRATIVE
RESEARCH



ANS DE SUCCÈS
YEARS OF SUCCESS



ABBREVIATIONS

BER	Business Energy Rebates
BNI	Business, non-profit and institutional
CFL	Compact Fluorescent Light
DLC	DesignLights Consortium
DOE	Department of Energy
DSM	Demand-side management
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
ETN	Efficiency Trade Network
EUL	Effective useful life
GHG	Greenhouse gas
HID	High intensity discharge
HOU	Hours of use
HRM	Halifax Regional Municipality
HVAC	Heating, ventilation and air conditioning
ISR	In-service rate
LED	Light emitting diode
NS Power	Nova Scotia Power
NSUARB	Nova Scotia Utility and Review Board
NTGR	Net-to-gross ratio
PCF	Peak coincidence factor
PTHPs	Packaged Terminal Heat Pumps
RTU	Rooftop unit

DEFINITIONS

Accuracy	Reflects the proximity of measurements to the true value.
Adjustment ratio	The ratio of evaluated results to tracked results. This ratio expresses the adjustment made to tracked savings or other tracked values such as effective useful life.
Baseline	To determine gross savings, a baseline (or base case) is established providing detailed information about the reference (e.g. pre-existing or standard) measure or equipment chosen to be compared with the efficient measure or equipment. For the reference measure or equipment, the baseline may include such information as the hours of operation, wattage and the base consumption.
Bias	Systematic deviations of measurements from the true value.
Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
Displaced wattage	The displaced wattage is defined as the difference between the wattage values of the baseline equipment or product and the efficient equipment or product.
EnerGuide rating	An EnerGuide (official brand of Natural Resources Canada) rating is a standard measure of the home's energy performance. It is a measure of the efficiency of the building only and does not take into account occupant behaviour. It shows how energy efficient the home is through modelled heat losses of the home, based on several factors including building envelope characteristics, heated volume, heating systems and air leakage.
Effective useful life	The period a measure is expected to be in service and provide both energy and peak demand savings. This value combines the equipment life and the measure persistence, which includes factors such as business turnover or early retirement.
Equipment life	The number of years installed equipment will operate before it fails.
Equivalent CO ₂	A unit of measurement indicating the amount of carbon dioxide to which various kinds of emitted greenhouse gases are equivalent in terms of warming effects. In this report, the gases' global-warming potential is estimated over a timescale of 100 years.
Equivalent effective useful life	The number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. This value takes into account variations in annual energy savings throughout the effective useful life due to increased baselines.

Evaluated savings	Gross and net energy or peak demand savings calculated by the Evaluator using the parameters (unitary savings values, installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process. Unless otherwise specified, the evaluated savings are the first-year savings.
Evaluation plan	The evaluation plan summarizes the program description, objectives, base cases, documentation, evaluation methodology, budget and schedule.
First-year savings	The first full year of energy or peak demand savings generated by an energy efficiency measure.
Free-ridership	Percentage of gross savings attributable to participants who would have implemented the same or similar energy efficiency measures, with no change in timing, in the absence of the program.
Gross savings	Change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated.
Induced consumption	Energy consumption of appliances that would have been unplugged and not replaced by participants in the absence of the program.
Interactive effects	Effects on the energy consumption of other systems in the building (such as heating and cooling) due to the installation of an energy efficiency measure.
Participant spillover	Savings attributable to participants who continue to implement the energy efficiency measure introduced by a program after participating in it once, without participating in the program a second time.
In-service rate	The proportion of incentivized products that are installed and operating. This rate is usually applied to programs through which rebates are offered in-store and products are likely to be stored for a certain period before being installed, such as LED lamps.
Installation rate	The proportion of incentivized products reported as installed that remain installed and operating at the time of evaluation. This rate is usually applied to direct install or mail-in rebate programs through which measures are expected to be installed immediately at the time of participation.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for a measure's effective useful life and any increase in the baseline efficiency level (which reduces attributable annual savings) over its lifetime.
Line loss factor	The multiplier to convert savings at the customer meter to savings at the utility generator. It accounts for the electrical losses of the transmission and distribution system.
Margin of error	The amount of random sampling error.
Market effects	The impact of the program on the market (such as increased product availability, practices, and prices) that extends beyond changing the program participants' behaviour. This includes spillover among non-participants.

Net savings	Energy or peak demand savings that can be reliably attributed to a program. This includes effects, such as free-ridership and spillover, that negatively or positively affect the savings attributable to a program.
Net-to-gross ratio	The ratio of net energy savings to gross energy savings.
Non-sampling error	Errors arising during the course of all survey activities other than sampling. Non-sampling errors tend to lead to bias in measurements and are very difficult to quantify.
Peak coincidence factor	The percentage of measure demand savings that coincide in time with the annual peak demand of the entire electricity system.
Peak demand savings	The demand savings that coincide in time with the expected annual peak demand period of the entire electricity system.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	The error in measurement due to the fact that measurements are taken from a subset of the population and not the entire population.
Realization rate	The ratio of evaluated savings to tracked savings.
Sample size	The number of observations or replicates included in a statistical sample.
Secondary market impacts	Energy consumption of appliances that would have been transferred to the secondary market if said appliances had not been retired.
Tracked savings	Gross and net savings calculated based on various parameters such as number of participants or units installed or sold, unitary savings values, installation rates, interactive effects, and the net-to-gross ratio. Those parameters, with the exception of the number of participants or units installed or sold, are obtained from the previous evaluation.
Unitary savings	Energy or peak demand savings established on a unitary basis. This unit can either be a product (e.g., an 8 W LED lamp), a capacity (e.g., one-ton capacity of an air-source heat pump) or a participant (e.g., one participant taking part in a behaviour-based program).

TABLE OF CONTENTS

EXECUTIVE SUMMARY	IX
INTRODUCTION	1
1 BER OVERVIEW	2
1.1 BER Description	2
1.2 Follow-up on Past Evaluation Report Recommendations	3
1.3 Participation History	4
2 BER EVALUATION APPROACH	9
3 BER PARTICIPANT AND DISTRIBUTOR PERSPECTIVES	14
3.1 Participant Awareness and Motivations	14
3.2 Participant Satisfaction	14
3.3 Distributor Satisfaction with Instant Rebates	17
3.4 Distributor Successes and Challenges with Instant Rebates	18
4 IMPACT EVALUATION FOR MAIL-IN	20
4.1 Tracking Sheet Audit	20
4.2 Gross Savings	20
4.2.1 Adjustment Ratios	20
4.2.2 Interactive Effects	22
4.2.3 Effective Useful Life	23
4.2.4 Evaluated Gross Savings	26
4.3 Net Savings	31
4.3.1 Free-ridership	31
4.3.2 Spillover	32
4.3.3 Net-to-gross Ratio Calculation	32
4.3.4 Evaluated Net Savings	33
4.4 Realization Rate	36
5 IMPACT EVALUATION FOR INSTANT REBATES	37
5.1 Tracking Sheet Audit	37
5.2 Gross Savings	37
5.2.1 Summary of Adjustments to Gross Energy Savings	37
5.2.2 In-service Rates	37
5.2.3 Peak Demand Savings	38
5.2.4 Interactive Effects	38

5.2.5	Effective Useful Life	38
5.2.6	Evaluated Gross Savings	40
5.3	Net Savings.....	43
5.3.1	Free-ridership.....	43
5.3.2	Net-to-gross Ratio Calculation	45
5.3.3	Evaluated Net Savings.....	46
5.4	Realization Rate.....	48
6	OVERALL BER RESULTS.....	49
7	BER MARKET EVOLUTION	50
7.1	Market Indicators – LED Lighting	50
7.1.1	Market Shares of Lamp Technologies	50
7.1.2	Market Shares of LED Fixture Types	52
7.1.3	BER Instant Rebates Rebated LED Lighting Units	53
7.1.4	Retail LED Lighting Prices.....	54
7.1.5	BER Participating Distributor Outlook – LED Lighting.....	55
7.1.6	Free-ridership Levels – LED Lighting	56
7.2	Codes and Standards.....	56
7.3	Market Evolution Summary.....	57
8	BER KEY FINDINGS AND RECOMMENDATIONS	60
	CONCLUSION.....	63

LIST OF TABLES

Table 1: Summary of Existing Residential Program Evaluation	ix
Table 2: Overall 2021 Efficient Product Rebates Participation and Evaluated Savings	x
Table 3: 2021 Mail-in NTGRs.....	xiii
Table 4: 2021 Instant Rebates NTGRs	xiii
Table 5: Comparison of 2021 BER Tracked and Evaluated Savings at the Generator	xiv
Table 6: Types of Evaluations Conducted for Each Program Component, 2021	1
Table 7: Implementation Status of Past Recommendations for BER	4
Table 8: 2021 BER Evaluation Approach	10
Table 9: 2021 Distributor Satisfaction with Instant Rebates (10-point Scale).....	18
Table 10: 2021 Mail-in Adjustment Ratios.....	22
Table 11: 2021 Mail-in Equivalent EUL Values by Lighting Product	23
Table 12: 2021 Mail-in Equivalent EUL Values by Non-lighting Product.....	24
Table 13: Evaluated 2021 Mail-in Gross Energy and Peak Demand Savings.....	28
Table 14: 2021 Mail-in Free-ridership.....	32
Table 15: 2021 Mail-in NTGRs.....	33
Table 16: Evaluated 2021 Mail-in Net Energy and Peak Demand Savings	34
Table 17: Evaluated 2021 Mail-in GHG Emission Reductions.....	35

Table 18: Comparison of 2021 Mail-in Tracked and Evaluated Savings at the Generator	36
Table 19: 2021 Instant Rebates Interactive Effects Factor Calculation Results	38
Table 20: 2021 Instant Rebates Equivalent EUL Values	39
Table 21: Evaluated 2021 Instant Rebates Gross Energy and Peak Demand Savings	41
Table 22: 2021 Instant Rebates Free-ridership	44
Table 23: 2021 Instant Rebates NTGR	45
Table 24: Evaluated 2021 Instant Rebates Net Energy and Peak Demand Savings	47
Table 25: Evaluated 2021 Instant Rebates GHG Emission Reductions.....	48
Table 26: Comparison of 2021 Instant Rebates Tracked and Evaluated Savings at the Generator	48
Table 27: Comparison of 2021 BER Tracked and Evaluated Savings at the Generator	49
Table 28: Average Rebate Values Under Instant Rebates for LED Linear Fixtures and Lamps, 2015-2021.....	55
Table 29: Free-ridership Levels for Instant Rebates on LED Linear Lamps and Fixtures, 2014-2021.	56
Table 30: 2021 Analysis of Key Factors in Program Planning	58
Table 31: Overall 2021 Efficient Product Rebates Participation and Evaluated Savings	63

LIST OF FIGURES

Figure 1: 2021 BER Targets and Evaluated Results	xi
Figure 2: Overview of Participation in Mail-in, 2015-2021.....	xi
Figure 3: Instant Rebates Measures Sold, 2015-2021	xii
Figure 4: Evolution of BER Net Savings, 2015-2021	xii
Figure 5: BER Program Overview	2
Figure 6: Overview of Participation in Mail-in, 2015-2021.....	4
Figure 7: Distribution of 2021 Mail-in Gross Energy Savings by Measure Category	5
Figure 8: Instant Rebates Measures Sold, 2013-2021	6
Figure 9: Instant Rebates Measures Sold by Product Category, 2020-2021	6
Figure 10: Distribution of 2021 Instant Rebates Gross Savings by Measure Category	7
Figure 11: Evolution of BER Gross Savings, 2015-2021	8
Figure 12: 2021 Participant Satisfaction with Mail-in (10-point Scale)	15
Figure 13: 2021 ENS Staff Interactions and Application Process (10-point Scale)	16
Figure 14: 2021 Participant Satisfaction with Instant Rebates (10-point Scale)	17
Figure 15: 2021 Mail-in Tracked and Evaluated Gross Energy Savings.....	30
Figure 16: 2021 Mail-in Tracked and Evaluated Gross Peak Demand Savings.....	31
Figure 17: 2021 Instant Rebates Tracked and Evaluated Gross Energy Savings.....	42
Figure 18: 2021 Instant Rebates Tracked and Evaluated Gross Peak Demand Savings.....	43
Figure 19: Atlantic Canada Commercial and Industrial Lighting Shipments by Technology (%), 2011-2020.....	51
Figure 20: Atlantic Canada Commercial and Industrial LED Lighting Shipment Shares by Type (%), 2011-2020.....	52
Figure 21: BER Instant Rebates Incented LED Units, 2014-2021	53
Figure 22: Average Retail Prices of Rebated LED Lamps and Fixtures, 2015-2021.....	54
Figure 23: 2021 Market Evolution for Commercial LED Lighting	59
Figure 24: 2021 Efficient Product Rebates Targeted and Evaluated Net Energy Savings	64
Figure 25: 2021 Efficient Product Rebates Targeted and Evaluated Net Peak Demand Savings	64

EXECUTIVE SUMMARY

This report presents the 2021 demand-side management (DSM) results of the Efficient Product Rebates program administered by EfficiencyOne (EOne). This program is comprised of the Business Energy Rebates (BER) program component. Through its Instant Rebates and Mail-in services, BER provides financial incentives in the form of prescriptive rebates or financing to business, non-profit, and institutional (BNI) participants to encourage reductions in electricity consumption and demand.

Evaluation Approach

The evaluation was aimed at calculating program component gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided greenhouse gas (GHG) emissions. Table 1 summarizes the type of evaluation conducted for the program component and the corresponding methodology.

Table 1: Summary of Existing Residential Program Evaluation

Program Component	Evaluation Type			Methodology
	Impact	Process	Market	
BER	Comprehensive		X	› Instant Rebates and Mail-in participant survey › Distributor interviews › Instant Rebates unitary savings review › Tracking sheet audit › Measure Assessment update › Calculations using evaluation results › GHG emission reduction calculations › EUL update › Market evolution and characterization study

Program Performance

Table 2 presents the participation levels, net-to-gross ratios (NTGRs), as well as evaluated gross and net savings at the generator for each service and for the Efficient Product Rebates program as a whole.

Table 2: Overall 2021 Efficient Product Rebates Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
Mail-in							
Energy Savings	301	Projects	16.366	GWh	0.74	12.111	GWh
Lifetime Energy Savings			258.596	GWh	0.74	191.361	GWh
Peak Demand Savings			2.433	MW	0.74	1.800	MW
Instant Rebates							
Energy Savings	188,956	Products sold	32.596	GWh	0.66	21.380	GWh
Lifetime Energy Savings			452.397	GWh	0.66	296.876	GWh
Peak Demand Savings			5.546	MW	0.65	3.600	MW
Total							
Energy Savings			48.962	GWh	0.684	33.491	GWh
Lifetime Energy Savings			710.993	GWh	0.687	488.237	GWh
Peak Demand Savings			7.979	MW	0.677	5.401	MW

Efficient Product Rebates was aimed at achieving 35.681 GWh in net electrical energy savings and 7.236 MW in net peak demand savings at the generator for 2021. The program achieved 33.491 GWh in net electrical energy savings and 5.401 MW in net peak demand savings at the generator in 2021. Therefore, the program fell short of achieving planned energy and peak demand savings. Instant Rebates was the largest contributor to total program net energy and peak demand savings.

The following subsections present evaluation results at the program component level.

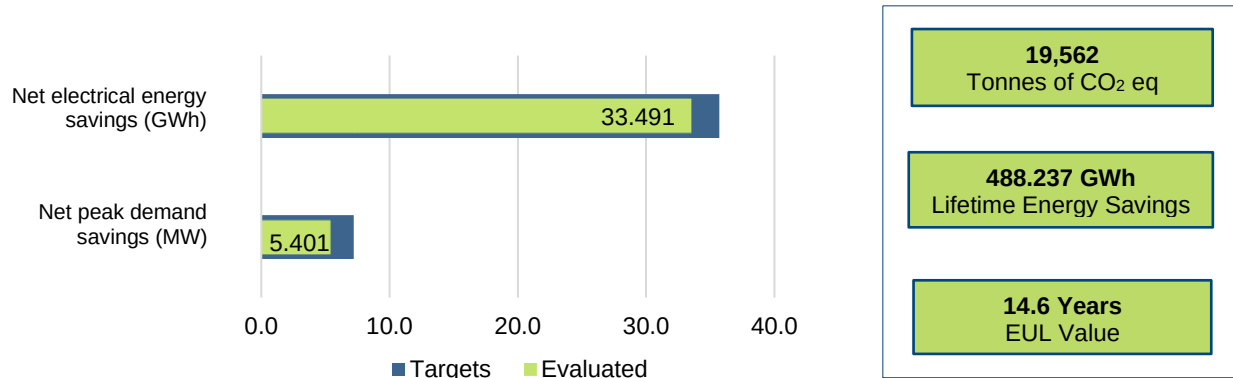
BER Findings and Recommendations

This subsection presents the key findings and recommendations from the BER evaluation.

2021 BER-Finding: BER net electrical energy and peak demand savings fell short of targets.

As outlined in Figure 1, BER net electrical energy and peak demand savings fell short of targets by 6% and 25% respectively. The figure also includes the evaluated tonnes of CO₂ eq in annually avoided GHG emissions, lifetime energy savings, and the EUL value.

Figure 1: 2021 BER Targets and Evaluated Results



2021 BER-Finding: Participation increased for both Mail-in and Instant Rebates in 2021, and total gross energy and peak demand savings increased compared to 2020 levels.

Figure 2 below illustrates the evolution of Mail-in in terms of participation and average gross energy savings per participant from 2015 to 2021, while Figure 3 illustrates the number of measures sold through Instant Rebates from 2015 to 2021. Figure 4 further below illustrates the evolution of overall BER net savings during the same period.

Figure 2: Overview of Participation in Mail-in, 2015-2021

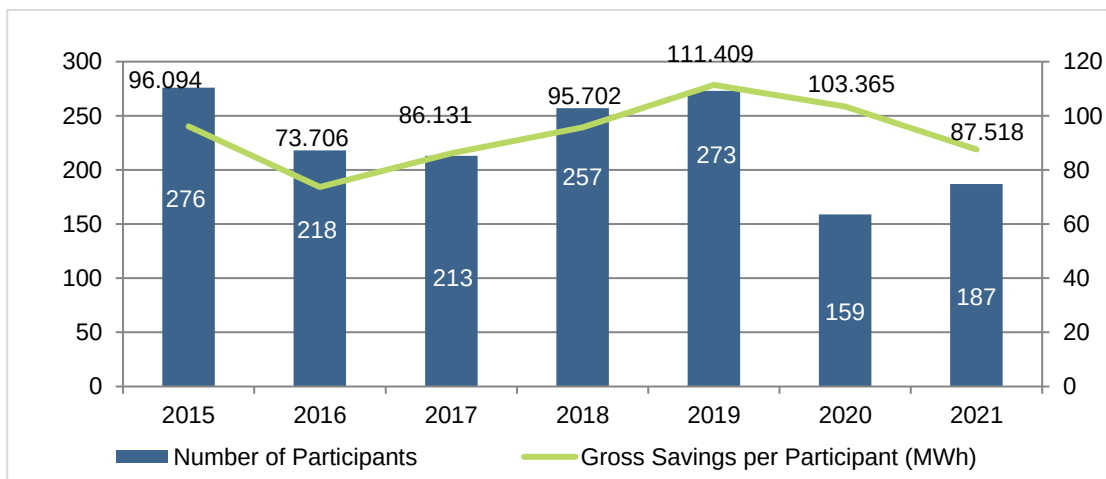


Figure 3: Instant Rebates Measures Sold, 2015-2021

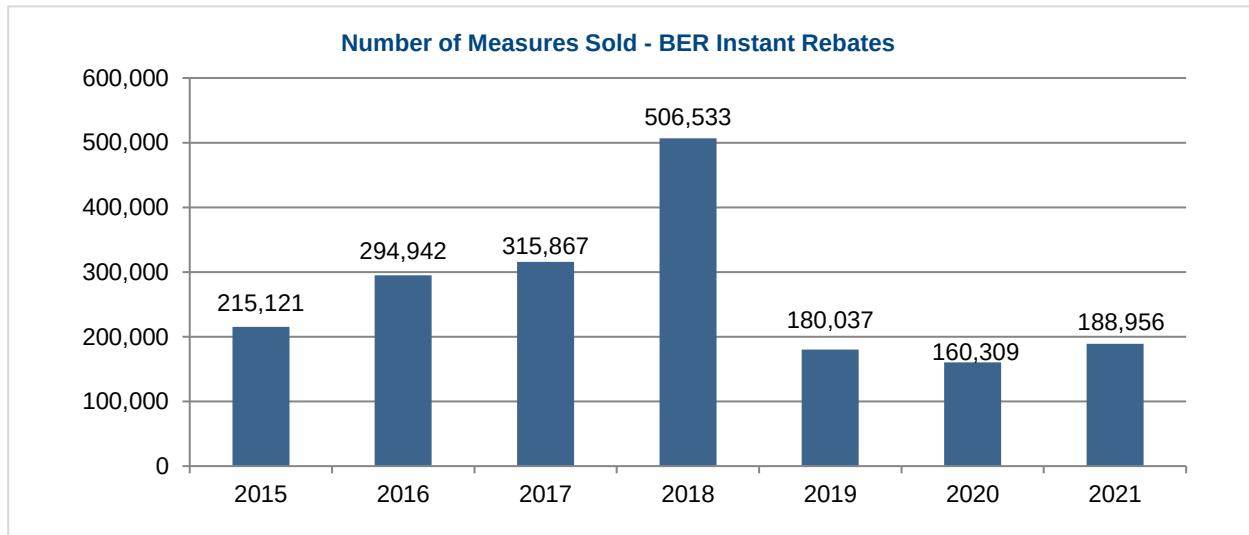
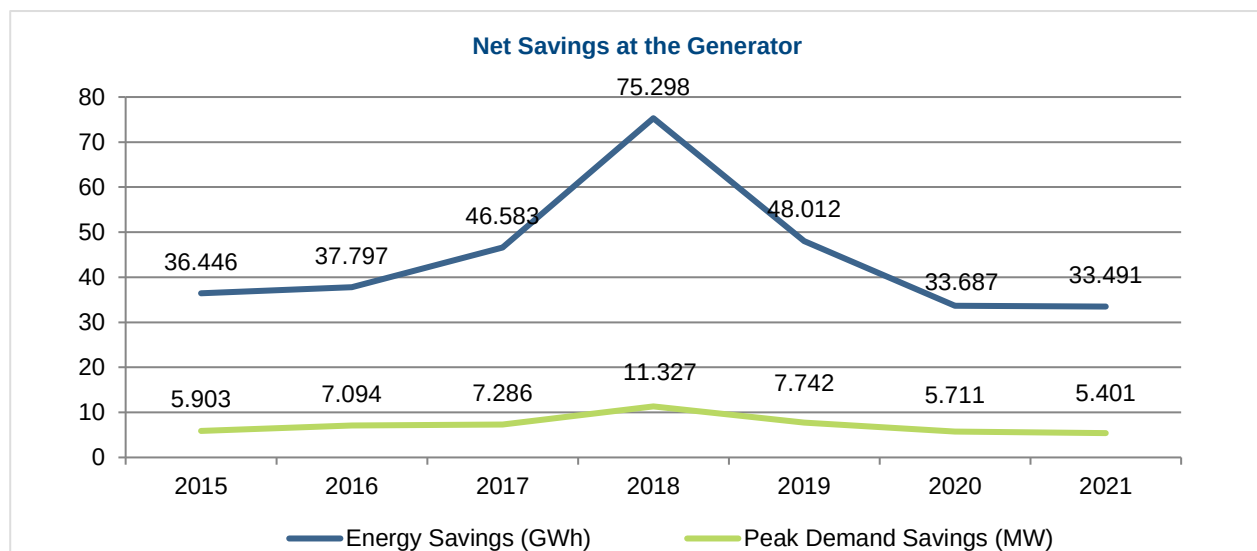


Figure 4: Evolution of BER Net Savings, 2015-2021



2021 BER-Finding: Overall satisfaction with BER is high among participants of both services and among Instant Rebates distributors.

2021 BER-Finding: Following the on-site visits, the Evaluator made downward adjustments to energy and peak demand savings for Mail-in. The Mail-in lighting project reviews and site visits results revealed that the parameters used to determine tracked savings, such as hours of use (HOU) and peak coincidence factors, are often incorrectly reported by participants. This could be mitigated by adjusting the lighting measure worksheet.

2021 BER – Recommendation 1: The Evaluator recommends that EOne consider changes to the lighting measure worksheet to improve the accuracy of tracked parameters, notably the fields used to collect information on the hours of use, peak coincidence factors, and heating systems. The Evaluator provides examples of the types of changes recommended in Subsection 5.2.1 of this report.

2021 BER-Finding: Average free-ridership levels for both Mail-in and Instant Rebates increased in 2021, while spillover for Mail-in remained nil.

Table 3 and Table 4 summarize these effects and the 2021 NTGRs for Mail-in and Instant Rebates respectively.

Table 3: 2021 Mail-in NTGRs

Measure Category	Free-ridership	Spillover	NTGR
All	26%	0%	0.74

Table 4: 2021 Instant Rebates NTGRs

Measure	Free-ridership	NTGR
LED Linear Fixtures	40%	0.60
LED Linear Lamps	30%	0.70
LED Outdoor Fixtures	35%	0.65
Other Measures	0%	1.00

2021 BER-Finding: The BNI LED lamp market has reached maturity and is now in a levelling-off phase as inferred by the decline in shipment shares in conjunction with price stability.

2021 BER-Finding: The LED fixtures market is approaching maturity yet still has some growth potential as suggested by increasing LED fixture shares, stabilizing prices, and distributors' opinions on the popularity of the products and sales trends.

2021 BER-Finding: Evaluated net energy and peak demand savings were respectively 10% and 13% lower than the values tracked by EOne. Table 5 compares the tracked and evaluated results.

Table 5: Comparison of 2021 BER Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	49.141	GWh	0.76	37.345	GWh	90%
Evaluation Results	48.962	GWh	0.68	33.491	GWh	
Peak Demand Savings						
Tracked Savings by EOne	8.282	MW	0.75	6.227	MW	87%
Evaluation Results	7.979	MW	0.68	5.401	MW	
*Different NTGRs were established for Mail-in and Instant Rebates. The average NTGR values presented in this table correspond to the ratios of net savings to gross savings for both services.						

INTRODUCTION

EfficiencyOne (EOne), an independent, non-profit organization, is responsible for helping Nova Scotians improve the energy efficiency of their homes and workplaces by designing, marketing, and delivering energy efficiency and conservation programs for Nova Scotians. EOne receives funding for its electricity demand-side management (DSM) activities from Nova Scotia Power (NS Power) ratepayers.

EOne has a DSM portfolio of three residential programs and three business, non-profit, and institutional (BNI) programs that are marketed to Nova Scotians through the Efficiency Nova Scotia (ENS) franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2021 DSM program portfolio. In addition, Econoler conducted research to inform EOne's approach to market transformation and treatment of codes and standards.

This evaluation report relates to the Efficient Product Rebates program, which is comprised of one component: Business Energy Rebates (BER). Table 6 below lists the Efficient Product Rebates program components and the type of evaluation conducted in 2021. A comprehensive impact evaluation involves reviewing the following four key elements: (1) the baseline definition; (2) the savings calculation methodology; (3) the values of the parameters used to calculate savings; and (4) net-to-gross ratios (NTGRs).

Table 6: Types of Evaluations Conducted for Each Program Component, 2021

Program	Program Component	2021		
		Process	Market	Impact
Efficient Product Rebates	BER		X	Comprehensive

To carry out this evaluation, Econoler collaborated with Equilibrium Engineering and Narrative Research. Econoler served as team leader and was involved in every aspect of the evaluation. Specifically, Econoler was in charge of coordinating and supervising all activities, conducting final reviews of all data-collection instruments, performing process and market evaluations and impact evaluation calculations, as well as preparing and reviewing evaluation reports. Equilibrium Engineering conducted on-site visits and also contributed to certain impact evaluation analyses. Narrative Research conducted interviews and surveys with participants and partners, as well as analyzed and reported on the data collected from those activities. Throughout this report, this team is referred to as the Evaluator.

Key findings, electrical first-year and lifetime energy savings, peak demand savings, and avoided greenhouse gas (GHG) emissions are presented in this report.

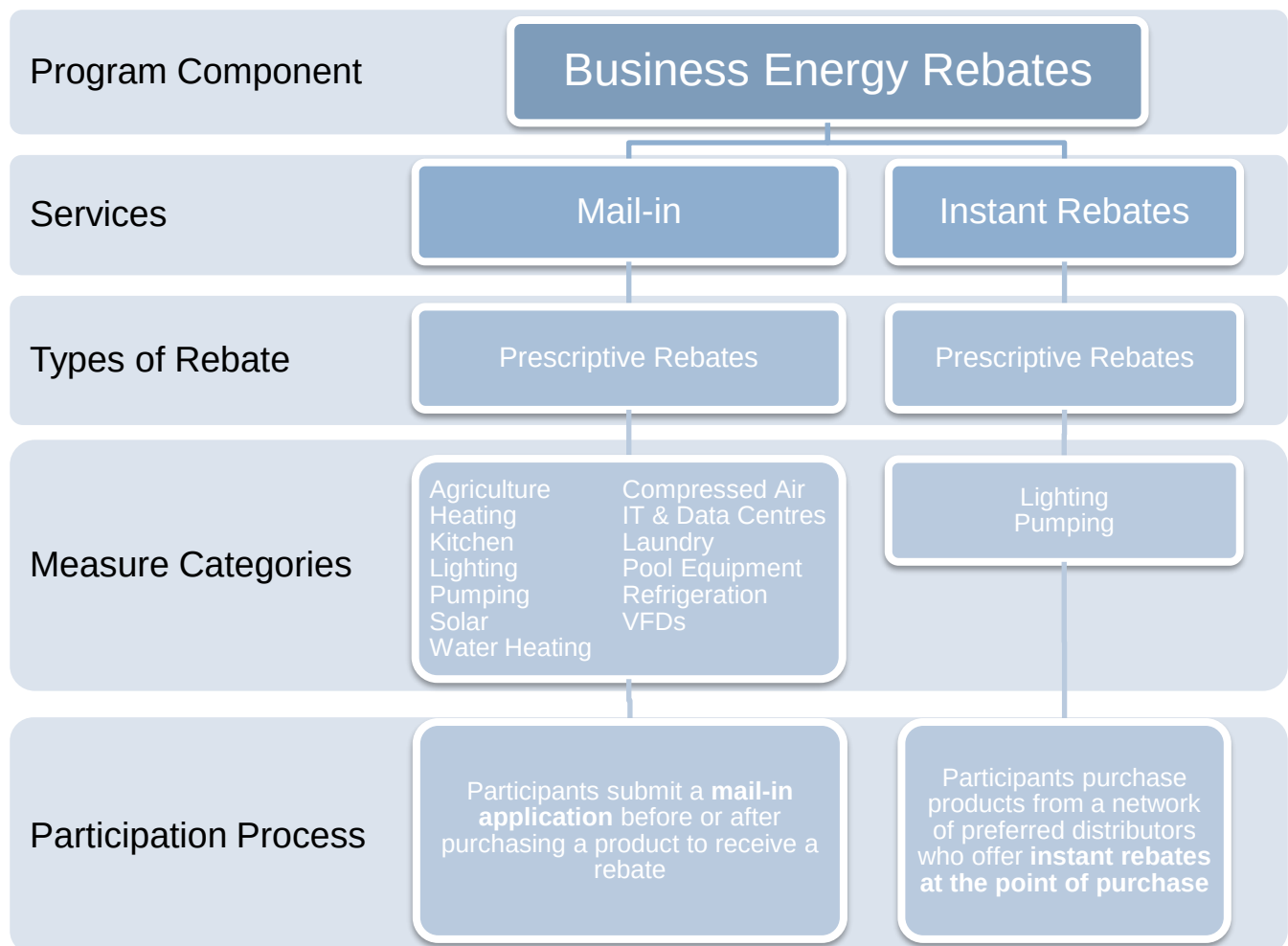
1 BER OVERVIEW

This section describes Business Energy Rebates (BER), follows up on past evaluation recommendations, and presents participation history.

1.1 BER Description

BER provides financial incentives in the form of prescriptive rebates or financing to business, non-profit, and institutional (BNI) participants to foster reductions in electricity consumption and peak demand. All businesses, non-profits, and institutions in Nova Scotia are eligible. Figure 5 presents an overview of the program component.

Figure 5: BER Program Overview



The term prescriptive rebate refers to a particular rebate value that is calculated prior to a participant purchasing an eligible measure. If a given measure or technology demonstrates energy savings potential, a corresponding rebate value is applied to the purchase price of said measure or technology.

Measures offered through BER must meet specific criteria including minimum efficiency/efficacy values as well as industry standards such as ENERGY STAR® certified performance levels or those established by the Design Lights Consortium (DLC) and the National Electrical Manufacturers Association.

Rebates offered through BER are delivered through two services, namely through Mail-in or Instant Rebates. Instant Rebates reaches a greater number of participants and offers quick and convenient access to BER. Conversely, Mail-in allows for better project-level control since more participant details are provided to EOne. All technologies are available through Mail-in, while only certain lighting and pumping technologies are eligible through Instant Rebates.

Instant Rebates is delivered through a network of participating distributors within the Province of Nova Scotia. These distributors play a key role in promoting Instant Rebates to end users. They also provide customer service for measures that are only eligible through Mail-in by sharing their expertise and assisting with completing Mail-in applications.

In 2021, BER was advertised through presentations to local industry associations, marketing materials for specific BNI segments, articles in trade association newsletters, and a media campaign to promote the contractors registered in the Preferred Partners Network. Information was also made available in distributor branches. EOne also used business development staff to promote BER services to potential BNI participants.

Although BER program delivery was not directly impacted by public health and government directives regarding the COVID-19 pandemic, the 2021 participation level was affected as it was in 2020, particularly in Mail-in due to supply chain delays. Mail-in also saw lower than usual participation in the retail and hospitality sectors.

In an effort to increase participation, EOne increased the rebate amounts on select lighting and heating measures during the last quarter of 2021.

BER was aimed at achieving 35.681 GWh in net electrical energy savings and 7.236 MW in net peak demand savings at the generator in 2021.

1.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated BER in previous years and issued improvement recommendations. Table 7 provides one past recommendation that has been carried forward; no recommendation was issued in 2020.

The Evaluator notes that the implementation of the outstanding recommendation has been delayed because of the COVID-19 pandemic.

Table 7: Implementation Status of Past Recommendations for BER

#	Past Recommendations	Status	Comments
2018 BER-R3	Investigate ways to liaise more clients with non-lighting contractors.	Deferred	Due to COVID-19 constraints, EOne was unable to offer training to lighting distributors in 2021. EOne continues to work closely with the Efficiency Trade Network (ETN) ¹ team to promote training and engagement opportunities for non-lighting contractors.

1.3 Participation History

BER Mail-in

In 2021, 301 Mail-in projects were implemented by 187 unique participants.² Figure 6 below illustrates how Mail-in participation has evolved since 2015. The number of participating businesses increased in 2021, with 18% more participating businesses compared to 2020. Despite this increase, participation in 2021 was still lower than in 2019 and the years prior, and the gross savings achieved per participant decreased in 2021 compared to 2020, reaching 87.518 MWh per participant. Program staff have suggested that the main reason for these lower participation results is related to the persistence of the COVID-19 pandemic. As a response to the pandemic and to stimulate program participation, rebate amounts were increased on select lighting and heating measures at the end of 2021. This change was however not sufficient for Mail-in to return to its pre-pandemic levels of participation.

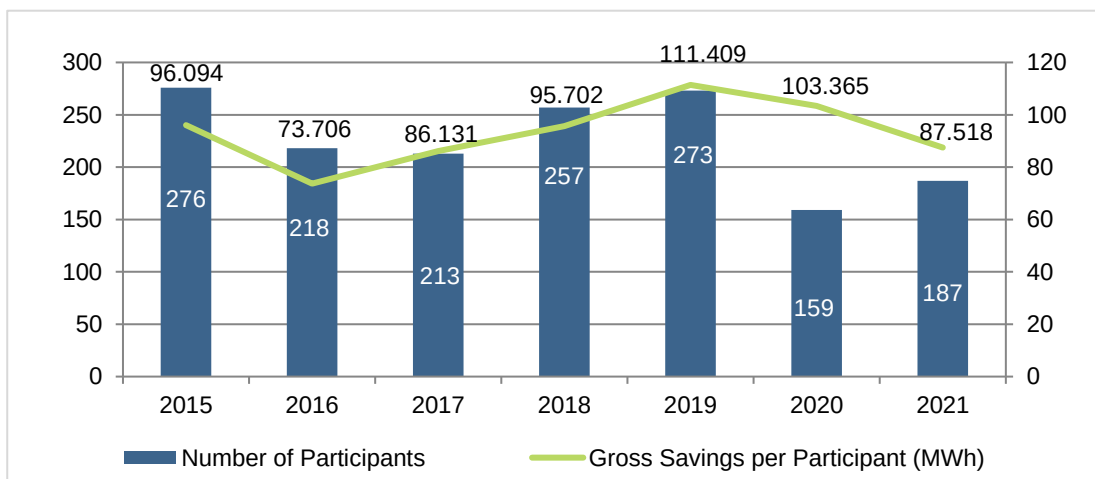
Figure 6: Overview of Participation in Mail-in, 2015-2021


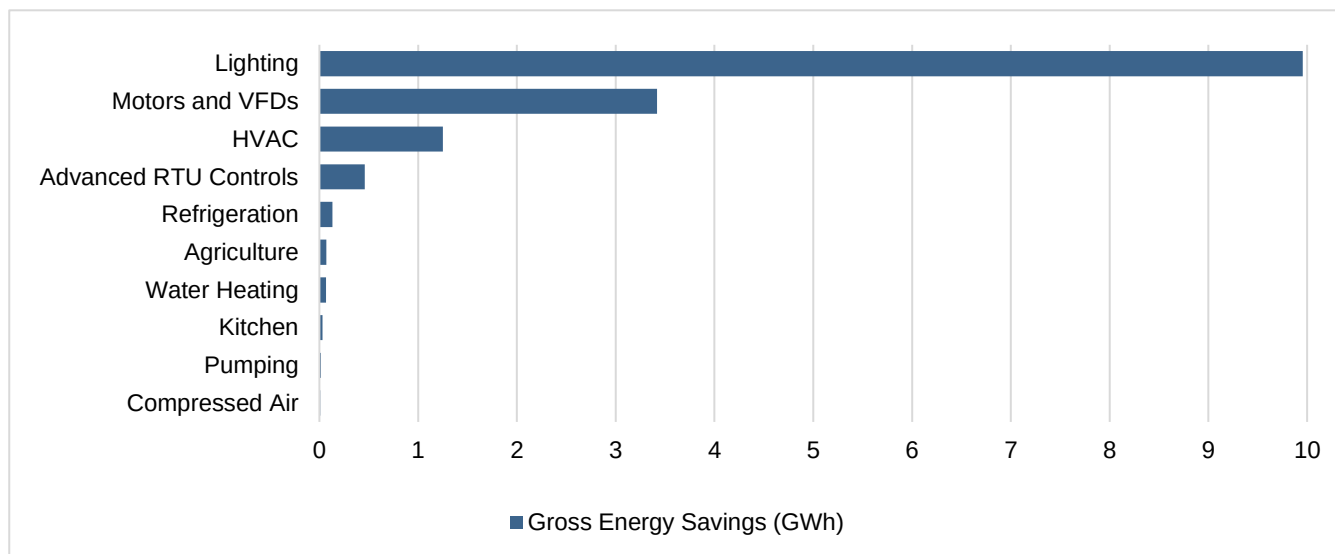
Figure 7 below illustrates the distribution of gross savings among Mail-in measure categories. With 64% and 22% of gross savings being respectively generated by the lighting measure category as well as the

¹ The ETN has since been renamed the "Preferred Partners Network".

² The number of unique participants in Mail-in corresponds to the number of businesses that participated in the service.

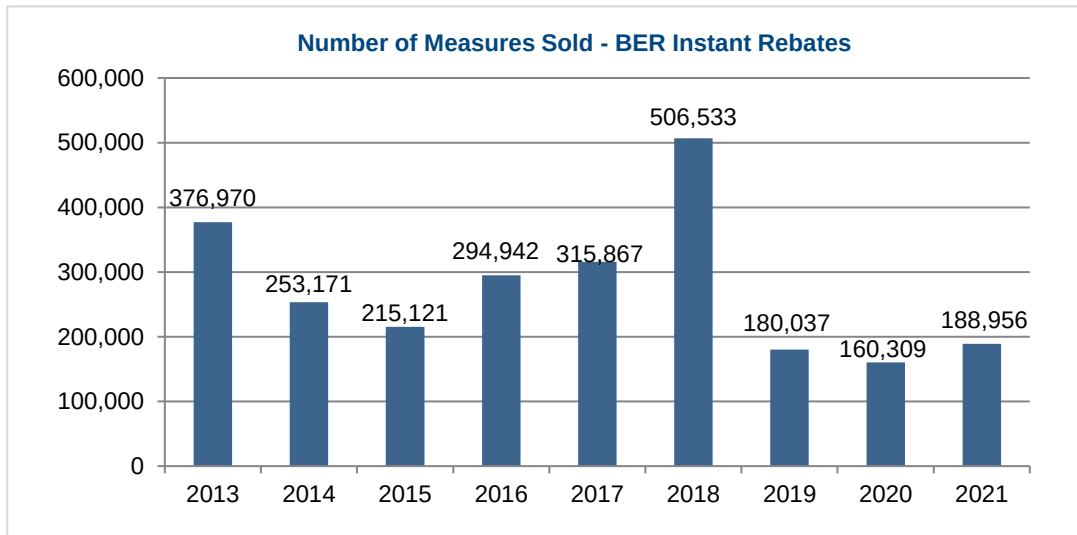
motor and VFD measure categories, these two categories account for most Mail-in savings. The Evaluator has observed a decrease in the proportion of Mail-in savings generated by lighting measures over the past two years. In 2019 and 2020, respectively 81% and 71% of gross energy savings were attributed to lighting. The decrease in the proportion of energy savings generated by lighting in 2021 is mainly due to a 10% decrease in energy savings from lighting measures compared to 2020, which in turn is partly explained by participants implementing smaller lighting projects than in previous years. The pool, IT, and data centre measure categories were not included in Figure 7 since no projects in those measure categories were submitted in 2021.

Figure 7: Distribution of 2021 Mail-in Gross Energy Savings by Measure Category



BER Instant Rebates

Although participant information tracking has improved over the past three years, the available data collected by distributors make it difficult to reliably establish the total number of Instant Rebates participants. The database does indicate the total number of units rebated through the program. Figure 8 below indicates that 188,956 measures were rebated through Instant Rebates in 2021, an 18% increase compared to 2020 levels. The number of measures sold in 2021 was slightly above 2019 levels, indicating a resumption of activities due in part to the adaptation of the program and its partners to the ongoing pandemic.

Figure 8: Instant Rebates Measures Sold, 2013-2021


As outlined in Figure 9 below, participation levels for the two most popular product categories i.e. light emitting- diode (LED) linear lamps and LED linear fixtures, significantly increased (21% and 12% respectively) from 2020. All other product categories had lower participation levels than in 2020. LED directional and architectural fixtures and booster pumps had the largest decreases (31% and 41% respectively) in participation levels.

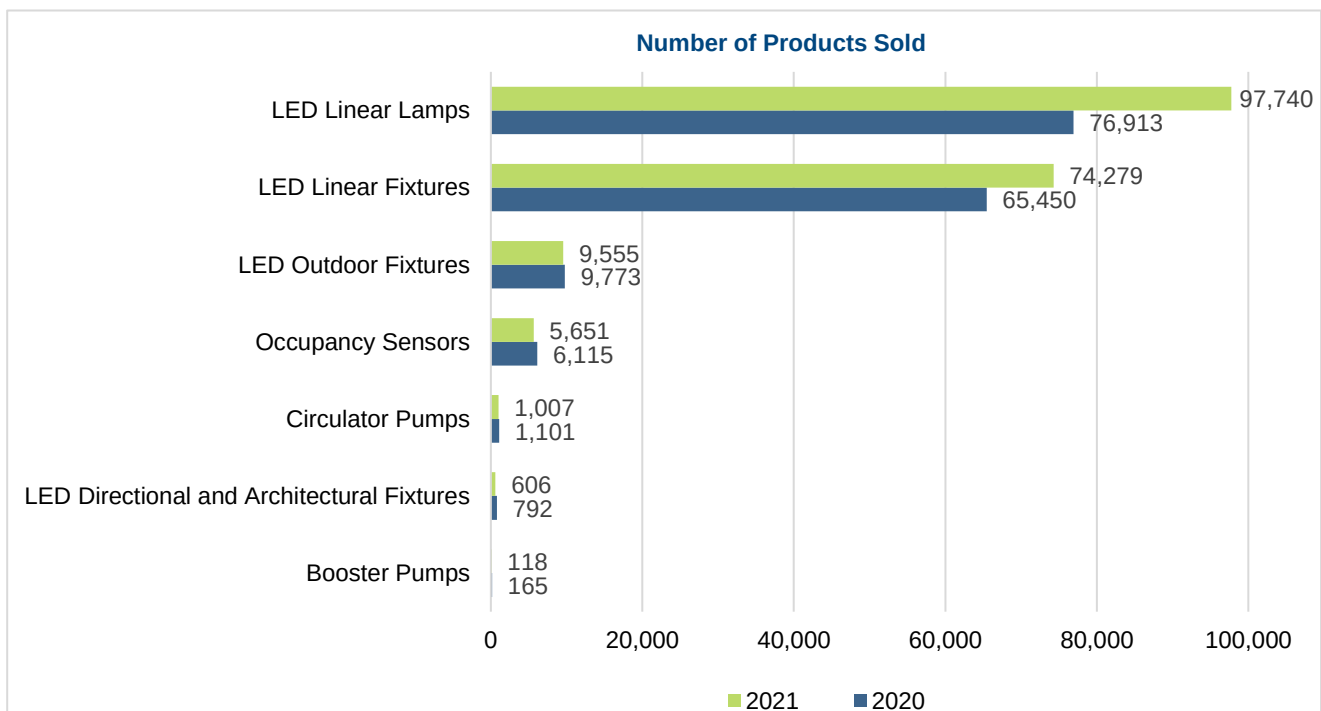
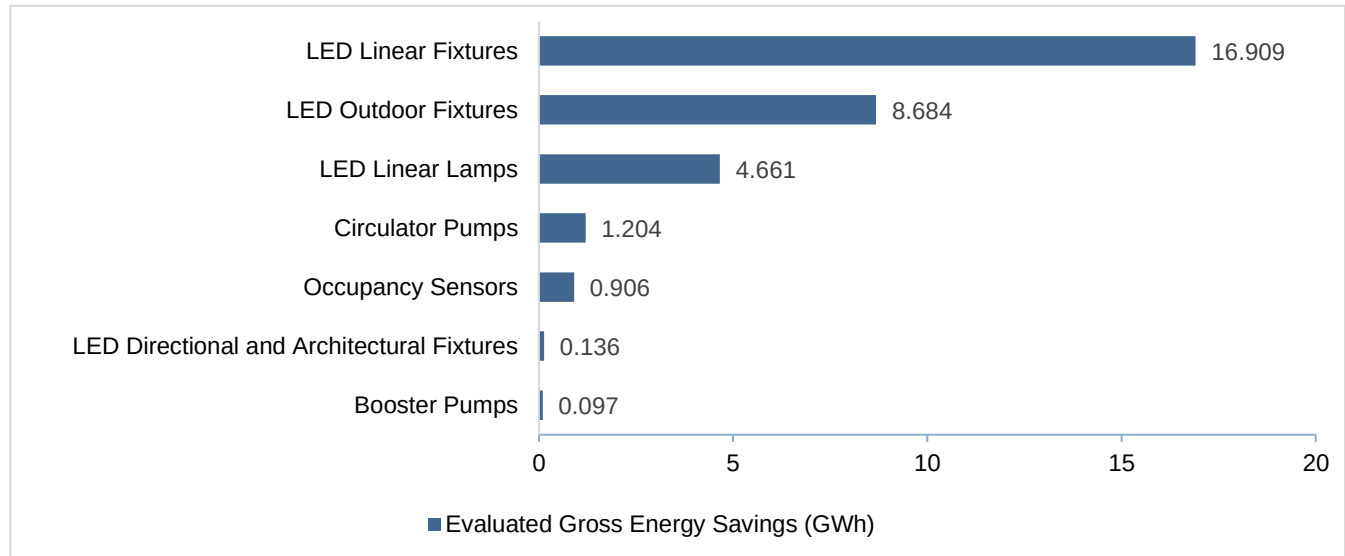
Figure 9: Instant Rebates Measures Sold by Product Category, 2020-2021


Figure 10 provides an overview of the distribution of Instant Rebates gross savings among the various pump and lighting measures. In 2021, LED linear fixtures generated the largest share of gross savings (52%), followed by LED outdoor fixtures (27%) and LED linear lamps (14%).

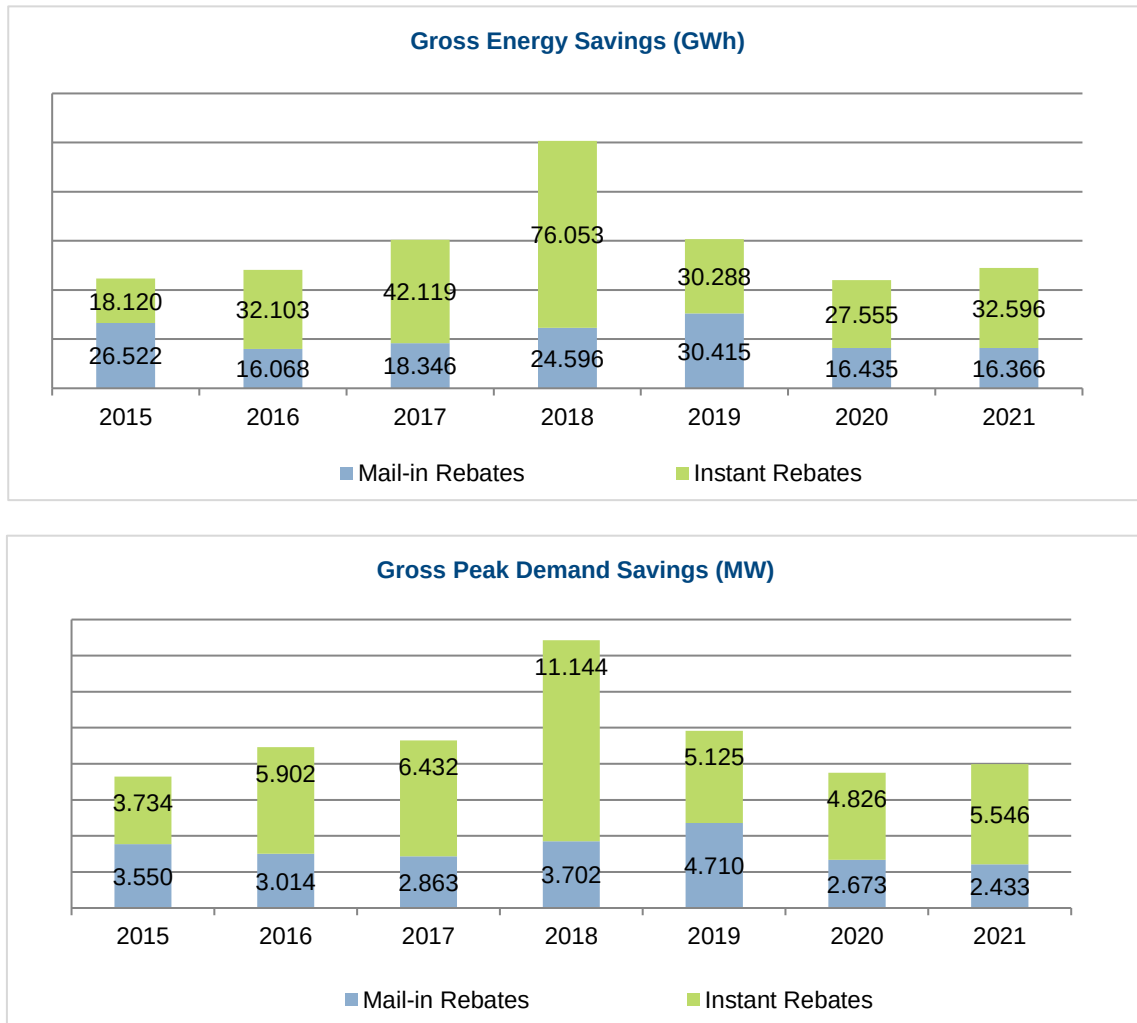
Figure 10: Distribution of 2021 Instant Rebates Gross Savings by Measure Category



BER Overall

As presented in Figure 11 below, BER generated a total of 48.962 GWh in gross energy savings at the generator in 2021, which represents a 10% increase compared to 2020 results. In 2021, gross peak demand savings totalled 7.979 MW for both Mail-in and Instant Rebates, representing a 6% increase from 2020. This is due to a slight resumption in participation in the context of the COVID-19 pandemic, especially for Instant Rebates, which resulted in more businesses purchasing energy efficiency products.

Figure 11: Evolution of BER Gross Savings, 2015-2021



2 BER EVALUATION APPROACH

The 2021 BER evaluation comprised a comprehensive impact evaluation as well as a market evaluation. The main objectives of the 2021 BER evaluation were as follows:

- › Collect information on participant and partner perspectives
- › Calculate gross and net BER results (for both Mail-in and Instant Rebates), namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions³
- › Analyze the evolution of LED lamps and fixtures in the commercial lighting market

The Evaluator identified key research questions aimed at achieving these objectives. Table 8 below outlines the evaluation objectives and maps them to the Evaluator's research questions, methods, and sample sizes (n). Each method is described further below.

³ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

Table 8: 2021 BER Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Collect information on participant and partner perspectives	› How do participants become aware of BER Instant Rebates? › How do participants become aware of BER Mail-in? › What is the level of satisfaction with BER among participants and distributors? › How could EOne improve BER Instant Rebates? › How could EOne improve BER Mail-in?	› Mail-in participant survey (n=42) › Instant Rebates participant survey (n=50) › Distributor interviews (n=8)
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › What are the appropriate baseline parameters and the unitary savings for each Instant Rebates product category? › Are the gross savings calculated for a sample of projects consistent with both EOne savings calculation methods and the measures observed on site? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Measure Assessment update › Site visits and desk reviews (n=40) › Calculations using evaluation results
Calculate net results	› What is the Instant Rebates free-ridership level for 2021? › What is the Mail-in free-ridership level for 2021? › What is the Mail-in spillover level for 2021? › What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What are the net avoided GHG emissions in CO₂ eq for BER?	› Mail-in participant survey (n=42) › Instant Rebates participant survey (n=50) › Distributor interviews (n=8) › Site visits (n=40) › Calculations using evaluation results › GHG emission reduction calculations
Analyze the market evolution of LED lamps	› How has the commercial lighting market evolved since 2019?	› Market evolution and characterization study

Mail-in Participant Survey

In November and December 2021, Narrative Research conducted a telephone survey with a total of 42 Mail-in participants. To meet the sampling targets, the Evaluator included participants from 2020 and 2021 in the survey sample. The average length of the survey was 16 minutes. The survey sample of 42 participants yields a maximum margin of error of $\pm 12.0\%$ at a confidence level of 90%. Although the margin of error is higher than the targeted $\pm 10\%$, the Evaluator finds it acceptable for the purpose of this evaluation.

The questionnaire is presented in Appendix I and complete survey results are outlined in Appendix II.

Instant Rebates Participant Survey

In November and December 2021, Narrative Research conducted a telephone survey with a total of 50 Instant Rebates participants. The average length of the survey was 14 minutes. The questionnaire is presented in Appendix III and complete survey results are outlined in Appendix IV. Since it is not possible to obtain a complete list of Instant Rebates participants due to the nature of this service, the margin of error is calculated using a conservative assumption that the service population is infinite. Drawing a random sample of 50 from an infinite population yields a margin of error of 11.8% at a 90% confidence level. Although the margin of error is higher than the targeted $\pm 10\%$, the Evaluator finds it acceptable for the purpose of this evaluation.

Instant Rebates Interviews with Distributors

In October and November 2021, Narrative Research conducted eight interviews with Instant Rebates participating distributors. The guide used for the distributor interviews is presented in Appendix V.

Tracking Sheet Audit

Prior to performing the savings calculation review, the Evaluator performed an audit of the final 2021 tracking sheets to ensure they were complete and the entered data were consistent. The detailed protocols used for the Mail-in and Instant Rebates tracking sheet audits and the results obtained are presented in Appendix VI and Appendix XI respectively.

Site Visits and Desk Reviews

In the fall of 2021, Equilibrium Engineering conducted 40 on-site visits at the facilities of participants who received a rebate through Mail-in for a lighting project. These on-site visits served to inform the savings reviews conducted on sampled projects and collect information on spillover levels. The on-site visit sampling methodology and protocol are presented in Appendix VII.

Unitary Savings Review

As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the equations, parameters, and assumptions used to establish savings values for eight BER measures. In 2021, unitary peak demand savings values for booster pumps offered under Instant Rebates were updated based on project data from eight Custom Retrofit booster pump projects, and unitary savings values for advanced rooftop unit (RTU) controls offered under Mail-in were established based on a literature review and a review of tracking sheet data. The 2020-2022 Measure Assessment⁴ was updated accordingly.

EUL Update

As part of the 2020-2022 Measure Assessment activities, the Evaluator also reviewed the effective useful life (EUL) values for all measure categories and recalculated the EUL values of lighting measures for which baseline changes are anticipated during the measure lifetimes.

Calculations Using Evaluation Results

Building on all the above methods and collected data, the Evaluator calculated first-year and lifetime energy and peak demand savings as per the calculation methodologies presented in Section 4 and Section 5 below.

⁴ The 2020-2022 Measure Assessment is a reference document that provides an in-depth review of all parameters necessary to calculate the annual and lifetime gross energy and peak demand savings of most prescriptive measures and some semi-prescriptive measures offered through EOne's DSM program portfolio. In addition, the Measure Assessment includes effective useful life values for all measures offered in EOne's program portfolio. For the evaluations conducted during the 2020-2022 DSM cycle, the Evaluator refers to the values presented in the 2020-2022 Measure Assessment.

GHG Emission Reduction Calculations

To obtain net avoided GHG emissions in CO₂ eq for BER, the Evaluator multiplied the net energy savings by the latest Nova Scotia-specific factor for GHG emissions generated by electricity production. This factor was established using NS Power data.

Note on Margin of Error

For evaluation activities that yield quantitative results based on a sample, the Evaluator aimed to achieve a maximum margin of error of 10% at a confidence level of 90%. This means that if measurements were conducted many times with different samples, the data would be within 10 percentage points above or below the percentage reported 90% of the time. Thus, the margin of error indicates the relative level of precision⁵ of a measurement, while its associated confidence level indicates the probability of a measurement falling within the margin of error.⁶

As part of the BER evaluation, the Evaluator calculated the margins of error for savings adjustment ratios and free-ridership levels. The margins of error are listed alongside results in the applicable sections. Examples of calculations used to establish margins of error are provided in Appendix II of the 2021 DSM Programs Evaluation Executive Summary.

⁵ Precision refers to how reproducible a set of measurements is. However, it does not consider how close the measured values are to the true values; this would refer to accuracy.

⁶ As part of this evaluation, the confidence levels and the margins of error only take random sampling errors into account; they do not reflect non-sampling errors or biases such as data entry errors, inaccurate responses from respondents, or the inability to contact certain people.

3 BER PARTICIPANT AND DISTRIBUTOR PERSPECTIVES

This section summarizes the findings obtained during the Mail-in participant survey, Instant Rebates participant survey, and interviews conducted with Instant Rebates distributors.

3.1 Participant Awareness and Motivations

Mail-in Participants

Awareness about the mail-in rebate primarily stems from contractors (29%), distributors or suppliers (19%), or someone else within participating organizations (14%). One in 10 participants each mentioned having first become aware of the mail-in rebate through a previous experience dealing with ENS or through word-of-mouth from their personal network.

A desire to save on energy costs (43%) remains the primary reason for organizations choosing to implement energy efficient measures, followed by the quality of efficiency products (17%), updating equipment (12%), and becoming more energy efficient (10%).

Instant Rebates Participants

Among business participants aware of Instant Rebates (n=20), most first learned of the service through their distributor (55%). Other sources of awareness far less commonly cited included contractors, someone else within the participating organization, or previous experience with another ENS program.

The purchase of a more energy efficient product was primarily motivated by a desire to improve energy efficiency (32%) and wanting to save on energy costs (23%).

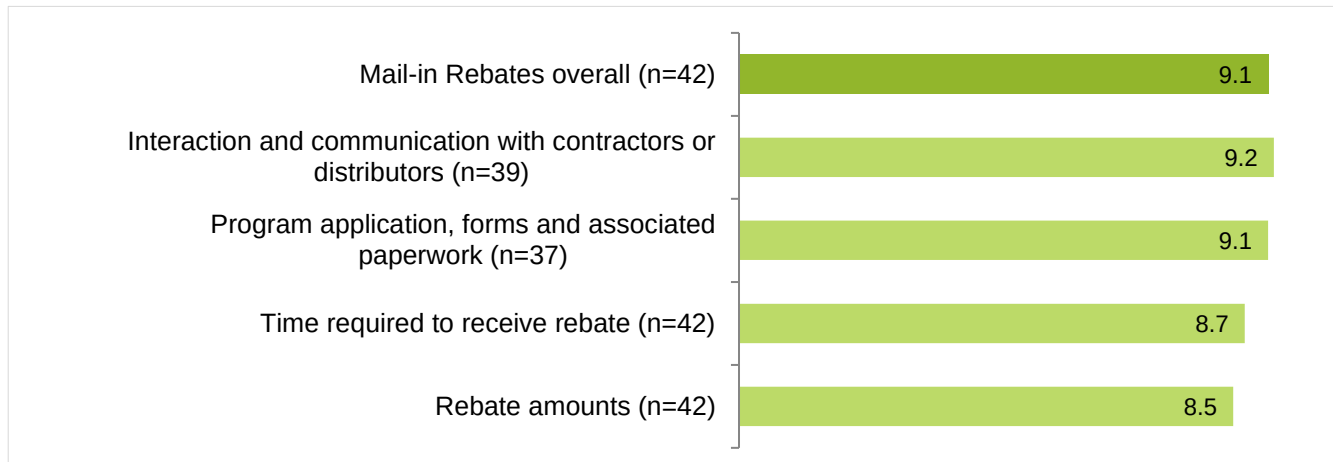
3.2 Participant Satisfaction

Mail-in Participants

There was a high level of satisfaction with Mail-in, with an average rating of 9.1 on a 10-point scale (where 1 indicates “Not at all satisfied” and 10 indicates “Completely satisfied”).

As illustrated in Figure 12 below, there was also a very high level of satisfaction with the various aspects of Mail-in, notably interactions and communications with contractors or distributors as well as the program application, forms, and associated paperwork. The few respondents who provided a satisfaction rating of 7 or lower for Mail-in (12%) reasoned that they did not like the products or measures rebated, they found it difficult to locate information on the website, they found ENS staff not helpful, or they found the rebate too small.

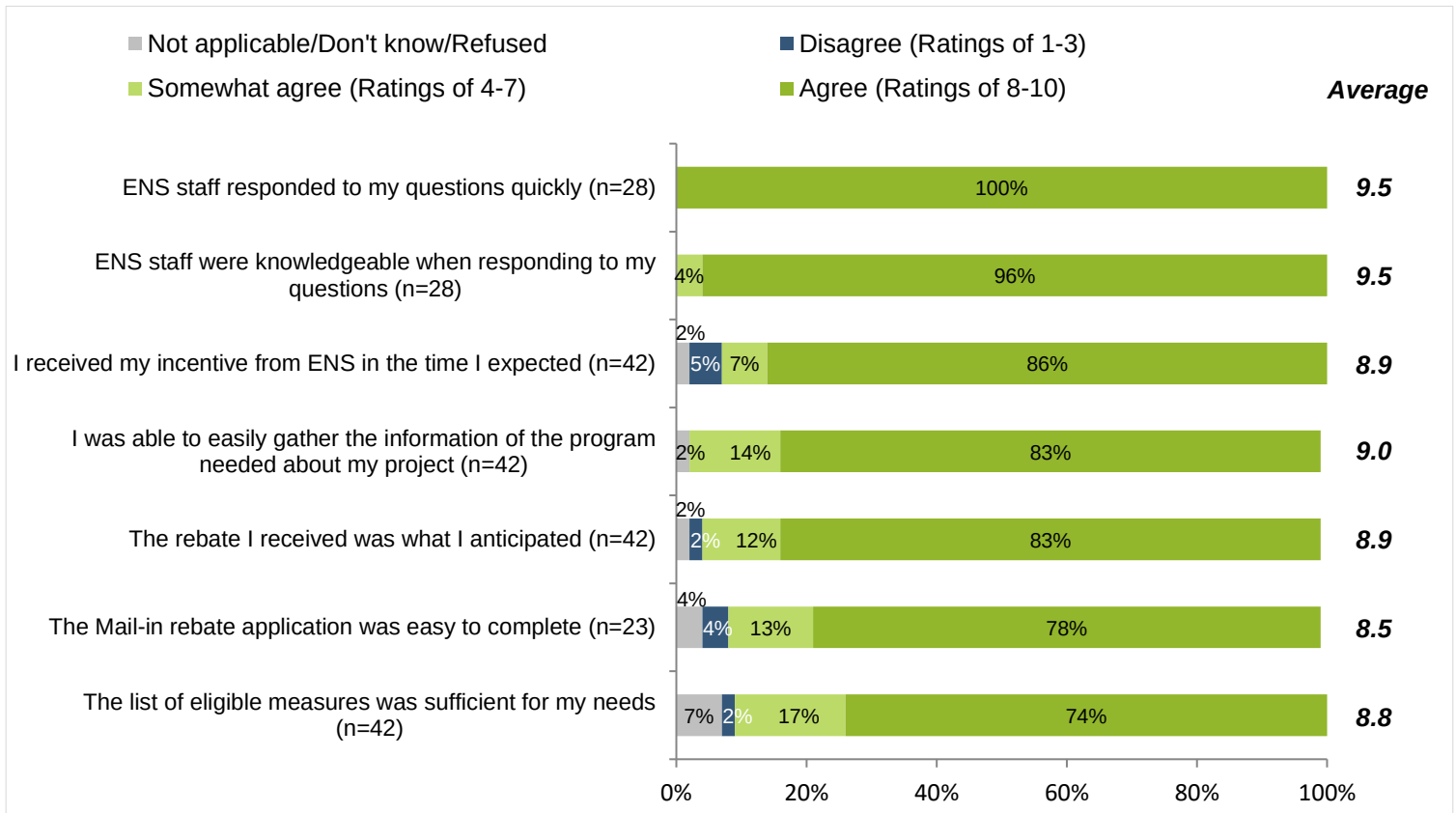
Figure 12: 2021 Participant Satisfaction with Mail-in (10-point Scale)



Note: Mean score of ratings on a scale of 1 to 10, where 1 means “Not at all satisfied” and 10 means “Completely satisfied”.

Respondents who were involved in completing the application process were asked to rate their agreement level with a number of statements about ENS staff interactions, using a scale from 1 to 10 where 1 indicates that they “Do not agree at all” and 10 means they “Completely agree” with the statement. As indicated in Figure 13 below, respondents were highly complimentary of EOne staff and their interactions, notably in terms of staff knowledge and the timeliness of responses.

Figure 13: 2021 ENS Staff Interactions and Application Process (10-point Scale)



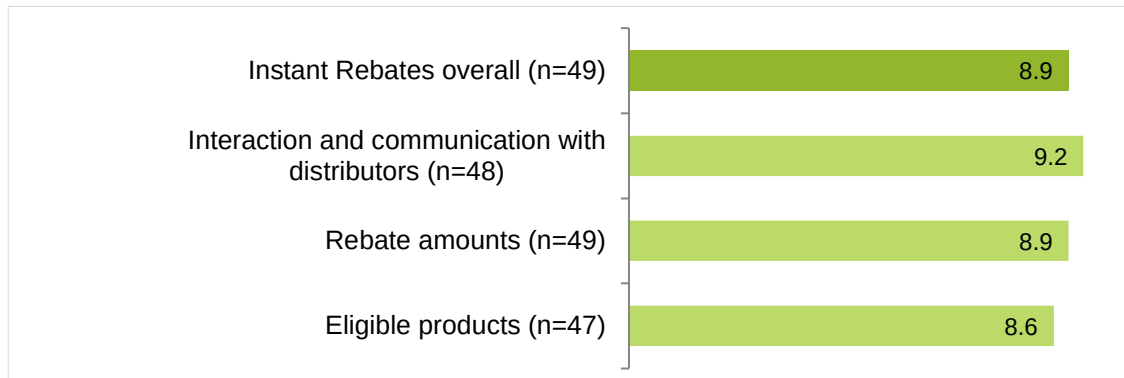
Note: Mean score of ratings on a scale of 1 to 10, where 1 means “Completely disagree” and 10 means “Completely agree”.

Just over one-half of respondents provided suggestions to improve Mail-in, notably improved marketing and awareness (12%), rebating more measures (10%), and providing more information (7%).

Instant Rebates Participants

As illustrated in Figure 14 below, there was a high level of satisfaction with Instant Rebates overall, resulting in an average satisfaction score of 8.9 on a 10-point scale. Very few participants provided a satisfaction score below 8 (10%), reasoning that they did not like the mail-in rebates or that the incentive was too small. Satisfaction was also high with various assessed Instant Rebates components, most notably interactions and communications with contractors and distributors.

Figure 14: 2021 Participant Satisfaction with Instant Rebates (10-point Scale)



Note: Mean score of ratings on a scale of 1 to 10 where 1 means “Not at all satisfied” and 10 is “Completely satisfied”. Excludes “Don’t know” responses.

Most respondents did not have any suggestions to improve Instant Rebates (72%). Improved marketing and awareness (8%), the inclusion of additional rebated measures (4%), more information on measures available for a rebate (2%), ENS staff being more accessible (2%), faster payment of the rebate (2%), and more consistency in measures available for rebates (2%) were most cited as suggested improvements.

3.3 Distributor Satisfaction with Instant Rebates

Distributors were asked to express their level of satisfaction with various aspects of Instant Rebates using a 10-point scale where 1 means “Not at all satisfied”, and 10 means “Very satisfied”.

Distributors provided good levels of satisfaction regarding Instant Rebates overall, with five distributors offering a rating of 8 to 10 and all others providing a rating of 5 to 7. The main point of dissatisfaction with Instant Rebates was the cost of administering the service, particularly for small distributors. Despite the administrative burden, distributors recognized the need for rebate processing, tracking, and reporting and provided a satisfactory score averaging 8.1 for those processes. However, one distributor mentioned that participating in the program requires a full-time employee dedicated to the program and that EOne should financially compensate distributors for the administrative functions. In addition, one distributor mentioned difficulty in collecting all the required customer information at the sales counter, thus resulting in incomplete forms that need to be corrected prior to being submitted.

Satisfaction with the service support and communications provided by ENS is high, with six distributors offering a satisfaction rating between 8 and 10. One distributor rated their satisfaction with this aspect a 4 based on a perception that other ENS programs that include incentives or rebates on lighting products offer unfair competition, while another distributor did not provide a rating.

With respect to rebate processing, tracking, and reporting, six distributors provided a rating ranging from 8 to 10, while one scored this aspect a 5 given the time required to administer the service, including the collection of customer information.

Table 9 presents the average ratings provided by distributors for each aspect assessed.

Table 9: 2021 Distributor Satisfaction with Instant Rebates (10-point Scale)

	Distributors	
	Mean*	Sample Size
The Overall Program	8.0	8
The Program Support and Communications provided by ENS	8.9	7
The Rebate Processing, Tracking, and Reporting	8.1	8

* Scale: 1 = Not at all satisfied; 10 = Very satisfied

3.4 Distributor Successes and Challenges with Instant Rebates

Distributors are generally pleased with BER Instant Rebates and how it benefits their business through the earlier adoption and increased sales of LED products. One distributor also believes that Instant Rebates is an attractive feature for customers who can financially benefit from the service during the purchase process. Other successes of the service each mentioned by one distributor include the service staff being supportive and easy to work with, the distributor awareness resulting from being listed on ENS preferred partner lists and having been able to grow their business and open a new retail outlet due to increased sales despite pandemic conditions.

In terms of challenges caused by Instant Rebates, the service's administrative burden is most cited, notably in terms of the time required to administer the service and the length of the process to assess product eligibility. It was suggested that distributors be provided with a way to reference the eligibility of products quickly at the point of sale. Other suggestions made were to offer a rebate on integrated fixtures, consider expanding the list of eligible lighting products, educate customers on concepts such as DLC-certified and ENERGY STAR including the concepts' relationship with product quality, and increase the percentage of the rebate amounts to be proportionate with the product price.

2021 BER Participant and Distributor Perspective Highlights

- › Awareness about Mail-in and Instant Rebates primarily stems from contractors, distributors, or suppliers.
- › BER participants are primarily motivated to implement energy efficient measures to save on energy costs and, for Instant Rebates, to also improve energy efficiency.
- › There is a very high degree of satisfaction among participants with both the Mail-in (average rating of 9.1 on a 10-point scale) and Instant Rebates (average rating of 8.9).
- › Participant satisfaction with the interaction and communication with contractors and distributors is elevated for both services. Furthermore, Mail-in participants reported a high degree of satisfaction with the program application, forms, and associated paperwork.
- › Mail-in participants who were involved in the application process are highly satisfied with the ENS staff interactions, notably in terms of timely responses and staff knowledge.
- › Improved marketing and awareness, an increased number of rebated measures, and the provision of more program information were suggestions commonly cited to improve BER.
- › Distributors offer good levels of satisfaction regarding Instant Rebates overall, with an average rating of 8.0 on a 10-point scale. The main point of dissatisfaction with Instant Rebates is the cost of administering the service, particularly for small distributors.

4 IMPACT EVALUATION FOR MAIL-IN

The objective of the 2021 Mail-in impact evaluation was to determine gross and net electrical energy and peak demand savings.

4.1 Tracking Sheet Audit

To ensure program component results were reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix VI. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

4.2 Gross Savings

Gross savings refer to changes in energy consumption resulting from actions taken by participants regardless of their reasons for participating.⁷ For each Mail-in project, EOne tracks annual gross savings using the equations defined in the most up-to-date CIRx Screening Tool (version 1.38), an EOne tool presenting the savings calculation methodologies, assumptions, and equipment parameters specific to each project. In 2021, there was one exception to this approach. The exception concerned the horticultural lighting measure that was added to the Mail-in offering in 2021 but was not included in the CIRx Screening Tool. For this measure, the Evaluator used the tracked assumptions proposed by EOne since they were deemed reasonable. Moreover, the Evaluator recommends that the savings assumptions for this measure be reviewed as part of the 2022 evaluation and be added to the next version of the CIRx Screening Tool with the appropriate source references.

4.2.1 Adjustment Ratios

As part of the 2021 evaluation, the Evaluator conducted on-site visits (n=40) to establish adjustment ratios and determine evaluated savings for lighting measures. The visits were focused on lighting measures that accounted for 64% of Mail-in gross energy savings in 2021. The on-site visits completed as part of the 2022 evaluation will be focused on measures other than lighting.

Based on the observations made on-site and an analysis of the calculations, the Evaluator calculated the evaluated savings of each project and then established an average adjustment ratio. The adjustment ratio corresponds to the evaluated savings divided by the tracked savings for all sampled projects. These were extrapolated to all savings (by multiplying the ratio by the tracked savings of the given category) when the margins of error were below the targets of 10% at a confidence level of 90%.

⁷ Definition adapted from National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

The most common adjustment was revising hours of use (HOUs) using data collected on site. About half of the measures (47%) required an adjustment greater than 5%, which represents a significant increase compared to the 23% and 15% in adjusted measures observed in the 2018 and 2019 evaluations respectively. Furthermore, about a quarter of measures (24%) required an adjustment greater than 30%. This was mostly due to applications providing hours of operation for the business in general and not HOUs specific to actual fixture operation. This had a similar effect on the peak coincidence factor.

While no efficient wattages were revised, which represents an improvement compared to the 2% of measures requiring an adjustment in 2019, baseline wattages were revised for 10% of measures despite having only been revised for 1% of measures in 2019. Baseline revisions occurred most often due to the double-application of ballast factors and determination of low-bay versus high-bay installations.

Interactive effects for energy savings and peak demand savings were revised for 13% and 8% of measures respectively. Adjustments were made to account for heating and cooling equipment either not included or not identified correctly in applications and to reflect the actual equipment in use in each area where measures are installed.

One project was also removed from the calculations of adjustment ratios as it was deemed unrepresentative of a typical project due to significant discrepancies between the information in the application and the situation on site. The savings associated with that project were instead manually adjusted.

Overall, the adjustments led to negative adjustment ratios of 0.993 and 0.841 for energy and peak demand savings respectively, which decreased Mail-in total gross savings by 0.5% and 9.7% respectively.

The Evaluator noted that the accuracy of some of the tracked savings calculation variables could be improved by making small changes to the lighting measure worksheet that participants fill out with their Mail-in application. For instance, the following changes could be made to the Area sections in the worksheet:

- › The “Hours of use per week” field could be renamed “Product hours of use per week” and could be required for each product. With these changes, participants would be more likely to provide HOUs specific to each product instead of general business hours of operation.
- › The “Will this area be in operation between 5 pm and 7 pm from December to February?” question could be reformulated as “Will this product be in operation between 5 pm and 7 pm from December to February?” and could be required for each product. Furthermore, other than “Yes” and “No”, a third option could also be added: “Partly (please specify the proportion of hours: _____%)”. These changes would improve the accuracy of tracked peak coincidence factors.
- › Adding the “How is this area heated?” question would allow for participants that have multiple heating systems in use in one area to provide an estimate of the mix of heating sources for that area. This would improve the accuracy of tracked interactive effects factors.

No data collection aimed at updating the adjustment ratios for any of the measure categories other than lighting was conducted in 2021. For measure categories other than lighting, most adjustment ratios for 2021 were based on 2019 data-collection results except for the adjustment ratio for advanced rooftop unit controls, which was established at 1.000 because that measure was only introduced in 2020. No data-collection activities occurred in 2020 due to the pandemic. Table 10 outlines the adjustment ratios for the 2021 evaluation.

Table 10: 2021 Mail-in Adjustment Ratios

Measure Category	Energy Savings		Peak Demand Savings	
	Adjustment Ratio	Margin of Error	Adjustment Ratio	Margin of Error
Lighting	0.993	6.7%	0.841	7.5%
HVAC	0.991	3.5%	1.000	-
Motors and Variable Frequency Drives	1.000	-	1.000	-
Pumping	0.724	6.1%	0.874	6.1%
Refrigeration	1.111	3.4%	1.000	-
Agriculture	1.000	-	1.000	-
Kitchen	1.000	-	1.000	-
IT & Data Centres	1.000	-	1.000	-
Water Heating	1.000	-	1.000	-
Compressed Air	1.000	-	1.000	-
Pool	1.000	-	1.000	-
Advanced RTU Controls	1.000	-	1.000	-

4.2.2 Interactive Effects

Interactive effects occur when the implementation of energy efficiency measures has an impact on the energy consumption of other elements such as heating and cooling; this is considered in the gross savings standard equation presented in the CIRx Screening Tool. For BER, interactive effects only apply to lighting projects. In 2021, based on-site visit observations, the Evaluator ensured that EOne used the correct interactive effects factors for visited projects. When applicable, the Evaluator adjusted the interactive effects factor based on the CIRx Screening Tool value that most accurately corresponds to the situation observed on site. The adjustments are included in the adjustment ratios presented in Subsection 4.2.1 above.

4.2.3 Effective Useful Life

As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the EUL values used in the calculation of electrical energy savings that are expected to persist over time. All EUL values established in the 2020 evaluation remain valid for the 2021 evaluation.

Table 11 and Table 12 below summarize the tracked and evaluated equivalent EUL values. The evaluated equivalent EUL values are applied to each product gross and net first-year electrical energy savings to obtain the gross and net lifetime electrical energy savings. As a result, the weighted average EUL values of gross and net savings differ (see Subsections 4.2.4 and 4.3.4 below).

Table 11: 2021 Mail-in Equivalent EUL Values by Lighting Product

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]
LED Linear Fixtures		
1 x 4 Luminaires	11.6	No change
2 x 2 Luminaires and Retrofit Kits	11.6	No change
2 x 4 Luminaires and Retrofit Kits	11.6	No change
Linear Ambient and Low-bay Luminaires	11.6	No change
High-bay Luminaires	22.3	No change
Troffers	20.9	No change
LED Linear Lamps		
2-foot Replacement Lamps	11.6	No change
3-foot Replacement Lamps	11.6	No change
4-foot Replacement Lamps	11.6	No change
8-foot Replacement Lamps	11.6	No change
U-bend	11.6	No change
LED General-use and Decorative Lamps		
Four Pin-base Replacement Lamps for Compact Fluorescent Lamps	11.6	No change
LED Outdoor Fixtures		
Outdoor Full-cutoff Wall-mounted Area Luminaires	17.1	No change
Flood and Spot Luminaires	17.1	No change
Fuel Pump Canopy Luminaires	11.4	No change
LED Replacements for High-intensity Discharge Lamps	11.4	No change
Non-cutoff and Semi-cutoff Wall-mounted Area Luminaires	22.8	No change
Pole/Arm-mounted Area Luminaires	13.7	No change
Pole/Arm-mounted Decorative Luminaires	22.8	No change
Parking Garage Luminaires	22.8	No change
Case Lighting for Sign Retrofit Applications	11.6	No change

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]
LED Directional and Architectural Fixtures		
Track or Mono-point Directional Luminaires, LED Wall Wash Luminaires	11.6	No change
Other LED Lighting		
Refrigerated Case Luminaires	16.3	No change
Horticultural Lighting	9.5	No change ⁸
Non-LED Lighting		
Occupancy Sensors	10.0	No change

Table 12: 2021 Mail-in Equivalent EUL Values by Non-lighting Product

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]
Agricultural		
Agriculture Heat Pads	10	No change
Dairy Scroll Compressors	15	No change
Energy Efficient Ventilation and Circulation Fans	15	No change
Heat Reclaimer Units	15	No change
High-volume Low-speed Fans	15	No change
Low-energy and Zero-energy Livestock Waterers	10	No change
Milk Pre-coolers	15	No change
Natural and Dual Ventilation	15	No change
Tractor Engine-block Heater Timers	5	No change
VFDs for Milk Vacuum Pumps	15	No change
VFDs for Milk Transfer Pumps	15	No change
Compressed Air		
Air Entraining Air Nozzles	15	No change
Cycling Air Dryers	10	No change
No-loss Drains	15	No change

⁸ The Evaluator recommends that the equivalent EUL value for horticultural lighting be reviewed in 2022.

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]
HVAC		
Air-source Heat Pumps Greater Than or Equal to 65,000 BTU/hr	15	No change
Air-source Heat Pumps Less Than 65,000 Btu/hr (excluding air-to-water)	18	No change
Air-to-water Heat Pumps	15	No change
Dual-enthalpy Economizer Controls	10	No change
Ground-source Heat Pumps	25	No change
HVAC Hotel Occupancy Sensors	8	No change
Packaged Terminal Heat Pumps (PTHPs)	15	No change
Water-source Heat Pumps	15	No change
Electric Thermal Storage	18	No change
IT & Data Centres		
Server-based Power Management Software	5	No change
Server Virtualization and Decommissioning	4	No change
ENERGY STAR® Uninterruptible Power Supplies	10	No change
Laundry		
Commercial Clothes Dryers (Natural Gas Conversion)	12	No change
Commercial Heat Pump Clothes Dryers	12	No change
Commercial Washing Machines	11	No change
Kitchen		
Demand-controlled Kitchen Exhausts	15	No change
Dishwashers	10, 15, or 20	No change
Freezers/Refrigerators	12	No change
Fryers	12	No change
Griddles	12	No change
Hot Food Holding Cabinets	12	No change
Ice Machines	10	No change
Ovens	12	No change
Steam Cookers	12	No change
Motors and VFDs		
Energy Efficient Motors	15	No change
Variable Frequency Drives	15	No change
Pumping		
Booster Pumps	15	No change
Circulator Pumps	15	No change

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]
Refrigeration		
Brushless DC Motors	15	No change
Cooler Night Covers/Display Case Strip Curtains	4	No change
Door Heater Controls	12	No change
Efficient Refrigeration Compressors	15	No change
Evaporator Fan Motor Controls	10	No change
Intelligent Freezer Defrost Controls	10	No change
Refrigerated Vending Machine Controllers	5	No change
Refrigeration Economizers	15	No change
Vertical Refrigeration Open-to-closed Cooler Conversion	12	No change
Zero-energy Doors	12	No change
Water Heating		
Electric-to-natural Gas Water Heating	15	No change
Heat Pump Water Heaters	10	No change
Solar		
Solar Water Heaters	20	No change
Solar Space Heating Systems	20	No change
Pool		
Efficient Pool Pumps	10	No change
Rooftop Unit		
Advanced RTU Controls	10	No change

4.2.4 Evaluated Gross Savings

The savings achieved for each Mail-in measure category are presented in Table 13 below. Both energy and peak demand savings were revised by applying the adjustment ratios discussed in Subsection 4.2.1 above.

The savings at the generator were calculated using a line loss factor that accounts for electricity losses occurring between the meter and the generator. This value is a weighted average of the line loss factors provided by NS Power for each rate code and the corresponding energy savings listed in the final 2021 tracking sheet. The line loss factors correspond to the values submitted to the Nova Scotia Utility and Review Board (NSUARB) as part of the 2014 Cost of Service Study Progress Update.⁹

⁹ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Overall, the total Mail-in gross energy and peak demand savings amounted to 16.366 GWh and 2.433 MW respectively at the generator. Lifetime energy savings were established at 258.596 GWh and the weighted average EUL value for gross energy savings was 15.8 years.

Table 13: Evaluated 2021 Mail-in Gross Energy and Peak Demand Savings

Measure Category	Lighting	Motors and VFDs	HVAC	Advanced RTU Controls	Refrigeration	Agriculture
Energy Savings						
Tracked Gross Energy Savings – at the Meter (GWh)	10.027	3.419	1.261	0.460	0.118	0.070
Overall Adjustment Ratio on Energy Savings	0.993	1.000	0.991	1.000	1.111	1.000
Gross Energy Savings – at the Meter (GWh)	9.957	3.419	1.249	0.460	0.131	0.070
Line Loss Factor	1.060	1.063	1.074	1.063	1.068	1.080
Gross Energy Savings – at the Generator (GWh)	10.556	3.634	1.341	0.489	0.140	0.076
Effective Useful Life (years)	16.3	15.0	16.8	10.0	14.5	12.5
Gross Lifetime Energy Savings – at the Generator (GWh)	171.859	54.514	22.520	4.894	2.035	0.951
Peak Demand Savings						
Tracked Gross Peak Demand Savings – at the Meter (MW)	1.534	0.410	0.486	0.022	0.014	0.019
Overall Adjustment Ratio on Peak Demand Savings	0.841	1.000	1.000	1.000	1.000	1.000
Gross Peak Demand Savings – at the Meter (MW)	1.291	0.410	0.486	0.022	0.014	0.019
Line Loss Factor	1.068	1.067	1.084	1.070	1.077	1.099
Gross Peak Demand Savings – at the Generator (MW)	1.379	0.437	0.527	0.023	0.016	0.021

Evaluated 2021 Mail-in Gross Energy and Peak Demand Savings (Continued)

Measure Category	Water Heating	Kitchen	Pumping	Compressed Air	Total for All Categories
Energy Savings					
Tracked Gross Energy Savings – at the Meter (GWh)	0.067	0.031	0.022	0.007	15.483
Adjustment Ratio on Energy Savings	1.000	1.000	0.724	1.000	0.995
Gross Energy Savings – at the Meter (GWh)	0.067	0.031	0.016	0.007	15.408
Line Loss Factor	1.063	1.071	1.063	1.063	1.062
Gross Energy Savings – at the Generator (GWh)	0.071	0.033	0.017	0.008	16.366
Effective Useful Life (years)	15.0	11.9	15.0	14.1	15.8
Gross Lifetime Energy Savings – at the Generator (GWh)	1.062	0.397	0.257	0.107	258.596
Peak Demand Savings					
Tracked Gross Peak Demand Savings – at the Meter (MW)	0.018	0.005	0.005	0.001	2.514
Adjustment Ratio on Peak Demand Savings	1.000	1.000	0.874	1.000	0.903
Gross Peak Demand Savings – at the Meter (MW)	0.018	0.005	0.004	0.001	2.270
Line Loss Factor	1.070	1.081	1.070	1.070	1.072
Gross Peak Demand Savings – at the Generator (MW)	0.020	0.006	0.004	0.001	2.433

Figure 15 compares the tracked and evaluated gross energy savings, while Figure 16 further below compares the tracked and evaluated gross peak demand energy savings.

The differences between tracked and evaluated savings outlined in the figures are due to the adjustment ratios that were applied to certain measure categories.

Figure 15: 2021 Mail-in Tracked and Evaluated Gross Energy Savings

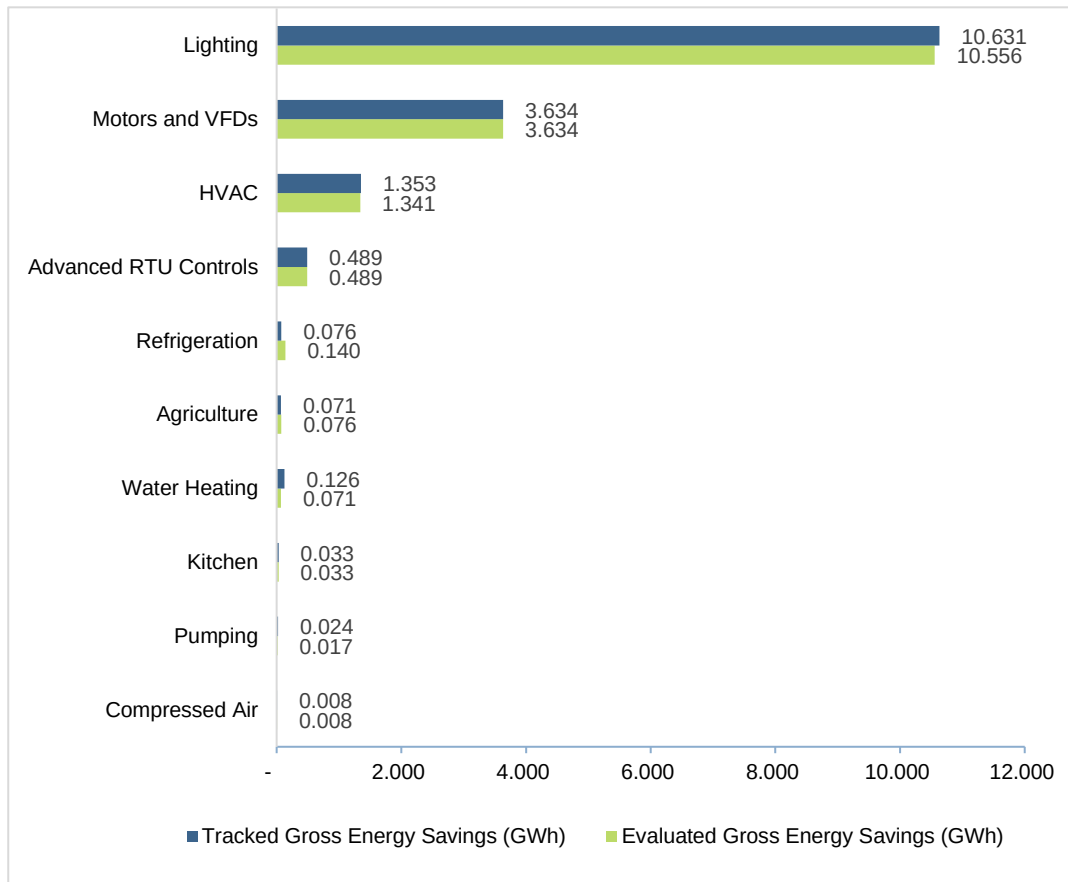
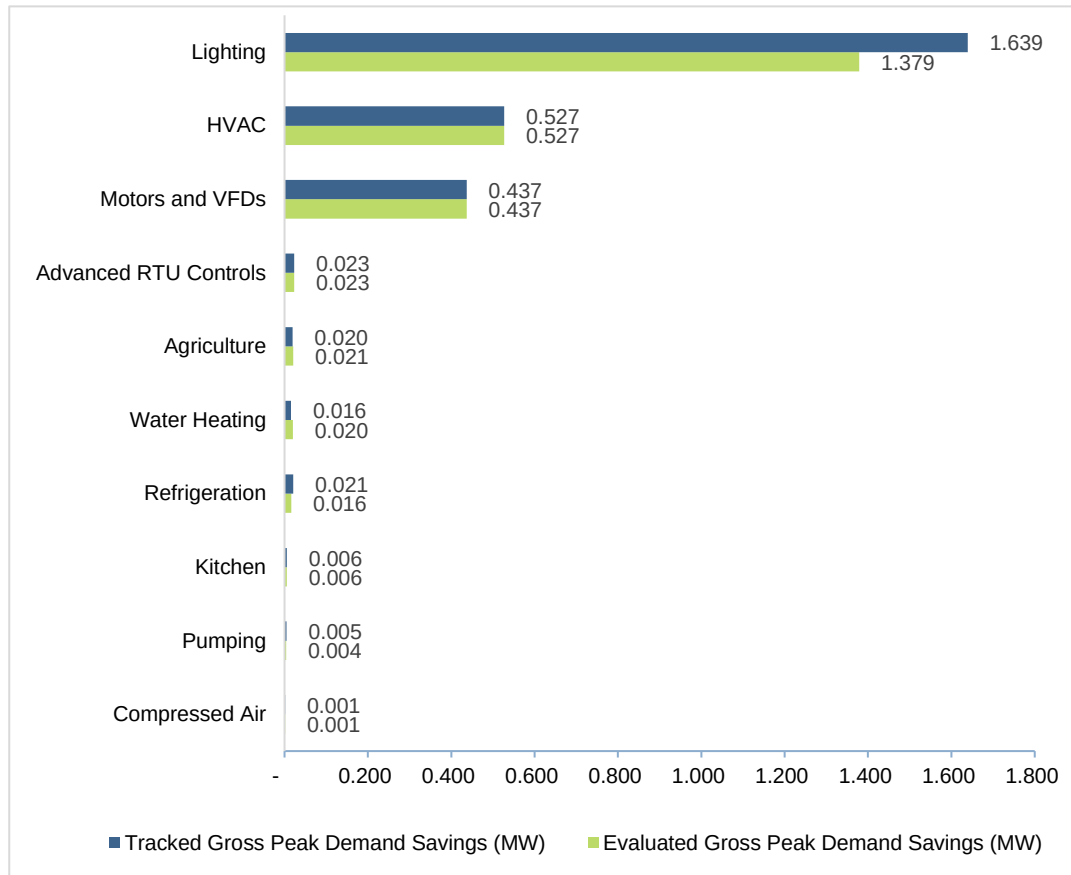


Figure 16: 2021 Mail-in Tracked and Evaluated Gross Peak Demand Savings


4.3 Net Savings

The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the net-to-gross ratio (NTGR). More precisely, the NTGR is established by considering the effects, namely free-ridership and spillover, that positively or negatively affect energy savings.

4.3.1 Free-ridership

In the case of Mail-in, free-ridership occurs when participants would have still implemented energy efficiency upgrades and measures in the absence of the service. The free-ridership levels were assessed during the 2021 evaluation using a self-report approach that involves asking participants a set of questions during a telephone survey. To reach the desired survey sample sizes, the Evaluator included participants from both 2020 and 2021 in the sample. Since no major changes to the program were made between 2020 and 2021, the Evaluator deemed that this strategy was reasonable to establish 2021 free-ridership results.

The survey questions were designed to assess the likelihood for participants to have implemented energy efficient measures in the absence of the service. The questions consider all applicable variables related to the decision-making process, including planning, efficiency, cost, timing, and quantity. Additional questions were used to determine the extent to which participant decisions had been influenced by previous participation in an EOne energy efficiency program component or EOne efforts to raise awareness about energy efficiency. When participant answers indicated that they had been significantly influenced by either of these two factors, the free-ridership level was adjusted downward.

The feedback collected from the participant survey was converted into an average free-ridership levels using the algorithm presented in Appendix IX. An overall free-ridership level was established in 2021 to reach the targeted margin of error given the lower-than-required number of survey respondents.

The 2021 overall average free-ridership level was established at 26%. For comparison, in 2019, the overall free-ridership was evaluated at 19%. One of the factors explaining the increase in free-ridership in 2021 is that more participants, especially for lighting projects, had already made the decision to implement their projects before hearing about BER.

Overall, as outlined in Table 14, the weighted average free-ridership level for Mail-in participants in 2021 is 26%.

Table 14: 2021 Mail-in Free-ridership

Measure Category	Average Free-ridership Level	Sample Size	Population Size	Margin of Error
All	26%	42	373	6.6%
* Sample populations included participants from both 2020 and 2021.				

4.3.2 Spillover

For Mail-in, spillover occurs when participants implement eligible energy efficiency measures due to previous participation in the service without having received any kind of additional support.

The Evaluator conducted on-site visits to directly question participants about any potential spillover effects and found that the spillover level for 2021 was nil, the same as in 2019. The algorithm used to determine the level of spillover is presented in Appendix X.

4.3.3 Net-to-gross Ratio Calculation

The NTGR is calculated using the following equation.

$$NTGR = (1 - \% \text{ Free-ridership} + \% \text{ Spillover})$$

Using the free-ridership and spillover levels established for Mail-in, the Evaluator calculated the NTGR values, the results of which is presented in Table 15.

Table 15: 2021 Mail-in NTGRs

Measure Category	Free-ridership	Spillover	NTGR
All	26%	0%	0.74

4.3.4 Evaluated Net Savings

Net savings are defined as the changes in energy use attributable specifically to Mail-in. Net savings were estimated by applying the above NTGRs to the evaluated gross savings, as illustrated in the following equation.

$$\text{Net Savings} = \text{Evaluated Gross Savings} \times \text{NTGR}$$

Overall, the total net energy and peak demand savings for Mail-in amounted to 12.111 GWh and 1.800 MW respectively at the generator.

The net lifetime energy savings for Mail-in were established at 191.361 GWh and, as a result, the weighted average EUL value for gross energy savings was 15.8 years. Detailed results are presented in Table 16 below.

Table 16: Evaluated 2021 Mail-in Net Energy and Peak Demand Savings

Measure Category	Lighting	Motors and VFDs	HVAC	Advanced RTU Controls	Refrigeration	Agriculture	Water Heating
Energy Savings							
Gross Energy Savings – at the Meter (GWh)	9.957	3.419	1.249	0.460	0.131	0.070	0.067
NTGR	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Net Energy Savings – at the Meter (GWh)	7.368	2.530	0.924	0.341	0.097	0.052	0.049
Line Loss Factor	1.060	1.063	1.074	1.063	1.068	1.080	1.063
Net Energy Savings – at the Generator (GWh)	7.811	2.689	0.992	0.362	0.104	0.056	0.052
Effective Useful Life (years)	16.3	15.0	16.8	10.0	14.5	12.5	15.0
Net Lifetime Energy Savings – at the Generator (GWh)	127.175	40.340	16.665	3.621	1.506	0.704	0.786
Peak Demand Savings							
Gross Peak Demand Savings – at the Meter (MW)	1.291	0.410	0.486	0.022	0.014	0.019	0.018
NTGR	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Net Peak Demand Savings – at the Meter (MW)	0.955	0.303	0.360	0.016	0.011	0.014	0.014
Line Loss Factor	1.068	1.067	1.084	1.070	1.077	1.099	1.070
Net Peak Demand Savings – at the Generator (MW)	1.020	0.323	0.390	0.017	0.012	0.015	0.014

Evaluated 2021 Mail-in Net Energy and Peak Demand Savings (Continued)

Measure Category	Kitchen	Pumping	Compressed Air	Total for All Categories
Energy Savings				
Gross Energy Savings – at the Meter (GWh)	0.031	0.016	0.007	15.408
NTGR	0.74	0.74	0.74	0.74
Net Energy Savings – at the Meter (GWh)	0.023	0.012	0.005	11.402
Line Loss Factor	1.071	1.063	1.063	0.724
Net Energy Savings – at the Generator (GWh)	0.025	0.013	0.006	12.111
Effective Useful Life (years)	11.9	15.0	14.1	15.8
Net Lifetime Energy Savings – at the Generator (GWh)	0.294	0.190	0.079	191.361
Peak Demand Savings				
Gross Peak Demand Savings – at the Meter (MW)	0.005	0.005	0.001	2.271
NTGR	0.74	0.74	0.74	0.74
Net Peak Demand Savings – at the Meter (MW)	0.004	0.003	0.001	1.680
Line Loss Factor	1.081	1.070	1.070	1.071
Net Peak Demand Savings – at the Generator (MW)	0.004	0.003	0.001	1.800

As presented in Table 17 below, applying the Nova Scotia-specific factor¹⁰ for GHG emissions generated by electricity production to Mail-in net savings corresponds to a total of 7,074 tonnes of annually avoided CO₂ eq.

Table 17: Evaluated 2021 Mail-in GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	12.111
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/GWh)	0.5841
Net Annual GHG Emission Reductions (tonnes of CO₂ eq)	7,074

¹⁰ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:
 Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),
 Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021
https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

4.4 Realization Rate

Table 18 below compares the energy and peak demand savings established through the 2021 Mail-in evaluation to those calculated in the 2021 tracking sheet. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 91% for energy savings and at 83% for peak demand savings.

Table 18: Comparison of 2021 Mail-in Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	16.446	GWh	0.80	13.238	GWh	91%
Evaluation Results	16.366	GWh	0.74	12.111	GWh	
Peak Demand Savings						
Tracked Savings by EOne	2.694	MW	0.80	2.164	MW	83%
Evaluation Results	2.433	MW	0.74	1.800	MW	

Evaluated gross energy and peak demand savings were respectively established at 0% and 10% below the tracked values mainly because of the negative adjustment ratios for lighting measures, which represented 64% and 57% of gross energy and peak demand savings respectively. Adjustment ratios from other measure categories also had an impact on evaluated gross savings, albeit to a lesser extent.

Evaluated net energy and peak demand savings were significantly lower than the values tracked by EOne, with decreases of 9% and 17% respectively. The increase in the overall free-ridership level had the largest impact on evaluated net savings.

5 IMPACT EVALUATION FOR INSTANT REBATES

The objectives of the 2021 Instant Rebates impact evaluation were to determine gross and net electrical energy and peak demand savings.

5.1 Tracking Sheet Audit

To ensure program service results were reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix XI. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

5.2 Gross Savings

For Instant Rebates, gross savings refer to changes in energy consumption resulting from actions taken by participants regardless of their reasons for participating.¹¹ Since eligible measures are tracked at the point of sale, EOne estimates savings based on a set of assumptions specific to each measure type rather than using the real operating conditions and old equipment of projects. Energy and peak demand savings are calculated for each data entry; the equations used include baseline wattages, the actual wattages of efficient measures, ballast factors where applicable, interactive effects factors, peak coincidence factors (PCFs), and in-service rates (ISRs).

As part of the 2020-2022 Measure Assessment activities, the Evaluator validated and, when necessary, revised the equations and their parameters as well as assessed the EUL values for Instant Rebates measures.

5.2.1 Summary of Adjustments to Gross Energy Savings

As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the equation parameters such as hours of use (HOUs) and baseline wattages used to determine energy savings of products eligible under Instant Rebates. In 2021, no changes were made in the 2020-2022 Measure Assessment to Instant Rebates energy savings.

5.2.2 In-service Rates

Research indicates that a percentage of measures purchased through rebate programs might be stored for later use. As part of the 2020-2022 Measure Assessment activities, the Evaluator established the in-service rate (ISR) for Instant Rebates measures. In 2021, the Evaluator maintained the ISR of 85% for linear LED lamps and the ISR of 100% for fixtures, occupancy/motion sensors, as well as circulator and booster pumps.

¹¹ Definition adapted from National Renewable Energy Laboratory, *The Uniform Methods Project, Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

5.2.3 Peak Demand Savings

As part of the 2020-2022 Measure Assessment activities, the Evaluator established a PCF of 71% for indoor lighting measures. This percentage is an average of the results from 2019 Mail-in and SBES on-site visits. A PCF of 100% was maintained for outdoor measures and circulator pumps since they are assumed to be used 24 hours per day. For booster pumps, the PCF was updated to 70% based on project data from eight Custom Retrofit projects.

5.2.4 Interactive Effects

Interactive effects occur when the implementation of energy efficiency measures has an impact on the energy consumption of other elements such as heating and cooling; this is taken into account in the gross unitary savings equation presented in the 2021 tracking sheet.

As part of the 2020-2022 Measure Assessment activities, the Evaluator established the interactive effects factors for each product eligible under Instant Rebates, the results of which are outlined in Table 19. The Evaluator also calculated the weighted average interactive effects factors for LED linear fixtures and LED linear lamps based on the products sold in 2021.

Table 19: 2021 Instant Rebates Interactive Effects Factor Calculation Results

Measure		Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings
LED Linear Fixtures	Recessed	-3.6%	-8.6%
	Non-recessed	-6.4%	-15%
	Weighted Average	-5.9%	-13.9%
LED Linear Lamps	Recessed	-3.6%	-8.6%
	Non-recessed	-6.4%	-15%
	Weighted Average	-5.9%	-13.9%
LED Outdoor Fixtures		0%	0%
Directional and Architectural LED Fixtures		-6.4%	-15%
Occupancy/Motion Sensors		-6.4%	-15%
Circulator Pumps		0%	0%
Booster Pumps		0%	0%

5.2.5 Effective Useful Life

As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the EUL values used in the calculation of electrical energy savings that are expected to persist over time. The Evaluator updated the EUL values for LED linear fixtures. For other fixtures, LED linear lamps, occupancy/motion sensors and pumps, the EUL values established in the 2020 evaluation remained valid for the 2021 evaluation.

Table 20 below summarizes the tracked and revised equivalent EUL values. The evaluated equivalent EUL values are applied to each product gross and net first-year electrical energy savings to obtain the gross and net lifetime electrical energy savings. As a result, the weighted average EUL values of gross and net savings differ (see Subsections 5.2.6 and 5.3.3 below).

Table 20: 2021 Instant Rebates Equivalent EUL Values

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]
LED Linear Fixtures		
1 x 4 Luminaires	11.6	No change
2 x 2 Luminaires and Retrofit Kits	11.6	No change
2 x 4 Luminaires and Retrofit Kits	11.6	No change
Linear Ambient and Low-bay Luminaires	11.6	No change
LED Linear Lamps		
2-foot, 3-foot, 4-foot, and 8-foot Replacement Lamps	11.6	No change
U-bend Replacement Lamps	11.6	No change
LED Outdoor Fixtures		
Outdoor Full-cut-off Wall-mounted Area Luminaires	17.1	No change
Flood and Spot Luminaires	17.1	No change
Non-cut-off and Semi-cut-off Wall-mounted Area Luminaires	22.8	No change
LED Directional and Architectural Fixtures		
Track or Mono-point Directional Luminaires, LED Wall Wash Luminaires	11.6	No change
Non-LED Lighting		
Occupancy/Motion Sensors	10.0	No change
Pumping		
Circulator Pumps	15.0	No change
Booster Pumps	15.0	No change

5.2.6 Evaluated Gross Savings

The energy and peak demand savings associated with Instant Rebates were calculated using the unitary savings values, ISRs, and interactive effects factors revised as part of this evaluation. The savings at the generator were calculated using a weighted average line loss factor calculated according to the distribution of rate code spending of other BNI programs. The line loss factors correspond to the values submitted to the NSUARB as part of the 2014 Cost of Service Study Progress Update.¹²

The total savings established for each measure type are presented in Table 21 below. For Instant Rebates, gross energy savings amounted to 32.596 GWh at the generator, which represent 451.973 GWh in lifetime energy savings and a resulting weighted average EUL value of 13.9 years. Total gross peak demand savings were estimated at 5.546 MW at the generator.

¹² Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 21: Evaluated 2021 Instant Rebates Gross Energy and Peak Demand Savings

Measure Category	LED Linear Fixtures	LED Linear Lamps	LED Outdoor Fixtures	LED Directional and Architectural Fixtures	Occupancy /Motion Sensors	Circulator Pumps	Booster Pumps	Total for All Measures
Number of Units	74,279	97,740	9,555	606	5,651	1,007	118	188,956
Energy Savings								
Tracked Gross Energy Savings – at the Meter (GWh)	16.856	5.467	8.146	0.136	0.907	1.130	0.091	32.734
Adjustment Ratio on Energy Savings	1.000	1.000	1.000	1.000	1.000	1.000	1.000	-
In-service Rate	1.000	0.850	1.000	1.000	1.000	1.000	1.000	-
Interactive Effects Factor	0.941	0.941	1.000	0.936	0.936	1.000	1.000	-
Gross Energy Savings – at the Meter (GWh)	15.862	4.373	8.146	0.127	0.849	1.130	0.091	30.578
Line Loss Factor	1.066	1.066	1.066	1.066	1.066	1.066	1.066	-
Gross Energy Savings – at the Generator (GWh)	16.909	4.661	8.684	0.136	0.905	1.204	0.097	32.596
Effective Useful Life (years)	11.6	11.6	19.8	11.6	10.0	15.0	15.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	196.139	54.072	171.614	1.573	9.052	18.063	1.460	451.973
Peak Demand Savings								
Tracked Gross Non-peak Demand Savings – at the Meter (MW)	3.920	1.271	1.860	0.032	0.171	0.108	0.009	7.370
Adjustment Ratio on Demand Savings	1.000	1.000	1.000	1.000	1.000	1.000	2.023	-
In-service Rate	1.000	0.850	1.000	1.000	1.000	1.000	1.000	-
Peak Coincidence Factor	0.71	0.71	1.00	0.71	0.741	1.000	0.700	-
Interactive Effects Factor	0.861	0.861	1.000	0.850	0.850	1.000	1.000	-
Total Peak Demand Savings – at the Meter (MW)	2.396	0.661	1.860	0.019	0.108	0.108	0.012	5.164
Line Loss Factor	1.074	1.074	1.074	1.074	1.074	1.074	1.074	-
Total Peak Demand Savings – at the Generator (MW)	2.574	0.710	1.998	0.020	0.116	0.116	0.013	5.546

Figure 17 compares the tracked and evaluated gross energy savings, while Figure 18 further below compares the tracked and evaluated gross peak demand energy savings.

Evaluated gross energy savings and demand savings are almost equal to tracked savings. The small difference in peak demand savings for booster pumps is due to the Evaluator making a downward adjustment to the peak coincidence factor. The small difference in energy savings and peak demand savings for linear fixtures and lamps is due to the Evaluator updating the proportion of recessed products in the interactive effects factors based on the 2021 tracking sheet. A slight change of the line loss factors affected the evaluated gross energy and peak demand savings for all categories.

Figure 17: 2021 Instant Rebates Tracked and Evaluated Gross Energy Savings

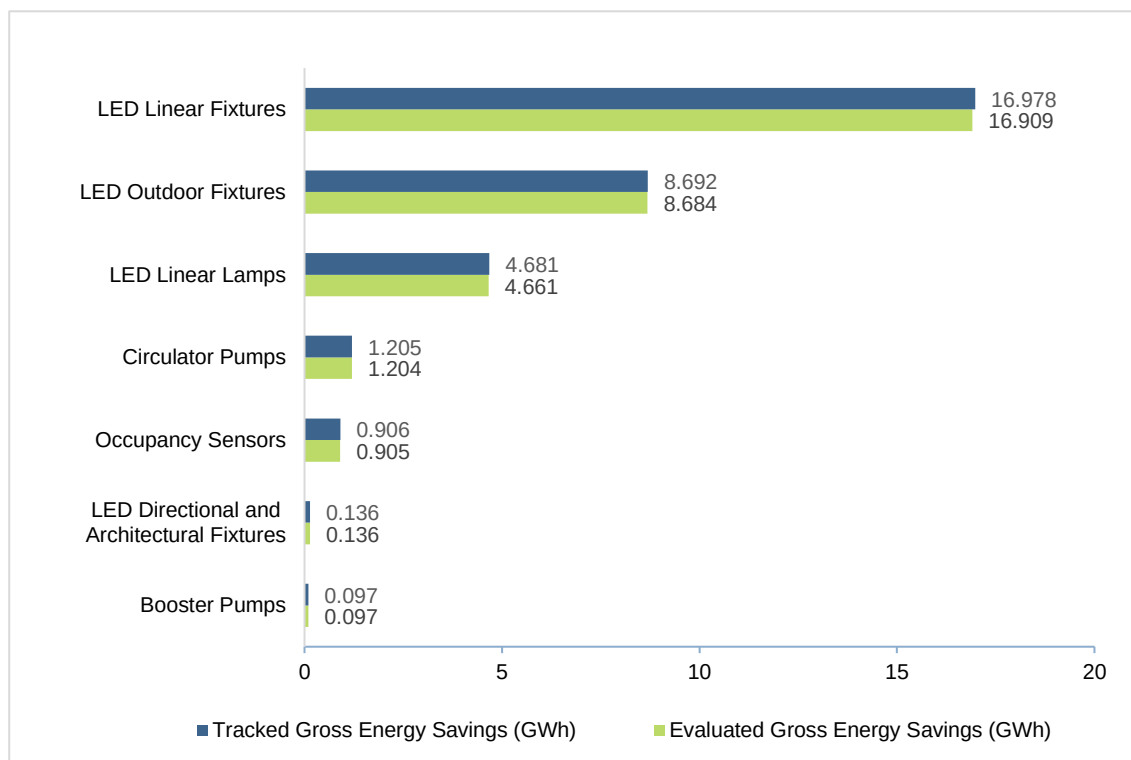
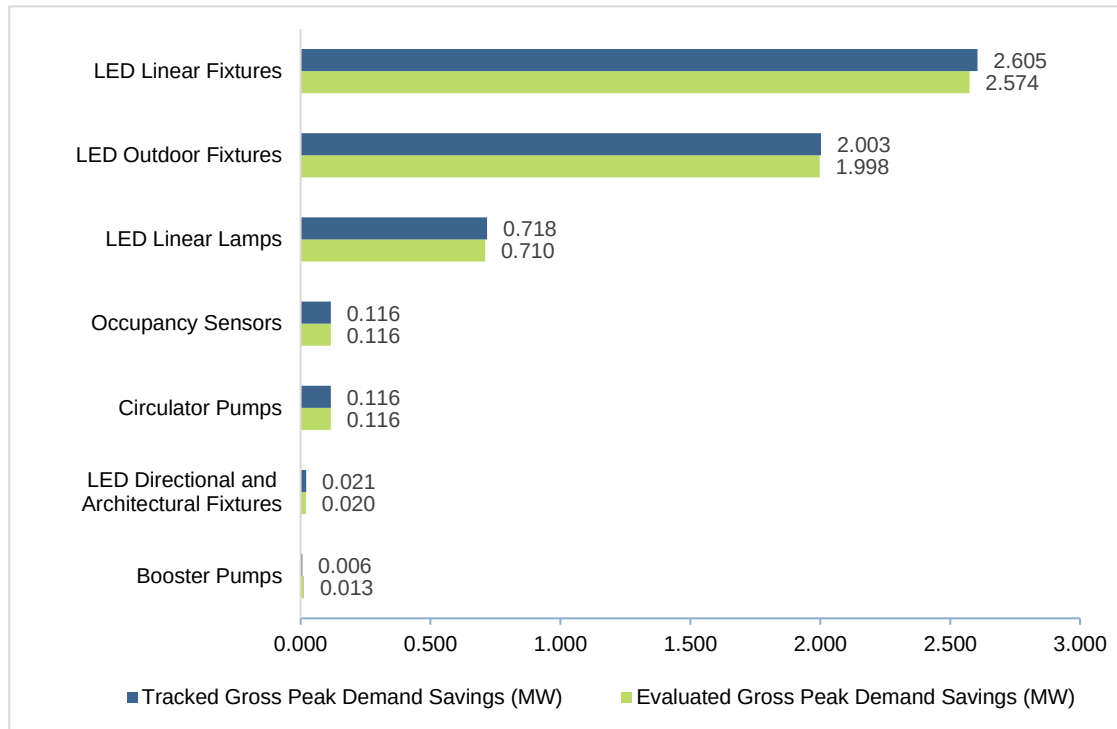


Figure 18: 2021 Instant Rebates Tracked and Evaluated Gross Peak Demand Savings



5.3 Net Savings

The Evaluator determined the net energy savings, i.e. the electrical energy savings that can be reliably attributed to a program component, by estimating the NTGR. In the case of Instant Rebates, the NTGR is established by considering free-ridership.

5.3.1 Free-ridership

For Instant Rebates, free-ridership corresponds to the proportion of savings due to natural market trends. Thus, the free-ridership assessment is aimed at estimating the level of sales of energy efficient measures that would have occurred in a market that evolved naturally, i.e. without service influence. The algorithm used to determine the level of free-ridership is presented in Appendix XII.

The Evaluator conducted a survey with 50 Instant Rebates participants to assess free-ridership. Free-ridership was measured through both the participant survey and in-depth interviews with 8 distributors. This approach served to incorporate the perspectives of both participants and distributors, the latter being especially important in services such as Instant Rebates because they influence measure offerings. Using multiple methods to assess free-ridership serves to triangulate results and provides the most defensible NTGR estimate.¹³

¹³ TecMarket Works, *The California Evaluation Framework*, June 2004.

The evaluation targeted the following three measure categories:

- › LED linear fixtures
- › LED linear lamps
- › LED outdoor fixtures

These categories represent 93% of all gross energy savings generated by Instant Rebates. They were selected because they were the best-selling categories in 2021.

During interviews with distributors, the Evaluator used a set of questions to identify the influence that the service had on the market. The in-depth interviews with distributors included questions to estimate:

- › The percentage of their energy efficient measures that would not have been sold in the absence of the service
- › The service influence (on a scale of 0 to 10 where 0 means "Not at all satisfied" and 10 means "Very satisfied") on participant decisions to purchase the energy efficient lighting measures
- › The service influence (on the scale of 0 to 10) on distributor decisions to carry DLC and ENERGY STAR certified measures

The participant survey sample included 50 end users (48% of end users and 52% of contractors) and eight distributors. The Evaluator used a set of questions to identify the influence of the service on participant decisions to purchase LED measures. The questions included in the questionnaire were aimed at estimating:

- › The influence of rebates on participant decisions to purchase energy efficient lighting measures
- › The cross-influence that previous exposure to ENS communication and programs had on participant decisions

The Evaluator calculated the level of free-ridership for each measure category using the results of the distributor interviews and participant survey, as presented in Table 22 below. The overall free-ridership level corresponds to the average of the free-ridership levels obtained through the participant survey and distributor interviews. Appendix XII presents the algorithm used to convert the participant survey results into free-ridership levels.

Table 22: 2021 Instant Rebates Free-ridership

Measure Category	Overall 2021 Free-ridership Level	Free-ridership Level (from distributor interviews)	Free-ridership Level (from participant survey)	Margin of Error (from distributor interviews)	Margin of Error (from participant survey)
LED Linear Fixtures	40%	48%	32%	7.0%	8.7%
LED Linear Lamps	30%	26%	33%	5.7%	8.3%
LED Outdoor Fixtures	35%	41%	29%	7.0%	10.8%

The free-ridership levels obtained for each measure category range between 30% and 40%, meaning that approximately one-third of rebated LED products would have been sold in the absence of the service. For reference, the overall free-ridership levels in 2020 were 27% for LED linear fixtures, 28% for LED linear lamps, and 31% for LED outdoor fixtures.

Most distributors (five out of eight) expressed that they would have sold fewer units in the absence of the program mostly because the incremental cost of those products remains sufficiently high. However, it should be noted that the proportion of distributors in agreement with this observation has declined slightly since 2020 when almost all distributors (80% or more depending on the lighting category) expressed that they would have sold fewer units in the absence of the program.

On average, distributors estimate that they would have sold from fewer units in the absence of the program, depending on the lighting category (38% fewer units for linear LED fixtures, 44% fewer units for LED linear lamps, and 29% fewer units for LED outdoor fixtures). Most distributors reported that Instant Rebates clearly influences consumer product choices given that it reduces overall price points most notably for LED linear lamps. The incentive levels are considered adequate to motivate customers to turn to new technologies rather than purchasing old technologies. Instant Rebates is also key in getting distributors to carry DLC-certified linear LED fixtures, LED linear lamps, and outdoor LED fixtures. Many distributors mentioned only carrying DLC-certified products to ensure they qualify for rebate programs and remain competitive in the Nova Scotia market.

Overall, these findings indicate that most distributors find that the program remains successful in encouraging participants to purchase energy efficient lighting products.

5.3.2 Net-to-gross Ratio Calculation

The NTGR is calculated using the following equation.

$$NTGR = (1 - \% \text{ Free-ridership})$$

As presented in Table 23, using the free-ridership levels outlined in Subsection 5.3.1 above, NTGRs were established for the main measure categories. For the other measures sold through Instant Rebates, a NTGR of 1.00 was used.

Table 23: 2021 Instant Rebates NTGR

Measure	Free-ridership	NTGR
LED Linear Fixtures	40%	0.60
LED Linear Lamps	30%	0.70
LED Outdoor Fixtures	35%	0.65
Other Measures	0%	1.00

5.3.3 Evaluated Net Savings

Net savings are defined as the changes in energy use that are specifically attributable to Instant Rebates. Net savings were estimated by applying the overall NTGR presented above to evaluated gross savings as exemplified in the following equation:

$$\text{Net Savings} = \text{Evaluated Gross Savings} \times \text{NTGR}$$

Net energy savings were first calculated separately for each measure category because the NTGR differed from one measure category to another.

The total net energy and peak demand savings amounted to 21.380 GWh and 3.600 MW respectively at the generator. The net lifetime energy savings were established at 296.878 GWh, which yields an average EUL of 13.9 years. Table 24 below presents the details of these calculations.

Table 24: Evaluated 2021 Instant Rebates Net Energy and Peak Demand Savings

Measure Category	LED Linear Fixtures	LED Linear Lamps	LED Outdoor Fixtures	LED Directional and Architectural Fixtures	Occupancy Sensors	Circulator Pumps	Booster Pumps	Total for All Measures
Energy Savings								
Gross Energy Savings – at the Meter (GWh)	15.862	4.373	8.146	0.127	0.849	1.130	0.091	30.578
NTGR	0.60	0.70	0.65	1.00	1.00	1.000	1.000	-
Net Energy Savings – at the Meter (GWh)	9.510	3.076	5.274	0.127	0.849	1.130	0.091	20.057
Line Loss Factor	1.066	1.066	1.066	1.066	1.066	1.066	1.066	-
Net Energy Savings – at the Generator (GWh)	10.137	3.279	5.622	0.136	0.905	1.204	0.097	21.380
Effective Useful Life (years)	11.6	11.6	19.8	11.6	10.0	15.0	15.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	117.592	38.034	111.102	1.573	9.052	18.063	1.460	296.876
Peak Demand Savings								
Gross Peak Demand Savings – at the Meter (MW)	2.396	0.661	1.860	0.019	0.108	0.108	0.012	5.164
NTGR	0.60	0.70	0.65	1.00	1.00	1.000	1.000	-
Net Peak Demand Savings – at the Meter (MW)	1.437	0.465	1.204	0.019	0.108	0.108	0.012	3.352
Line Loss Factor	1.074	1.074	1.074	1.074	1.074	1.074	1.074	-
Net Peak Demand Savings – at the Generator (MW)	1.543	0.499	1.293	0.020	0.116	0.116	0.013	3.600

As presented in Table 25. applying the Nova Scotia-specific factor¹⁴ for GHG emissions generated by electricity production to Instant Rebates net savings corresponds to a total of 12,488 tonnes of annually avoided CO₂ eq.

Table 25: Evaluated 2021 Instant Rebates GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	21.380
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/GWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	12,488

5.4 Realization Rate

Table 26 compares the total tracked and evaluated savings for Instant Rebates. The realization rate representing the ratio of evaluated net savings to tracked net savings was established at 89% for energy savings and for peak demand savings.

Table 26: Comparison of 2021 Instant Rebates Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	32.696	GWh	0.74	24.107	GWh	89%
Evaluation Results	32.596	GWh	0.66	21.380	GWh	
Peak Demand Savings						
Tracked Savings by EOne	5.588	MW	0.73	4.063	MW	89%
Evaluation Results	5.546	MW	0.65	3.600	MW	
* The average NTGR values presented in this table correspond to the ratios of net savings to gross savings for Instant Rebates.						

The evaluated net energy and demand savings were 11% lower than the values tracked by EOne. These differences are mainly attributed to the increase in free-ridership levels for lighting measures.

¹⁴ At the time of writing, 2020 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2019 total system emissions data (6,574,414 CO₂ eq tonnes) and total electricity generation (11,201 GWh) was drawn from the following two sources:
 Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed August 7, 2020), Emera inc., *Management's Discussion & Analysis*, as at February 14, 2020
https://s25.q4cdn.com/978989322/files/doc_financials/2019/q4/78b8ca7a-c3dc-536f-3c3b-f095e9f448fb.pdf (Last accessed August 7, 2020).

6 OVERALL BER RESULTS

Table 27 compares the savings tracked by EOne to the 2021 evaluated savings for BER. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 90% for energy savings and at 87% for peak demand savings.

Table 27: Comparison of 2021 BER Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	49.141	GWh	0.76	37.345	GWh	90%
Evaluation Results	48.962	GWh	0.68	33.491	GWh	
Peak Demand Savings						
Tracked Savings by EOne	8.282	MW	0.75	6.227	MW	87%
Evaluation Results	7.979	MW	0.68	5.401	MW	
*Different NTGRs were established for Mail-in and Instant Rebates. The average NTGR values presented in this table correspond to the ratios of net savings to gross savings for both services.						

Evaluated net energy and peak demand savings were respectively 10% and 13% lower than the values tracked by EOne. These differences are mainly attributed to the increase in free-ridership level for lighting measures under Mail-in and for LED linear fixtures under Instant Rebates. Evaluated results were also impacted by adjustments to parameters such as free-ridership levels from the other measure categories of both program components and Mail-in adjustment ratios.

7 BER MARKET EVOLUTION

EOne has been active in the LED market of the BNI sector through BER since 2010. Market evolution assessments were completed as part of the 2017, 2018, and 2019 evaluations, the results of which served to analyze key market indicators and present a technology diffusion curve illustrating the market adoption of LED lighting in the Nova Scotia BNI sector. The aim of this section is to update the data collected as part of previous evaluations and provide up-to-date insights regarding the market transformation of LED lighting in Nova Scotia. Given that the LED market is rapidly evolving, regularly monitoring barriers to LED adoption is important to enable EOne to adapt the program component offer if needed.

7.1 Market Indicators – LED Lighting

To understand the state of the Nova Scotia LED lighting market for the BNI sector, the Evaluator established key market indicators and analyzed available market data. The Evaluator also used data from Instant Rebates for the analysis since sales quantities and prices are documented in greater detail than for Mail-in lighting measure categories.

In the following subsections, the Evaluator examines at LED lamp and fixture market shares separately since the data come from two different sources.

7.1.1 Market Shares of Lamp Technologies

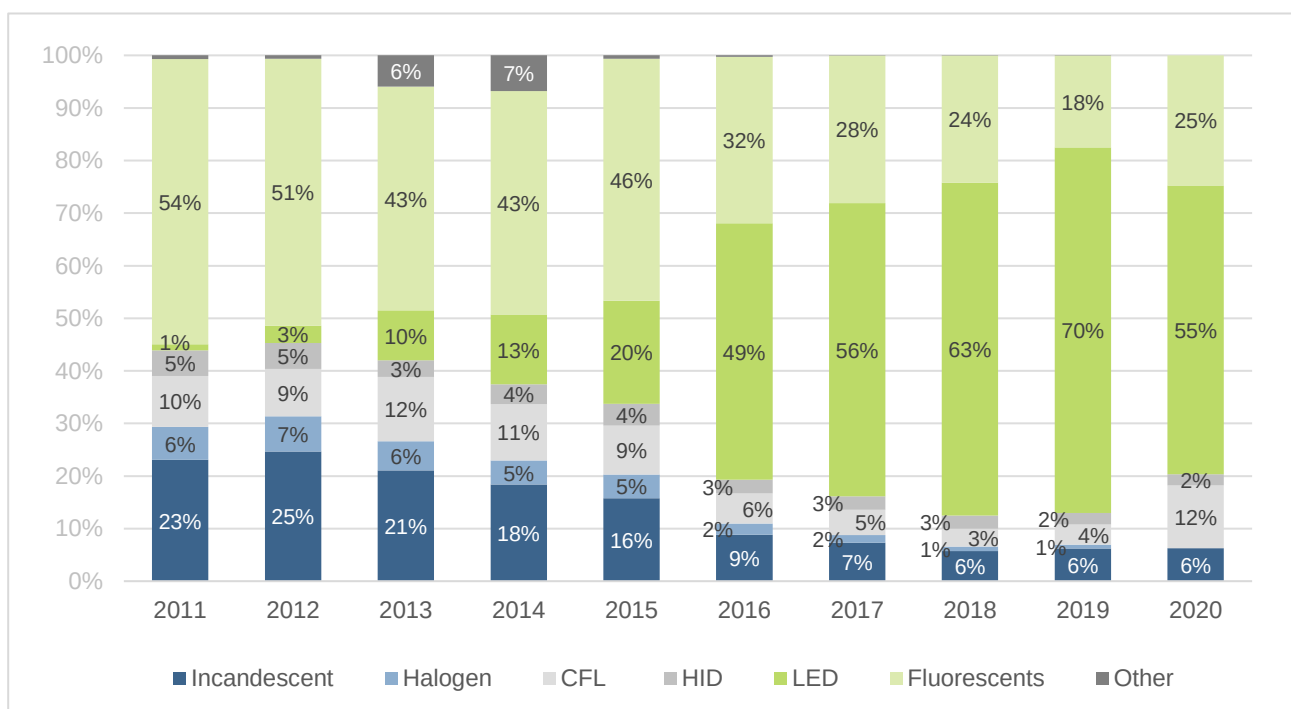
The BNI lamp market is comprised of six main technologies: Incandescent, halogen, Compact Fluorescent Light (CFLs), high intensity discharge (HID), LEDs, and fluorescent. As in the 2017 to 2019 evaluations, Electro-Federation Canada data as well as Electro-Federation coverage assumptions were used to estimate total lamp shipments and market shares in the commercial and industrial sectors¹⁵ of the Atlantic region.

¹⁵ Data were not available specifically for the BNI sector. Data were available for two groups: consumers, as well as commercial and industrial. The commercial and industrial sectors were selected as the most similar sectors to the BNI sector among available data.

The size of the commercial and industrial lamp market¹⁶ in Atlantic Canada contracted by almost half (-46%) between 2018 and 2020 (by -38% from 2018 to 2019 and by -13% from 2019 to 2020). While the effects of the COVID-19 pandemic on product availability, distribution, and demand may partially explain the market contraction, a larger decline was observed prior to 2020. Distributors observed significant supply chain issues in 2021 due to COVID-19 and expect these to continue into 2022. This observation could be verified once future shipment numbers for 2021 and 2022 become available. Shipments of all technologies¹⁷ except CFL lamps recorded similar declines over the 2018-2020 period. This includes a drop in LED lamp shipments (-53%) whose decrease may be due to a number of factors: The LED market, already close to maturity in 2019, may have peaked; LEDs have longer product lives and require fewer replacement lamps; and a possible shift to integrated lamps as fixtures become more popular.

In terms of shipment shares, Figure 19 below illustrates that the share of LED lamp shipments grew quickly as of 2013, attained a high of 70% in 2019, and declined in 2020 by 15% compared to the 2019 peak. The increase in CFL lamp shipments to a 12% share is an anomaly from the trend in the previous four years for which CFLs had less than a 5% share.

Figure 19: Atlantic Canada Commercial and Industrial Lighting Shipments by Technology (%), 2011-2020



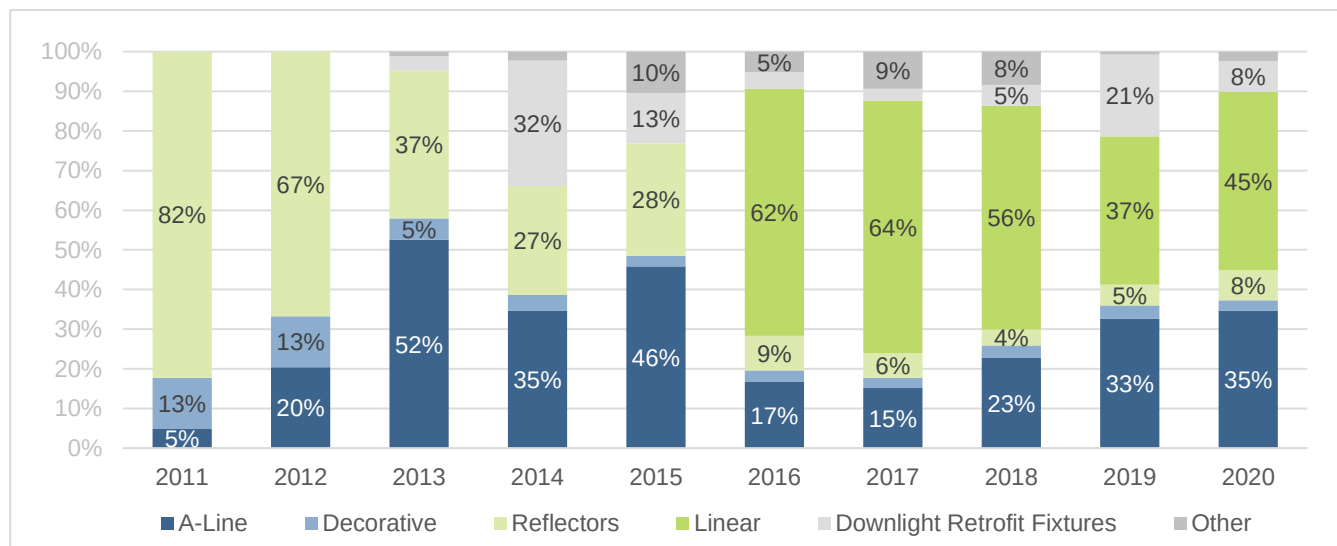
Source: Electro-Federation Canada, Lamp Data - Consumer Channel and C&I Channel 2018-2020, October 2021.

¹⁶ The size of the market is estimated using total unit shipments.

¹⁷ In 2020, data for halogen lamps were included under incandescent lamps due to confidentiality restraints; therefore, the Evaluator was unable to determine growth or decline for this technology.

A breakdown of LED shipment shares in the Atlantic region by lamp type is presented in Figure 20 below. The share of LED A-type lamps more than doubled from 2016 to 2020 (from 17% to 35%), with LED decorative and reflector bulb shares remaining relatively stable between 2016 and 2020. The share of LED linear lamps declined by 17% between 2016 and 2020 (from 62% to 45%) likely due to the gradual replacement of ballast fixtures (housing fluorescent tubes) as they fail by integrated LEDs.¹⁸ Note that while Electro-fed data do not distinguish between the new construction and the retrofit markets, there are likely differences in market uptake between the two, namely with LED fixtures being more attractive in the new construction market.

Figure 20: Atlantic Canada Commercial and Industrial LED Lighting Shipment Shares by Type (%), 2011-2020



Source: Electro-Federation Canada, Lamp Data - Consumer Channel and C&I Channel 2018-2020, October 2021.

7.1.2 Market Shares of LED Fixture Types

As with LED lamps, the Evaluator relied on secondary data available for 2018 to 2020 from Electro-Federation Canada and data from Instant Rebates to understand the state of the Nova Scotia LED fixture market.

The fixture market comprises many different categories of indoor and outdoor lighting products. The main ones include high/low-bay and enclosed/gasketed units, which are both indoor fixtures, as well as floodlights and area/site lights, which are outdoor fixtures. Since secondary data from Electro-Federation Canada for the BNI sector were unavailable, the Evaluator used data for the industrial sector to provide an estimate of lighting fixture market sales and shares in Atlantic Canada.

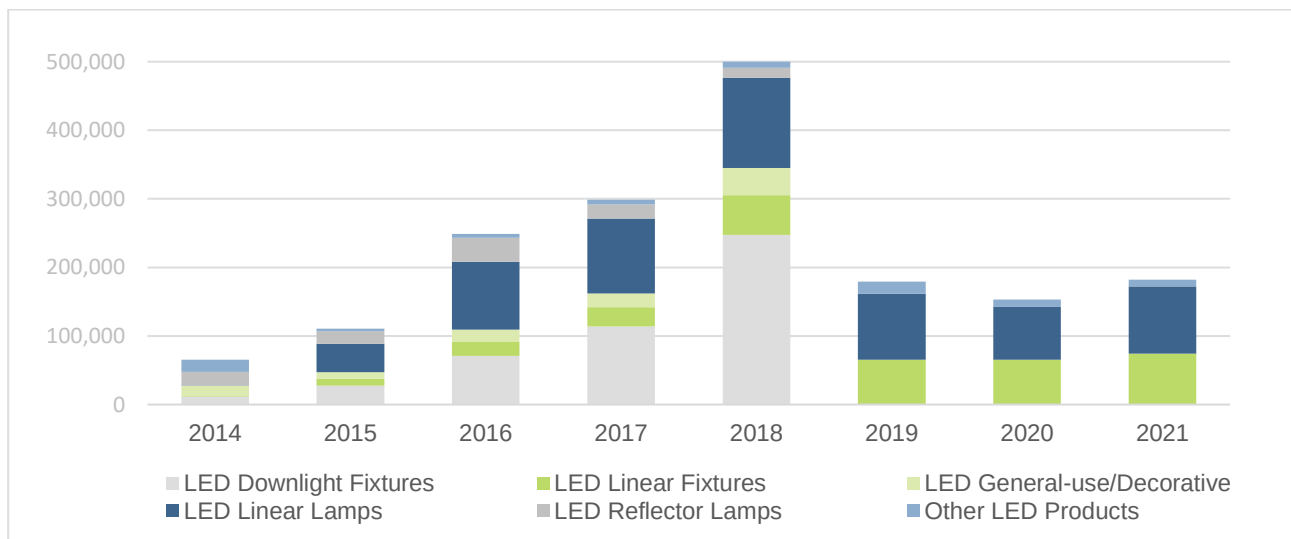
¹⁸ Data were unavailable for LED linear lamps before 2016.

Between 2018 and 2020, the industrial fixtures market¹⁹ declined by 39% and the industrial LED fixtures market declined just slightly less in comparison (-34%). Despite these contractions, the share of LED fixtures continued to grow, representing almost the entirety (92%) of the total fixture shipments reported by Electro-fed in 2020 (an increase of seven percent over 2018 levels). In 2020, this market was split roughly between outdoor and indoor fixtures, with the former category comprising 56%.

7.1.3 BER Instant Rebates Rebated LED Lighting Units

The total number of LED lamps and fixtures per measure category incented by Instant Rebates since 2014 is presented in Figure 21 below. Since 2019, rebates are no longer provided for downlight fixtures as well as general-use, decorative use, and reflector lamps. The total number of rebated LED linear lamps and LED linear fixtures increased by 27% and 14% respectively between 2020-2021, similar to 2019 results. LED linear lamps constituted 54% and LED linear fixtures comprised 41% of all BER rebated LED lighting products in 2021.

Figure 21: BER Instant Rebates Incented LED Units, 2014-2021²⁰



As mentioned above, BER has not incented downlight fixtures, general-use, decorative, and reflector lamps since 2019. To gain perspective on the potential impact of the removal of these incentives, distributors were asked about their 2021 lighting product sales.

Looking at their own historical sales, distributors generally report that sales of LED downlight fixtures have increased in the past three years, with one exception who saw a decline. This increase is primarily explained by the appeal of LED technology, a desire to install recessed lighting in new constructions, the large number of multi-unit building construction projects in the Halifax Regional Municipality (HRM), and the ease of installation of these products.

¹⁹ The size of the market is estimated using sales amounts in \$ and includes all fixture types (not just LED).

²⁰ Data by type of LEDs before 2015 should be used with caution since measure descriptions found in the 2012-2014 tracking sheets were not as detailed as they have been since 2015.

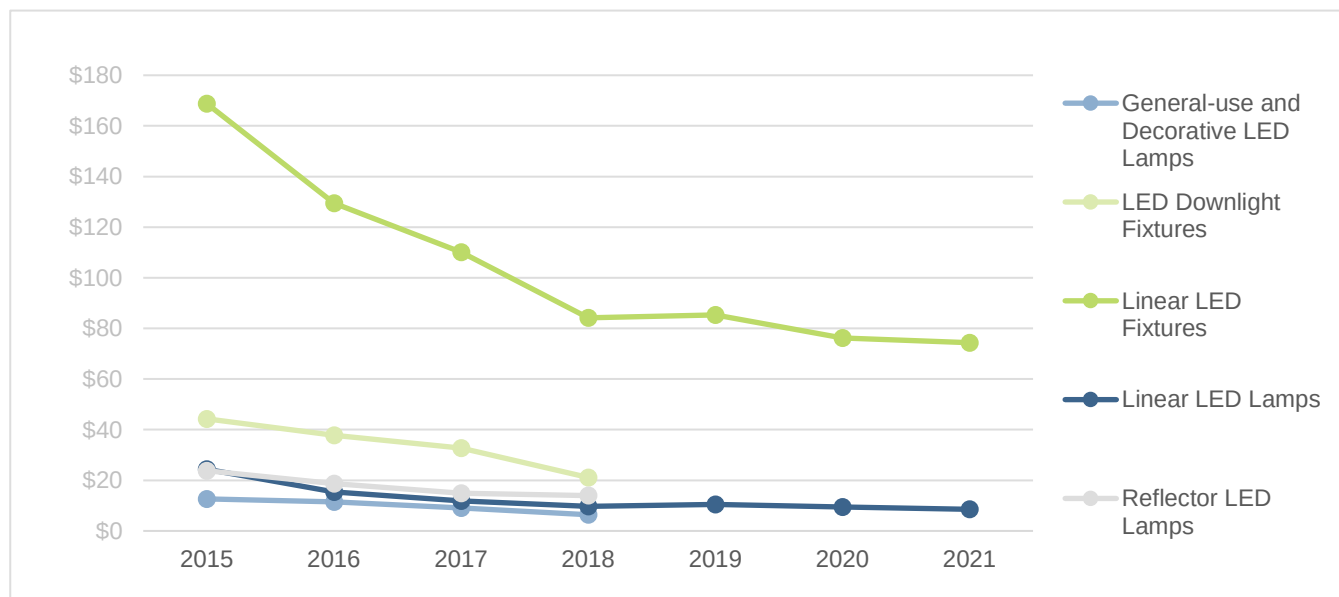
The situation with general use and decorative lamps is somewhat different. Three distributors saw their sales of general use and decorative lamps decline in the past three years mainly due to customer preference for fixtures. Three distributors did not see any change in their sales of general use and decorative lamps despite recognizing the increased appeal and variety of fixtures over lamps. Finally, two distributors saw a marginal increase in sales from their customers involved in new construction.

7.1.4 Retail LED Lighting Prices

Figure 22 below illustrates the evolution of the average cost per unit (before rebates) for the following LED lighting categories: Linear lamps and fixtures as well as general and decorative use and reflector lamps. The average cost per unit for linear lamps and linear fixtures is presented from 2015 to 2021. Since rebates were no longer offered through BER after 2018 for general and decorative use and reflector lamps, data for 2019-2021 are not available. The data originate from Instant Rebates tracking sheets and are unavailable prior to 2015.

The average retail price of both LED linear lamps and LED linear fixtures reached new low levels of \$8.54 and \$74.36 respectively in 2021. Prices have been relatively stable for LED linear lamps since 2017 and appear to be stabilizing for LED linear fixtures, even though their quality, variety and elaborateness continues to grow.

Figure 22: Average Retail Prices of Rebated LED Lamps and Fixtures, 2015-2021



As listed in Table 28, the average rebate value offered under Instant Rebates for LED linear lamps decreased in 2020 and reached its lowest level in 2021, which is in line with average retail prices. The average rebate values offered for LED linear fixtures seems to have stabilized over the past few years.

Table 28: Average Rebate Values Under Instant Rebates for LED Linear Fixtures and Lamps, 2015-2021

Measure Category	2015	2016	2017	2018	2019	2020	2021
LED Linear Fixtures	\$37.04	\$34.67	\$29.24	\$25.43	\$25.31	\$23.35	\$24.55
LED Linear Lamps	\$8.49	\$5.76	\$4.48	\$3.77	\$3.89	\$3.71	\$3.39

7.1.5 BER Participating Distributor Outlook – LED Lighting

Instant Rebates collaborates with distributors to provide rebates on lighting measures to BNI participants. As part of the market evolution analysis, the Evaluator asked distributors where on a product adoption curve they would position LED linear lamps, LED general-use and decorative lamps, LED linear fixtures, and LED downlight fixtures in the context of the Nova Scotia commercial, industrial, and institutional sectors.

A product adoption curve depicts the product market evolution process. When a new product is first introduced into the market, sales are relatively low; then sales grow over time, reach a point of maturity, and sales peak. Sales then level off, taper, and eventually phase out. Distributors were asked, for each measure category, whether measures were at the initial uptake, gaining popularity, at sustained growth, nearing product maturity, levelling off, waning interest, or obsolete phase.

The market for general use and decorative LED lamps primarily stands between nearing product maturity and waning interest, although one distributor believes it remains in sustained growth given product improvements such as lamps without blue light and a better colour rendering index. Other distributors believe that the product category is maturing despite the introduction of new features given the high market penetration of LED lamps and the increased interest in fixtures over lamps.

There are varying opinions in terms of where the BNI market for lighting products stands on the product adoption curve. With respect to LED linear lamps, distributors generally place this product category between sustained growth and levelling off. The product's improved features (better colour rendering index, lower wattage, smaller lighting) and a lower price point are considered to contribute to sustaining the appeal of LED linear lamps. One distributor believes that there is waning interest for LED linear lamps and that the product is near being displaced as interest in these products have significantly declined. This is consistent with the fact that sold fixtures are overwhelmingly LED fixtures (92% as mentioned in Subsection 7.1.2). As fluorescent fixtures are replaced with LED fixtures, the potential market for LED linear lamps will diminish.

According to distributors, there is more market potential for LED fixtures in general compared to lamps. They position both LED downlight fixtures and LED linear fixtures somewhere between gaining popularity and levelling off. The popularity of these fixtures is explained by familiarity with the product, improvements in terms of options and variety (e.g. colour selection, varying colour temperatures, increased lumens per watt, and various voltages and outputs), new features (e.g. integrated controls, time dimming, and occupancy sensors), and the appeal of recessed lighting.

7.1.6 Free-ridership Levels – LED Lighting

The Evaluator examined the unitary savings values and free-ridership levels to gain insights into the evolution of the BNI LED lighting market in Nova Scotia.

For Instant Rebates, free-ridership corresponds to the proportion of savings that is due to natural market trends. From 2012 to 2016, the free-ridership levels were measured via in-depth interviews with distributors. Conversely since 2017, the free-ridership approach has been changed to include results from distributor interviews as well as an end-user survey. This should be considered when comparing 2017-2021 results to those of past evaluations. Table 29 below lists the free-ridership levels calculated since 2014 for LED lamps.

The free-ridership of LED linear lamps and outdoor fixtures is similar in 2021, with small increases from 2020. The level for LED linear fixtures rose to 40% in 2021, up from 27% in 2019. As discussed in Subsection 5.3.1, this increase is due to an increase in the distributor free-ridership level, with more distributors indicating that they would have sold the same proportion of LED fixtures than in 2020 in the absence of the program.

Table 29: Free-ridership Levels for Instant Rebates on LED Linear Lamps and Fixtures, 2014-2021

Measure Category	2014	2015	2016	2017	2018	2019	2020	2021
LED Linear Lamps	-	-	-	38%	37%	21%	28%	30%
LED Linear Fixtures	-	25%	37%	32%	29%	29%	27%	40%
LED Outdoor Fixtures	-	-	-	-	-	32%	31%	35%

7.2 Codes and Standards

The ultimate indicator of market transformation is the adoption of more stringent codes and standards. Currently, general-use lamps²¹ are required to meet an efficiency level that corresponds to halogen incandescent bulbs. For instance, a standard 60 W incandescent bulb is no longer allowed, and its equivalent is a 43 W halogen incandescent bulb. This minimum energy performance standard has been in effect since early 2014 or early 2015, depending on lamp wattages. The latest amendment to the Canadian Energy Efficiency Regulations (Amendment 14 published on October 31, 2018)²² increased the range of fluorescent lamp ballasts affected by the regulation and introduced minimum energy performance requirements for metal halide ballasts in an effort to align Canadian to American regulations.

²¹ The Energy Efficiency Regulation for general-use lamps covers most A-type lamps (incandescent and LEDs). Natural Resources Canada, *General Service Lamps and Modified Spectrum Incandescent Lamps Energy Efficiency Regulations*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869> (Last accessed December 06, 2018).

²² Natural Resources Canada, *Amendment 14, October 2018*. <http://www.nrcan.gc.ca/energy/regulations-codes-standards/18437> (Last accessed December 06, 2018).

Importantly, Amendment 14 did not have any significant impact on the efficiency of lamps and fixtures rebated through BER. While the new regulation is an indication that the market is evolving, it does not represent significant improvements to the overall efficiency of lighting measures and does not affect the base case technologies as defined in Instant Rebates savings calculations for LED linear lamps and fixtures.

As in the residential market and as described in Appendix II of the 2020-2022 Measure Assessment, in terms of government regulations, the U.S. Energy Independence and Security Act continues to be a key consideration.²³ The previous U.S. administration decided to eliminate the EISA backstop on inefficient lighting products. In response, six states passed their own state legislation to implement the efficient lighting standards on January 1, 2020 regardless of what happened nationally. In 2021, the Biden administration put general service lighting back on the regulatory agenda, and it was expected to restore the lighting standards for the extended definition of general service lamps (including decorative and reflector lamps) to the 45 lumens/W efficiency standard before the end of 2021.²⁴ As of December 2021, the standards had not been adopted yet, but it should be imminently. The standards could still take some time to take effect, and there remains uncertainty as to the amount of time the Department of Energy (DOE) will allow between the adoption of the standards and compliance enforcement, with some observers estimating that the standard will be in effect in 2023.²⁵

In Canada, lighting is not currently on Natural Resources Canada's Forward Regulatory Plan for 2021-2023, although Canadian regulations typically follow the U.S. within approximately two years. While the upcoming regulation is set to establish a minimum efficiency level corresponding to a CFL, recent studies²⁶ indicate that the U.S. market is rapidly moving away from CFL lamps toward LED lamps. These regulations and trends will impact the base case technology for decorative, general-use, and reflector lamps as well as downlight fixtures that are no longer part of the BER offering.

7.3 Market Evolution Summary

In their recommendations on market transformation program planning, Rosenberg and Hoefgen (2009) identify a number of factors, listed in Table 30 below, to be analyzed to identify whether program support should be withdrawn or reduced in light of changes observed in the market.²⁷

²³ Illinois Energy Efficiency Stakeholder Advisory Group, *Illinois Statewide Technical Reference Manual for Energy Efficiency Version 8.0, Volume 3*, October 2019, p. 258.

²⁴ Apex Analytics. *LED Market Update: LEDs Continue to Gain Market Share, Biden Administration Exploring Options for EISA Backstop*, August 26, 2021.

²⁵ Ibid.

²⁶ Ibid.

²⁷ Rosenberg and Hoefgen, *Market Effects and Market Transformation: Their Role in Energy Efficiency Program Design and Evaluation*, prepared for the California Institute of Energy and the Environment, 2009.

Table 30: 2021 Analysis of Key Factors in Program Planning

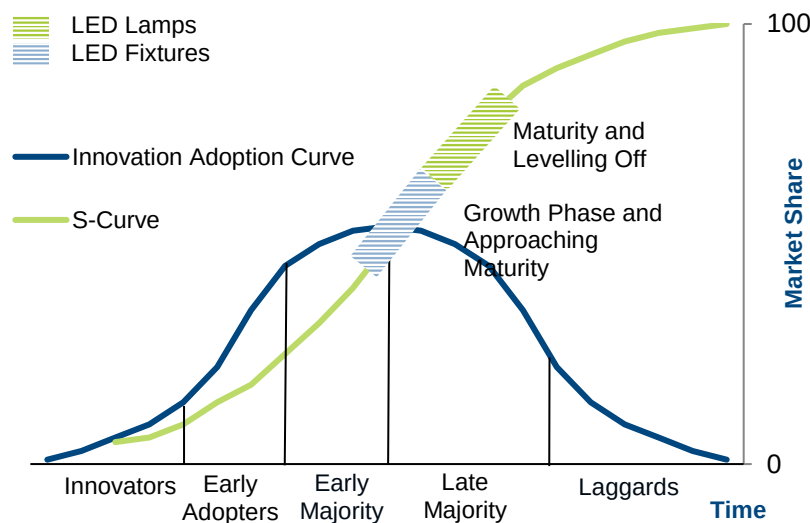
Factor	Results
Market share of LED lamps for BNI sector	Although LED lamp shipments targeted at the commercial and industrial sectors in Atlantic Canada still constituted the highest share of lighting shipments in 2020 at 55%, their part of the market declined by 15 percentage points over the 2019 peak (70%) and the market overall is contracting. Note that 2020 (and in all likelihood 2021 and 2022) may not be representative of trends due to the COVID-19 pandemic. Most distributors see the market for LED linear lamps as well as general-use and decorative LEDs as close to maturity and predict that sales will begin to level off, with some distributors already reporting a decrease in sales of these products due to a preference for fixtures.
Market share of LED fixtures for BNI sector	Despite declining industrial fixture (including LED fixture) shipments, which dropped by 39% between 2018 and 2020, the share of LED fixtures continued to grow in 2020, representing almost the entirety of the industrial shipments reported by Electro-fed (92%). As with LED lamps, 2020 may not be a representative year due to the COVID-19 pandemic. The majority of distributors report that their LED downlight fixture sales have generally increased due to factors such as the appeal of the technology, the variety of styles and options available, ease of installation, and switching to integrated lamps. Most distributors are of the opinion that the markets for LED linear and downlight fixtures still have some growth potential but are approaching the maturity phase.
Trends in prices and availability	The average retail prices of LED linear fixtures and LED linear lamps reached a new low at approximately \$74 and \$9 respectively in 2021. Prices seem to be stabilizing even though their quality, variety and elaborateness continues to grow. The majority of distributors in Nova Scotia are involved in BER; therefore, the technology is widely available to BNI customers across the province.
Likelihood of inclusion in a near-term code or standard	The efficiency levels of LED linear fixtures and lamps rebated through BER remain far superior to the efficiency levels required by current Canadian regulations. The U.S. is imminently set to adopt a general service lamp minimum energy performance requirement. The update is expected to effectively ban halogen incandescent lamps from being manufactured or imported once the standard comes into force. In Canada, lighting is not currently in Natural Resources Canada's Forward Regulatory Plan for 2021-2023, although Canadian regulations typically follow the U.S. within approximately two years.
Market readiness of more efficient substitute technology	No more efficient substitute than LEDs has come to market. Efficiency improvements in LED lamps and fixtures are likely with organizations like the Design Lights Consortium increasing their criteria for certification.

Figure 23 below provides a qualitative indication of the stage of LED lighting adoption in the Nova Scotia BNI sector. The technology diffusion curve illustrates how successive groups of customers adopt the new technology (as illustrated by the innovation adoption curve in black)²⁸ and how the market share (illustrated by the S-curve in grey) eventually reaches saturation levels.

²⁸ Everett M. Rogers, *Diffusion of Innovations – Fifth Edition*, August 16, 2003.

The Evaluator finds that the commercial/industrial LED lamp market has reached maturity and is now in a levelling-off phase as inferred by the decline in shipment shares in conjunction with price stability (see green striped box below). For LED fixtures, the 2021 data lead the Evaluator to believe that the category is approaching the maturity phase (early majority – late majority), but still has some growth potential as suggested by increasing LED fixture shares, indications that prices are beginning to stabilize, and distributors’ opinions on the popularity of the products and increasing sales (see blue striped box below). As noted by the distributors, both products and particularly LED fixtures are evolving with more efficient models becoming available, which will impact market trends over time.

Figure 23: 2021 Market Evolution for Commercial LED Lighting



8 BER KEY FINDINGS AND RECOMMENDATIONS

The main objectives of the 2021 BER evaluation were as follows:

- › Collect information on BER participant and partner perspectives
- › Calculate gross and net BER results (for both Mail-in and Instant Rebates), namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions²⁹
- › Analyze the market evolution of LED lamps and fixtures

This section provides the Evaluator's key findings in relation to these objectives. The Evaluator has two specific recommendations for BER.

2021 BER-Finding: BER net electrical energy and peak demand savings fell short of targets.

BER achieved 33.491 GWh in net electrical energy savings and 5.401 MW in net peak demand savings at the generator in 2021, thus not attaining the planned net electrical energy savings of 35.681 GWh and net peak demand savings of 7.236 MW.

2021 BER-Finding: Participation increased for both Mail-in and Instant Rebates in 2021 and total gross energy and peak demand savings increased compared to 2020 levels.

Mail-in participation increased with 18% more participating businesses although gross savings per participant declined by 20% in 2021. Instant Rebates participation also increased with 18% more measures sold. Overall, BER gross energy and peak demand savings increased by 10% and 7% respectively. The increase is due to a slight resumption in participation in the context of the COVID-19 pandemic, especially in Instant Rebates, which resulted in more businesses purchasing energy efficient products.

2021 BER-Finding: Overall satisfaction with BER is high among participants of both services and among Instant Rebates distributors.

For Instant Rebates, on a 10-point scale, average satisfaction ratings of 8.9 and 8.0 were reported by participants and distributors respectively. For Mail-in, an average satisfaction rating of 9.1 was reported by participants. Participants from both services reported being very satisfied with the interactions and communications with their distributors and contractors.

²⁹ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

2021 BER-Finding: Following the site visits, the Evaluator made downward adjustments to energy and peak demand savings for Mail-in.

The Mail-In lighting project review and site visit results revealed that the parameters used to determine tracked savings, such as HOU's and peak coincidence factors, are often incorrectly reported by participants. This could be mitigated by adjusting the application worksheet.

Overall, on-site visits led to negative adjustment ratios of 0.993 and 0.841 for energy and peak demand savings respectively, which decreased Mail-in total gross energy and peak demand savings by 0.5% and 9.7% respectively. Tracked HOU's, peak coincidence factors, and interactive effects were the parameters that required the most adjustments. The Evaluator noted that the related fields in the lighting measure worksheet were either not specific to each product or did not provide an opportunity for the participant to customize their answer to reflect how the products would be used in their facility.

2021 BER-Recommendation 1: The Evaluator recommends that EOne consider changes to the lighting measure worksheet to improve the accuracy of tracked parameters, notably the fields used to collect information on the hours of use, peak coincidence factors, and heating systems. The Evaluator provides examples of the types of changes recommended in Subsection 5.2.1 of this report.

2021 BER-Finding: Average free-ridership levels for both Mail-in and Instant Rebates increased in 2021, while spillover for Mail-in remained nil.

The Mail-in NTGR was evaluated at 0.74 in 2021 compared to 0.82 in 2020, while the Instant Rebates NTGR was evaluated at 0.66 compared to 0.73 in 2020. These decreases are largely due to the increase in free-ridership for Mail-in lighting measures and the large increase of free-ridership for LED linear fixtures under Instant Rebates.

2021 BER-Finding: The BNI LED lamp market has reached maturity and is now in a levelling-off phase as inferred by the decline in shipment shares in conjunction with price stability.

Total commercial and industrial lamp shipments in Atlantic Canada contracted by almost half (- 46%) between 2018 and 2020. This includes a drop in LED lamp shipments (-53%). The share of LED linear lamps declined by 17 percentage points between 2016 and 2020 (from 62% to 45%), likely due to the gradual replacement of ballast fixtures (housing fluorescent tubes) as they fail by integrated LEDs.³⁰ The average retail price of LED linear lamps has stabilized.

³⁰ Data were unavailable for LED linear lamps prior to 2016.

2021 BER-Finding: The LED fixture category is approaching maturity yet still has some growth potential as suggested by increasing LED fixture shares, stabilizing prices, and distributors' opinions on the popularity of the products and sales trends.

Despite a decline (of 39%) in total fixture shipment sales between 2018 and 2020, the share of LED fixtures continued to grow, representing almost the entirety (92%) of the total fixture shipments reported by Electro-Fed in 2020. This trend was also reflected in the increase in free-ridership for LED fixtures in 2021 compared to 2020. Distributors perceive more market potential for LED fixtures than for LED lamps particularly because more efficient models and a larger variety of styles and features are becoming available. The average retail price and rebate value for LED linear fixtures appear to be stabilizing even though customers are receiving better value for their money.

2021 BER-Finding: Evaluated net energy and peak demand savings were respectively 10% and 13% lower than the values tracked by EOne.

These differences are mainly attributed to the increase in free-ridership levels for in both Mail-in and Instant Rebates. The evaluated savings were also impacted by Mail-in adjustment ratios pursuant to on-site visits.

CONCLUSION

Table 31 presents the participation levels as well as evaluated gross and net savings for each Efficient Product Rebates program component and for the program as a whole.

Table 31: Overall 2021 Efficient Product Rebates Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
Mail-in							
Energy Savings	301	Projects	16.366	GWh	0.74	12.111	GWh
Lifetime Energy Savings			258.596	GWh	0.74	191.361	GWh
Peak Demand Savings			2.433	MW	0.74	1.800	MW
Instant Rebates							
Energy Savings	188,956	Products sold	32.596	GWh	0.66	21.380	GWh
Lifetime Energy Savings			452.397	GWh	0.66	296.876	GWh
Peak Demand Savings			5.546	MW	0.65	3.600	MW
Total							
Energy Savings			48.962	GWh	0.68	33.491	GWh
Lifetime Energy Savings			710.993	GWh	0.69	488.237	GWh
Peak Demand Savings			7.979	MW	0.68	5.401	MW

Figure 24 and Figure 25 below illustrate the net energy and peak demand savings targets for the overall Efficient Product Rebates program, as well as indicate whether targets were achieved in 2021. Efficient Product Rebates was aimed at achieving 35.681 GWh in net electrical energy savings and 7.236 MW in net peak demand savings at the generator for 2021. It achieved 33.491 GWh in net electrical energy savings and 5.401 MW in net peak demand savings at the generator. Therefore, the program fell short of achieving planned energy and peak demand savings. Instant Rebates was the largest contributor to total program net energy and peak demand savings.

Figure 24: 2021 Efficient Product Rebates Targeted and Evaluated Net Energy Savings

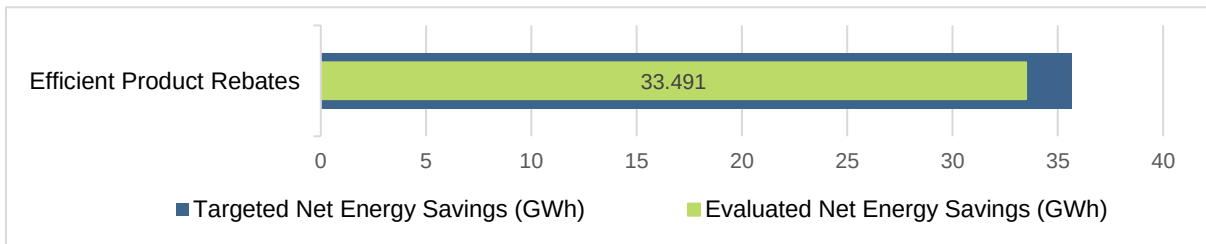
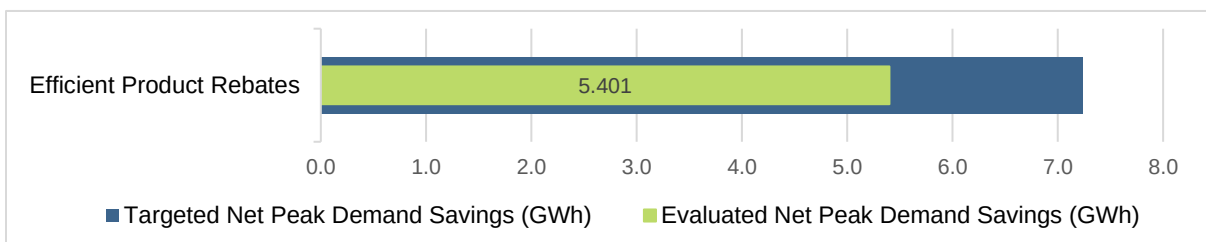


Figure 25: 2021 Efficient Product Rebates Targeted and Evaluated Net Peak Demand Savings



LIST OF APPENDICES

The following are presented in the Efficient Products Rebates Program – Appendices document.

Business Energy Rebates

Appendix I BER: Mail-in Participant Survey Questionnaire

Appendix II BER: Mail-in Participant Survey Results

Appendix III BER: Instant Rebates Participant Survey Questionnaire

Appendix IV BER: Instant Rebates Participant Survey Results

Appendix V BER: Instant Rebates Interview Guide with Distributors

Appendix VI BER: Mail-in Tracking Sheet Audit

Appendix VII BER: Mail-in On-site Visit Sampling Methodology and Protocol

Appendix VIII BER: Mail-in Adjustment Ratio Calculation Example

Appendix IX BER: Mail-in Algorithm for Free-Ridership Calculation

Appendix X BER: Mail-in Algorithm for Participant Spillover Calculation

Appendix XI BER: Instant Rebates Tracking Sheet Audit

Appendix XII BER: Instant Rebates Algorithm for Free-ridership Calculation

Appendix XIII BER: 2021 Recommendations



EFFICIENT PRODUCT REBATES 2021 DSM EVALUATION

EFFICIENCYONE

Appendix Report

March 17, 2022



TABLE OF CONTENTS

APPENDIX I BER: MAIL-IN PARTICIPANT SURVEY QUESTIONNAIRE	1
APPENDIX II BER: MAIL-IN PARTICIPANT SURVEY RESULTS	15
APPENDIX III BER: INSTANT REBATES PARTICIPANT SURVEY QUESTIONNAIRE	35
APPENDIX IV BER: INSTANT REBATES PARTICIPANT SURVEY RESULTS	48
APPENDIX V BER: INSTANT REBATES INTERVIEW GUIDE WITH DISTRIBUTORS	64
APPENDIX VI BER: MAIL-IN TRACKING SHEET AUDIT	73
APPENDIX VII BER: MAIL-IN ON-SITE VISIT SAMPLING METHODOLOGY AND PROTOCOL	76
APPENDIX VIII BER: MAIL-IN ADJUSTMENT RATIO CALCULATION EXAMPLE	82
APPENDIX IX BER: MAIL-IN ALGORITHM FOR FREE-RIDERSHIP CALCULATION	86
APPENDIX X BER: MAIL-IN ALGORITHM FOR PARTICIPANT SPILLOVER CALCULATION	88
APPENDIX XI BER: INSTANT REBATES TRACKING SHEET AUDIT	90
APPENDIX XII BER: INSTANT REBATES ALGORITHM FOR FREE-RIDERSHIP CALCULATION	95
APPENDIX XIII BER: 2021 RECOMMENDATIONS	99

APPENDIX I

BER: MAIL-IN PARTICIPANT SURVEY QUESTIONNAIRE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Participant Survey
Estimated Time to Complete	15 minutes
Target Audience	Participants who received a mail-in rebate
Expected Number of Completions	70
Contact List Source	EOne
Fielding Firm	Narrative Research
Estimated Timeline for fielding	October - November

Table 2: Research Questions and Associated Survey Sections

Research Questions	Section
How do participants become aware of BER Mail-in?	B
What is the Mail-In free-ridership level for 2021?	C, D
What is the level of satisfaction among participants with BER Mail-in?	E
How could EOne improve BER Mail-in?	F

To be adapted by Econoler **[Blue text]**

Import variables from database < **LIKE THIS** >

Skip pattern or programming instructions **[LIKE THIS]**

Black text: instructions for interviewer **[NOTE: xxxx] / [PROBE: xxxx]**

INTRODUCTION

Could I speak with <INSERT NAME>?

1. Yes [**GO TO INTRODUCTION**]
2. No [**SAY** "Perhaps you can help me anyway." **GO TO INTRODUCTION**]

[INTRODUCTION]

Hello, my name is _____ and I am calling from Narrative Research, a Halifax based survey research company. We are performing an evaluation of energy efficiency services provided by Efficiency Nova Scotia. Our records indicate that your organization recently participated in Efficiency Nova Scotia's Business Energy Rebates Program. We would appreciate your help in answering questions related to your participation in this program. The information you provide will be used to help Efficiency Nova Scotia evaluate and improve the program. Is this a good time for you?

[**IF NEEDED:** You may have recently been contacted by Narrative Research or by an Efficiency Nova Scotia representative about your experience with the program. This survey is different as it focuses on other aspects of your participation in the program.]

[**IF NEEDED:** The survey will take about fifteen minutes.]

A. Verification and Recall

A1. Our records indicate that your organization has received a mail-in rebate for energy efficiency measures that were implemented at your facility located at <**FACILITY ADDRESS**> in <**FACILITY CITY**>, as part of Efficiency Nova Scotia's Business Energy Rebates Program. Are you the person in your organization who is most knowledgeable about your experience with the Business Energy Rebates Program?

1. Yes [**SKIP A2**]
2. No [**CONTINUE**]

A2. We would like to talk to the person who is the most knowledgeable about your organization's experience with the Business Energy Rebates Program. Could you give me the name and telephone number of this person? [**Probe** if respondent is unsure who best to forward the call to. This individual may be an engineer, equipment contractor, or utility account manager].

Name: _____

Telephone #: _____

(Note: Thank, record and keep data. If this other person is available, ask to speak to them and restart at introduction. If this other person is unavailable, schedule an interview with them at a different time.)

- A3. **[ASK IF NUMBER OF FACILITIES = UNIQUE]** According to our information, through its participation in the Business Energy Rebates Program, your organization submitted **<INSERT NUMBER OF APPLICATIONS>** application(s) in 2021. For **[IF ONE APPLICATION: THIS / IF MULTIPLE APPLICATIONS: ONE]** application submitted in **<APPLICATION DATE>**, you implemented **<MEASURE CATEGORY>** measures at your facility located at **<FACILITY ADDRESS>** in **<FACILITY CITY>**, and received a rebate of **<REBATE>**. When answering the survey questions, please take into account this specific application for **<MEASURE CATEGORY>** measures.
- A4. **[ASK IF NUMBER OF FACILITIES = MULTIPLE]** According to our information, through its participation in the Business Energy Rebates Program, your organization submitted **<INSERT NUMBER OF APPLICATIONS>** application(s) in 2021. For **[IF ONE APPLICATION: THIS / IF MULTIPLE APPLICATIONS: ONE]** application submitted in **<APPLICATION DATE>**, you implemented **<MEASURE CATEGORY>** measures at your facility located at **<FACILITY ADDRESS>** in **<FACILITY CITY>**, and received a rebate of **<REBATE>**. When answering the survey questions, please take into account this specific application for **<MEASURE CATEGORY>** measures.

B. Program Awareness

- B1. How did you first hear about the Business Energy Rebate (BER) program? **[DO NOT READ – ACCEPT ONE RESPONSE]**
1. (A contractor)
 2. (A distributor or supplier)
 3. (An ENS representative or employee)
 4. (A trade group)
 5. (Digital advertising – social media, website, etc.)
 6. (Traditional advertising – billboards, radio, etc.)
 7. (Someone else within my organization)
 96. (Other: Please Specify: _____)
 98. (Don't know)
 99. (Refused)

- B2. What was the SINGLE most important reason your organization chose to implement energy-efficient **[MEASURE CATEGORY]** measures? **[DO NOT READ – ACCEPT ONE RESPONSE]**
1. (Take advantage of program rebates)
 2. (Save on energy costs / bills)
 3. (Reduce maintenance costs)
 4. (Update equipment)
 5. (Quality of efficiency products)
 6. (Protect the environment)
 97. (Other: Please Specify: _____)
 98. (Don't know)
 99. (Refused)
- B3. **[DO NOT ASK IF B1=98 OR B2=99]** What was the SECOND most important reason your organization chose to implement energy-efficient **[MEASURE CATEGORY]** measures? **[DO NOT READ – ACCEPT ONE RESPONSE – SAME LIST AS B2]**
- 96 No other reason
- B4. Did the impacts of the COVID-19 pandemic have an influence on your business' decision to participate in the Business Energy Rebates program?
1. Yes
 2. No
- [VOLUNTEERED]
98. (Don't know)
99. (Refused)
- B5. **[IF B4 = 1]** How did the COVID-19 pandemic influence your decision to participate in the program? **[DO NOT READ]**
1. Incentives made it attractive to participate
 2. Business closed so allowed for time to do upgrades
 3. Business less busy so allowed for time to do upgrades
 96. Other [RECORD]
 98. (Don't know)
 99. (Refused)

C. Free-Ridership

- C1. Had your organization **already** decided to implement energy-efficient **<MEASURE CATEGORY>** measures **before** you heard about the Business Energy Rebates Program?
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)
- C2. **[ASK IF C1= YES]** I just want to make sure I understand - Before you decided to participate in the Business Energy Rebate Program, you had already made the decision to implement energy-efficient **<MEASURE CATEGORY>** measures?
1. **YES, I HAD ALREADY MADE THE DECISION**
 2. **NO, I HAD NOT MADE THE DECISION**
 98. (Don't know)
 99. (Refused)
- C3. Efficiency Nova Scotia paid your organization **\$<REBATE VALUE FROM SAMPLE BY CATEGORY>** for the energy-efficient **<MEASURE CATEGORY>** measures. If your organization had not received the rebate from Efficiency Nova Scotia, would you have paid the full cost of the energy-efficient **<MEASURE CATEGORY>** measures? Please answer on a scale of 0 to 10, with a 0 indicating that you "Definitely **Would Not** Have Paid," and a 10 indicating that you "Definitely **Would Have** Paid." **PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE**
- ___ Response ___ 98 Don't Know ___ 99 Refused
- C4. **[ASK IF MEASURE CATEGORY=LIGHTING]** Were you aware that the lighting products rebated through the Business Energy Rebates Program are premium products certified by Design Light Consortium or ENERGY STAR®?
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)

[READ FIRST TIME THROUGH ONLY] Now I would like to ask you to consider which actions your organization would have taken if the Business Energy Rebates Program had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is "Very Unlikely," and a 10 indicating that it is "Very Likely." **[DO NOT ACCEPT A RANGE – ASK C5 TO C8 SEQUENCE IN ORDER/DO NOT RANDOMIZE]**

C5. **[ASK IF MEASURE CATEGORY IS NOT LIGHTING]** If the program rebate had not been offered, what is the likelihood that you would have implemented exactly the same energy efficient **<MEASURE CATEGORY>** measures that you purchased through the Business Energy Rebates Program?

___ Response ___98 Don't Know ___99 Refused

C6. **[ASK IF MEASURE CATEGORY=LIGHTING]** If the program rebate had not been offered, what is the likelihood that you would have purchased the exact same model of lighting products?

___ Response ___98 Don't Know ___99 Refused

C7. **[ASK IF MEASURE CATEGORY = LIGHTING AND NUMBER OF MEASURES >1]** If the program rebate had not been offered, what is the likelihood that you would have implemented exactly the same quantity of lighting products that you installed through the program?

___ Response ___98 Don't Know ___99 Refused

C8. **[IF C3≥5]** If the program rebate had not been offered, what is the likelihood that you would have postponed implementing the **<MEASURE CATEGORY>** measures by at least one year?

___ Response ___98 Don't Know ___99 Refused

C9. Using a scale from 0 to 10, where 0 means "No influence" and 10 means "Great influence," please rate the influence of each of the following in your organization's decision to implement energy-efficient **<MEASURE CATEGORY>** measures.

Factor (READ AND RANDOMIZE)	Responses
a. The program rebate	___ Response ___98 Don't Know ___99 Refused
b. Information received from a program representative	___ Response ___98 Don't Know ___99 Refused
<ASK IF OEM=YES> c. The assistance provided by your on-site energy manager in identifying and implementing the measure	___ Response ___98 Don't Know ___99 Refused

D. Cross-Influence

READ AND ROTATE (D1 + D2-D4) AND (D5 + D6-D8) SEQUENCES

D1. Before participating in the Business Energy Rebates program in **<APPLICATION DATE>**, had your organization at any time in the past already participated in the Business Energy Rebates program or any other Efficiency Nova Scotia programs?

1. Yes, in Business Energy Rebates
2. Yes, in another program(s)
3. Yes, in both Business Energy Rebates and another program(s)
4. No
98. (Don't know)
99. (Refused)

For the following statements, please indicate whether you agree or disagree.

D2. **[IF D1=1, 2 OR 3]** Your company's previous participation in an Efficiency Nova Scotia program was a major factor in the decision to implement energy-efficient **<MEASURE CATEGORY>** measures.

1. Agree
2. Disagree
98. (Don't know)
99. (Refused)

D3. **[IF D1=1, 2 OR 3]** Because of your company's previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, a company representative asked a contractor or a technical staff member to examine the energy efficiency options for your facility.

1. Agree
2. Disagree
98. (Don't know)
99. (Refused)

D4. **[IF D1=1, 2 OR 3]** Because of your company's previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, a company representative took into account the cost-effectiveness of energy-efficient **<MEASURE CATEGORY>** measures when evaluating different options for your facility.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

D5. Before participating in the Business Energy Rebates program in **<DATE>**, had you at any time in the past seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

For the following statements, please indicate whether you agree or disagree.

D6. **[IF D5=1]** The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in your company's decision to implement energy-efficient **<MEASURE CATEGORY>** measures.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

D7. **[IF D5=1]** The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to ask a contractor or a technical staff member to examine the energy efficiency options for your facility.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

D8. **[IF D5=1]** The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to take into account the cost-effectiveness of energy efficient **<MEASURE CATEGORY>** measures when evaluating different options for the facility.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

E. Satisfaction

E1. For your most recent Business Energy Rebates Program supported project, which of the following statements best describes who completed your rebate application? **[READ IN ORDER, SINGLE RESPONSE]**

- 1. I completed the application, on my own or with the help of others in my organization
- 2. A coworker completed the application
- 3. My contractor completed the application on my behalf
- 98. (Don't know)
- 99. (Refused)

E2. Did you interact with any Efficiency Nova Scotia staff during the process of applying for the rebate? **[DO NOT READ, CODE ONE ONLY]**

- 1. **YES**
- 2. **NO**
- 98. Don't know
- 99. Refused

- E3. On a scale of 1 to 10 where 1 means completely disagree and 10 means completely agree, how much do you agree or disagree with the following statements? **[RANDOMIZE; RESPONSE OPTIONS 1-10 AND NOT APPLICABLE, DK AND REFUSED]**
- [ASK IF E1=1]** The mail-in rebate application was easy to complete
 - [ASK IF E2=1]** Efficiency Nova Scotia staff responded to my questions quickly
 - [ASK IF E2=1]** Efficiency Nova Scotia staff were knowledgeable when responding to my questions
 - I received my incentive from Efficiency Nova Scotia in the time I expected
 - The list of eligible measures was sufficient for my needs
 - The rebate I received was what I anticipated
 - I was able to easily gather the information the program needed about my project
- E4. **[ASK IF E3E<8]** You mentioned that the eligible measures were not sufficient. Were there types of efficient equipment or services you would like to see Efficiency Nova Scotia provide rebates for? **[OPEN-END RESPONSE]**
98. Don't know
- E5. Using a scale from 1 to 10 where 1 is "not at all satisfied" and 10 is "completely satisfied" how would you rate your satisfaction with the Business Energy Rebates program overall? **[RECORD NUMBER, 98=DON'T KNOW, 99 REFUSED] [DO NOT ACCEPT A RANGE]**
- E6. **[IF E5<8]** What is the most important reason you are not more satisfied with the program overall? **[DO NOT READ. PROBE FOR SPECIFIC REASON. ACCEPT MULTIPLE RESPONSES CODING THE FIRST RESPONSE SEPARATELY]** Probe: Any other reasons?
- (Timely process/Took too long)
 - (Too expensive)
 - (I don't like the products/measures rebated)
 - (Rebate/incentive is too small)
 - (Too difficult to sign up/too much work)
 - (Other: _____)
 - (Don't know)
 - (Refused)

- E7. On a scale of 1 to 10, where 1 is 'not at all satisfied' and 10 is 'completely satisfied,' how was your organization's experience with each of the following aspects of the Business Energy Rebates Program? If your organization did not have experience with one of these aspects please tell me. **[DO NOT RANDOMIZE] [97 = NOT APPLICABLE, 98 = DON'T KNOW/DON'T RECALL, 99 = REFUSED]**
- a. The program application, forms and associated paperwork
 - b. Interaction and communication with contractors or distributors
 - c. Rebate amounts
 - d. Time required to receive the rebate
- E8. **[ASK IF AT LEAST ONE OF E7A-D<8]** Why were you not more satisfied with the **[READ STATEMENTS IN ORDER AS APPLICABLE]?** **[DO NOT READ. PROBE FOR SPECIFIC REASON. ACCEPT MULTIPLE RESPONSES]**
- a. **[ASK IF E7A<8]** program application, forms and associated paperwork
 - 1. (Difficult/too long to fill out)
 - 2. (Took too long/Time delay in processing)
 - 3. (Communication problems)
 - 96. (Other: _____)
 - 98. (Don't know)
 - 99. (Refused)
 - b. **[ASK E796.98.99.B<8]** Interaction and communication with contractors or distributors
 - 1. (Lack of communication/availability with contractor/distributor)
 - 2. (Less knowledgeable about the program)
 - 3. (Took too long/Communication was slow)
 - 96. (Other: _____)
 - 98. (Don't know)
 - 99. (Refused)
 - c. **[ASK IF E796.98.99.C<8]** rebate amounts
 - 1. (Rebate is too small/Expected higher rebate)
 - 2. (Cost of measures was expensive)
 - 96. (Other: _____)
 - 98. (Don't know)
 - 99. (Refused)

- d. **[ASK IF E796.98.99.D<8]** Time required to receive the rebate
 - 1. (Took too long to process/get rebate)
 - 2. (Lack of communication/follow-up)
 - 96. (Other _____)
 - 98. (Don't know)
 - 99. (Refused)

F. Recommendations

- F1. Do you have any suggestions to improve the Business Energy Rebates Program? Consider all aspects of the program: process, measures covered, marketing, interactions with program staff, and program forms. PROBE: Anything else? **[DO NOT READ. ACCEPT MULTIPLE]**
- 1. (Provide more information/information sessions)
 - 2. (Better marketing/awareness)
 - 3. (Increase/better rebates)
 - 4. (Speed up process/receive rebate quicker)
 - 5. (Offer more measures rebated)
 - 6. (Make forms more user-friendly)
 - 7. (Efficiency Nova Scotia staff should be more knowledgeable)
 - 8. (No recommendation)
 - 96. (Other – SPECIFY: _____)
 - 98. (Don't know)
 - 99. (Refused)
- F2. **[ASK IF F1=1]** What kind of information would improve the Business Energy Rebate Program?
[RECORD ANSWER. 98 = DON'T KNOW, 99 = REFUSED]

G. Firmographics

These final questions are asked for statistical purposes only. The information collected is strictly confidential.

G1. What is the main activity of your organization? **[DO NOT READ—BUT CONFIRM WITH RESPONDENT THAT THE CATEGORY YOU CHOOSE IS CORRECT]**

1. (Education)
2. (Food Sales (grocery))
3. (Food Service (restaurant))
4. (Health Care – Inpatient)
5. (Health Care – Outpatient)
6. (Lodging)
7. (Mercantile– Retail (Enclosed and Strip Malls))
8. (Mercantile – Retail (Other than Mall))
9. (Office)
10. (Public Assembly)
11. (Public Order and Safety)
12. (Religious Worship)
13. (Service)
14. (Warehouse / storage)
15. (Manufacturing)
16. (Building is vacant)
17. (Agriculture)
96. (Other (SPECIFY: _____))
98. (Don't know)
99. (Refused)

- G2. Approximately how many full-time equivalent workers DOES YOUR ORGANIZATION employ at all locations within Nova Scotia? **[DO NOT READ, CODE APPROPRIATE CATEGORY]**
1. (Fewer than 5)
 2. (5 to 9)
 3. (10 to 19)
 4. (20 to 49)
 5. (50 to 99)
 6. (100 to 249)
 7. (250 or more)
 98. (Don't know)
 99. (Refused)
- G3. Is your organization independent, or part of a larger organization?
1. Independent
 2. Part of a larger company/organization
 96. Other (_____)
 98. (Don't know)
 99. (Refused)
- G4. Do you own or rent your space?
1. Own
 2. Rent
 3. Other (_____)
 98. (Don't know)
 99. (Refused)
- G5. How many business locations does your organization have in Nova Scotia? **[RECORD A NUMBER 1-99; 998 = DON'T KNOW, 999 = REFUSED]**

END. Those are all the questions I have for you. I thank you very much for your time and cooperation and have a nice day!

APPENDIX II

BER: MAIL-IN PARTICIPANT SURVEY RESULTS

B1. How did you first hear about the Business Energy Rebate (BER) program?

First Heard About the Business Energy Rebate (BER) Program	2021
Sample Size	42
A contractor	29%
A distributor or supplier	19%
Someone else in my organization	14%
Previous experience dealing with ENS	10%
Word of mouth/Through family and friends	10%
Digital advertising – Social media, website, etc.	2%
A trade group	2%
An ENS representative or employee	2%
Others	10%
Don't know/Refused	2%

B2. What was the SINGLE most important reason your organization chose to implement energy-efficient measures?

Most Important Reason Organization Implemented Efficient Measure	2019	2021
Sample Size	70	42
Save on energy costs/bills	51%	43%
Quality of efficiency products	6%	17%
Update equipment	24%	12%
More energy efficient	-	10%
Protect the environment	4%	5%
Reduce maintenance costs	-	2%
Take advantage of program rebates	7%	-
Need renovations	3%	-
Others	3%	12%
Don't know	1%	-

B3. What was the SECOND most important reason your organization chose to implement energy-efficient measures?

Second Most Important Reason Organization Implemented Efficient Measure	2019	2021
Sample Size	69	42
Save on energy costs/bills	25%	33%
Quality of efficiency products	19%	14%
Protect the environment	10%	12%
Look better/Better lighting	-	7%
Need renovations	-	5%
Update equipment	16%	5%
More energy efficient	4%	2%
Better comfort	7%	2%
Take advantage of program rebates	4%	-
Reduce maintenance costs	1%	-
Others	4%	7%
No other reason	7%	5%
Don't know	1%	7%
Base: Respondents who answered question B2		

B2/B3. What was the most important reason your organization chose to implement energy-efficient measures? TOTAL MENTIONS

Most Important Reasons Organization Implemented Efficient Measure	2019	2021
Sample Size	70	42
Save on energy costs/bills	74%	69%
Quality of efficiency products	23%	29%
Protect the environment	13%	17%
Update equipment	37%	17%
More energy efficient	4%	12%
Look better/Better lighting	-	7%
Need renovations	3%	5%
Better comfort	7%	2%
Reduce maintenance costs	1%	2%
Take advantage of program rebates	11%	-
Others	7%	19%
No other reason	-	-
Don't know	1%	7%
Multiple response		

B4. Did the impacts of the COVID-19 pandemic have an influence on your business' decision to participate in the Business Energy Rebates program?

Impact of COVID-19 Pandemic Influenced Business Decision to Participate in BER Program	2021
Sample Size	42
Yes	7%
No	93%

B5. How did the COVID-19 pandemic influence your decision to participate in the program?

How COVID-19 Pandemic Influenced Business Decision to Participate in BER Program	2021
Sample Size	3 (#)
May not have been able to buy energy efficient equipment if we weren't open	1
Uncertainty of how long the pandemic will last	1
Don't know	1
Base: Respondents whose decision to participate in the Business Energy Rebates Program was influenced by the COVID-19 pandemic	

C1. Had your organization already decided to implement energy-efficient [MEASURE CATEGORY] measures before you heard about the Business Energy Rebates Program?

C2. I just want to make sure I understand - Before you decided to participate in the Business Energy Rebate Program, you had already made the decision to implement energy efficient [MEASURE CATEGORY] measures?

Already Made Decision to Implement Energy Efficient Measures Prior to Program Component Participation	2017	2018	2019	2021
Sample Size	70	70	70	42
Yes	46%	56%	49%	71%
No	50%	43%	50%	26%
Don't know	4%	1%	1%	2%

- C3. Efficiency Nova Scotia paid your organization \$[REBATE VALUE FROM SAMPLE BY CATEGORY] for the energy-efficient [MEASURE CATEGORY] measures. If your organization had not received the rebate from Efficiency Nova Scotia, would you have paid the full cost of the energy-efficient [MEASURE CATEGORY] measures? Please answer on a scale of 0 to 10, with a 0 indicating that you “Definitely **Would Not** Have Paid,” and a 10 indicating that you “Definitely **Would Have** Paid.”

Would Have Paid Cost of Project	2017		2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Paid cost of project	70	6.0	69	6.3	67	6.4	42	7.8
Don't know/Refused excluded from calculations								

- C4. Were you aware that the lighting products rebated through the Business Energy Rebates Program are premium products certified by Design Light Consortium or ENERGY STAR?

Aware that Lighting Products are Premium Certified Design Light Consortium or ENERGY STAR	2017	2018	2019	2021
Sample Size	43	43	44	29
Yes	49%	58%	59%	55%
No	47%	40%	39%	34%
Don't know	5%	2%	2%	10%
Base: Respondents who had implemented lighting measures				

C5-C8. Now I would like to ask you to consider which actions your organization would have taken if the Business Energy Rebates Program had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is “Very Unlikely,” and a 10 indicating that it is “Very Likely.”

Actions Taken in Absence of Program Component	2017		2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Implemented exactly the same quantity of lighting products that you installed through the program*	41	6.7	40	6.7	43	7.1	27	8.2
Implemented exactly the same energy-efficient [MEASURE CATEGORY] measures that you purchased through the Business Energy Rebates Program?***	27	5.4	27	5.3	25	6.3	13	7.5
Purchased the exact same model of lighting products***	43	6.0	41	6.7	44	6.0	28	7.3
Postponed implementing the [MEASURE CATEGORY] measures by at least one year?****	51	3.6	49	4.6	53	4.2	36	2.8
Don't know/Refused excluded from calculations *Base: Respondents who installed more than one lighting product **Base: Respondents who did <u>not</u> install lighting products ***Base: Respondents who installed lighting products ****Base: Respondents who would have likely paid full cost of the energy-efficient measure [IF C3≥5]								

- C9. Using a scale from 0 to 10, where 0 means “No influence” and 10 means “Great influence”, please rate the influence of each of the following in your organization's decision to implement energy-efficient [MEASURE CATEGORY] measures.

Influence of Factors in Decision to Implement Energy Efficient Measures	2017		2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
The assistance provided by your on-site energy manager in identifying and implementing the measure*	2	7.0	5	7.4	1	9.0	18	7.7
The program rebate	69	7.6	70	7.3	70	6.8	42	6.9
Information received by a program representative	64	5.7	69	5.0	68	5.5	42	5.9
Don't know/Refused excluded from calculations								
*Respondents who had received assistance from their on-site energy manager								

- D1. Before participating in the Business Energy Rebates program in <APPLICATION DATE>, had your organization at any time in the past already participated in the Business Energy Rebates program or any other Efficiency Nova Scotia programs?*

Previous Participation in Another ENS Program Component	2017	2018	2019	2021
Sample Size	70	70	70	42
Yes (Total)	47%	49%	51%	33%
Yes, in Business Energy Rebates	-	-	-	5%
Yes, in another program(s)	-	-	-	5%
Yes, in both Business Energy Rebates and another program(s)	-	-	-	24%
No	51%	46%	44%	57%
Don't know	1%	6%	4%	10%
*Wording change in 2021				

- D2. Your company's previous participation in an Efficiency Nova Scotia program was a major factor in the decision to implement energy-efficient [MEASURE CATEGORY] measures.*

Previous Participation in Another ENS Program Component Was a Major Factor in Decision	2017	2018	2019	2021
Sample Size	33	34	36	14 (#)
Agree	76%	74%	81%	13
Disagree	21%	26%	17%	1
Don't know	3%	-	3%	-
Base: Respondents who previously participated in another ENS program component *Slight wording change in 2021				

- D3. Because of the company's previous participation in an Efficiency Nova Scotia program and what was learned by participating in the program, a company representative asked a contractor or a technical staff member to examine the energy efficiency options for the facility.

Previous ENS Program Component Participation Led to Examine Options for Facility	2017	2018	2019	2021
Sample Size	33	34	36	14 (#)
Agree	73%	71%	64%	11
Disagree	24%	26%	28%	2
Don't know	3%	3%	8%	1
Base: Respondents who previously participated in another ENS program component				

- D4. Because of your company's previous participation in an Efficiency Nova Scotia program and what was learned by participating in the program, a company representative took into account the cost-effectiveness of energy efficient [MEASURE CATEGORY] measures when evaluating different options for the facility.

Previous ENS Program Component Participation Led to Assess Product Cost-effectiveness	2017	2018	2019	2021
Sample Size	33	34	36	14 (#)
Agree	91%	79%	86%	14
Disagree	9%	15%	11%	-
Don't know/refused	-	6%	3%	-
Base: Respondents who previously participated in another ENS program component				

- D5. Before participating in the Business Energy Rebates program in [DATE], had you at any time in the past already seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?

Previously Seen Energy Efficiency Promotional Materials Distributed by ENS	2017	2018	2019	2021
Sample Size	70	70	70	42
Yes	93%	76%	76%	83%
No	7%	24%	24%	17%
Don't know	-	-	-	-

- D6. The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in the company's decision to implement energy-efficient [MEASURE CATEGORY] measures.

Previously Seen ENS Energy Efficiency Promotional Materials Was a Major Factor in Decision	2017	2018	2019	2021
Sample Size	65	53	53	35
Agree	68%	60%	55%	40%
Disagree	32%	38%	45%	60%
Don't know	-	2%	-	-
Base: Respondents who previously saw ENS energy-efficiency promotional materials				

- D7. The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to ask a contractor or a technical staff member to examine the energy efficiency options for the facility.

Previously Seen ENS Energy Efficiency Promotional Materials Led to Examine Options for Facility	2017	2018	2019	2021
Sample Size	65	53	53	35
Agree	62%	53%	49%	54%
Disagree	35%	43%	49%	46%
Don't know/Refused	3%	4%	2%	-
Base: Respondents who previously saw ENS energy-efficiency promotional materials				

- D8. The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to take into account the cost-effectiveness of energy efficient [MEASURE CATEGORY] measures when evaluating different options for the facility.

Previously Seen ENS Energy Efficiency Promotional Materials Led to Assess Product Cost-effectiveness	2017	2018	2019	2021
Sample Size	65	53	53	35
Agree	77%	75%	64%	63%
Disagree	23%	23%	36%	37%
Don't know/refused	-	2%	-	-
Base: Respondents who previously saw ENS energy-efficiency promotional materials				

- E1. For your most recent Business Energy Rebates Program supported project, which of the following statements best describes who completed your rebate application?

Who Completed the Application	2018	2019	2021
Sample Size	70	70	42
I completed the application, on my own or with the help of others in my organization*	57%	57%	55%
My contractor completed the application on my behalf	29%	26%	31%
A co-worker completed the application	14%	16%	14%
Don't know	-	1%	-
*Wording change in 2021			

- E2. Did you interact with any Efficiency Nova Scotia staff during the process of applying for the rebate?

Interaction with ENS Staff During Application Process	2018	2019	2021
Sample Size	70	70	42
Yes	63%	46%	67%
No	36%	54%	31%
Don't know	1%	-	2%

E3. On a scale of 1 to 10 where 1 means 'completely disagree' and 10 means 'completely agree', how much do you agree with the following statements?***

Agreement with Statements	2019		2021	
	Sample Size	Mean	Sample Size	Mean
ENS staff were knowledgeable when responding to my questions	32*	9.4	28	9.5
ENS staff responded to my questions quickly	32*	9.2	28	9.5
I was able to easily gather the information the program needed about my project	69	8.5	41	9.0
The rebate I received was what I anticipated	69	9.2	41	8.9
I received my incentive from ENS in the time I expected	68	8.9	41	8.9
The list of eligible measures was sufficient for my needs	68	8.6	39	8.8
The mail-in rebate application was easy to complete	40**	8.2	22	8.5
Not applicable/Don't Know/Refused excluded from calculations *Base: Respondents who interacted with ENS staff while applying **Base: Respondents who completed the application themselves ***Slight wording and scale change in 2021				

E4. You mentioned that the eligible measures were not sufficient. Were there types of efficient equipment or services you would like to see Efficiency Nova Scotia provide rebates for?

Other Types of Efficient Equipment or Services for ENS to Provide Rebates	2018	2019	2021
Sample Size	9 (#)	11 (#)	8 (#)
More lighting	1	2	1
Ventilation systems	1	-	1
Solar panels	-	-	1
Insulation	-	-	1
Variable speed motors	-	-	1
Equipment other than lighting	-	-	1
Content/format of eligible measures list		2	-
Heat pump	-	1	-
Induction burners	-	1	-
Would like to be able to customize	1	-	-
Hot water heating systems	1	-	-
Others	2	1	2
None	-	4	2
Don't know	4	1	-
Base: Respondents who said that the list of eligible measures was insufficient (E3e<8) Multiple responses			

E5. Using a scale from 1 to 10 where 1 is 'not at all satisfied' and 10 is 'completely satisfied' how would you rate your satisfaction with the Business Energy Rebates program overall?

Satisfaction with Mail-in Overall	2017	2018	2019	2021
Sample Size	70	69	70	42
Mean	9.0	9.1	8.8	9.1
Don't know/Refused excluded from calculations				

E6. What was the most important reason you were not more satisfied with the program overall?
Any other reasons?

Key Reasons Not More Satisfied	2017	2018	2019	2021
Sample Size	7 (#)	5 (#)	7 (#)	5 (#)
I don't like the products/measures rebated	-	-	1	1
Difficult to find information on website	-	-	-	1
Efficiency Nova Scotia/ENS staff were not helpful	-	-	-	1
Rebate/incentive is too small	1	4	3	1
Too difficult to sign up/too much work	2	1	2	-
Timely process/took too long before getting rebate	2	-	1	-
Equipment was not qualified	1	-	-	-
Didn't deal directly with ENS	1	-	-	-
Don't like location of equipment	1	-	-	-
Communication problems leading to believe rebate would be higher	-	-	-	-
Too expensive	-	-	-	-
Did not receive rebate	-	1	-	-
Others	1	-	2	1
Base: Respondents who were not satisfied with BER Mail-in (NOT SATISFIED: E5<8) Multiple responses				

E7. On a scale of 1 to 10, where 1 is 'not at all satisfied' and 10 is 'completely satisfied', how was your organization's experience with each of the following aspects of the Business Energy Rebates Program?

Satisfaction with Aspects of Mail-in	2017		2018		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Interaction and communication with contractors or distributors	67	8.6	64	8.7	62	8.7	39	9.2
The program application, forms and associated paperwork	65	8.4	62	8.2	62	8.2	37	9.1
Time required to receive rebate	68	8.5	68	8.1	68	8.6	42	8.7
Rebate amounts	70	8.4	69	8.5	68	8.5	42	8.5
Don't know/Not applicable/Refused/Don't recall excluded from calculations								

E8a. Why were you not more satisfied with the program application, forms and associated paperwork?

Reasons Not More Satisfied with Application, Forms, and Paperwork	2017*	2018*	2019*	2021
Sample Size	18 (#)	18 (#)	14 (#)	4 (#)
Difficult/too long to fill out	15	11	11	2
Communication problems	3	5	2	1
Took too long/time delay in processing	1	-	2	-
Would prefer to fill out forms online	1	-	1	-
Didn't deal with ENS directly	1	-	-	-
Others	2	1	1	1
Don't know	-	1	-	-
Base: Respondents who were not satisfied with BER Mail-in application, forms and associated paperwork (NOT SATISFIED: E7a<8)				
*Multiple responses				

E8b. Why were you not more satisfied with interaction and communication with contractors or distributors?

Reasons Not More Satisfied with Interaction and Communication with Contractors or Distributors	2017*	2018*	2019*	2021
Sample Size	10 (#)	8 (#)	7 (#)	3 (#)
Lack of communication/availability with contractor/distributor	-	2	1	2
Some products installed were not working	-	-	-	1
Took too long/communication was slow	4	1	2	-
Not satisfied with the equipment recommended	-	-	1	-
Less knowledgeable about the program	4	4	1	-
Contractors didn't provide all the information to complete the application	1	1	-	-
Had to ensure the most energy efficient product was being used	1	-	-	-
The contractor tried to overcharge me	1	-	-	-
Others	-	1	1	-
Don't know	-	1	1	-
Base: Respondents who were not satisfied with interaction and communication with contractors or distributors (NOT SATISFIED: E7b<8)				
*Multiple responses				

E8c. Why were you not more satisfied with the rebate amounts?

Reasons Not More Satisfied with Rebate Amounts	2017*	2018*	2019*	2021
Sample Size	16 (#)	16 (#)	13 (#)	11 (#)
Rebate is too small/expected higher rebate	13	15	11	9
Rates are different across facilities	-	-	-	1
Cost of measures was expensive	2	2	-	-
Others	2	1	-	1
Don't know	1	-	2	-
Base: Respondents who were not satisfied with the rebate amounts (NOT SATISFIED: E7c<8)				
*Multiple responses				

E8d. Why were you not more satisfied with the time required to receive rebate?

Reasons Not More Satisfied with the Time Required to Receive Rebate	2017*	2018*	2019*	2021
Sample Size	13 (#)	13 (#)	14 (#)	9 (#)
Took too long to process/get rebate	11	10	11	3
Lack of communication/follow-up	3	-	1	2
Have not received rebate	-	1	-	2
Application/Paper work getting misplaced/falling through the cracks	-	-	-	1
Applications were too long to fill out and confusing	1	-	-	-
Others	-	2	2	1
Don't know	-	-	1	-
Base: Respondents who were not satisfied with the time required to receive rebate (NOT SATISFIED: E7d<8)				
*Multiple responses				

- F1. Do you have any suggestions to improve the Business Energy Rebates Program? Consider all aspects of the program: process, measures covered, marketing, interactions with program staff, and program forms. PROBE: Anything else?

Suggestions to Improve Mail-in	2018	2019	2021
Sample Size	70	70	42
No recommendation	59%	64%	45%
Better marketing/awareness	10%	7%	12%
Offer more measures rebated	-	4%	10%
Provide more information/information sessions	7%	3%	7%
Speed up process/receive rebate quicker	4%	3%	5%
Increase/better rebates	6%	1%	5%
Make the whole process easier/more efficient	-	7%	2%
Inform/educate contractors	1%	1%	2%
Make forms more user-friendly	14%	6%	-
Provide information about rebate changes ahead of time	3%	1%	-
ENS staff should be more knowledgeable	4%	-	-
Offer more measures rebated	4%	-	-
Improve quality of information on ENS website	3%	-	2%
Others	1%	7%	14%
Don't know	1%	3%	-
Multiple responses			

G1. What is the main activity of your organization?

Principal Building Activity	2017	2018	2019	2021
Sample Size	70	70	70	42
Farming/agriculture*	13%	13%	10%	21%
Manufacturing	7%	14%	10%	12%
Mercantile/retail (other than mall)	10%	1%	6%	10%
Property management/real estate	11%	10%	9%	7%
Wholesale	4%	-	1%	5%
Automotive repair/Cars and truck repair shop*	1%	4%	-	5%
Healthcare – inpatient	-	-	1%	5%
Food service (restaurant)	6%	1%	7%	5%
Public assembly	-	-	-	2%
Healthcare – outpatient	-	-	-	2%
Education	4%	9%	7%	2%
Lodging	10%	6%	13%	-
Construction	9%	7%	9%	-
Service	-	6%	4%	-
Mercantile/retail (enclosed and strip malls)	1%	1%	3%	-
Fishing	-	-	3%	-
Water treatment	-	-	3%	-
Warehouse/storage	1%	-	1%	-
Religious worship	-	1%	1%	-
Food sales (grocery)	-	-	1%	-
Food processing/manufacturing	-	-	1%	-
Building is vacant	-	-	1%	-
Recreation	4%	6%	-	-
Health care	3%	1%	-	-
Government	3%	4%	-	-
Transportation	1%	1%	-	-
Public order and safety	-	3%	-	-
Others	10%	9%	7%	24%
*Wording change in 2021				

- G2. Approximately how many full-time equivalent workers does your organization employ at all locations within Nova Scotia?

Number of Full-time Employees	2017	2018	2019	2021
Sample Size	70	70	70	42
Fewer than 5	40%	30%	24%	31%
5 to 9	10%	11%	13%	7%
10 to 19	7%	9%	20%	12%
20 to 49	10%	16%	16%	17%
50 to 99	11%	6%	3%	12%
100 to 249	6%	11%	11%	7%
250 or more	14%	14%	9%	7%
Don't know	1%	3%	3%	7%
Refused	-	-	1%	-

- G3. Is your organization independent, or part of a larger organization?

Type of Organization	2018	2019	2021
Sample Size	70	70	42
Independent	77%	83%	76%
Part of a larger company/organization	19%	14%	21%
Other	4%	3%	2%

- G4. Do you own or rent your space?

Rent or Own Location	2018	2019	2021
Sample Size	70	70	42
Own	83%	84%	76%
Rent	10%	13%	21%
Other	6%	3%	2%

G5. How many business locations does your organization have in Nova Scotia?

Number of Locations	2017	2018	2019	2021
Sample Size	70	70	70	42
1-5	86%	77%	84%	86%
6 or more	11%	17%	11%	14%
Don't know	3%	6%	4%	-
Mean	4.4	4.9	4.6	3.1

APPENDIX III

BER: INSTANT REBATES PARTICIPANT SURVEY QUESTIONNAIRE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Participant Survey
Estimated Time to Complete	10 minutes
Target Audience	Business
Expected Number of Completions	50 (17 LED linear lamps, 17 LED linear fixtures, 16 LED outdoor lamps)
Contact List Source	EOne
Fielding Firm	Narrative Research
Estimated Timeline for fielding	October - November

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
Program awareness and participation	C
Free-ridership	D
Cross-influence	E
Satisfaction	F

To be adapted by Econoler **[Blue text]**

Import variables from database < **LIKE THIS** >

Skip pattern or programming instructions **[LIKE THIS]**

Black text: instructions for interviewer **[NOTE: xxxx] / [PROBE: xxxx]**

A. INTRODUCTION A – Business with a contact name

Could I speak with <INSERT NAME>?

1. Yes **[GO TO INTRODUCTION]**
2. No **[SAY “PERHAPS YOU CAN HELP ME ANYWAY.” GO TO INTRODUCTION]**

Hello, I am with Narrative Research, and we are performing an evaluation of energy efficiency services provided by Efficiency Nova Scotia. We have a few questions about your recent experience with Efficiency Nova Scotia’s Business Energy Rebates Program through which you or your organization recently purchased rebated <**PRODUCT**> at a participating distributor.

A1. Are you the person in your organization who is most knowledgeable about the decision to purchase these <**PRODUCT**> from <**DISTRIBUTOR**> in 2021?

1. Yes **[GO TO A3]**
2. No **[GO TO A2]**

A2. Is there someone else in your organization who would know about the decision to purchase these <**PRODUCT**>? [**PROBE:** if respondent is unsure who best to forward the call to. This individual may be an engineer, equipment contractor, or utility account manager].

1. Yes (Ask for name: _____ and telephone #: _____) (Ask to speak to that person and restart at introduction. If other person is unavailable, thank, terminate, record data and schedule interview with best contact)
2. No **[GO TO A2A]**

A2a **[IF NO IN A2]** Could you give me the name of the person we should we be speaking to about your organization’s participation in the Efficiency Nova Scotia’s Business Energy Rebates Program?

1. Yes (Ask for name: _____ and telephone #: _____) (Ask to speak to that person and restart at introduction. If other person is unavailable, thank, terminate, record data and schedule interview with best contact)
2. No **[THANK, TERMINATE, RECORD AND KEEP DATA]**

- A3. Did you purchase these products for your own organization, or are you a company purchasing products for a client or project outside of your organization? **[ALLOW ONE RESPONSE ONLY]**
1. I purchased them for my organization
 2. I purchased them for a client or project outside of my organization/I am a contractor
 3. Other, please specify **[IF BOTH, SELECT OPTION 1]**
 98. Don't know
 99. Refused
- A4. We would appreciate your help in answering questions about these products and your participation in this program. The information you provide will help Efficiency Nova Scotia improve its program. The survey will take about 10 minutes to complete. Is now a good time to conduct this survey?
1. Yes **[CONTINUE]**
 2. No **[ASK "CAN WE SCHEDULE A MORE CONVENIENT TIME FOR YOU TO CONDUCT THIS SURVEY?"] [SCHEDULED, IF NECESSARY, FOR: _____]**

B. INTRODUCTION B – Business with no contact name

Hello, I am with Narrative Research, and we are performing an evaluation of energy efficiency services provided by Efficiency Nova Scotia. We have a few questions about your recent experience with Efficiency Nova Scotia's Business Energy Rebates Program through which you or your organization recently purchased rebated **<PRODUCT>** at a participating distributor.

- B1. Could you help us identify the person who is most knowledgeable about the decision to purchase these products? **[PROBE** if respondent is unsure who best to forward the call to. This individual may be an engineer, equipment contractor, or utility account manager].
1. Yes, the person is available (Ask for name: _____ and telephone #: _____) (And ask to speak to this person – Go back to Intro A)
 2. Yes, but the person is unavailable (Ask for name: _____ and telephone #: _____) **[THANK AND TERMINATE; SCHEDULE CALL BACK TO SPEAK TO THAT PERSON]**
 3. No **[THANK AND TERMINATE]**

C. Program Awareness and Participation

- C1. **[ASK IF CONTRACTOR (A3=2)]** Who usually makes the decision to buy <PRODUCT> rather than standard <STANDARD PRODUCT>? Is it... **[READ, CODE ONLY ONE]**
1. You (or your organization)
 2. Your client
 96. (Other (SPECIFY: _____))
 98. (Don't know)
- C2. **[ASK IF A3=1 OR C1=1]** Can you describe the main activity of your organization? **[DO NOT READ—BUT CONFIRM WITH RESPONDENT THAT THE CATEGORY YOU CHOOSE IS CORRECT]**
1. (Education)
 2. (Food Sales (grocery))
 3. (Food Service (restaurant))
 4. (Health Care – Inpatient)
 5. (Health Care – Outpatient)
 6. (Lodging)
 7. (Mercantile– Retail (Enclosed and Strip Malls))
 8. (Mercantile – Retail (Other than Mall))
 9. (Office)
 10. (Public Assembly)
 11. (Public Order and Safety)
 12. (Religious Worship)
 13. (Service)
 14. (Warehouse / storage)
 15. (Manufacturing)
 16. (Building is vacant)
 17. (Agriculture)
 96. (Other (SPECIFY: _____))
 98. (Don't know)
 99. (Refused)

- C3. **[ASK IF C1=2 OR 98]** Before making the decision to purchase **<PRODUCT>**, do clients usually ask for your advice? **[CODE ONLY ONE]**
1. Yes **[GO TO C4]**
 2. No **[GO TO C6]**
 98. Don't Know
 99. Refused
- C4. **[ASK IF A3=1, C1=1 OR 1=1]** What was the SINGLE most important reason you purchased **<PRODUCT>** rather than standard **<STANDARD PRODUCT>**? **[RECORD RESPONSE]**
96. (Specify: _____)
 98. (Don't know)
 99. (Refused)
- C5. **[ASK IF A3=1, C1=1 OR 1=1; DO NOT ASK IF 98 OR 99 IN C4]** What was the SECOND most important reason you purchased **<PRODUCT>** rather than standard **<STANDARD PRODUCT>**? **[RECORD RESPONSE]**
96. (Specify: _____)
 97. No other reason
 98. (Don't know)
- C6. **[ASK ALL]** Did your distributor recommend **<PRODUCT>** to you? **[CODE ONLY ONE]**
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)
- C7. **[ASK IF CONTRACTOR (A3=2)]** For what type of project did you purchase the majority of the **<PRODUCT>**? Was it for a... **[READ. CODE ONLY ONE]**
1. New construction
 2. Replacement of existing fixtures or lamps
 98. (Don't know)
 99. (Refused)

- C8. **[ASK IF END-USER A3=1]** For what type of project did you purchase the **<PRODUCT>** that you bought through the Business Energy Rebates Program? Was it for a... **[READ. CODE ONLY ONE]**
1. New construction
 2. Replacement of existing fixtures or lamps
 98. (Don't know)
 99. (Refused)
- C9. **[ASK IF C7=2 OR C8=2]** In what state were your existing fixtures or lamps when you decided to purchase the **<PRODUCT>**? Were they... **[READ. CODE ONLY ONE]**
1. Working but at the end of their useful life
 2. Working and not close to the end of their useful life
 3. Broken
 4. **[DO NOT READ]** (Some were working, some were not working)
 96. **[DO NOT READ]** (Other, please specify)
 98. (Don't know)
 99. (Refused)
- C10. Did the impacts of the COVID-19 pandemic have an influence on your business' decision to participate in the Business Energy Rebates program?
1. Yes
 2. No
- [VOLUNTEERED]
98. (Don't know)
 99. (Refused)
- C11. **[IF C10 = 1]** How did the COVID-19 pandemic influence your decision to participate in the program? **[DO NOT READ]**
1. Incentives made it attractive to participate
 2. Business closed so allowed for time to do upgrades
 3. Business less busy so allowed for time to do upgrades
 96. Other **[RECORD]**
 98. (Don't know)
 99. (Refused)

D. Free-Ridership

- D1. **[ASK ALL]** Were you aware that you had received a rebate when purchasing these **<PRODUCT>?** **[CODE ONLY ONE]**
1. Yes
 2. No
 98. (Don't know)
- D2. **[ASK IF D1=2 OR 98]** I just want to make sure I understand – When you purchased **<PRODUCT>**, you were unaware that a rebate would be given to reduce the product's total cost? **[DO NOT READ, CODE ONLY ONE]**
1. Yes, Unaware of the rebate
 2. No, Aware of the rebate
 98. Don't know
 99. Refused
- D3. **[ASK IF D1=1 OR D2=2]** Were you aware that the rebate was offered by Efficiency Nova Scotia as part of its Business Energy Rebates Program? **[CODE ONLY ONE]**
1. Yes
 2. No
 98. Don't know
- D4. **[ASK IF END-USER A3=1 AND D3=1]** How did you first become aware of the rebates available under Efficiency Nova Scotia's Business Energy Rebates Program? **[DO NOT READ. CODE ONLY ONE]**
1. Through my contractor
 2. Through my distributor
 3. Efficiency Nova Scotia staff contacted me about the program
 4. Efficiency Nova Scotia website
 5. Efficiency Nova Scotia promotion
 6. Past experience with another Efficiency Nova Scotia program
 96. Other, please specify
 98. Don't know
 99. Refused

- D5. **[ASK IF AWARE (D1=1 OR D2=2)]** Had you *already* decided to purchase **<PRODUCT>** *before* knowing that these products were rebated?
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)
- D6. **[ASK ALL]** Had you *already* decided to purchase **<PRODUCT>** *before* knowing the price of those products?
1. Yes
 2. No
 97. (Did not get any quotes)
 98. (Don't know)
 99. (Refused)
- D7. **[ASK ALL]** Efficiency Nova Scotia offered a rebate for the purchase of efficient lighting products. If your organization had not received the rebate, and the cost for each **<PRODUCT>** had been about \$**<REBATE AVERAGE VALUE BY CATEGORY>** higher, would you have paid the full cost of the **<PRODUCT>**? Please answer on a scale of 0 to 10, with a 0 indicating that you "Definitely **Would Not Have Paid**" and a 10 indicating that you "Definitely **Would Have Paid**." **[PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]**
- ___ Response ___ 98 Don't Know ___ 99 Refused
- D8. **[ASK ALL]** Prior to your purchase, were you aware that the **<PRODUCT>** you purchased were premium products certified by Design Light Consortium or ENERGY STAR®? **[CODE ONLY ONE]**
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)

[ASK D9 TO D12 IF AWARE OF REBATE (D1=1 OR D2=2), RANDOMIZE D9 TO D12]

READ FIRST TIME THROUGH ONLY: Now I would like to ask you to consider which actions your organization would have taken if the rebate had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is “Very Unlikely,” and a 10 indicating that it is “Very Likely.” **[PROBE TO NOT ACCEPT A RANGE]**

D9. If the rebate had not been offered, what is the likelihood that you would have purchased the exact same model of premium lighting products?

___ Response ___ 98 Don't Know ___ 99 Refused

D10. **[ASK IF C9=2]** If the rebate had not been offered, what is the likelihood that you would have kept your existing fixtures or lamps?

___ Response ___ 98 Don't Know ___ 99 Refused

D11. **[ASK IF TOTAL MEASURE CATEGORY QTY>1]** If the rebate had not been offered, what is the likelihood that you would have purchased exactly the same quantity of lighting products that you bought?

___ Response ___ 98 Don't Know ___ 99 Refused

D12. **[ASK IF D7≥5]** If the rebate had not been offered, what is the likelihood that you would have postponed the purchase of the lighting products by at least one year?

___ Response ___ 98 Don't Know ___ 99 Refused

D13. Using a scale from 0 to 10, where 0 means “No influence” and 10 means “Great influence”, please rate the influence of each of the following in your organization’s decision to purchase **<PRODUCT>**.

Factor (READ AND RANDOMIZE)	Responses
a. [ASK IF D1=1 OR D2 =2] The program rebate	___ Response ___ 98 Don't Know ___ 99 Refused
b. [ASK IF D3=1] Information received from an Efficiency Nova Scotia program representative on high-efficiency lighting products	___ Response ___ 98 Don't Know ___ 99 Refused
c. [ASK ALL] Information received from a distributor on high-efficiency lighting products	___ Response ___ 98 Don't Know ___ 99 Refused
d. [ASK ALL] Prevalence of LED products among products that met your lighting requirements	___ Response ___ 98 Don't Know ___ 99 Refused

E. Cross-Influence

ASK ALL - READ AND ROTATE (E1 + E2-E4) AND (E5 + E6-E8) SEQUENCES

E1. Before participating in the Business Energy Rebates program in 2021, had your organization at any time in the past already participated in the Business Energy Rebates program or any other Efficiency Nova Scotia programs?

1. Yes, in Business Energy Rebates
2. Yes, in another program(s)
3. Yes, in both Business Energy Rebates and another program(s)
4. No
98. (Don't know)
99. (Refused)

For the following statements, please indicate whether you agree or disagree.

E2. **[IF E1=1, 2 OR 3]** Your organization's previous participation in an Efficiency Nova Scotia program was a major factor in the decision to purchase **<PRODUCT>**.

1. Agree
2. Disagree
98. (Don't know)
99. (Refused)

E3. **[IF E1=1, 2 OR 3]** Because of your organization's previous participation in an Efficiency Nova Scotia program and what was learned by participating in the program, a company representative asked a contractor or a distributor about efficient lighting options for your organization.

1. Agree
2. Disagree
98. (Don't know)
99. (Refused)

E4. **[IF E1=1, 2 OR 3]** Because of your organization's previous participation in an Efficiency Nova Scotia program and what was learned by participating in the program, a company representative took into account the cost-effectiveness of **<PRODUCT>** when evaluating different options for your organization.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

E5. **[ASK ALL]** Before participating in the Business Energy Rebates program, had you at any time in the past already seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

[READ IF E5=1] For the following statements, please indicate whether you agree or disagree.

E6. **[IF E5=1]** The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in the company's decision to purchase **<PRODUCT>**.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

E7. **[IF E5=1]** The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to ask a contractor or a distributor about efficient lighting options for your organization.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

E8. **[IF E5=1]** The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to take into account the cost-effectiveness of **<PRODUCT>** when evaluating different options for the facility.

1. Agree
2. Disagree
98. (Don't know)
99. (Refused)

F. Satisfaction

F1. **[ASK ALL]** Using a scale from 1 to 10 where 1 is “not at all satisfied” and 10 is “completely satisfied” how would you rate your satisfaction with the Business Energy Rebates program overall? **[RECORD NUMBER, 98=DON'T KNOW, 99 REFUSED] [DO NOT ACCEPT A RANGE]**

F2. **[IF F1<8]** What was the most important reason you were not more satisfied with the program overall? **[DO NOT READ. PROBE FOR SPECIFIC REASON. ACCEPT MULTIPLE RESPONSES]** Probe: Any other reasons? **[RECORD FIRST AND SUBSEQUENT MENTIONS SEPARATELY]**

1. (Too expensive)
2. (I don't like the products rebated)
3. (Rebate/incentive is too small)
96. (Other: _____)
98. (Don't know)
99. (Refused)

F3. **[ASK ALL]** On a scale of 1 to 10, where 1 is ‘not at all satisfied’ and 10 is ‘completely satisfied,’ how was your organization’s experience with each of the following aspects of the Business Energy Rebates Program? If your organization did not have experience with one of these aspects please tell me. **[DO NOT RANDOMIZE] [97 = NOT APPLICABLE, 98 = DON'T KNOW/DON'T RECALL, 99 = REFUSED]**

- a. Interaction and communication with distributors
- b. Rebate amounts
- c. Eligible products

F4. Why were you not more satisfied with the **READ STATEMENTS IN ORDER AS APPLICABLE?** **[DO NOT READ PRE-CODES. PROBE FOR SPECIFIC REASON. ACCEPT MULTIPLE RESPONSES. REPEAT ENTIRE QUESTION TEXT FOR F4A AND F4B]**

a. **[ASK F3A <8]** Interaction and communication with contractors or distributors

1. (Lack of communication/availability with distributors)
2. (Less knowledgeable about the program)
3. (Took too long/Communication was slow)
96. (Other: _____)
98. (Don't know)
99. (Refused)

b. **[ASK IF F3B <8]** Rebate amounts

1. (Rebate is too small/Expected higher rebate)
2. (Cost of measures was expensive)
96. (Other: _____)
98. (Don't know)
99. (Refused)

c. **[ASK IF F3C <8]** Were there other types of efficient equipment or services you would have liked to see Efficiency Nova Scotia provide rebates for? **[OPEN-END RESPONSE]**

98. (Don't know)

F5. Do you have any suggestions on how to improve the Business Energy Rebates program? **[OPEN-ENDED RESPONSE. RECORD RESPONSE]**

98. (Don't know)

END. Those are all the questions I have for you. I thank you very much for your time and cooperation and have a nice day!

APPENDIX IV

BER: INSTANT REBATES PARTICIPANT SURVEY RESULTS

Note: Due to rounding, certain percentages in the tables of this appendix do not sum to 100%.

- A3. Did you purchase these products for your own organization, or are you a company purchasing products for a client or project outside of your organization?

Purchase for Contractor or End User	2018	2019	2020	2021
Sample Size	50	60	51	50
I purchased them for my organization	60%	62%	41%	50%
I purchased them for a client or project outside of my organization/I am a contractor	40%	28%	59%	44%
I purchased them for my personal use	-	5%	-	-
The contractor made the purchase for me	-	3%	-	-
Others	-	-	-	6%
Don't know	-	2%	-	-

- C1. Who usually makes the decision to buy [PRODUCT] rather than standard [STANDARD PRODUCT]? Is it...?

Purchase Decision-maker	2018	2019	2020	2021
Sample Size	20	17 (#)	30	22
Contractor (or their organization)	65%	12	63%	77%
Client	35%	5	23%	9%
Both	-	-	13%	14%
Base: Contractors				

C2. Can you describe the main activity of your organization?

Main Activity of Organization	2019	2020	2021
Sample Size	12 (#)	40	42
Electrical contracting/installation	11	55%	43%
Manufacturing	-	20%	10%
Service	-	-	7%
Agriculture	-	3%	5%
Construction	-	-	2%
Mercantile/Retail (Other than Mall)	-	3%	2%
Food Service (Restaurant)	-	3%	2%
Public Assembly	-	3%	-
Lodging	-	3%	-
Religious Worship	1	-	-
Others	-	13%	29%
Base: Contractors that make the purchase decision			

C3. Before making the decision to purchase [PRODUCT], do clients usually ask for your advice?

Clients Seeking Purchase Decision Advice from Contractors	2018	2019	2020	2021
Sample Size	7 (#)	5 (#)	7 (#)	2 (#)
Yes	6	4	6	2
No	1	1	1	-
Base: Contractors whose client makes the purchase decision				

C4. What was the SINGLE most important reason you purchased [PRODUCT] rather than a standard [STANDARD PRODUCT]?**

C5. What was the SECOND most important reason you purchased [PRODUCT] rather than a standard [STANDARD PRODUCT]?**

Motivations for Buying Efficient Products	2018		2019		2020		2021	
	Most Important Reason	Other Reasons*	Most Important Reason	Other Reasons*	Most Important Reason	Other Reasons*	Most Important Reason	Other Reasons*
Sample Size	49	49	53	53	46	46	44	44
To improve energy efficiency	27%	10%	26%	4%	22%	9%	32%	11%
Save on energy costs/bills	18%	14%	45%	13%	46%	4%	23%	20%
Better lighting	-	-	-	-	-	-	16%	11%
Price of product	4%	6%	4%	8%	2%	2%	7%	7%
Longer lifespan	-	-	6%	9%	4%	17%	5%	9%
Quality of efficiency products	29%	41%	6%	25%	9%	26%	5%	2%
Take advantage of program rebates	2%	2%	-	4%	7%	9%	2%	7%
Safer/More secure	-	-	-	-	-	-	-	5%
More recyclable	-	-	-	-	-	-	-	5%
Availability of product/easier to get	2%	4%	-	4%	2%	7%	-	5%
Reduce maintenance and associated costs	8%	6%	2%	11%	2%	4%	-	2%
Update equipment	2%	-	2%	-	-	4%	-	2%
What the customer/owner wanted	-	2%	2%	-	4%	2%	-	-
Protect the environment	2%	-	-	6%	2%	2%	-	-
To replace non-working equipment	-	-	2%	-	-	-	-	-
Recommended by contractor	-	2%	-	-	-	-	-	-
Others	6%	2%	6%	8%	-	2%	11%	11%
None/No other reason	-	10%	-	9%	-	11%	-	-
Don't know	-	-	-	-	-	-	-	2%
Base: Respondents who purchased products for their organization or who make the decision to buy efficient products, or before making the decision to purchase clients usually ask respondent for advice								
*Multiple Responses								
**Slight wording change in 2020								

C6. Did your distributor recommend [PRODUCT] to you?

Distributor Recommended Product	2018	2019	2020	2021
Sample Size	49	60	51	50
Yes	51%	62%	71%	60%
No	43%	33%	29%	40%
Don't know	6%	5%	-	-

C7. For what type of project did you purchase the majority of the [PRODUCT]? Was it for a...

Type of Project – Contractors	2018	2019	2020	2021
Sample Size	20	17 (#)	30	22
Replacement of existing fixtures or lamps	35%	8	57%	59%
New construction	60%	9	43%	36%
Don't know	5%	-	-	5%
Base: Contractors				

C8. For what type of project did you purchase the [PRODUCT] that you bought through the Business Energy Rebates Program? Was it for a...

Type of Project – End-users	2018	2019	2020	2021
Sample Size	30	37	21	25
Replacement of existing fixtures or lamps	80%	76%	86%	80%
New construction	17%	22%	14%	20%
Don't know	3%	3%	-	-
Base: End users				

- C9. In what state were your existing fixtures or lamps when you decided to purchase the [PRODUCT]? Were they...

Condition of Existing Fixtures or Lamps	2018	2019	2020	2021
Sample Size	31	36	35	33
Working but at the end of their useful life	29%	53%	49%	39%
Some were working, some were not working	13%	3%	17%	21%
Broken	16%	22%	20%	18%
Working and not close to the end of their useful life	32%	19%	11%	9%
Others	3%	3%	3%	6%
Don't know	6%	-	-	6%
Base: Respondents who are replacing existing fixtures				

- C10. Did the impacts of the COVID-19 pandemic have an influence on your business' decision to participate in the Business Energy Rebates program?

Impact of COVID-19 Pandemic Influenced Business Decision to Participate in BER Program	2021
Sample Size	50
Yes	6%
No	94%

96. C11. How did the COVID-19 pandemic influence your decision to participate in the program?

How COVID-19 Pandemic Influenced Business Decision to Participate in BER Program	2021
Sample Size	3 (#)
Others	3
Base: Respondents whose business decision to participate in the Business Energy Rebates Program was influenced by the COVID-19 pandemic	

- D1. Were you aware that you had received a rebate when purchasing these [PRODUCT]?
- D2. I just want to make sure I understand – When you purchased [PRODUCT], you were unaware that a rebate was given to reduce the product's total cost?

Aware of Product Rebate Prior to Purchase	2018	2019	2020	2021
Sample Size	50	60	51	50
Yes	92%	98%	98%	98%
No	8%	-	2%	2%
Don't know	-	2%	-	-

- D3. Were you aware that the rebate was offered by Efficiency Nova Scotia as part of its Business Energy Rebates Program?

Aware Rebate Was Offered by ENS	2018	2019	2020	2021
Sample Size	46	59	50	49
Yes	93%	85%	94%	86%
No	7%	14%	6%	14%
Don't know	-	2%	-	-
Base: Respondents who were aware they received a rebate when purchasing products				

D4. How did you first become aware of the rebates available under Efficiency Nova Scotia's Business Energy Rebates Program?

Source of Awareness of Rebates	2018	2019	2020	2021
Sample Size	30*	31**	20**	20
Through my distributor	57%	39%	65%	55%
Through my contractor	3%	3%	5%	20%
Through my business	-	-	-	10%
Past experience with another ENS program	3%	10%	-	5%
Word of mouth	7%	6%	10%	-
ENS website	7%	6%	10%	-
ENS promotion	7%	6%	5%	-
ENS staff contacted me about the program	10%	6%	5%	-
I contacted ENS	-	6%	-	-
Others	-	10%	-	10%
Don't know	7%	6%	-	-
*Base: End users				
**Base: End users aware of the rebate				

D5. Had you **already** decided to purchase [PRODUCT] **before** knowing that these products were rebated?

Already Made Decision to Purchase Product Before Knowing About Rebate	2018	2019	2020	2021
Sample Size	46	59	50	49
Yes	59%	66%	56%	73%
No	39%	32%	44%	22%
Don't know	2%	2%	-	4%
Base: Respondents who were aware of rebate				

- D6. Had you **already** decided to purchase [PRODUCT] **before** knowing the price of those products?

Already Made Decision to Purchase Product Before Knowing the Price of Products	2018	2019	2020	2021
Sample Size	50	60	51	50
Yes	52%	50%	37%	62%
No	42%	47%	63%	38%
Don't know	6%	3%	-	-

- D7. Efficiency Nova Scotia offered a rebate for the purchase of efficient lighting products. If your organization had not received the rebate, and the cost for each [PRODUCT] had been about \$[REBATE AVERAGE VALUE BY CATEGORY] higher, would you have paid the full cost of the [PRODUCT]? Please answer on a scale of 0 to 10, with a 0 indicating that you “Definitely **Would Not Have Paid**” and a 10 indicating that you “Definitely **Would Have Paid**.”*

Would Have Paid Cost of Product	2018		2019		2020		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Paid cost of project	49	5.7	60	6.4	51	5.2	48	6.6
Don't know/Refused excluded from calculations								
*Slight wording change in 2020								

- D8. Prior to your purchase, were you aware that the [PRODUCT] you purchased were premium products certified by Design Light Consortium or ENERGY STAR®?

Aware Product Was Certified by DesignLights Consortium or ENERGY STAR	2019	2020	2021
Sample Size	60	51	50
Yes	53%	61%	62%
No	47%	39%	38%

D9-D12. Now I would like to ask you to consider which actions your organization would have taken if the rebate had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is “Very Unlikely,” and a 10 indicating that it is “Very Likely.”

Actions Taken in Absence of BER Instant Rebates	2018		2019		2020		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
If the rebate had not been offered, what is the likelihood that you would have purchased the exact same model of premium lighting products*	46	5.5	59	6.4	50	4.9	49	6.1
If the rebate had not been offered, what is the likelihood that you would have purchased exactly the same quantity of lighting products that you bought***	40	5.5	46	7.3	39	5.2	40	5.8
If the rebate had not been offered, what is the likelihood that you would have postponed the purchase of the lighting products by at least one year****	31	2.4	48	3.6	32	4.1	39	3.5
If the rebate had not been offered, what is the likelihood that you would have kept your existing fixtures or lamps**	10	4.8	7	6.1	4	8.0	4	3.0
*Base: Respondents who were aware of rebate **Base: Respondents who were aware of rebate and who had existing products that were working and not close to the end of their useful life ***Base: Respondents who were aware of rebate and who purchased more than one product ****Base: Respondents who were aware of rebate and who would have likely paid full cost of the energy-efficient measure [IF D7≥5] Don't know/Refused excluded from calculations								

D13. Using a scale from 0 to 10, where 0 means “No influence” and 10 means “Great influence”, please rate the influence of each of the following in your organization’s decision to purchase [PRODUCT].

Influence of Factors in Decision to Implement Energy Efficient Products	2018		2019		2020		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Prevalence of LED products among products that met your lighting requirements	50	7.1	60	7.7	51	7.3	49	7.4
The program rebate*	45	7.4	59	7.3	50	7.1	49	6.7
Information received from a distributor on high-efficiency lighting products	49	6.2	59	6.6	51	7.3	50	6.5
Information received from an Efficiency Nova Scotia program representative on high-efficiency lighting products**	42	5.0	49	5.5	47	4.3	41	5.4
*Base: Respondents who were aware of rebate **Base: Respondents who were aware rebate was offered by ENS as part of program component Don't know/Refused excluded from calculations								

E1. Before participating in the Business Energy Rebates program in 2021, had your organization at any time in the past already participated in the Business Energy Rebates program or any other Efficiency Nova Scotia programs?

Previous Participation in Another ENS Program Component		2018	2019	2020	2021
Sample Size		50	60	51	50
Yes (Total)	Yes, in Business Energy Rebates*	58%	62%	69%	22%
	Yes, in another program(s)*				2%
	Yes, in both Business Energy Rebates and another program(s)*				34%
No		34%	35%	31%	30%
Don't know		8%	3%	-	12%
*Wording change in 2021					

- E2. Your organization's previous participation in an Efficiency Nova Scotia program was a major factor in the decision to purchase [PRODUCT].

Previous Participation in Another ENS Program Component Was a Major Factor in Purchase	2018	2019	2020	2021
Sample Size	29	37	35	29
Agree	76%	73%	69%	62%
Disagree	24%	27%	31%	38%
Base: Respondents who previously participated in another ENS program component				

- E3. Because of your organization's previous participation in an Efficiency Nova Scotia program and what was learned by participating in the program, a company representative asked a contractor or a distributor about efficient lighting options for your organization.

Previous ENS Program Component Participation Led to Ask About Products	2018	2019	2020	2021
Sample Size	29	37	35	29
Agree	69%	78%	74%	72%
Disagree	24%	22%	20%	17%
Don't know/refused	6%	-	6%	10%
Base: Respondents who previously participated in another ENS program component				

- E4. Because of your organization's previous participation in an Efficiency Nova Scotia program and what was learned by participating in the program, a company representative took into account the cost-effectiveness of [PRODUCT] when evaluating different options for your organization.

Previous ENS Program Component Participation Led to Assess Product Cost-effectiveness	2018	2019	2020	2021
Sample Size	29	37	35	29
Agree	86%	89%	94%	86%
Disagree	7%	11%	6%	14%
Don't know	6%	-	-	-
Base: Respondents who previously participated in another ENS program component				

- E5. Before participating in the Business Energy Rebates program, had you at any time in the past already seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?

Previously Seen Energy Efficiency Promotional Materials Distributed by ENS	2018	2019	2020	2021
Sample Size	50	60	51	50
Yes	96%	87%	88%	88%
No	2%	13%	12%	10%
Don't know	2%	-	-	2%

- E6. The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in the company's decision to purchase [PRODUCT].

ENS Energy Efficiency Promotional Materials Was a Major Factor in Purchase Decision	2018	2019	2020	2021
Sample Size	48	52	45	44
Agree	67%	62%	69%	61%
Disagree	33%	38%	31%	39%
Base: Respondents who previously saw ENS energy-efficiency promotional materials				

- E7. The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to ask a contractor or a distributor about efficient lighting options for your organization.

ENS Energy Efficiency Promotional Materials Led to Ask About Products	2018	2019	2020	2021
Sample Size	48	52	45	44
Agree	63%	62%	69%	61%
Disagree	35%	37%	31%	36%
Don't know	2%	2%	-	2%
Base: Respondents who previously saw ENS energy-efficiency promotional materials				

- E8. The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to take into account the cost-effectiveness of [PRODUCT] when evaluating different options for the facility.

ENS Energy Efficiency Promotional Materials Led to Assess Product Cost-Effectiveness	2018	2019	2020	2021
Sample Size	48	52	45	44
Agree	81%	77%	71%	66%
Disagree	19%	23%	29%	32%
Don't know	-	-	-	2%
Base: Respondents who previously saw ENS energy-efficiency promotional materials				

- F1. Using a scale from 1 to 10 where 1 is "not at all satisfied" and 10 is "completely satisfied" how would you rate your satisfaction with the Business Energy Rebates program overall?

Satisfaction with BER Overall	2019		2020		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Overall Satisfaction	60	8.8	51	8.6	49	8.9

- F2. What was the most important reason you were not more satisfied with the program overall?

Most Important Reason Not More Satisfied with BER Overall	2019	2020	2021
Sample Size	7 (#)	12 (#)	5 (#)
Don't like the mail-in rebates/Prefer the instant rebates	-	2	1
Rebate/incentive is too small	3	1	1
Lack of knowledge on the program/how things work	-	4	-
Too many changes/Rebates not consistent	-	2	-
Delays with suppliers/distributors	-	1	-
Have to give a specific address where the products will be used	-	1	-
Too much paperwork	2	-	-
Others	2	1	2
Don't know	-	-	2
Base: Respondents dissatisfied with BER program overall (F1<8) Multiple response			

F3. On a scale of 1 to 10, where 1 is 'not at all satisfied' and 10 is 'completely satisfied,' how was your organization's experience with each of the following aspects of the Business Energy Rebates Program? If your organization did not have experience with one of these aspects please tell me.

Satisfaction with Aspects of BER	2019		2020		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Interaction and communication with distributors	56	9.0	48	8.4	48	9.2
Rebate amounts	58	8.3	51	7.9	49	8.9
Eligible products	58°	7.9°	48	7.3	47	8.6
° Note: correction in 2019 mean calculation and sample size Don't know/Refused/Not applicable excluded from calculations						

F4A. Why were you not more satisfied with the interaction and communication with contractors or distributors?

Most Important Reason Not More Satisfied with Interaction and Communication with Contractors or Distributors	2019	2020	2021
Sample Size	4 (#)	13 (#)	5 (#)
Took too long/Communication was slow	-	1	1
Rebate can be more than the cost	-	-	1
Always room for improvement	-	-	1
Limited to the product that's available	-	-	1
Lack of communication and availability of distributor	2	4	-
Lack of knowledge / less knowledgeable about the program	1	3	-
Have to give specific address for products	-	1	-
Other	1	1	-
Don't know	-	3	1
Base: Respondents dissatisfied with the interaction and communication with contractors or distributors Multiple Response			

F4B. Why were you not more satisfied with the rebate amounts?

Most Important Reason Not More Satisfied with Rebate Amounts	2019	2020	2021
Sample Size	12 (#)	17 (#)	10 (#)
Rebate is too small/Expected higher rebate	9	6	6
Rebate amounts not consistent/kept changing	1	-	1
Rebate should be based on quality/output of product	-	-	1
Rebate sometimes higher than the cost of the lights	-	-	1
Some measures don't have a rebate	-	4	-
Lack of information on the amount/structure of the rebate	-	2	-
Cost of measures was expensive	-	1	-
Not informed about all of the rebates available	1	-	-
Cost of measures was expensive	1	-	-
Others	1	1	1
Don't know	-	4	-
Base: Respondents dissatisfied with the rebate amount Multiple Response			

F4C. Were there other types of efficient equipment or services you would like to see Efficiency Nova Scotia provide rebates for?

Other Equipment or Services Like to See Rebated by ENS	2019	2020	2021
Sample Size	20	22	13 (#)
More lighting	15%	18%	4
Heat pumps/Geothermal heat pumps	5%	5%	-
Heating equipment	5%	5%	-
Solar equipment	10%	-	-
More residential equipment/services	5%	-	-
Energy storage	5%	-	-
Appliances	5%	-	-
Insulation	5%	-	-
Others	-	-	2
No other equipment or services	40%	73%	7
Don't know	20%	-	-
Base: Respondents dissatisfied with eligible products Multiple Response			

F5. Do you have any suggestions on how to improve the Business Energy Rebates program?

Suggestions to Improve BER	2019	2020	2021
Sample Size	60	51	50
Better marketing/awareness	3%	-	8%
Offer more measures rebated	7%	4%	4%
More information on measures available for rebates	5%	6%	2%
More consistency in measures available for rebates/Too many changes	-	6%	2%
ENS staff should be easier to contact	2%	-	2%
Rebates should be paid back quicker	-	-	2%
Increase the rebates/Rebate is too small	-	8%	-
More instant rebates/Prefer instant rebates over mail-in	-	2%	-
Less paperwork	2%	-	-
Others	5%	8%	8%
No recommendation	78%	71%	72%

APPENDIX V

BER: INSTANT REBATES INTERVIEW GUIDE WITH DISTRIBUTORS

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview Guide
Estimated Time to Complete	25 minutes
Target Audience	Business Energy Rebates Lighting Distributors
Expected Number of Completions	10 (census)
Contact List Source	Efficiency Nova Scotia
Fielding Firm	Narrative Research
Estimated Timeline for fielding	3 weeks

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
Assessing free ridership	B,C,D
Assessing program satisfaction and suggestions for improvements	F
Monitoring the market evolution of lighting products	E

To be adapted by Econoler **[Blue text]**

Import variables from database < **LIKE THIS** >

Skip pattern or programming instructions **[LIKE THIS]**

Black text: instructions for interviewer **[NOTE: xxxx] / [PROBE: xxxx]**

INTRODUCTION

Thank you for taking the time to speak with me today. I am interested in your opinion regarding Efficiency Nova Scotia's Business Energy Rebates program, from your perspective as a program partner. As you may recall, Econoler, in partnership with Narrative Research, is conducting a program evaluation again this year for the Business Energy Rebates program.

We would appreciate your collaboration in answering questions related to your involvement in this program. The information you provide will be used to help Efficiency Nova Scotia evaluate and improve the program. Our discussion should last approximately 20-30 minutes, depending on your responses. Is this a good time for you?

Please note that your responses will be kept strictly confidential and that we will not share the information you provide with any other party in a way that could identify your individual or corporate responses.

A. Identification and Screening of Respondent

A1. I'd like to speak with someone in your company/store who is knowledgeable about the stocking and supplying of specific products that were rebated by the program. These products are 1) **linear LED fixtures**, 2) **LED linear lamps** and 3) **outdoor LED fixtures**. Would that person be you?

1. Person responsible available [CONTINUE]
2. Person responsible currently unavailable [ARRANGE CALL BACK WITH THE RIGHT PERSON]
3. No person responsible for stocking or management of products [CONTINUE INTERVIEW WITH STORE MANAGER/HEAD OFFICE CONTACT - CONTINUE]
98. Don't know [CONTINUE INTERVIEW WITH STORE MANAGER/HEAD OFFICE CONTACT-CONTINUE]
99. Refused [THANK AND TERMINATE]

Note that I will be asking the same questions for each of these product categories; we will discuss each product category one at a time. Also, if you work in many provinces, please always keep in mind only the Nova Scotia market when answering. First, I would like to discuss the LED fixtures in general.

B. Linear LED Fixtures

ASK IF LINEAR LED FIXTURES WERE REBATED THROUGH THE PROGRAM

I have a few questions about your sales of **linear LED fixtures** that are promoted by the Business Energy Rebates Program. This category includes the following measures (as defined in Efficiency Nova Scotia's rebate schedule): low-bay luminaires, troffers, linear ambient luminaires, and retrofit kits. Those fixtures would all be Design Light Consortium (DLC) or ENERGY STAR certified. Our records indicate that you sold _____ linear LED fixtures as part of the BER Instant Rebates program up to September 2021 (inclusively), **[READ IF SALES DATA AVAILABLE]** while you sold _____ units for the year in 2020.

- B1. **[ASK IF SALES DATA AVAILABLE]** Based on those numbers, you should sell **[FROM SAMPLE: fewer / more]** linear LED fixtures by the end of 2021 than the number of units you sold in 2020. Does this sound accurate? If so, what explains this change? **[PROBE: market trend, more competitors offering these products, etc.]**
- B2. **[ASK IF SALES DATA NOT AVAILABLE]** If things stay the course for the remainder of this year, will you sell more, less or the same number of linear LED fixtures by the end of 2021 than the number of units you sold in 2020? If "more" or "less", how do you explain the difference? **[PROBE: market trend, more competitors offering these products, etc.]**
- B3. This year, the Business Energy Rebates Program provided an incentive ranging from \$10 to \$55 per linear LED fixture, depending on the type, until September 15th. Since September 15th, the incentive provided by the program range from \$15 to \$55 per linear LED fixtures. If this incentive had not been offered, would the number of linear LED fixtures you will sell in 2021 have been about the same or lower?
1. Same [GO TO B4]
 2. Lower [GO TO B5]
 98. (Don't know) [GO TO B6]
 99. (Refused) [GO TO B6]
- B4. **[IF SAME]** Just to confirm... without the program incentive, you would have sold the same number of **linear LED fixtures** this year?
- B5. **[IF LOWER]** In your estimation, by what percentage would the number of linear LED fixtures you sold have been lower in 2021 if the Business Energy Rebates Program incentive was not available?

RECORD PERCENTAGE ____%

RECORD EXPLANATION:

- B6. I am interested in understanding the impact of the Business Energy Rebates program on customers' product choice. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on your customers' choice of linear LED fixtures instead of fluorescent tube fixtures?

RECORD RATING: _____

RECORD EXPLANATION:

- B7. Is the incentive ranging from \$10 to \$55 per fixture, until September 15, and then from \$15 to \$55 after that enough to encourage customers who would not have done so otherwise to purchase linear LED fixtures? Why?

- B8. Through the Business Energy Rebates Program, only products meeting the program's criteria, such as DLC or Energy Star certifications, are eligible for rebate. I would like to understand the impact of the program on your company's decision to carry these products. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on the proportion of DLC or ENERGYSTAR certified linear LED fixtures carried by your company?

RECORD RATING: _____

RECORD EXPLANATION:

C. LED Linear Lamps

ASK IF LED LINEAR LAMPS WERE REBATED THROUGH THE PROGRAM

I have a few questions about your sales of LED linear lamps that are promoted by the Business Energy Rebates Program. This category includes lamps such as two-foot and foot-foot linear replacement lamps and retrofit kits for ambient lighting. Those lamps would all be Design Light Consortium (DLC) certified. Our records indicate that you sold _____ LED linear lamps as part of the BER Instant Rebates program up to September 2021 (inclusively), **[READ IF SALES DATA AVAILABLE]** while you sold _____ units for the year 2020.

- C1. **[ASK IF SALES DATA AVAILABLE]** Based on those numbers, you should sell **[FROM SAMPLE: fewer / more]** LED linear lamps by the end of 2021 than the number of units you sold in 2020. Does this sound accurate? If so, what explains this change? **[PROBE: market trend, more competitors offering these products, etc.]**
- C2. **[ASK IF SALES DATA NOT AVAILABLE]** If things stay the course for the remainder of this year, will you sell more, less or the same number of LED linear lamps by the end of 2021 than the number of units you sold in 2020? If "more" or "less", how do you explain the difference? **[PROBE: market trend, more competitors offering these products, ability to purchase LEDs at a good price, etc.]**

C3. This year, the Business Energy Rebates Program provided an incentive ranging from \$2.50 to \$6 per LED linear lamp, depending on the type. If this incentive had not been offered, would the number of LED linear lamps you will sell in 2021 have been about the same or lower?

1. Same [GO TO D4]
2. Lower [GO TO D5]
98. (Don't know) [GO TO D6]
99. (Refused) [GO TO D6]

C4. **[IF SAME]** Just to confirm... without the program incentive, you would have sold the same number of **LED linear lamps** this year?

C5. **[IF LOWER]** In your estimation, by what percentage would the number of LED linear lamps you sold have been lower in 2021, if the Business Energy Rebates Program incentive had not been available?

RECORD PERCENTAGE ____%

RECORD EXPLANATION:

C6. I am interested in understanding the impact of the Business Energy Rebates program on customers' product choice. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on your customers' choice of LED linear lamps instead of fluorescent lamps?

RECORD RATING: _____

RECORD EXPLANATION:

C7. Is the current incentive ranging from \$2.50 to \$6 per lamp enough to encourage customers who would not have done so otherwise to purchase LED linear lamps? Why?

C8. Through the Business Energy Rebates Program, only products meeting program's criteria, such as DLC or Energy Star certifications, are eligible for rebate. I would like to understand the impact of the program on your company's decision to carry these products. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on the proportion of DLC certified LED linear lamps carried by your company?

RECORD RATING: _____

RECORD EXPLANATION:

D. Outdoor LED fixtures

ASK IF OUTDOOR LED FIXTURES WERE REBATED THROUGH THE PROGRAM

I have a few questions about your sales of **Outdoor LED fixtures** that are promoted by the Business Energy Rebates Program. This category includes the following measures (as defined in Efficiency Nova Scotia's rebate schedule): full, semi, and non-cutoff wall-mounted area luminaires; as well as flood and spot luminaires. Those fixtures would all be Design Light Consortium (DLC) certified fixtures that replace metal halide, high pressure sodium or halogen fixtures. Our records indicate that you sold _____ Outdoor LED fixtures as part of the BER Instant Rebates program up to September 2021 (inclusively), **[READ IF SALES DATA AVAILABLE]** while you sold _____ units for the year 2020.

- D1. **[ASK IF SALES DATA AVAILABLE]** Based on those numbers, you should sell **[FROM SAMPLE: fewer / more]** Outdoor LED fixtures by the end of 2021 than the number of units you sold in 2020. Does this sound accurate? If so, what explains this change? **[PROBE: market trend, more competitors offering these products, etc.]**
- D2. **[ASK IF SALES DATA NOT AVAILABLE]** If things stay the course for the remainder of this year, will you sell more, less or the same number of Outdoor LED fixtures by the end of 2021 than the number of units you sold in 2020? If "more" or "less", how do you explain the difference? **[PROBE: market trend, more competitors offering these products, ability to purchase LEDs at a good price, etc.]**
- D3. This year, the Business Energy Rebates Program provided an incentive ranging from \$15 to \$450 per outdoor LED fixture, depending on the type. If this incentive had not been offered, would the number of Outdoor LED fixtures you will sell in 2021 have been about the same or lower?
1. Same [GO TO C5]
 2. Lower [GO TO C6]
 98. (Don't know) [GO TO C7]
 99. (Refused) [GO TO C7]
- D4. **[IF SAME]** Just to confirm...without the program incentive, you would have sold the same number of **Outdoor LED fixtures** this year?
- D5. **[IF LOWER]** In your estimation, by what percentage would the number of Outdoor LED fixtures you sold have been lower in 2021, if the Business Energy Rebates Program incentive had not been available?

RECORD PERCENTAGE ____%

RECORD EXPLANATION:

- D6. I am interested in understanding the impact of the Business Energy Rebates program on customers' product choice. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on your customers' choice of Outdoor LED fixtures instead of metal halide, high pressure sodium, or halogen fixtures?

RECORD RATING: _____

RECORD EXPLANATION:

- D7. Is the incentive ranging from \$15 to \$450 per fixture enough to encourage customers who would not have done so otherwise to purchase Outdoor LED fixtures? Why?
- D8. Through the Business Energy Rebates Program, only products meeting program's criteria, such as DLC or Energy Star certifications, are eligible for rebate. I would like to understand the impact of the program on your company's decision to carry these products. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on the proportion of DLC certified Outdoor LED fixtures carried by your company?

RECORD RATING: _____

RECORD EXPLANATION:

E. Market Evolution

The next set of questions are to understand the state of the market in Nova Scotia for LED lighting, specifically LED general-use and decorative lamps, LED downlight fixtures, LED linear fixtures and LED linear lamps.

[Note to interviewer: In 2019, Efficiency Nova Scotia chose to remove LED downlight fixtures as well as general-use and decorative lamps from Business Energy Rebates product offer. E1-E6 are to understand impact of this change on future sales.]

- E1. Over the last 3 years, as best as you know, have your sales of general use and decorative lamps increased, decreased or stayed the same?
- E2. What makes you say that?
- E3. Over the past 3 years, as best as you know, have your sales of LED downlight fixtures increased, decreased or stayed the same?
- E4. What makes you say that?

- E5. **[IF 2019 CURVE IS NOT AVAILABLE]** For the next questions, please refer to the product adoption curve that was emailed to you before this interview. Thinking of the Nova Scotia business lighting market, where on the product adoption curve would you place each of the following lighting products?

By business market we mean the commercial, industrial and institutional markets for lighting products.

Lighting Products	2021 Letter on the Curve	Explanation
a. General-use/Decorative LED lamps		
b. LED downlight fixtures		
c. LED linear lamps		
d. LED linear fixtures		

- E6. **[IF 2019 CURVE IS AVAILABLE]** For the next questions, please refer to the product adoption curve that was emailed to you before this interview. Thinking of the Nova Scotia business lighting market, where on the product adoption curve would you place each of the following lighting products?

By business market we mean the commercial, industrial and institutional markets for lighting products.

[NOTE: Use 2019 Letter Curve to remind respondents what they answered in 2019.]

Lighting Products	[2019 LETTER CURVE]	2021 Letter on the Curve	Explanation
a. General-use/Decorative LED lamps			
b. LED downlight fixtures			
c. LED linear lamps			
d. LED linear fixtures			

F. Satisfaction and Recommendations

ASK ALL RESPONDENTS

- F1. On a scale from 1 to 10 (where 1 = not at all satisfied and 10 = very satisfied) ...
- a. how would you rate your satisfaction with each of the following aspects?
 - b. If less than 8, please explain the reason(s) for your score.

Aspects of the program	Score	Reason
1. The overall program		
2. The program support and communications provided by ENS		
3. The rebate processing, tracking and reporting		

- F2. What, if anything, has been a key success of the program for your company over the last year?
- F3. What challenges, if any, has your company experienced with the program over the last year?
- F4. Finally, do you have any suggestions to improve the program?

Record: _____

☐ No suggestion at this time

Those are all the questions I have for you today. Would you like to add anything else regarding the program or talk about any other topic that was not covered during the interview?

THANK YOU FOR TAKING THE TIME TO TAKE PART IN THIS INTERVIEW.

APPENDIX VI

BER: MAIL-IN TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying that all data fields required for the evaluation were included and filled out in the tracking sheet submitted by EfficiencyOne (EOne)
- › Ensuring that tracked results were accurate by:
 - Verifying that parameters used to calculate program results (gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating that all calculation steps were performed consistently

EOne started using their new Integrated Customer Information System in 2021 for Mail-in; therefore, the format of the tracking sheet was changed compared to previous years.

Data Completeness and Accuracy

Table 1 lists all the parameters required for the Mail-in evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the table details the actions carried out by the Evaluator to adjust data where required.

Table 1: Verification of 2021 Mail-in Data Field Completeness and Accuracy

Data Fields	Complete (Y/N/ Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Gross Energy Savings at the Meter (Column BO)	Y	N/A	
Gross Peak Demand Savings at the Meter (Column BS)	Partial	N/A	The Evaluator calculated the corrected gross peak demand savings of five air-source heat pump entries with nil tracked savings using the third method in the related memo prepared by EOne while ensuring that each heat pump had a cut-off temperature below 15°C (one heat pump did not, and the savings associated with the corresponding entry remained nil).

Data Fields	Complete (Y/N/ Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Rate Code (Column BD)	Y	Y	The Evaluator found 22 entries (out of 668 in total) that had incorrect line loss factors (their rate class was "Municipal"). The line loss factors were consistent with the previous evaluation but inconsistent with EOne's new directive regarding projects with a municipal rate class. The line loss factors were corrected using the average energy and peak demand line loss factors of all other entries weighted by their corresponding gross savings at the meter.
Net-to-gross Ratio (Column CK)	Y	Y	
Effective Useful Life (Column CJ)	Y	N	The Evaluator found and corrected the tracked EUL of 19 linear replacement lamp entries that used the value from the 2019 evaluation instead of that of the 2020 evaluation. The Evaluator also corrected the EUL values of two custom LED poultry lighting entries using their rated lifetime and annual hours of use.

Data Consistency

The second step of the tracking sheet audit involved recreating calculations and comparing related tracking sheet data fields to identify any potential inconsistencies. Table 2 below lists the data fields of the Mail-in tracking sheet that were compared to ensure consistency.

Table 2: Verification of 2021 Mail-in Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Calculated Line Loss Factor (Gross Energy Savings at the Generator / Gross Energy Savings at the Meter)	Tracked Rate Codes	Y	N/A
Total Gross Energy Savings at the Meter at Measure Level	Total Gross Energy Savings at the Meter at Project Level	Y	N/A
Total Gross Peak Demand Savings at the Meter at Measure Level	Total Gross Peak Demand Savings at the Meter at Project Level	Y	N/A
Verification of Duplicate IDs or Projects	-	Y	N/A

Equations and Compilation

Once the correct values were established (as per Table 1), the Evaluator validated that the equations in the tracking sheet correctly calculated each of the main program component results as presented in Table 3.

Table 3: Verification of 2021 Mail-in Savings Compilation

Service Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	Y	N/A
Gross Peak Demand Savings at the Generator	Y	N/A
Net Energy Savings at the Generator	N	The Evaluator found one entry that had inconsistent net energy and peak demand savings at the generator. The inconsistency was found to be due to net savings being calculated with another NTGR value than the one tracked in Column CK. The Evaluator corrected the net results.
Net Peak Demand Savings at the Generator	N	

Corrected Tracked Savings

Table 4 presents the corrected tracked savings resulting from all changes made by the Evaluator as described in this appendix.

Table 4: 2021 Mail-in Corrected Tracked Savings

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
BER Mail-in					
Gross Energy Savings at the Generator	16.447	GWh	16.446	GWh	-0.01%
Gross Peak Demand Savings at the Generator	2.549	MW	2.694	MW	5.66%
Net Energy Savings at the Generator	13.239	GWh	13.238	GWh	-0.01%
Net Peak Demand Savings at the Generator	2.056	MW	2.164	MW	5.27%

The main differences between the tracked and corrected values are in the peak demand savings results and are mainly explained by the correction to the peak demand savings for air-source heat pumps.

The other corrections made by the Evaluator did not have a significant impact on results and consisted of correcting the energy and demand line loss factors for 22 entries and correcting the NTGR of one entry.

APPENDIX VII

BER: MAIL-IN ON-SITE VISIT SAMPLING METHODOLOGY AND PROTOCOL

Sampling Methodology

The 2021 Business Energy Rebates (BER) sample covered 40 lighting projects. The sampling plan was developed based on the October 2021 tracking sheet that included all completed projects to date. The tracking sheet contained 134 lighting projects implemented by a total of 91 participants. The sample included all projects that generated over 2,000 kWh. The Evaluator followed industry best practices for sampling as described by the Uniform Methods Project¹ and designed the random sample so that the probability of a project being selected was approximately proportional to its size.

On-site Visit Protocol

The 2021 BER Mail-in on-site visit protocol was prepared based on the 2019 protocol. The only major change to the latter was that the sections for all measure categories other than for lighting were removed. The protocol contains a general section for project information as well as a section on measure-specific variables. The General Information section documents the facility type and contact information. The measure-specific data sections provide the parameters required for savings calculations, based on the data documented in the CIRx Screening Tool v1.37, and are completed with the information gathered on site. These data consist of, but are not limited to, measure types, quantities, model numbers, wattages or capacity, runtime hours, and operation during peak demand periods. Most fields in the protocol were filled out prior to on-site visits with the information in the project documentation provided by EOne. This allowed saving time and only recording additional details if on-site conditions did not match the tracked information.

¹ NREL, *The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures*, Chapter 11: Sample Design Cross-Cutting Protocol, September 2017, pp. 60-61.

On-site Visit Data-collection Form
1. General Information

Person Conducting the Visit			
Date of Site Visit			
Project ID			
Project Name			
NSPI Rate Code			
Company Name			
Contact Name			
Address			
Contact Phone Number			
Name of Person Met During Visit			
Type of Facility	Retail: ☐	Manufacturing/ Industrial: ☐	Grocery/ Supermarket: ☐
	College/ University: ☐	Multi-Unit Res.: ☐	Other (Specify): ☐
Operation During Peak Period (b/n 5-7 pm in Dec/Jan/Feb)?	Yes ☐	No ☐	
If "Yes", Determine % Load Operational During Peak Period			
Project Type:	Early Replacement ☐	End of Useful Life ☐	New/No Replacement ☐
Year Existing Equipment Was Installed (if applicable)			
Spillover Questions Completed	Yes ☐	No ☐	

Notes:

2. Building Heating/Cooling System Description

Heating Systems:

Please fill the table below for each heating system at the site

Parameter	Heating System 1	Heating System 2
Energy Source		
% of Heat		
Type of System		

Cooling Systems:

Please fill the table below for each cooling system at the site

Parameter	Cooling System 1	Cooling System 2
% of Cooling		
Type of System		

Notes:

3. Occupancy Schedule

Business Hours (Mon-Fri)	
Open Weekends?	
Business Hours (Weekends)	
Staff Early Open	
Staff Late Close	
Cleaning Hours per Week	
Days/Year with no Occupancy (i.e. holidays or weekends)	
Working Days	
Annual HOU	
Are Heating/Cooling Systems Set Back During Unoccupied Times?	
Notes	

**Normal week/holiday lighting
operation schedule (hours per day):**

Please fill the table below for each lighting schedule reported by the site contact as usage could vary for each section of the facility. Use additional sheets if necessary.

Weekdays - Hours/Day with Regular Schedule	Weekends - Hours/Day with Regular Schedule	Hours/Day with Holiday Schedule	Hours/Day with No Occupancy	Notes

Notes:

4. Measures Information

Lighting: *Collect the information in the tables below. Use on-site observation and contact declaration. Use additional sheets if required. Econoler will then compare the information collected with the information in the tracking sheet.*

General Measure Information

Measure #	
Location (from tracking sheet)	
Location (validation on site)	
Is Cooling Installed in the Section with the Lighting Measure?	Y Yes Y No
Is Heating Installed in the Section with the Measure?	Y Yes Y No
Percentage of Lighting that Remains on When the Facility Is Closed	

Existing Measure Information

Existing Product Type (from tracking sheet)	
Existing Product Type (validation on-site)	
Existing # of Lamps per Fixture	
If Existing Is T12 HO Strip, What Length?	
Existing Wattage/Unit (from tracking sheet)	
Existing Wattage/Unit (validation on site)	
Existing Hours per Week of Operation (from tracking sheet)	
Existing Quantity (from tracking sheet)	
Existing Quantity (validation on site)	
Notes	

New Measure Information

New Product Type (from tracking sheet)	
New Product Type (validation on site)	
# of Lamps per Fixture	
Is Lighting Installed Inside, Outside, or in a Refrigerated Area?	
New Wattage/Unit (from tracking sheet)	
New Wattage/Unit (validation on site)	
New Hours per Week of Operation (from tracking sheet)	
Explanation if New Hours Are Different from Existing Hours (e.g. occupancy sensor was added)	
New Quantity (from tracking sheet)	
New Quantity (validation on site)	
Difference in New Quantities	
Explanation if New Quantities Are Different	
Explanation if New Quantity Is Different from Existing Quantity (e.g. delamping, too much light before)	
Quantity of Lamps that Are Burnt Out	
How Long Have they Been Burnt Out?	
Will Burnt Out Lamps Be Replaced?	
Are Lights Used Seasonally?	
Notes (occupancy sensor?)	

APPENDIX VIII

BER: MAIL-IN ADJUSTMENT RATIO CALCULATION EXAMPLE

This appendix presents a sample calculation to demonstrate the process of revising energy and peak demand savings. The lighting measure category was the focus of the 2021 BER Mail-in evaluation; hence, one of the lighting measures was chosen to exemplify the calculation details for the following:

- › Algorithms for calculating energy and peak demand savings
- › Comparison of the calculation of tracked energy and peak demand savings and the calculation of revised energy and peak demand savings
- › Algorithm for establishing the adjustment ratio

Energy and Peak Demand Savings Equations

The following equations include the parameters required to determine the annual energy and peak demand savings associated with efficient lighting measures.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{(W_b \times Qty_b - W_e \times Qty_e) \times HOU \times IE}{1,000}$$

$$\text{Peak Demand Savings} \left[\frac{\text{kW}}{\text{yr}} \right] = \frac{(W_b \times Qty_b - W_e \times Qty_e) \times CF \times IE_{pd}}{1,000}$$

Where:

- › W_b : The total wattage of the baseline system
- › W_e : The total wattage of the efficient system
- › HOU : The annual hours of use
- › Qty_b : The number of fixtures in the baseline system
- › Qty_e : The number of fixtures in the efficient system
- › IE : The interactive effects factor for energy savings
- › IE_{pd} : The interactive effects factor for peak demand savings
- › CF : The peak coincidence factor
- › 1,000: The conversion factor from watts to kilowatts

Tracked Savings Calculation

The measure used for the example calculation was a lighting retrofit in an existing large garage. The model and manufacturer of the existing fixtures were not known and were only listed as generic fixtures; thus, the Duke Fixture Wattage Table was used for the baseline wattage. The proposed efficient measure wattage was obtained from the DLC Qualified Products List using the specification sheet submitted with the application.

Table 1 presents the values used for the case of LED 123 W high-bay LED fixtures installed as replacements for six-lamp T8 fixtures.

Table 1: Tracked Variables for Example Calculation

Baseline Measure – Six-lamp T8 High-bay Fixture		
Parameter	Value	Source
Baseline Fixture Quantity	43	Tracking Sheet
Baseline System Wattage (W)	175	Tracking Sheet
Hours of Use (hrs/year)	6,569.64	Tracking Sheet
Interactive Effects Factor (energy)	1.00	Tracking Sheet
Interactive Effects Factor (peak demand)	1.00	Tracking Sheet
Peak Coincidence Factor	1.00	Tracking Sheet
Annual Energy Consumption (kWh)	49,436.54	Calculation
Annual Peak Demand (kW)	7.525	Calculation
Efficient Measure – 123W LED High-bay Fixture		
Efficient Fixture Quantity	43	Tracking Sheet
Efficient System Wattage	123	Tracking Sheet
Hours of Use (hrs/year)	6,569.64	Tracking Sheet
Interactive Effects Factor (energy)	1.00	Tracking Sheet
Interactive Effects Factor (peak demand)	1.00	Tracking Sheet
Peak Coincidence Factor	1.00	Tracking Sheet
Annual Energy Consumption (kWh)	34,746.83	Calculation
Annual Peak Demand (kW)	5.289	Calculation
Tracked Savings		
Tracked Energy Savings (kWh)	14,689.72	Tracking Sheet
Tracked Demand Savings (kW)	2.236	Tracking Sheet

Revised Savings Calculation

The revised savings calculations are based on two adjustments. The first adjustment increased the baseline wattage as a result of selecting a different baseline fixture description in the Duke Fixture Wattage Table. The specification sheet for the efficient fixture indicated it was suitable to replace a six-lamp high lumens (HL) T8 fixture. This high-output format is typically found in high-bay applications where T8 tubes are driven with higher power to obtain increased lighting levels at the work surface.

The tracked baseline wattage of 175 W represents a six-lamp 32 W T8 fixture with two electronic ballasts in the Duke Table; these would be considered a normal ballast factor and would be more appropriate for a low-bay application wherein the mounting height is under 20 feet. The revised fixture specification would be a six-lamp 32 W T8 fixture with two high-power electronic ballasts in the Duke Table and with an input wattage of 221 W.

The second adjustment was to the hours of use variable based on site visit findings. The final application did not list the hours of use per week and only listed general business hours of 5 am to 11 pm daily, with no holiday closures. It was verified by email that the lights were operated 18 hours per day based on the listed business hours on the application.

The site visit served to determine that the lights were installed in the main service garage located within a gated complex of buildings owned by the municipality. The contacts for the site visit were the in-house electrician who installed the fixtures and the shop foreman for the garage. The contacts confirmed the site was available between 5 am and 11 pm to allow access to the fuel pump and other work buildings. The service garage had a standard workday from 7 am to 7 pm, with operations outside those hours being the rare exception for emergency repairs. The site contacts also confirmed there was good discipline with turning off lights at the end of shifts; thus, the Evaluator accepted the 7 am to 7 pm hours of use.

The variables used in the calculation for the revised savings and final results are summarized in Table 2.

Table 2: Revised Variables for Example Calculation

Baseline Measure – Six-lamp T8 High-bay Fixture		
Parameter	Value	Source
Baseline Fixture Quantity	43	Validated on-site
Revised Baseline System Wattage (W)	221	Duke Energy Fixture Wattage for 6-lamp 32 W T8 with 2 high-power electronic ballasts
Revised Hours of Use (hrs/year)	4,380	Validated on-site 12 hours daily
Interactive Effects Factor (energy)	1.00	High-bay lighting
Interactive Effects Factor (peak demand)	1.00	High-bay lighting
Peak Coincidence Factor	1.00	Validated on-site

		Lights on from 5 PM - 7 PM
Annual Energy Consumption (kWh)	41,623.14	Calculation
Annual Peak Demand (kW)	9.503	Calculation
Efficient Measure – 123 W LED High-bay Fixture		
Efficient Fixture Quantity	43	Validated on-site
Efficient System Wattage (W)	123	Specification sheet
Hours of Use (hrs/year)	4,380	Validated on-site 12 hours daily
Interactive Effects Factor (energy)	1.00	High-bay lighting
Interactive Effects Factor (peak demand)	1.00	High-bay lighting
Peak Coincidence Factor	1.00	Validated on-site Lights on from 5 PM - 7 PM
Annual Energy Consumption (kWh)	23,165.82	Calculation
Annual Peak Demand (kW)	5.289	Calculation
Revised Savings		
Revised Energy Savings (kWh)	18,457.32	Calculation
Revised Demand Savings (kW)	4.214	Calculation

Adjustment Ratio Algorithm

The adjustment ratio is determined by comparing the revised savings values with the tracked savings values. Due to the revisions made to this measure, the calculated ratios were 1.256 for energy savings and 1.885 for peak demand savings.

$$\frac{\text{Revised ES}}{\text{Tracked ES}} = \frac{18,457.32 \text{ kWh}}{14,689.72 \text{ kWh}} = 1.256$$

$$\frac{\text{Revised Peak DS}}{\text{Tracked Peak DS}} = \frac{4.214 \text{ kW}}{2.236 \text{ kW}} = 1.885$$

APPENDIX IX

BER: MAIL-IN ALGORITHM FOR FREE-RIDERSHIP CALCULATION

Table below presents the algorithm for calculating the free-ridership level for Mail-in measures. The algorithm is based on participant survey questions designed to assess variables such as planning, quantity, efficiency, timing, cost, and program influence. Each group of questions was transposed into a level of program attribution that was then used to calculate the free-ridership level associated with each participant.

Table 1: BER-MI Participant Survey Free-ridership Algorithm

C3. If your organization had not received the rebate from Efficiency Nova Scotia, would you have paid the full cost of the energy-efficient <MEASURE CATEGORY> measures? (Scale 0 to 10)	IF DK OR REF: C3 = EMPTY OTHERWISE: C3 = Answer x 10%
C4. [ASK IF MEASURE CATEGORY=LIGHTING] Were you aware that the lighting products rebated through the Business Energy Rebates Program are premium products certified by Design Light Consortium or ENERGY STAR®?	IF 1. Yes: Use C5 or C6 IF 2. No OR DK OR REF: C5 or C6 = 0%
C5. [ASK IF MEASURE CATEGORY IS NOT LIGHTING] If the program rebate had <u>not been</u> offered, what is the likelihood that you would have implemented exactly the same energy efficient <MEASURE CATEGORY> measures that you purchased through BER? (Scale 0 to 10) / C6. [ASK IF MEASURE CATEGORY=LIGHTING] If the program rebate had <u>not been</u> offered, what is the likelihood that you would have purchased the exact same model of lighting products? (Scale 0 to 10)	IF DK OR REF: C5 or C6 = EMPTY OTHERWISE: C5 or C6 = Answer x 10%
PA1 Score:	MEAN VALUE OF: (C3; C5 or C6)
C1. Had your organization <i>already</i> decided to implement energy-efficient <MEASURE CATEGORY> measures <i>before</i> you heard about the Business Energy Rebates Program?	IF Yes: Use C2 IF DK OR REF OR No: C1 = 0%
C2. [ASK IF C1= YES] I just want to make sure I understand - Before you decided to participate in the Business Energy Rebate Program, you had already made the decision to implement energy-efficient <MEASURE CATEGORY> measures?	IF Yes: C1 = 100% IF DK OR REF OR No: C1 = 0%
PA2 Score:	C1
C9. Level of influence (Scale 0 to 10) Factors a, b and c	C9 = MAX (C9a; C9b; C9c)
PA3 Score:	(10 – C9) x 10%
C8. [IF C3≥5] If the program rebate had <u>not been</u> offered, what is the likelihood that you would have postponed implementing the <MEASURE CATEGORY> measures by at least one year?	C8 = (10 – Answer) x 10% IF DK OR REF: C8 = EMPTY
PA4 Score:	C8

C7. [ASK IF MEASURE CATEGORY = LIGHTING AND NUMBER OF MEASURES >1] If the program rebate had <u>not been</u> offered, what is the likelihood that you would have implemented exactly the same <u>quantity</u> of lighting products that you installed through the program?	C7 = Answer x 10% IF DK OR REF: C7 = EMPTY
PA5 Score:	C7
Inconsistency Test PA1	IF ABS(C3 – C5 or C6) ≥ 50% PA1 = MIN (C3; C5 or C6)
Inconsistency Test PA2=	IF C2 = 100% AND C3 < 70% PA2 = EMPTY
Inconsistency Test PA5	IF C3 < 70% PA5 = EMPTY
Free-Ridership	IF MIN(PA4; PA5) < MEAN (PA1; PA2; PA3) FR = MEAN (PA1; PA2; PA3; MIN(PA4; PA5)) OTHERWISE FR = MEAN (PA1; PA2; PA3)
D2. [IF D1=1, 2 OR 3] Your company's previous participation in an Efficiency Nova Scotia program was a major factor in the decision to implement energy-efficient <MEASURE CATEGORY> measures. / D6. [IF D5=1] The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in your company's decision to implement energy-efficient <MEASURE CATEGORY> measures. D3. [IF D1=1, 2 OR 3] Because of your company's previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, a company representative asked a contractor or a technical staff member to examine the energy efficiency options for your facility / D7. [IF D5=1] The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to ask a contractor or a technical staff member to examine the energy efficiency options for your facility. D4. [IF D1=1, 2 OR 3] Because of your company's previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, a company representative took into account the cost-effectiveness of energy-efficient <MEASURE CATEGORY> measures when evaluating different options for your facility. / D8. [IF D5=1] The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to take into account the cost-effectiveness of energy efficient <MEASURE CATEGORY> measures when evaluating different options for the facility.	Cross-influence (CI) = IF(D2 OR D6 = Agree; 1) + IF(D3 OR D7 = Agree; 1) + IF(D4 OR D8 = Agree; 1)
Revised Free-Ridership	IF CI = 0 OR 1, Revised FR = FR IF CI = 2, Revised FR = FR*.75 IF CI = 3, Revised FR = FR*.50

APPENDIX X

BER: MAIL-IN ALGORITHM FOR PARTICIPANT SPILLOVER CALCULATION

The Mail-in participant spillover level was measured using a participant survey conducted during on-site visits. Participants were asked, pursuant to participating in BER, whether they implemented any additional energy efficiency measures without benefitting from any rebates or financing offered by EOne programs. If a participant mentioned having implemented additional recommended measures, another question was asked to quantify the level of influence the program had on the participant's decision to implement the additional measures. The value established regarding this level of influence was used to determine the portion of additional savings attributable to the program. Then, for each additional energy efficiency measure identified, the participant was asked a set of questions designed to identify the additional energy efficiency measures implemented and quantify the associated savings (type of measure, quantity, efficiency level, etc.).

The level of participant spillover was established by dividing the total quantity of the additional savings attributable to the program by the total quantity of savings achieved by the program for all survey respondents.

Table 1 below illustrates the methodology used to calculate the participant spillover level.

Table 1: BER-MI Site Visit Spillover Algorithm

SO1. Have you installed additional energy efficiency measures other than those implemented through BER?	IF 1. Yes: CONTINUE IF 2. No OR DK OR REF: END
SO2. Did you receive, or plan on requesting, financing or rebates from Efficiency Nova Scotia for these additional energy efficiency upgrades?	IF 2. No: CONTINUE IF 1. Yes OR DK OR REF: END
SO4. For each of the additional EE measures identified in SO1: Describe these additional measures. [If the measures were part of SBES audit, use these savings. Otherwise, record the following for each measure]: SO4a. Measure type (e.g. T8 28 W replacing T12) SO4b. Energy source saved (if all non-electric → FINISH) SO4c. Facility location where implemented (if not in Nova Scotia → FINISH) SO4d. Measure quantity (or area covered by the measure) SO4e. Technical information (i.e. HOU's, capacity, efficiency, HP, etc.) SO4f. Estimated savings (in kWh or \$) SO4g. If no quantitative information is available, but the measure is the same as the one implemented, probe participant on its relative size with respect to the project evaluated (% of size, area covered by the measure or price of the measure)	SO4 = SUM of kWh associated with each upgrade
Additional Upgrade Savings:	SO4
SO3. Did your experience with BER influence your decision to implement these additional energy efficiency measures on your own? (Scale 0 to 10)	SO3 = Answer x 10%
Attribution Level:	SO3
Spillover Savings:	SO3 X SO4
Final Spillover Level = $\frac{\text{SUM of (SO3 x SO4) for All Respondents}}{\text{SUM of Program Savings for All Respondents}}$	

APPENDIX XI

BER: INSTANT REBATES TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying that all data fields required for the evaluation were included and filled out in the tracking sheets submitted by EOne
- › Ensuring that tracked results were accurate by:
 - Verifying that the parameters used to calculate program results (gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating that all calculation steps were performed consistently

There are two tracking sheets for the Instant Rebates service, namely the Lighting and Pumping tracking sheets.

Data Accuracy

Table 1 and Table 2 below list all the parameters required for the Instant Rebates evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the tables detail the actions carried out by the Evaluator to adjust data where required.

Table 1: Verification of 2021 Instant Rebates Data Field Completeness and Accuracy – Lighting

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Light Output (Column P) ²	Y	N/A	N/A
Rated Wattage (Column Q) ³	Y	N/A	The rated wattage value was verified against DLC rated wattages for the five most popular products for each evaluation category.
Quantity Sold (Column R)	Y	N/A	N/A
Wattage Baseline (Column W)	Y	N	The tracked baseline wattage of 48 entries (less than 1% of entries) did not reflect the values recommended in the 2020 evaluation. These values were corrected.
Hours of Operation (Column X)	Y	N	The tracked HOU of 12,179 entries (70%) did not reflect the values recommended in the 2020 evaluation. These were corrected.
Interactive Effects Factor for Energy Savings (Column Y)	Y	Y	N/A
Interactive Effects Factor for Peak Demand Savings (Column Z)	Y	Y	
Peak Coincidence Factor (Column AA)	Y	Y	N/A
In-service Rate (Column AB)	Y	Y	N/A
Ballast Factor (Column AC)	Y	Y	N/A
Line Loss Factor (Column BE)	Y	Y	N/A
Net-to-gross Ratio for Energy Savings (Column BE)	Y	Y	N/A
Net-to-gross Ratio for Peak Demand Savings (Column BF)	Y	Y	N/A
Effective Useful Life (Column AN)	Y	Y	N/A
Total Gross Energy Savings at the Generator (Column AL)	Y	N	The tracked values for 13,214 entries (76%) were incorrect due to the use of the wrong wattage baselines, HOU, and unitary energy savings for occupancy sensors.
Total Gross Peak Demand Savings at the Generator (Column AK)	Y	N	The tracked values for 9,527 entries (55%) were incorrect due to inconsistent parameter values for wattage baselines and unitary demand savings for occupancy sensors.

**Table 2: Verification of 2021 Instant Rebates
Data Field Completeness and Accuracy – Pumping**

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Quantity Sold (Column Q)	Y	N/A	N/A
Interactive Effects Factor (Column V)	Y	Y	N/A
Peak Coincidence Factor (Column W)	Y	Y	N/A
In-service Rate (Column X)	Y	Y	N/A
Line Loss Factor (Columns AE and AF)	Y	Y	N/A
Net-to-gross Ratio for Energy Savings (Column AG)	Y	N	All NTGRs for the 866 entries (100%) were incorrect. The NTGRs should be equal to 1 according to the previous evaluation. The Evaluator corrected these values.
Net-to-gross Ratio for Peak Demand Savings (Column AG)	Y	N	
Effective Useful Life (Column AC)	Y	Y	N/A
Reference Data			
Maximum Input Power	Y	N/A	N/A
Estimated Energy Savings per Unit (Column Z)	Y	N	All energy and demand savings per unit were incorrect according to the values issued in the previous evaluation. The Evaluator corrected these values.
Estimated Demand Savings per Unit (Column Y)	Y	N	

Data Consistency

The second step of the tracking sheet audit involved recreating calculations and comparing related tracking sheet data fields to uncover any potential inconsistencies. This step was not necessary for Instant Rebates since all potential issues with data accuracy are covered as per Table 1 and Table 2 above.

Equations and Compilation

Once the correct values were established (as per Table 1 and Table 2 above), the Evaluator validated that the equations in the tracking sheet correctly calculated each of the main program component results as presented in Table 3 and Table 4 below.

² For all products except occupancy sensors.

³ Ibid.

Table 3: Verification of 2021 Instant Rebates Savings Compilation – Lighting

Program Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	N	The total savings calculations were based on the energy savings per unit and demand savings per unit, which were both incorrect. The equations did not consider the correct values for interactive effect factors and peak coincidence factors even though the correct values were inputted into the tracking sheet. For example, the interactive effects factor used in the energy savings calculations for LED linear lamps is 96.7% even though the correct value (94.4%) is tracked in Column Y. The Evaluator had to implement the correct equations to obtain values that EOne should have had with the data presented in the tracking sheet. These adjustments modified the values for each of the four saving results in 8,275 rows (48%).
Gross Peak Demand Savings at the Generator	N	
Net Energy Savings at the Generator	N	
Net Peak Demand Savings at the Generator	N	

Table 4: Verification of 2021 Instant Rebates Savings Compilation – Pumping

Program Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	Y	N/A
Gross Peak Demand Savings at the Generator	Y	N/A
Net Energy Savings at the Generator	Y	N/A
Net Peak Demand Savings at the Generator	Y	N/A

Corrected Tracked Savings

The main differences between the tracked and corrected values are in the calculation of unitary energy and demand savings. The reasons the energy and demand savings decrease are mainly explained by the correction to the hours of operation, the interactive effects and coincidence factors, and the occupancy sensor unitary savings.

Table 5 and Table 6 present the corrected tracked savings resulting from all changes made by the Evaluator, as described in this appendix.

Table 5: 2021 Instant Rebates Corrected Tracked Savings – Lighting

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
BER Instant Rebates - Lighting					
Gross Energy Savings at the Generator	33.584	GWh	31.393	GWh	-6.5%
Gross Peak Demand Savings at the Generator	5.734	MW	5.463	MW	-4.7%
Net Energy Savings at the Generator	24.765	GWh	22.804	GWh	-7.9%
Net Peak Demand Savings at the Generator	4.249	MW	3.937	MW	-7.3%

The main differences between the tracked and corrected values are in the calculation of unitary energy and demand savings. The reasons the energy and demand savings decrease are mainly explained by the correction to the hours of operation, the interactive effects and coincidence factors, and the occupancy sensor unitary savings.

Table 6: 2021 Instant Rebates Tracked and Corrected Savings – Pumping

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
BER Instant Rebates – Pumping					
Gross Energy Savings at the Generator	0.707	GWh	1.303	GWh	84.4%
Gross Peak Demand Savings at the Generator	0.148	MW	0.126	MW	-15.4%
Net Energy Savings at the Generator	0.530	GWh	1.303	GWh	145.8%
Net Peak Demand Savings at the Generator	0.111	MW	0.126	MW	12.8%

The Evaluator significantly increased the gross energy savings due to the use of incorrect unitary energy savings per unit. The increase to net energy savings was even more significant as the Evaluator corrected the NTGR (from 0.75 to 1.00).

The gross demand savings slightly decreased due to the use of incorrect demand savings per unit but increased a lot more because of the use of incorrect NTGRs.

APPENDIX XII

BER: INSTANT REBATES ALGORITHM FOR FREE-RIDERSHIP CALCULATION

The figure below presents the algorithms for calculating the free-ridership level for Instant Rebates measures. The algorithm is based on participant survey questions designed to assess variables such as planning, quantity, efficiency, timing, cost, and program influence as well as based on distributor interview questions designed to assess variables such as quantity, cost, and influence of the service. Each group of questions was transposed into a level of program attribution that was then used to calculate the free-ridership level associated with each participant.

BER Instant Rebates – Participant Survey

Table 1: Instant Rebates End-users

D7. Efficiency Nova Scotia offered a rebate for the purchase of efficient lighting products. If your organization had not received the rebate and the cost for [PRODUCT] had been about \$[REBATE AVERAGE VALUE BY CATEGORY] higher, would you have paid the full cost of the [PRODUCT]? (Scale 0 to 10)	IF DK OR REF: D7 = EMPTY OTHERWISE: D7 = Answer x 10%
D9. If BER rebate had <u>not been</u> offered, what is the likelihood that you would have purchased the exact same model of premium lighting products? (Scale 0 to 10)	IF DK OR REF: D9 = EMPTY OTHERWISE: D9 = Answer x 10%
PA1 Score:	MEAN VALUE OF: (D7; D9)
D6. Had you <i>already</i> decided to purchase [PRODUCT] <i>before</i> knowing the price of those products?	IF Yes: D6 = 100% IF DK OR REF OR No: D6 = 0%
PA2 Score:	D6
D13. Level of influence (Scale 0 to 10) Factors a, b, c and d	D13 = MAX(D13a; D13b; D13c; D13d)
PA3 Score:	(10 – D13) x 10%
D11. [ASK IF TOTAL MEASURE CATEGORY QTY>1] If the rebate had <u>not been</u> offered, what is the likelihood that you would have purchased exactly the same <u>quantity</u> of lighting products that you bought?	D11 = Answer x 10% IF DK OR REF: D11 = EMPTY
D12. [ASK IF D7≥5] If the program rebate had <u>not been</u> offered, what is the likelihood that you would have postponed the purchase of the lighting products by at least one year?	D12 = (10 – Answer) x 10% IF DK OR REF: D12 = EMPTY
PA4 Score:	Min (D11; D12)

Inconsistency Test PA1	IF ABS(D7 – D9) ≥ 50% PA1 = MIN (D7; D9)
Inconsistency Test PA2	IF D6 = 100% AND D7 < 70% PA2 = EMPTY
Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)
E2/E6. [Your organization’s previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] was a major factor in the decision to purchase <PRODUCT>. E3. Your organization’s previous participation in an ENS program and what was learned by participating in that program, a company representative asked a contractor or a distributor about efficient lighting options for your facility. / E7. The energy-efficiency promotional materials distributed by ENS prompted a company representative to ask a contractor or a distributor about efficient lighting options for your facility. E4. Your organization’s previous participation in an ENS program and what was learned by participating in that program, a company representative took into account the cost-effectiveness of <PRODUCT> when evaluating different options for your facility. / E8. The energy-efficiency promotional materials distributed by ENS prompted a company representative to take into account the cost-effectiveness of <PRODUCT> when evaluating different options for the facility.	Cross-influence (CI) = IF(E2 OR E6 = Agree; 1) + IF(E3 OR E7 = Agree; 1) + IF(E4 OR E8 = Agree; 1)
Revised Free-Ridership	IF CI = 0 OR 1, Revised FR = FR IF CI = 2, Revised FR = FR*.75 IF CI = 3, Revised FR = FR*.50

BER Instant Rebates – Distributor Interviews
Table 2: IR Distributors

B1. [ASK IF SALES DATA AVAILABLE] Based on those numbers, you should sell [FROM SAMPLE: fewer / more] [EFFICIENT PRODUCT] by the end of 2021 than the number of units you sold in 2020. Does this sound accurate? If so, what explains this shift? B2. [ASK IF SALES DATA NON AVAILABLE] If the current trend is maintained, do you think you will sell more, less or the same number of [EFFICIENT PRODUCT] by the end of 2021 than the number of units you sold in 2020? If "more" or "less", how do you explain the difference?	IF DK OR REF: B1 = EMPTY OTHERWISE: B1 = Answer
B3. In 2021, BER provided a per-unit incentive ranging from [REBATE RANGE], depending on the type of [EFFICIENT PRODUCT]. If this incentive had not been offered this year, would the number of [EFFICIENT PRODUCT] you will sell in 2021 have been about the same or lower? 1. Same [GO TO B4] 2. Lower [GO TO B5] 98. (Don't know) [GO TO FR4] 99. (Refused) [GO TO F4]	IF DK OR REF: B3 = EMPTY OTHERWISE: B3 = Answer
B4. [IF B3 = SAME] Just to confirm... without the program incentive, you would have sold the same number of [EFFICIENT PRODUCT] this year? RECORD EXPLANATION:	IF YES: B4 = 0% OTHERWISE: Use B5
B5. [IF B3 = LOWER] In your estimation, by what percentage would the number of [EFFICIENT PRODUCT] you sold have been lower in 2021 if BER incentive was not available? RECORD PERCENTAGE ____% RECORD EXPLANATION:	B5 = Answer %
PA1 Score:	100% – (B4 or B5)
B6. I am interested in understanding the impact of BER on customers' product choice. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on your customers' choice of [EFFICIENT PRODUCT] instead of [BASELINE PRODUCT]? RECORD RATING: ____ RECORD EXPLANATION:	B6 = Answer
PA2 Score:	(10 – B6) x 10 %

B7. Is the incentive ranging from [REBATE RANGE] per fixture enough to encourage customers who would not have done so otherwise to purchase [EFFICIENT PRODUCT]? Why?	B7 = Answer
B8. Through BER, only products meeting program's criteria, such as DLC or ENERGY STAR certifications, are eligible for rebate. I would like to understand the impact of BER on the models of products your company carries. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on the proportion of DLC certified [EFFICIENT PRODUCT] carried by your company? RECORD RATING: _____ RECORD EXPLANATION:	B8 = Answer
PA3 Score:	(10 – B8) x 10%
Inconsistency Test PA1, PA2, PA3	IF EXPLANATION DOES NOT FIT PERCENTAGE/RATING PA SCORE = EMPTY
Free-Ridership	MEAN (PA1; PA2; PA3)
Weighted Free-Ridership = $\frac{\text{SUM of (Free-ridership x Units Sold) for All Distributors}}{\text{SUM of Units Sold by All Distributors}}$	

APPENDIX XIII

BER: 2021 RECOMMENDATIONS

This appendix summarizes all the recommendations issued by the Evaluator as part of the 2021 evaluation as well as all past evaluation recommendations that were not fully implemented or deferred.

Sections	Recommendations
Executive Summary	- Consider making changes to the lighting measure worksheet to improve the accuracy of tracked parameters. For instance, the following changes could be made to the Area sections in the worksheet: › The “Hours of use per week” field could be renamed “Product hours of use per week” and could be required for each product. With these changes, participants would be more likely to provide HOUs specific to each product instead of general business hours of operation. › The “Will this area be in operation between 5 pm and 7 pm from December to February?” question could be reformulated as “Will this product be in operation between 5 pm and 7 pm from December to February?” and could be required for each product. Furthermore, other than “Yes” and “No”, a third option could also be added: “Partly (please specify the proportion of hours: _____%)”. These changes would improve the accuracy of tracked peak coincidence factors. › Adding the “How is this area heated?” question would allow for participants that have multiple heating systems in use in one area to provide an estimate of the mix of heating sources for that area. This would improve the accuracy of tracked interactive effects factors.
2018 Recommendations (deferred)	Investigate ways to liaise more clients with non-lighting contractors.



CUSTOM INCENTIVES PROGRAM 2021 DSM EVALUATION

EFFICIENCYONE

Final Report

March 17, 2022



ABBREVIATIONS

BAS	Building automation system
BDM	Business development manager
BNI	Business, non-profit, and institutional
BPA	Bouthillette Parizeau
COP	Coefficient of performance
CPA	Custom Project Agreement
DSM	Demand-side management
EMIS	Energy Management Information Systems
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
EUL	Effective useful life
GHG	Greenhouse gas
IEM	Industrial energy manager
IPMVP	International Performance Measurement and Verification Protocol
LED	Light-emitting diode
LEED	Leadership in Energy and Environmental Design
M&V	Measurement and verification
MURB	Multi-unit residential building
NECB	National Energy Code of Canada for Buildings
NS Power	Nova Scotia Power
NTGR	Net-to-gross ratio
OEMs	On-site energy managers
P4P	Pay-for-Performance
PCF	Peak coincidence factor
PV	Photovoltaic
SEM	Strategic Energy Management
UARB	Utility and Review Board
VFD	Variable frequency drive
WWR	Window-to-wall ratio

DEFINITIONS

Accuracy	Reflects the proximity of measurements to the true value.
Adjustment ratio	The ratio of evaluated results to tracked results. This ratio expresses the adjustment made to tracked savings or other tracked values such as effective useful life.
Baseline	To determine gross savings, a baseline (or base case) is established providing detailed information about the reference (e.g. pre-existing or standard) measure or equipment chosen to be compared with the efficient measure or equipment. For the reference measure or equipment, the baseline may include such information as the hours of operation, wattage and the base consumption.
Bias	Systematic deviations of measurements from the true value.
Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
Displaced wattage	The displaced wattage is defined as the difference between the wattage values of the baseline equipment or product and the efficient equipment or product.
EnerGuide rating	An EnerGuide (official brand of Natural Resources Canada) rating is a standard measure of the home's energy performance. It is a measure of the efficiency of the building only and does not take into account occupant behaviour. It shows how energy efficient the home is through modelled heat losses of the home, based on several factors including building envelope characteristics, heated volume, heating systems and air leakage.
Effective useful life	The period a measure is expected to be in service and provide both energy and peak demand savings. This value combines the equipment life and the measure persistence, which includes factors such as business turnover or early retirement.
Equipment life	The number of years installed equipment will operate before it fails.
Equivalent CO ₂	A unit of measurement indicating the amount of carbon dioxide to which various kinds of emitted greenhouse gases are equivalent in terms of warming effects. In this report, the gases' global-warming potential is estimated over a timescale of 100 years.
Equivalent effective useful life	The number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. This value takes into account variations in annual energy savings throughout the effective useful life due to increased baselines.

Evaluated savings	Gross and net energy or peak demand savings calculated by the Evaluator using the parameters (unitary savings values, installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process. Unless otherwise specified, the evaluated savings are the first-year savings.
Evaluation plan	The evaluation plan summarizes the program description, objectives, base cases, documentation, evaluation methodology, budget and schedule.
First-year savings	The first full year of energy or peak demand savings generated by an energy efficiency measure.
Free-ridership	Percentage of gross savings attributable to participants who would have implemented the same or similar energy efficiency measures, with no change in timing, in the absence of the program.
Gross savings	Change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated.
Induced consumption	Energy consumption of appliances that would have been unplugged and not replaced by participants in the absence of the program.
Interactive effects	Effects on the energy consumption of other systems in the building (such as heating and cooling) due to the installation of an energy efficiency measure.
Participant spillover	Savings attributable to participants who continue to implement the energy efficiency measure introduced by a program after participating in it once, without participating in the program a second time.
In-service rate	The proportion of incentivized products that are installed and operating. This rate is usually applied to programs through which rebates are offered in-store and products are likely to be stored for a certain period before being installed, such as LED lamps.
Installation rate	The proportion of incentivized products reported as installed that remain installed and operating at the time of evaluation. This rate is usually applied to direct install or mail-in rebate programs through which measures are expected to be installed immediately at the time of participation.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for a measure's effective useful life and any increase in the baseline efficiency level (which reduces attributable annual savings) over its lifetime.
Line loss factor	The multiplier to convert savings at the customer meter to savings at the utility generator. It accounts for the electrical losses of the transmission and distribution system.
Margin of error	The amount of random sampling error.
Market effects	The impact of the program on the market (such as increased product availability, practices, and prices) that extends beyond changing the program participants' behaviour. This includes spillover among non-participants.

Net savings	Energy or peak demand savings that can be reliably attributed to a program. This includes effects, such as free-ridership and spillover, that negatively or positively affect the savings attributable to a program.
Net-to-gross ratio	The ratio of net energy savings to gross energy savings.
Non-sampling error	Errors arising during the course of all survey activities other than sampling. Non-sampling errors tend to lead to bias in measurements and are very difficult to quantify.
Peak coincidence factor	The percentage of measure demand savings that coincide in time with the annual peak demand of the entire electricity system.
Peak demand savings	The demand savings that coincide in time with the expected annual peak demand period of the entire electricity system.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	The error in measurement due to the fact that measurements are taken from a subset of the population and not the entire population.
Realization rate	The ratio of evaluated savings to tracked savings.
Sample size	The number of observations or replicates included in a statistical sample.
Secondary market impacts	Energy consumption of appliances that would have been transferred to the secondary market if said appliances had not been retired.
Tracked savings	Gross and net savings calculated based on various parameters such as number of participants or units installed or sold, unitary savings values, installation rates, interactive effects, and the net-to-gross ratio. Those parameters, with the exception of the number of participants or units installed or sold, are obtained from the previous evaluation.
Unitary savings	Energy or peak demand savings established on a unitary basis. This unit can either be a product (e.g., an 8 W LED lamp), a capacity (e.g., one-ton capacity of an air-source heat pump) or a participant (e.g., one participant taking part in a behaviour-based program).

TABLE OF CONTENTS

EXECUTIVE SUMMARY	XI
INTRODUCTION	1
1 CUSTOM OVERVIEW	2
1.1 Custom Description.....	2
1.2 Follow-up on Past Evaluation Report Recommendations	4
1.3 Participation History.....	5
2 CUSTOM EVALUATION APPROACH	9
3 OEM OPERATIONAL DEMAND SAVINGS PILOT PARTICIPANT PERSPECTIVES	14
4 OEM OPERATIONAL DEMAND SAVINGS PILOT IMPACT EVALUATION.....	16
4.1 Tracking Sheet Audit.....	16
4.2 Gross Savings	16
4.2.1 Project Review Findings.....	16
4.2.2 Energy Interactive Effects	18
4.2.3 Effective Useful Life	18
4.2.4 Evaluated Gross Savings	19
4.3 Net Savings.....	21
4.3.1 Evaluated Net Savings	21
4.4 Realization Rate.....	23
5 RETROFIT PARTICIPANT PERSPECTIVES	24
6 RETROFIT IMPACT EVALUATION	26
6.1 Tracking Sheet Audit.....	26
6.2 Gross Savings	26
6.2.1 Sampling Methodology.....	27
6.2.2 Project Review Findings.....	27
6.2.3 Interactive Effects	29
6.2.4 Effective Useful Life	30
6.2.5 Evaluated Gross Savings	31
6.3 Net Savings.....	33
6.3.1 Free-ridership.....	33
6.3.2 Participant Spillover	34
6.3.3 Net-to-gross Ratio Calculation	35
6.3.4 Evaluated Net Savings	35

6.4	Realization Rate.....	37
7	NEW CONSTRUCTION PROCESS EVALUATION.....	39
7.1	New Construction Participation Process and Influences on Building Design	39
7.2	Developing a New Data-collection Approach	42
7.3	Key Findings and Recommended Approach for Future Data Collection.....	45
8	NEW CONSTRUCTION PARTICIPANT PERSPECTIVES	47
9	NEW CONSTRUCTION IMPACT EVALUATION	49
9.1	Tracking Sheet Audit.....	49
9.2	Gross Savings	49
9.2.1	Sampling Methodology.....	49
9.2.2	Project Review Findings.....	50
9.2.3	Energy Interactive Effects	51
9.2.4	Effective Useful Life	52
9.2.5	Evaluated Gross Savings	52
9.3	Net Savings.....	53
9.3.1	Free-ridership.....	53
9.3.2	NTGR Calculation	54
9.4	Evaluated Net Savings	55
9.5	Realization Rate.....	56
10	BUILDING OPTIMIZATION PARTICIPANT PERSPECTIVES	58
11	BUILDING OPTIMIZATION IMPACT EVALUATION.....	59
11.1	Tracking Sheet Audit.....	59
11.2	Gross Savings	59
11.2.1	Project Review Findings.....	59
11.2.2	Interactive Effects	60
11.2.3	Effective Useful Life	60
11.2.4	Evaluated Gross Savings	60
11.3	Net Savings.....	61
11.3.1	Free-ridership.....	61
11.3.2	Participant Spillover	62
11.3.3	Net-to-gross Ratio Calculation	62
11.3.4	Evaluated Net Savings.....	63
11.4	Realization Rate.....	65
12	OVERALL SAVINGS FOR CUSTOM.....	66

13	CUSTOM KEY FINDINGS AND RECOMMENDATIONS.....	68
14	EMIS OVERVIEW.....	75
14.1	EMIS Description	75
14.2	Follow-up on Past Evaluation Report Recommendations	76
14.3	Participation History.....	76
15	EMIS EVALUATION APPROACH.....	78
16	EMIS IMPACT EVALUATION	80
16.1	Impact Definitions	80
16.2	Tracking Sheet Audit.....	81
16.3	Gross Savings	81
16.3.1	Project Review Findings.....	81
16.3.2	Interactive Effects	81
16.3.3	Effective Useful Life	81
16.3.4	Evaluated Gross Savings	81
16.4	Net Savings.....	82
16.4.1	Evaluated Net Savings	83
16.5	Realization Rate.....	83
17	EMIS KEY FINDINGS AND RECOMMENDATIONS	85
18	SEM OVERVIEW.....	86
18.1	SEM Description	86
18.2	Follow-up on Past Evaluation Report Recommendations	88
18.3	Participation History.....	88
19	SEM EVALUATION APPROACH.....	90
20	SEM IMPACT EVALUATION	92
20.1	Tracking Sheet Audit.....	92
20.2	Gross Savings	92
20.2.1	Project Review Findings.....	92
20.2.2	Interactive Effects	94
20.2.3	Effective Useful Life	94
20.2.4	Evaluated Gross Savings	95
20.3	Net Savings.....	96
20.3.1	Evaluated Net Savings	97
20.4	Realization Rate.....	97

21 SEM KEY FINDINGS AND RECOMMENDATIONS	99
CONCLUSION.....	101

LIST OF TABLES

Table 1: Summary of Custom Incentives Program Evaluation.....	xii
Table 2: Overall 2021 Custom Incentives Participation and Savings	xiii
Table 3: 2021 Custom Net-to-gross Ratios for Energy Savings.....	xvi
Table 4: Comparison of 2021 Custom Tracked and Evaluated Savings at the Generator	xvii
Table 5: Comparison of 2021 EMIS Tracked and Evaluated Savings at the Generator	xxii
Table 6: Comparison of 2021 SEM Tracked and Evaluated Savings at the Generator	xxiv
Table 7: Types of Evaluations Conducted for Each Program Component, 2021	1
Table 8: Implementation Status of Past Recommendations for Custom	4
Table 9: 2021 Custom Evaluation Approach	9
Table 10: Summary of Tracked and Evaluated Effective Useful Life	18
Table 11: Tracked and Evaluated Gross Energy and Peak Demand Savings by Project at the Meter	19
Table 12: Evaluated Gross Energy and Peak Demand Savings.....	20
Table 13: Evaluated 2021 OEM Operational Demand Savings Pilot Net Energy and Peak Demand Savings.....	22
Table 14: Evaluated 2021 OEM Operational Demand Savings Pilot GHG Emission Reductions	23
Table 15: Comparison of 2021 OEM Operational Demand Savings Pilot Tracked and Evaluated Savings at the Generator	23
Table 16: Evaluated 2021 Retrofit Projects	26
Table 17: Example of a 2021 True-up Adjustment	31
Table 18: Evaluated 2021 Retrofit Gross Energy and Peak Demand Savings.....	32
Table 19: Evaluated 2021 Retrofit NTGRs.....	35
Table 20: Evaluated 2021 Retrofit Net Energy and Peak Demand Savings.....	36
Table 21: Evaluated 2021 Retrofit GHG Emission Reductions	37
Table 22: Comparison of 2021 Retrofit Tracked and Evaluated Savings at the Generator	37
Table 23: Typical New Construction Participation Process and Actions by Key Actors that Potentially Influence Building Design.....	40
Table 24: EOne Influence Factors on Building Design	41
Table 25: Evaluated 2021 New Construction Gross Energy and Peak Demand Savings	53
Table 26: Evaluated 2021 New Construction NTGRs.....	55
Table 27: Evaluated 2021 New Construction Net Energy and Peak Demand Savings	55
Table 28: Evaluated 2021 New Construction GHG Emission Reductions	56
Table 29: Comparison of 2021 New Construction Tracked and Evaluated Savings at the Generator.	56
Table 30: Evaluated 2021 Building Optimization Gross Energy and Peak Demand Savings.....	61
Table 31: Evaluated 2021 Building Optimization NTGR	62
Table 32: Evaluated 2021 Building Optimization Net Energy and Peak Demand Savings.....	64
Table 33: Evaluated 2021 Building Optimization GHG Emission Reductions	65
Table 34: Comparison of 2021 Building Optimization Tracked and Evaluated Savings at the Generator	65
Table 35: Comparison of 2021 Custom Tracked and Evaluated Savings at the Generator	66
Table 36: Implementation Status of Past Recommendation for EMIS	76
Table 37: 2021 EMIS Evaluation Approach.....	78
Table 38: Definition of Terms Related to EMIS and SEM	80

Table 39: Evaluated 2021 EMIS Gross Energy and Peak Demand Savings	82
Table 40: Evaluated 2021 EMIS GHG Emission Reductions.....	83
Table 41: Comparison of 2021 EMIS Tracked and Evaluated Savings at the Generator	84
Table 42: Implementation Status of Past Recommendations for SEM.....	88
Table 43: 2021 SEM Evaluation Approach.....	90
Table 44: Evaluated 2021 SEM Gross Energy and Peak Demand Savings	96
Table 45: Evaluated 2021 SEM GHG Emission Reductions.....	97
Table 46: Comparison of 2021 SEM Tracked and Evaluated Savings at the Generator	98
Table 47: Overall 2021 Custom Incentives Participation and Evaluated Savings	101

LIST OF FIGURES

Figure 1: 2021 Custom Targets and Evaluated Results	xiv
Figure 2: Overview of Custom Performance, 2014-2021.....	xv
Figure 3: 2021 EMIS Targets and Evaluated Results	xx
Figure 4: EMIS Performance Overview, 2015-2021	xxi
Figure 5: 2021 SEM Targets and Evaluated Results	xxii
Figure 6: SEM Performance Overview, 2015-2021	xxiii
Figure 7: Custom Services	2
Figure 8: Overview of Retrofit Participation, 2014-2021	6
Figure 9: Overview of Participation in New Construction, 2014-2021	7
Figure 10: Overview of Participation in Building Optimization, 2014-2021.....	8
Figure 11: 2021 Participant Satisfaction with Retrofit (10-point Scale)	24
Figure 12: 2021 Participant Satisfaction with New Construction (10-point Scale).....	48
Figure 13: 2021 Participant Satisfaction with Building Optimization (10-point Scale).....	58
Figure 14: EMIS Participation Process Summary	75
Figure 15: Overview of EMIS Participation, 2015-2021	77
Figure 16: Evolution of EMIS Gross Savings, 2015-2021.....	77
Figure 17: 2021 SEM Participation Process Summary	87
Figure 18: Overview of SEM Participation, 2015-2021	89
Figure 19: Evolution of SEM Gross Savings, 2015-2021.....	89
Figure 20: 2021 Custom Incentives Program Targeted and Evaluated Net Energy Savings	102
Figure 21: 2021 Custom Incentives Program Targeted and Evaluated Net Peak Demand Savings	102

EXECUTIVE SUMMARY

This report presents the 2021 demand-side management (DSM) results of the Custom Incentives program administered by EfficiencyOne (EOne). This program is comprised of three components: (1) Custom; (2) Energy Management Information Systems (EMIS); and (3) Strategic Energy Management (SEM). Combined, these program components help commercial, industrial, and institutional participants identify, prioritize, and implement energy efficiency projects, processes, or policies in their organizations by providing support, training, and financial incentives.

Evaluation Approach

The evaluation was aimed at calculating program component gross and net results, namely electrical first-year- and lifetime energy savings, peak demand savings, as well as avoided greenhouse gas (GHG) emissions. For Custom New Construction, this evaluation also served to assess process questions. Table 1 summarizes the types of evaluation conducted for each program component and the corresponding methodology.

Table 1: Summary of Custom Incentives Program Evaluation

Program Component	Evaluation Type			Methodology
	Impact	Process	Market	
Custom	Comprehensive	X - NC		› Participant phone interviews (New Construction) or participant follow-up interview during the project review (Retrofit and Building Optimization [BOpt]) › Participant and OEM phone interviews (OEM Pilot) › Interviews with participants who recently signed CPAs (New Construction) › EOne staff interview (New Construction) › EOne business development manager (BDM) interviews (New Construction) › Modelling consultant interview (New Construction) › Review of service documentation, including flow charts (New Construction) › Project file reviews and participant follow-up interviews (Retrofit, BOpt, OEM Pilot) › Calls and energy model reviews (New Construction) › Tracking sheet audit › Effective useful life (EUL) update (New Construction and OEM Pilot) › Calculations using a net-to-gross ratio (NTGR) of 1 (OEM Pilot) › Calculations using evaluation results › GHG emission reduction calculations
EMIS	Comprehensive			› Participant interviews (as part of desk reviews) › Desk reviews › Tracking sheet audit › EUL update › Calculations using evaluation results › GHG emission reduction calculations
SEM	Comprehensive			› Participant interviews (as part of desk reviews) › Desk reviews › Tracking sheet audit › EUL update › Calculations using evaluation results › GHG emission reduction calculations

Program Performance

Table 2 presents the participation levels, NTGRs, as well as evaluated gross and net savings at the generator for each program component and for the Custom Incentives program as a whole.

Table 2: Overall 2021 Custom Incentives Participation and Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
Custom							
Energy Savings	102	Projects completed	26.729	GWh	0.87	23.293	GWh
Lifetime Energy Savings			392.118	GWh	0.86	337.282	GWh
Peak Demand Savings			6.897	MW	0.89	6.105	MW
EMIS							
Energy Savings	1	Participants	0.027	GWh	1	0.027	GWh
Lifetime Energy Savings			0.053	GWh	1	0.053	GWh
Peak Demand Savings			0.003	MW	1	0.003	MW
SEM							
Energy Savings	6	Participants	1.845	GWh	1	1.845	GWh
Lifetime Energy Savings			10.402	GWh	1	10.402	GWh
Peak Demand Savings			0.282	MW	1	0.282	MW
Total							
Energy Savings			28.601	GWh		25.165	GWh
Lifetime Energy Savings			402.573	GWh		347.737	GWh
Peak Demand Savings			7.182	MW		6.390	MW

Custom Incentives aimed to achieve 33.610 GWh in net electrical energy savings and 8.476 MW in net peak demand savings at the generator for 2021. The program achieved 25.165 GWh in net electrical energy savings and 6.390 MW in net peak demand savings at the generator in 2021. Therefore, the program fell short of achieving planned energy and peak demand savings. Custom was the largest contributor to total program net energy and peak demand savings.

The following subsections present evaluation results at the program component level.

Custom Findings and Recommendations

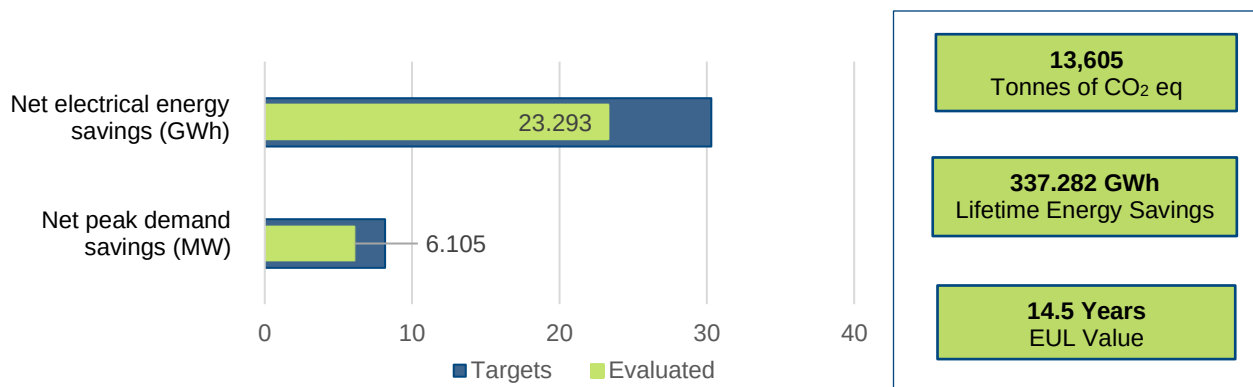
This section provides the Evaluator's key findings and recommendations in relation to these objectives. The first key findings and recommendations apply to the Custom component in general, while others are specific to certain Custom services. The recommendations are also outlined in Appendix XIV.

Custom General Key Findings and Recommendations

2021 Custom-Finding: Custom net electrical energy and peak demand savings fell short of targets in 2021.

Custom achieved 23.293 GWh in net electrical energy savings and 6.105 MW in net peak demand savings at the generator in 2021, thus not attaining the planned net electrical energy savings of 30.310 GWh and net peak demand savings of 8.166 MW.

Figure 1: 2021 Custom Targets and Evaluated Results

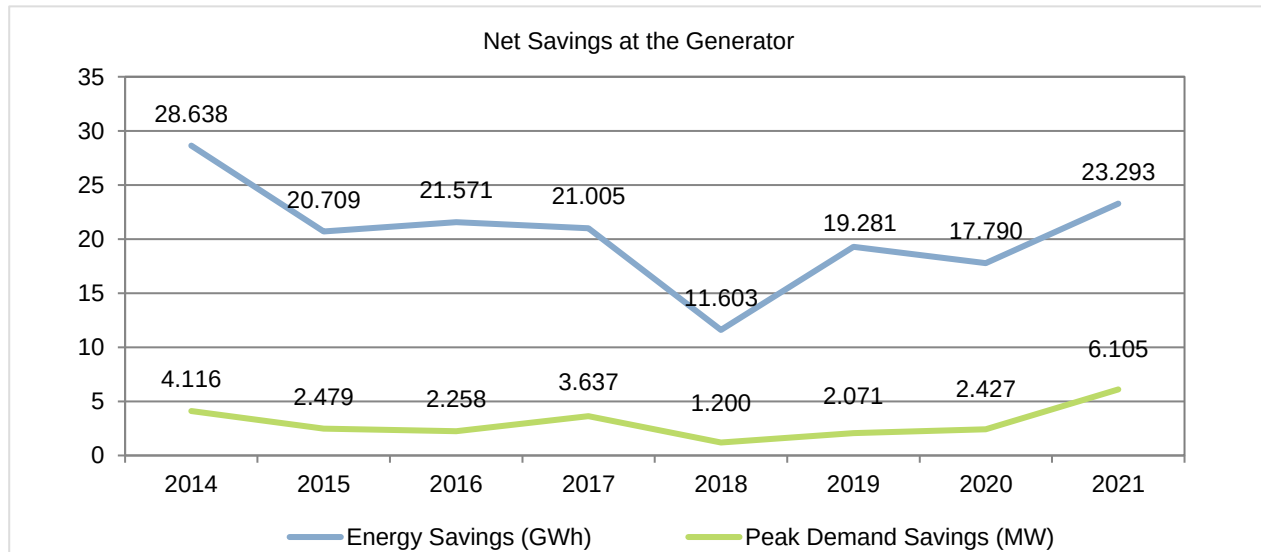


2021 Custom-Finding: Compared to 2020, Custom participation increased in 2021 due in part to higher participation from New Construction and the closure of 18 multiyear projects in Retrofit.

With 102 projects completed across the three Custom services¹ and the OEM Operational Demand Savings Pilot, the 2021 participation level for Custom was 85% higher than in 2020. Retrofit, which accounts for the bulk of projects completed through Custom, increased from 41 projects completed in 2020 to 72 projects completed in 2021, which represents a similar participation level to that in 2019. Additionally, New Construction had its highest participation level since 2014 with 21 completed projects in 2021, up from eight completed projects in 2020. Building Optimization had the same participation level in 2021 as in 2020, with six completed projects. The OEM Operational Demand Savings Pilot contributed 3 projects.

¹ Custom includes three services: Retrofit, New Construction and Building Optimization.

Figure 2: Overview of Custom Performance, 2014-2021



2021 Custom-Finding: Participant satisfaction with Custom continues to be very high across the three services. Participant satisfaction was also high with the OEM Operational Demand Savings Pilot.

2021 Custom-Finding: Following the project reviews, the Evaluator adjusted the energy and peak demand savings for OEM Operational Demand Savings Pilot, Retrofit and New Construction as well as the energy savings for Building Optimization.

For the OEM Operational Demand Savings Pilot, the adjustment ratios for gross energy and peak demand savings were 0.99 and 0.90 respectively. More robust M&V methodologies might reduce future adjustments. For Retrofit, the adjustment ratios for gross energy and peak demand savings were 0.981 and 1.030 respectively. For New Construction, they were of 0.839 and 0.898 respectively. For Building Optimization, the adjustment ratio for energy savings was 0.934. The Evaluator made several adjustments to the reviewed projects.

For New Construction, the Evaluator noted a significant improvement in the information available in the project files submitted by EOne. The project files were complete and well documented, which facilitated the project reviews. The Program Guide requirements were also better followed.

For Retrofit and Building Optimization, most of the adjustments fell into one of the following categories:

- › M&V methodology errors or gaps
- › Peak demand savings absent from project files
- › Keying and typographical errors

While adjustment ratios were generally low for these services, this is due in large part to a lack of available data in the project files to make more precise adjustments as well as a balancing of upward and downward adjustments (particularly for peak demand savings). Adjustments were required in 46% of sampled files in 2021, and the Evaluator notes that, despite past recommendations in these areas, there continues to be room for improvement in addressing methodological issues and quality in Retrofit and Building Optimization M&V activities.

2021 Custom Recommendation 1: For Retrofit and Building Optimization, on a priority basis, review, improve and deploy M&V processes, savings calculation protocols, service requirements, as well as documentation and associated supporting materials to align these with best practices for custom programs.

EOne should work on a priority basis to increase service requirements relating to the level of detail, quality, and accessibility of service documentation as well as internal review processes and practices related to M&V. These include M&V methods to capture energy and demand savings. Ideally, this recommendation would be actioned and implemented early in 2022 to the benefit of 2022 Custom participants.

2021 Custom-Finding: Retrofit free-ridership increased slightly, while free-ridership for New Construction was measured with a new approach to capture all levels of influence, including building modelling.

Table 3 presents the NTGRs for the three Custom services.

Table 3: 2021 Custom Net-to-gross Ratios for Energy Savings

	Retrofit	New Construction	Building Optimization
Free-ridership Level	16%	15%	9%
Spillover Level	0%	0%	0%
Net-to-gross Ratio	0.84	0.85	0.91
For the OEM Operational Demand Savings Pilot, the Evaluator assumed free-ridership and spillover levels to be zero given the pilot was offered to a small number of organizations with OEMs and the nature of the service as a limited pilot.			

2021 Custom-Finding: There is a trend in recent years of more projects closing after the sampling period necessitated by the evaluation timetable. While having a minimal impact on 2021 results, this could create future challenges related to the quality of the adjustment ratios and NTGRs if larger projects are not well represented in the sample.

2021 Custom-Finding: Both the evaluated net energy and peak demand savings determined by the Evaluator were higher than the savings tracked by EOne.

Table 4 below compares the tracked and evaluated results.

Table 4: Comparison of 2021 Custom Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	29.014	GWh	0.77	22.263	GWh	105%
Evaluation Results	26.729	GWh	0.87	23.293	GWh	
Peak Demand Savings						
Tracked Savings by EOne	7.119	MW	0.77	5.488	MW	111%
Evaluation Results	6.897	MW	0.89	6.105	MW	
* NTGRs differ for each service. The NTGRs listed in this table match the rounded averages obtained from dividing net savings by gross savings.						

OEM Operational Demand Savings Pilot Key Findings and Recommendations

2021 OEM Operational Demand Savings Pilot Finding: The incentive had the desired effect of prompting participants to look for rapid and low-cost measures to reduce their energy demand during the system peak period. That said, the nature of participating projects provides insights for potential improvements and clarifications to program guidelines if operational demand programs are to officially enter the portfolio.

2021 OEM Operational Demand Savings Pilot Finding: M&V methodologies for peak reduction projects can be further refined.

2021 OEM Operational Demand Savings Pilot Recommendation 1: If operational demand programs are offered in the future, deploy improved M&V and savings calculation protocol reviews. As for Retrofit and Building Optimization, detailed M&V guidance will be required to support this demand-focused program. This guidance should be developed to include information about common demand response M&V methods that measure demand in the hours before the peak window and that compare results to those during the window. In addition, the guidance should be updated to include:

- › Information about M&V requirements and methods that capture the full effects of any load shifting projects that may be submitted.
- › An emphasis on the fact that reductions must be well outside the margin of error of the M&V methodologies. This will be particularly important for any whole building approaches but could also be applicable to sub-metered approaches.
- › This guidance should be produced and published to make program materials accessible to participants. Where required, simple capability development strategies could be deployed, such as online workshops.

Retrofit Key Findings and Recommendations

2021 Retrofit-Finding: The pay-for-performance projects reviewed by the Evaluator included an excellent client-led M&V approach that required almost no adjustments, had a free-ridership level of zero, and high customer satisfaction.

2021 Retrofit Recommendation 1: Consider expanding the use of this type of structured pay-for-performance approach and encouraging larger return participants in Retrofit, Building Optimization, and Operational Demand Savings to participate in this offering.

Custom Retrofit, Building Optimization, and Operational Demand Savings participants may be considered in two groups: one-time participants with unique projects and returning participants applying multiple times for an ongoing stream of projects. For the latter group, it may make sense to consider an encompassing pay-for-performance approach. As seen in the 2021 evaluation results, this approach could potentially improve M&V practices, reduce adjustments, and reduce free-ridership while maintaining very high satisfaction levels and reducing administrative requirements for certain participants.

2021 Retrofit-Finding: During Retrofit project reviews, the Evaluator made adjustments and further observations relating to the specific M&V approach used for solar PV and compressed air leak repair projects.

For solar PV and compressed air leak repair projects, EOne has deployed de-facto quasi-prescriptive or engineered approach in Custom. This is in recognition that these projects have lower technical complexity, few interactive effects and savings that can be qualified using appropriate engineering assumptions (or models in the case of solar PV), which can be supplemented with a relatively small number of local site condition-dependant variables. This type of approach is wholly suitable for these specific project types. Conversely, including them in Custom without explicit distinctions from true custom projects poses certain challenges for the evaluation. First, the evaluation approach for quasi-prescriptive engineered savings projects generally should include a distinct evaluation activity to determine the most appropriate assumptions and savings determination methodology. Second, to avoid confusion, there needs to be clarity for the participant about the nature and rigour of the M&V required for different project types.

2021 Retrofit Recommendation 2: Develop and implement a process to identify project types more suited to quasi-prescriptive approaches (including solar PV, compressed air leaks, and possibly others such as domestic water booster pumps), and explicitly distinguish these project types from traditional custom projects within the Custom service. This should include developing appropriate protocols, documentation, and allowances for reviews of underlying savings determination methodologies as part of the annual evaluation plan.

EOne should work with the Evaluator to determine savings methodologies, parameters, M&V documentation, and applicant requirements for these project types. For solar PV and compressed

air leak projects, these should be accomplished on a priority basis given the popularity of such projects in Retrofit.

New Construction Key Findings and Recommendations

2021 New Construction-Finding: EOne succeeds in influencing New Construction building design through the many influence factors, and influence on design occurs by the end of the design phase.

The process evaluation conducted for New Construction served to confirm the different sources of influence that EOne and New Construction have on the participant decision-making process, such as the energy model, implementation incentives, as well as technical assistance provided by the energy modeller, BDMS, and EOne staff. After discussion with EOne, to better take these influence factors and their impacts on building design decisions into account, the Evaluator developed a new phone interview questionnaire to assess free-ridership, which was used as part of this evaluation. Moreover, since major decisions related to energy use occur by the end of the design phase, which coincides with participants signing the CPA, the timing for the free-ridership assessment should be adjusted going forward.

2021 New Construction Recommendation 1: Interview participants shortly after having signed the CPA.

- › To do so, EOne could identify participants who have signed a CPA at the end of every quarter and ask a third party to interview them. The third party should safeguard the answers until the project closes and then transfer results directly to the Evaluator to maintain the confidentiality of responses.
- › To increase the likelihood that the third party conducting the interviews will be able to reach key project decision-makers, EOne should provide a second contact, if available, from within the participant organization from the start.
- › Reasonable efforts should be invested in contacting the provided contacts via phone interviews. If unsuccessful, the third party should send a web survey to the contacts who have not been interviewed by phone.
- › If the provided contacts remain unreachable through the phone interview and web survey, the free-ridership questionnaire should be administered once the project is completed at the time of evaluation.

EMIS Findings and Recommendations

This subsection presents the key findings and recommendations resulting from the EMIS evaluation.

2021 EMIS-Finding: EMIS net energy savings did not reach target levels due to low participation.

As outlined in Figure 3 below, 2021 EMIS net electrical energy savings only represented 9% of targets, and net peak demand savings were almost nil. EMIS only had one participant in 2021, who also participated in SEM and therefore split their savings between the two program components. The figure

also includes the evaluated tonnes of CO₂ eq in annually avoided GHG emissions, lifetime energy savings, and the effective useful life (EUL) value.

Figure 3: 2021 EMIS Targets and Evaluated Results

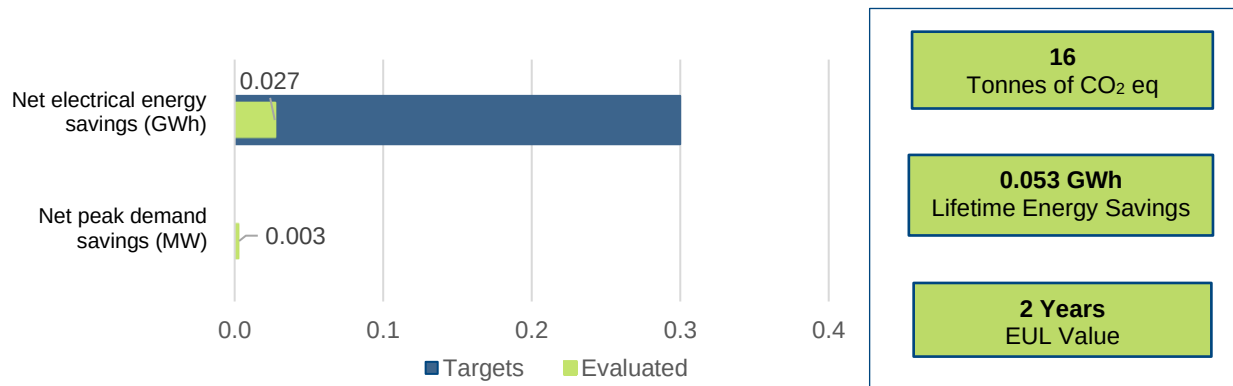
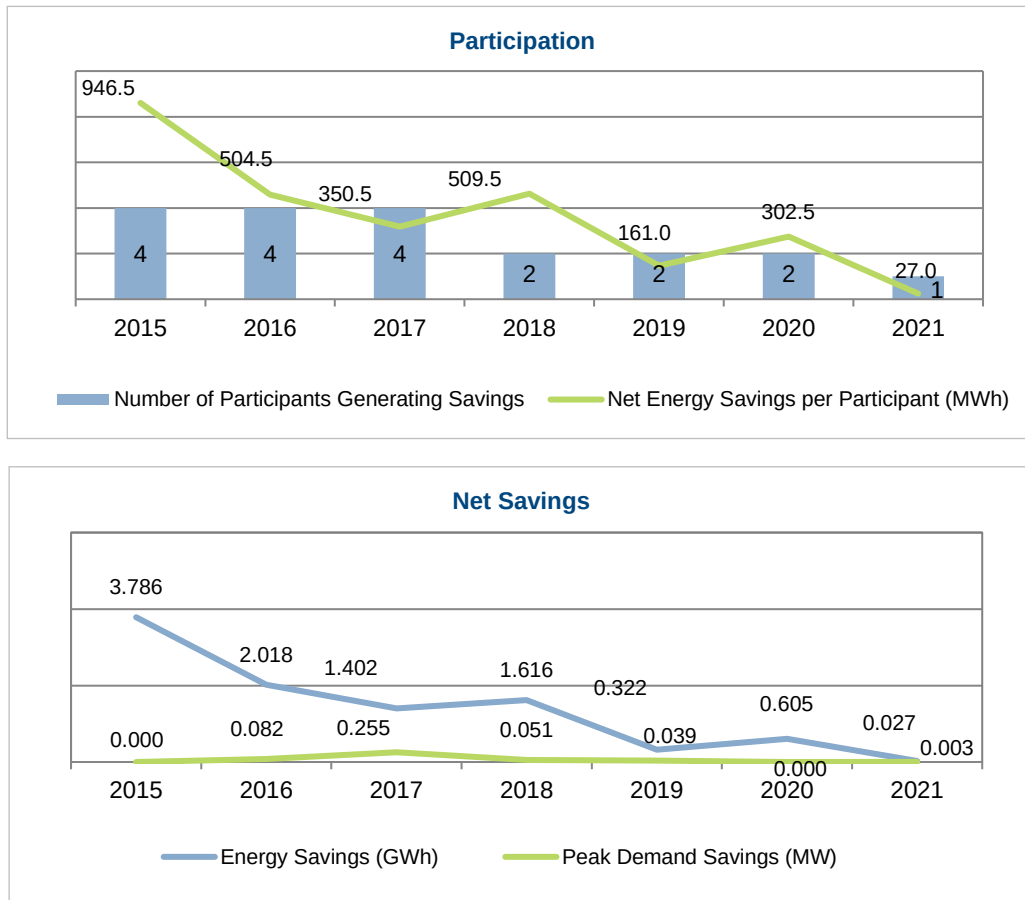


Figure 4 illustrates the evolution of EMIS in terms of participation and average savings per participant as well as net energy and peak demand savings from 2015 to 2021.

Figure 4: EMIS Performance Overview, 2015-2021²



2021 EMIS-Finding: Both the evaluated energy and peak demand savings determined by the Evaluator were the same as the savings tracked by EOne. The assumption that free-ridership and spillover levels were nil for EMIS remained valid in 2021, so the Evaluator maintained a NTGR of 1.

Table 5 compares the tracked and evaluated results.

² The 2018 savings values per participant are based on the savings of 2018 participants only.

Table 5: Comparison of 2021 EMIS Tracked and Evaluated Savings at the Generator

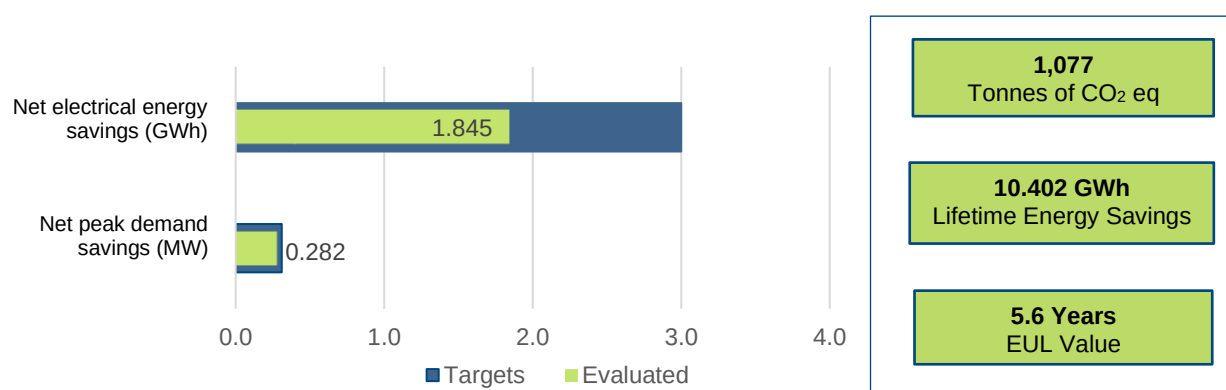
	Gross Savings		NTGR	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	0.027	GWh	1.00	0.027	GWh	100%
Evaluation Results	0.027	GWh	1.00	0.027	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.003	MW	1.00	0.003	MW	100%

SEM Findings and Recommendations

This subsection presents the key findings and recommendations resulting from the SEM evaluation. The recommendations are also outlined in Appendix XIX.

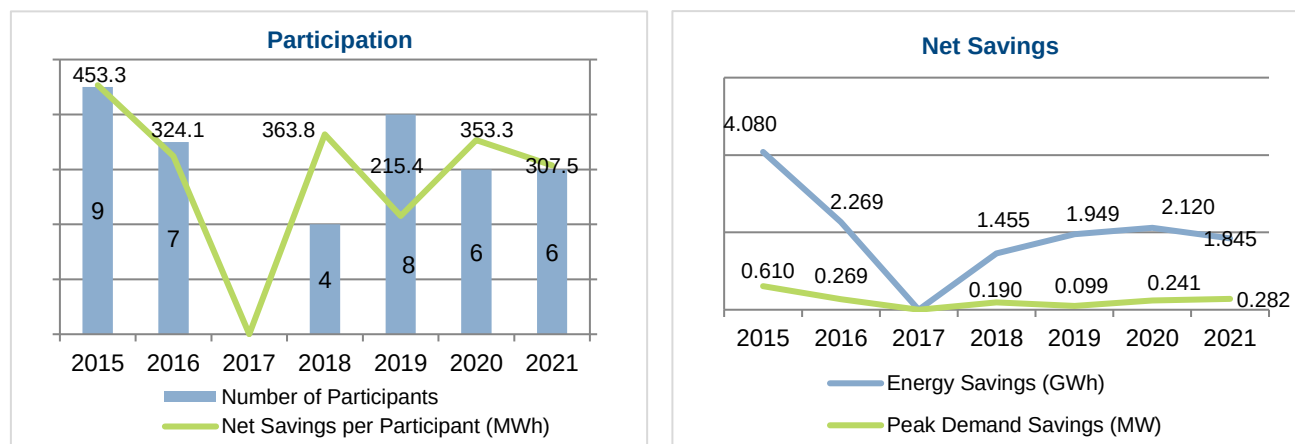
2021 SEM-Finding: SEM net energy and peak demand savings did not meet targets.

As outlined in Figure 5, SEM achieved 1.845 GWh and 0.282 MW in energy and peak demand savings respectively. These values were 39% below the planned energy savings target and 9% below the planned peak demand savings. The figure also includes the evaluated tonnes of CO₂ eq in annually avoided GHG emissions, lifetime energy savings, and the effective useful life (EUL) value.

Figure 5: 2021 SEM Targets and Evaluated Results


2021 SEM-Finding: The SEM participation level has remained stable over the past four years.

Figure 6 illustrates the evolution of SEM in terms of participation and average savings per participant as well as net energy and peak demand savings from 2015 to 2021.

Figure 6: SEM Performance Overview, 2015-2021³


2021 SEM-Finding: The savings measurement approaches are now more diversified, and an increasing proportion of participants use a bottom-up approach.

The Evaluator noted that only two of the six participants used a whole-facility energy model to estimate their savings in 2021. Bottom-up approaches for savings calculations are used when it is difficult to obtain a satisfactory energy model at the facility level although also in other instances such as for new projects that did not complete all investigation steps of the SEM process. While bottom-up approaches are an appropriate tool for some SEM projects, the decision to use this type of approach has other implications that EOne should carefully consider. The Evaluator is mostly concerned that choosing this approach could lead participants to miss out on important elements of SEM, such as continuously monitoring and improving energy performance or overlooking operational improvements that are not easily captured at measure level, potentially resulting in fewer savings overall. Indeed, the Evaluator noted that measures for which savings were quantified using a bottom-up approach in 2021 included more equipment retrofit or control automation measures and no operational or behavioural measures.

2021 SEM-Recommendation 1: Develop guidelines on the usage of bottom-up approaches in SEM and ensure they are consistent with program objectives. The guidelines should define the conditions under which a bottom-up approach can be used and how the results will be used for multi-year reporting. They should include measurement and verification (M&V) requirements that are consistent with those of similar Custom Retrofit projects. The guidelines should also cover how the bottom-up approach will fit into an integrated energy management strategy at facility level, so that the focus is not entirely on individual measures, but also on overall energy performance improvement since it is a key SEM objective.

³ The 2019 savings values per participant are based only on the savings that occurred in 2019 since the total amount of savings reported in 2019 included some adjustments for other years.

2021 SEM-Finding: Applying a different methodology for estimating EUL values resulted in higher EUL values for SEM.

For participants using a whole-facility model, the Evaluator estimated the EUL based on the remaining time in the program and a decay rate of savings after participation ends, which is the method used for all projects in previous years and resulted in an EUL of two years for both participants. The Evaluator updated the methodology for projects that used a bottom-up approach to quantify measure-specific savings by applying EUL values specific to the measures implemented for projects. The average measure-specific EUL was estimated at 6.2 years, which is significantly higher than the EUL of approximately three years that would have been estimated using the methodology based on the remaining time in the program.

2021 SEM-Finding: While adjustments to energy savings were minor, adjustments to peak demand savings were significant since EOne did not report savings for some projects that did generate peak demand savings.

Table 6 below compares the tracked and evaluated results.

Table 6: Comparison of 2021 SEM Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	1.859	GWh	1.00	1.859	GWh	99%
Evaluation Results	1.845	GWh	1.00	1.845	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.172	MW	1.00	0.172	MW	164%
Evaluation Results	0.282	MW	1.00	0.282	MW	

INTRODUCTION

EfficiencyOne (EOne), an independent, non-profit organization, is responsible for helping Nova Scotians improve the energy efficiency of their homes and workplaces by designing, marketing, and delivering energy efficiency and conservation programs for Nova Scotians. EOne receives funding for its electricity demand-side management (DSM) activities from Nova Scotia Power (NS Power) ratepayers.

EOne has a DSM portfolio of three residential programs and three business, non-profit, and institutional (BNI) programs that are marketed to Nova Scotians through the Efficiency Nova Scotia (ENS) franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2021 DSM program portfolio. In addition, Econoler conducted research to inform EOne's approach to market transformation and treatment of codes and standards.

This evaluation report relates to the Custom Incentives program, which is comprised of three components: Custom; Energy Management Information Systems (EMIS); and Strategic Energy Management (SEM). Table 7 below lists the Custom Incentives program components and the types of evaluations conducted in 2021. A comprehensive impact evaluation involves reviewing the following four key elements: (1) the baseline definition; (2) the savings calculation methodology; (3) the values of the parameters used to calculate savings; and (4) net-to-gross ratios (NTGRs).

Table 7: Types of Evaluations Conducted for Each Program Component, 2021

Program	Program Component	2021		
		Process	Market	Impact
Custom Incentives	Custom	X - NC		Comprehensive
	EMIS			Comprehensive
	SEM			Comprehensive

To carry out these services, Econoler collaborated with Equilibrium Engineering, Bouthillette Parizeau, Richard Patterson of CDM Energy Solutions and Narrative Research. Econoler served as team leader and was involved in every aspect of the evaluation. Specifically, Econoler was in charge of coordinating and supervising all activities, conducting final reviews of all data-collection instruments, performing process and market evaluations and impact evaluation calculations, as well as preparing and reviewing evaluation reports. Bouthillette Parizeau and Richard Patterson conducted desk reviews and phone interviews. Equilibrium Engineering conducted desk reviews and on-site visits for selected program components. These organizations also contributed to certain impact evaluation analyses. Narrative Research conducted interviews with New Construction participants, as well as analyzed and reported on the data collected from those activities. Throughout this report, this team is referred to as the Evaluator.

Key findings, electrical first-year and lifetime energy savings, peak demand savings, and avoided greenhouse gas (GHG) emissions are presented in this report.

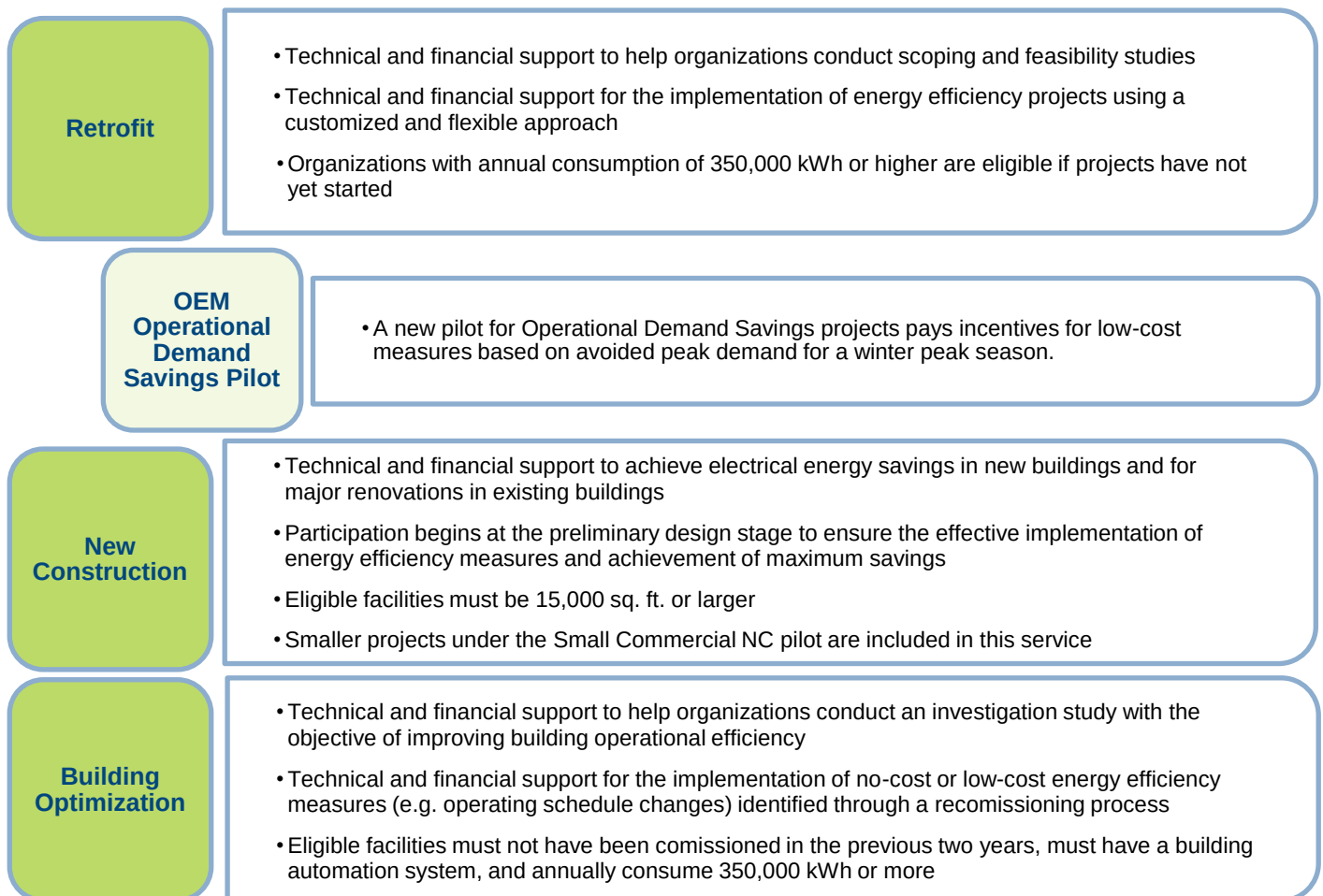
1 CUSTOM OVERVIEW

This section describes the Custom component of the Custom Incentives program, follows up on past evaluation recommendations, and provides an overview of participation history.

1.1 Custom Description

Custom provides large business, non-profit, and institutional (BNI) participants with technical assistance, financial incentives, and project financing to help reduce their electricity consumption and demand. Business development managers also work with participants to assist them in moving their projects forward and identifying consultants. As illustrated in Figure 7, Custom includes three different services and one pilot.

Figure 7: Custom Services



EfficiencyOne (EOne) claims savings for certain Custom projects over multiple years since certain phases or measures can be fully operational before the entire project is completed. The four types of projects for which savings were tracked in 2021 were:

- › Projects not completed in 2021. For those projects, the portion of savings corresponding to the savings claims submitted in 2021 were claimed as partial savings.
- › Projects started and completed in 2021. For those projects, all project savings were claimed in 2021 as final savings – 2021 projects.
- › Multiyear projects that had partial savings claimed in previous years and were fully completed in 2021. For those projects, the remaining portion of savings corresponding to the savings claims submitted in 2021 were claimed as final savings – multiyear projects. The 2021 adjustment ratios and net-to-gross ratios (NTGRs) were applied to the savings for those projects since they were completed in 2021.
- › So-called “Pay-for-Performance” (P4P) projects within Custom. These were projects undertaken at multiple locations under one master program application, and which were paid incentives based on year-over-year savings over a two-year period. As with Multiyear projects, these P4P projects had partial savings claimed in previous years and were fully completed in 2021. For those projects, the remaining portion of savings corresponding to the savings claims submitted in 2021 were claimed as final savings P4P projects. The 2021 adjustment ratios and net-to-gross ratios (NTGRs) were applied to the savings for those projects since they were completed in 2021.

In 2020, EOne launched the OEM Operational Demand Savings Pilot that ran during the 2020-2021 winter peak season from December 2020 to February 2021 under Retrofit. The pilot offered participants with on-site energy managers (OEMs) a demand-based incentive to make low-cost automated operational changes that result in lower utility peak demand. An incentive of \$125/kW was paid based on realized savings. The objective of this pilot was to drive greater demand savings in a low-cost and rapid manner. EOne was interested in learning more about the costs, barriers, measure persistence, as well as measurement and verification (M&V) for these projects. In 2020, EOne also launched the Klondike pilot that involved enhanced incentives, awareness and, in some cases, new measures under EOne’s existing services to homes and businesses serviced by the Klondike electrical substation. One OEM Operational Demand Savings Pilot participant also fell under the Klondike pilot.

Similarly to 2020, Custom was not notably impacted by public health and government directives associated with the COVID-19 pandemic in 2021, although certain delays related to finalizing savings claims were observed. In addition, a slowdown in the initiation of new projects was observed, which may impact future results.

Retrofit, New Construction, and Building Optimization combined were aimed at generating net electrical energy savings of 30.310 GWh and peak demand savings of 8.166 MW at the generator in 2021.

1.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated Custom in previous years and issued improvement recommendations. Table 8 below provides a summary of the implementation status of each recommendation presented in the Executive Summary section of the 2020 Evaluation Report.

Table 8: Implementation Status of Past Recommendations for Custom

#	Recommendations	Status	Comments
2019 Custom-R2	Better document peak demand savings calculations.	New Construction - Implemented Retrofit – In Progress	EOne has developed a Demand Savings Guide, including a model library file, to accurately capture peak demand savings from New Construction projects in eQuest. The evaluation revealed that some details need to be updated in the guide (notably to be able to remove lighting savings from calculations and take into consideration holidays when they occur during winter weekdays) and the methodology tested on a few projects before use. For Retrofit, EOne has developed an internal guideline document that will result in better capturing peak demand savings. EOne deployed the document in April of 2021, the guidelines will be followed for all Retrofit projects initiated after April of 2021.
2020-Custom-R1	Implement improved M&V activities in Retrofit and Building Optimization.	In Progress	EOne is working on developing a more comprehensive M&V template for complex projects and has developed a new M&V process flow chart, M&V plan, and result templates for small, medium, and large Custom projects. EOne plans on creating a training plan and internal guide. The Evaluator has not yet seen the results of these improved M&V documents. Progress on this recommendation should be hastened and prioritized given that M&V and demand methodology recommendations have been central to adjustments in both the 2020 and 2021 evaluations and so that 2022 Custom projects can benefit from enhanced internal and participant guidance.

#	Recommendations	Status	Comments
2020-Custom-R2	Improve project file documentation processes.	Implemented	EOne has developed a checklist to ensure consistency across projects to include relevant and complete documentation. EOne has included a written procedure in the Program Manual to describe the process of using this checklist and folder structure. EOne will modify the checklist based on any feedback received following the current evaluation.
2020 Custom-R3	Incorporate a multi-source approach to measure free-ridership for projects that account for a large proportion of savings.	Implemented	A multi-source approach to measure free-ridership was incorporated into the 2021 evaluation activities for projects that account for a large proportion of savings.
2020 Custom-R4	Update the New Construction Service Guide to include the cases identified during the evaluation that were not covered and/or required more clarity in their interpretation.	In Progress	EOne is working with the Evaluator to update New Construction Service Guide to include a window-to-wall ratio (WWR), thermal bridging, and outside air flow rates. EOne plans to update the service guide in January 2022.
2020 Custom-R5	Perform an HVAC market characterization study for New Construction.	In Progress	An HVAC market characterization study was initiated in 2021 and will be completed as part of the 2022 evaluation.

1.3 Participation History

OEM Operational Demand Savings Pilot

In 2021, three Pilot projects generated total energy and demand savings of 0.674 GWh and 0.495 MW respectively (gross at the generator). This is the first year of the service and, as such, no year-over-year comparisons of results are yet available.

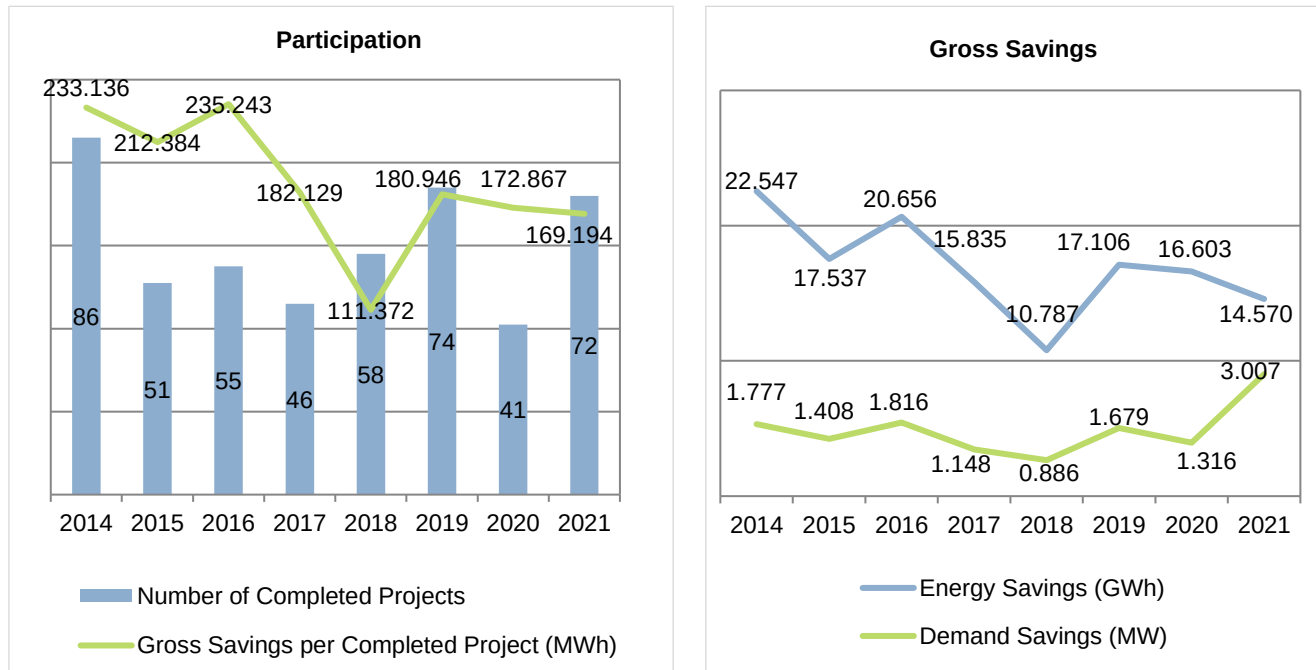
Retrofit

In 2021, energy savings were generated by a total of 79 Retrofit projects, including:

- › 54 projects started and completed in 2021
- › 18 multiyear projects completed in 2021
- › Six projects started in 2021 but that were not completed and claimed partial savings in 2021
- › One multiyear project started prior to 2021 and claimed partial savings in 2021 but was not completed

As presented in Figure 8 below, the number of completed projects increased significantly in 2021, and the average energy savings per completed project were similar to those observed in 2020. Much of the increase in projects is due to the closure of 18 multiyear projects in 2021. Altogether, the Retrofit achieved 12% fewer gross energy savings in 2021 compared with 2020.

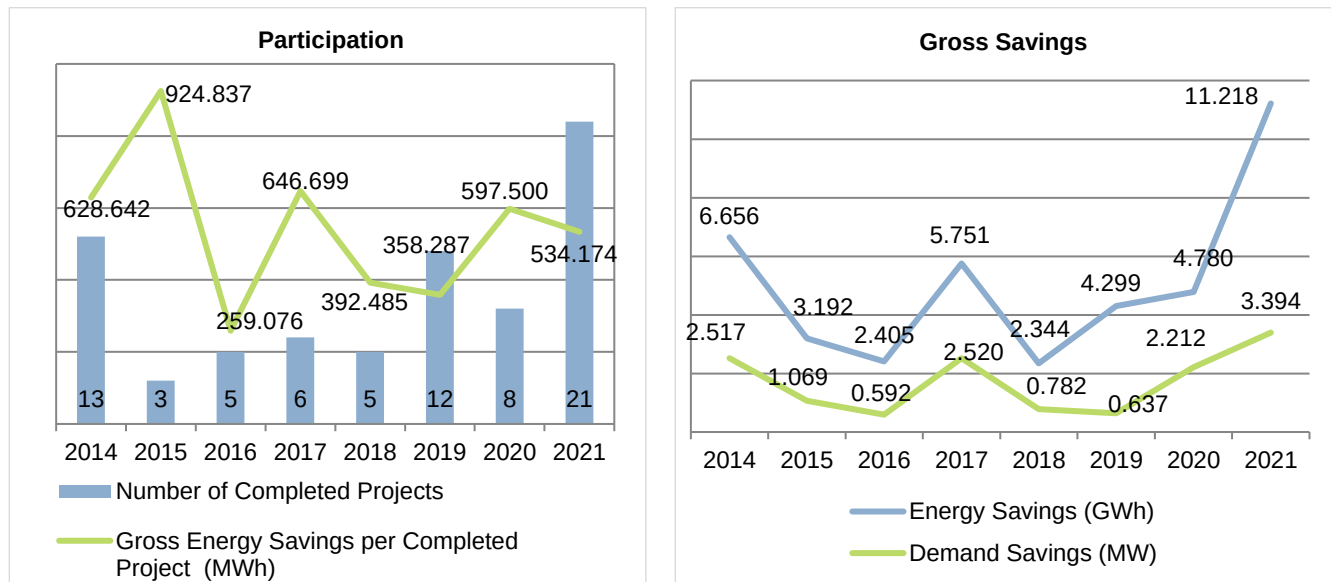
Figure 8: Overview of Retrofit Participation, 2014-2021



New Construction

In 2021, 21 projects were completed under New Construction. As highlighted in Figure 9 below, the number of completed projects reached a new high in 2021. A number of those projects were small commercial buildings, which can explain that energy savings per completed project decreased by 11% compared to 2020. Due to the increase in participation, gross energy and peak demand savings for New Construction increased significantly compared to 2020, both achieving higher results than any other year.

Figure 9: Overview of Participation in New Construction, 2014-2021

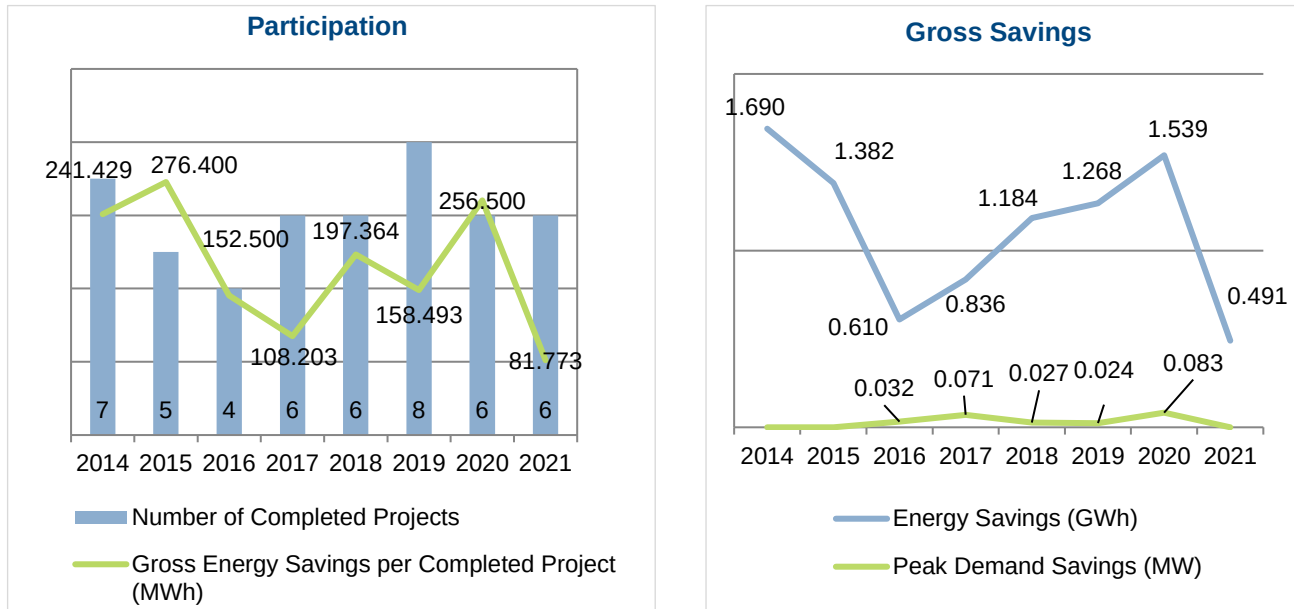


Building Optimization

A total of six Building Optimization projects reported savings in 2021 and all of them were completed in the same year. Although the number of projects completed in 2021 remains modest, it is comparable to the participation levels of previous years. As depicted in Figure 10 below, the average energy savings per project decreased substantially in 2021 compared to 2020, which likewise resulted in lower total gross energy savings for 2021. There were no peak demand savings claimed in 2021 for Building Optimization since none of the projects in question had an impact during the system peak demand period.

The Evaluator notes that the absence of peak demand savings and the decrease in energy savings can in part be attributed to some participants choosing to engage with the OEM Operational Demand Savings Pilot which attracted similar project types as Building Optimization (system scheduling), although these are specifically focused on peak demand impacts. This could account for about 0.5 GWh in energy savings and 0.6 MW in peak demand savings that would likely otherwise be included in Building Optimization.

Figure 10: Overview of Participation in Building Optimization, 2014-2021



2 CUSTOM EVALUATION APPROACH

The 2021 Custom evaluation comprises a comprehensive impact evaluation for Retrofit, Building Optimization, and New Construction and a process evaluation for New Construction. The main objectives of the 2021 Custom evaluation are as follows:

- › Collect information on participant perspectives
- › Collect information on the New Construction participation decision-making process
- › Collect early free-ridership information for New Construction participants for future evaluation
- › Calculate gross and net Custom results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions⁴

The Evaluator identified key research questions aimed at achieving the above objectives. Table 9 outlines the evaluation objectives and maps them to the evaluator-established research questions, methods, and sample sizes (n). Each method is described further below.

Table 9: 2021 Custom Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Collect information on participant perspectives	› How satisfied are participants with Custom? › What challenges or barriers, if any, have participants experienced with Custom? › How satisfied are participants with the OEM Operational Demand Savings Pilot overall and its aspects such as participation processes and requirements? › What are the motivations of OEM Demand Savings participants to participate? › For the OEM Operational Demand Savings Pilot, did the implementation of measures require changes to service levels or operations that were ultimately sustainable in the longer term? › What challenges or barriers, if any, have participants experienced with the OEM Operational Demand Savings Pilot? › What impacts on operations, if any, did participants experience by participating in the OEM Operational Demand Savings Pilot?	› Participant phone interviews^{5,6} – New Construction (n = 10 projects, 12 decision-makers (multisource)) – Retrofit (n=26) – Building Optimization (n=6) › Participant and OEM phone interviews for OEM Operational Demand Savings Pilot (n=6)
Collect information on	› During the New Construction participation process, when could or should information about participant intentions,	› EOne staff interview (n=2) › EOne Business Development

⁴ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

⁵ For Retrofit and Building Optimization, the majority of interviews were completed as part of a participant follow-up interview during the project review.

⁶ Where a single program participant undertook multiple similar projects, interviews were grouped together for scheduling purposes to increase the efficiency of the process.

Evaluation Objectives	Research Questions	Methodology
the New Construction participant decision-making process	- project planning, and the influence of EOne on those elements be collected to ensure the most reliable and accurate free-ridership assessments? › How should this information be collected?	- Managers (BDM) interview (n=2) › Modelling Consultant interview › Review of service documentation, including flow charts
Collect early free-ridership information for New Construction participants for future evaluation	› What were the intentions related to building design during the project planning stage of New Construction participants who recently signed a Customer Project Agreement (CPA), and what information does EOne have on these elements?	› Interviews with participants who have recently signed CPAs (n=5)
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › Are the gross savings calculated for a sample of projects consistent with both EOne savings calculation methods and the measures observed on site? › Have the correct EUL values been applied to sampled Custom project measures, and which values require revision based on baseline changes? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Project file reviews and participant follow-up interviews – Retrofit (n=26) – Building Optimization (n=6) – OEM Pilot (n=3) › Calls and energy model reviews – New Construction (n=12) › EUL update (New Construction and OEM Pilot) › Calculations using evaluation results
Calculate net results	› What are the Retrofit free-ridership and spillover levels for 2021? › What is the New Construction free-ridership level for 2021? › What are the free-ridership and spillover levels for Building Optimization for 2021? › What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What is the net avoided GHG emissions in CO₂ eq for Custom?	› Participant phone interviews – Retrofit (n=26) – Building Optimization (n=6) – New Construction (n=10 projects, 12 decision-makers (multi-source)) › For OEM Pilot, calculations using a NTGR of 1 › Calculations using evaluation results › GHG emission reduction calculations

Tracking Sheet Audit

Prior to performing any savings calculations, the Evaluator conducted an audit of the final 2021 tracking sheet to ensure it was complete and data entry was consistent. The detailed protocol used for the tracking sheet audit and the results thereof are presented in Appendix I.

OEM Phone Interviews

The Evaluator conducted phone interviews in July 2021 with the OEM of each OEM Operational Demand Savings Pilot project. OEMs are technical staff for which a portion of their salary is paid by EOne and are an integral part of the participating organization to identify and implement energy savings opportunities. OEMs were interviewed given their integral role in developing the projects in question.

The participant and OEM questionnaires are presented in Appendix II.

New Construction Participant Decision-making Process Interviews

During the 2021 summer, Econoler conducted interviews with different stakeholders to collect information on the Custom New Construction participant decision-making process once their project is complete and to explore ways to measure free-ridership closer to the time when decisions are made. The interviews started with EOne staff responsible for managing New Construction, followed by interviews with EOne Business Development Managers (BDMs) and a modelling consultant.

The new free-ridership approach developed after the above interviews was then tested by conducting five phone interviews with participants who had recently signed Custom Project Agreements (CPAs). The interview guide is presented in Appendix III.

Participant Phone Interviews

To collect information on participant free-ridership and participant perspectives, the Evaluator conducted participant phone interviews in the fall of 2021 and in January 2022 to cover 10 out of the 12 sampled New Construction projects. Where applicable, multiple sources for each project were interviewed. A total of 12 decision makers were interviewed. The interview guide is presented in Appendix IV.

To collect information on participant perspectives, the Evaluator conducted phone interviews in July 2021 with all three participants of the OEM Operational Demand Savings Pilot.

Project File Reviews and Participant Follow-up Phone Interviews

In the fall of 2021 and January 2022, Econoler and its subcontractor CDM Energy Solutions carried out a full technical review of project documentation for 26 Retrofit projects and six Building Optimization projects. Pursuant to the desk reviews, follow-up phone interviews with participants were conducted to finalize project reviews. The phone interviews were also used to collect information on free-ridership and spillover as well as participant perspectives on the service. In addition, where applicable, further phone interviews were conducted to collect free-ridership and spillover information from multiple sources for one of the 26 reviewed Retrofit projects. Although the 8 largest Retrofit projects were selected for additional participant phone interviews, despite best efforts, this approach was only possible for one project. In all other cases, either there was no second key decision-maker involved in the project, or they were not available for an interview.

The protocols presented in Appendices VI and VII were used to review Retrofit and Building Optimization projects respectively. The Retrofit and Building Optimization participant interview guide is presented in Appendix V.

The Evaluator reviewed project study documents, Custom Project Agreements (CPAs), as well as detailed M&V files submitted by OEMs in the course of pilot participation.

Pursuant to the desk reviews, follow-up phone interviews with OEMs were conducted to finalize project reviews and clarify outstanding questions. As part of those interviews, the Evaluator asked technical questions relating to details on project implementation and performance and requested clarification and supporting evidence on certain operating parameters such as motor loads or control sequences.

These same follow-up interviews also served to collect information on OEM perspectives on the pilot, as noted above.

The protocol presented in Appendix VIII was used to evaluate the OEM Operational Demand Savings Pilot.

Energy Model Reviews

In the fall of 2021 and in January 2022, Bouthillette Parizeau (BPA) performed energy model reviews for 12 of the New Construction projects. After validating the information available in each project file, BPA determined whether a site visit, a phone call or just a project file review was needed to review the energy model. The protocol for the energy model reviews is presented in Appendix IX.

EUL Update

As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the EUL values for New Construction to ensure they were still valid and revised them where appropriate.

In addition, the Evaluator reviewed the EUL value of each reviewed project based on the EUL values presented in the 2020-2022 Measure Assessment.

Calculations Using Evaluation Results

Building on all the above methods and collected data, the Evaluator calculated the first-year and lifetime energy and peak demand savings as per the calculation methodology presented in Sections 6, 9, and 11 below.

GHG Emission Reduction Calculations

To obtain Custom net avoided GHG emissions in CO₂ eq, the Evaluator multiplied the net energy savings by the latest Nova Scotia-specific factor for GHG emissions generated by electricity production. This factor was established using Nova Scotia Power (NS Power) data. Where applicable, the Evaluator also considered fuel switching. The increased consumption levels of fuels other than electricity resulting from a given project was multiplied by an emissions factor specific to the relevant fuel type to calculate the overall impact on GHG emissions.

Note on Margin of Error

For evaluation activities that yield quantitative results based on a sample, the Evaluator aimed to achieve a maximum margin of error of 10% at a confidence level of 90%. This means that if measurements were conducted many times with different samples, the data would be within 10 percentage points above or below the percentage reported 90% of the time. Thus, the margin of error indicates the relative level of precision⁷ of the measurement, while its associated confidence level indicates the probability of a measurement falling within the margin of error.⁸

As part of the Custom evaluation, the Evaluator calculated the margins of error for savings adjustment ratios for Retrofit and New Construction. No margins of error were calculated for Building Optimization since all completed projects in 2021 were reviewed by the Evaluator. The margins of error are listed alongside results in the applicable sections herein. Examples of calculations used to establish margins of error are provided in Appendix II of the 2021 DSM Programs Evaluation Executive Summary.

⁷ Precision refers to how reproducible a set of measurements is. It does not take into account, however, how close the measured values are to the true values since this would refer to accuracy.

⁸ As part of this evaluation, the confidence level and the margin of error only take random sampling errors into account; they do not reflect non-sampling errors or biases such as data entry errors, inaccurate responses from respondents, or the inability to contact certain people.

3 OEM OPERATIONAL DEMAND SAVINGS PILOT PARTICIPANT PERSPECTIVES

During the interviews with participants and OEMs, interviewees commented on their motivations, experience, and satisfaction with the pilot. All participants who completed projects were interviewed, while the OEMs associated with these projects were interviewed to gather their perspective on the pilot.

Participants all became aware of the pilot via their OEMs. Their motivations to participate were financially driven, notably:

- › The incentives (3 out of 3 participants)
- › Gas and/or electricity cost savings (2 of 3 participants)

Overall satisfaction with the OEM Operational Demand Savings Pilot was high among all three participants who provided ratings ranging between 8 and 10 (with 1 indicating “Not at all satisfied” and 10 indicating “Completely satisfied”). The most important factor supporting this level of satisfaction was the attractiveness of the incentive (2 out of 3 interviewees). Other reasons reported by participants for being satisfied were as follows:

- › High-quality work of the OEM (2 mentions)
- › Sense of gratification in innovating on a project (1 mention)
- › Satisfaction in contributing to reduce the peak for NSP (1 mention)

All participants and OEMs mentioned that they would participate should the same service be offered in the future. Many interviewees (5 out of 6) mentioned that they were already looking at other areas or opportunities in anticipation of this eventuality.

Four out of six interviewees faced challenges in implementing their project, such as the specific operating standards and conditions for their type of building (1 mention), resistance to change in some facilities (2 mentions), and meeting M&V requirements for the baseline (1 mention). One interviewee whose project involved the installation of new equipment mentioned delays in material delivery linked to COVID-19 as a challenge. Two interviewees noted that the M&V procedure for the pilot lacked clarity and was not sufficiently described. Justifying project costs was a challenge stated by two of the interviewees. In both cases, this involved the risks associated with the incentive. One mentioned the fact that operational peak demand savings can be challenging to estimate, leaving the eventual incentive uncertain should the peak demand savings be less than expected. The other mentioned that, without the incentive, it would be very difficult to focus on system peak demand savings projects as a top priority given that the utility rate structure does not encourage peak demand savings on the system peak (only on the monthly billing facility peak demand).

The implementation of the measures had little impact on the service levels or operational conditions of participating facilities. Five out of six interviewees reported no impact at all, and one reported only some minor troubleshooting and tuning at the beginning of the project.

Two of the three participants expected all or some of their measures to remain in place year-round without an additional incentive. Of the two organizations where measures remain in place, the expected effective useful life (EUL) of the measures was more than three years. The participant with measures that are only in place for the peak period commented that, since system peak demand savings have no impact on invoiced monthly facility peak demand, an annual incentive would be more appropriate than one at the beginning of the three-year period.

When asked how EOne could improve the OEM Operational Demand Savings Pilot, participants and OEMs provided the following suggestions:

- › Improve communication (2 mentions)
 - Provide the big picture to potential participants, explaining the peak demand constraints facing the province and how this pilot contributes to that challenge (1 mention).
 - Consult with participants and potential participants to explain NSP constraints to potential participants as well as gather ideas on the service offer. This could involve a meeting with EOne, NSP, and potential participants (1 mention).
- › Further clarify M&V requirements for the pilot (1 mention).
- › Adjust the incentive
 - A higher or different form of incentive is required to implement capital intensive projects for permanent demand savings in the system peak window (1 mention).
 - Consider an annual incentive, lower than the initial one, since current project types (low-cost schedule change projects) might require an annual incentive to ensure persistence (1 mention).
 - Consider an incentive for fuel oil reduction, which could support GHG reduction initiatives (1 mention).
- › Including technical assistance on HVAC guidelines in service documentation would be helpful since there have been changes in ventilation protocols due to the COVID-19 pandemic (1 mention).
- › Make it a regular service by promoting the offer more broadly and informing potential participants in other sectors (2 mentions).

2021 OEM Operational Demand Savings Pilot Participant Perspective Highlights

- › Participants were very satisfied with the pilot, each providing a rating between 8 and 10 on a 10-point scale.
- › All participants mentioned the financial incentive as a key motivation factor for participation.
- › For the most part, the implementation of measures had little impact on the service levels or operational conditions of participating facilities, which may indicate that the measures are more consistent with retrofit energy efficiency measures rather than operational peak demand reduction measures.

4 OEM OPERATIONAL DEMAND SAVINGS PILOT IMPACT EVALUATION

4.1 Tracking Sheet Audit

To ensure service results are reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix I. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

4.2 Gross Savings

Gross savings correspond to changes in energy consumption resulting from actions taken by OEM Operational Demand Savings Pilot participants regardless of why they participated.⁹ EOne tracks the annual gross savings of each project. This subsection describes the methodology used by the Evaluator to review the gross savings of OEM Operational Demand Savings Pilot projects.

4.2.1 Project Review Findings

Three organizations participated in the pilot. Given this small number and a desire for more detailed results to inform the pilot, the Evaluator presents anonymized evaluation results by project in the remainder of this document. The projects were implemented in institutional or municipal buildings through OEM-led studies and proposals. All projects involved multiple air handling units from HVAC systems. Two projects reported no capital costs (schedule optimization) as these were not required to be reported in the OEM Operational Demand Savings Pilot, whereas the third project reported capital costs (> \$200 K) to replace controls, recommission systems that were near the end of their useful life, and install new VFDs, and was managed through the Custom Retrofit process, with an additional incentive for the peak demand reduction component.

Based on the information provided during the interviews and the additional documentation received from the participant, the Evaluator has no reason to believe that the projects were not implemented as stated in project documents.

⁹ Definition adapted from the National Renewable Energy Laboratory, "Chapter 23: Estimating Net Savings: Common Practices," The Uniform Methods Project, September 2014, p. 3, available at: http://energy.gov/sites/prod/files/2015/02/f19/UMPCChapter23-estimating-net-savings_0.pdf (Last accessed November 19, 2015).

Project Types

All three projects involved scheduling fans to be turned off during the system peak period, and two also involved reducing the speed of VFDs for certain fans. The Evaluator notes for context that typical demand reduction programs may require inconvenient scheduling changes for equipment operating during the system peak period or such changes that otherwise require a compromise in operating conditions; the projects are generally not economically viable on their own merits because they do not generate bill savings or improve operational performance.

While the intent of the pilot was to focus on low-cost/no-cost demand reduction measures to reduce demand during the three-month system peak period, only Participant 2's project met the true spirit of the pilot. Participant 1 and Participant 3 both developed projects that can remain in place indefinitely, and Participant 3's project involved a significant capital improvement to controls and VFDs. Therefore, while the pilot is focused on demand reduction and may have initiated activities to search for demand-based projects, they ultimately resulted in projects that also yielded significant energy savings.

Further to the point above, the two facilities that generated significant electrical energy savings (kWh) would have also both saved considerable energy by heating the associated make-up air of the ventilation systems in question. Since such savings would normally be derived from natural gas or another fuel, these savings are not quantified but would weigh into the financial calculations of participants when making the decision to implement the project.

Both of the points above challenge the program logic of offering an exclusive targeted demand incentive on the basis that system peak demand savings do not offer utility bill savings for participants. While this may be true if the projects as implemented are indeed restricted to the system peak period, many projects that are ultimately implemented may have broader participant benefits, and the incentives offered should reflect this.

If operational demand programs are to officially enter the portfolio, the Evaluator recommends that EOne consider offering the operational demand incentive as an integral part of Building Optimization (similarly to how this is done in Custom Retrofit). Further consider allowing participants to stream their proposed projects either into a peak demand stream or an energy savings stream (or indeed into Retrofit) pursuant to a feasibility study based on whichever would benefit the participant the most. This would better reflect the reality of how potential projects can change or evolve during feasibility studies and would still allow for appropriate marketing and messaging to participants about EOne's desire to find system peak demand reduction projects.

Further, for those projects that are limited to demand reduction measures affecting only the system peak (and by extension for which the participant is not inherently motivated due to inconvenient operational changes), the Evaluator recommends that EOne should consider offering an annual incentive and allowing participants to opt in on an annual basis ahead of the peak period. This would notionally allow participants the choice of proceeding or not with the measures for each peak season depending on their tolerance for the ensuing inconvenience.

4.2.2 Energy Interactive Effects

Operational scheduling projects such as those found in the current pilot need to consider electrical interactive effects when appropriate either in the project engineering calculations used to establish gross savings or when using whole building or system-level data as part of the M&V approach.

Two of the projects used whole building approaches to quantify peak demand and energy savings and therefore captures all interactive effects in the analysis period. The third project used an M&V approach that drew a verification boundary around fan systems and only quantified ventilation fan power. With this approach, interactive effects could occur, but these were not identified or quantified in the project documentation. The Evaluator considered these effects as part of the evaluation as follows. In heating mode, these effects cause a decrease in natural gas use, which are not relevant to EOne for this evaluation. In cooling mode, these effects cause a decrease in electricity consumption and the participant having ignored them, led to a more conservative estimate. The Evaluator notes that these cooling savings are relatively low compared to fan savings given that fans are scheduled to operate in early evening when cooling loads are typically relatively low. Hence, the Evaluator chose not to make any adjustments.

4.2.3 Effective Useful Life

As presented in Table 10, the tracked EUL of the two projects with operational energy saving components was three years. The project with controls and variable frequency drive (VFD) installations had tracked EULs of five and 15 years for these measures respectively, for a combined EUL of 11 years based on their proposed energy saving ratios.

Table 10: Summary of Tracked and Evaluated Effective Useful Life

Project	Tracked EUL [years]	Evaluated EUL [years]
Participant 1	3	3
Participant 2	3	1
Participant 3	11	12.7

The EUL for Participant 2 was adjusted to one year from three years because the facility ventilation requirements changed in response to the COVID-19 pandemic and the measure schedules were removed from service. The EUL for Participant 3's HVAC control measure was adjusted up to 10 years from five years to reflect standard practice for control replacement measures. The revised project EUL of 12.7 years was determined by maintaining the originally proposed ratio lifetime savings based on the measure EULs from the Custom Project Agreement (CPA).¹⁰

¹⁰ The Evaluator maintained originally proposed EUL proportions because there was no means of assessing the actual performance of each measure individually to arrive at a new post-retrofit EUL for the whole project.

4.2.4 Evaluated Gross Savings

Table 11 presents a summary of the total claimed gross savings for peak demand (MW) and annual energy savings (GWh) at the meter.¹¹

Table 11: Tracked and Evaluated Gross Energy and Peak Demand Savings by Project at the Meter¹²

Project	Corrected Tracked or Evaluated	Total Claimed Gross Peak Demand Savings		Total Claimed Gross Energy Savings			
		MW	% Corrected Tracked Savings	GWh/year	% Corrected Tracked Savings	EUL	Lifetime Savings (GWh)
Participant 1	Tracked	0.133	100%	0.374	100%	3	1.121
	Evaluated	0.133		0.374		3	1.121
Participant 2	Tracked	0.374	86%	0.045	84%	3	0.134
	Evaluated	0.322		0.038		1	0.038
Participant 3	Tracked	0.011	100%	0.222*	100%	11	2.440
	Evaluated	0.011		0.222		12.7	2.817
TOTAL	Tracked	0.517	90%	0.640	99%	5.8	3.695
	Evaluated	0.465		0.634		6.3	3.976
*This is a multiyear project for which these energy savings were claimed as part of the 2020 Custom Retrofit evaluation.							

Overall, the gross evaluated peak demand savings were 0.465 MW, or 90% of tracked savings. Gross energy savings were evaluated at 0.634 GWh, or 99% of tracked savings, and the service effective useful life (EUL) was adjusted upward to 6.3 years from 5.8 years. The differences and adjustments are described here below.

For Participant 1, the Evaluator noted an appropriate savings calculation methodology for both energy and peak demand savings and no adjustments are proposed.

¹¹ The Evaluator compared gross evaluated values with gross tracked values from the tracking sheet because the July tracking sheet report contained errors in the NTGRs applied to arrive at net values due to the migration of the new Customer Information System (CIS). These issues are expected to be resolved ahead of the full impact evaluation in the fall.

¹² This table presents total savings by project which includes both partial claims from 2020 and final claims in 2021.

Participant 2 experienced significant differences in occupancy levels due to the COVID-19 pandemic. Therefore, the planned International Performance Measurement and Verification Protocol (IPMVP) Option C year-to-year savings approach was considered by both EOne and the Evaluator as unsuitable to determine savings. As a result, EOne proposed setting the tracked savings equal to the proposed savings in the CPA, which were based on an IPMVP Option B approach. The Evaluator supported claiming savings using this approach except for in several cases wherein direct demand meter data indicated that savings were lower than expected in two buildings.

For Participant 3, the Evaluator noted an appropriate savings calculation methodology for both energy and peak demand savings and no adjustments were proposed. Table 12 presents a summary of gross evaluated energy and peak demand savings.

Table 12: Evaluated Gross Energy and Peak Demand Savings

	Savings for 2021
Number of Projects	3
Energy Savings	
Tracked Gross Energy Savings – at the Meter (GWh)	0.418
Adjustment Ratio for Energy Savings	0.99
Gross Energy Savings Without True-up Adjustment (GWh)	0.414
True-up Adjustment for Gross Energy Savings (GWh)	0.010
Gross Energy Savings – at the Meter (GWh)	0.424
Line Loss Factor	1.063
Gross Energy Savings – at the Generator (GWh)	0.451*
Effective Useful Life (years)	3.0
Gross Lifetime Energy Savings – at the Generator (GWh)	1.358
Peak Demand Savings	
Tracked Gross Peak Demand Savings – at the Meter (MW)	0.517
Adjustment Ratio for Peak Demand Savings	0.90
Gross Demand Savings Without True-up Adjustment (MW)	0.465
True-up Adjustment for Gross Demand Savings (MW)	0.00
Gross Peak Demand Savings – at the Meter (MW)	0.465
Line Loss Factor	1.065
Gross Peak Demand Savings – at the Generator (MW)	0.496**
*Energy savings generated by the Klondike pilot were claimed as part of the 2020 Custom Retrofit evaluation (0.223 GWh were claimed in gross energy savings at the generator). A true-up adjustment was applied to those savings, contributing 0.010 GWh in gross energy savings at the generator from by the Klondike pilot in 2021.	
**The gross peak demand savings at the generator include 0.010 MW generated by the Klondike pilot.	

4.3 Net Savings

The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a service, by estimating the net-to-gross ratio (NTGR). More precisely, the NTGR represents the positive or negative impacts of spillover and free-ridership effects on gross savings. For the OEM Operational Demand Savings Pilot, the Evaluator assumed free-ridership and spillover levels to be zero given the pilot was offered only to a small number of organizations with OEMs and the nature of the service as a limited pilot. Neither free-ridership nor spillover questions were included in participant interviews.

4.3.1 Evaluated Net Savings

The OEM Operational Demand Savings Pilot generated 0.492 GWh in net energy savings and 0.496 MW in net peak demand savings at the generator. The results are listed in Table 13 below. The net lifetime energy savings were established at 1.887 GWh, yielding an average EUL of 3.8 years.

**Table 13: Evaluated 2021 OEM Operational Demand Savings Pilot Net Energy
and Peak Demand Savings**

	Savings for 2021
Energy Savings	
Gross Energy Savings – at the Meter (GWh)	0.424
NTGR	1.00
Net Energy Savings Without True-up Adjustment	0.424
True-up Adjustment for Net Energy Savings (GWh)	0.039
Net Energy Savings – at the Meter (GWh)	0.463
Line Loss Factor	1.063
Net Energy Savings – at the Generator (GWh)	0.492*
Effective Useful Life (years)	3.8
Net Lifetime Energy Savings – at the Generator (GWh)	1.887
Peak Demand Savings	
Gross Peak Demand Savings – at the Meter (MW)	0.465
NTGR	1.00
Net Peak Demand Savings Without True-up Adjustment (MW)	0.465
True-up Adjustment for Net Peak Demand Savings (MW)	0.00
Net Peak Demand Savings – at the Meter (MW)	0.465
Line Loss Factor	1.065
Net Peak Demand Savings – at the Generator (MW)	0.496**
*Energy savings generated by the Klondike pilot were claimed as part of the 2020 Custom Retrofit evaluation (0.192 GWh were claimed in net energy savings at the generator). A true-up adjustment was applied to those savings, contributing 0.052 GWh in net energy savings at the generator from the Klondike pilot for 2021.	
**The net peak demand savings at the generator include 0.010 MW generated by the Klondike pilot.	

As presented in Table 14, applying the Nova Scotia-specific factor¹³ for GHG emissions generated by electricity production, 0.5841 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 288 tonnes of annually avoided CO₂ eq.

¹³ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:

Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021), Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021 https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

Table 14: Evaluated 2021 OEM Operational Demand Savings Pilot GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	0.492
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	288

4.4 Realization Rate

Table 15 below compares the total tracked and evaluated savings for the OEM Operational Demand Savings Pilot. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 111% for energy savings and 90% for peak demand savings.

Table 15: Comparison of 2021 OEM Operational Demand Savings Pilot Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	0.445	GWh	1.00	0.445	GWh	111%
Evaluation Results	0.451	GWh	1.09	0.492	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.550	MW	1.00	0.550	MW	90%
Evaluation Results	0.496	MW	1.00	0.496	MW	
* The NTGRs listed in this table match the rounded averages obtained by dividing net savings by gross savings. They differ from the values presented in Subsection 4.3.1 above because of true-up adjustments.						

2021 OEM Operational Demand Savings Pilot Evaluation Highlights

- › The OEM Operational Demand Savings Pilot achieved 0.492 GWh in net electrical energy savings and 0.496 MW in net peak demand savings at the generator in 2021.
- › Project reviews resulted in adjustment ratios of 0.99 for energy savings and 0.90 for peak demand savings.

5 RETROFIT PARTICIPANT PERSPECTIVES

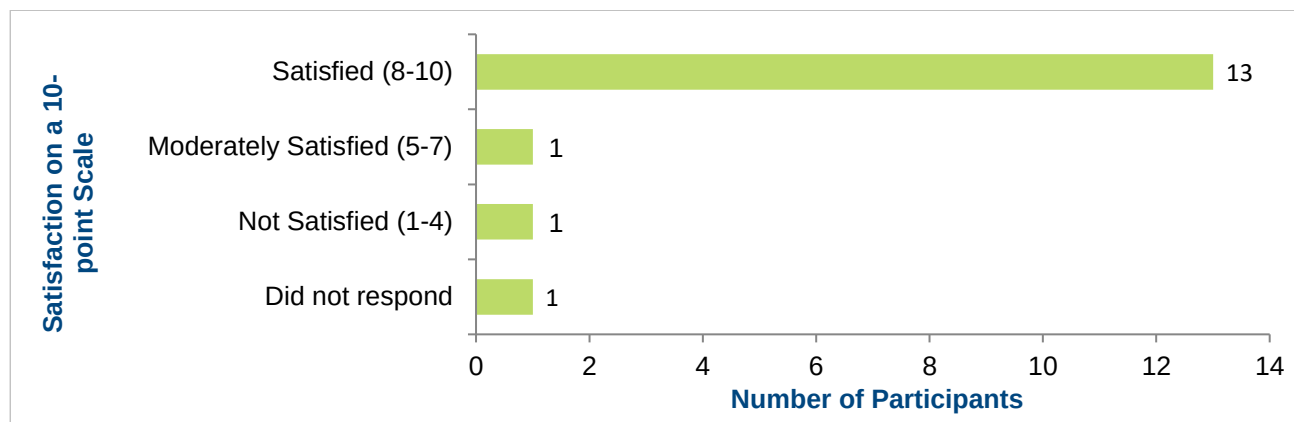
As part of the Retrofit project file reviews and follow-up interviews with participants, respondents commented on their experience and satisfaction with the service. A total of 16 of the 26 participants whose projects were reviewed were reached for an interview. The difference is attributable to several unique participants responding for multiple projects, and one participant who was not available for interview within the timeframe of the evaluation.

Overall satisfaction with Retrofit was high among respondents who provided an average rating of 8.4 on a 10-point scale (with 1 indicating “Not at all satisfied” and 10 indicating “Completely satisfied”). As outlined in Figure 11 below, most respondents provided a rating of 8 or higher, while two respondents expressed lower satisfaction, and one did not respond. Among the participants who expressed high satisfaction, the main reasons reported for being satisfied were as follows:

- › Applying to the service was easy and overall participation was smooth (9 mentions)
- › The incentives allowed them to improve the energy efficiency of their facilities (3 mentions)
- › Great service and support from EOne staff (1 mention from a participant with multiple projects)

Two participants who expressed moderate satisfaction (5/10) and low satisfaction (3/10) found that the incentive wasn’t commensurate with the amount of time and money invested in the development of the project. As for the participant who expressed low satisfaction (3/10), an additional reason given was that the incentive ultimately received was far below initial expectations based on early discussions with EOne.

Figure 11: 2021 Participant Satisfaction with Retrofit (10-point Scale)



Most respondents said they did not face any challenges or barriers when implementing their projects through the service. As for the few participants (4) who faced challenges, one respondent mentioned the participation process was lengthy and required multiple follow-ups, while all others cited internal issues related to delays, scope changes, or technical barriers.

Two thirds of interviewed participants provided suggestions on how to improve Custom Retrofit. The suggestions provided fell into the following areas:

- › Increase incentive amounts (3 mentions)
- › Clarify and broaden the eligibility criteria (2 mentions)
- › Reduce processing times for the application and incentive payment (2 mentions)
- › Quantify annual savings more clearly (1 mention)
- › Notify sooner and more clearly that an interview would be required with the Evaluator (1 mention)
- › Provide other financing options such as loans instead of rebates (1 mention)

2021 Retrofit Participant Perspective Highlights

- › Overall satisfaction with Retrofit was high among interviewed participants who provided an average rating of 8.4 on a 10-point scale.
- › Most respondents did not face challenges related to their participation in Retrofit.
- › Most respondents identified at least one area of improvement for service implementation, including higher incentive amounts, clearer and more inclusive eligibility criteria, and reduced processing times.

6 RETROFIT IMPACT EVALUATION

The objective of the 2021 Retrofit impact evaluation was to determine gross and net electrical energy and peak demand savings, annually avoided GHG emissions, as well as EUL and associated lifetime energy savings. As described in Subsection 1.1 above, Retrofit includes four types of savings: (1) Partial savings (projects to be completed in future years); (2) final savings of 2021 projects; (3) final savings of multiyear projects; and (4) unsubstantiated projects closed in 2021.

As presented in Table 16, seven projects achieved partial savings in 2021, 54 final savings projects were started and completed in 2021, and 18 multiyear projects claimed final savings in 2021, 2 from the regular Retrofit projects (Regular), and the 16 Pay-for-Performance projects (P4P).

Table 16: Evaluated 2021 Retrofit Projects

	Partial Savings	Final Savings for Projects Started and Completed in 2021	Final Savings for Multiyear Projects (Regular)	Final Savings for Multiyear Projects (P4P)	Total
Number of Projects	7	54	2	16	79

6.1 Tracking Sheet Audit

To ensure service results are reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix I. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

6.2 Gross Savings

Gross savings correspond to changes in energy consumption resulting from actions taken by Retrofit participants regardless of why they participated.¹⁴ EOne tracks the annual gross savings of each project. This subsection describes the methodology used by the Evaluator to review the gross savings of Retrofit projects.

The Evaluator calculates gross savings for Retrofit projects for each individual file in accordance with best practices for measurement and verification of commercial and industrial energy efficiency projects. The Evaluator uses the information and data made available by applicants and EOne and supplements these with engineering assumptions and professional judgement where necessary.

¹⁴ Definition adapted from the National Renewable Energy Laboratory, "Chapter 23: Estimating Net Savings: Common Practices," The Uniform Methods Project, September 2014, p. 3, available at: http://energy.gov/sites/prod/files/2015/02/f19/UMPCchapter23-estimating-net-savings_0.pdf (Last accessed November 19, 2015).

6.2.1 Sampling Methodology

The Evaluator selected a sample of 26 projects from a total of 72 projects completed in 2021 (only completed projects are considered for sampling). The overall sample of 26 projects represented 53% of total tracked energy savings for projects completed in 2021. All projects with partially claimed savings were excluded from the project reviews. Those projects will be reviewed in a future evaluation when they are considered complete (in 2022 or later).

The Evaluator followed industry best practices as described by the Uniform Methods Project and designed a random sampling plan so that the probability of a project being selected was approximately proportional to its size. The sample was stratified between 21 projects in the regular Retrofit project stream, and a set of five projects from the sub-group of Pay-for-Performance project files submitted by one applicant which was treated as a separate stratum from the total population of projects files. In the balance of the report, the Pay-for-Performance stratum is referred to as “P4P” in the following subsections, while the larger main sample stratum is referred to as regular (“Regular” in data tables).

Since a high proportion (census) of closed regular Retrofit projects was sampled, the Evaluator could not use a further stratified sampling methodology. At the time of conducting the sampling in November 2021, only 21 projects were completed, and all were sampled.¹⁵ At the time, the Evaluator worked with EOne to reserve a possible 10 additional positions within the sample for larger projects that might be closed prior to the end of the calendar year. In the end, the final sample allowed for only one additional project to be reviewed within the evaluation timetable. This was a large project that had been forecast to be completed before the end of 2021.

While the resulting random sample represents a variety of project types, the final tracking sheet for Retrofit projects included more project closures than previously forecast by EOne and expected by the Evaluator. Several of these additions were projects with high savings. The Evaluator notes that the resulting adjustment ratios and NTGR margins of error for the selected sample are within acceptable limits. However, due to the sensitivity of these parameters to the performance of larger projects, the Evaluator contends that a more complete sample that includes more projects that will eventually be closed and allows for the possibility of a separate large project stratum would yield more representative results. The Evaluator notes where this may become relevant below.

6.2.2 Project Review Findings

As a result of the Evaluator review, adjustments were made to the savings of 12 Retrofit projects representing 46% of sampled files. These are broken down as eight files having a combination of energy and peak demand adjustments and four files having only peak demand adjustments.

¹⁵ One file for which savings were very low (less than 1,000 kWh) was excluded.

Of the eight files for which energy and peak demand adjustments were made, four were solar photovoltaic (PV) installation projects. For those files, the Evaluator adjusted the consumption savings based on the calibration of PV system modelled versus actual electrical generation from data provided with the project files, which resulted in a downward adjustment to energy savings.

Of the four other projects for which energy or peak demand savings were adjusted:

- › One of the projects consisted of a compressed air project whereby performance period air flow was lower than in the baseline system. The Evaluator created a downward non-routine adjustment to the energy and consumption savings.
- › One of the projects involved the installation of horticultural lighting. For this project, the Evaluator made downward adjustments to energy and demand savings to reflect the fact that some of the lights were operated on a shorter schedule than expected in certain areas.
- › One of the projects required adjustments due to the misapplication of fan affinity laws in the provided energy savings calculations for several impacted air-handling systems. These corrections resulted in downward adjustments to both energy and peak demand savings.
- › Finally, through phone interviews, the Evaluator learned that the hours of operation for one of the projects were lower than stated in the energy and peak demand savings calculations. The Evaluator made the appropriate downward adjustments to energy and peak demand savings in accordance with the reduced operating schedule.

For four projects, the Evaluator adjusted peak demand savings only:

- › One of the files included a compressed air plant for which peak demand savings were claimed but not substantiated. The Evaluator assessed the peak demand savings using annual average energy consumption savings as a suitable estimate to reassess the demand savings. This resulted in a downward adjustment to peak demand savings.
- › Two of the files contained keying errors in the peak demand savings figures provided, and these errors were corrected by the Evaluator to result in very small (non-material) increases in peak demand savings.
- › One of the files included documentation indicating that incremental energy efficiency measures did not include demand savings estimates. The Evaluator adjusted the demand savings upward to include the contributions of these measures by dividing those measure savings by 8,760 hours to establish an annual average.

All of the above adjustments fell into three broad categories:

- › Projects for which the applied M&V methodology did not adequately capture energy and demand savings in accordance with accepted industry best practices
- › Projects for which demand savings were not adequately considered and developed
- › Projects for which there were keying and typographical errors relating to process quality

The Evaluator notes that a relatively high proportion of sample files required adjustments in areas for which past recommendations have been made (most notably M&V and demand savings). Adjustments were required in 46% of the sampled files in 2021. For comparison, this result is generally consistent and in alignment with past evaluation results for files requiring Evaluator adjustments – except for 2019 in which a higher percentage of files required adjustment. The adjustments required in past years were: in 2020, 11 of 26 (42%), in 2018, 13 of 25 (52%), however, in 2019, 20 of 24 (83%) of sampled files required adjustments.

The Evaluator noted a mix in quality in the projects reviewed. The Evaluator observed examples of excellent M&V practices, supporting plans, and reports in files where M&V was undertaken by participants (most often by their energy efficiency contractor). This was particularly apparent in the highly complex pay-for-performance files for which there were only very minor adjustments proposed by the Evaluator. In contrast, while some of the EOne-led project M&V was also of excellent quality, EOne staff mentioned many challenges associated with providing M&V on behalf of participants, including difficulty in obtaining data, challenges with understanding project implementation changes, and difficulties obtaining information about operating condition changes for non-routine adjustments; this was often reflected in the level of completeness or rigour, particularly in regard to supporting documentation for EOne-led M&V. In recognition of these challenges, the Evaluator recommends that EOne look for opportunities to address them when it is necessary to directly provide M&V support to projects. For example, there may be opportunities to adjust program requirements and clarify participant communications for ongoing information exchange. Where this is not practical, particularly for large and complex projects, EOne should consider requiring applicants to furnish their own supporting M&V plans and reports as part of service requirements.

The Evaluator developed further observations and recommendations relating to each of the adjustment categories above in Section 13.

6.2.3 Interactive Effects

Since interactive effects vary significantly from one Retrofit project to another, they are taken into account in the project engineering calculations used to obtain initial gross savings. Any adjustments required to interactive effects were made as part of the project review.

6.2.4 Effective Useful Life

The Evaluator reviewed the EUL values of all sampled projects by selecting an appropriate EUL for each measure implemented. The revised measure-level EULs were selected based on the values outlined in the 2020-2022 Measure Assessment.

Following the review of the 21 projects sampled from the regular Retrofit participants, the Evaluator found that eight of the 21 projects required adjustments to their EUL values. Changes made by the Evaluator were a result of establishing a better understanding of the measures through the project reviews. For example, one project implemented two measures with different EUL values, notably the installation of building automation system (BAS) controls with a 10-year EUL and the installation of variable frequency drives (VFDs) with a 15-year EUL, resulting in an adjusted 12.5-year EUL to account for the equal contribution of each measure to energy savings. The Evaluator also revised the EUL for four projects that implemented solar PV systems by adjusting the tracked 10-year or 15-year EUL values to a 25-year EUL, which is the value that the Evaluator supports for such systems. For the regular Retrofit group, since the EUL value of each project is an estimated value and the tracked EULs were reasonably close to the revised values, the Evaluator did not extrapolate an EUL adjustment ratio to all tracked EULs and instead only adjusted the projects that were reviewed.

Additionally, following the review of the five projects sampled from the Pay-for-Performance group (P4P), the Evaluator found that all those projects required adjustments to their EUL values. For example, one project implemented various measures including HVAC and refrigeration recommissioning, light-emitting diode (LED) lamps, and a VFD compressor, and each measure contributed its own weight to overall project energy savings and each measure had a different EUL. The Evaluator revised the overall project EUL based on a weighted average of all the measures implemented for that project. The Evaluator revised the EUL of the four other projects based on the same method. Of those five reviewed projects, the Evaluator revised the EUL of three projects from 15 years to six years, while the two other projects had their EUL values adjusted from 15 years to eight years. Based on those adjustments, the Evaluator calculated an EUL adjustment ratio of 0.44 with a margin of error of 5.6%. The Evaluator then extrapolated this result to all projects in the P4P group. As a result, the Evaluator revised the EUL from 15 years to 6.6 years for all projects in that group.

6.2.5 Evaluated Gross Savings

Savings are claimed under the three defined categories: (1) Partial savings; (2) final savings for projects started and completed in the current year; (3) final savings of multiyear projects (separated into the regular Retrofit and P4P sub-groups). For projects that claimed partial savings in previous years and were completed in 2021, the Evaluator calculated a true-up adjustment. This true-up adjustment is added to the total adjusted gross savings claimed over the years so that the sum is equivalent to the total tracked project savings multiplied by the adjustment ratio determined for the year of project completion. For all categories, the Evaluator applied an overall current-year adjustment ratio that was established by calculating a weighted average of individual completed project adjustment ratios according to respective total project savings.

Table 17 below presents an example of how the true-up adjustment was applied to the gross energy savings of a multiyear project completed in 2021. Note that no savings were claimed for this project in 2020.

Table 17: Example of a 2021 True-up Adjustment

	2018	2019	2020	2021	Total
Tracked Savings (kWh)	272,843	141,058	-	328,732	742,633
Year-specific Adjustment Ratio	0.995	0.948	-	0.946	-
Revised Savings Prior to True-up (kWh)	271,479	133,723	-	310,980	716,182
Total Project Revised Savings with 2021 Adjustment Ratio (kWh)					702,531
True-up (kWh)					-13,651

Table 18 below presents the evaluated gross savings for Retrofit, which were obtained by applying the overall adjustment ratios for energy savings and peak demand savings as well as the true-up adjustments to the final savings of multiyear projects completed in 2021. The savings at the generator were calculated using line loss factors that account for electricity losses occurring between the meter and the generator. For each project, the Evaluator applied energy and peak demand line loss factors corresponding to the relevant rate code based on the values drawn from the 2014 Cost of Service Study Progress Update¹⁶ provided by NS Power.

The 2021 Retrofit gross energy savings at the generator were established at 14.570 GWh and total gross peak demand savings were established at 3.007 MW at the generator. Retrofit gross lifetime energy savings were established at 179.288 GWh.

¹⁶ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 18: Evaluated 2021 Retrofit Gross Energy and Peak Demand Savings

	Partial Savings	Final Savings for Projects Fully Claimed in 2021	Final Savings for Multiyear Projects (Regular)	Final Savings for Multiyear Projects (P4P)	Total
Number of Projects	7	54	2	16	79
Energy Savings					
Tracked Gross Energy Savings – at the Meter (GWh)	2.294	8.947	2.393	0.190	13.824
Adjustment Ratio for Energy Savings	0.981	0.981	0.981	1.000	0.981
Gross Energy Savings Without True-up Adjustment (GWh)	2.250	8.777	2.348	0.190	13.565
True-up Adjustment for Gross Energy Savings (GWh)	-	-	0.053	0.103	0.156
Gross Energy Savings – at the Meter (GWh)	2.250	8.777	2.401	0.293	13.721
Line Loss Factor	1.061	1.063	1.058	1.063	1.062
Gross Energy Savings – at the Generator (GWh)	2.388	9.330	2.541	0.311	14.570
Effective Useful Life (years)	15.5	12.3	N/A*	6.6	-
Gross Lifetime Energy Savings – at the Generator (GWh)	36.974	114.922	25.339	2.052	179.288
Peak Demand Savings					
Tracked Gross Peak Demand Savings – at the Meter (MW)	0.272	0.544	1.824	0.000	2.640
Adjustment Ratio for Peak Demand Savings	1.007	1.007	1.007	-.**	1.030
Gross Peak Demand Savings Without True-up Adjustment (MW)	0.274	0.548	1.837	0.061**	2.719
True-up Adjustment for Gross Peak Demand Savings (MW)	-	-	0	0.110	0.110
Gross Peak Demand Savings – at the Meter (MW)	0.274	0.548	1.837	0.171	2.830
Line Loss Factor	1.069	1.068	1.060	1.070	1.063
Gross Peak Demand Savings – at the Generator (MW)	0.293	0.585	1.946	0.183	3.007
* The Evaluator did not include the EUL for Regular Retrofit multiyear projects because the mix of positive and negative savings with different EUL values resulted in an unrepresentative average EUL value. **The revised gross peak demand savings for P4P projects are based on one-time adjustments for two sampled projects; therefore, no adjustment ratio was used in this case.					

6.3 Net Savings

The Evaluator determined net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a service, by estimating a net-to-gross ratio (NTGR). More precisely, the NTGR includes effects such as free-ridership and spillover that positively or negatively affect the energy savings generated by a service. For Retrofit, free-ridership and participant spillover are both considered in the NTGR.

6.3.1 Free-ridership

In the case of Retrofit, free-ridership occurs when participants would have still implemented energy efficiency upgrades and measures in the absence of the service. The free-ridership level was assessed using a self-report approach that involved asking participants a set of questions during phone interviews. The questionnaire was updated in 2021 to align with the relevant updates undertaken in New Construction and included questions for all applicable variables in the decision-making process, including planning, efficiency, timing, and cost.

Certain questions were also used to determine the extent to which participant decisions about whether to have products installed or not had been influenced by previous participation in an EOne program component or EOne efforts to raise awareness about energy efficiency. When participant answers indicated that they had been significantly influenced by these one of these two factors, the free-ridership level was adjusted downward to better capture the overall influence of EOne activities on participant decisions.

The feedback collected from the participant interviews was converted into an overall free-ridership level using the algorithm presented in Appendix XI.

Two separate free-ridership levels were calculated for the regular Retrofit participants and for the Pay-for-Performance participant, the latter having a unique implementation approach, decision-making process, and relationship with EOne. Interviewing 15 unique respondents among the 21 regular Retrofit participants (several respondents represented multiple projects) revealed an overall free-ridership level of 16% with a margin of error of 10.6% for 2021. This result represents the latest data point in what appears to be a continuing trend of small incremental increases in free-ridership since the inception of the service in 2014.

While the overall free-ridership levels remain reasonable within the context of North American custom programs, the Evaluator believes that some portion of the relatively low free-ridership can be attributed to the moderating effects of influence section of the free-ridership algorithm. Due to this, EOne is encouraged to consider ways to ensure that influence remains current and that Retrofit projects continue to be implemented over and above the standard operating and maintenance practices for these types of participants.

Notably, for P4P projects, which were all implemented by a unique participant, the interview conducted with the respondent revealed a free-ridership level of 0%.

In recognition that large and complex projects may involve more than one decision-maker, the Evaluator planned to use a multisource approach to allow for the views of two key decision-makers to be collected and analyzed to establish free-ridership. This approach had very limited success in 2021 due in large part to a lack of availability or no identification of a second decision-maker in many files and, in smaller part, to difficulties in scheduling data-collection activities with the second decision-maker.

The project sampling methodology is based on energy savings because Retrofit incentives have been historically paid based on energy savings. Therefore, consistent with past evaluations, free-ridership was calculated based on energy savings and the resulting NTGR was applied to both energy and demand savings to establish net savings for both parameters. Going forward, if EOne incentivizes more projects based on Retrofit demand savings, the Evaluator might consider a sampling and free-ridership methodology that stratifies based on whether the incentive is paid for energy or peak demand savings.

As in past evaluation periods, the Evaluator considered the free-ridership level to be representative of the balance of projects in the project database given that it is still very close to the stated target of 10% for this parameter and the limited sample sizes.

6.3.2 Participant Spillover

For Retrofit, participant spillover occurs when participants implement eligible energy efficiency measures due to influence from previously participating in the service without receiving any kind of additional support. The Evaluator used phone interviews to question participants directly about any potential spillover effects. The algorithm used to determine the level of participant spillover is presented in Appendix XII.

Similarly to free-ridership, spillover was assessed separately for the regular Retrofit participants and for the Pay-for-Performance participant.

Among the 15 unique respondents from the regular Retrofit participants, two mentioned having implemented energy efficiency measures on their own. The first mentioned that their participation in Custom had no influence on their decision to implement the measures. The second mentioned having been moderately influenced by their participation in Custom for building envelope improvements. With the information provided by the interviewee, the Evaluator estimated energy savings generated by those measures. Once the influence factor applied, this resulted in a negligible spillover level (less than 0.5%), which represents a decrease compared to the 2020 level (1%).

The Pay-for-Performance participant did not implement further energy efficiency measures on their own, therefore, a spillover level of 0% was established.

6.3.3 Net-to-gross Ratio Calculation

The NTGR was calculated using the following equation:

$$NTGR = (1 - \% \text{ Free-ridership} + \% \text{ Participant Spillover})$$

Table 19 outlines the free-ridership and spillover levels established for Retrofit along with the NTGR values calculated for each project category.

Table 19: Evaluated 2021 Retrofit NTGRs

	Final Savings for Projects Started and Completed in 2021	Final Savings for Multiyear Projects (Regular)	Final Savings for Multiyear Projects (P4P)	Partial Savings
Free-ridership Level	16%	16%	0%	16%
Spillover Level	0%	0%	0%	0%
NTGR	0.84	0.84	1.00	0.84

6.3.4 Evaluated Net Savings

Net savings are defined as changes in energy use that are specifically attributable to Retrofit. Net Retrofit impacts are calculated by applying the NTGR value to gross savings as illustrated in the following equation:

$$\text{Net Savings} = \text{Revised Gross Savings} \times \text{NTGR}$$

The Evaluator applied a true-up adjustment to the net energy savings of multiyear projects completed in 2021 so that the total revised net savings over the complete duration of each project are equivalent to the total revised gross project savings multiplied by the NTGR for 2021. This approach is similar to the one described in Subsection 6.2.5 above.

In 2021, Retrofit generated 12.821 GWh in net energy savings and 2.724 MW in net peak demand savings at the generator. The results are listed in Table 20 below. The net lifetime energy savings were established at 154.589 GWh. The Evaluator did not determine an overall EUL because the mix of positive and negative savings with different EUL values for regular Retrofit multiyear projects resulted in an unrepresentative average EUL value.

Table 20: Evaluated 2021 Retrofit Net Energy and Peak Demand Savings

	Partial Savings	Final Savings for Projects Fully Claimed in 2021	Final Savings for Multiyear Projects (Regular)	Final Savings for Multiyear Projects (P4P)	Total
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	2.250	8.777	2.401	0.293	13.721
NTGR	0.841	0.841	0.841	1.000	0.844
Net Energy Savings Without True-up Adjustment	1.892	7.382	2.019	0.293	11.586
True-up Adjustment for Net Energy Savings (GWh)	-	-	0.017	0.470	0.488
Net Energy Savings – at the Meter (GWh)	1.892	7.382	2.037	0.763	12.074
Line Loss Factor	1.061	1.063	1.058	1.063	1.062
Net Energy Savings – at the Generator (GWh)	2.009	7.846	2.155	0.811	12.821
Effective Useful Life (years)	15.5	12.3	N/A*	6.6	-
Net Lifetime Energy Savings – at the Generator (GWh)	31.095	96.650	21.498	5.346	154.589
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.274	0.548	1.837	0.171	2.830
NTGR	0.841	0.841	0.841	1.000	0.851
Net Peak Demand Savings Without True-up Adjustment (MW)	0.231	0.461	1.545	0.171	2.407
True-up Adjustment for Net Peak Demand Savings (MW)	-	-	0	0.155	0.155
Net Peak Demand Savings – at the Meter (MW)	0.231	0.461	1.545	0.326	2.562
Line Loss Factor	1.069	1.068	1.060	1.070	1.063
Net Peak Demand Savings – at the Generator (MW)	0.246	0.492	1.637	0.349	2.724
* The Evaluator did not include the EUL for Regular Retrofit multiyear projects because the mix of positive and negative savings with different EUL values resulted in an unrepresentative average EUL value.					

As presented in Table 21, applying the Nova Scotia-specific factor¹⁷ for GHG emissions generated by electricity production, 0.5841 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 7,489 tonnes of annually avoided CO₂ eq.

Table 21: Evaluated 2021 Retrofit GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	12.821
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	7,489

6.4 Realization Rate

Table 22 below compares the total tracked and evaluated savings for Retrofit. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 107% for energy savings and 119% for peak demand savings.

Table 22: Comparison of 2021 Retrofit Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	14.680	GWh	0.82	12.038	GWh	107%
Evaluation Results	14.570	GWh	0.88	12.821	GWh	
Peak Demand Savings						
Tracked Savings by EOne	2.790	MW	0.82	2.288	MW	119%
Evaluation Results	3.007	MW	0.91	2.724	MW	
* The NTGRs listed in this table match the rounded averages obtained by dividing net savings by gross savings. They differ from the values presented in Subsection 6.3.3 above because of true-up adjustments and the different NTGRs applied to the two sample strata.						

¹⁷ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:
 Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),
 Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021
https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

2021 Retrofit Impact Evaluation Highlights

- › Retrofit gross energy savings at the generator were established at 14.570 GWh and total gross peak demand savings were established at 3.007 MW at the generator.
- › Retrofit gross lifetime energy savings were established at 179.288 GWh.
- › Retrofit achieved an overall free-ridership level of 16%.
- › Retrofit generated 12.821 GWh in net energy savings and 2.724 MW in net peak demand savings at the generator.
- › The net lifetime energy savings were established at 154.589 GWh.
- › The net energy savings resulted in 7,489 tonnes of annually avoided CO₂ eq.
- › The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 107% for energy savings and 119% for peak demand savings.

7 NEW CONSTRUCTION PROCESS EVALUATION

This section provides a summary of the key findings from the New Construction process evaluation.

The Evaluator collects information on the New Construction participant decision-making process only once a project is completed. The information collected at that time is used to determine free-ridership levels and covers how participants would have chosen to design their building in the absence of the service. Since New Construction projects can take several years to complete, questions about the decision-making process are asked, in some cases, several years after participants made their decisions.

Through this process evaluation, the Evaluator explored ways to collect information about the participant decision-making process and intentions more closely to when decisions are made.

7.1 New Construction Participation Process and Influences on Building Design

This section outlines the participation process for a typical New Construction project and sources of influence on participants' decisions to build better-than-code buildings.

Overview of the NC Participation Process

As listed in Table 23 below, there are four main stages in a typical project, namely the conceptual phase, design phase, construction phase, and building occupancy phase. Projects typically last between three and seven years. The table also details actions, by key actors, which can have an influence on building design. Except in certain rare cases, all major decisions that influence building energy consumption are finalized by the end of the design phase, which coincides with the participant signing the Custom Project Agreement (CPA). It should be noted that, in fewer than 10% of cases, the CPA is signed by participants at a later project stage such as during the construction or building occupancy stage.

Table 23: Typical New Construction Participation Process and Actions by Key Actors that Potentially Influence Building Design

Stage Number	Stage Name	Typical Duration	Milestones	Actions by Key Actors that Potentially Influence Building Design		
				NC Staff	BDMs	Energy Modeler
1	Conceptual	6 months to 3 years	› After contacting EOne and choosing an energy modeler, the participant finalizes design decisions and builds energy model.	› Provide guidance to energy modeler on service and modeling requirements. › Provide information on constructing better-than-code buildings.	› Interact with participants as early as possible, often before the start of the conceptual phase. › Guide participants through the NC participation process. › Provide information on constructing better-than-code buildings.	› Run simulations to help participants examine different design options, provide guidance, and estimate incentive amounts.
2	Design		› NC staff reviews the Energy Model Package submitted by the participant and requests modifications if necessary. › Participant typically signs the Custom Project Agreement (CPA), which confirms the total implementation incentive value, and receives the energy model incentive.	› Review model and suggest changes that could help the participant achieve greater savings and incentives.	› Interact with participants if they reach out directly to BDMs with questions.	› Occasionally, run additional simulations to refine energy model.
3	Construction	2 to 3 years	› Participant builds their new building. In rare cases, changes to design are made at this stage.	› N/A	› N/A	› N/A
4	Building Occupancy	3 to 6 months	› NC staff reviews the project to identify any changes in savings and pays the implementation incentive.	› N/A	› N/A	› N/A

EOne Influence on Building Design

According to NC staff, BDMs, and the modeling consultant, EOne is successful in encouraging participants to design buildings with greater energy efficiency than they would have in the absence of the service. More specifically, EOne influences participants' choice of equipment through education on the different available options provided mostly by BDMs at the beginning of a project and by energy modelers when they prepare the energy model for a client. Furthermore, the service encourages participants to choose the highest efficiency level since the implementation incentive is based on the energy savings (\$/kWh) generated. The service also influences the quantity of measures installed by participants by requiring participants to have at least two energy efficiency measures in their building.

Table 24 provides more detail about the different influence factors to which EOne contributes to improve the energy performance of participants' building design.

Table 24: EOne Influence Factors on Building Design

Influence Factors	Details
Incentive for implementation	› All respondents indicated that the implementation incentive is critical in participants' decision to design better-than-code buildings. › Since the incentive amount is based on energy savings (\$/kWh), participants are encouraged to achieve maximum efficiency.
Incentive for energy model	› To participate in the service, EOne requires participants to build an energy model and provides an incentive for this specific activity. › According to respondents, non-participants do not build energy models for new building projects, except when they participate in other new construction programs that require an energy model, which suggests that the service is influential in encouraging participants to build an energy model. › The energy model is key in encouraging participants to consider and compare different design options. › NC staff communicate frequently with energy modelers to clarify service requirements. Consequently, energy modelers are equipped to provide guidance to participants on how to achieve greater savings and incentive amounts. › Energy modelers also provide technical assistance to participants.
Technical assistance	› BDMs and NC staff provide technical assistance for projects. For example, they answer questions about efficient equipment with which participants are not familiar. › EOne also developed and distributes a list of efficient equipment models for measures such as heat pumps and lighting.
Non-technical assistance	› BDMs and NC staff provide non-technical assistance for projects by providing information about project non-energy-related benefits and challenges. For example, they answer questions about market trends, building certifications, operating costs, and tradespeople availability.
On-site Energy Managers (OEMs)	› OEMs are co-funded by EOne and work within organizations to save energy. While not specifically involved in NC projects, they have the ability to reach key actors responsible for new buildings in their organizations and facilitate discussions where multiple decision-makers are involved.
Promotion of energy efficiency and capacity building in Nova Scotia	› EOne promotes energy efficiency in new buildings and improves knowledge in the market through several activities such as distributing monthly newsletters, providing eQuest training, providing a "How to sell energy" training, and conducting outreach activities with engineers and design centers in Nova Scotia.

Other Influence Factors on Building Design

In addition to the influence factors to which EOne contributes, other aspects motivate participants to build a better-than code building. For example, government buildings in Nova Scotia are required to reach a Leadership in Energy and Environmental Design (LEED) certification. Similarly, some organizations have internal policies that set energy efficiency targets for their buildings. Furthermore, participants consider the long-term costs of energy use and carbon pricing, which motivates them to build energy efficient buildings.

For developers of multi-residential buildings specifically, several market trends are encouraging them to build more efficient buildings. For example, if energy costs are included in rent, developers are incentivized to build efficient buildings. On the other hand, if energy costs are not included, designing an efficient building allows them to advertise to potential tenants that energy bills will be low. Other market trends and pressures such as the need for air conditioning and reducing operating costs to remain competitive also encourage developers to adopt energy efficient practices.

Summary

The data-collection activities allowed the Evaluator to confirm that NC projects can take up to seven years to finalize, yet major decisions related to energy use as well as EOne influences on design occur by the end of the conceptual phase (3 years into a project at the most). EOne succeeds in influencing building design through the many influence factors described during interviews, such as the energy model, implementation incentives, as well as technical assistance provided by the energy modeler, BDMS, and NC staff. The interviews revealed that the service has an influence on energy modelers and that energy models are an important tool that encourages participants to consider and compare different design options. Still, it should be noted that other factors influence building design, such as participating organizations' internal energy efficiency policies as well as market demand for energy efficient buildings.

7.2 Developing a New Data-collection Approach

Based on the insights presented in the previous section about the participant decision-making process and how EOne influences building design, the Evaluator developed a new approach to obtain the most reliable and accurate free-ridership assessment.

Timing

The Evaluator asked surveyed New Construction staff, BDMS, and the modelling consultant about the most appropriate time to interview participants about their decision-making process. All parties agreed that interviewing participants once they had signed the CPA was ideal. As discussed above, participants make all decisions related to energy use at that point in the project, and design changes rarely occur in subsequent phases. Furthermore, since the construction stage can be very long, surveying participants directly after they sign the CPA allows them to answer questions about their decision more closely to when those decisions are made.

According to the best practices described in the literature, free-ridership assessments should be conducted soon after project completion so it is easier for participants to remember their intention in the absence of the service and how the latter influenced their decision-making process. While a project is not technically complete once a participant signs the CPA, the Evaluator considered assessing free-ridership at that time follows the spirit of the rapid feedback surveys recommended in the literature since all key decisions on projects are already made and changes to design rarely occur. Considering that and the duration of the construction phase (two to three years), the Evaluator did not consider it relevant to survey participants again once the building construction was completed.

As mentioned previously, it should be noted that in fewer than 10% of cases the CPA is signed by participants at a later project stage such as during the construction or building occupancy stage. For these participants, the Evaluator maintains the recommendation that they be interviewed once they have signed the CPA to guarantee that the project will eventually be claimed under New Construction as well as to ensure that the respondent is aware of the incentive value they will be receiving.

Frequency

Jurisdictions that adopt a rapid feedback approach generally survey participants between one and three months following project completion. The Evaluator therefore suggested that EOne identify, at the end of every quarter, participants who have signed a CPA and who should be interviewed.

Proposed Questionnaire and Free-ridership Algorithm

The Evaluator developed a questionnaire and free-ridership algorithm to obtain early feedback on participant free-ridership levels. The questionnaire and algorithm, which are presented in Appendix XIII, were developed following industry best practices, meaning that questions served to:

- › Identify key decision-makers and survey multiple decision-makers
- › Address the intention of the participant in the absence of the service through questions that capture plans for designing a better-than-code building before becoming aware of the service, financial considerations, and energy efficiency levels as well as quantity measures implemented in the absence of the service
- › Quantify service influence on the decision to design a better-than-code building through the various factors identified above in Table 24 as EOne influence factors
- › Use multiple questions with a mix of open-ended and multiple-choice questions
- › Test for inconsistencies in the answers provided by respondents

Respondents

New Construction staff and BDMs indicated that the individual who signed the CPA should be interviewed for the free-ridership assessment because they are usually one of the key decision-makers. The Evaluator also proposed a multisource approach so that all key decision-makers are interviewed. The Evaluator did not recommend interviewing energy modellers and OEMs to assess the free-ridership level since they do not ultimately make the decision to design a better-than-code building. However, their influence is captured in the proposed algorithm.

Mode

Considering the importance of identifying the key decision-makers and complexity of the questionnaire, the Evaluator recommended that the questionnaire be administered via phone interviews. The Evaluator considered other options such as administering a web survey or including a questionnaire in the CPA paperwork, both of which were rejected. These options are more cost-effective but would not allow respondents to express themselves at length or immediately clarify any inconsistencies. It would also be difficult to identify all key decision-makers that should be surveyed. The CPA questionnaire option was also dismissed out of concern that it could introduce a bias in answers since participants could think that the CPA is conditional on them providing correct answers. For such reasons and to ensure a neutral measurement of free-ridership, the Evaluator proposed that an independent third party, such as the Evaluator or a market research firm, conduct the interviews.

Risks and Mitigation Strategies

The Evaluator identified the following risks with the proposed approach and mitigation strategies:

- › **Risk:** Participants could be worried that their answers affect the implementation incentive amount obtained at the end of the project or that they could affect incentive amounts for future projects, leading to dishonest answers.
 - **Mitigation strategy:** The Evaluator recommended that the interview be conducted by a third party. The interview introduction clearly states that answers will remain confidential and will in no way influence incentive amounts for that or a future project.
- › **Risk:** EOne influence on new building projects sometimes begins years before a project is started, especially for repeat participants, which makes it difficult to adequately capture free-ridership.
 - **Mitigation strategy:** The Evaluator included cross-influence questions in the algorithm to capture the influence of past participation in New Construction and other EOne program components.
- › **Risk:** For some unanticipated reason, this proposed approach to assess free-ridership at an earlier stage is not successful.
 - **Mitigation strategy:** The Evaluator suggested that the approach be tested with five participants who signed a CPA in Q3 or Q4 of 2021. The Evaluator would then reassess if this strategy is sound based on the quality of the responses obtained, response rate, and effort required by New Construction staff.

Summary and Plan for Testing the Data-collection Approach

The Evaluator found that obtaining feedback from participants once they sign the CPA to obtain a more accurate free-ridership assessment is appropriate. The Evaluator developed a new phone interview questionnaire and recommended that it be adopted for all New Construction free-ridership assessments going forward. However, the timing differed for participants who had already signed their CPA before the new approach was developed. For clarity, the following summarizes the approaches that were used in 2021 and will be used going forward.

- › **For participants who signed their CPA before Q3 of 2021:** The Evaluator conducted a phone interview after project completion using the new questionnaire.
- › **For five participants who signed their CPA during Q3 of 2021:** The Evaluator conducted a phone interview to test the new questionnaire.
- › **For other participants who will sign their CPA in Q4 of 2021 or later:** A third party will conduct a phone interview as soon as possible after receiving the list of participants who recently signed the CPA at the end of each quarter.

7.3 Key Findings and Recommended Approach for Future Data Collection

The Evaluator tested the new approach during the fall of 2021 with five projects in which participants had recently signed the CPA. The Evaluator had planned to interview participants who had signed their CPA during Q3, but due to the low number of participants, participants who had signed their CPA during Q2 were also included in the sample.

This subsection outlines the key findings gleaned from this testing period and the resulting recommended approach for future data collection soon after participants sign the CPA.

Overall, the new methodology and data-collection instruments are effective. The questions are well understood by respondents and allow the Evaluator to collect the necessary information to assess free-ridership and identify the right contacts. The chosen mode (phone interviews) and timing of the data collection (up to three months after signing the CPA) were found to be appropriate.

Reaching builders for phone interviews has historically been challenging due to their busy schedules. Although EOne and the Evaluator were hopeful that interviewing them at the CPA stage would facilitate this process as builders tend to be less busy than at the project completion stage, the Evaluator found that it was still very challenging to reach them. In several cases, it took over five attempts via a combination of phone calls and emails to do so. For one project, the Evaluator was unable to reach the builder and thus could not complete the necessary interview.

Asking questions to identify other key decision makers is appropriate for all types of New Construction projects. The Evaluator identified that other decision makers were involved in three of the four projects where participants were successfully reached.¹⁸ The Evaluator found no correlation between the size of projects and the number of key decision makers. For example, among the five sampled projects, the one with the lowest amount of energy savings had two decision makers, whereas another much larger project had only one.

Therefore, the Evaluator recommends adopting an approach whereby participants are interviewed shortly after having signed the CPA.

- › To do so, EOne could identify, at the end of every quarter, participants who have signed the CPA and ask a third party to interview them. The third party should safeguard the answers until the project closes and transfer them directly to the Evaluator to maintain the confidentiality of responses.
- › To increase the likelihood that the third party conducting the interviews will be able to reach the key project decision makers, EOne should provide a second contact, if available, from within the participant's organization from the start.
- › A reasonable effort should be invested in contacting the provided contacts via phone interviews. If unsuccessful, the third party should send a web survey to the contacts who have not been interviewed by phone. Although phone interviews are the preferred mode for this data-collection activity, the potential drawbacks related to the web survey, such as a lack of opportunity to clarify answers and potential difficulties related to obtaining the right contacts, are acceptable if they still allow the Evaluator to obtain higher response rates.
- › If the provided contacts remain unreachable through the phone interview and the web survey, the free-ridership questionnaire should be administered once the project is completed at the time of evaluation.

2021 New Construction Process Evaluation Highlights

- › The evaluation served to confirm that EOne succeeds in influencing building design through many avenues such as the mandatory energy model, implementation incentives, as well as technical assistance provided by EOne staff.
- › New Construction projects can take several years to complete although the Evaluator collects information on the participant decision-making process only once a project is completed. Since major decisions related to energy use occur by the end of the project design phase, which coincides with participants signing the CPA, the Evaluator recommends collecting feedback from participants once they sign the CPA to obtain a more accurate free-ridership assessment.
- › The Evaluator developed a new phone interview questionnaire and, following a testing period with five participants, found that it was effective. The Evaluator therefore recommends that it be adopted for all New Construction free-ridership assessments going forward.
- › The Evaluator also found that asking questions to identify other key decision-makers is appropriate for all types of New Construction projects since no correlation between the size of projects and the number of key decision-makers was found.

¹⁸ It should be noted that a multisource approach was only successful for one of the three projects. For one project, the respondent refused to provide the contact information for the second decision maker since they assumed that their responses would be identical. For the other project, the Evaluator was unable to reach the second decision maker.

8 NEW CONSTRUCTION PARTICIPANT PERSPECTIVES

As part of the New Construction evaluation, 11 interviewed decision-makers, corresponding to nine projects, were asked questions regarding their awareness, motivations for participating, satisfaction with and concerns about New Construction, and recommendations for service improvements. The one interview completed during the summer as part of the process evaluation did not include questions on participant perspectives.

Awareness and Participation

Eight out of 11 participants have been familiar with EOne for a long time and came to learn about New Construction via this avenue. Among them, four noted that they either have a designated EOne representative or some other form of ongoing relationship with EOne, which led to their becoming aware of New Construction. As for the other participants who more recently learned about New Construction, one participant indicated that they learned about New Construction by reaching out to EOne themselves, although they already had some idea that an available service would meet their needs while another participant learned of New Construction through word of mouth.

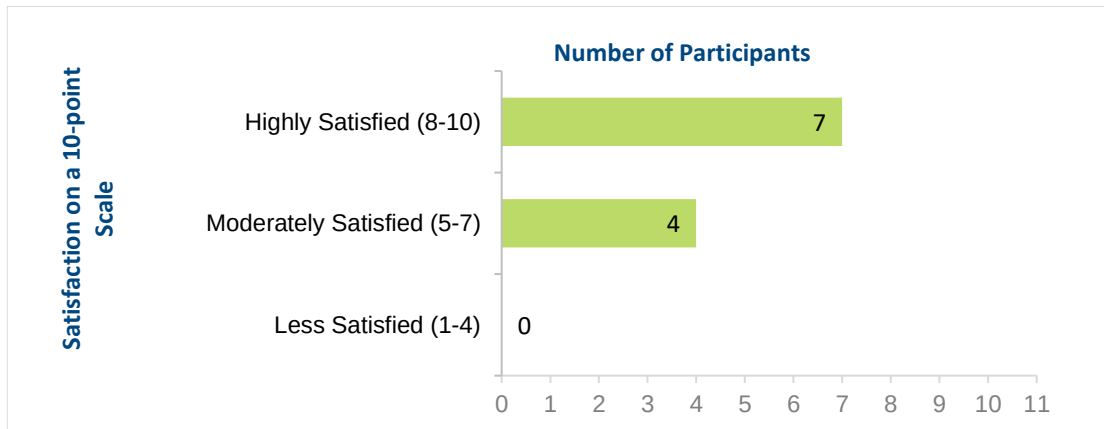
The incentive played a role in the decision of nine out of 11 participants to take part in New Construction given the high cost of energy efficiency measures. Nine of 11 participants also cited their aspirations to build a more energy efficient building than the code requires, and three of 11 noted the anticipated long lifetime of new buildings as a reason to participate in New Construction.

Only two participants faced challenges or barriers related to New Construction during the planning and construction of their building. One participant raised concerns with new and somewhat untested technology, causing hesitancy among some decision-makers to move forward with an energy efficient option. Another participant noted their frustration with changes in the efficiency requirements for New Construction often occurring more quickly than the time it takes to evaluate a new energy system, such that by the time a contractor has chosen a system and applied for the service, the system may no longer be approved under New Construction.

Satisfaction

Overall satisfaction with New Construction is high among participants who provided an average rating of 8.0 on a 10-point scale (with 1 indicating “Not at all satisfied” and 10 indicating “Completely satisfied”). Participants appreciated the overall ease of the participation process and of working with EOne staff. Other participants mentioned that New Construction lived up to expectations and they were pleased that it includes multi-unit residential buildings (MURBs). The slightly less satisfied participants mentioned they would have liked to see an incentive that matches initial expectations for how much builders will receive upon project completion and one that keeps pace with the ever-increasing costs of constructing new buildings. One participant also mentioned that they would like a guarantee that the programming in place at the time of initial approval will persist until the building is completed.

Figure 12: 2021 Participant Satisfaction with New Construction (10-point Scale)



Six out of 11 participants offered suggestions for how to improve New Construction. A variety of different suggestions were made, including proposed increases to the incentive amounts and increased communication with and site visits from EOne.

2021 New Construction Participant Perspective Highlights

- › Awareness about New Construction arises primarily through an established relationship with EOne.
- › Cost savings and a desire to be energy efficient followed by a belief in the importance of investing in building stock for long-term use are the top reasons for partaking in New Construction.
- › Overall satisfaction with New Construction is high with an average of 8.0 on a 10-point scale.

9 NEW CONSTRUCTION IMPACT EVALUATION

The objective of the 2021 New Construction impact evaluation was to determine gross and net electrical energy and peak demand savings. Unlike Retrofit, New Construction currently claims only one type of savings, i.e. final savings.

9.1 Tracking Sheet Audit

To ensure service results are reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix I. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

9.2 Gross Savings

This subsection describes the methodology used by the Evaluator to review the gross savings of New Construction projects.

For New Construction, gross savings are calculated based on energy models developed with building energy simulation software for each new building. The savings consist of the difference in the modelled electricity consumption between the baseline case and the proposed case. The baseline case corresponds to the reference building as defined in the National Energy Code for Buildings (NECB) Part 8 and the guidelines developed by EOne. The proposed case refers to the final building design, which includes the energy efficiency measures that reduce electricity consumption.

The gross savings evaluation approach for New Construction is based on an energy model review.

9.2.1 Sampling Methodology

For the energy model review, the Evaluator selected a sample of 12 projects from a total of 21 projects completed in 2021. The project sample represented 91% of total tracked energy savings for projects completed in 2021.

The Evaluator followed industry best practices as described by the Uniform Methods Project¹⁹ and designed a random sample so that the probability of a project being selected was approximately proportional to its size. The resulting random sample represents a variety of project types and includes all major projects (more than or equal to 250,000 kWh in savings) and a selection of smaller projects (less than 250,000 kWh in savings).

¹⁹ NREL, *The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures, Chapter 11: Sample Design Cross-Cutting Protocol*, September 2017, pp. 60-61.

9.2.2 Project Review Findings

The 12 project reviews were aimed at validating the energy models developed for the reference and proposed cases of each project and the resulting savings. The Evaluator based its review mainly on the project file documents provided by EOne. The pictures, mechanical plans, specification sheets, and other documents available in the project files included enough details to confirm measure installations and validate the input data of the energy models. In addition, the Evaluator managed to reach seven participants to collect or validate technical information such as operating schedules. It should be mentioned that the most common simulation software remains eQuest, although two selected 2021 projects were modelled in different simulation software, namely HAP and IES.

The main finding of the project reviews is the significant improvement in the information available in project files. Unlike previous years, project files were complete and well documented with photos, EOne site visit results, explanatory notes, etc. This is why only phone calls had to be made to complete the energy model review for 2021. The Program Guide requirements were also better followed.

The following summarizes the adjustments to energy and peak demand savings resulting from the project reviews.

Energy Savings

Positive or negative adjustments were made to the tracked gross energy savings of the 12 projects reviewed by the Evaluator for 2021, with some of the adjustments being minor.

One large project was reviewed separately due to a baseline exemption that was discussed prior to project approval. Indeed, this project was intended to install water loop heat pumps with natural gas boilers. Considering the difficult interpretation of the NECB for water loop heat pump baselines and the absence of specific requirements for this scenario in the Program Guide at the time of project approval, the Evaluator and EOne agreed on this baseline exemption. The review of this project resulted in an adjustment ratio of 0.650 on gross energy savings, mainly related to a change in the modelling method for water loop heat pumps and the ratio in energy consumption between the baseline and the proposed case.

For the 11 other projects, the energy model reviews resulted in an average adjustment ratio of 0.884 for gross energy savings with a margin of error of 10.1%.

- › The negative adjustments that had major impacts on energy savings are related to operating schedules. In three cases, the modeled operating schedules were adjusted to match the current operation schedules of the buildings.
- › Other recurrent adjustments, negative or positive, were made to match the energy models with project technical data. Several corrections were made on coefficient of performance (COP) values and envelope characteristics.

- › For one project, an adjustment had to be made to comply with a Program Guide requirement. Due to the COVID-19 pandemic, New Construction program staff had more difficulties conducting on-site visits and, consequently, ensuring the energy models were consistent with the as-built mechanical systems as per the Service Guide.
- › For one arena project, changes were made to the baseline energy model to better reflect the NECB requirement that only includes heat recovery for domestic hot water or space heating. These changes resulted in an upward adjustment. For future arena projects, the Evaluator recommends that EOne adjust the baseline on a case-by-case basis considering that heat recovery on space heating systems is more and more common for new arenas. In its commercial program, Hydro-Quebec²⁰ uses a baseline for new arenas that includes heat recovery on the heating system.

It should also be mentioned that one of the reviewed projects started in New Construction in 2017 when old service rules applied. At that time, a participant-specific baseline corresponding to “what you would have done without the service” was established for each project and fuel switching was allowed. Therefore, for this project, the Evaluator did not revise the baseline and only reviewed technical data. The energy savings resulting from fuel switching for this project were approximately 700,000 kWh.

Peak Demand Savings

To establish evaluated peak demand savings, the Evaluator averaged the monthly peak demand reductions calculated in the revised energy models for the months of December, January, and February. The differences between tracked peak demand savings and evaluation results are mainly due to the adjustments made to the energy models for energy savings calculations and minor adjustments directly related to the peak demand savings calculation, namely removing lighting energy savings from total peak demand savings.

As a result, the average adjustment ratio for gross peak demand savings was of 0.954 with a margin of error of 14.8%. As mentioned above, this result is mainly explained by the changes made to the energy models for energy savings. Since the changes made thereto do not have the same impact on energy and peak demand savings, the average adjustment percentage is higher for peak demand savings than for energy savings.

For the large project reviewed separately, the adjustment ratio was of 0.551.

9.2.3 Energy Interactive Effects

Since New Construction savings are based on the results of simulation models that comprise the total electricity consumption of both proposed and reference buildings, interactive effects are already included. No further interactive effects factor was thus applied to savings.

²⁰ <https://www.hydroquebec.com/data/affaires/pdf/aff-4656Guide-documents-techniques-arena-curling-fr.pdf>.

9.2.4 Effective Useful Life

The Evaluator reviewed the EUL values of each project in the sample by calculating a weighted average EUL value based on measure-specific EULs and their associated annual energy savings.

The revised measure-level EULs were selected based on the values outlined in the 2020-2022 Measure Assessment and the measure category identified in the tracking sheet.

All projects had their EUL values adjusted upward.

- › Adjustments were made to a few EUL values that did not correspond to the EUL value defined for the given measure category.
- › Two measures identified as industrial processes were modified to refrigeration or another measure category, which both have an EUL value of 15 years.
- › For one project, the repartition of energy savings per measure was not listed in the tracking sheet. As this project was part of the sample, the Evaluator was able to retrieve the repartition and update the EUL.

9.2.5 Evaluated Gross Savings

The 2021 gross energy and peak demand savings calculated for New Construction are presented in Table 25 below. They were obtained by applying the average adjustment ratios of 0.884 on energy savings and 0.954 on peak demand savings for all projects completed in 2021, except the large one treated separately (with adjustments of 0.650 and 0.551 on energy and peak demand savings respectively). The resulting overall adjustments presented in Table 25 are 0.839 for energy savings and of 0.898 for peak demand savings.

To obtain savings at the generator, the line loss factor was applied specifically for each project based on the rate code and corresponding line loss factor provided by NS Power.

New Construction achieved gross electrical energy savings of 11.218 GWh at the generator and gross peak demand savings of 3.394 MW at the generator. Lifetime energy savings were calculated at 210.000 GWh and the weighted average EUL value for gross energy savings was 18.7 years.

Table 25: Evaluated 2021 New Construction Gross Energy and Peak Demand Savings

	Final Savings for Projects Fully Claimed in 2021
Number of Projects	21
Energy Savings	
Tracked Gross Energy Savings – at the Meter (GWh)	12.529
Adjustment Ratio for Energy Savings	0.839
Gross Energy Savings – at the Meter (GWh)	10.514
Line Loss Factor	1.067
Gross Energy Savings – at the Generator (GWh)	11.218
Effective Useful Life (years)	18.7
Gross Lifetime Energy Savings – at the Generator (GWh)	210.000
Peak Demand Savings	
Tracked Gross Peak Demand Savings – at the Meter (MW)	3.520
Adjustment Ratio for Peak Demand Savings	0.898
Gross Peak Demand Savings – at the Meter (MW)	3.161
Line Loss Factor	1.074
Gross Peak Demand Savings – at the Generator (MW)	3.394

9.3 Net Savings

The NTGR serves to determine net savings, i.e. the savings that can be reliably attributed to a service. For New Construction, the NTGR was established by considering free-ridership. Spillover was considered nil and was not measured as part of this evaluation.

9.3.1 Free-ridership

In the case of New Construction, free-ridership occurs when participants would have still implemented energy efficiency measures in their new building in the absence of the service. The free-ridership level was assessed using a self-report approach that involved asking decision makers a set of questions during phone interviews. The questionnaire included questions for all applicable variables in the decision-making process, including planning, efficiency, and cost.

For the 2021 evaluation, the Evaluator used the new free-ridership questionnaire developed as part of the process evaluation because it better captures all influence factors that can have an impact on building design decisions, such as the energy model, modelling, and implementation incentives as well as on technical assistance provided by the energy modeller, BDMs, and New Construction staff. Other factors such as participating organizations' internal energy efficiency policies as well as market demand for energy efficient buildings were also factored into the calculation.

Certain questions were also added in 2021 to determine the extent to which participant decisions to have products installed had been influenced by previous participation in an EOne program component or EOne efforts to raise awareness about energy efficiency. When participant answers indicated that they had been significantly influenced by one of these two factors, the free-ridership level was adjusted downward to better capture the overall influence of EOne activities on participant decisions.

Finally, a multisource approach was incorporated for all 2021 New Construction projects in the sample.

The algorithm used to calculate the overall free-ridership level is presented in Appendix XIII.

The Evaluator attempted to measure free-ridership for the 12 sampled projects in the project review. One of the interviews was completed in the summer of 2021 as part of the process evaluation. In total, 12 decision-makers associated with 10 projects were interviewed. The Evaluator was not able to reach two participants.

The weighted average free-ridership level was measured at 15% with a margin of error of 5.4%. It was 30% in 2020.

The new questionnaire and algorithm developed as part of this evaluation allowed the Evaluator to capture the different levels of EOne influence such as the mandatory energy model, implementation incentive, as well as technical assistance. The results confirmed that the energy model and implementation incentive had a significant influence in the decision-making process as did the fact that several participants considered the implementation incentive they could receive from EOne when they decided to build a better-than-code building.

It should be noted that with only two additional respondents interviewed, the multisource approach had limited success and did not have a significant impact on free-ridership results.

It should be noted that no significant difference was observed in the average free-ridership levels weighted with the energy savings versus peak demand savings. Therefore, the 15% free-ridership level was applied to both total gross energy and peak demand savings.

9.3.2 NTGR Calculation

The NTGR is calculated using the following equation:

$$NTGR = (1 - \% \text{ Free-ridership})$$

Table 26 outlines the free-ridership levels established for New Construction along with the NTGR values calculated for both the project excluded from the average free-ridership level calculation and all other projects.

Table 26: Evaluated 2021 New Construction NTGRs

	All Other Projects Fully Claimed in 2021
Free-ridership Level	15 %
Participant Spillover Level	0 %
NTGR	0.85

9.4 Evaluated Net Savings

For New Construction, total net electrical energy and peak demand savings amounted to 9.535 GWh and 2.885 MW respectively at the generator.

Net lifetime energy savings were established at 178.500 GWh, which yields a weighted average EUL of 18.7 years based on net savings. Detailed results are presented in Table 27.

Table 27: Evaluated 2021 New Construction Net Energy and Peak Demand Savings

	Final Savings for Projects Fully Claimed in 2021
Number of Projects	21
Energy Savings	
Gross Energy Savings – at the Meter (GWh)	10.514
NTGR	0.85
Net Energy Savings – at the Meter (GWh)	8.937
Line Loss Factor	1.067
Net Energy Savings – at the Generator (GWh)	9.535
Effective Useful Life (years)	18.7
Net Lifetime Energy Savings – at the Generator (GWh)	178.500
Peak Demand Savings	
Gross Peak Demand Savings – at the Meter (MW)	3.161
NTGR	0.850
Net Peak Demand Savings – at the Meter (MW)	2.687
Line Loss Factor	1.074
Net Peak Demand Savings – at the Generator (MW)	2.885

As presented in Table 28, applying the Nova Scotia-specific factor²¹ for GHG emissions generated by electricity production, 0.5841 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 5,569 tonnes of annually avoided CO₂ eq.

Table 28: Evaluated 2021 New Construction GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	9.535
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	5,569

9.5 Realization Rate

Table 29 below compares the total tracked and evaluated savings for New Construction. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 102% for energy savings and 109% for peak demand savings.

Table 29: Comparison of 2021 New Construction Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	13.364	GWh	0.70	9.355	GWh	102%
Evaluation Results	11.217	GWh	0.85	9.535	GWh	
Peak Demand Savings						
Tracked Savings by EOne	3.779	MW	0.70	2.645	MW	109%
Evaluation Results	3.394	MW	0.85	2.885	MW	

While the evaluated gross energy savings were lower than those tracked by EOne because of adjustments made to the energy models resulting in an overall downward adjustment to gross savings, the realization rates were above 100%. This was due to the reduced free-ridership level measured for this evaluation (15% compared to 30% in 2020), which compensated for the reduced gross energy and peak demand savings.

²¹ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:
Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),
Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021
https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

2021 New Construction Impact Evaluation Highlights

- › New Construction achieved 9.535 GWh in net electrical energy savings and 2.885 MW in net peak demand savings at the generator in 2021.
- › Project reviews resulted in overall adjustment ratios of 0.839 for energy savings and 0.898 for peak demand savings.
- › Evaluated net energy savings and peak demand savings were above the values tracked by EOne because of the higher NTGR.

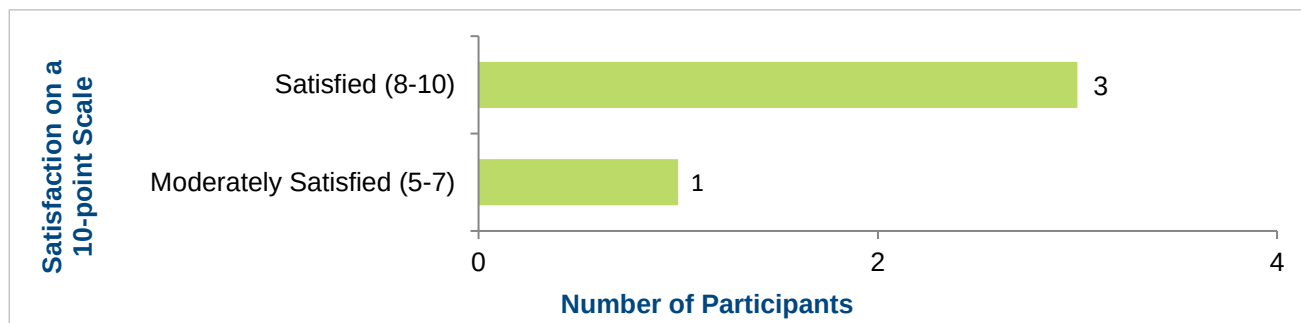
10 BUILDING OPTIMIZATION PARTICIPANT PERSPECTIVES

As part of the Building Optimization project file reviews and follow-up interviews with participants, respondents commented on their experience and satisfaction with the service. All six projects completed in 2021 were reviewed. Four unique respondents were interviewed covering five projects; one respondent represented two projects, and one project key decision-maker was no longer employed by the organization so no interview was completed.

Overall satisfaction with Building Optimization was high among respondents who provided an average rating of 8.5 on a 10-point scale (with a score of 1 indicating “Not at all satisfied” and of 10 indicating “Completely satisfied”). A breakdown of the ratings provided by the respondents is presented in Figure 13 below. While the one less satisfied participant experienced delays during the incentive approval process, the three participants who expressed high satisfaction reported the following reasons for being satisfied:

- › Applying to the service was easy and the overall participation was smooth (3 mentions).
- › The service helps to find great optimization opportunities (1 mention).

Figure 13: 2021 Participant Satisfaction with Building Optimization (10-point Scale)



Other than the approval delays mentioned above, one respondent mentioned having difficulties in getting buy-in from the users of the space with the measures implemented through the Building Optimization project.

Three of the four interviewed participants provided recommendations on how to improve Building Optimization. Two respondents would have liked to see shorter processing times for the application and rebate approvals, while one respondent suggested increasing service awareness among contractors.

2021 Building Optimization Participant Perspective Highlights

- › Overall satisfaction with Building Optimization was high among interviewed participants who provided an average rating of 8.5 on a 10-point scale.
- › Most respondents did not face challenges in their participation in Building Optimization.
- › Reducing processing times for application and incentive approvals is the area of improvement that stands out among respondents.

11 BUILDING OPTIMIZATION IMPACT EVALUATION

The objective of the 2021 Building Optimization impact evaluation was to determine gross and net electrical energy and peak demand savings, annually avoided GHG emissions, as well as EUL and associated lifetime energy savings. In 2021, all six projects were started and completed with final savings claimed.

11.1 Tracking Sheet Audit

To ensure service results were reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix I. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

11.2 Gross Savings

Gross savings correspond to changes in energy consumption resulting from actions taken by Building Optimization participants regardless of why they participated. This subsection describes the review methodology used for all Building Optimization projects and the adjustments made to specific projects.

The Evaluator calculated gross savings for Building Optimization projects for each individual file in accordance with best practices for measurement and verification in commercial and industrial energy efficiency projects using the information and data made available by applicants and EOne as well as by supplementing the data with engineering assumptions and judgement where necessary.

11.2.1 Project Review Findings

As a result of the Evaluator review, adjustments were made to the savings of one of the six projects in the service.

For that project, the Evaluator identified an error in the electrical heating efficiency value in the energy consumption calculations. An efficiency of 80% had been used, which caused the energy savings to be overestimated. The Evaluator corrected the heating efficiency to 100% and made a downward adjustment to the energy savings.

This adjustment resulted in an adjustment ratio of 0.934 for energy savings. None of the Building Optimization projects had any peak demand savings claimed and no revisions were made to the peak demand savings.

11.2.2 Interactive Effects

Since interactive effects vary significantly from one Building Optimization project to another, they are either taken into account in the project engineering calculations used to establish gross savings or included when using whole building consumption data. For all six projects, the measures implemented did not cause interactive effects. Therefore, no other adjustment was made to the gross savings of reviewed projects.

11.2.3 Effective Useful Life

The Evaluator validated the EUL values based on the 2020-2022 Measure Assessment. The EUL values are used in the calculation of electrical energy savings that are expected to persist over time.

The Evaluator revised the EUL value for one project for which EOne applied an EUL value of five years. The Evaluator applied a three-year EUL value for the implementation of modified scheduling control parameters of the central building automation system (BAS).

11.2.4 Evaluated Gross Savings

The annual gross savings at the generator are presented in Table 30 below. Overall, the annual gross energy savings at the generator amounted to 0.491 GWh, which represents 1.472 GWh in lifetime energy savings. There were no peak demand savings for Building Optimization.

The gross savings at the generator were estimated by using an average line loss factor of 1.063 between the meter and the generator for energy savings. This value was established by calculating weighted average line loss factors for Building Optimization participants according to their rate codes. The line loss factors correspond to the values submitted to the Utility and Review Board (UARB) as part of the 2014 Cost of Service Study Progress Update.²²

²² Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 30: Evaluated 2021 Building Optimization Gross Energy and Peak Demand Savings

	Final Savings for Projects Started and Completed in 2021
Number of Projects	6
Energy Savings	
Tracked Gross Energy Savings – at the Meter (GWh)	0.494
Adjustment Ratio for Energy Savings	0.934
Gross Energy Savings Without True-up Adjustment (GWh)	0.462
True-up Adjustment for Gross Energy Savings (GWh)	-
Gross Energy Savings – at the Meter (GWh)	0.462
Line Loss Factor	1.063
Gross Energy Savings – at the Generator (GWh)	0.491
Effective Useful Life (years)	3.0
Gross Lifetime Energy Savings – at the Generator (GWh)	1.472
Peak Demand Savings	
Tracked Gross Peak Demand Savings – at the Meter (MW)	0
Adjustment Ratio for Peak Demand Savings	-
Gross Peak Demand Savings Without True-up Adjustment (MW)	0
True-up Adjustment for Gross Peak Demand Savings (MW)	-
Gross Peak Demand Savings – at the Meter (MW)	0
Line Loss Factor	-
Gross Peak Demand Savings – at the Generator (MW)	0

11.3 Net Savings

The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a service, by estimating the net-to-gross ratio (NTGR). For Building Optimization, free-ridership and spillover are considered in the NTGR.

11.3.1 Free-ridership

Free-ridership occurs when participants would have implemented energy efficiency upgrades and measures in the absence of a service. The free-ridership level assessment was based on a self-report approach that involved asking participants a set of questions during a phone interview. The questionnaire included questions about all applicable variables related to the decision-making process, including planning, efficiency, timing, and cost.

The feedback collected from the participant interviews was converted into an overall free-ridership level using the algorithm presented in Appendix XI.

Following the interviews with four unique respondents, the weighted average free-ridership level for 2021 was established at 9% for energy savings, with a margin of error of 7.2%. Notably, due to the low number of participants, the weighted average free-ridership levels were very dependent on the free-ridership level of participants who achieved high energy savings.

All respondents indicated that the service was highly influential in their decision to implement their recommissioning projects the way they did. More specifically, three quarters of respondents mentioned that the guidance and technical assistance provided by their EOne on-site energy manager or other EOne staff were key factors in shaping their decision making. Additionally, all respondents reported being significantly influenced by the incentive for the implementation of energy efficient measures, with three quarters indicating that without the incentive they would have either delayed the project by at least one year or not implemented it at all.

11.3.2 Participant Spillover

Since the Evaluator opted to measure free-ridership for Building Optimization in 2021, the participant phone interviews were leveraged to measure spillover as well.

For Building Optimization, participant spillover occurs when participants implement eligible energy efficiency measures due to influence from previously participating in the service without receiving any kind of additional support. The Evaluator used phone interviews to question participants directly about any potential spillover effects. The algorithm used to determine the level of participant spillover is presented in Appendix XII.

No respondents reported having implemented additional electrical energy savings measures other than those implemented through the service. Therefore, spillover for Building Optimization in 2021 was nil.

11.3.3 Net-to-gross Ratio Calculation

The NTGR was calculated using the following equation:

$$NTGR = (1 - \% \text{ Free-ridership} + \% \text{ Participant Spillover})$$

Table 31 outlines the free-ridership and spillover levels established for Building Optimization along with the NTGR value.

Table 31: Evaluated 2021 Building Optimization NTGR

	Projects Fully Claimed in 2021
	Energy Savings
Free-ridership Level	9%
Participant Spillover Level	0%
NTGR	0.91

11.3.4 Evaluated Net Savings

Net savings represent the savings that can be reliably attributed to a service. For Building Optimization, net savings are calculated by applying the NTGR value in the following equation:

$$\text{Net Savings} = \text{Gross Savings} \times \text{NTGR}$$

As outlined in Table 32 below, the 2021 net energy savings for Building Optimization were estimated at 0.444 GWh at the generator, which represents 1.332 GWh in lifetime net energy savings and yields a weighted average EUL of 3.0 years.

Table 32: Evaluated 2021 Building Optimization Net Energy and Peak Demand Savings

	Final Savings for Projects Fully Claimed in 2021
Energy Savings	
Gross Energy Savings – at the Meter (GWh)	0.462
NTGR	0.905
Net Energy Savings Without True-up Adjustment	0.418
True-up Adjustment for Net Energy Savings (GWh)	-
Net Energy Savings – at the Meter (GWh)	0.418
Line Loss Factor	1.063
Net Energy Savings – at the Generator (GWh)	0.444
Effective Useful Life (years)	3.0
Net Lifetime Energy Savings – at the Generator (GWh)	1.332
Peak Demand Savings	
Gross Peak Demand Savings – at the Meter (MW)	0
NTGR	-
Net Peak Demand Savings Without True-up Adjustment (MW)	0
True-up Adjustment for Net Peak Demand Savings (MW)	-
Net Peak Demand Savings – at the Meter (MW)	0
Line Loss Factor	-
Net Peak Demand Savings – at the Generator (MW)	0

As presented in Table 33 below, applying the Nova Scotia-specific factor²³ for GHG emissions generated by electricity production, 0.5841 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 259 tonnes of annually avoided CO₂ eq.

²³ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:
Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),
Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021
https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

Table 33: Evaluated 2021 Building Optimization GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	0.444
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	259

11.4 Realization Rate

A comparison of the energy and peak demand savings values established through this evaluation and those tracked by EOne is presented in Table 34 below. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 104% for energy savings. There were no peak demand savings for Building Optimization.

Table 34: Comparison of 2021 Building Optimization Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	0.525	GWh	0.81	0.426	GWh	104%
Evaluation Results	0.491	GWh	0.91	0.444	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0	MW	-	0	MW	-
Evaluation Results	0	MW	-	0	MW	

2021 Building Optimization Impact Evaluation Highlights

- › The annual gross energy savings at the generator amounted to 0.491 GWh, which represents 1.472 GWh in lifetime energy savings. There were no peak demand savings for Building Optimization.
- › The weighted average free-ridership level for 2021 was established at 9% for energy savings.
- › The net energy savings for Building Optimization were estimated at 0.444 GWh at the generator, which represents 1.332 GWh in lifetime net energy savings and yields a weighted average EUL of 3.0 years.
- › The net energy savings resulted in 259 tonnes of annually avoided CO₂ eq.

12 OVERALL SAVINGS FOR CUSTOM

A comparison of the energy and peak demand savings values established through this evaluation and those tracked by EOne is presented in Table 35. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 105% for energy savings and 111% for peak demand savings.

Table 35: Comparison of 2021 Custom Tracked and Evaluated Savings at the Generator

		Gross Savings		NTGR*	Net Savings		Realization Rate
		Value	Unit	Value	Value	Unit	Value
Retrofit **	Energy Savings						
	Tracked Savings by EOne	15.125	GWh	0.83	12.482	GWh	107%
	Evaluation Results	15.021	GWh	0.89	13.314	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	3.340	MW	0.85	2.838	MW	113%
	Evaluation Results	3.503	MW	0.92	3.220	MW	
New Construction	Energy Savings						
	Tracked Savings by EOne	13.364	GWh	0.70	9.355	GWh	102%
	Evaluation Results	11.217	GWh	0.85	9.535	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	3.779	MW	0.70	2.645	MW	109%
	Evaluation Results	3.394	MW	0.85	2.885	MW	
Building Optimization	Energy Savings						
	Tracked Savings by EOne	0.525	GWh	0.81	0.426	GWh	104%
	Evaluation Results	0.491	GWh	0.91	0.444	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	0	MW	-	0	MW	-
	Evaluation Results	0	MW	-	0	MW	

		Gross Savings		NTGR*	Net Savings		Realization Rate
		Value	Unit	Value	Value	Unit	Value
Total Custom	Energy Savings						
	Tracked Savings by EOne	29.014	GWh	0.77	22.263	GWh	105%
	Evaluation Results	26.729	GWh	0.87	23.293	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	7.119	MW	0.77	5.488	MW	111%
	Evaluation Results	6.897	MW	0.89	6.105	MW	
* NTGRs differ for each service. The NTGRs listed in this table match the rounded averages obtained from dividing net savings by gross savings. ** For Retrofit, total evaluated net savings include 0.492 GWh in energy savings and 0.496 MW in peak demand savings from the OEM Operational Demand Savings Pilot. For this service, the Evaluator set the corrected tracked NTGRs to 1.0 for both energy and peak demand savings in recognition that this is a new pilot service. The evaluated NTGR was also 1.0 for the OEM Operational Demand Savings Pilot. The resulting NTGRs and realization rates for Retrofit shown in this table are weighted averages of the combined Retrofit and OEM Operational Demand Savings Pilot values.							

13 CUSTOM KEY FINDINGS AND RECOMMENDATIONS

The main objectives of the 2021 Custom evaluation were as follows:

- › Collect information on participant perspectives
- › Collect information on the New Construction participation decision-making process
- › Collect early free-ridership information for New Construction participants for future evaluation
- › Calculate gross and net Custom results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions²⁴

This section provides the Evaluator's key findings and recommendations in relation to these objectives. The first key findings and recommendations apply to the Custom component in general, while others are specific to certain Custom services. The recommendations are also outlined in Appendix XIV.

General Custom Key Findings and Recommendations

2021 Custom-Finding: Custom net electrical energy and peak demand savings fell short of targets in 2021.

Custom achieved 23.293 GWh in net electrical energy savings and 6.105 MW in net peak demand savings at the generator in 2021, thus not attaining the planned net electrical energy savings of 30.310 GWh and net peak demand savings of 8.166 MW.

2021 Custom-Finding: Compared to 2020, Custom participation increased in 2021 due in part to higher participation from New Construction and the closure of 18 multiyear projects in Retrofit.

With 102 projects completed across the three Custom services²⁵ and the OEM Operational Demand Savings Pilot, the 2021 participation level for Custom was 85% higher than in 2020. Retrofit, which accounts for the bulk of projects completed through Custom, increased from 41 projects completed in 2020 to 72 projects completed in 2021, which represents a similar participation level to that in 2019. Additionally, New Construction had its highest participation level since 2014 with 21 completed projects in 2021, up from eight completed projects in 2020. Building Optimization had the same participation level in 2021 as in 2020, with six completed projects. The OEM Operational Demand Savings Pilot contributed 3 projects.

²⁴ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

²⁵ Custom includes three services: Retrofit, New Construction and Building Optimization.

2021 Custom-Finding: Participant satisfaction with Custom continues to be very high across the three services. Participant satisfaction was also high with the OEM Operational Demand Savings Pilot.

All participants rated the OEM Operational Demand Savings Pilot highly, each providing a rating between 8 and 10 on a 10-point scale with 1 indicating “Not at all satisfied” and 10 indicating “Completely satisfied”. All participants would participate again should the service continue to be offered. Retrofit participants provided an average satisfaction rating of 8.4. They found that the participation process went smoothly and appreciated the incentives offered by the service. New Construction participants provided an average rating of 8.0 and reported that they appreciated the overall ease of the participation process and working with EOne staff. Building Optimization participants provided an average rating of 8.5 and found that the participation process went smoothly.

2021 Custom-Finding: Following the project reviews, the Evaluator adjusted the energy and peak demand savings for OEM Operational Demand Savings Pilot, Retrofit and New Construction as well as the energy savings for Building Optimization.

For the OEM Operational Demand Savings Pilot, the adjustment ratios for gross energy and peak demand savings were 0.99 and 0.90 respectively. More robust M&V methodologies might reduce future adjustments. For Retrofit, the adjustment ratios for gross energy and peak demand savings were 0.981 and 1.030 respectively. For New Construction, they were of 0.839 and 0.898 respectively. For Building Optimization, the adjustment ratio for energy savings was 0.934. The Evaluator made several adjustments to the reviewed projects.

For New Construction, the Evaluator noted a significant improvement in the information available in the project files submitted by EOne. The project files were complete and well documented, which facilitated the project reviews. The Program Guide requirements were also better followed.

For Retrofit and Building Optimization, most of the adjustments fell into one of the following categories:

- › M&V methodology errors or gaps
- › Peak demand savings absent from project files
- › Keying and typographical errors

While adjustment ratios were generally low for these services, this is due in large part to a lack of available data in the project files to make more precise adjustments as well as a balancing of upward and downward adjustments (particularly for peak demand savings). Adjustments were required in 46% of sampled files in 2021, and the Evaluator notes that, despite past recommendations in these areas, there continues to be room for improvement in addressing methodological issues and quality in Retrofit and Building Optimization M&V activities.

2021 Custom Recommendation 1: For Retrofit and Building Optimization, on a priority basis review, improve and deploy M&V processes, savings calculation protocols, service requirements, as well as documentation and associated supporting materials to align these with best practices for custom programs.

EOne should work on a priority basis to increase service requirements relating to the level of detail, quality, and accessibility of service documentation as well as internal review processes and practices related to M&V. These include M&V methods to capture energy and demand savings. Ideally, this recommendation would be actioned and implemented early in 2022 to the benefit of 2022 Custom participants.

2021 Custom-Finding: Retrofit free-ridership increased slightly, while free-ridership for New Construction was measured with a new approach to capture all levels of influence, including building modelling.

The overall free-ridership level for Retrofit is 16%, 15% for New Construction, and 9% for Building Optimization. By comparison, the free-ridership levels in 2020 were 15% for Retrofit, 30% for New Construction, and 19% for Building Optimization. While the free-ridership level remains reasonable for Retrofit, the Evaluator noticed that 2021 results are the final point in a modest upward trend since program inception. This is not a cause for concern and rather something that should be noted with a view to developing strategies to ensure that levels remain at reasonable levels.

As for spillover for Retrofit and Building Optimization, the Evaluator determined that it was nil for both services.

2021 Custom-Finding: There is a trend in recent years of more projects closing after the sampling period necessitated by the evaluation timetable. While having a minimal impact on 2021 results, this could create future challenges related to the quality of the adjustment ratios and NTGRs if larger projects are not well represented in the sample.

2021 Custom-Finding: Both the evaluated net energy and peak demand savings determined by the Evaluator were higher than the savings tracked by EOne.

Evaluated gross energy and peak demand savings were slightly lower than those tracked by EOne for all services (except for Retrofit peak demand savings) due to adjustments resulting from the project reviews. As for evaluated net energy and peak demand savings, they were respectively 11% and 5% higher than the values tracked by EOne. This result is mainly due to lower free-ridership rates for New Construction and Building Optimization established in 2021 and to positive true-up adjustments to several multiyear Retrofit projects.

OEM Operational Demand Savings Pilot Key Findings and Recommendations

2021 OEM Operational Demand Savings Pilot Finding: The incentive had the desired effect of prompting participants to look for rapid and low-cost measures to reduce their energy demand during the system peak period. That said, the nature of participating projects provides insights for potential improvements and clarifications to program guidelines if operational demand programs are to officially enter the portfolio.

2021 OEM Operational Demand Savings Pilot Finding: M&V methodologies for peak reduction projects can be further refined.

One of the three projects required the Evaluator to change the M&V methodology, which led to a reduction in evaluated savings for that project. Moreover, participants indicated a desire for more guidance on demand savings M&V, and the Evaluator noted several potential gaps in current M&V guidance.

The Evaluator notes that whole building (IPMVP Option C) approaches applied to the pilot projects are not particularly suited to small demand savings projects and that system level (IPMVP Option B) M&V would be more appropriate for such projects. For example, the demand savings associated with reducing VFD speeds during peak hours are very low as a percentage of the total load and therefore challenge the boundaries of whole building M&V margins of error. Furthermore, the Evaluator notes that, for projects scheduled exclusively to come into effect at the beginning of the peak period, introducing M&V methods used in demand response initiatives, such as “average X of Y”, could be appropriate in certain cases.

The Evaluator also notes that load-shifting projects are a possibility under the auspices of any eventual operational demand reduction program (such as pre-heating spaces or pre-purging fresh air). These potential load-shifting projects would require that special attention be brought to M&V because the demand savings generated in the peak period may be offset by additional loads in another period for which baselines would need to be established and measurements taken. EOne must ensure that M&V guidance provided to prospective participants deals with these types of projects appropriately.

EOne has M&V requirements and documented methodologies for establishing peak energy savings for Building Optimization and Retrofit, both of which have been improved through many updates. In general,

these methodologies still very much apply to any future initiative based on the Operational Demand Savings Pilot for a wide range of projects that might be brought forward.

2021 OEM Operational Demand Savings Pilot Recommendation 1: If operational demand programs are offered in the future, deploy improved M&V and savings calculation protocol reviews. As for Retrofit and Building Optimization, detailed M&V guidance will be required to support this demand-focussed program. This guidance should be developed to include information about common demand response M&V methods that measure demand in the hours before the peak window and that compare results to those during the window. In addition, the guidance should be updated to include:

- › Information about M&V requirements and methods that capture the full effects of any load-shifting projects that may be submitted.
- › An emphasis on the fact that reductions must be well outside the margin of error of the M&V methodologies. This will be particularly important for any whole building approaches but could also be applicable to sub-metered approaches.
- › This guidance should be produced and published to make program materials accessible to participants. Where required, simple capability development strategies could be deployed, such as online workshops.

Retrofit Key Findings and Recommendations

2021 Retrofit-Finding: The pay-for-performance projects reviewed by the Evaluator included an excellent client-led M&V approach that required almost no adjustments, had a free-ridership level of zero, and high customer satisfaction.

2021 Retrofit Recommendation 1: Consider expanding the use of this type of structured pay-for-performance approach and encouraging larger return participants in Retrofit, Building Optimization, and Operational Demand Savings to participate in this offering.

Ideally, Custom Retrofit, Building Optimization, and Operational Demand Savings would cater to individual applicants who have a distinct project idea that truly requires a custom savings determination approach. Participants may be considered in two groups: one-time participants with unique projects and returning participants applying multiple times for an ongoing stream of projects. For the latter group, it may make sense to consider an encompassing pay-for-performance approach. As seen in the 2021 evaluation results, this approach could potentially improve M&V practices, reduce adjustments, and reduce free-ridership while maintaining very high satisfaction levels and reducing administrative requirements for certain participants.

2021 Retrofit-Finding: During Retrofit project reviews, the Evaluator made adjustments and further observations relating to the specific M&V approach used for solar PV and compressed air leak repair projects.

For solar PV and compressed air leak repair projects, EOne has deployed de-facto quasi-prescriptive or engineered approach in Custom. This is in recognition that these projects have lower technical complexity, few interactive effects and savings that can be qualified using appropriate engineering assumptions (or models in the case of solar PV), which can be supplemented with a relatively small number of local site condition-dependant variables. This type of approach is wholly suitable for these specific project types. Conversely, including them in Custom without explicit distinctions from true Custom projects poses certain challenges for the evaluation. First, the evaluation approach for quasi-prescriptive engineered savings projects generally should include a distinct evaluation activity to determine the most appropriate assumptions and savings determination methodology. Second, to avoid confusion, there needs to be clarity for the participant about the nature and rigour of the M&V required for different project types.

2021 Retrofit Recommendation 2: Develop and implement a process to identify project types more suited to quasi-prescriptive approaches (including solar PV, compressed air leaks, and possibly others such as domestic water booster pumps), and explicitly distinguish these project types from traditional custom projects within the Custom service. This should include developing appropriate protocols, documentation, and allowances for reviews of underlying savings determination methodologies as part of the annual evaluation plan.

EOne should work with the Evaluator to determine savings methodologies, parameters, M&V documentation, and applicant requirements for these project types. For solar PV and compressed air leak projects, these should be accomplished on a priority basis given the popularity of such projects in Retrofit.

New Construction Key Findings and Recommendations

2021 New Construction-Finding: EOne succeeds in influencing New Construction building design through the many influence factors, and influence on design occurs by the end of the design phase.

The process evaluation conducted for New Construction served to confirm the different sources of influence that EOne and New Construction have on the participant decision-making process, such as the energy model, implementation incentives, as well as technical assistance provided by the energy modeller, BDMS, and EOne staff. After discussion with EOne, to better take these influence factors and their impacts on building design decisions into account, the Evaluator developed a new phone interview questionnaire to assess free-ridership, which was used as part of this evaluation. Moreover, since major decisions related to energy use occur by the end of the design phase, which coincides with participants signing the CPA, the timing for the free-ridership assessment should be adjusted going forward.

2021 New Construction Recommendation 1: Interview participants shortly after having signed the CPA.

- › To do so, EOne could identify participants who have signed a CPA at the end of every quarter and ask a third party to interview them. The third party should safeguard the answers until the project closes and then transfer results directly to the Evaluator to maintain the confidentiality of responses.
- › To increase the likelihood that the third party conducting the interviews will be able to reach key project decision-makers, EOne should provide a second contact, if available, from within the participant organization from the start.
- › Reasonable efforts should be invested in contacting the provided contacts via phone interviews. If unsuccessful, the third party should send a web survey to the contacts who have not been interviewed by phone.
- › If the provided contacts remain unreachable through the phone interview and web survey, the free-ridership questionnaire should be administered once the project is completed at the time of evaluation.

14 EMIS OVERVIEW

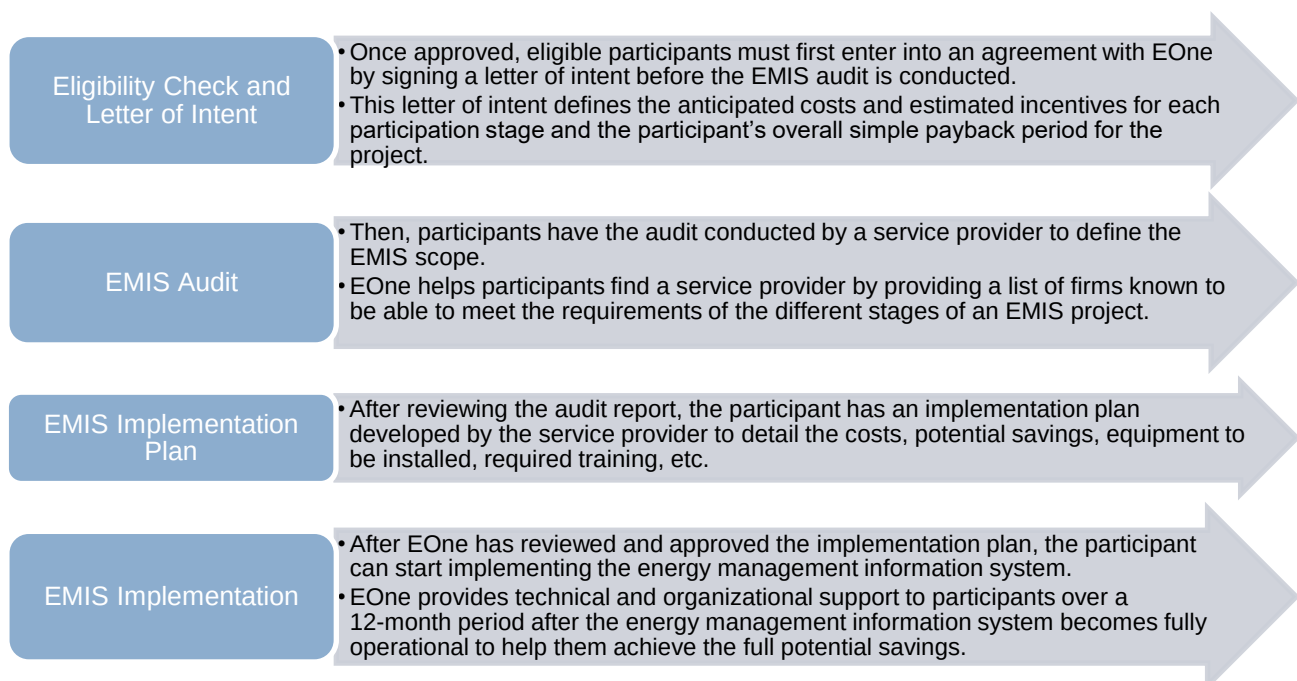
This section describes the Energy Management Information Systems (EMIS) program component, follows up on past evaluation recommendations, and provides an overview of participation history.

14.1 EMIS Description

EMIS offers incentives in the form of incentives or zero-percent on-bill financing to help facilities reduce their electricity consumption through the implementation of an energy management information system.

EMIS assists industrial businesses and institutions in making real-time decisions about their processes based on energy consumption data from metered systems. To achieve this goal, EMIS provides participants with the funding required to hire a service provider to audit their systems (EMIS audit), develop an energy management information system implementation plan (EMIS implementation plan) and install metering and monitoring equipment (EMIS implementation). EOne maintains an EMIS Consultant and Service Provider Roster consisting of a list of qualified professionals that meet program requirements. EMIS also provides training and organizational support to help convert energy performance information into concrete actions. To be eligible, participants must possess the necessary resources to carry out all project stages, demonstrate commitment to energy management and an adequate level of expertise, as well as agree to complete all stages of an EMIS project. EMIS projects can encompass an entire facility or just specific processes or departments within a facility. Figure 14 illustrates the EMIS participation process along with details about the program component.

Figure 14: EMIS Participation Process Summary



EMIS participants can also take part in Strategic Energy Management (SEM), another component under the Custom Incentives program, if they wish to develop an energy management plan focused on changing business practices. The savings of participants who take part in both SEM and EMIS are divided between the two components.

After some delays in measure implementation and new participant recruitment in 2020, the EMIS component was not impacted significantly by the COVID-19 pandemic in 2021.

EMIS was aimed at achieving 0.300 GWh in net electricity energy savings and 0.000 MW net peak demand savings at the generator in 2021.

14.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated EMIS in previous years and issued improvement recommendations. Table 36 provides a summary of the implementation status of each recommendation presented in the Executive Summary section of the 2020 Evaluation Report. No recommendations from previous years have been carried forward.

Table 36: Implementation Status of Past Recommendation for EMIS

#	Recommendations	Status	Comments
2020 EMIS – R1	Use the Evaluator's peak demand savings calculation guidelines to develop a protocol to track peak demand savings.	Being implemented	Although EOne has taken proper note of the approach recommended by the Evaluator for peak demand savings calculations and has tried to apply it to 2021 calculations, it has not been formally included in internal guidelines.

14.3 Participation History

Only one participant took part in EMIS in 2021, and that participant was also an SEM participant; therefore, their savings were divided between the two program components. The participant was a continuing participant for SEM and claimed savings under EMIS for the first time in 2021. As presented in Figure 15 and Figure 16 below, participation levels and savings have been steadily decreasing since program inception in 2015. The participant has been active in SEM for four years and therefore generated minimal incremental savings in 2021.

Figure 15: Overview of EMIS Participation, 2015-2021²⁶

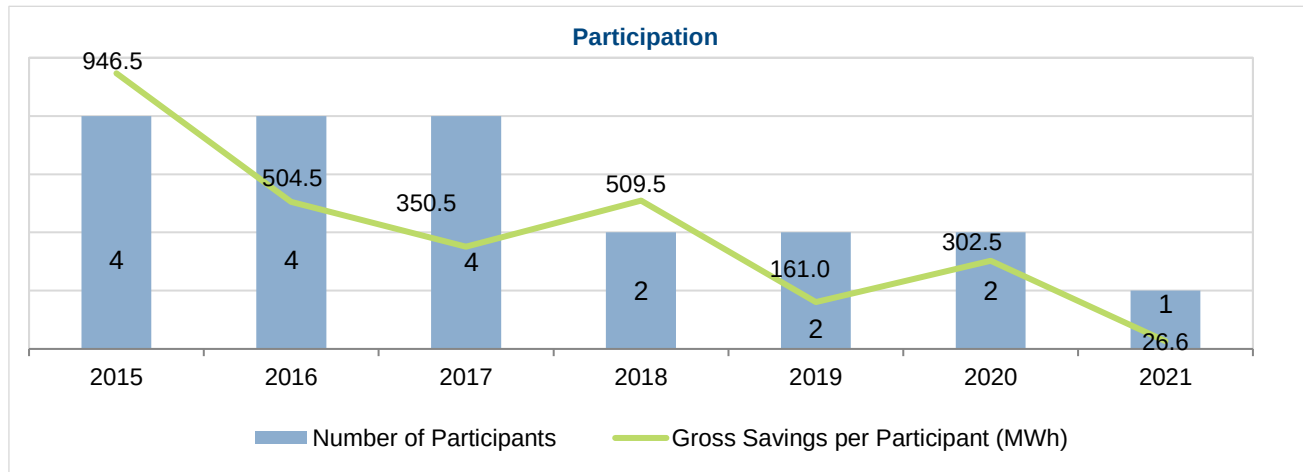
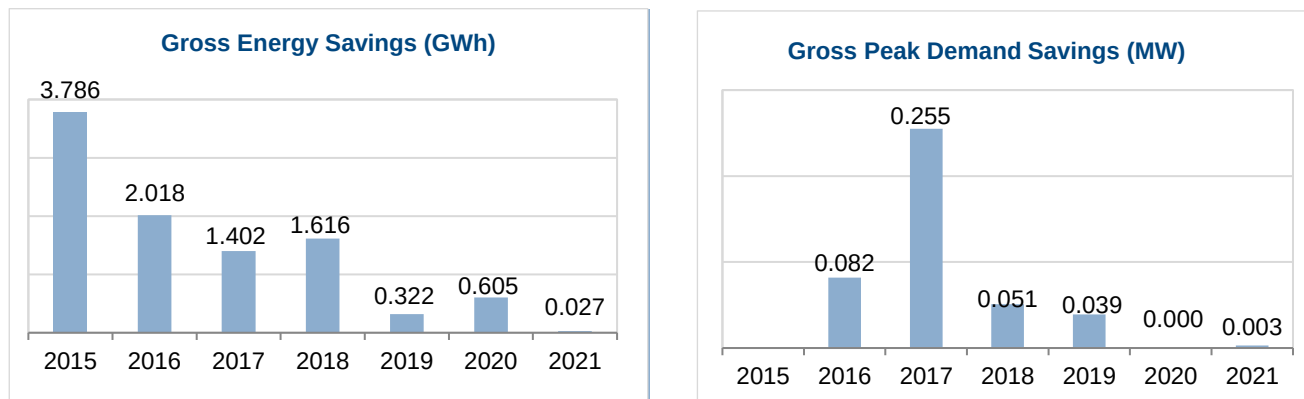


Figure 16: Evolution of EMIS Gross Savings, 2015-2021²⁷



²⁶ The 2018 savings values per participant are based on the savings of 2018 participants only and do not include participants from previous years for which savings were reported in 2018.

²⁷ The 2018 results included savings achieved by one participant in 2017 since their energy consumption data became available only in 2018. This participant was not counted as a 2018 participant.

15 EMIS EVALUATION APPROACH

The 2021 EMIS evaluation comprises a comprehensive impact evaluation. The main objective of the EMIS evaluation is as follows:

- › Calculate gross and net EMIS results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions²⁸

The Evaluator identified key research questions aimed at achieving the objective. Table 37 outlines the evaluation objectives and maps them to research questions, methods, and sample sizes (n). Each method is described further below.

Table 37: 2021 EMIS Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › Are the gross savings for each project accurately calculated? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Desk reviews supported by site visits or phone interviews › Calculations using evaluation results
Calculate net results	› What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What are the net avoided GHG emissions in CO₂ eq for EMIS?	› Participant interviews through phone interviews › Calculations using evaluation results › GHG emission reduction calculations

Tracking Sheet Audit

Prior to performing the savings review, the Evaluator audited the final 2021 tracking sheet to ensure it was complete and data entry was consistent. The detailed protocol used for the tracking sheet audit and the results obtained are presented in Appendix XV.

Desk Reviews and Phone Interviews

In January 2021, a savings review was conducted through desk reviews supported by phone interviews. The Evaluator also contacted the service provider for clarifications. Since the only EMIS participant this year was also an SEM participant, the SEM project review protocol was used for EMIS projects as well. This protocol is presented in Appendix XVII.

²⁸ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

EUL Update

As part of the 2020-2022 Measure Assessment²⁹ activities, the Evaluator reviewed the EUL values for all measure categories to ensure they were still valid and revised them where appropriate.

Calculations Using Evaluation Results

Building on all the above methods and collected data, the Evaluator calculated the first-year and lifetime gross energy and peak demand savings as per the calculation methodology presented in Section 16.

GHG Emission Reduction Calculations

To obtain net avoided GHG emissions in CO₂ eq for EMIS, the Evaluator multiplied the net energy savings by the latest Nova Scotia-specific factor for GHG emissions generated by electricity production. This factor was established using NS Power data.

²⁹ The 2020-2022 Measure Assessment is a reference document that provides an in-depth review of all parameters necessary to calculate the annual and lifetime gross energy and peak demand savings of most prescriptive measures and some semi-prescriptive measures offered through EOne's DSM program portfolio. In addition, the Measure Assessment includes effective useful life measures for all measures offered in EOne's program portfolio. For the evaluations conducted during the 2020-2022 DSM cycle, the Evaluator refers to the values presented in the 2020-2022 Measure Assessment.

16 EMIS IMPACT EVALUATION

The objective of the 2021 EMIS impact evaluation is to determine gross and net electrical energy and peak demand savings, as well as annually avoided GHG emissions, EUL, and associated lifetime energy savings.

16.1 Impact Definitions

Table 38 defines certain terms to allow the reader to better understand the vocabulary and concepts used in the EMIS Impact Evaluation section of this report. SEM and EMIS vocabulary being the same, the definitions below apply to both program components.

Table 38: Definition of Terms Related to EMIS and SEM

Term	Definition
Baseline	Referring to the systems, time period, energy use, or conditions that provide a reference with which later performance of an energy conservation measure is compared.*
Baseline Period	Defined time period representing the operation of the facility or system before the implementation of an energy conservation measure.*
Baseline Regression	A mathematical model correlating energy use to one or more independent variables during the baseline period.
Cumulative Savings	The annual savings achieved with respect to the baseline situation prior to EMIS or SEM participation.
Incremental Baseline	Referring to the systems, time period, energy use, or conditions that provide a reference with which later performance of an energy conservation measure is compared to obtain incremental savings.
Incremental Savings	Additional annual savings not measured in previous years. Incremental savings result from new measures implemented during the evaluation year or from recent improvements to energy efficiency measures that were initiated in previous evaluation years. These savings are calculated by using the previous year's situation as the baseline.
Independent Variable	Parameter that is expected to change routinely and have a measurable impact on the energy consumption and/or demand of a system or facility.*
Reporting Period	Defined time period for the purposes of verifying savings after the implementation of an energy conservation measure.*

*The definitions identified with an asterisk are drawn from the IPMVP.³⁰

³⁰ Efficiency Valuation Organization, *Core Concepts, International Performance Measurement and Verification Protocol*, October 2016.

16.2 Tracking Sheet Audit

To ensure program component results are reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix XV. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

16.3 Gross Savings

Gross savings correspond to the change in energy consumption resulting from actions taken by participants regardless of why they participated. This subsection describes the methodology used to review the EMIS project that generated savings in 2021 and summarizes the review findings. Interactive effects, EUL values, and revised gross savings are also assessed.

While EOne tracks both incremental and cumulative savings, the savings reported by EOne are incremental savings and are therefore the focus of this evaluation.

16.3.1 Project Review Findings

The Evaluator considered the savings calculations appropriate and adequately documented. No changes were made to tracked savings.

16.3.2 Interactive Effects

Since savings were calculated based on a facility-wide electricity consumption model, all interactive effects were already included in the savings calculations.

16.3.3 Effective Useful Life

The EUL for the EMIS participant is based on the remaining time in the program and a decay rate of 50% per year after the end of program engagement. This participant was in their fourth year of SEM participation; since the average engagement length is three years for EMIS and SEM participants in 2021, the Evaluator assumed they would persist for one year of program participation and for one year of post-program participation, resulting in a EUL of two years.

16.3.4 Evaluated Gross Savings

EMIS gross incremental energy and peak demand savings are listed in Table 39 below. Gross incremental energy savings at the generator were established at 0.027 GWh while gross peak demand savings at the generator were established at 0.003 MW. Lifetime energy savings were established at 0.053 GWh, which resulted in an average equivalent EUL value of two years.

The gross savings at the generator were estimated by using different line loss factors between the meter and the generator for energy and peak demand savings based on each facility rate code and line loss factor values drawn from the 2014 Cost of Service Study Progress Update.³¹

Table 39: Evaluated 2021 EMIS Gross Energy and Peak Demand Savings

	Continuing Project
Number of Projects	1
Energy Savings	
Tracked Gross Energy Savings (GWh)	0.025
Adjustment Ratio for Energy Savings	1.00
Gross Energy Savings – at the Meter (GWh)	0.025
Line Loss Factor	1.055
Gross Energy Savings – at the Generator (GWh)	0.027
Equivalent Effective Useful Life (years)	2.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.053
Peak Demand Savings	
Tracked Gross Peak Demand Savings (MW)	0.003
Adjustment Ratio for Peak Demand Savings	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.003
Line Loss Factor	1.056
Gross Peak Demand Savings – at the Generator (MW)	0.003

16.4 Net Savings

The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the NTGR. The NTGR serves to determine net savings, i.e. the energy savings that can be reliably attributed to a program component. More precisely, the NTGR represents the positive or negative impacts of spillover and free-ridership effects on gross savings.

³¹ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

For EMIS, free-ridership and spillover effects were considered to be nil and a NTGR of 1.00 was applied. The Evaluator believes that the limited number of participants and the limited penetration of energy management information systems in industrial and institutional facilities justify the decision of not applying any factor associated with free-ridership. Moreover, participant spillover effects were expected to be negligible because energy management information systems measure savings at the facility level, which means that low potential savings occur outside the system measurement boundaries.

16.4.1 Evaluated Net Savings

Net savings are defined as the changes in energy use that are specifically attributable to EMIS. Since spillover and free-ridership effects were considered nil, the net program component impacts are equal to the gross savings generated by the program component. The 2021 net energy and peak demand savings for EMIS were estimated at 0.027 GWh and 0.003 MW at the generator respectively.

As presented in Table 40, applying the Nova Scotia-specific factor³² for GHG emissions generated by electricity production, 0.5841 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 16 tonnes of annually avoided CO₂ eq.

Table 40: Evaluated 2021 EMIS GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	0.027
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	16

16.5 Realization Rate

A comparison of the energy and peak demand savings values established through this evaluation and those tracked by EOne is presented in Table 41. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 100% for both energy savings and peak demand savings.

³² At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:
Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),
Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021.
https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

Table 41: Comparison of 2021 EMIS Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	0.027	GWh	1.00	0.027	GWh	100%
Evaluation Results	0.027	GWh	1.00	0.027	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.003	MW	1.00	0.003	MW	100%
Evaluation Results	0.003	MW	1.00	0.003	MW	

2021 EMIS Impact Evaluation Highlights

- › EMIS had one participant in 2021 and achieved 0.027 GWh in net electrical energy savings and 0.003 MW in net peak demand savings at the generator.
- › The assumption that free-ridership and spillover levels are nil for EMIS remained valid in 2021.
- › Both the evaluated energy and peak demand savings determined by the Evaluator were identical to those tracked by EOne.

17 EMIS KEY FINDINGS AND RECOMMENDATIONS

As mentioned previously, the main objectives of the 2021 EMIS evaluation were as follows:

- › Calculate gross and net EMIS results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions

This section presents the Evaluator's key findings related to these objectives. The Evaluator has no recommendation for EMIS. Section 21 presents SEM key findings and recommendations; many of those are also applicable to EMIS since the two programs are integrated. SEM had more projects this year, and the higher number of project reviews allowed deeper analyses to be conducted.

2021 EMIS-Finding: EMIS net energy savings did not reach target levels due to low participation.

In 2021, EMIS achieved 0.027 GWh and 0.003 MW in energy and peak demand savings respectively. The energy savings values fell short of the planned targets of 0.300 GWh in energy savings. The target for peak demand savings was nil. EMIS only had one participant in 2021, who also participated in SEM and therefore split their savings between the two program components.

2021 EMIS-Finding: Both the evaluated energy and peak demand savings determined by the Evaluator were identical to those tracked by EOne.

For the one project that generated savings in EMIS this year, no adjustments were required.

18 SEM OVERVIEW

This section describes the SEM program component, follows up on past evaluation recommendations, and provides an overview of participation history.

18.1 SEM Description

SEM provides industrial and institutional participants with funding and support to implement energy management practices within their organizations.

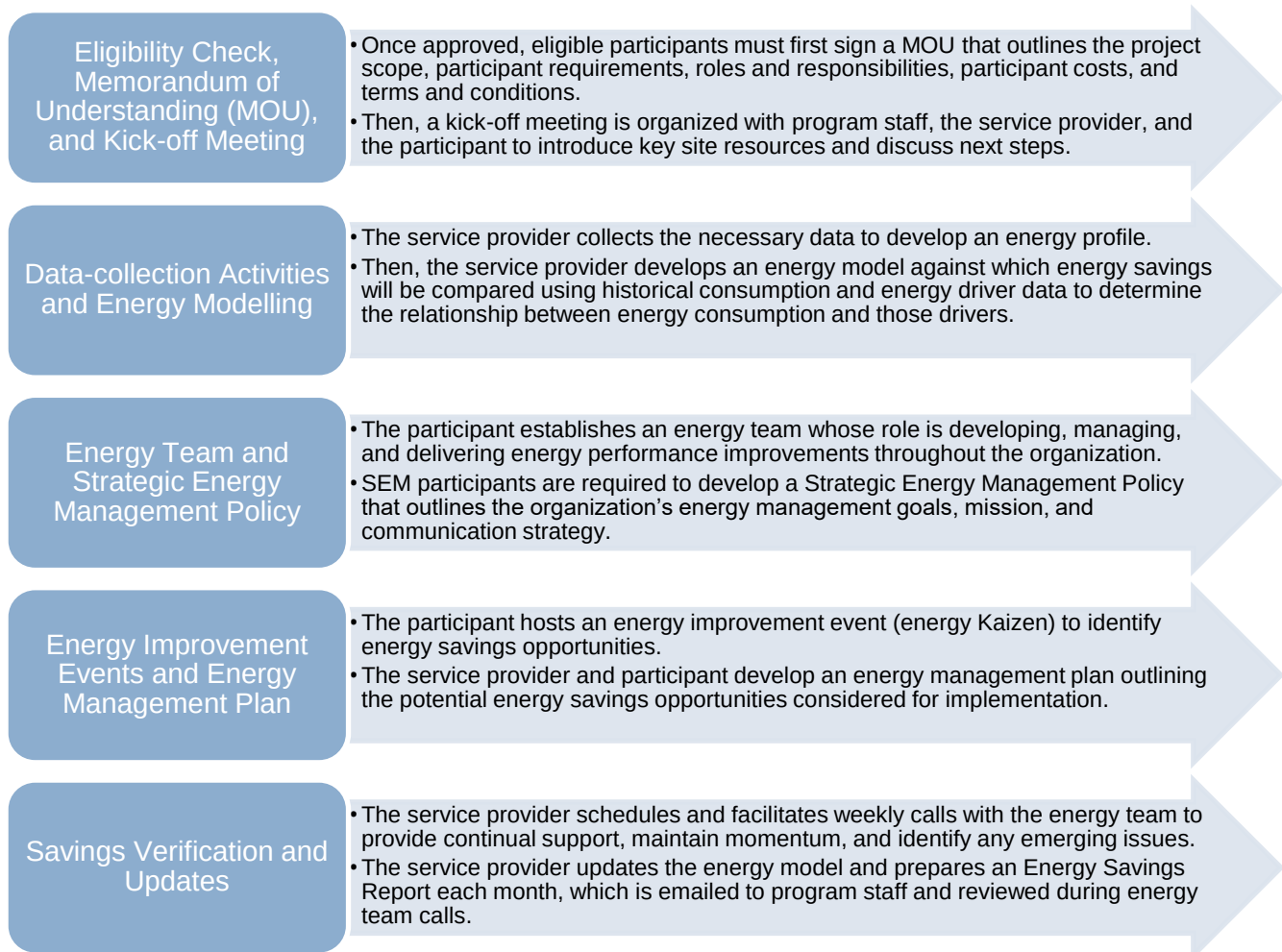
SEM helps participants achieve continuous energy savings by offering a structured approach to identifying, prioritizing, and completing energy saving actions through the implementation of energy management policies and processes. To be eligible, participants must possess the necessary resources to implement energy efficient improvements, demonstrate commitment to energy management, and identify committed personnel to work in collaboration with EOne throughout the duration of projects.³³ SEM activities are conducted through a third-party service provider that delivers the program component. Participants commit to participating for 12 months, although EOne offers a second year to participants who want to continue operating the energy management system. SEM participants have the opportunity to also register under EMIS, another program component under the Custom Incentives program, to have an audit conducted.

SEM provides participants with energy Kaizens³⁴ and mapping, energy management assessments, as well as performance monitoring and reporting tools. SEM also provides employee training and organizational support for the implementation of energy management engagement activities that use energy performance information to prompt actions aimed at achieving behavioural change and operation and maintenance-related energy saving measures. Ultimately, SEM helps develop an energy management plan focused on business practice changes to enhance long-term energy performance. Figure 17 below illustrates the SEM participation process along with details about the program component.

³³ An SEM project is defined as the implementation of a strategic energy management system in a facility.

³⁴ Energy Kaizens are activities aimed at continuously improving energy consumption by identifying waste and focusing on eliminating it.

Figure 17: 2021 SEM Participation Process Summary



Starting in 2021, SEM participants were offered performance-based incentives for the savings achieved through SEM. The objective of this new incentive is to facilitate recruitment and encourage the completion of energy efficiency projects. SEM participants may enrol in the Large Industrial initiative; as such, they receive additional support in the form of a dedicated industrial energy manager (IEM), and the savings they achieve through SEM are incentivized at \$0.06/kWh. This offer was aimed at filling energy management capacity gaps for large industrial customers. SEM participants who are not part of the Large Industrial initiative also receive a performance-based incentive although at a lower rate of \$0.04/kWh.

EOne has continued to operate SEM and the latter was not directly impacted by public health and government directives regarding the COVID-19 pandemic. Some projects experienced delays, although the overall impact on the program component has been minimal.

SEM was aimed at generating net electrical energy savings of 3.00 GWh and peak demand savings of 0.310 MW at the generator in 2020.

18.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated SEM in previous years and issued improvement recommendations. Table 42 below provides a summary of the implementation status of the recommendation presented in the Executive Summary section of the 2020 Evaluation Report. No recommendations from previous years have been carried forward.

Table 42: Implementation Status of Past Recommendations for SEM

#	Recommendations	Status	Comments
2020 SEM – R1	Clearly emphasize the project management support that participants receive and the personnel resources required to fully benefit from SEM during the recruitment and engagement process.	Completed	Project management support is now mentioned in market materials, and business development managers have been notified of the importance of telling prospective participants of this benefit.
2020 SEM – R2	Offer support for semi-annual management reviews to SEM participants that leave the program at the conclusion of the two-year participation period.	Not recommended for action	EOne has no immediate plan to support participants with management reviews after concluding their participation in SEM. Due to the limited SEM budget, it is difficult to commit to addressing this recommendation at this time.
2020 SEM – R3	Use the Evaluator's peak demand savings calculation guidelines to develop a protocol to track peak demand savings.	Being implemented	Although EOne has taken proper note of the approach recommended by the Evaluator for peak demand savings calculations and has tried to apply it to 2021 calculations, it has not been formally included in internal guidelines. The Evaluator made multiple adjustments to tracked peak demand savings in SEM projects, as described in Subsection 20.2.1.

18.3 Participation History

Six participants took part in SEM in 2021; one was new and five were continuing participants who were in their second, third or fourth year of participation.

As illustrated by Figure 18 and Figure 19 below, the participant and savings levels remained similar to those of 2020. One continuing participant had a major impact on energy savings; that project represented 64% of the savings achieved in 2021.

Figure 18: Overview of SEM Participation, 2015-2021³⁵

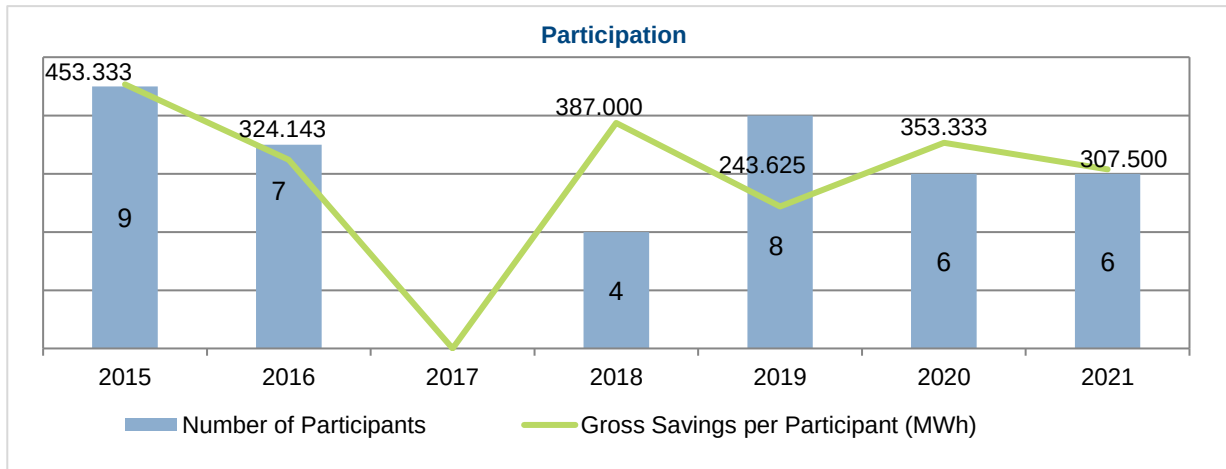
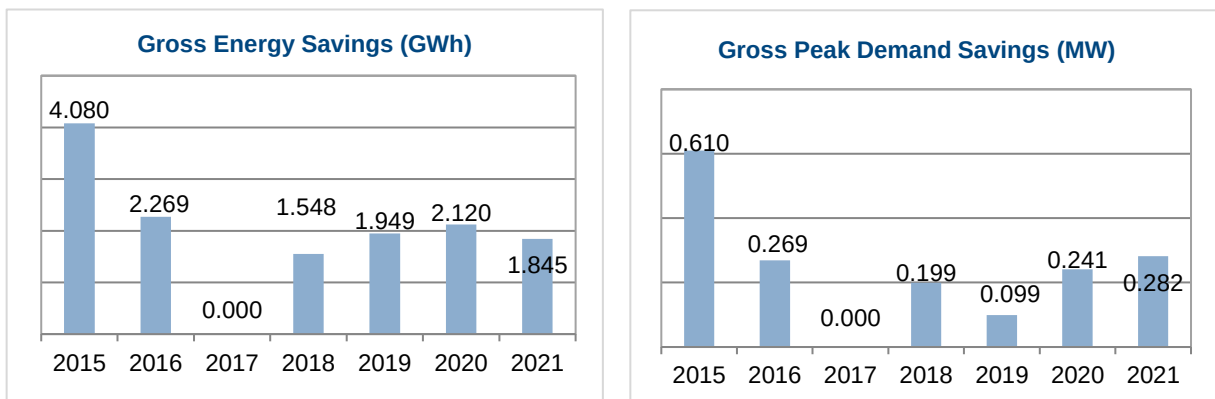


Figure 19: Evolution of SEM Gross Savings, 2015-2021



³⁵ The 2019 savings values per participant are based only on the savings that occurred in 2019.

19 SEM EVALUATION APPROACH

The 2021 SEM evaluation comprised a comprehensive impact evaluation. The main objective of the SEM evaluation was as follows:

- › Calculate gross and net SEM results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions³⁶

The Evaluator identified key research questions aimed at achieving the objectives. Table 43 outlines the evaluation objectives and maps them to the Evaluator's research questions, methods, and sample sizes (n). Each method is described further below.

Table 43: 2021 SEM Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › Are the gross savings for each project accurately calculated? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Desk reviews supported by site visits or phone interviews › Calculations using evaluation results
Calculate net results	› Are net free-ridership and spillover levels still valid? › What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What are the net avoided GHG emissions in CO₂ eq for SEM?	› Participant interviews through phone and in-person interviews › Calculations using evaluation results › GHG emission reduction calculations

Tracking Sheet Audit

Prior to performing the savings review, the Evaluator audited the final 2021 tracking sheet to ensure it was complete and the data entry was consistent. The detailed protocol used for the tracking sheet audit and the results obtained are presented in Appendix XVII.

Project Reviews and Phone Interviews

In January 2021, savings reviews were conducted for each continuing participant through desk reviews supported by phone interviews. Richard Patterson performed the review of one of the continuing projects. The desk reviews and phone interviews for all other continuing participants were conducted by Econoler. While site visits are usually conducted when evaluating new participants, they were cancelled in 2021 due to the COVID-19 pandemic. In addition, these participants were at early stages of their involvement in the program, so the interviews that serve to evaluate free-ridership levels and collect information on participant perspectives were postponed to the 2022 evaluation. The Evaluator also contacted the service provider for clarifications where necessary.

³⁶ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

The protocol used to conduct the interviews and project reviews is presented in Appendix XVII followed by detailed project review adjustments in Appendix XVIII.

EUL Update

The Evaluator reconsidered the EUL values used for SEM participants in light of the types of measures implemented by participants in 2021. Where appropriate, an EUL value was selected from the values presented in the 2020-2022 Measure Assessment. In other cases, the Evaluator kept the previous methodology, which meant selecting an EUL value based on the remaining time in the program component and a decay rate of 50% per year after the end of program engagement.

Calculations Using Evaluation Results

Building on all the above methods and collected data, the Evaluator calculated the first-year and lifetime gross energy and peak demand savings as per the calculation methodology presented in Section 20.

GHG Emission Reduction Calculations

To obtain net avoided GHG emissions in CO₂ eq for SEM, the Evaluator multiplied the net energy savings by the latest Nova Scotia-specific factor for GHG emissions generated by electricity production. This factor was established using NS Power data.

20 SEM IMPACT EVALUATION

The objective of the 2021 SEM impact evaluation is to determine project gross and net electrical energy and peak demand savings. The various terms related to the SEM impact evaluation are defined in the EMIS section of this report (see Subsection 16.1) since the definitions apply to both program components.

20.1 Tracking Sheet Audit

To ensure program component results are reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix XVI. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

20.2 Gross Savings

This subsection describes the methodology used to review the six SEM projects that generated savings in 2021 and summarizes the review findings. Interactive effects, EUL values, and revised gross savings are also assessed.

While EOne tracks both incremental and cumulative savings, the savings reported by EOne are incremental savings and are therefore the focus of this evaluation.

20.2.1 Project Review Findings

The Evaluator reviewed the calculation methodologies for all six projects based on project documentation as well as the information obtained through interviews with participants and the service provider. The information was complete and clear, and M&V data were provided in a spreadsheet where applicable, which allowed for easy validations of calculations.

The Evaluator made only minor adjustments to energy savings. In two projects, the Evaluator reduced savings to account for measures that had already been claimed through BER Instant Rebates. While EOne carefully listed and deducted savings from BER Mail-in and Custom Retrofit, the BER Instant Rebates measures were not accounted for. These were small projects that had a limited impact on overall savings. For one of those two projects, the Evaluator also removed savings from one measure for which the M&V was insufficient to determine the hours of operation reduction due to the measure. Since this participant plans to continue improving the operation of equipment impacted by this measure in 2022, the Evaluator and EOne agreed that this measure will be submitted again next year with a more comprehensive M&V approach. The adjustments made by the Evaluator resulted in a 99% realization rate for energy savings.

The two projects for which energy savings were reduced also saw their peak demand savings decrease by a similar amount. However, the Evaluator applied large upward adjustments to two other projects for which no peak demand savings were claimed when the projects in fact generated savings. In one case, a continuing project had not claimed peak demand savings in 2020 for one measure because that measure was not operational in January and February of that year – that approach is consistent with the Evaluator’s recommended approach for multi-year SEM savings. The peak demand savings for that measure should therefore have been claimed in 2021, but they were not accounted for. In another case, EOne applied a peak coincidence factor (PCF) of zero when the measure indeed operated during the peak demand period. These two adjustments resulted in a 163% realization rate for peak demand savings.

The Evaluator noted that, for 2021, fewer participants used a whole-facility energy model to estimate savings (also called the top-down approach that follows the IPMVP Option C); only two of the continuing participants did, while the four other participants used measure-specific M&V (or the bottom-up approach that follows IPMVP Option A or B) to estimate savings. While a bottom-up approach can estimate savings with accuracy, current reference protocols for SEM typically recommend limiting their usage. For instance, the BPA MT&R Guidelines³⁷ state that the “quantification of energy savings using a bottom-up approach consists of engineering calculations supported by short-term data logging. The application of this approach is limited to specific cases when top-down, whole-facility energy modelling efforts are unsuccessful.” The Uniform Methods Project Chapter 24: Strategic Energy Management (SEM) Evaluation Protocol³⁸ also explains that they favour whole-facility models to measure all SEM savings.

EOne’s rule for selecting the measurement approach is that bottom-up approaches are preferred when it is difficult to obtain a satisfactory energy model at the facility level; this can be the case when a facility’s processes are especially complex or if there have been major changes to operations (for instance due to a global pandemic). This rule is in line with the recommendations of the BPA M&T Guidelines. Moreover, the Evaluator noted that bottom-up approaches were also used in other instances in 2021, including for the two projects that had not completed all investigation steps of the SEM process. In this case, a bottom-up approach allowed claiming savings from a specific measure rather than the overall performance improvement of the facility.

³⁷ Bonneville Power Administration. 2019. *MT&R Guidelines Monitoring, Targeting and Reporting (MT&R) Reference Guide*, Report prepared by ESI Energy Performance Tracking (EPT) Team.

³⁸ Stewart, J. 2017. *Chapter 24: Strategic Energy Management (SEM) Evaluation Protocol*. Golden, CO; National Renewable Energy Laboratory. NREL/SR-7A40-68316. <http://www.nrel.gov/docs/fy17osti/68316.pdf>.

While bottom-up approaches can estimate savings with accuracy, they have many implications on savings reporting and have some limitations or drawbacks that should be considered:

- › When using a bottom-up approach, savings are typically annualized rather than measured on an on-going basis. This approach is effectively the same as that taken for Custom Retrofit projects. If that approach is selected, EOne should be consistent with this methodology from year to year; switching from a bottom-up approach to a whole-facility model approach could result in double-counting savings that have already been annualized.
- › A bottom-up approach is focussed on only one measure and does not capture small incremental improvements that result from increased energy awareness or education over the entire SEM engagement period, as explained in the UMP Chapter 24. This can result in participants focussing on capital projects that are more easily measured through a bottom-up approach.
- › If a bottom-up approach uses short-term metering, it foregoes one element of SEM, which is to continuously monitor and improve energy performance. The Evaluator recognizes that whole-facility energy performance indicators can be used to track overall progress, while bottom-up approaches can serve to quantify and report program component savings. Currently, participants who use bottom-up measurement approaches do not report on whole-facility energy performance indicators.

Developing guidelines for when the usage of bottom-up savings calculation approaches is accepted and describing what elements are needed to meet program objectives would allow using such approaches effectively in SEM and EMIS.

20.2.2 Interactive Effects

For the two projects for which savings were established based on a whole-facility model, the review confirmed that the whole facility was metered and, since measurement boundaries included all existing systems, interactive effects were already included in metered savings. For other projects that used a bottom-up approach, the Evaluator validated if interactive effects should have been considered and concluded that no interactive effects impacted the concerned measures. Hence, no additional interactive effects were applied to measured savings.

20.2.3 Effective Useful Life

As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the EUL values for all measure categories to ensure they were still valid and revised them where appropriate.

In previous years, EUL values were based on the remaining time in the program and decay rate of savings after participation ends. The rationale for this approach was that support from SEM was the source of a large portion of operational measure persistence and that savings gradually decay after the end of program support.

For 2021, the Evaluator reconsidered the approach in light of the increasingly significant proportion of savings that results from equipment retrofits, control automations, or other types of projects for which the Evaluator would typically assign an EUL if they were part of another program component such as Custom. As discussed in Subsection 20.2.1, savings for these measures are now often estimated using a bottom-up approach, so savings are measure-specific, which makes it simple to select an appropriate EUL. For the four participants who used a bottom-up approach, an EUL was assigned based on the measure implemented in accordance with the EUL values found in the 2020-2022 Measure Assessment report. This resulted in a weighted average EUL of 6.2 years for these four participants.

Since whole-facility models capture all operational and behavioural energy performance improvements, the Evaluator elected to continue using an estimate of the EUL based on the remaining time in the program and a decay rate of 50% per year after the end of program engagement. The two participants who had whole-facility models were in their third and fourth year of participation; since the average engagement length is three years, the Evaluator assumed they would persist for one year of program participation and one year post-participation, resulting in a EUL of two years. Overall, the weighted average EUL for all SEM participants was estimated at 5.6 years.

20.2.4 Evaluated Gross Savings

The 2021 evaluated SEM gross energy and peak demand savings at the generator are listed in Table 44 below. Gross incremental energy and peak demand savings at the generator were established at 1.845 GWh and 0.282 MW respectively. Lifetime energy savings amounted to 10.402 GWh, which resulted in an average equivalent EUL of 5.6 years.

The gross energy and peak demand savings at the generator were estimated by using different line loss factors between the meter and the generator for energy and peak demand savings based on each facility rate code and line loss factor values drawn from the 2014 Cost of Service Study Progress Update.³⁹ The average line loss factors were obtained by dividing total gross savings at the generator by total gross savings at the meter for both energy and peak demand savings.

³⁹ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 44: Evaluated 2021 SEM Gross Energy and Peak Demand Savings

	New Projects	Continuing Projects	Total
Number of Projects	1	5	6
Energy Savings			
Tracked Gross Energy Savings (GWh)	0.049	1.728	1.777
Adjustment Ratio for Energy Savings	0.83	1.00	0.99
Gross Energy Savings – at the Meter (GWh)	0.041	1.722	1.763
Average Line Loss Factor	1.045	1.046	1.046
Gross Energy Savings – at the Generator (GWh)	0.043	1.802	1.845
Average Equivalent Effective Useful Life (years)	4.0	5.7	5.6
Gross Lifetime Energy Savings – at the Generator (GWh)	0.171	10.231	10.402
Peak Demand Savings			
Tracked Gross Peak Demand Savings (MW)	0.005	0.160	0.165
Adjustment Ratio for Peak Demand Savings	0.93	1.66	1.64
Gross Peak Demand Savings – at the Meter (MW)	0.005	0.265	0.270
Average Line Loss Factor	1.043	1.044	1.044
Gross Peak Demand Savings – at the Generator (MW)	0.005	0.277	0.282

20.3 Net Savings

The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the NTGR. More precisely, the NTGR represents the positive or negative impacts of spillover and free-ridership effects on gross savings.

As was the case for the 2020 evaluation, the Evaluator applied a NTGR of 1.00 to 2021 savings since free-ridership and spillover were considered to be nil. The Evaluator still believes that the small number of participants and the limited penetration of strategic energy management practices in industrial and institutional facilities justify the decision of not applying any free-ridership effects. This view was supported by the results of the interviews conducted with current continuing participants in previous years. The Evaluator notes that the 2021 projects of two participants (one new and one continuing participant in their second year) were submitted before the SEM investigation phase was completed; in those cases, strategic energy management practices might not be the driving factor for implementing those projects. As discussed in previous subsections, the nature of the measures and the fact that they received a performance incentive make them very similar to Custom Retrofit measures. The Evaluator recommends that the free-ridership questionnaire be used to survey participants on those new elements of the SEM program component in future evaluations.

20.3.1 Evaluated Net Savings

Net savings are defined as the changes in energy use that are specifically attributable to SEM. Since spillover and free-ridership effects were considered nil, the net program component impacts are equal to the gross savings generated by the program component. The 2021 net energy and peak demand savings for SEM were estimated at 1.845 GWh and 0.282 MW at the generator respectively.

As presented in Table 45, applying the Nova Scotia-specific factor⁴⁰ for GHG emissions generated by electricity production, 0.5841 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 1,077 tonnes of annually avoided CO₂ eq.

Table 45: Evaluated 2021 SEM GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	1.845
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	1,077

20.4 Realization Rate

A comparison of the energy and peak demand savings values established through this evaluation and those tracked by EOne is presented in Table 46 below. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 99% for energy savings and 164% for peak demand savings.

⁴⁰ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:

Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),

Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021.

https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

Table 46: Comparison of 2021 SEM Tracked and Evaluated Savings at the Generator

	Gross Savings		NTGR	Net Savings		Realization Rate
	Value	Unit	Value	Value	Unit	Value
Energy Savings						
Tracked Savings by EOne	1.859	GWh	1.00	1.859	GWh	99%
Evaluation Results	1.845	GWh	1.00	1.845	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.172	MW	1.00	0.172	MW	164%
Evaluation Results	0.282	MW	1.00	0.282	MW	

The evaluated net energy savings are about 1% lower than the tracked value because of a few deductions made to two projects due to BER Instant Rebates savings that had not been considered and a small measure for which the M&V was insufficient to determine savings with confidence.

The reduction of energy savings for those two projects also reduced peak demand savings in a similar manner. The evaluated peak demand savings overall were 64% higher than the tracked value due to two projects for which peak demand savings had not been tracked when they were in fact significant.

2021 SEM Impact Evaluation Highlights

- › SEM achieved 1.845 GWh in net electrical energy savings and 0.282 MW in net peak demand savings at the generator in 2021.
- › While energy savings were not adjusted significantly by the Evaluator, the peak demand savings were increased by as much as 63% due to some projects not reporting any savings.
- › The approach to estimating EUL values was reviewed to take into consideration the fact that savings are estimated at the measure level for four of the six projects.
- › The assumption that free-ridership and spillover levels were nil for SEM remained valid for 2021, although the new types of measures implemented through the program will require further validation in upcoming evaluations.

21 SEM KEY FINDINGS AND RECOMMENDATIONS

As mentioned previously, the main objectives of the 2021 SEM evaluation were as follows:

- › Calculate gross and net SEM results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions

This section presents the Evaluator's key findings and recommendations related to the above objectives. The recommendations are also outlined in Appendix XIX.

2021 SEM-Finding: SEM net energy and peak demand savings did not meet targets.

In 2021, SEM achieved 1.845 GWh and 0.282 MW in energy and peak demand savings respectively. These values were 38% below the planned energy savings target of 3.00 GWh and 9% below the planned peak demand savings of 0.310 MW.

2021 SEM-Finding: The SEM participation level has remained stable over the past four years.

Six facilities participated in SEM in 2021, which corresponds to the average for the previous three years. Similarly, the energy savings achieved per participant were also stable over those four years.

2021 SEM-Finding: The savings measurement approaches are now more diversified, and an increasing proportion of participants use a bottom-up approach.

The Evaluator noted that only two of the six participants used a whole-facility energy model to estimate their savings in 2021. Bottom-up approaches for savings calculations are used when it is difficult to obtain a satisfactory energy model at the facility level although also in other instances such as for new projects that did not complete all investigation steps of the SEM process. While bottom-up approaches are an appropriate tool for some SEM projects, the decision to use this type of approach has other implications that EOne should carefully consider. The Evaluator is mostly concerned that choosing this approach could lead participants to miss out on important elements of SEM, such as continuously monitoring and improving energy performance or overlooking operational improvements that are not easily captured at measure level, potentially resulting in fewer savings overall. Indeed, the Evaluator noted that measures for which savings were quantified using a bottom-up approach in 2021 included more equipment retrofit or control automation measures and no operational or behavioural measures.

2021 SEM-Recommendation 1: Develop guidelines on the usage of bottom-up approaches in SEM and ensure they are consistent with program objectives. These guidelines should define the conditions under which a bottom-up approach can be used and how the results will be used for multi-year reporting. They should include M&V requirements that are consistent with those of similar Custom Retrofit projects. These guidelines should also cover how the bottom-up approach will fit into an integrated energy management strategy at facility level, so that the focus is not entirely on individual measures, but also on overall energy performance improvement since it is a key SEM objective.

2021 SEM-Finding: While adjustments to energy savings were minor, adjustments to peak demand savings were significant since EOne did not report savings for some projects that did generate peak demand savings.

The adjustment ratio for energy savings and peak demand savings were of 99% and 164% respectively. As discussed in Subsection 14.2, EOne has not yet completed implementing the 2020 evaluation recommendation to use the Evaluator's peak demand savings calculation guidelines to develop a protocol to track peak demand savings. Doing so should improve the accuracy of reported savings in future years.

2021 SEM-Finding: Applying a different methodology for estimating EUL values resulted in higher EUL values for SEM.

For participants using a whole-facility model, the Evaluator estimated the EUL based on the remaining time in the program and a decay rate of savings after participation ends, which is the method used for all projects in previous years. The Evaluator updated the methodology for projects that used a bottom-up approach to quantify measure-specific savings by applying EUL values specific to the measures implemented for projects. The average measure-specific EUL was estimated at 6.2 years, which is significantly higher than the EUL of approximately three years that would have been estimated using the methodology based on the remaining time in the program. The EUL based on expected remaining time in the program is still appropriate for participants that implement various measures, including behavioural measures for which savings cannot be estimated precisely for each measure.

CONCLUSION

Table 47 presents the participation levels as well as evaluated gross and net savings at the generator for each Custom Incentives program component and for the program as a whole.

Table 47: Overall 2021 Custom Incentives Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
Custom							
Energy Savings	102	Projects completed	26.729	GWh	0.87	23.293	GWh
Lifetime Energy Savings			392.118	GWh	0.86	336.308	GWh
Peak Demand Savings			6.897	MW	0.89	6.105	MW
EMIS							
Energy Savings	1	Participants	0.027	GWh	1.00	0.027	GWh
Lifetime Energy Savings			0.053	GWh	1.00	0.053	GWh
Peak Demand Savings			0.003	MW	1.00	0.003	MW
SEM							
Energy Savings	6	Participants	1.845	GWh	1.00	1.845	GWh
Lifetime Energy Savings			10.402	GWh	1.00	10.402	GWh
Peak Demand Savings			0.282	MW	1.00	0.282	MW
Total							
Energy Savings			28.601	GWh		25.165	GWh
Lifetime Energy Savings			402.573	GWh		346.763	GWh
Peak Demand Savings			7.182	MW		6.390	MW

Figure 20 and Figure 21 below respectively illustrate the net energy and peak demand savings targets for each program component and Custom Incentives as a whole, as well as whether targets were achieved in 2021. Custom Incentives was aimed at achieving 33.610 GWh in net electrical energy savings and 8.476 MW in net peak demand savings at the generator for 2021. It achieved 25.165 GWh in net electrical energy savings and 6.390 MW in net peak demand savings at the generator in 2021. Therefore, the program fell short of achieving planned energy and peak demand savings. Custom was the largest contributor to total program net energy and peak demand savings.

Figure 20: 2021 Custom Incentives Program Targeted and Evaluated Net Energy Savings

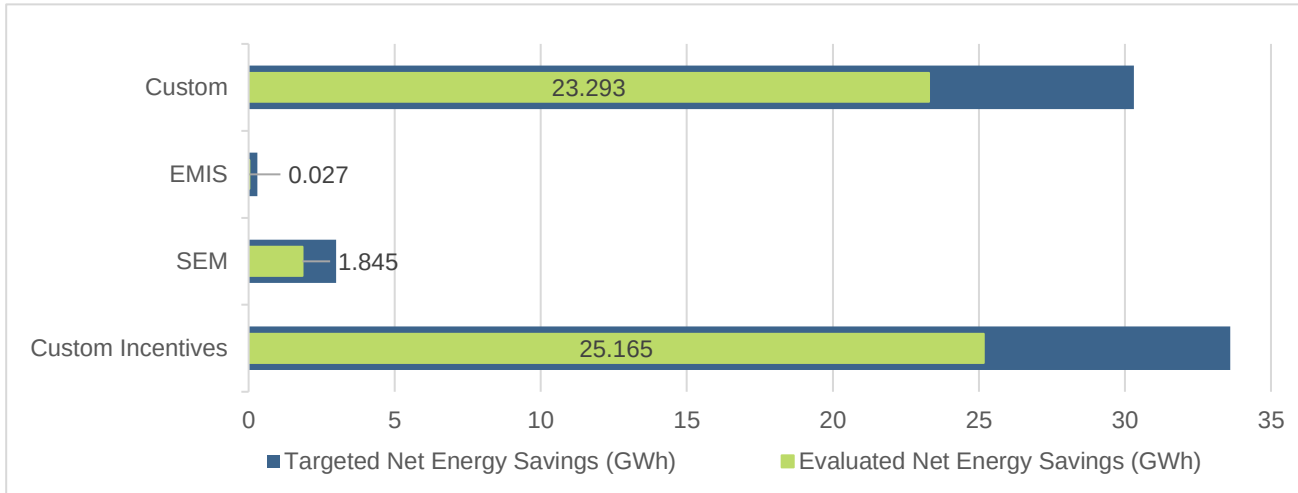
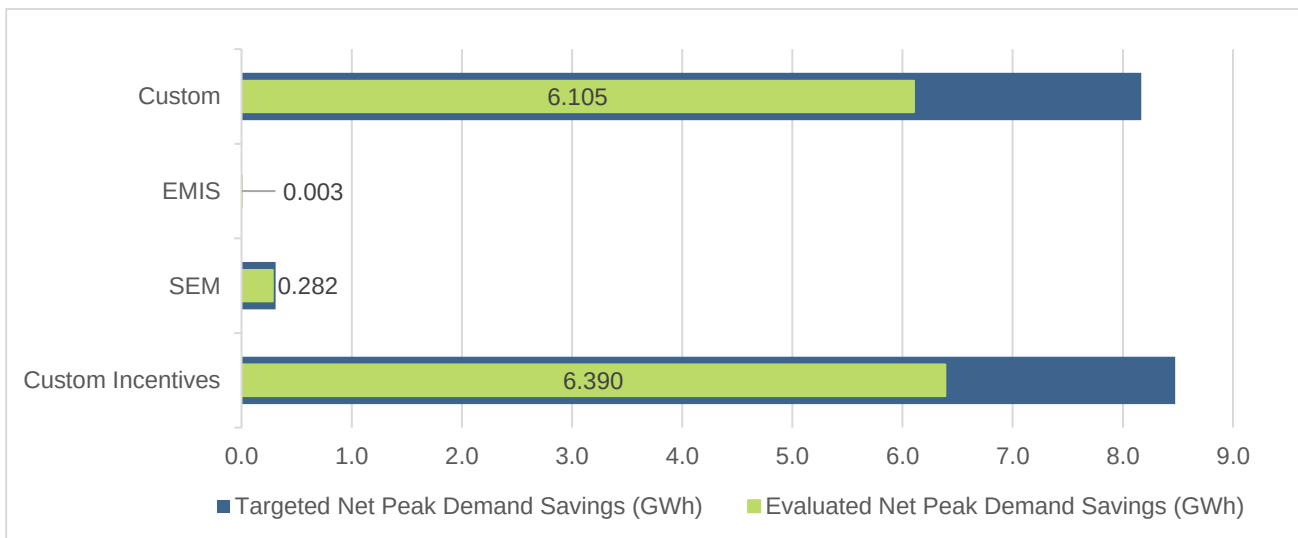


Figure 21: 2021 Custom Incentives Program Targeted and Evaluated Net Peak Demand Savings



LIST OF APPENDICES

The following are presented in the Custom Incentives Program – Appendices document.

Custom

Appendix I Custom: Tracking Sheet Audit

Appendix II Custom: OEM Operational Demand Savings Pilot Participant Interview Guide

Appendix III Custom: New Construction CPA Stage Participant Interview Guide

Appendix IV Custom: New Construction Participant Interview Guide

Appendix V Custom: Retrofit and Building Optimization Participant Interview Guide

Appendix VI Custom: Retrofit Project Review Protocol

Appendix VII Custom: Building Optimization Project Review Protocol

Appendix VIII Custom: OEM Demand Savings Pilot Project Review Protocol

Appendix IX Custom: New Construction Energy Model Review Protocol

Appendix X Custom: Adjustment Calculation Example

Appendix XI Custom: Retrofit and Building Optimization Algorithm for Free-ridership Calculation

Appendix XII Custom: Retrofit and Building Optimization Algorithm for Participant Spillover Calculation

Appendix XIII Custom: New Construction Algorithm for Free-ridership Calculation

Appendix XIV Custom: 2021 Recommendations

Appendix XV EMIS: Tracking Sheet Audit

Appendix XVI SEM: Tracking Sheet Audit

Appendix XVII SEM: Project Review Protocol

Appendix XVIII SEM: Detailed Project Review Adjustments

Appendix XIX EMIS-SEM: 2021 Recommendations



CUSTOM INCENTIVES PROGRAM 2021 DSM EVALUATION

EFFICIENCYONE

Appendix Report

March 17, 2022



TABLE OF CONTENTS

APPENDIX I CUSTOM: TRACKING SHEET AUDIT	1
APPENDIX II CUSTOM: OEM OPERATIONAL DEMAND SAVINGS PILOT PARTICIPANT INTERVIEW GUIDE.....	5
APPENDIX III CUSTOM: NEW CONSTRUCTION CPA STAGE PARTICIPANT INTERVIEW GUIDE.....	7
APPENDIX IV CUSTOM: NEW CONSTRUCTION PARTICIPANT INTERVIEW GUIDE.....	14
APPENDIX V CUSTOM: RETROFIT AND BUILDING OPTIMIZATION PARTICIPANT INTERVIEW GUIDE.....	22
APPENDIX VI CUSTOM: RETROFIT PROJECT REVIEW PROTOCOL.....	27
APPENDIX VII CUSTOM: BUILDING OPTIMIZATION PROJECT REVIEW PROTOCOL.....	34
APPENDIX VIII CUSTOM: OEM DEMAND SAVINGS PILOT PROJECT REVIEW PROTOCOL	41
APPENDIX IX CUSTOM: NEW CONSTRUCTION ENERGY MODEL REVIEW PROTOCOL.....	47
APPENDIX X CUSTOM: ADJUSTMENT CALCULATION EXAMPLE	54
APPENDIX XI CUSTOM: RETROFIT AND BUILDING OPTIMIZATION ALGORITHM FOR FREE- RIDERSHIP CALCULATION.....	56
APPENDIX XII CUSTOM: RETROFIT AND BUILDING OPTIMIZATION ALGORITHM FOR PARTICIPANT SPILLOVER CALCULATION	62
APPENDIX XIII CUSTOM: NEW CONSTRUCTION ALGORITHM FOR FREE-RIDERSHIP CALCULATION.....	65
APPENDIX XIV CUSTOM: 2021 RECOMMENDATIONS.....	71
APPENDIX XV EMIS: TRACKING SHEET AUDIT	73
APPENDIX XVI SEM: TRACKING SHEET AUDIT.....	76
APPENDIX XVII SEM: PROJECT REVIEW PROTOCOL	79
APPENDIX XVIII SEM: DETAILED PROJECT REVIEW ADJUSTMENTS	83
APPENDIX XIX EMIS-SEM: 2021 RECOMMENDATIONS	85

APPENDIX I

CUSTOM: TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator. Its objectives were as follows:

- › Verify that all data fields required for the evaluation were included and filled out in the tracking sheet submitted by EOne
- › Ensure that tracked results were accurate by using the following methods:
 - Verify that the parameters used to calculate program results (gross and net energy and demand savings at the generator) were consistent with previous evaluation results
 - Validate that all calculation steps were performed consistently

Data Accuracy

Table 1 lists all the parameters required for the Custom evaluation. Based on a comparison with previous evaluation results, the Evaluator validated whether or not the data contained in the tracking sheet submitted by EOne was complete and accurate. Finally, the table details the actions carried out by the Evaluator to adjust the data where required.

Table 1: Verification of 2021 Custom Data Field Completeness and Accuracy

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Gross Energy Savings at the Meter (Column T*)	Y	N/A	N/A
Gross Peak Demand Savings at the Meter (Column X)	Y	N/A	N/A
Effective Useful Life (Column AA)	Y	Y	N/A
Rate Code (Column O)	Y	N/A	N/A
Equivalent Net-to-gross Ratios (Column AC)	Y	N	A correction was made to the NTGRs for the three OEM Operational Demand Saving Pilot projects to set these to a value of 1.
Utility PCF (Column AE)	Y	N/A	N/A
Power Factor (Column AD)	Y	N/A	N/A
*Column labels refer to the "Cleaned Up TS" sheet of the final tracking sheet shared by EOne.			

Data Consistency

The second step in the tracking sheet audit consisted in recreating calculations and comparing related tracking sheet data fields to identify any potential inconsistencies. Table 2 lists the Custom tracking sheet data fields, which were compared to ensure consistency.

Table 2: Verification of 2021 Custom Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Calculated Line Loss Factor (Gross Energy Savings at the Generator / Gross Energy Savings at the Meter)	Tracked Rate Codes	N	Corrections were made to the Energy LLF for 5 projects, one of which also received a correction to the Demand LLF
Total Gross Energy Savings at the Meter (including projects from previous years where applicable)	Total Claimed Project Gross Energy Savings at the Meter	Y	N/A
Total Gross Peak Demand Savings at the Meter	Total Claimed Project Gross Peak Demand Savings at the Meter	N	A correction was made to one project for the tracked value under "Total Claimed Project DS kW (g@m)" which incorrectly included the facility demand value instead of the peak demand value. A correction was made to the tracked demand for one project to adjust a rounding error, and to another to reflect demand savings timing to coincide with the system peak period.
Verification of Duplicate IDs or Projects	-	N	3 PIDs have additional unused lines
Other	-		

Equations and Compilation

Once the correct values were established (as per Table 1), the Evaluator validated that the equations in the tracking sheet correctly calculated each of the main program component results, the results of which are presented in Table 3.

Table 3: Verification of 2021 Custom Savings Compilation

Program Component Result	Valid Equation (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	Y	N/A
Gross Peak Demand Savings at the Generator	Y	N/A
Net Energy Savings at the Generator	Y	N/A
Net Peak Demand Savings at the Generator	Y	N/A

Corrected Tracked Savings

Following all changes made by the Evaluator, Table 4, Table 5, Table 6, and Table 7 respectively present the corrected tracked savings for the OEM Operational Demand Savings Pilot, Retrofit, New Construction, and Building Optimization programs. Further details are described in this appendix.

Table 4: 2021 OEM Operational Demand Savings Pilot Corrected Tracked Savings

Service Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	
Gross Energy Savings at the Generator	0.445	GWh	0.445	GWh	0.00%
Gross Peak Demand Savings at the Generator	0.553	MW	0.550	MW	-0.52%
Net Energy Savings at the Generator	0.365	GWh	0.445	GWh	21.95%
Net Peak Demand Savings at the Generator	0.454	MW	0.550	MW	21.31%

Table 5: 2021 Retrofit Corrected Tracked Savings

Service Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	
Gross Energy Savings at the Generator	14.680	GWh	14.680	GWh	0.00%
Gross Peak Demand Savings at the Generator	2.790	MW	2.790	MW	0.00%
Net Energy Savings at the Generator	12.002	GWh	12.038	GWh	0.30%
Net Peak Demand Savings at the Generator	2.285	MW	2.288	MW	0.12%

Table 6: 2021 New Construction Corrected Tracked Savings

Service Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	
Gross Energy Savings at the Generator	13.355	GWh	13.364	GWh	0.07%
Gross Peak Demand Savings at the Generator	3.768	MW	3.779	MW	0.31%
Net Energy Savings at the Generator	9.348	GWh	9.355	GWh	0.07%
Net Peak Demand Savings at the Generator	2.637	MW	2.645	MW	0.31%

Table 7: 2021 Building Optimization Corrected Tracked Savings

Service Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	
Gross Energy Savings at the Generator	0.522	GWh	0.525	GWh	0.70%

Service Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	
Gross Peak Demand Savings at the Generator	0.000	MW	0.000	MW	0.00%
Net Energy Savings at the Generator	0.423	GWh	0.426	GWh	0.70%
Net Peak Demand Savings at the Generator	0.000	MW	0.000	MW	0.00%

Four factors contributed to the differences between the tracked and corrected overall savings. Several small differences are due to four corrected energy line loss factors, and one corrected demand line loss factor. In all these cases, line loss factors had been tracked but not applied between meter and generator values. Another small difference between tracked and corrected savings is due to three incorrect net-to-gross ratios (NTGR), which had been correctly tracked but not correctly applied. Additionally, the differences between the tracked and corrected savings for the OEM Operational Demand Savings Pilot reflect small adjustments to tracked peaked demand for two projects, one to correct a rounding error and the other to reflect peak demand savings timing to coincide with the system peak period. Finally, the OEM Operational Demand Savings Pilot's net energy and peak demand savings were also adjusted to reflect the fact that the NTGR was established at 1 by the Evaluator.

APPENDIX II

CUSTOM: OEM OPERATIONAL DEMAND SAVINGS PILOT PARTICIPANT INTERVIEW GUIDE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview Guide
Estimated Time to Complete	15 minutes
Target Audience	OEM Operational Demand Savings Pilot participants
Expected Number of Completions	Census
Contact List Source	2020 Custom OEM Operational Demand Savings Pilot tracking sheet
Fielding Firm	Econoler
Estimated Timeline for fielding	July - August 2021

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
How satisfied are the participants with OEM Operational Demand Savings pilot?	A
What challenges or barriers, if any, have participants experienced with OEM Operational Demand Savings pilot?	B
Were the cost and efforts of implementation reasonable?	B
What is the expected persistence of these measures?	B

A. Satisfaction

- A1. Using a scale from 1 to 10 where 1 is “not at all satisfied” and 10 is “completely satisfied” how would you rate your satisfaction with the OEM Operational Demand Savings Pilot overall?
- A2. [IF E1<8] What single factor or issue, if resolved, would allow you to provide a higher score?
- A3. [IF E1>8] What is the most important factor supporting your assessment?
- A4. If the program is offered again in future, would you try and find new measures to implement?

B. Participant Perspectives

- B1. How did you first hear about the OEM Operational Demand Savings Pilot?
- B2. What motivated you to participate in the OEM Operational Demand Savings Pilot?
- B3. Did you face any challenges or barriers when implementing your OEM Operational Demand Savings project through the pilot?
- B4. [IF B1= YES, then ask:] What was the most significant challenge or barrier?
- B5. Did the cost of implementation of these measures present any challenge or barrier?
- B6. [IF B1= YES, then ask:] How did the cost present a challenge or barrier?
- B7. Did the implementation of the measure(s) require changes to service levels or operations that can only be maintained in the peak period, and then need to be returned to normal?
- B8. [IF B7 = YES] To clarify, is this measure in place only seasonally (in the peak period of December, January, February)?
- B9. [If B7=NO] Is the measure now in place year-round or for some other period? What is the period and why?.
- B10. How many years do you expect this measure to be in place or repeated?
- B11. [IF B10< 3 years, then ask:] Are there changes in the building function that would explain this?
- B12. [IF B10< 3 years AND IF B11= NO, then ask:] What is the main reason this would be repeated less than 3 years?
- B13. [IF B10>= 3 years AND B9=NOT Year-round, then ask:] By which process do you reactivate this measure each peak season?
- B14. Do you have any suggestions to improve the OEM Operational Demand Savings Pilot?

END: These are all the questions I have for you. Thank you very much for your time and cooperation!

APPENDIX III

CUSTOM: NEW CONSTRUCTION CPA STAGE PARTICIPANT INTERVIEW GUIDE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview Guide
Estimated Time to Complete	20 minutes
Target Audience	New Construction participants (at completion stage)
Expected Number of Completions	Census
Contact List Source	Participants who signed a CPA during Q2 or Q3 of 2021
Fielding Firm	Econoler
Estimated Timeline for fielding	N/A

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
What is the free-ridership level for New Construction?	C, E, D

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Skip pattern or programming instructions **[LIKE THIS]**

Black text: instructions for interviewer **[NOTE: xxxx] / [PROBE: xxxx]**

A. Introduction

I am with Econoler, and we are conducting an evaluation of the Efficiency Nova Scotia Custom New Construction program. This interview should take about 20 minutes. Is this still a good time for you?

The purpose of the interview is to better understand your organization's decision to build an energy efficient building, including your choice of energy efficient materials or equipment that exceed building code requirements. During this interview, I will refer to this as your decision "to design a better-than-code building".

Your responses will be kept confidential, and your comments will be combined with those of other program participants. Your responses will not affect the incentive amount you have received for this project.

B. Identifying Key Decision-makers

B1. We would like to speak with a person that played a key role in the decision to build a better-than-code building. Are you that person?

1. Yes
2. No
98. Don't know
99. Refused

B2. **[IF B1= YES]** Please describe your role in the decision making process.

B3. **[IF B1= YES]** Did others play a key role in the decision to build a better-than-code building? If so, can you provide the name, role, and contact information (either email or telephone) of one or two of the key decision-makers?

[IF B1= YES: GO TO SECTION B]

B4. **[IF B1= NO, DK or REFUSED]** Can you give us the names, roles and contact information of one or two people who played a key role in the decision to build a better-than-code building?

[IF B1= NO, DK or REFUSED: END] These are all the questions I have for you. Thank you very much for your time and cooperation!

C. Project Stage

C1. What stage of the project are you currently in? Has the construction phase already begun?

D. Free-ridership

D1. Why did your organization decide to build a better-than-code building? **[DO NOT READ]**

1. Lower operation costs
2. Energy policy in my organization
3. Environmental reasons/energy efficiency
4. Competitors are doing it
96. Other, specify: _____
98. Don't know
99. Refused

- D2. Was the design of your better-than-code building finalized BEFORE knowing that you would receive an incentive from Efficiency Nova Scotia?
1. Yes
 2. No
 98. Don't know
 99. Refused
- D3. **[IF D2= YES]** During the design stage, how confident were you that you would receive an incentive from Efficiency Nova Scotia? Were you **[READ]**?
1. Very confident
 2. Somewhat confident
 3. Not very confident
 4. Not at all confident
 98. Don't know
 99. Refused
- D4. Did the financial incentive offered by Efficiency Nova Scotia have an impact on the financing of your new building project? Which one of the following best represents the impact of the financial incentive? **[READ]**
1. Reduced the cost of the building's energy efficiency measures, allowing the project to be within **its approved budget**.
 2. Reduced the cost of the building's energy efficiency measures, significantly **strengthening the case for the overall project from a financial perspective**.
 3. Reduced the cost of the building's energy efficiency measures, **but even without the financial incentive, you would have included the same measures** for other reasons.
 4. Did not have a significant impact on the financing of the project.
 98. Don't know
 99. Refused
- D5. You received an incentive of **<MODELING INCENTIVE \$\$\$>** from Efficiency Nova Scotia for your building's energy model. Without this incentive, what is the likelihood that you would have hired an energy modeling consultant for your project? Answer on a scale of 0 to 10, where 0 means "Very unlikely" and 10 means "Very likely".
1. Score: _____
 98. Don't know
 99. Refused

- D6. **[IF D5 ≠ 98 OR 99]** Did the energy modeling consultant help you assess different options available for building envelope and HVAC equipment?
1. Yes
 2. No
 98. Don't know
 99. Refused
- D7. You will receive an incentive from Efficiency Nova Scotia specifically for the implementation of the energy efficiency measures. Without this incentive, which of the following scenarios would have been the most likely?
1. You would have designed the exact same better-than-code building.
 2. You would have designed a less efficient building but would have still exceeded the minimum energy efficiency requirements prescribed in the building code.
 3. You would have designed a less efficient building that met the minimum energy efficiency requirements prescribed in the building code.
 98. Don't know
 99. Refused
- D8. **[IF D7 = 2]** Without the incentive from Efficiency Nova Scotia or the expertise provided by the energy modeler, what is the likelihood that you would have designed a building with **HVAC equipment as efficient as those you plan to install**? Please answer on a scale of 0 to 10, where 0 means "Very unlikely" and 10 means "Very likely".
1. Score: _____
 98. Don't know
 99. Refused
- D9. **[IF D7 = 2]** Without the incentive from Efficiency Nova Scotia or the expertise provided by the energy modeler, what is the likelihood that you would have designed a building with **a building envelope as efficient as the one you designed, including insulation levels and glazing performance**? Please answer on a scale of 0 to 10, where 0 means "Very unlikely" and 10 means "Very likely".
1. Score: _____
 98. Don't know
 99. Refused

D10. **[IF D7 = 2]** Without the incentive Efficiency Nova Scotia or the expertise provided by the energy modeler, what is the likelihood that you would have designed a building with **as many efficiency measures as you included?** Please answer on a scale of 0 to 10, where 0 means “Very unlikely” and 10 means “Very likely”.

1. Score: _____

98. Don’t know

99. Refused

D11. **[IF D7 = 2 AND IF AVERAGE (D8,D9,D10) ≥ 8]** You mentioned that, without an incentive from Efficiency Nova Scotia or the energy modeler, you would have designed a less efficient building than your current design. Can you explain how your building would have been different than how it is designed right now?

D12. I would like you to rate the influence of specific factors in your decision to build a better-than-code building.

Using a scale of 0 to 10, where 0 means “Not at all important” and 10 means “Extremely important”, rate the importance of each of the following in your decision to build a better-than-code building.

- i. The program financial incentive for energy modeling.
- ii. The program financial incentive for implementation of energy efficiency measures.
- iii. The insights gained from the energy modeling regarding the energy savings associated with each potential measure.
- iv. The recommendations and technical assistance provided by the energy modeler, Business Development Manager, onsite energy manager, or other Efficiency Nova Scotia staff.
- v. The non-technical information offered by the energy modeler, Business Development Manager, onsite energy manager, or other Efficiency Nova Scotia staff on building better-than-code buildings, for example, the market trends, building certifications, operating costs, and tradespeople availability, among other things.

For each sub-question:

1. Score: _____

98. Don’t know

99. Refused

E. Cross-Influence

E1. Before participating in the Custom New Construction program for the building we discussed today, had you already participated in Custom New Construction or in another Efficiency Nova Scotia program?

1. Yes, Custom New Construction
2. Yes, in another Efficiency Nova Scotia program
3. Yes, both
4. No **[SKIP TO E4]** Erreur ! Source du renvoi introuvable.
98. Don't know **[SKIP TO E4]**
99. Refused **[SKIP TO E4]**

[ASK E2 AND E3 IF YES IN E1] For the following statements, please indicate whether you agree or disagree on a scale of 0 to 10, where 0 indicates "Completely disagree" and 10 indicates "Completely agree".

E2. Because of your previous participation in an Efficiency Nova Scotia program and what you learned from it, you asked a technical staff member or energy modeler to examine the energy efficiency options for your current building project.

1. Score: _____
98. Don't know
99. Refused

E3. Because of your previous participation in an Efficiency Nova Scotia program and what you learned from it, you looked at the cost effectiveness of the energy efficiency measures in your new building and evaluated the different options available.

1. Score: _____
98. Don't know
99. Refused

E4. Before participating in the New Construction program, had you seen energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, advertisements, brochures, newsletters or presentations?

1. Yes
2. No **[THANK AND TERMINATE]**
98. Don't know **[THANK AND TERMINATE]**
99. Refused **[THANK AND TERMINATE]**

Tell me whether you agree or disagree with each of the following statements, using a scale of 0 to 10, where 0 means “Completely disagree” and 10 means “Completely agree”.

E5. The energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, brochures, newsletters, or presentations were a major factor in your decision to build a better-than-code building.

1. Score: _____

98. Don't know

99. Refused

E6. The energy efficiency promotional materials through its website, brochures, newsletters, or presentations distributed by Efficiency Nova Scotia prompted you to ask a technical staff member or energy modeler to examine the energy efficiency options for your building project.

1. Score: _____

98. Don't know

99. Refused

E7. The energy efficiency promotional materials through its website, brochures, newsletters, or presentations distributed by Efficiency Nova Scotia prompted you to consider the cost effectiveness of the energy efficiency measures in your new building and evaluate the different options offered to your organization.

1. Score: _____

98. Don't know

99. Refused

END: These are all the questions I have for you. Thank you very much for your time and cooperation!

APPENDIX IV

CUSTOM: NEW CONSTRUCTION PARTICIPANT INTERVIEW GUIDE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview Guide
Estimated Time to Complete	20 minutes
Target Audience	New Construction participants (at completion stage)
Expected Number of Completions	Census
Contact List Source	2021 New Construction tracking sheet
Fielding Firm	Econoler/Narrative
Estimated Timeline for fielding	November 2021 – January 2022

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
How satisfied are the participants with New Construction?	E
What challenges or barriers, if any, have participants experienced with New Construction?	B
How did participants become aware of New Construction and what motivated them to participate?	B
What is the free-ridership level for New Construction for 2021?	C, E

To be adapted by Econoler **[Blue text]**

Import variables from database < **LIKE THIS** >

Skip pattern or programming instructions **[LIKE THIS]**

Black text: instructions for interviewer **[NOTE: xxxx] / [PROBE: xxxx]**

Introduction

I am with Narrative, and we are conducting an evaluation of the Efficiency Nova Scotia Custom New Construction program. This interview should take about 20 minutes. Is this still a good time for you?

The purpose of the interview is to better understand your organization's decision to build an energy efficient building, including your choice of energy efficient materials or equipment that exceed building code requirements. During this interview, I will refer to this as your decision "to build a better-than-code building".

Your responses will be kept confidential, and your comments will be combined with those of other program participants. Your responses will not affect the incentive amount you have received for this project.

A. Identifying Key Decision-makers

A1. We would like to speak with a person that played a key role in the decision to build a better-than-code building. Are you that person?

1. Yes
2. No
98. Don't know
99. Refused

A2. **[IF B1= YES]** Please describe your role in the decision-making process.

A3. **[IF B1= YES]** Did others play a key role in the decision to build a better-than-code building? If so, can you provide the name, role, and contact information (either email or telephone) of one or two of the key decision-makers?

[IF B1= YES: GO TO SECTION B]

A4. **[IF B1= NO, DK or REFUSED]** Can you give us the names, roles and contact information of one or two people who played a key role in the decision to build a better-than-code building?

[IF B1= NO, DK or REFUSED: END] These are all the questions I have for you. Thank you very much for your time and cooperation! **SCHEDULE INTERVIEW WITH KEY DECISION-MAKERS**

B. Participant Perspectives

- B1. How did you first hear about the New Construction program?
- B2. Why did you decide to participate in this program?
- B3. Did you face any challenges or barriers related to the program during the planning and construction of your building?
- B4. **[IF B3= YES]** What was the greatest challenge or barrier?

C. Free-ridership

- C1. Why did your organization decide to build a better-than-code building? **[DO NOT READ]**
1. Lower operation costs
 2. Energy policy in my organization
 3. Environmental reasons/energy efficiency
 4. Competitors are doing it
 96. Other, specify: _____
 98. Don't know
 99. Refused
- C2. Was the design of your better-than-code building finalized BEFORE knowing that you would receive an incentive from Efficiency Nova Scotia?
1. Yes
 2. No
 98. Don't know
 99. Refused
- C3. **[IF D1 = YES]** During the design stage, how confident were you that you would receive an incentive from Efficiency Nova Scotia? Were you **[READ]**?
1. Very confident
 2. Somewhat confident
 3. Not very confident
 4. Not at all confident
 98. Don't know
 99. Refused

- C4. Did the financial incentive offered by Efficiency Nova Scotia have an impact on the financing of your new building project? Which one of the following best represents the impact of the financial incentive? **[READ]**
1. Reduced the cost of the building's energy efficiency measures, allowing the project to be **within its approved budget**.
 2. Reduced the cost of the building's energy efficiency measures, significantly **strengthening the case for the overall project from a financial perspective**.
 3. Reduced the cost of the building's energy efficiency measures, **but even without the financial incentive, you would have included the same measures** for other reasons.
 4. Did not have a significant impact on the financing of the project.
 98. Don't know
 99. Refused
- C5. You received an incentive of **<MODELING INCENTIVE \$\$\$>** from Efficiency Nova Scotia for your building's energy model. Without this incentive, what is the likelihood that you would have hired an energy modeling consultant for your project? Answer on a scale of 0 to 10, where 0 means "Very unlikely" and 10 means "Very likely".
1. Score: _____
 98. Don't know
 99. Refused
- C6. **[IF D5 ≠ 98 OR 99]** Did the energy modeling consultant help you assess different options available for building envelope and HVAC equipment?
1. Yes
 2. No
 98. Don't know
 99. Refused
- C7. You have received an incentive of **<IMPLEMENTATION INCENTIVE \$\$\$>** from Efficiency Nova Scotia specifically for the implementation of the energy efficiency measures. Without this incentive, which of the following scenarios would have been the most likely?
1. You would have designed the exact same better-than-code building.
 2. You would have designed a less efficient building but still exceeded the minimum energy efficiency requirements prescribed in the building code.
 3. You would have designed a less efficient building that met the minimum energy efficiency requirements prescribed in the building code.
 98. Don't know
 99. Refused

- C8. **[IF C77 = 2]** Without the incentive provided by Efficiency Nova Scotia or the expertise provided by the energy modeler, what is the likelihood that you would have designed a building with **HVAC equipment as efficient as those you installed**? Please answer on a scale of 0 to 10, where 0 means “Very unlikely” and 10 means “Very likely”.
1. Score: _____
98. Don’t know
99. Refused
- C9. **[IF C7 = 2]** Without the incentive from Efficiency Nova Scotia or the expertise provided by the energy modeler, what is the likelihood that you would have designed a building with **a building envelope as efficient as the one you designed, including insulation levels and glazing performance**? Please answer on a scale of 0 to 10, where 0 means “Very unlikely” and 10 means “Very likely”.
1. Score: _____
98. Don’t know
99. Refused
- C10. **[IF C7 = 2]** Without the incentive from Efficiency Nova Scotia or the expertise provided by the energy modeler, what is the likelihood that you would have designed a building with **as many efficiency measures as you included**? Please answer on a scale of 0 to 10, where 0 means “Very unlikely” and 10 means “Very likely”.
1. Score: _____
98. Don’t know
99. Refused
- C11. **[IF C7 = 2 AND IF AVERAGE (D8,D9,D10) ≥ 8]** You mentioned that, without an incentive from Efficiency Nova Scotia or the energy modeler, you would have designed a less efficient building than your current design. Can you explain how your building would have been different than what it is right now?

C12. I would like you to rate the influence of specific factors in your decision to build a better-than-code building.

Using a scale of 0 to 10, where 0 means “Not at all important” and 10 means “Extremely important”, rate the importance of each of the following in your decision to build a better-than-code building.

- a. The program financial incentive for energy modeling.
- b. The program financial incentive for implementation of energy efficiency measures.
- c. The insights gained from the energy modeling regarding the energy savings associated with each potential measure.
- d. The recommendations and technical assistance provided by the energy modeler, Business Development Manager, onsite energy manager, or other Efficiency Nova Scotia staff.
- e. The non-technical information offered by the energy modeler, Business Development Manager, onsite energy manager, or other Efficiency Nova Scotia staff on building better-than-code buildings, for example, the market trends, building certifications, operating costs, and tradespeople availability, among other things.

For each sub-question:

1. Score: _____
98. Don't know
99. Refused

D. Cross-Influence

D1. Before participating in the Custom New Construction program for the building we discussed today, had you already participated in Custom New Construction or in another Efficiency Nova Scotia program?

1. Yes, Custom New Construction
2. Yes, in another Efficiency Nova Scotia program
3. Yes, both
4. No **[SKIP TO ERREUR ! SOURCE DU RENVOI INTROUVABLE.]**
98. Don't know **[SKIP TO Erreur ! Source du renvoi introuvable.]**
99. Refused **[SKIP TO D4]**

[ASK D2 AND D3 IF D1= YES] Tell me whether you agree or disagree with the following statements, using a scale of 0 to 10, where 0 means “Completely disagree” and 10 means “Completely agree”.

D2. **[ASK IF D1= YES]** Because of your previous participation in an Efficiency Nova Scotia program and what you learned from it, you asked a technical staff member or energy modeler to examine the energy efficiency options for your current building project.

- 1. Score: _____
- 98. Don't know
- 99. Refused

D3. **[ASK IF D1= YES]** Because of your previous participation in an Efficiency Nova Scotia program and what you learned from it, you looked at the cost effectiveness of the energy efficiency measures in your new building by evaluating the different options available.

- 1. Score: _____
- 98. Don't know
- 99. Refused

D4. Before participating in the New Construction program, had you seen energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, advertisements, brochures, newsletters or presentations?

- 1. Yes
- 2. No **[SKIP TO E1]**
- 98. Don't know **[SKIP TO E1]**
- 99. Refused **[SKIP TO E1]**

[ASK D5 TO D7 IF D4=YES] Tell me whether you agree or disagree with each of the following statements, using a scale of 0 to 10, where 0 means "Completely disagree" and 10 means "Completely agree".

D5. **[ASK IF D4= YES]** The energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, brochures, newsletters, or presentations were a major factor in your decision to build a better-than-code building.

- 1. Score: _____
- 98. Don't know
- 99. Refused

- D6. **[ASK IF D4= YES]** The energy efficiency promotional materials through its website, brochures, newsletters, or presentations distributed by Efficiency Nova Scotia prompted you to ask a technical staff member or energy modeler to examine the energy efficiency options for your building project.
1. Score: _____
98. Don't know
99. Refused
- D7. **[ASK IF D4= YES]** The energy efficiency promotional materials through its website, brochures, newsletters, or presentations distributed by Efficiency Nova Scotia prompted you to consider the cost effectiveness of the energy efficiency measures in your new building by evaluating the different options offered to your organization.
1. Score: _____
98. Don't know
99. Refused

E. Satisfaction

- E1. Using a scale from 1 to 10 where 1 is "not at all satisfied" and 10 is "completely satisfied" how would you rate your satisfaction with the New Construction program overall?
- E2. **[IF E1<8]** What one factor or issue, if resolved, would increase your satisfaction score?
- E3. **[IF E1>8]** What is the one thing you are most satisfied with?
- E4. Finally, do you have any suggestions to improve the New Construction program?

END: These are all the questions I have for you. Thank you very much for your time and cooperation!

APPENDIX V

CUSTOM: RETROFIT AND BUILDING OPTIMIZATION PARTICIPANT INTERVIEW GUIDE

Question
INTRODUCTION I am with _____ and we are performing an evaluation of the [Custom Retrofit or Building Optimization program] service offered by Efficiency Nova Scotia. This interview should take up to 30 minutes. Is this still a good time for you? Through this interview, we hope to better understand your organization's decision-making process regarding to your energy efficiency project. More specifically, we hope to better understand how you made the decision to proceed with the implementation of your energy efficiency [Retrofit or Building Optimization Project]. We will refer to this as your decision "to implement your energy efficiency project" throughout this interview. Your responses will be kept confidential, and the results will be combined with those of other program participants. Your responses will not affect the incentive amount you have or will receive for this project.
Identifying Key Decision-makers
A1a. We hope to interview the key decision-makers that played a key role in the decision to implement the energy efficiency project. Were you a key decision-maker? 1) Yes 2) No 98) DK/Refuse
A1b. [IF A1a=YES OR DK/Refuse] Please describe your role in the decision-making process.
A1c. [IF A1a=YES] Were there other key decision-makers that played a role in the decision to implement the energy efficiency project? If so, can you provide their names, roles, and contact information?
A2. [IF A1a=NO] Who were the key decision-makers that played a key role in the decision to implement the energy efficiency project? Can you provide their names, roles, contact information?
Satisfaction
B1. Using a scale from 1 to 10 where 1 is "not at all satisfied" and 10 is "completely satisfied" how would you rate your satisfaction with the Custom [Retrofit or Building Optimization] program overall? Score: _____
B2. [IF B1<8] What single factor or issue, if resolved, would allow you to provide a higher score?
B3. [IF B1≥8] What is the most important factor supporting your assessment?
Participant Perspectives
C1. How did you first hear about the Custom [Retrofit or Building Optimization] program?
C2. What motivated you to participate in the Custom [Retrofit or Building Optimization] program?
C3. Did you face any challenges or barriers when implementing your energy efficiency project through the program?
C4. [IF C3=YES, then ask:] What was the most significant challenge or barrier?
C5. Do you have any suggestions to improve the [Custom Retrofit or Building Optimization program]?

Question
Planning
D1. Had your organization finalized the details of the energy efficiency project BEFORE knowing that you would receive an incentive from Efficiency Nova Scotia? 1) Yes 2) No 98) DK/Refuse
D2. [IF D1=1] When you decided to implement the energy efficiency project, how confident were you that you would receive an incentive from Efficiency Nova Scotia? [READ] 1) Very confident 2) Somewhat confident 3) Not very confident 4) Not at all confident 98) DK/Refuse
Cost
E1. Efficiency Nova Scotia gave your organization a rebate of \$<STUDY INCENTIVE> for the [Investigation or Feasibility] study and \$<IMPLEMENTATION INCENTIVE> for the project implementation. Did the financial incentives have an impact on the financial case for your energy efficiency project? Which of the following best represents the role of the financial incentive? [READ]? 1) Reduced the cost of the energy efficiency measures to bring the project within the organization's pre-determined financial thresholds for approval. 2) Reduced the cost of the energy efficiency measures to make the financial case more attractive within the decision-making process. 3) Reduced the cost of the energy efficiency measures, but even without financial support, you would have included the same measures for other reasons. 4) Did not have a significant impact on the decision. 98) DK/Refuse
[ASK IF \$<STUDY INCENTIVE> ≥ 0] E2a. As part of its Custom [Retrofit or Building Optimization] program, Efficiency Nova Scotia gave your organization a \$<STUDY INCENTIVE> incentive for the [Investigation or Feasibility] study. In the absence of the program, what is the likelihood that you would have conducted this study? Please answer on a scale of 0 to 10, where 0 means "Very unlikely" and 10 means "Very likely". Score: _____ 98) DK/Refuse
E2b. [IF E2a ≠ 98] Did you use the study as a decision-making tool to develop and compare the potential measures for the eventual energy efficiency project? 1) Yes 2) No 98) DK/Refuse

Question
Efficiency and Quantity F1. You received an \$<IMPLEMENTATION INCENTIVE> incentive based on energy savings when your energy efficiency project was completed. Without the implementation incentive from Efficiency Nova Scotia, which of the following scenarios would have been the most likely? [READ] 1) Would have implemented the exact same energy efficiency project. 2) Would have implemented a project with fewer or less impactful energy efficiency measures. 3) Would have delayed the project by at least a year. 4) Would not have implemented the project at all. 98) DK/Refuse
Influence G1. I'm going to ask you to rate the importance of factors that may have influenced your decision to implement the energy efficiency project based on your participation in the Custom [Retrofit or Building Optimization] program. Using a scale of 0 to 10, where 0 means "Not at all important" and 10 means "Extremely important", please rate the importance of each of the following in your decision to implement the energy efficiency measures through the Custom [Retrofit or Building Optimization] program. a. The program financial incentive for [Investigation or Feasibility Study]. b. The program financial incentive for implementation of energy efficiency measures. c. The insights obtained through the study to make decisions about the energy savings associated with each potential measure. d. The recommendations and technical assistance provided by the Business Development Manager, or other Efficiency Nova Scotia staff in selecting and designing your energy efficiency measures. e. The non-technical information offered by the Business Development Manager, onsite energy manager, or other Efficiency Nova Scotia staff on energy efficiency such as but not limited to market trends, operating costs, and tradespeople availability. For each sub-question : Score : _____ 98) DK/Refuse
G2. We understand that your organization availed itself of the services of an Onsite Energy Manager during the time that this project was being considered for implementation. Can you confirm this? 1) Yes 2) No 98) DK/Refuse
G3. [IF G2=YES] Using a scale of 0 to 10, where 0 means "Not at all important" and 10 means "Extremely important", please rate the importance of the OEM contributions to the decision process that led to implementing the energy efficiency measures through the Custom [Retrofit or Building Optimization] program. For each sub-question. Score: _____ 98) DK/Refuse a. Identification of the measure in the project. b. Development of the business case for the project. c. Socializing the project with relevant decision-making stakeholders and/or selling the business case. d. Developing the technical specification of the measures and/or interfacing with third-party service providers. e. Managing and advancing decision-making tasks and maintaining project momentum.

Question
G4. Can you explain why your organization decided to implement the energy efficiency project? [DO NOT READ] Answer: _____ Pre-coded answers [DO NOT READ]: 1) Lower operation costs 2) Energy policy in my organization 3) Environmental reasons/energy efficiency 4) Competitors are doing it 96) Other, specify: _____ 98) DK/Refuse
Cross Influence H1. Before participating in the [Custom Retrofit or Building Optimization program] service for this project, had you already participated in [Custom Retrofit or Building Optimization program] or in another Efficiency Nova Scotia program? 1) Yes, Custom Retrofit or Building Optimization program. 2) Yes, in another Efficiency Nova Scotia program 3) Yes, both 4) No (SKIP TO H4) 98) DK/Refuse (SKIP TO H4) For the following statements, please indicate whether you agree or disagree on a scale of 0 to 10, where 0 indicates “Completely disagree” and 10 indicates “Completely agree”.
H2. [IF H1 = 1 OR 2] Due to your previous participation in an Efficiency Nova Scotia program and what you learned by participating in that program, you asked a technical staff member to examine the energy efficiency options for your project. Score: _____ 98) DK/Refuse
H3. [IF H1 = 1 OR 2] Due to your previous participation in an Efficiency Nova Scotia program and what you learned by participating in that program, you considered the cost effectiveness of the energy efficiency measures for your project by evaluating the different options for your organization. Score: _____ 98) DK/Refuse
H4. Before participating in the [Custom Retrofit or Building Optimization program] had you already seen energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, brochures, newsletters or presentations? 1) Yes 2) No (Thank and terminate) 98) DK/Refuse (Thank and terminate) For the following statements, please indicate whether you agree or disagree on a scale of 0 to 10, where 0 indicates “Completely disagree” and 10 indicates “Completely agree”.
H5. [IF H4 = 1] The energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, brochures, newsletters, or presentations were a major factor in your decision to implement the energy efficiency project. Score: _____

Question
98) DK/Refuse
H6. [IF H4 = 1] The energy efficiency promotional materials distributed by Efficiency Nova Scotia prompted you to ask a technical staff member to examine the energy efficiency options for your project. Score: _____ 98) DK/Refuse
H7. [IF H4 = 1] The energy efficiency promotional materials distributed by Efficiency Nova Scotia prompted you to consider the cost effectiveness of the energy efficiency measures by evaluating the different options for your organization. Score: _____ 98) DK/Refuse
Spillover
I1. Since first taking part in the Custom [Retrofit or Building Optimization] program, have you implemented any additional energy efficiency measures other than those implemented through the program? 1) Yes 2) No 98) DK/Refuse
I2. [IF I1 = 1] For the energy efficiency upgrades that you implemented on your own, did you receive or plan on requesting financing or rebates from Efficiency Nova Scotia? 1) Yes 2) No 98) DK/Refuse
I3. [IF I1 = 1] Can you please describe these measures? 1. Name of measure 2. Type of energy source saved If all non-electric, thank and terminate. 3. Location of the facility If not in Nova Scotia, thank and terminate. 4. Quantity of measures (or area covered by the measure) 5. Technical information, such as HOU, capacity, efficiency, etc. 6. Estimated savings (in kWh or \$) 7. If no quantitative information is available, but the measure is the same as the one implemented through Custom [Retrofit or Building Optimization], probe participant on its relative size with respect to the Custom [Retrofit or Building Optimization] project evaluated (% of size, area covered by measure, price, etc).
I4. Did your experience with the energy efficiency project implemented through Custom [Retrofit or Building Optimization] program influence your decision to implement these additional energy efficiency measures on your own? Please, rate the level of influence on a scale of 0 to 10, where 0 indicates that the program “had no influence at all on your decision to implement the energy efficiency measures” and 10 indicates that the program was “extremely influential to your decision to implement energy efficiency measures.” Score: _____ 98) DK/Refuse
I5. What is/are the main reason or reasons that you implemented this project without the assistance of an Efficiency Nova Scotia program?

APPENDIX VI

CUSTOM: RETROFIT PROJECT REVIEW PROTOCOL

This appendix describes the protocol used as part of Retrofit project reviews and follow-up participant interviews.

Project Review Protocol

The Evaluator made several improvements to the 2020 project review protocol to develop the 2021 project review protocol. Those improvements included the addition of questions and assessment fields for measurement and verification (M&V) plans and reports to ensure that the review is consistent with past Evaluator recommendations. We also migrated the measure-specific data fields to dedicated worksheets for individual project measures. This change resolved certain minor formatting concerns to streamline the main project worksheet.

Prior to conducting telephone project review interviews or on-site visits, the Evaluator reviewed all project documentation submitted by EfficiencyOne (EOne). Those documents included, although were not limited to, the following: Scoping and/or feasibility studies, energy efficiency measure (EEM) savings calculations, project development agreements, M&V reports, and email correspondence.

The Evaluator used the protocol form presented below to collect technical data and summarize information such as project details, key parameters to be reviewed during the telephone project review interviews, and previous M&V activities. Other collected technical information includes, although is not limited to, equipment operating schedules, equipment specifications and quantities, baseline conditions, typical equipment loads, and changes that occurred since M&V had been conducted.

1. General Information

Virtual Visit Date:		Team:		Contact Name:									
Project ID:				Contact Title:									
Project Type:				Contact Phone:									
Company Name:				Email:									
Facility Name:													
Address:													
Consultant:													
List of people met during the visit:													
Type of building:	<table border="1"> <tr> <td>Commercial/institutional</td> <td>☐</td> </tr> <tr> <td>Municipal</td> <td>☐</td> </tr> </table>	Commercial/institutional	☐	Municipal	☐	<table border="1"> <tr> <td>Industrial/manufacturing</td> <td>☐</td> </tr> <tr> <td>Other (specify)</td> <td>☐</td> </tr> </table>	Industrial/manufacturing	☐	Other (specify)	☐		Specify:	
Commercial/institutional	☐												
Municipal	☐												
Industrial/manufacturing	☐												
Other (specify)	☐												

2. Facility and Project Description

Facility Description: Outline a quick description of the facility and its primary operation/purpose.

NOTE: PC Users "Alt+Enter" for new line in cell. MAC Users "CMD+Option+Enter".

Project Description:

Indicate the key variables & observations from all available reports. These notes will serve to guide the virtual visit and identify the main information to collect and/or verify.

Measure #1:
Measure #2:
Add other lines as needed

3. M&V Plans and Documentation

1a. Is there any documentation that describes the plan for M&V dated from before the project takes place? (Y/N)

IF ANSWER TO QUESTION 1a. IS "NO", GO TO NEXT SECTION

1b. Does this document provide a description of:

- i. Selection and substantiation of the project measurement boundary and justification of IPVMP Option? (Y/N)
- ii. Selection and substantiation of the baseline measurement period? (Y/N)
- iii. Selection and substantiation of the performance measurement period? (Y/N)
- iv. Description of the savings calculation methodology? (Y/N)
- v. Consideration of actual and potential independent variables? (Y/N)
- vi. Consideration of actual and potential interactive effects? (Y/N)
- vii. Description of the data collection approach for capturing relevant dependant and independent variables? (Y/N)
- viii. Consideration of potential operational impacts and non-routine adjustments? (Y/N)
- ix. Consideration of potential COVID impacts and non-routine adjustments? (Y/N)

2. Is the scope and detail of the documentation above commensurate with the energy and demand savings, budget, incentive level or technical complexity of the project in general alignment with the table from tab "M&V Table"?

i. For the M&V plan (Y/N)

ii. For the M&V results (Y/N)

Please see table to the right for definitions of Small to Large projects

3. If an M&V plan was prepared ahead of project completion, was it followed and reflected in the M&V Report? (Y/N)

Intermediate M&V score - Pre-evaluation

#DIV/0!

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Écrire questions en rouge (pour interview) et les notes en noir

Notes during/after interview

4. On-site or Virtual Review

Filled out on subsequent worksheets, one worksheet for each measure.

5. Other questionnaires

Market questionnaire filled-in (Y/N)

Free-ridership questionnaire filled-in (Y/N)

Spillover questionnaire filled-in (Y/N)

Sections below to be filled after the visit
6. Estimated Useful Life "EUL" of the project

	Type of replacement	EUL	
Measure #1			
Measure #2			
Tracked Project EUL (yrs)			Refer to project documentation for tracked baseline EUL
Evaluated Project EUL (yrs)			Refer to program document for standard EUL to be used
Explanation			

7. Energy and Demand Savings Adjustments PAR MEASURE

Measure #1		#REF!				
		Tracking sheet	Evaluator	% of Tracked savings	Project status	Finish month
Electricity Savings	kWh/yr					
Peak Demand Savings	kW					
Peak Coincidence Factor	-					

Measure #2		#REF!				
		Tracking sheet	Evaluator	% of Tracked savings	Project status	Finish month
Electricity Savings	kWh/yr					
Peak Demand Savings	kW					
Peak Coincidence Factor	-					

TOTAL		0				
		Tracking sheet	Evaluator	% of Tracked savings	Project status	Finish month
Electricity Savings	kWh/yr	0	0	#DIV/0!		
Peak Demand Savings	kW	0	0	#DIV/0!		
Peak Coincidence Factor	-					

Adjustments made to electricity savings?		(Y/N)
Adjustments made to demand savings?		(Y/N)
Adjustments made to PCF?		(Y/N)
Changes between PDA and completion?		(Y/N)
If Yes, was the tracking sheet adjusted accordingly?		(Y/N)

8. Summarize Project Adjustments and Final Savings Values - SUMMARY FOR EOne

If any adjustments were made to the energy savings, demand savings or PCF, describe the rationale and provide calculations.

4. On-site or Virtual Review (continued)

Section to be filled out with questions prior to virtual visits, and answers to be included during the call. Create new worksheet and repeat for each measure, as needed.

Measure #1

Validation of the measure

Validate the installation and quantities. Do we have pictures (nameplate) in the file? Can we see it during the call? Is there invoices confirming the quantities?

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Baseline

4. Does the baseline measurement match what the project says is the baseline, and is it aligned with program rules?

9. Has anything changed between the baseline and reporting period? (Y/N)

a. If #9 is Y, has a non-routine adjustment been applied? (Y/N)

What is the baseline? Existing equipment, new construction? Was the equipment at the end of its useful life?

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Operating Schedule

Include notes on schedule and seasonal variations. The operating schedule corresponds to the **typical** one (non-COVID).

6. Is the M&V period appropriate? (Y/N)

a. Do both the baseline and reporting periods cover all ranges of operation parameters?

b. Is M&V occurring in a reasonable period before and right after the EE project was implemented?

c. Does the period capture seasonal effects?

Savings calculation approach

How are savings calculated? What are the key parameters to validate?

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Savings calculation approach -Projects using engineering calculations (Q #11 & #12 + Smaller Simpler projects)

- 11.,a) Do the equation respect the laws of physics and accurately represent the system that is being modified as part of the project?
- b) Are the values used in the calculation reasonable and based on valid references?
- c) Are the calculations computed correctly?

Savings calculation approach - Projects with M&V

5. Are the M&V boundaries capturing all the energy consumption that's impacted by the project? (Y/N)
7. Are M&V results measured in a short period extrapolated to annual results appropriately? (Y/N)
- a. Is the extrapolation consistent with what a "typical year" should be?
- b. Are operating conditions that were not covered in M&V taken into consideration when developing the extrapolation
8. If a regression is used (based on HDD, tons/day...) to build a performance equation as part of the M&V, is it valid?
- a. The Evaluator will want to be satisfied that the regression makes sense when looking at the physics of the situation.
- b. The Evaluator will want to be satisfied that statistical indicators were used to validate the fitness of the regression?

Report the virtual visit and indicate the key observations and findings made during the interview..

Seasonal Load Profile? (Y/N) Summer Load Variations? (Y/N)

Predicted Results (MWh)	M&V Results	Percent of Expected (%)	M&V Start Date	M&V Finish Date	Days in Period
					0

Intermediate M&V score - MEASURE #1

#####

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

COVID Impact for Measure #1

Include notes on how calculated savings are impacted by COVID, if so.

Detail any adjustment, along with the rationale, needed to bring back the savings to a typical year.

10 .Has this measure been impacted by COVID? (Y/N)	
a.i.Hours of occupancy, or production schedules? (Y/N)	
a.ii. Level of occupancy during occupied hours, or production intensity during production periods? (Y/N)	
b.If so, how has this impacted the selection of the baseline or reporting periods M&V methods? (Y/N)	
c.Is a non-routine adjustment warranted? (Y/N)	
d.Has a non-routine adjustment been appropriately applied? (Y/N)	

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Peak Demand Savings? YES ☐ NO ☐

Notes on peak demand savings (Nova Scotia Peak Period: weekdays between 5 and 7 p.m. between Dec and Feb)

Are demand savings based on measurements? ☐ (Y/N)

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Interactive Effects? YES ☐ NO ☐

Briefly describe interactive effects for the project and relevant information on **heating/cooling system** as required.

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

APPENDIX VII

CUSTOM: BUILDING OPTIMIZATION PROJECT REVIEW PROTOCOL

This appendix describes the protocol used for Building Optimization project reviews and follow-up participant interviews.

Project Review Protocol

The Evaluator made several minor improvements to the 2020 project review protocol to develop the 2021 project review protocol. These improvements included the addition of questions and assessment fields for measurement and verification (M&V) plans and reports to ensure that the review is consistent with past Evaluator recommendations. We also migrated the measure-specific data fields to dedicated worksheets for individual project measures. This change resolved certain minor formatting concerns to streamline the main project worksheet.

Prior to conducting telephone project review interviews, the Evaluator reviewed all project documentation submitted by EfficiencyOne (EOne). These documents included, although were not limited to, the following: Scoping and/or feasibility studies, energy efficiency measure (EEM) savings calculations, project development agreements, M&V reports, and email correspondence.

The Evaluator used the protocol form presented below to collect technical data and summarize information such as project details, key parameters to be reviewed during the telephone project review interviews, and previous M&V activities. The Evaluator reviewed such information as the quantity and type of systems commissioned, the equipment and facility operation schedules, and changes made to the control methods and set points. If a building automation system (BAS) was installed, the Evaluator also reviewed screenshots of monitored data.

1. General Information

Virtual Visit Date:		Team:		Contact Name:									
Project ID:				Contact Title:									
Project Type:				Contact Phone:									
Company Name:				Email:									
Facility Name:													
Address:													
Consultant:													
List of people met during the visit:													
Type of building:	<table border="1"> <tr> <td>Commercial/institutional</td> <td>☐</td> </tr> <tr> <td>Municipal</td> <td>☐</td> </tr> </table>	Commercial/institutional	☐	Municipal	☐	<table border="1"> <tr> <td>Industrial/manufacturing</td> <td>☐</td> </tr> <tr> <td>Other (specify)</td> <td>☐</td> </tr> </table>	Industrial/manufacturing	☐	Other (specify)	☐		Specify:	
Commercial/institutional	☐												
Municipal	☐												
Industrial/manufacturing	☐												
Other (specify)	☐												

2. Facility and Project Description

Facility Description: Outline a quick description of the facility and its primary operation/purpose.

NOTE: PC Users "Alt+Enter" for new line in cell. MAC Users "CMD+Option+Enter".

Project Description:

Indicate the key variables & observations from all available reports. These notes will serve to guide the virtual visit and identify the main information to collect and/or verify.

Measure #1:
Measure #2:
Add other lines as needed

3. M&V Plans and Documentation

1a. Is there any documentation that describes the plan for M&V dated from before the project takes place? (Y/N)

IF ANSWER TO QUESTION 1a. IS "NO", GO TO NEXT SECTION

1b. Does this document provide a description of:

- i. Selection and substantiation of the project measurement boundary and justification of IPVMP Option? (Y/N)
- ii. Selection and substantiation of the baseline measurement period? (Y/N)
- iii. Selection and substantiation of the performance measurement period? (Y/N)
- iv. Description of the savings calculation methodology? (Y/N)
- v. Consideration of actual and potential independent variables? (Y/N)
- vi. Consideration of actual and potential interactive effects? (Y/N)
- vii. Description of the data collection approach for capturing relevant dependant and independent variables? (Y/N)
- viii. Consideration of potential operational impacts and non-routine adjustments? (Y/N)
- ix. Consideration of potential COVID impacts and non-routine adjustments? (Y/N)

2. Is the scope and detail of the documentation above commensurate with the energy and demand savings, budget, incentive level or technical complexity of the project in general alignment with the table from tab "M&V Table"?

i. For the M&V plan (Y/N)

ii. For the M&V results (Y/N)

Please see table to the right for definitions of Small to Large projects

3. If an M&V plan was prepared ahead of project completion, was it followed and reflected in the M&V Report? (Y/N)

Intermediate M&V score - Pre-evaluation

#DIV/0!

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Écrire questions en rouge (pour interview) et les notes en noir

Notes during/after interview

4. On-site or Virtual Review

Filled out on subsequent worksheets, one worksheet for each measure.

5. Other questionnaires

Market questionnaire filled-in (Y/N)

Free-ridership questionnaire filled-in (Y/N)

Spillover questionnaire filled-in (Y/N)

Sections below to be filled after the visit
6. Estimated Useful Life "EUL" of the project

	Type of replacement	EUL
Measure #1		
Measure #2		
Tracked Project EUL (yrs)		Refer to project documentation for tracked baseline EUL
Evaluated Project EUL (yrs)		Refer to program document for standard EUL to be used

Explanation

7. Energy and Demand Savings Adjustments PAR MESURE

Measure #1		#REF!				
		Tracking sheet	Evaluator	% of Tracked savings	Project status	Finish month
Electricity Savings	kWh/yr					
Peak Demand Savings	kW					
Peak Coincidence Factor	-					

Measure #2		#REF!				
		Tracking sheet	Evaluator	% of Tracked savings	Project status	Finish month
Electricity Savings	kWh/yr					
Peak Demand Savings	kW					
Peak Coincidence Factor	-					

TOTAL		0				
		Tracking sheet	Evaluator	% of Tracked savings	Project status	Finish month
Electricity Savings	kWh/yr	0	0	#DIV/0!		
Peak Demand Savings	kW	0	0	#DIV/0!		
Peak Coincidence Factor	-					

Adjustments made to electricity savings?		(Y/N)
Adjustments made to demand savings?		(Y/N)
Adjustments made to PCF?		(Y/N)
Changes between PDA and completion?		(Y/N)
If Yes, was the tracking sheet adjusted accordingly?		(Y/N)

8. Summarize Project Adjustments and Final Savings Values - SUMMARY FOR EOne

If any adjustments were made to the energy savings, demand savings or PCF, describe the rationale and provide calculations.

4. On-site or Virtual Review (continued)

Section to be filled out with questions prior to virtual visits, and answers to be included during the call. Create new worksheet and repeat for each measure, as needed.

Measure #1

Validation of the measure

Validate the installation and quantities. Do we have pictures (nameplate) in the file? Can we see it during the call? Is there invoices confirming the quantities?

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Baseline

4. Does the baseline measurement match what the project says is the baseline, and is it aligned with program rules?

9. Has anything changed between the baseline and reporting period? (Y/N)

a. If #9 is Y, has a non-routine adjustment been applied? (Y/N)

What is the baseline? Existing equipment, new construction? Was the equipment at the end of its useful life?

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Operating Schedule

Include notes on schedule and seasonal variations. The operating schedule corresponds to the **typical** one (non-COVID).

6. Is the M&V period appropriate? (Y/N)

a. Do both the baseline and reporting periods cover all ranges of operation parameters?

b. Is M&V occurring in a reasonable period before and right after the EE project was implemented?

c. Does the period capture seasonal effects?

Savings calculation approach

How are savings calculated? What are the key parameters to validate?

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Savings calculation approach -Projects using engineering calculations (Q #11 & #12 + Smaller Simpler projects)

- 11.,a) Do the equation respect the laws of physics and accurately represent the system that is being modified as part of the project?
- b) Are the values used in the calculation reasonable and based on valid references?
- c) Are the calculations computed correctly?

Savings calculation approach - Projects with M&V

5. Are the M&V boundaries capturing all the energy consumption that's impacted by the project? (Y/N)
7. Are M&V results measured in a short period extrapolated to annual results appropriately? (Y/N)
- a. Is the extrapolation consistent with what a "typical year" should be?
- b. Are operating conditions that were not covered in M&V taken into consideration when developing the extrapolation
8. If a regression is used (based on HDD, tons/day...) to build a performance equation as part of the M&V, is it valid?
- a. The Evaluator will want to be satisfied that the regression makes sense when looking at the physics of the situation.
- b. The Evaluator will want to be satisfied that statistical indicators were used to validate the fitness of the regression?

Report the virtual visit and indicate the key observations and findings made during the interview..

Seasonal Load Profile? (Y/N) Summer Load Variations? (Y/N)

Predicted Results (MWh)	M&V Results	Percent of Expected (%)	M&V Start Date	M&V Finish Date	Days in Period
					0

Intermediate M&V score - MEASURE #1

#####

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

COVID Impact for Measure #1

Include notes on how calculated savings are impacted by COVID, if so.

Detail any adjustment, along with the rationale, needed to bring back the savings to a typical year.

10. Has this measure been impacted by COVID? (Y/N)	
a.i. Hours of occupancy, or production schedules? (Y/N)	
a.ii. Level of occupancy during occupied hours, or production intensity during production periods? (Y/N)	
b. If so, how has this impacted the selection of the baseline or reporting periods M&V methods? (Y/N)	
c. Is a non-routine adjustment warranted? (Y/N)	
d. Has a non-routine adjustment been appropriately applied? (Y/N)	

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Peak Demand Savings? YES ☐ NO ☐

Notes on peak demand savings (Nova Scotia Peak Period: weekdays between 5 and 7 p.m. between Dec and Feb)

Are demand savings based on measurements? ☐ (Y/N)

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Interactive Effects? YES ☐ NO ☐

Briefly describe interactive effects for the project and relevant information on **heating/cooling system** as required.

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

APPENDIX VIII

CUSTOM: OEM DEMAND SAVINGS PILOT PROJECT REVIEW PROTOCOL

This appendix describes the protocol used for OEM Demand Savings Pilot project reviews.

Project Review Protocol

For the 2021 OEM Demand Savings Pilot, the Evaluator used the 2020 Custom Retrofit protocol as the basis for the project reviews (the evaluation of this pilot was conducted prior to both Custom Retrofit and Building Optimization; therefore, this review did not include the updated 2021 protocols).

Prior to conducting telephone project review interviews, the Evaluator reviewed all project documentation submitted by Efficiency One (EOne). These documents included, although were not limited to, the following: Scoping and/or feasibility studies, energy efficiency measure (EEM) savings calculations, project development agreements, measurement and verification (M&V) reports, and email correspondence.

The Evaluator used the protocol form presented below to collect technical data and summarize information such as project details, key parameters to be reviewed during the telephone project review interviews, and previous M&V activities. The Evaluator reviewed such information as the quantity and type of systems commissioned, the equipment and facility operation schedules, and changes made to control methods and set points. If a building automation system (BAS) was installed, the Evaluator also reviewed screenshots of monitored data.

 ECONOLER	Custom OEM Operational Demand Savings Pilot Efficiency Nova Scotia On-Site Visit Protocol								
1. General Information									
Date of interview:	Team:								
Project ID:	Contact Name:								
Project Type:	Contact Title:								
Company Name:	Contact Phone:								
Facility Name:	Email:								
Address:									
Consultant:									
List of people interviewed:									
Type of building: <table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="background-color: #92d050;">Commercial/institutional</td> <td style="width: 20px;"></td> <td style="background-color: #92d050;">Industrial/manufacturing</td> <td style="width: 20px;"></td> </tr> <tr> <td style="background-color: #92d050;">Municipal</td> <td></td> <td style="background-color: #92d050;">Other (specify)</td> <td></td> </tr> </table> Specify:		Commercial/institutional		Industrial/manufacturing		Municipal		Other (specify)	
Commercial/institutional		Industrial/manufacturing							
Municipal		Other (specify)							
2. Facility and Project Description									
Facility Description: <i>Outline a quick description of the facility and its primary operation/purpose.</i> NOTE: PC Users "Alt+Enter" for new line in cell. MAC Users "CMD+Option+Enter".									
Project Description: <i>Indicate the key variables & observations from all available reports. These notes will serve to guide the virtual visit and identify the main information to collect and/or verify.</i>									
<i>Add other lines as needed</i>									

3. Desktop Review

Section to be filled out with questions prior to virtual visits, and answers to be included during the call. Repeat as needed.

Measure #1

Validation of the measure

Validate the installation and quantities. Do we have pictures (nameplate) in the file? Can we see it during the call? Is there invoices Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Baseline

What is the baseline? Existing equipment, new construction? Was the equipment at the end of its useful life?

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Operating Schedule

Include notes on schedule and seasonal variations. The operating schedule corresponds to the **typical** one (non-COVID).

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Savings calculation approach

How are savings calculated? What are the key parameters to validate? If it is based on M&V, fill out section 4.

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

COVID

Include notes on how calculated savings are impacted by COVID, if so.

Detail any adjustment, along with the rationale, needed to bring back the savings to a typical year.

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

How has Covid affected the building occupation level & schedule and energy demand vs normal?

Notes during/after interview

Peak Demand Savings? YES ☐ NO ☐

Notes on peak demand savings (Nova Scotia Peak Period: weekdays between 5 and 7 p.m. between Dec and Feb)

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Interactive Effects? YES ☐ NO ☐

*Briefly describe interactive effects for the project and relevant information on **heating/cooling system** as required.*

Notes before interview. Include specific questions to be asked (highlight them if needed to be sure not to forget to ask them)

Notes during/after interview

Measure #2

Validation of the measure

4. M&V

Section to be repeated as necessary for any number of measures for which M&V is conducted.

Was there M&V conducted ? (Y/N) if not, hide the section

Were any baseline measurements taken ? (Y/N)

Are electrical savings based on measurements? (Y/N)

Are demand savings based on measurements? (Y/N)

IF so summarize measurement plan, and measurement type.

Report the virtual visit and indicate the key observations and findings made during the interview.

Predicted Results (kW)	M&V Results	Percent of Expected (%)	M&V Start Date	M&V Finish Date	Days in Period
		#DIV/0!			0

Notes: Insert Comments from M&V Reports

5. Other questionnaires

Market questionnaire filled-in (Y/N)

Sections below to be filled after the visit
6. Estimated Useful Life of the project

Type of replacement	EUL
Measure #1	
Measure #2	
Tracked Project EUL (yrs)	
Evaluated Project EUL (yrs)	

Refer to project documentation for tracked baseline EUL

Explanation

7. Energy and Demand Savings Adjustments

Total Electricity Savings from Tracking Sheet:		kWh/yr	Notes on Project Status:	
Total Peak Demand Savings from Tracking Sheet:		kW	Project Estimated Finish Month:	
Peak Coincidence Factor Used by ENSC:				
Adjustment from the Evaluator			Project Adjustment Ratios	
Evaluated Electricity Savings:		kWh/yr	% of Tracked Electricity Savings	#DIV/0!
Evaluated Peak Demand Savings:		kW	% of Tracked Demand Savings	#DIV/0!
Peak Coincidence Factor Used by the Evaluator:				
Adjustments made to electricity savings?		(Y/N)		
Adjustments made to demand savings?		(Y/N)		
Adjustments made to PCF?		(Y/N)		
Changes between PDA and completion?		(Y/N)		
If Yes, was the tracking sheet adjusted accordingly?		(Y/N)		

8. Summarize Project Adjustments and Final Savings Values

If any adjustments were made to the energy savings, demand savings or PCF, describe the rationale and provide calculations.

APPENDIX IX CUSTOM: NEW CONSTRUCTION ENERGY MODEL REVIEW PROTOCOL

This appendix describes the protocol used to conduct the energy model reviews for New Construction.

Project Review Protocol

The Evaluator modified the 2020 New Construction simulation review protocol for the 2021 evaluation. Because of the COVID-19 pandemic, in 2020 virtual visits were held with the support of EOne personnel. For the 2021 evaluation, EOne is providing additional project information compared to previous years. The Evaluator reviewed the provided documentation and assessed the need to conduct a virtual visit, contact participants by phone or base its review on the project file information. This decision was shared with EOne.

The protocol outlined below is used to prepare virtual visits or calls (if necessary), to collect information (from virtual visits, phone calls or project file information), and to document the findings of the simulation model review in a single document. The first page presents the key findings of the project review along with adjustments made to energy savings and peak demand savings, while the ensuing pages detail findings on the general buildings and then each individual measure.

1. General Information

Virtual Visit Date:	_____	Contact Name:	_____
Project ID:	_____	Contact Title:	_____
Project Type:	_____	Contact Phone:	_____
Project Status:	_____	Email:	_____
Project Name:	_____		
Address:	_____		
List of people participating to the virtual visit/call:	_____		

Project Energy Efficiency Measure(s)

Information Sent by E1 Sufficient to Review the Project? _____ (Y/N)

Call or Virtual Visit Needed _____ (Call/Visit)

2. Facility Operation Schedules

These data should be asked prior the virtual visit by email or phone to the final beneficiary of the building or found in documentation sent by E1

People/ Document giving information _____

Facility Description: *Outline a quick description of the facility and its primary operation/purpose.*

NOTE: PC Users "Alt+Enter" for new line in cell. MAC Users "CMD+Option+Enter".

Facility Annual Schedule: *Gather info for each occupancy schedule reported by the site contact as occupancy could vary for each section of the facility. Use additional lines if necessary. Ensure info is for a typical year (non-COVID).*

HVAC System Operation Schedule: *Gather info for each HVAC system.*

3. Virtual Visit, Call or Document Review Summary

4. Adjustments to Energy Model per Measure

The reviewer must verify the model following guidance defined in the tab "Modelling Review Checklist".

Description from project documentation	
Virtual visit, call or document	
As modeled by participant	
Changes to model by Econoler	

Description from project documentation	
Virtual visit, call or document	
As modeled by participant	
Changes to model by Econoler	

5. Simulation Outputs

Name of the simulation file

	EOne	Evaluator
Basecase		
Proposed		

Energy Consumption (kWh)

	EOne		Evaluator	
	Basecase	Proposed	Basecase	Proposed
LIGHTS				
TASK LIGHTS				
MISC EQUIP				
SPACE HEATING				
SPACE COOLING				
HEAT REJECT				
PUMPS & AUX				
VENT FANS				
REFRIG DISPLAY				
HT PUMP SUPPLEM				
DOMESTIC HOT WTR				
EXT USAGE				
Total	0	0	0	0

Peak Demand - Average for Jan, Feb and Dec

EOne		Evaluator	
Basecase	Proposed	Basecase	Proposed
0,0	0,0	0,0	0,0

6. Energy and Demand Savings Adjustments

Energy Savings from Tracking Sheet:		kWh/yr	Project Estimated Finish Month:	
Demand Savings from Tracking Sheet:		kW	Notes on Project Status:	
Diversity Factor Used by ENSC:				

Adjustment from the Evaluator

Adjusted Energy Savings:	0
Adjusted Demand Savings:	0,0
Adjusted Demand Savings with PCF:	
Diversity Factor Used by Econoler:	

Adjustments made to energy savings?		(Y/N)	Percent of Tracked Energy Savings	#DIV/0!
Adjustments made to demand savings?		(Y/N)	Percent of Tracked Peak Demand Savings	#DIV/0!
			Client Rate Code	
Adjustments made to PCF?		(Y/N)	Line Loss Factor Used	

7. Summarize Adjustments to Energy, Demand & Diversity Factor

Modeling Review Checklist

Reminder of Evaluation Goals and Key Principles

While developing the checklist, the Evaluator kept in mind the key evaluation goals and the five guiding principles presented in the 2020-2022 Overall Strategic Evaluation Plan. Notably for New Construction, Principle 4 states that: For some complex program services (e.g. Custom New Construction), the Evaluator thoroughly reviews measures that contribute the most savings to a project but does not comprehensively review the entire model or measurement and verification (M&V) procedures. Thus, the evaluation review should not be interpreted as vetting all modelling or M&V practices.

Simulation Model Review Checklist

The checklist consists of the six main items below. This checklist should be considered as general guidelines. Simulation model reviews are treated on a case-by-case basis and other items may be considered depending on the building type, complexity of the HVAC systems, energy efficiency measures installed etc.

1. Results General Overview

- › Check savings (in %) for each end use and identify where the major savings lie. Crosscheck with the energy efficiency measure list to validate if the savings claimed make sense.
- › Verify GJ/m² and check benchmarking data to verify if energy intensity is normal based on the type of building. Pay attention to differences in buildings that can explain discrepancies (e.g. two apartment buildings with the same area will not have a comparable GJ/m² if only one of them has an underground parking).

2. Envelope Review

- › Check envelope resistance value (wall/fenestration/roof/etc.) and validate with shop drawings and construction details. Make sure that effective R/RSI – U/USI values are used in the simulation.
- › Pay particular attention to curtain walls. Although the nominal insulation value may be high (up to R15-20), the effective value rarely exceeds R8 because of the effect of the frame.
- › Verify fenestration-to-wall ratio (%) in the proposed model. If the ratio is above baseline allowance, validate that the reference model ratio has been reduced to maximum allowance.
- › Validate that the values used for the reference are in accordance with the specifications of the code used.

3. Parametrization and Zoning

- › For buildings with a repetitive storey pattern, if the “Copy” function is used, the modeller often forgets to check the “Over conditioned space” option, which may create an “exterior floor”.
- › Verify the zoning to make sure it is appropriate.

4. Loads and Schedules

- › Validate occupancy and plug-load values according to NECB.
- › Validate lighting loads by spot-checking installed lighting power in random rooms vs. electrical plans and shop drawings.
- › Validate domestic hot water (DHW) loads according to the guideline developed by EfficiencyOne for DHW consumption values.
- › Validate that the schedules used are typical for the type of building modelled.

5. HVAC Systems

This section can be very complex, depending on the building modelled, so the following should be considered as general guidelines.

- › Validate that all HVAC inputs concord with shop drawings.
- › In the case of a dedicated outside air system, pay attention to how it has been modelled.
- › Validate that the systems selected are in accordance with the specification of the code used (type of system, efficiency, sizing) for the reference building.
- › Carefully read the operating sequence and verify that the HVAC systems operate accordingly.
- › Take special care to validate the modelling of energy efficiency measures.
- › Make sure that the air flow (cfm) of installed systems match the cfm modelled (reference and proposed) for fresh air.
- › Be on the lookout if known bugs/miscalculations in the modelling software are present due to the system types used within the model. If present, see if the energy modeller can address them.

6. External Calculations

- › Review external calculations, if any.

APPENDIX X

CUSTOM: ADJUSTMENT CALCULATION EXAMPLE

This appendix provides a sample of the calculations used to adjust the energy savings results for one of the projects reviewed as part of the 2021 Custom impact evaluation. The calculation described below presents the adjustments made to a solar photovoltaic project for which the system was installed on the roof of a multi-unit residential building. The adjustment is based on information collected during a phone call, as well as a review of project documentation carried out by the Evaluator.

The project background is presented first, followed by the savings tracked by EOne, revised savings, and rationale behind the adjustments.

Project Background

The Retrofit project involved the installation of a solar photovoltaic (PV) system consisting of 66 panels. The original system design assumed an individual panel capacity of 310 W, for a total installed capacity of 20.46 kW. Following the signature of the Custom Project Agreement (CPA), the participant increased the individual panel capacity to 325 W, bringing the total installed capacity to 21.45 kW. The system was installed with a net metering billing approach.

Tracked Savings Calculation

For this project, EOne's on-site energy manager (OEM) created an energy model using PVWatts. This was used to estimate the system's projected annual electricity generation, which is equivalent to the annual energy savings claimed by the participant. The original PVWatts model estimated an annual electricity generation of 25,903 kWh but relied on the original system design, which assumed an individual panel capacity of 310W. The tracked energy savings were therefore equivalent to the results of this original estimate and did not account for the revision to the PV system's size. Given negligible electricity generation occurring during the utility's winter peak demand period (December to February, from 5pm to 7pm), no peak demand savings were claimed for this project. This was confirmed by the Evaluator.

Revised Savings Calculation

EOne's OEM created an updated PVWatts model to reflect the change in system size, which was shared with the Evaluator during the project review process. The updated model estimated an annual electricity generation, and annual energy savings, of 25,992 kWh.

Following installation and commissioning, the project implementer measured the actual output of the PV system over a period of 92 days (March 1 to May 31, 2021). As presented in Table 1, the total actual electricity generation over the measurement period was equivalent to 92% of the modeled electricity generation. The Evaluator applied the ratio of 92% obtained through output measurement to the total annual modeled electricity generation, yielding an estimated annual actual electricity generation of 23,913 kWh. This value was used to establish the revised annual energy savings.

Table 1: Modeled and Actual Electricity Generation

Month	Modeled Electricity Generation (kWh)	Actual Electricity Generation (kWh)	Ratio Actual/Modeled
March	2,625	2,039	-
April	2,514	2,428	-
May	2,868	2,892	-
Total	8,007	7,359	92%

Adjustment Ratio Calculation

Adjustment ratios are determined by comparing revised savings values with tracked savings values. Due to the revisions made to this measure, the calculated adjustment ratios for energy savings is 0.923.

$$\frac{\text{Revised ES}}{\text{Tracked ES}} = \frac{23,913 \text{ kWh}}{25,903 \text{ kWh}} = 0.923$$

APPENDIX XI

CUSTOM: RETROFIT AND BUILDING OPTIMIZATION ALGORITHM FOR FREE-RIDERSHIP CALCULATION

Table 1 below presents the algorithm for calculating free-ridership levels for the Custom Retrofit and Building Optimization Program participants. The participant interview guide included questions designed to assess planning, quantity, efficiency, timing, cost, and program influence aspects. Each group of questions was transposed to a level of program attribution, the results of which were then used to calculate the free-ridership level associated with each participant in accordance with the algorithm.

Table 1: Free-ridership Algorithm for Retrofit and Building Optimization

Question	Response	Score
Satisfaction		
B1. Using a scale from 1 to 10 where 1 is “not at all satisfied” and 10 is “completely satisfied” how would you rate your satisfaction with the Custom [Retrofit or Building Optimization] program overall?	Score: _____	To report on participant satisfaction with the program.
B2. [IF B1<8] What single factor or issue, if resolved, would allow you to provide a higher score?	Answer: _____	
B3. [IF B1≥8] What is the most important factor supporting your assessment?	Answer: _____	
Participant Perspectives		
C1. How did you first hear about the Custom [Retrofit or Building Optimization] program?	Answer: _____	To report on participant perspectives on the program.
C2. What motivated you to participate in the Custom [Retrofit or Building Optimization] program?	Answer: _____	
C3. Did you face any challenges or barriers when implementing your energy efficiency project through the program?	Answer: _____	
C4. [IF C3=YES, then ask:] What was the most significant challenge or barrier?	Answer: _____	
C5. Do you have any suggestions to improve the [Custom Retrofit or Building Optimization program]?	Answer: _____	

Question	Response	Score
Planning		
D1. Had your organization finalized the details of the energy efficiency project BEFORE knowing that you would receive an incentive from Efficiency Nova Scotia?	Yes	USE D2
	No	0%
	98) DK/Refuse	0%
D2. [IF D1=1] When you decided to implement the energy efficiency project, how confident were you that you would receive an incentive from Efficiency Nova Scotia? [READ]	Very confident	0%
	Somewhat confident	25%
	Not very confident	75%
	Not at all confident	100%
	98) DK/Refuse	50%
Cost		
E1. Efficiency Nova Scotia gave your organization a rebate of \$<STUDY INCENTIVE> for the [Investigation or Feasibility] study and \$<IMPLEMENTATION INCENTIVE> for the project implementation. Did the financial incentives have an impact on the financial case for your energy efficiency project? Which of the following best represents the role of the financial incentive? [READ] ?	Reduced the cost of the energy efficiency measures to bring the project within the organization's pre-determined financial thresholds for approval.	0%
	Reduced the cost of the energy efficiency measures to make the financial case more attractive within the decision-making process.	25%
	Reduced the cost of the energy efficiency measures, but even without financial support, you would have included the same measures for other reasons.	100%
	Did not have a significant impact on the decision.	100%
	98) DK/Refuse	EMPTY
[ASK IF \$<STUDY INCENTIVE> ≥0]		
E2a. As part of its Custom [Retrofit or Building Optimization] program, Efficiency Nova Scotia gave your organization a \$<STUDY INCENTIVE> incentive for the [Investigation or Feasibility] study. In the absence of the program, what is the likelihood that you would have conducted this study? Please answer on a scale of 0 to 10, where 0 means "Very unlikely" and 10 means "Very likely".	Score: _____	USE E2b
	98) DK/Refuse	EMPTY
E2b. [IF E2a ≠ 98] Did you use the study as a decision-making tool to develop and compare the potential measures for the eventual energy efficiency project?	1) Yes	E2a Score x 10%
	2) No	EMPTY
	98) DK/Refuse	EMPTY

Question	Response	Score
Efficiency and Quantity		
F1. You received an \$<Implementation INCENTIVE> incentive based on energy savings when your energy efficiency project was completed. Without the implementation incentive from Efficiency Nova Scotia, which of the following scenarios would have been the most likely? [READ]	Would have implemented the exact same energy efficiency project.	100%
	Would have implemented a project with fewer or less impactful energy efficiency measures.	50%
	Would have delayed the project by at least a year.	0%
	Would not have implemented the project at all.	0%
	98) DK/Refuse	EMPTY
Influence		
G1. I'm going to ask you to rate the importance of factors that may have influenced your decision to implement the energy efficiency project based on your participation in the Custom [Retrofit or Building Optimization] program. Using a scale of 0 to 10, where 0 means "Not at all important" and 10 means "Extremely important", please rate the importance of each of the following in your decision to implement the energy efficiency measures through the Custom [Retrofit or Building Optimization] program. a. The program financial incentive for [Investigation or Feasibility Study]. b. The program financial incentive for implementation of energy efficiency measures. c. The insights obtained through the study to make decisions about the energy savings associated with each potential measure. d. The recommendations and technical assistance provided by the Business Development Manager, or other Efficiency Nova Scotia staff in selecting and designing your energy efficiency measures. e. The non-technical information offered by the Business Development Manager, onsite energy manager, or other Efficiency Nova Scotia staff on energy efficiency such as but not limited to market trends, operating costs, and tradespeople availability.	For each sub-question : Score : _____	For each sub-question : (Score) x 10%
	98) DK/Refuse	EMPTY

Question	Response	Score
G2. We understand that your organization availed itself of the services of an Onsite Energy Manager during the time that this project was being considered for implementation. Can you confirm this?	1) Yes	To provide context on the whether or not the proponent had the services of an OEM
	2) No	EMPTY
	98) DK/Refuse	EMPTY
G3. [IF G2=YES] Using a scale of 0 to 10, where 0 means “Not at all important” and 10 means “Extremely important”, please rate the importance of the OEM contributions to the decision process that led to implementing the energy efficiency measures through the Custom [Retrofit or Building Optimization] program. a. Identification of the measure in the project. b. Development of the business case for the project. c. Socializing the project with relevant decision-making stakeholders and/or selling the business case d. Developing the technical specification of the measures and/or interfacing with third-party service providers. e. Managing and advancing decision-making tasks and maintaining project momentum.	For each sub-question : Score : _____	For each sub-question : (Score) x 10%
	98) DK/Refuse	EMPTY
G4. Can you explain why your organization decided to implement the energy efficiency project? [DO NOT READ]	Answer: _____ Pre-coded answers [DO NOT READ]: Lower operation costs Energy policy in my organization Environmental reasons/energy efficiency Competitors are doing it 96) Other, specify: _____ 98) DK/Refuse	Contextual information to help explain free-ridership results.

Question	Response	Score
Cross Influence		
H1. Before participating in the [Custom Retrofit or Building Optimization program] service for this project, had you already participated in [Custom Retrofit or Building Optimization program] or in another Efficiency Nova Scotia program?	Yes, Custom Retrofit or Building Optimization program.	To determine if participants should respond to questions H2 and H3.
	Yes, in another Efficiency Nova Scotia program	
	Yes, both	
	No (SKIP TO H4)	
	98) DK/Refuse (SKIP TO H4)	
For the following statements, please indicate whether you agree or disagree on a scale of 0 to 10, where 0 indicates "Completely disagree" and 10 indicates "Completely agree".		
H2. [IF H1 = 1 OR 2] Due to your previous participation in an Efficiency Nova Scotia program and what you learned by participating in that program, you asked a technical staff member to examine the energy efficiency options for your project.	Score: _____	Score
	98) DK/Refuse	EMPTY
H3. [IF H1 = 1 OR 2] Due to your previous participation in an Efficiency Nova Scotia program and what you learned by participating in that program, you considered the cost effectiveness of the energy efficiency measures for your project by evaluating the different options for your organization.	Score: _____	Score
	98) DK/Refuse	EMPTY
H4. Before participating in the [Custom Retrofit or Building Optimization program] had you already seen energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, brochures, newsletters or presentations?	1) Yes	To determine if participants should respond to questions H5, H6, and H7.
	2) No (Thank and terminate)	
	98) DK/Refuse (Thank and terminate)	
For the following statements, please indicate whether you agree or disagree on a scale of 0 to 10, where 0 indicates "Completely disagree" and 10 indicates "Completely agree".		
H5. [IF H4 = 1] The energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, brochures, newsletters, or presentations were a major factor in your decision to implement the energy efficiency project.	Score: _____	Score
	98) DK/Refuse	EMPTY
H6. [IF H4 = 1] The energy efficiency promotional materials distributed by Efficiency Nova Scotia prompted you to ask a technical staff member to examine the energy efficiency options for your project.	Score: _____	Score
	98) DK/Refuse	EMPTY

Question	Response	Score
H7. [IF H4 = 1] The energy efficiency promotional materials distributed by Efficiency Nova Scotia prompted you to consider the cost effectiveness of the energy efficiency measures by evaluating the different options for your organization.	Score: _____	Score
	98) DK/Refuse	EMPTY
Intention	AVERAGE (D1, E1, E2, F1) D1: Adjusted with D2 E1: No adjustment E2: No adjustment F1: No adjustment	
Influence	MAXIMUM (G1a, G1b, G1c, G1d, G1e, G3a, G3b, G3c, G3d, G3e) Maximum score among influence factors in G1 and G3	
Free-ridership Calculation	FR = AVERAGE (Intention, (100-Influence))	
Cross Influence	CI = IF (H5 ≥ 8: 1) + IF (MAX (H2, H6) ≥ 8: 1) + IF (MAX (H3, H7) ≥ 8: 1)	
Revised Free-ridership	IF CI = 0 OR 1: Revised FR = FR IF CI = 2: Revised FR = FR x 75% IF CI = 3: Revised FR = FR x 50%	
Multi-source Free-ridership	If multiple decision-makers, use average of Revised FRs: Multi-source FR = AVERAGE (Revised FR1, Revised FR2, ...)	

APPENDIX XII

CUSTOM: RETROFIT AND BUILDING OPTIMIZATION ALGORITHM FOR PARTICIPANT SPILLOVER CALCULATION

Table 1 below presents the algorithm for calculating the participant spillover levels for the Custom Retrofit and Building Optimization Programs. Following their participation in the program, participants were asked whether they implemented any additional energy efficiency measures without benefitting from any rebates or financing offered by ENS programs. If a participant mentioned having implemented additional measures, another question was asked to quantify the level of influence the program had on the participant's decision to implement these additional measures. The value established regarding this level of influence was used to determine the portion of additional savings attributable to the program. Then, for each additional energy efficiency measure identified, the participant was asked a set of questions designed to identify the additional energy efficiency measures implemented and quantify the associated savings (type of measure, quantity, efficiency level, etc.).

The level of participant spillover was established by dividing the total quantity of additional savings attributable to the program by the total quantity of savings achieved by the program for all interviewed participants.

Table 1: Spillover Algorithm for Retrofit and Building Optimization

Question	Response	Score
Spillover		
I1. Since first taking part in the Custom [Retrofit or Building Optimization] program, have you implemented any additional energy efficiency measures other than those implemented through the program?	1) YES	Continue to I2
	2) NO 98) DK/Refuse	Thank and Terminate
I2. [IF I1 = 1] For the energy efficiency upgrades that you implemented on your own, did you receive or plan on requesting financing or rebates from Efficiency Nova Scotia?	1) YES	Thank and terminate.
	2) NO 98) DK/Refuse	Continue to I3
I3. [IF I1 = 1] Can you please describe these measures?	Name of measure	To inform estimate of additional energy savings (in kWh). If respondent is unable to provide details on spillover project, thank and terminate.
	Type of energy source saved If all non-electric, thank and terminate.	
	Location of the facility If not in Nova Scotia, thank and terminate.	
	Quantity of measures (or area covered by the measure)	
	Technical information, such as HOU, capacity, efficiency, etc.	
	Estimated savings (in kWh or \$)	
	If no quantitative information is available, but the measure is the same as the one implemented through Custom [Retrofit or Building Optimization], probe participant on its relative size with respect to the Custom [Retrofit or Building Optimization] project evaluated (% of size, area covered by measure, price, etc.).	

Question	Response	Score
I4. Did your experience with the energy efficiency project implemented through Custom [Retrofit or Building Optimization] program influence your decision to implement these additional energy efficiency measures on your own? Please, rate the level of influence on a scale of 0 to 10, where 0 indicates that the program “had no influence at all on your decision to implement the energy efficiency measures” and 10 indicates that the program was “extremely influential to your decision to implement energy efficiency measures.”	Score: _____	Score
	98) DK/Refuse	EMPTY
I5. What is/are the main reason or reasons that you implemented this project without the assistance of an Efficiency Nova Scotia program?	Answer: _____	For contextual information on spillover.
Spillover	SO = SUM OF (I3 x I4) for All Respondents/SUM of Respondent Savings	

APPENDIX XIII

CUSTOM: NEW CONSTRUCTION ALGORITHM FOR FREE-RIDERSHIP CALCULATION

This new set of questions and algorithms for Custom New Construction free-ridership assessment was developed as part of the 2021 process evaluation.

Table 1: Participant Interview Questionnaire and Free-ridership Algorithm

Question (From the Custom New Construction Participant Interview Guide)	Response	Score
INTRODUCTION I am with _____ and we are performing an evaluation of the Custom New Construction program service offered by Efficiency Nova Scotia. This interview should take up to 30 minutes. Is this still a good time for you? Through this interview, we hope to better understand your organization's decision-making process regarding the decision to build an energy efficient building. More specifically, we hope to better understand how you made the decision to use energy efficient materials or equipment that exceed building code requirements on efficiency levels. We will refer to this as your decision "to design a better-than-code building" throughout this interview. Your responses will be kept confidential, and the results will be combined with those of other program participants. Your responses will not affect the incentive amount you will receive for this project.	N/A	EMPTY
Identifying Key Decision-makers		
A1. We hope to interview the key decision-makers that played a key role in the decision to build a better-than-code building. Were you a key decision-maker?	1) Yes	EMPTY
	2) No	
	98) DK/Refuse	
A2 [IF A1=YES] Please describe your role in the decision-making process.	Answer: _____	Contextual information to help identify if respondent is a key decision-maker.

Question (From the Custom New Construction Participant Interview Guide)	Response	Score
A3. [IF A1=YES] Were there other key decision-makers that played a role in the decision to build a better-than-code building? If so, can you provide their names, roles, and contact information?	Answer: _____	Contextual information to help identify other key decision-makers to interview. If participant is unable to identify other key decision-makers, the Evaluator will ask EOne if they are aware of other key decision-makers.
A4. [IF A1=NO, DK or REFUSED] Who were the key decision-makers that played a key role in the decision to build a better-than-code building? Can you provide their names, roles, contact information?	Answer: _____ [IF A4= NO, DK or REFUSED: END] These are all the questions I have for you. Thank you very much for your time and cooperation!	Contextual information to help identify other key decision-makers to interview.
Planning		
C2. Had your organization finalized the design of the new building BEFORE knowing that you would receive an incentive from Efficiency Nova Scotia?	Yes	USE C3
	No	0%
	98) DK/Refuse	0%
[ASK IF C2=1] C3. When you decided to build a better-than-code building, how confident were you that you would receive an incentive from Efficiency Nova Scotia? [READ]	Very confident	0%
	Somewhat confident	25%
	Not very confident	75%
	Not at all confident	100%
	98) DK/Refuse	50%
Cost		
C4. Did the financial incentive offered by Efficiency Nova Scotia have an impact on the financial case for your new building project? Which of the following best represents the role of the financial incentive? [LIRE]	Reduced the cost of the additional energy efficiency measures included in the building to bring the project within the project's pre-determined financial thresholds for approval.	0%
	Reduced the cost of the energy efficiency measures, significantly strengthening the case for the overall project from a financial perspective.	25%
	Reduced the cost of the additional energy efficiency measures included in the building, but even without financial support, you would have included the same measures for other reasons.	100%

Question (From the Custom New Construction Participant Interview Guide)	Response	Score
	Did not have a significant impact on the decision.	100%
	98) DK/Refuse	EMPTY
C5. You received an incentive of <\$\$\$> from Efficiency Nova Scotia for your energy model. Without Efficiency Nova Scotia, what is the likelihood that you would have hired an energy modeling consultant for your project? Please answer on a scale of 0 to 10, where 0 means “Very unlikely” and 10 means “Very likely”.	Score: _____	USE C6
	98) DK/Refuse	EMPTY
[ASK IF C5 ≠ 98]	1) Yes	C5 Score x 10%
C6. Did the energy modeling consultant help you assess different options available for building envelope and HVAC equipment?	2) No	EMPTY
	98) DK/Refuse	EMPTY
Efficiency and Quantity		
	Would have designed the exact same better-than-code building.	100%
C7. You will also be receiving an incentive based on energy savings once your building is complete. Without the implementation incentive from Efficiency Nova Scotia, which of the following scenarios would have been the most likely?	Would have designed a less efficient building but would have still exceeded the minimum energy efficiency requirements prescribed in the building code.	AVERAGE (C8, C9, C10)*10%
	Would have designed a less efficient building that met the minimum energy efficiency requirements prescribed in the building code.	0%
	98) DK/Refuse	EMPTY
[ASK IF C7=2]	Score: _____	Score x 10%
C8. Without Efficiency Nova Scotia or the energy modeler, what is the likelihood that you would have designed a building with HVAC equipment as efficient as you did? Please answer on a scale of 0 to 10, where 0 means “Very unlikely” and 10 means “Very likely”.	98) DK/Refuse	EMPTY
[ASK IF C7=2]	Score: _____	Score x 10%
C9. Without Efficiency Nova Scotia or the energy modeler, what is the likelihood that you would have designed a building with a building envelope as efficient as you did, including insulation levels and glazing performance? Please answer on a scale of 0 to 10, where 0 means “Very unlikely” and 10 means “Very likely”.	98) DK/Refuse	EMPTY

Question (From the Custom New Construction Participant Interview Guide)	Response	Score
[ASK IF C7=2] C10. Without Efficiency Nova Scotia or the energy modeler, what is the likelihood that you would have designed a building with as many efficiency measures as you did? Please answer on a scale of 0 to 10, where 0 means “Very unlikely” and 10 means “Very likely”.	Score: _____	Score x 10%
	98) DK/Refuse	EMPTY
[ASK IF C7=2 AND IF AVERAGE (A8, A9, A10) ≥ 8] C11. You explained that, without an incentive from Efficiency Nova Scotia or the energy modeler, you would have designed a less efficient building. Can you explain how your building would have been different?	Answer: _____	Inconsistency Test Analyze verbatim. If building would have been different in the absence of the program: AVERAGE (A8, A9, A10)/2
Influence		
C12. Finally, I’m going to ask you to rate the importance of factors that may have influenced your decision to build a better-than-code building based on your plan through New Construction. Using a scale of 0 to 10, where 0 means “Not at all important” and 10 means “Extremely important”, please rate the importance of each of the following in your decision to implement the energy efficiency measures you plan to implement in your new building through the New Construction program. - The program financial incentive for energy modeling. - The program financial incentive for implementation of energy efficiency measures. - The insights obtained through energy modeling about the energy savings associated with each potential measure. - The recommendations and technical assistance provided by the energy modeler, Business Development Manager, onsite energy manager, or other Efficiency Nova Scotia staff in selecting and designing your energy efficiency measures. - The non-technical information offered by the energy modeler, Business Development Manager, onsite energy manager, or other Efficiency Nova Scotia staff on building better-than-code buildings, such as but not limited to market trends, building certifications, operating costs, and tradespeople availability.	For each sub-question : Score : _____	For each sub-question : Score x 10%
	98) DK/Refuse	EMPTY

Question (From the Custom New Construction Participant Interview Guide)	Response	Score
C1. Can you explain why your organization decided to build a better-than-code building? [DO NOT READY]	Answer: _____ Pre-coded answers [DO NOT READ]: Lower operation costs Energy policy in my organization Environmental reasons/energy efficiency Competitors are doing it 96) Other, specify: _____ 98) DK/Refuse	Contextual information to help explain free-ridership results.
Cross Influence		
D1. Before participating in the Custom New Construction program service for this building, had you already participated in Custom New Construction or in another Efficiency Nova Scotia program?	Yes, Custom New Construction Yes, in another Efficiency Nova Scotia program Yes, both No (SKIP TO D4) 98) DK/Refuse (SKIP TO D4)	To determine if participants should respond to questions D2 and D3.
For the following statements, please indicate whether you agree or disagree on a scale of 0 to 10, where 0 indicates "Completely disagree" and 10 indicates "Completely agree".		
D2. Due to your previous participation in an Efficiency Nova Scotia program and what you learned by participating in that program, you asked a technical staff member or energy modeler to examine the energy efficiency options for your building project.	Score: _____ 98) DK/Refuse	Score EMPTY
D3. Due to your previous participation in an Efficiency Nova Scotia program and what you learned by participating in that program, you considered the cost effectiveness of the energy efficiency measures in your new building by evaluating the different options for your organization.	Score: _____ 98) DK/Refuse	Score EMPTY
D4. Before participating in the Custom New Construction program service, had you already seen energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, brochures, newsletters or presentations?	1) Yes 2) No (Thank and terminate) 98) DK/Refuse (Thank and terminate)	To determine if participants should respond to questions D5, D6, and D7.
For the following statements, please indicate whether you agree or disagree on a scale of 0 to 10, where 0 indicates "Completely disagree" and 10 indicates "Completely agree".		

Question <i>(From the Custom New Construction Participant Interview Guide)</i>	Response	Score
D5. The energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, brochures, newsletters, or presentations were a major factor in your decision to build a better-than-code building.	Score: _____	Score
D6. The energy efficiency promotional materials through its website, brochures, newsletters, or presentations distributed by Efficiency Nova Scotia prompted you to ask a technical staff member or energy modeler to examine the energy efficiency options for your building project.	98) DK/Refuse	EMPTY
D7. The energy efficiency promotional materials through its website, brochures, newsletters, or presentations distributed by Efficiency Nova Scotia prompted you to consider the cost effectiveness of the energy efficiency measures in your new building by evaluating the different options for your organization.	Score: _____	Score
Inconsistency	98) DK/Refuse	EMPTY
Intention	The Evaluator will analyze project file notes to validate the consistency of the answers provided by participants with E1 knowledge of the project. If the Evaluator finds that an answer is inconsistent, the score will be “EMPTY”. AVERAGE (C2, C4, C5, C7) C2: Adjusted with C3 C4: No adjustment C5: Adjusted with C6 C7: Adjusted with C8, C9, C10 and validated with C11	
Influence	MAXIMUM (C12a, C12b, C12c, C12d, C12e) Maximum score among influence factors in C12	
Free-ridership Calculation	FR = AVERAGE (Intention, 100-Influence)	
Cross Influence	CI = IF (D5 ≥ 8: 1) + IF (MAX (D2, D6) ≥ 8: 1) + IF (MAX (D3, D7) ≥ 8: 1)	
Revised Free-ridership	IF CI = 0 OR 1: Revised FR = FR IF CI = 2: Revised FR = FR x 75% IF CI = 3: Revised FR = FR x 50%	
Multi-source Free-ridership	If multiple decision-makers, use average of Revised FRs: Multi-source FR = AVERAGE (Revised FR1, Revised FR2, ...)	

APPENDIX XIV

CUSTOM: 2021 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2021 evaluation of Custom, as well as past evaluation recommendations that remain unimplemented.

Sections	Recommendations
Executive Summary (Custom)	2021 Custom Recommendation 1: For Retrofit and Building Optimization, on a priority basis review, improve and deploy M&V processes, savings calculation protocols, service requirements, as well as documentation and associated supporting materials to align these with best practices for custom programs.
Executive Summary (OEM Operational Demand Savings Pilot)	2021 OEM Operational Demand Savings Pilot Recommendation 1: If operational demand programs are offered in the future deploy improved M&V and savings calculation protocol reviews.
Executive Summary (Retrofit)	2021 Retrofit Recommendation 1: Consider expanding the use of this type of structured pay-for-performance approach and encouraging larger return participants in Retrofit, Building Optimization, and Operational Demand Savings to participate in this offering.
	2021 Retrofit Recommendation 2: Develop and implement a process to identify project types more suited to quasi-prescriptive approaches (including solar PV, compressed air leaks, and possibly others such as domestic water booster pumps), and explicitly distinguish these project types from traditional custom projects within the Custom service. This should include developing appropriate protocols, documentation, and allowances for reviews of underlying savings determination methodologies as part of the annual evaluation plan.
Executive Summary (New Construction)	2021 New Construction Recommendation 1: Interview participants shortly after having signed the CPA.
OEM Operational Demand Savings Pilot (Impact Evaluation)	If operational demand programs are to officially enter the portfolio, the Evaluator recommends that EOne consider offering the operational demand incentive as an integral part of Building Optimization (similarly to how this is done in Custom Retrofit).
	Further, for those projects that are limited to demand reduction measures affecting only the system peak (and by extension for which the participant is not inherently motivated due to inconvenient operational changes), the Evaluator recommends that EOne should consider offering an annual incentive and allowing participants to opt in on an annual basis ahead of the peak period.
Retrofit (Impact Evaluation)	The Evaluator recommends that EOne work with the Evaluator to implement a project closure timetable that better aligns with the evaluation activities and work to improve the robustness and detail of forecasts of projects expected to close in a calendar year across Custom services.

Sections	Recommendations
	EOne staff mentioned many challenges associated with providing M&V on behalf of participants, including difficulty in obtaining data, challenges with understanding project implementation changes, and difficulties obtaining information about operating condition changes for non-routine adjustments; this was often reflected in the level of completeness or rigour, particularly in regard to supporting documentation for EOne-led projects. In recognition of these challenges, the Evaluator recommends that EOne look for opportunities to address them when it is necessary to directly provide M&V support to projects. Where this is not practical, particularly for large and complex projects, EOne should consider requiring applicants to furnish their own supporting M&V plans and reports as part of service requirements.
New Construction (Process Evaluation)	The Evaluator developed a new phone interview questionnaire and, following a testing period with five participants, found that it was effective. The Evaluator therefore recommends that it be adopted for all New Construction free-ridership assessments going forward.
New Construction (Impact Evaluation)	For future arena projects, the Evaluator recommends that EOne adjust the baseline on a case-by-case basis considering that heat recovery on space heating systems is more and more common for new arenas.
2019 Custom-R2 (Retrofit – In progress)	Better document peak demand savings calculations.
2020-Custom-R1 (In progress)	Implement improved M&V activities in Retrofit and Building Optimization.
2020 Custom-R4 (In progress)	Update the New Construction Service Guide to include the cases identified during the evaluation that were not covered and/or required more clarity in their interpretation.
2020 Custom-R5 (In progress)	Perform an HVAC market characterization study for New Construction.

APPENDIX XV

EMIS: TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying that all data fields required for the evaluation were included and filled out in the tracking sheet submitted by EOne
- › Ensuring that tracked results were accurate by:
 - Verifying that the parameters used to calculate program results (gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating that all calculation steps were performed consistently

Data Accuracy

Table 1 lists all the parameters required for the EMIS evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the table details the actions carried out by the Evaluator to adjust data where required.

Table 1: Verification of 2021 EMIS Data Field Completeness and Accuracy

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Gross Energy Savings at the Meter (Column G in “Savings” sheet)	Y	N/A	
Gross Peak Demand Savings at the Meter (Column J in “Savings” sheet)	Y	N/A	
Rate Class (Column B in “Savings” sheet)	Y	N/A	
Reference Data			
Net-to-gross Ratios for Energy Savings	Y	Y	
Net-to-gross Ratios for Peak Demand Savings	Y	Y	
Effective Useful Life	Y	N	The same EUL of 3 years is applied to all participants independently of their participation year. The EUL will be reviewed for each participant as part of the impact evaluation.

Data Consistency

The second step of the tracking sheet audit involved recreating calculations and comparing related tracking sheet data fields to identify any potential inconsistencies in calculations and correct them if needed. The Evaluator also compared the tracking sheet values to those in the project documentation. Table 2 lists the EMIS tracking sheet data fields that were compared to ensure consistency.

Table 2: Verification of 2021 EMIS Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Calculated Line Loss Factor (Gross Energy Savings at the Generator / Gross Energy Savings at the Meter)	Tracked Rate Codes	Y	
Gross Energy Savings at the Meter	Energy Savings Reported in the Project Documentation	Y	
Verification of Duplicate IDs or Projects	-	Y	

Equations and Compilation

Once the correct values were established (as per Table 1), the Evaluator validated that the equations in the tracking sheet correctly calculated each of the main program component results, the results of which are presented in Table 3.

Table 3: Verification of 2021 EMIS Savings Compilation

Program Component Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	Y	
Gross Peak Demand Savings at the Generator	Y	
Net Energy Savings at the Generator	Y	
Net Peak Demand Savings at the Generator	Y	

Corrected Tracked Savings

Table 4 presents the corrected tracked savings, which were identical to the values tracked by EOne.

Table 4: 2021 EMIS Corrected Tracked Savings

Program Component Result	Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	
Gross Energy Savings at the Generator	0.027	GWh	0.027	GWh	0%
Gross Peak Demand Savings at the Generator	0.003	MW	0.003	MW	0%
Net Energy Savings at the Generator	0.027	GWh	0.027	GWh	0%
Net Peak Demand Savings at the Generator	0.003	MW	0.003	MW	0%

The Evaluator found no discrepancy in the tracked values and therefore no changes were made.

APPENDIX XVI

SEM: TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying that all data fields required for the evaluation were included and filled out in the tracking sheet submitted by EOne
- › Ensuring that tracked results were accurate by:
 - Verifying that the parameters used to calculate program results (gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating that all calculation steps were performed consistently

Data Accuracy

Table 1 lists all the parameters required for the SEM evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the table details the actions carried out by the Evaluator to adjust data where required.

Table 1: Verification of 2021 SEM Data Field Completeness and Accuracy

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Gross Energy Savings at the Meter (Column I in "Savings" sheet)	Y	N/A	
Gross Peak Demand Savings at the Meter (Column L in "Savings" sheet)	Y	N/A	
Rate Class (Column C in "Savings" sheet)	Y	N/A	
Reference Data			
Net-to-gross Ratios for Energy Savings	Y	Y	
Net-to-gross Ratios for Peak Demand Savings	Y	Y	
Effective Useful Life	Y	N	The same EUL of 3 years is applied to all participants independently of their participation year. The EUL will be reviewed for each participant as part of the impact evaluation.

Data Consistency

The second step of the tracking sheet audit involved recreating calculations and comparing related tracking sheet data fields to identify any potential inconsistencies in calculations and correct them if needed. The Evaluator also compared the tracking sheet values to those in the project documentation. Table 2 lists the SEM tracking sheet data fields that were compared to ensure consistency.

Table 2: Verification of 2021 SEM Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Calculated Line Loss Factor (Gross Energy Savings at the Generator / Gross Energy Savings at the Meter)	Tracked Rate Codes	Y	
Gross Energy Savings at the Meter	Energy Savings Reported in the Project Documentation	Y	
Verification of Duplicate IDs or Projects	-	Y	

Equations and Compilation

Once the correct values were established (as per Table 1), the Evaluator validated that the equations in the tracking sheet correctly calculated each of the main program component results, the results of which are presented in Table 3.

Table 3: Verification of 2021 SEM Savings Compilation

Program Component Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	Y	
Gross Peak Demand Savings at the Generator	Y	
Net Energy Savings at the Generator	Y	
Net Peak Demand Savings at the Generator	Y	

Corrected Tracked Savings

Table 4 presents the corrected tracked savings, which were identical to the values tracked by EOne.

Table 4: 2021 SEM Corrected Tracked Savings

Program Component Result	Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	
Gross Energy Savings at the Generator	1.859	GWh	1.859	GWh	0%
Gross Peak Demand Savings at the Generator	0.172	MW	0.172	MW	0%
Net Energy Savings at the Generator	1.859	GWh	1.859	GWh	0%
Net Peak Demand Savings at the Generator	0.172	MW	0.172	MW	0%

The Evaluator found no discrepancy in the tracked values and therefore no changes were made.

APPENDIX XVII

SEM: PROJECT REVIEW PROTOCOL

The 2021 SEM impact evaluation involved conducting project reviews for four continuing participants and two new participants. One of the continuing participants was also an EMIS participant. For this reason, the protocol below was used for both EMIS and SEM.

This protocol was adapted to include sections that allowed reviewing both bottom-up and top-down approaches. For projects where a top-down approach was used, the Evaluator reviewed components such as the baseline energy regression, independent variables, quality of correlation, and any usual variations. The Evaluator also ensured that the baseline was accurately adjusted to obtain incremental savings. Where a bottom-up approach was applied, the Evaluator reviewed the engineering calculations, M&V results, and assumptions.

The phone interviews were conducted after a review of EOne digital project files. The Evaluator noted questions in the protocol as well as the answers from participants where relevant.

Since new participants were not sufficiently far along in the SEM process to answer satisfaction and free-ridership questions, this appendix only presents the technical portion of the project review protocol, which is typically used for continuing participants.

1. General Information

Interview/Site Visit Date:		Team:		Contact Name:									
Project ID:				Contact Title:									
NSPI Rate Code:				Phone:									
Company Name:				Email:									
Address:													
List of people met during the visit:													
Person(s) Responsible for SEM:													
Type of building:	<table border="1"> <tr> <td>Commercial/institutional</td> <td>☐</td> <td>Industrial/manufacturing</td> <td>☐</td> </tr> <tr> <td>Municipal</td> <td>☐</td> <td>Other (specify)</td> <td> </td> </tr> </table>					Commercial/institutional	☐	Industrial/manufacturing	☐	Municipal	☐	Other (specify)	
Commercial/institutional	☐	Industrial/manufacturing	☐										
Municipal	☐	Other (specify)											

2. Manufacturing Process & Key Energy Consumption Drivers

3. Facility Operation

The objective is to get a sense of their general schedule, to take it into consideration into the review of individual measures.

General Schedule	Schedule	NOTES
Weekdays - (Days/Week)		
Hours Per Weekday (Hrs/Day)		
Weekends - (Days/Weekend)		
Hours Per Weekend (Hrs/Day)		
Seasonal Schedules (Y/N)		
Reduced Seasonal HOU (Hrs/Day)		
Annual Seasonal Duration (Day/Year)		
Holiday Schedules (Y/N)		
Annual Holidays (Days/Year)		
Holiday HOU (Hrs/Day)		

NOTES:

4. SEM Management

SEM MANAGEMENT	NOTES
Were all activities held according to the Event Log?	
Annual Reduction Target? (Y/N)	
Percent Target Reduction (%)	
Did you Meet the Reduction Target(s)? (Y/N)	
If Not, Can You Explain Why?	
Who Is Responsible for Managing the M&T? Including updating the model, filling out the event log, etc.	
How Often is the M&T Reviewed?	
How Do You Handle Variations In the M&T?	
How Are the MT&R Results Communicated to the staff and management?	
Would your energy team be able to update and interpret your energy model, including calculating monthly energy savings, without support from the SEM service provider?	

5. Impact Evaluation & Savings Adjustments

Measure (List all SEM measures that are captured by one M&V approach - Repeat section 5 for each M&V approach)
Description

5. Impact Evaluation & Savings Adjustments

Measure (List all SEM measures that are captured by one M&V approach - Repeat section 5 for each M&V approach)
Description

COVID

Did Covid had an impact on the implemented measures?	
Are the savings calculations impacted by Covid?	
Were any adjustments made by the SP regarding Covid?	
Are the reported savings based on a typical year?	

IMPACT EVALUATION
NOTES

Project Measurement Boundary (full facility meter, subsystem?)		
Reporting Period (Days and dates)		
Baseline Period (Days and dates)		
Summary of Non-Routine Baseline Adjustments in Current Model		

Regression Equation Analysis

Regression Equation Used		
Coefficient of Determination (R2)		
Is R2 IPMVP Compliant (0.75 or greater)?		
Coefficient of Variation (CV)		
Is the CV below 10%		
Is the p-value for independent variables below 10%?		
Is the equation adequate (form and independent variables?)		

Are the baseline and reporting period appropriate?

When did the change occur?		
Is the baseline period adequate?		
Does the reporting period need to be extrapolated?		

Does the model account for changes in energy consumption due to factors other than the ECM?

Are there changes other than the ECM between the baseline and reporting periods? Changes in operation, changes in equipment?		
Does the ECM cause other impacts outside of the measurement boundaries?		

Documented Savings Calculations

Energy Savings (kWh)	Tracking Sheet	Annual report
Peak Demand Savings (kW)		
PCF		

Evaluator's Savings Calculations

Energy Savings (kWh)	Value	Notes
Peak Demand Savings (kW)		
PCF		

Summary of Adjustments

Energy Adjustment Ratio (%)	#DIV/0!	
Peak Demand Adjustment Ratio (%)	#DIV/0!	

Summary of Evaluator's Adjustment

(TO BE COPIED IN THE SUMMARY FILE SHARED WITH EONE)									

APPENDIX XVIII

SEM: DETAILED PROJECT REVIEW ADJUSTMENTS

Table 1: 2021 SEM Energy Savings Adjustments

Project	Tracked Savings (kWh)	Evaluated Savings (kWh)	Adjustment Ratio	Explanation for Adjustment
1	255,977	250,470	97.8%	The Evaluator applied a deduction for 2 BER Instant Rebates measures in March and in October: The participant could not remember what those were and they thought it may have been for a while ago. Therefore, the whole annual savings of 1,663 kWh and 2,706 kWh were deducted instead of only deducting a few months worth of savings. An adjustment was also made to include one more month to the deduction for the BER Mail-in ground-source heat pump measure.
2	15,778	15,778	100.0%	None.
3	211,026	211,026	100.0%	None.
4	49,040	40,794	83.2%	The lighting measure was removed from the savings as it turned out to be already claimed under BER Instant Savings. The fan control measure was also removed because M&V was insufficient to determine the operation hours reduction – this measure will be improved and M&V will be conducted again next year to resubmit the measure.
5	1,128,405	1,128,405	100.0%	None.
6	116,544	116,544	100.0%	None.
Total	1,776,770	1,763,017	99.2%	

Table 2: 2021 SEM Peak Demand Savings Adjustments

Project	Tracked Savings (kW)	Evaluated Savings (kW)	Adjustment Ratio	Explanation for Adjustment
1	29.2	28.6	97.8%	The reduction to the energy savings resulted in a proportional reduction of the peak demand savings.
2	1.8	1.8	100.0%	None.
3	0.0	24.5	N/A	EOne had incorrectly assumed a PCF of one measure although it generated savings during the peak demand period. The Evaluator estimated the PCF for the three measures to be 0.69, 0.64, and 0.75.
4	5.5	4.7	85.4%	Removing two of the three measures (as described in the Energy Savings Adjustment table above) had a similar downward impact on the peak demand savings.
5	128.8	128.8	100.0%	None.
6	0.0	81.8	N/A	This continuing project did not claim peak demand savings in 2020 for one measure because that measure was not operational in January and February of that year – that approach is consistent with the Evaluator’s recommended approach for multi-year SEM savings. The peak demand savings for that measure should therefore have been claimed in 2021, but they were forgotten.
Total	165.3	270.1	163.4%	

APPENDIX XIX

EMIS-SEM: 2021 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2021 EMIS and SEM evaluations along with past evaluation recommendations that remain unimplemented.

Sections	Recommendations
Executive Summary (SEM)	SEM-Recommendation 1: Develop guidelines on the usage of bottom-up approaches in SEM and ensure they are consistent with program objectives.
2020 EMIS – R1 (Being implemented)	Use the Evaluator’s peak demand savings calculation guidelines to develop a protocol to track peak demand savings.
2020 SEM – R2 (Not recommended for action)	Offer support for semi-annual management reviews to SEM participants that leave the program at the conclusion of the two-year participation period.
2020 SEM – R3 (Being implemented)	Use the Evaluator’s peak demand savings calculation guidelines to develop a protocol to track peak demand savings.



DIRECT INSTALLATION PROGRAM 2021 DSM EVALUATION

EFFICIENCYONE

Final Report

March 17, 2022



NARRATIVE
RESEARCH



ANS DE SUCCÈS
YEARS OF SUCCESS

ABBREVIATIONS

BNI	Business, non-profit and institutional
CDI	Commercial Direct Install
DIY	Do-it-yourself
DSM	Demand-side management
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
ETN	Efficiency Trade Network
EUL	Effective useful life
GHG	Greenhouse gas
HVAC	Heating, ventilation and air conditioning
LED	Light emitting diode
NS Power	Nova Scotia Power
NSUARB	Nova Scotia Utility and Review Board
NTGR	Net-to-gross ratio
SBEA	Small Business Energy Auditor
SBES	Small Business Energy Solutions

DEFINITIONS

Accuracy	Reflects the proximity of measurements to the true value.
Adjustment ratio	The ratio of evaluated results to tracked results. This ratio expresses the adjustment made to tracked savings or other tracked values such as effective useful life.
Baseline	To determine gross savings, a baseline (or base case) is established providing detailed information about the reference (e.g. pre-existing or standard) measure or equipment chosen to be compared with the efficient measure or equipment. For the reference measure or equipment, the baseline may include such information as the hours of operation, wattage and the base consumption.
Bias	Systematic deviations of measurements from the true value.
Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
Displaced wattage	The displaced wattage is defined as the difference between the wattage values of the baseline equipment or product and the efficient equipment or product.
EnerGuide rating	An EnerGuide (official brand of Natural Resources Canada) rating is a standard measure of the home's energy performance. It is a measure of the efficiency of the building only and does not take into account occupant behaviour. It shows how energy efficient the home is through modelled heat losses of the home, based on several factors including building envelope characteristics, heated volume, heating systems and air leakage.
Effective useful life	The period a measure is expected to be in service and provide both energy and peak demand savings. This value combines the equipment life and the measure persistence, which includes factors such as business turnover or early retirement.
Equipment life	The number of years installed equipment will operate before it fails.
Equivalent CO ₂	A unit of measurement indicating the amount of carbon dioxide to which various kinds of emitted greenhouse gases are equivalent in terms of warming effects. In this report, the gases' global-warming potential is estimated over a timescale of 100 years.
Equivalent effective useful life	The number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. This value takes into account variations in annual energy savings throughout the effective useful life due to increased baselines.

Evaluated savings	Gross and net energy or peak demand savings calculated by the Evaluator using the parameters (unitary savings values, installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process. Unless otherwise specified, the evaluated savings are the first-year savings.
Evaluation plan	The evaluation plan summarizes the program description, objectives, base cases, documentation, evaluation methodology, budget and schedule.
First-year savings	The first full year of energy or peak demand savings generated by an energy efficiency measure.
Free-ridership	Percentage of gross savings attributable to participants who would have implemented the same or similar energy efficiency measures, with no change in timing, in the absence of the program.
Gross savings	Change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated.
Induced consumption	Energy consumption of appliances that would have been unplugged and not replaced by participants in the absence of the program.
Interactive effects	Effects on the energy consumption of other systems in the building (such as heating and cooling) due to the installation of an energy efficiency measure.
Participant spillover	Savings attributable to participants who continue to implement the energy efficiency measure introduced by a program after participating in it once, without participating in the program a second time.
In-service rate	The proportion of incentivized products that are installed and operating. This rate is usually applied to programs through which rebates are offered in-store and products are likely to be stored for a certain period before being installed, such as LED lamps.
Installation rate	The proportion of incentivized products reported as installed that remain installed and operating at the time of evaluation. This rate is usually applied to direct install or mail-in rebate programs through which measures are expected to be installed immediately at the time of participation.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for a measure's effective useful life and any increase in the baseline efficiency level (which reduces attributable annual savings) over its lifetime.
Line loss factor	The multiplier to convert savings at the customer meter to savings at the utility generator. It accounts for the electrical losses of the transmission and distribution system.
Margin of error	The amount of random sampling error.
Market effects	The impact of the program on the market (such as increased product availability, practices, and prices) that extends beyond changing the program participants' behaviour. This includes spillover among non-participants.

Net savings	Energy or peak demand savings that can be reliably attributed to a program. This includes effects, such as free-ridership and spillover, that negatively or positively affect the savings attributable to a program.
Net-to-gross ratio	The ratio of net energy savings to gross energy savings.
Non-sampling error	Errors arising during the course of all survey activities other than sampling. Non-sampling errors tend to lead to bias in measurements and are very difficult to quantify.
Peak coincidence factor	The percentage of measure demand savings that coincide in time with the annual peak demand of the entire electricity system.
Peak demand savings	The demand savings that coincide in time with the expected annual peak demand period of the entire electricity system.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	The error in measurement due to the fact that measurements are taken from a subset of the population and not the entire population.
Realization rate	The ratio of evaluated savings to tracked savings.
Sample size	The number of observations or replicates included in a statistical sample.
Secondary market impacts	Energy consumption of appliances that would have been transferred to the secondary market if said appliances had not been retired.
Tracked savings	Gross and net savings calculated based on various parameters such as number of participants or units installed or sold, unitary savings values, installation rates, interactive effects, and the net-to-gross ratio. Those parameters, with the exception of the number of participants or units installed or sold, are obtained from the previous evaluation.
Unitary savings	Energy or peak demand savings established on a unitary basis. This unit can either be a product (e.g., an 8 W LED lamp), a capacity (e.g., one-ton capacity of an air-source heat pump) or a participant (e.g., one participant taking part in a behaviour-based program).

TABLE OF CONTENTS

EXECUTIVE SUMMARY	VIII
INTRODUCTION	1
1 SBES OVERVIEW.....	2
1.1 Description.....	2
1.2 Follow-up on Past Evaluation Report Recommendations	4
1.3 Participation History.....	5
2 SBES EVALUATION APPROACH.....	7
3 SBES PARTICIPANT PERSPECTIVES	9
3.1 Participant Awareness and Motivations	9
3.2 Satisfaction and Barriers	9
4 SBES IMPACT EVALUATION	11
4.1 Tracking Sheet Audit.....	11
4.2 Gross Savings	11
4.2.1 Summary of 2021 Gross Savings Adjustments	11
4.2.2 Unitary Energy and Peak Demand Savings	12
4.2.3 Installation Rates	13
4.2.4 Interactive Effects	13
4.2.5 Effective Useful Life	13
4.2.6 Evaluated Gross Savings.....	17
4.3 Net Savings.....	22
4.3.1 Free-ridership.....	22
4.3.2 Participant Spillover	23
4.3.3 Net-to-gross Ratio Calculation	23
4.3.4 Evaluated Net Savings.....	24
4.4 Realization Rate.....	25
5 SBES KEY FINDINGS AND RECOMMENDATIONS	26
CONCLUSION.....	27

LIST OF TABLES

Table 1: Summary of 2021 Direct Installation Program Evaluation	viii
Table 2: Overall 2021 Direct Installation Participation and Evaluated Savings	viii
Table 3: Comparison of 2021 SBES Tracked and Evaluated Savings at the Generator	xi
Table 4: Types of Evaluations Conducted for Each Program Component, 2021	1
Table 5: 2021 SBES Evaluation Approach	7
Table 6: 2021 SBES Gross Savings Adjustments	12
Table 7: 2021 SBES Equivalent Effective Useful Life Values by Lighting Product	14
Table 8: 2021 SBES Equivalent Effective Useful Life Values by Non-lighting Product	15
Table 9: Evaluated 2021 SBES Gross Energy and Peak Demand Savings – Audit Path	18
Table 10: Evaluated 2021 SBES Gross Energy and Peak Demand Savings – DIY Path	19
Table 11: Evaluated 2021 SBES Gross Energy and Peak Demand Savings – CDI Pilot	20
Table 12: Evaluated 2021 SBES Gross Energy and Peak Demand Savings – All Paths	21
Table 13: 2021 SBES Free-ridership Level	23
Table 14: 2021 SBES NTGRs	24
Table 15: Evaluated 2021 SBES Net Energy and Peak Demand Savings	24
Table 16: Evaluated 2021 SBES GHG Emission Reductions	25
Table 17: Comparison of 2021 SBES Tracked and Evaluated Savings at the Generator	25
Table 18: Overall 2021 Direct Installation Participation and Evaluated Savings	27

LIST OF FIGURES

Figure 1: 2021 SBES Targets and Evaluated Results	ix
Figure 2: Overview of SBES Participation, 2015-2021	x
Figure 3: Evolution of SBES Net Savings, 2015-2021	x
Figure 4: 2021 Audit Path Participation Process	3
Figure 5: 2021 DIY Path Participation Process	4
Figure 6: Overview of SBES Participation, 2015-2021	5
Figure 7: Evolution of SBES Gross Savings, 2015-2021	6
Figure 8: 2021 Participant Satisfaction with SBES (10-point Scale)	10
Figure 9: 2021 SBES Tracked and Evaluated Gross Energy Savings	21
Figure 10: 2021 SBES Tracked and Evaluated Gross Peak Demand Savings	22
Figure 11: 2021 Direct Installation Targets and Evaluated Results	27

EXECUTIVE SUMMARY

This report presents the 2021 demand-side management (DSM) results of the Direct Installation program administered by EfficiencyOne (EOne). This program is comprised of the Small Business Energy Solutions (SBES) program component. SBES offers incentives and resources to Nova Scotia small businesses to encourage them to make energy efficient upgrades in their facilities.

Evaluation Approach

The evaluation was aimed at calculating program component gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided greenhouse gas (GHG) emissions. Table 1 summarizes the type of evaluation conducted and the corresponding methodology.

Table 1: Summary of 2021 Direct Installation Program Evaluation

Program Component	Evaluation Type			Methodology
	Impact	Process	Market	
Small Business Energy Solutions	Condensed	-	-	› Participant survey › Tracking sheet audit › Measure Assessment update › Peak demand savings review for heat pumps › Calculations using evaluation results › GHG emission reduction calculations

Program Performance

Table 2 presents the participation levels, net-to-gross ratios (NTGRs), as well as evaluated gross and net savings at the generator for the Direct Installation program.

Table 2: Overall 2021 Direct Installation Participation and Evaluated Savings¹

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
Energy Savings	512 ²	Projects	11.105	GWh	0.85	9.486	GWh
Lifetime Energy Savings			158.138	GWh	0.85	134.696	GWh
Peak Demand Savings			2.397	MW	0.85	2.045	MW

Direct Installation achieved 9.486 GWh and 2.045 MW in net energy and peak demand savings respectively at the generator.

¹ The results presented in this table include savings for SBES and the Commercial Direct Install (CDI) pilot.

² 76 of the 512 projects were CDI pilot projects.

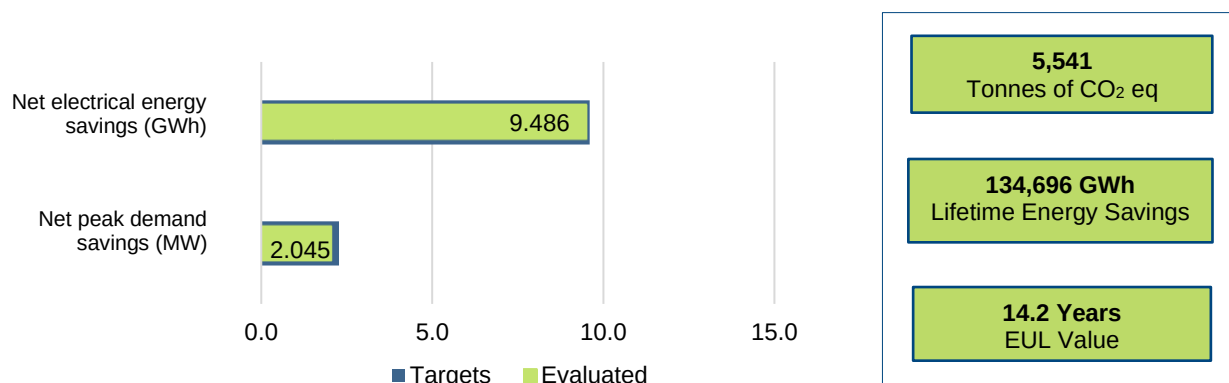
SBES Findings and Recommendations

This subsection presents the key findings from the SBES evaluation. The Evaluator has no specific recommendation for SBES in 2021.

2021 SBES-Finding: Net energy savings were within 1% of target, while peak demand savings fell short of targets.

In 2021, SBES achieved 9.486 GWh and 2.045 MW in net energy and peak demand savings respectively. SBES was within 1% of its planned targets of 9.60 GWh in net energy savings and 10% below the peak demand savings target of 2.27 MW. SBES achieved 5,541 tonnes of annually avoided GHG emissions, 134,696 GWh in net lifetime energy savings, and an overall average effective useful life (EUL) of 14.2 years. Figure 1 summarizes these findings.

Figure 1: 2021 SBES Targets and Evaluated Results



2021 SBES-Finding: Participation as well as gross energy and peak demand savings considerably increased in 2021 compared to 2020, although participation in the Audit path remained low.

Overall participation in SBES increased by 77% in 2021 compared to 2020, almost reaching the pre-pandemic participation level of 2019. This increase appears to have been driven in large part by the incentive increase motivating more businesses to participate in the program despite the COVID-19 pandemic continuing into 2021. The addition of the CDI pilot also contributed somewhat to the participation increase. While DIY projects continue to be the most popular, representing 82% of all projects, the number of Audit projects reached its lowest level since 2016. Due to the increase in DIY participation and stable level of savings per project, gross energy and peak demand savings almost doubled compared to 2020.

Figure 2 below illustrates the changes in SBES participation between 2015 and 2021, while Figure 3 presents the changes in SBES energy and peak demand savings over the same period.

Figure 2: Overview of SBES Participation, 2015-2021

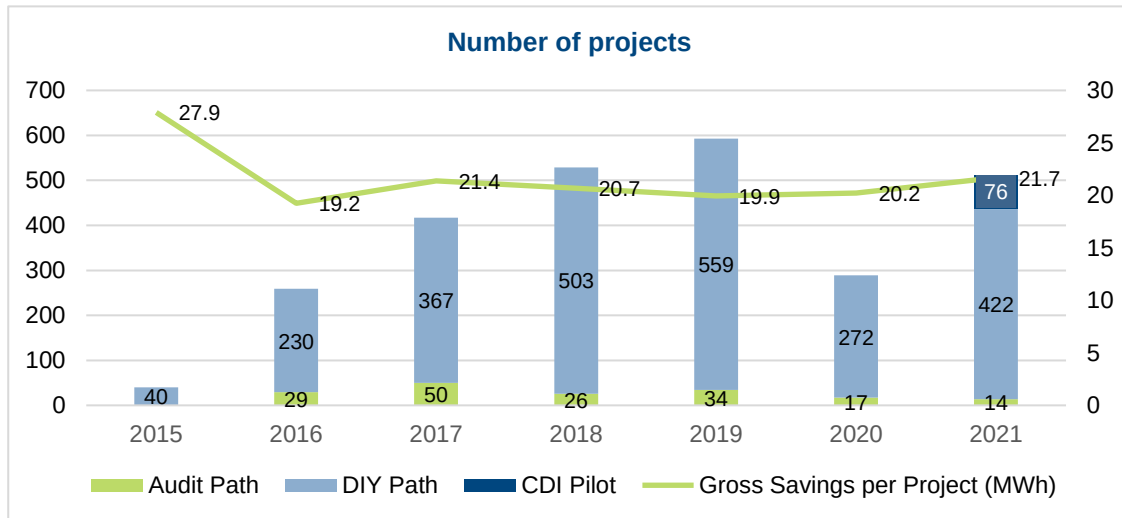
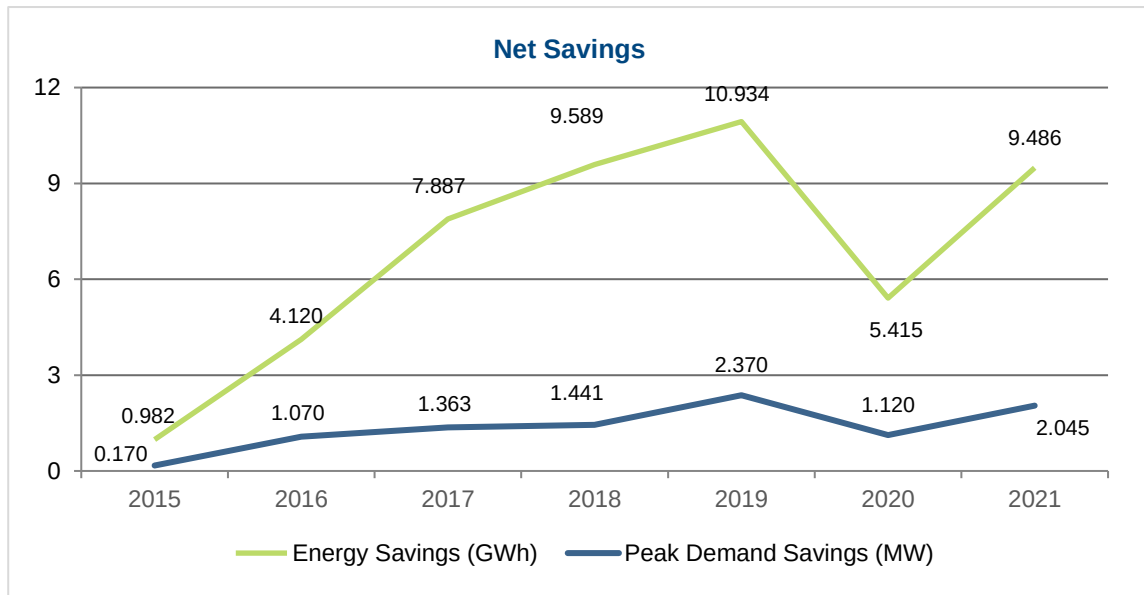


Figure 3: Evolution of SBES Net Savings, 2015-2021



2021 SBES-Finding: Overall satisfaction with SBES is high among participants, with an average rating of 9.1 out of 10.

2021 SBES-Finding: The average free-ridership level for DIY participants was established at 15%, up from 7% in 2019. For Audit participants, the 2019 free-ridership level of 12% was used.

2021 SBES-Finding: The evaluated net energy and peak demand savings determined by the Evaluator were 7% lower than the net savings tracked by EOne.

While the evaluated gross energy and peak demand savings were slightly higher than the values tracked by EOne due to the higher unitary savings value established by the Evaluator for the CDI pilot measures, the evaluated net energy and peak demand savings were 7% lower than the values tracked by EOne due to the higher free-ridership established in 2021 for the DIY path, as presented in Table 3.

Table 3: Comparison of 2021 SBES Tracked and Evaluated Savings at the Generator³

	Gross Savings		NTGR	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	10.937	GWh	0.93	10.169	GWh	93%
Evaluation Results	11.105	GWh	0.85	9.486	GWh	
Peak Demand Savings						
Tracked Savings by EOne	2.365	MW	0.93	2.199	MW	93%
Evaluation Results	2.397	MW	0.85	2.045	MW	

³ The results presented in this table include savings for SBES and the CDI pilot.

INTRODUCTION

EfficiencyOne (EOne), an independent, non-profit organization, is responsible for helping Nova Scotians improve the energy efficiency of their homes and workplaces by designing, marketing, and delivering energy efficiency and conservation programs for Nova Scotians. EOne receives funding for its electricity demand-side management (DSM) activities from Nova Scotia Power (NS Power) ratepayers.

EOne has a DSM portfolio of three residential programs and three business, non-profit, and institutional (BNI) programs that are marketed to Nova Scotians through the Efficiency Nova Scotia (ENS) franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2021 DSM program portfolio. In addition, Econoler conducted research to inform EOne's approach to market transformation and treatment of codes and standards.

To carry out these services, Econoler collaborated with Equilibrium Engineering, Bouthillette Parizeau, Richard Patterson of CDM Energy Solutions, Narrative Research and Energetix. Econoler served as team leader and was involved in every aspect of the evaluation. Specifically, Econoler was in charge of coordinating and supervising all activities, conducting final reviews of all data-collection instruments, performing process and market evaluations and impact evaluation calculations, as well as preparing and reviewing evaluation reports. Bouthillette Parizeau and Richard Patterson conducted desk reviews. Equilibrium Engineering conducted desk reviews and on-site visits for selected program components. These organizations also contributed to certain impact evaluation analyses. Narrative Research conducted interviews and surveys with participants and partners, as well as analyzed and reported on the data collected from those activities. Energetix provided insight on evaluation planning activities for EOne's demand response initiatives planned for the 2021-2022 winter peak period. Throughout this report, this team is referred to as the Evaluator.

This evaluation report relates to the Direct Installation program, which is comprised of one component: Small Business Energy Solutions (SBES). Table 4 below lists the Direct Installation program component and the type of evaluation conducted in 2021. A condensed impact evaluation involves using some or all of the previous year's impact evaluation parameters such as unitary savings values, adjustment ratios, installation rates, and net-to-gross ratios (NTGRs) to provide evaluated results.

Table 4: Types of Evaluations Conducted for Each Program Component, 2021

Program	Program Component	2021		
		Process	Market	Impact
Direct Installation	SBES	-	-	Condensed

Key findings, electrical first-year and lifetime energy savings, peak demand savings, and avoided greenhouse gas (GHG) emissions are presented in this report.

1 SBES OVERVIEW

This section describes the Small Business Energy Solutions (SBES) program component, follows up on past evaluation recommendations, and provides an overview of participation history.

1.1 Description

SBES offers incentives and resources to Nova Scotia small businesses to encourage them to make energy efficient upgrades in their facilities. To be eligible, businesses must consume less than 350,000 kWh of electricity annually. Businesses with electricity consumption higher than this limit are directed toward the EOne Custom or Business Energy Rebates program components.

SBES offers two paths for participation: Audit and Do-it-yourself (DIY). The Audit path provides a no-cost energy audit conducted by a Small Business Energy Auditor (SBEA). The DIY path does not include an energy audit and is intended for participants that have identified one or more savings measures that they wish to implement.

Since the last quarter of 2020, SBES incentive amounts were increased considerably. New incentive levels were set for integrated light-emitting diode (LED) fixtures, linear replacement lamps, outdoor lighting, sign lighting, case lighting, and commercial heating measures. In addition, the incentive cap was increased from 60% to 80% and the expiry time of project completion was extended to 120 days.

Eligible measures generating non-electrical savings were added to the SBES offering in July 2021. SBES funding now comes from two sources: (1) Electricity ratepayer funding is used for upgrades that reduce electricity consumption; and (2) funding for the Government of Nova Scotia for upgrades that reduce the use of other fuels. This report presents the evaluator results for the electricity ratepayer portion of SBES only.

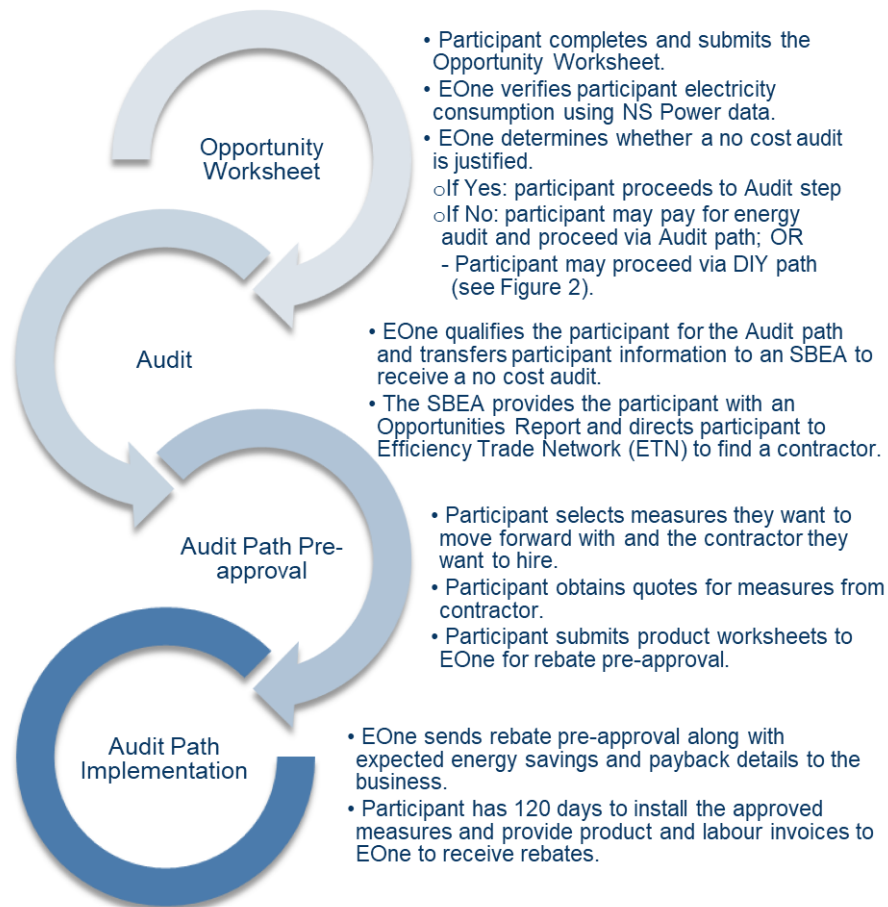
SBES applicants have the choice of two program applications that partially serve to determine whether their project will follow the Audit or DIY path:

- › Opportunity Worksheet: Participants who do not know which measures they plan to implement or are interested in receiving a no-cost energy audit use the Opportunity Worksheet to apply. EOne uses the information from the Opportunity Worksheet and the business' electricity consumption history provided by NS Power to determine whether the applicant is eligible for SBES and if an audit would help identify additional potential energy saving upgrades.
 - Participants who are approved for a no-cost audit proceed via the Audit path.
 - Participants who are not approved for a no-cost audit may choose to have an audit conducted at their own expense and proceed via the Audit path.
 - Participants who are not approved for a no-cost audit and who choose not to conduct an audit at their own expense may proceed via the DIY path.

- › Before You Buy Commercial Product Rebate Application: Participants who know which measures they plan to implement and are not interested in receiving a no-cost audit complete the Before You Buy Commercial Product Rebate Application. Once approved by EOne, these participants proceed via the DIY path.

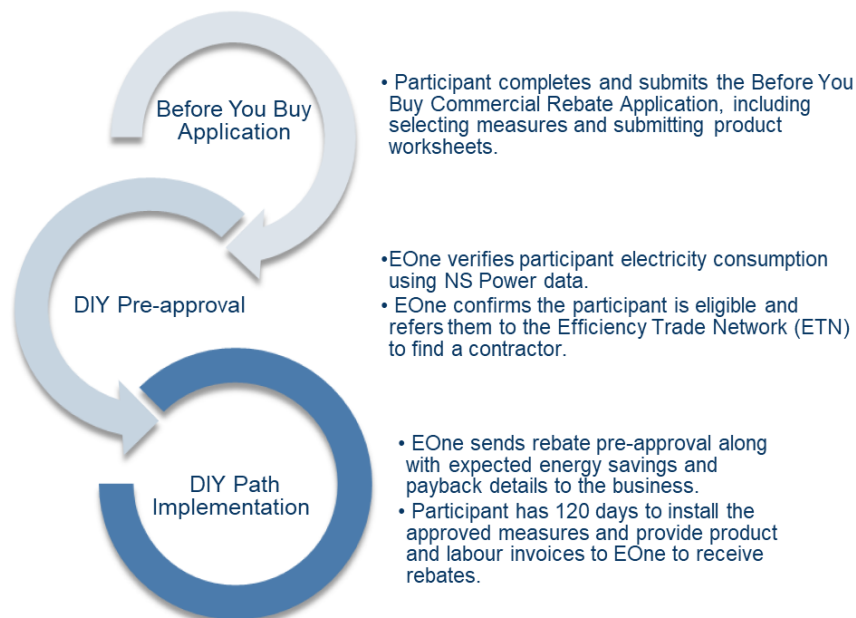
Figure 4 illustrates the key steps of the Audit path participation process.

Figure 4: 2021 Audit Path Participation Process



Applicants who do not qualify for an audit follow the DIY path summarized in Figure 5.

Figure 5: 2021 DIY Path Participation Process



Rebates vary according to factors related to specific technologies, including incremental costs, adoption rates, and the strategic importance of a given technology to SBES and the EOne portfolio.

In 2021, EOne also launched the Commercial Direct Install (CDI) pilot. The pilot provides small businesses with free-of-charge direct installations of energy efficient products. The pilot relies on service providers contracted through the Efficient Product Installation (EPI) program component and includes efficient products from EPI, namely LED screw-in lamps, faucet aerators, low-flow showerheads, thermostatic shower valves, pipe wrap, and hot water tank wrap.

SBES was aimed at achieving net electrical energy savings of 9.60 GWh and net peak demand savings of 2.27 MW at the generator in 2021.

1.2 Follow-up on Past Evaluation Report Recommendations

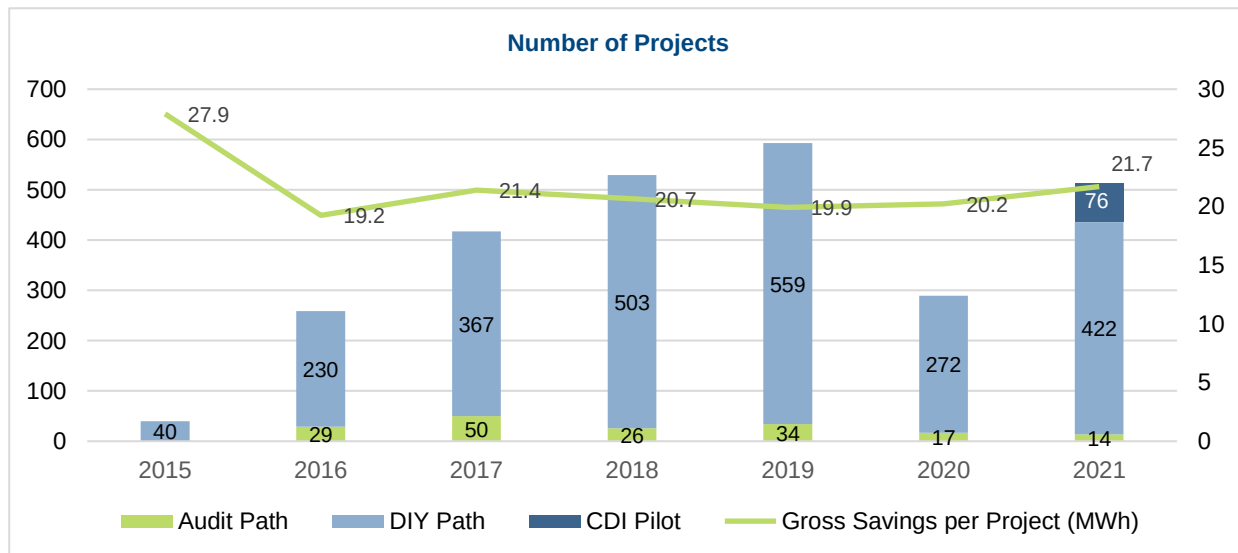
No major improvement recommendations were made for SBES in 2020.

1.3 Participation History

As presented in Figure 6 below, SBES participation reached 512 projects in 2021, nearly returning to 2019 levels after the large drop in participation observed in 2020. This increase appears to have been driven in large part by the incentive increase motivating more businesses to participate in the program despite the COVID-19 pandemic continuing into 2021. The addition of the Commercial Direct Install (CDI) pilot also contributed to the participation increase (76 participants).

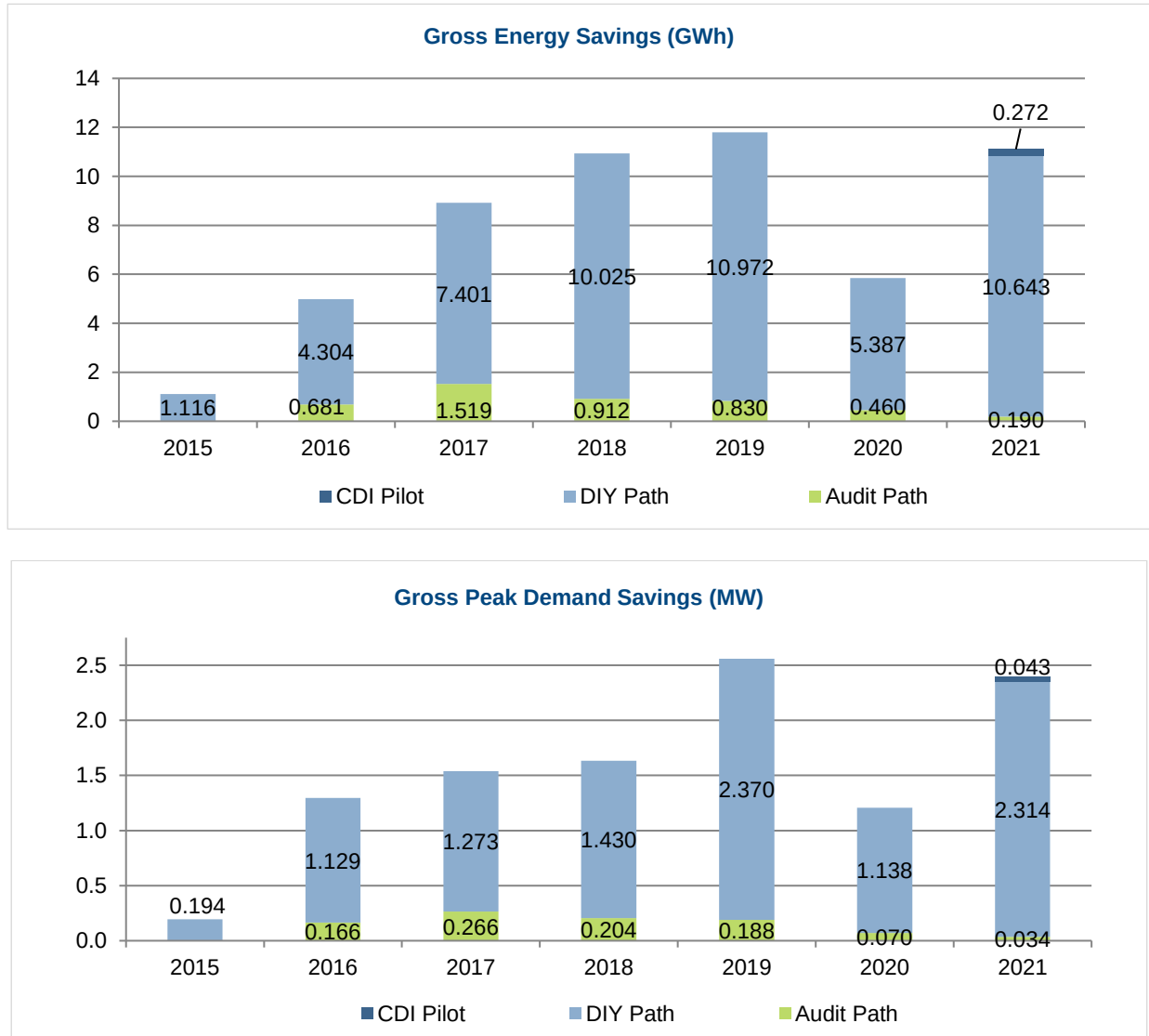
DIY projects continue to be the most popular, representing 82% of all projects, while the number of Audit projects remains low. Gross energy savings per project have remained relatively stable since 2017 and increased slightly in 2021 to 21.7 MWh.

Figure 6: Overview of SBES Participation, 2015-2021



The increase in participation is reflected in gross energy and peak demand savings as illustrated in Figure 7 below. Gross energy and peak demand savings increased by 90% and 98% respectively in 2021 compared to 2020, thereby almost reaching 2019 levels. The DIY path represented 96% of SBES energy savings.

Figure 7: Evolution of SBES Gross Savings, 2015-2021



2 SBES EVALUATION APPROACH

The 2021 SBES evaluation consisted of a condensed impact evaluation. The objectives of the 2021 SBES evaluation were to calculate gross and net SBES results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions.⁴

The Evaluator identified key research questions aimed at achieving the objectives. Table 5 outlines the evaluation objectives and maps them to the research questions and methods. Each method is described further below.

Table 5: 2021 SBES Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Collect information on participant perspectives	› How do participants become aware of SBES? › What is the level of satisfaction with SBES among participants? › How could EOne improve SBES?	› Participant survey
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › Are the peak demand savings for heat pumps valid? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Peak demand savings review for heat pumps › Measure Assessment update › Calculations using evaluation results
Calculate net results	› What is the SBES free-ridership level for 2021? › What are the evaluated first-year and lifetime net electrical energy and peak demand savings? › What are the net avoided GHG emissions in CO₂ eq for SBES?	› Participant survey › Calculations using evaluation results › GHG emission reduction calculations

Participant survey

In November and December 2021, Narrative Research conducted a telephone survey with a total of 50 SBES participants, including one Audit path participant and 49 DIY path participants. The average duration of the survey was 16 minutes. The survey questionnaire is presented in Appendix I and complete survey results are outlined in Appendix II. Drawing a random sample of 50 from a population of 366 yields a margin of error of 11% at a 90% confidence level.

Tracking Sheet Audit

Prior to performing the savings calculation review, the Evaluator performed an audit of the final 2021 tracking sheet to ensure it was complete and the entered data were consistent. The detailed protocol used for the tracking sheet audit and the results obtained are presented in Appendix III.

⁴ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

Unitary Savings Review

As part of the 2021 evaluation, the Evaluator established unitary savings for new SBES measures, which include all measures of the CDI pilot, and updated the 2020-2022 Measure Assessment⁵ document accordingly.

Peak Demand Savings Review for Heat Pumps

The Evaluator revised the peak demand savings for air-source heat pumps with nil peak demand savings tracked by EOne based on specific characteristics of each model.

EUL Update

The Evaluator updated the EUL values of lighting products given the rapid evolution of the lighting market and established EUL values for the new measures. The 2020-2022 Measure Assessment was updated accordingly.

Calculations Using Evaluation Results

Building on all the above methods and collected data, the Evaluator calculated the first-year and lifetime gross energy and peak demand savings as per the calculation methodology presented in Section 3 below.

GHG Emission Reduction Calculations

To obtain net avoided GHG emissions in CO₂ eq for SBES, the Evaluator multiplied the net energy savings by the latest Nova Scotia-specific factor for GHG emissions generated by electricity production. This factor was established using NS Power data.

⁵ The 2020-2022 Measure Assessment is a reference document that provides an in-depth review of all parameters necessary to calculate the annual and lifetime gross energy and peak demand savings of most prescriptive measures and some semi-prescriptive measures offered through EOne's DSM program portfolio. In addition, the Measure Assessment includes effective useful life measures for all measures offered in EOne's program portfolio. For the evaluations conducted during the 2020-2022 DSM cycle, the Evaluator refers to the values presented in the 2020-2022 Measure Assessment.

3 SBES PARTICIPANT PERSPECTIVES

A survey of 50 participants was conducted as part of the SBES evaluation, including 49 participants who took the DIY path (8 HVAC and 41 lighting), and one participant who took the Audit path. In addition to the questions designed for impact evaluation purposes, survey respondents were asked questions regarding the source of awareness, reasons for participating, satisfaction, potential barriers to the installation of energy efficient upgrades equipment, and recommendations for improvement.

3.1 Participant Awareness and Motivations

Word of mouth from a contractor, equipment vendor, energy consultant (24%), or from friends and colleagues (20%) are the primary sources of SBES awareness for participants. Fewer first learned of SBES through a previous program experience (14%), a general internet search (12%), or from an ENS representative (10%).

For the most part, businesses first initiated the discussion with their contractor or EOne about participating in SBES (44%), while fewer were approached by a contractor (28%). For about one in six (16%), the idea of taking part in SBES arose in discussion between them and their contractors.

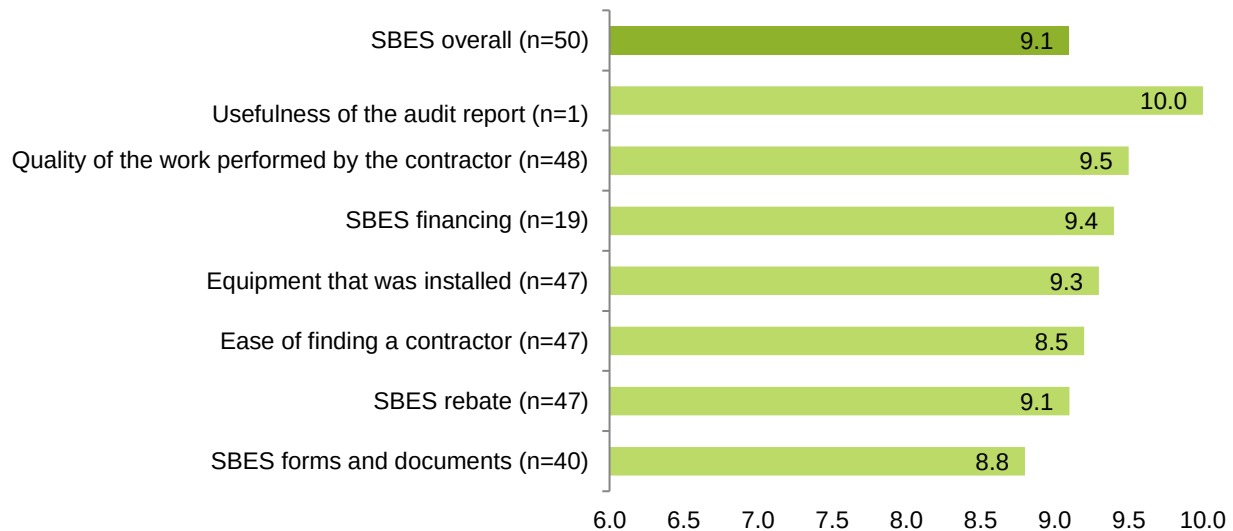
Participation in SBES is primarily motivated by a desire to save money (32%), save energy (26%), or upgrade to more efficient equipment (22%). Only a small proportion of participants (10%) indicated that the impacts of the COVID-19 pandemic influenced their business decision to participate in SBES. The pandemic influenced these participants (n=5) in various ways, notably due to challenges causing them not to participate in the beginning, a desire to reduce energy costs, or making the rebate more attractive to them.

3.2 Satisfaction and Barriers

As illustrated in Figure 8 below, there is a high degree of general satisfaction with SBES and with all of the aspects assessed. The main points of dissatisfaction are the rebate payment period being too long and the overall program component process taking too much time to complete.

The one interviewed Audit path participant was completely satisfied with the usefulness of the audit report and provided a perfect score of 10. The level of satisfaction with all other aspects of SBES is high among all SBES participants, notably with the quality of the work performed by the contractor, SBES financing, installed equipment, ease of finding a contractor, and the SBES rebate (see Figure 8).

Figure 8: 2021 Participant Satisfaction with SBES (10-point Scale)



Nearly four in ten respondents (38%) offered a suggestion for improving SBES. The most cited recommendations include increasing the rebates (6%), speeding up the rebate payment process (4%), offering financing options (4%), increasing the number of rebate-eligible measures (2%), enhancing program component awareness and improving marketing (2%), improving communication (2%), and simplifying the program component administrative requirements (2%).

Respondents were asked to what extent they considered four factors as barriers preventing their business from installing energy efficiency upgrades. They were asked to rate the influence of each factor on a 10-point scale with 1 meaning “Not at all a barrier” to 10 meaning “A major barrier”. In general, the four factors, namely (1) financial challenges, (2) lack of knowledge about energy efficiency incentives or equipment, (3) not knowing where to start when planning upgrades, and (4) time constraints, were not significant barriers to the installation of energy efficiency upgrades, with participants providing ratings below the mid-point on the scale.

2021 SBES Participant Perspective Highlights

- › Participants primarily learn about SBES through a contractor, equipment vendor, energy consultant, friends, or colleagues.
- › A desire to save money or energy and upgrade to more efficient equipment are the main reasons for participating in SBES.
- › The COVID-19 pandemic has had a minimal influence on SBES participation.
- › There is a high degree of participant satisfaction with SBES (average rating of 9.1 out of 10).

4 SBES IMPACT EVALUATION

The objectives of the 2021 SBES impact evaluation were to determine gross and net electrical energy and peak demand savings. This section discusses the gross and net savings results.

4.1 Tracking Sheet Audit

To ensure program component results were reliably compiled, the Evaluator first performed a tracking sheet audit aimed at verifying the completeness and consistency of the data submitted by EOne. The verification and corrective actions taken by the Evaluator, where applicable, are described in detail in Appendix III. The tracked savings results presented in this report therefore refer to the corrected tracked savings validated by the Evaluator.

4.2 Gross Savings

Gross savings correspond to the change in energy consumption resulting from actions taken by participants regardless of their reasons for participating.⁶ For each SBES Audit or DIY project, EOne calculates gross savings using the standard equations defined in the CIRx Screening Tool⁷ or the custom calculations performed by energy auditors or EOne program component staff. For the CDI pilot, savings are based on unitary savings values.

The lighting measure category comprised 99% of all implemented SBES measures and accounted for 82% of total savings in 2021.

4.2.1 Summary of 2021 Gross Savings Adjustments

As part of the 2019 evaluation, the Evaluator conducted site visits (n=50) to establish adjustment ratios and determine evaluated savings. Based on the observations made on site and an analysis of the calculations, the Evaluator calculated the revised savings of each sampled project and then established an average adjustment ratio for each SBES path. The adjustment ratios correspond to the evaluated savings divided by the tracked savings for all sampled projects within a path. These adjustment ratios were extrapolated to all energy savings (by multiplying the ratio by the tracked savings of the given path) since the margins of error were below the targets of 10% at a confidence level of 90%. No data collection aimed at updating the adjustment ratios was conducted in 2020 or 2021. Therefore, the 2019 adjustment ratios were used to establish evaluated energy savings in 2021.

⁶ Definition adapted from: National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3. http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter23-estimating-net-savings_0.pdf (Last accessed November 25, 2016).

⁷ The CIRx Screening Tool is a tool provided by EOne presenting the savings calculation methodologies, assumptions, and calculation parameters for measures implemented under SBES.

In the 2019 SBES evaluation, the Evaluator applied one-time adjustments to peak demand savings from sampled projects and did not apply an adjustment ratio to all peak demand savings because margins of error were not within the target range. The application of one-time adjustments to demand savings from sampled projects in 2019 resulted in an overall impact very close to an equivalent adjustment ratio of 1.0 for each path (with the exception of Audit path HVAC projects, which led to a recommendation that has since been implemented by EOne). For this reason, the Evaluator applied an adjustment ratio of 1.0 to peak demand savings for both SBES paths in 2021.

For the CDI pilot, savings are calculated differently than for the other two paths. Therefore, the Audit and DIY path adjustment ratios were not applicable to pilot savings. Instead, the Evaluator applied the 2019 adjustment ratios from EPI since they come from tracking errors that are expected to be similar between EPI and the pilot considering that they are offered through the same service providers.

Table 6 summarizes the adjustment ratios for the 2021 evaluation.

Table 6: 2021 SBES Gross Savings Adjustments

SBES Path	Energy Savings		Peak Demand Savings
	Overall Adjustment Ratio	Margin of Error	Overall Adjustment Ratio
Audit	0.925	5.67%	1.000
DIY	0.972	8.39%	1.000
CDI Pilot – A-type LED Lamps	0.960	5%	0.960
CDI Pilot – Other Products	1.000	N/A	1.000

In addition, the Evaluator revised the peak demand savings for four air-source heat pumps with nil peak demand savings tracked by EOne using specific characteristics of each model. Two of these four heat pump models were found to be on electric resistance heating at cold temperatures and they were left no peak demand savings. The Evaluator calculated peak demand savings for the two other heat pumps based on rated characteristics from manufacturers adjusted to cold climate performance since they were identified to be in heat pump mode at cold temperatures but no data for performance in cold temperature were available.⁸

4.2.2 Unitary Energy and Peak Demand Savings

While savings of SBES Audit or DIY projects are obtained through calculations using data specific to each project, the CDI pilot relies on unitary savings values for each measure. The Evaluator established unitary savings values by either adapting the equations and assumptions for the measures already used for the residential sector or, when needed, conducting a literature review.

⁸ The details of the adjustment factors applied by the Evaluator are included in the 2020-2022 Measure Assessment.

For the CDI pilot, the energy and peak demand unitary savings values used for the 2021 evaluation are presented in Appendix IV. The equations and assumptions used for the unitary savings are presented in the 2020-2022 Measure Assessment.

The unitary savings established by the Evaluator were generally higher than those used by EOne since commercial hours of use were determined to be higher than residential hours of use for most measures, notably for lighting measures.

4.2.3 Installation Rates

While installation rates are accounted for in the adjustment ratios for SBES Audit or DIY projects, the CDI pilot adjustment ratios do not encompass installation rates. For the pilot, the Evaluator assumed an installation rate of 100% since no activity aimed at establishing installation rates for SBES were conducted during the 2021 evaluation.

4.2.4 Interactive Effects

Interactive effects occur when the implementation of energy efficiency measures has an impact on the energy consumption of other elements such as heating and cooling. For the SBES Audit and DIY paths, these are taken into account by the gross savings standard equation in the EOne CIRx Screening Tool. Since 2016, specific interactive effects factors have been taken into account for both energy and peak demand savings.

For the CDI pilot, the Evaluator established average interactive effects factors to be applied to each measure. The interactive effects factors used for the 2021 evaluation are presented in Appendix IV. The equations and assumptions used for these factors are presented in the 2020-2022 Measure Assessment.

4.2.5 Effective Useful Life

As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the EUL values used in the calculation of electrical energy savings that are expected to persist over time. Most of the EUL values established in the 2020 evaluation remained valid for the 2021 evaluation. The Evaluator updated the EUL values for lighting measures that will be impacted by upcoming regulations and established EUL values for new measures.

Table 7 and Table 8 below summarize the tracked and evaluated equivalent EUL values. The EUL values of CDI pilot measures are presented in Appendix IV.

Table 7: 2021 SBES Equivalent Effective Useful Life Values by Lighting Product

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]
LED Linear Fixtures		
1 x 4 Luminaires	11.6	No change
2 x 2 Luminaires and Retrofit Kits	11.6	No change
2 x 4 Luminaires and Retrofit Kits	11.6	No change
Linear Ambient and Low-bay Luminaires	11.6	No change
High-bay Luminaires	23.3	No change
Troffers	20.9	No change
LED Linear Lamps		
2-foot Replacement Lamps	11.6	No change
3-foot Replacement Lamps	11.6	No change
4-foot Replacement Lamps	11.6	No change
8-foot Replacement Lamps	11.6	No change
U-bend	11.6	No change
LED General-use and Decorative Lamps		
LED Decorative (Chandelier)	3.7	3.2
LED Omnidirectional (A-lamp and Globe)	3.7	3.2
Four Pin-base Replacement Lamps for Compact Fluorescent Lamps	11.6	No change
LED Reflector Lamps		
Small LED Reflector Lamps - PAR, MR, MRX 16	4.3	3.5
Small LED Reflector Lamps - PAR, R 20	4.3	3.5
Large LED Reflector Lamps - PAR, BR, R 30/30L	4.3	3.5
Large LED Reflector Lamps - PAR, BR, R 38/40	4.3	3.5
LED Downlight Fixtures		
LED Recessed	6.3	4.7
LED Ceiling Mount, LED Surface Mount, LED Solid State Retrofit, LED Inseparable Solid State Luminaire, LED Wall Sconces, LED Wall Sconce Retrofits	5	4.3
LED Outdoor Fixtures		
Outdoor Full-cutoff Wall-mounted Area Luminaires	17.1	No change
Flood and Spot Luminaires	17.1	No change
Fuel Pump Canopy Luminaires	11.4	No change
LED Replacements for High-intensity Discharge Lamps	11.4	No change
Non-cutoff and Semi-cutoff Wall-mounted Area Luminaires	22.8	No change
Pole/Arm-mounted Area Luminaires	13.7	No change
Pole/Arm-mounted Decorative Luminaires	22.8	No change
Parking Garage Luminaires	22.8	No change
Case Lighting for Sign Retrofit Applications	11.6	No change
LED Directional and Architectural Fixtures		
Track or Mono-point Directional Luminaires, LED Wall Wash Luminaires	11.6	No change
Other LED Lighting		
Refrigerated Case Luminaires	16.3	No change
Non-LED Lighting		
Occupancy Sensors	10.0	No change

Table 8: 2021 SBES Equivalent Effective Useful Life Values by Non-lighting Product

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]
Agricultural		
Agriculture Heat Pads	10	No change
Dairy Scroll Compressors	15	No change
Energy Efficient Ventilation and Circulation Fans	15	No change
Heat Reclaimer Units	15	No change
High-volume Low-speed Fans	15	No change
Low-energy and Zero-energy Livestock Waterers	10	No change
Milk Pre-coolers	15	No change
Natural and Dual Ventilation	15	No change
Tractor Engine-block Heater Timers	5	No change
VFDs for Milk Vacuum Pumps	15	No change
VFDs for Milk Transfer Pumps	15	No change
Compressed Air		
Air Entraining Air Nozzles	15	No change
Cycling Air Dryers	10	No change
No-loss Drains	15	No change
HVAC		
Air-source Heat Pumps Greater Than or Equal to 65,000 BTU/hr	15	No change
Air-source Heat Pumps Less Than 65,000 Btu/hr (excluding air-to-water)	18	No change
Air-to-water Heat Pumps	15	No change
Dual-enthalpy Economizer Controls	10	No change
Ground-source Heat Pumps	25	No change
HVAC Hotel Occupancy Sensors	8	No change
Packaged Terminal Heat Pumps (PTHPs)	15	No change
Water-source Heat Pumps	15	No change
Electric Thermal Storage	18	No change
IT & Datacentres		
Server-based Power Management Software	5	No change
Server Virtualization and Decommissioning	4	No change
ENERGY STAR® Uninterruptible Power Supplies	10	No change
Laundry		
Commercial Clothes Dryers (Natural Gas Conversion)	12	No change
Commercial Heat Pump Clothes Dryers	12	No change
Commercial Washing Machines	11	No change

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]
Kitchen		
Demand-controlled Kitchen Exhausts	15	No change
Dishwashers	10, 15, or 20	No change
Freezers/Refrigerators	12	No change
Fryers	12	No change
Griddles	12	No change
Hot Food Holding Cabinets	12	No change
Ice Machines	10	No change
Ovens	12	No change
Steam Cookers	12	No change
Motors and VFDs		
Energy Efficient Motors	15	No change
Variable Frequency Drives	15	No change
Pumping		
Circulator Pumps	15	No change
Refrigeration		
Brushless DC Motors	15	No change
Cooler Night Covers/Display Case Strip Curtains	4	No change
Door Heater Controls	12	No change
Efficient Refrigeration Compressors	15	No change
Evaporator Fan Motor Controls	10	No change
Intelligent Freezer Defrost Controls	10	No change
Refrigerated Vending Machine Controllers	5	No change
Refrigeration Economizers	15	No change
Vertical Refrigeration Open-to-closed Cooler Conversion	12	No change
Zero-energy Doors	12	No change
Water Heating		
Electrical-to-natural Gas Water Heating	15	No change
Heat Pump Water Heaters	10	No change
Solar		
Solar Water Heaters	20	No change
Solar Space Heating Systems	20	No change
Pool		
Efficient Pool Pumps	10	No change

4.2.6 Evaluated Gross Savings

Total gross energy and peak demand savings at the generator were respectively 0.190 GWh and 0.034 MW for the Audit path, 10.643 GWh and 2.321 MW for the DIY path, and 0.272 GWh and 0.043 MW for the Commercial Direct Instal (CDI) pilot. Total SBES gross energy savings were established at 11.105 GWh at the generator and lifetime energy savings were established at 158.138 GWh, resulting in a weighted average EUL value of 14.2 years. Total gross peak demand savings were 2.397 MW at the generator.

Table 9, Table 10, and Table 11 below present the revised total gross savings at the meter and at the generator for both paths and the CDI pilot. The savings at the generator were calculated by applying the appropriate line loss factor for each participant based on their rate code, which resulted in average line loss factors of 1.071 and 1.091 for Audit path energy and peak demand savings respectively and line loss factors of 1.070 and 1.083 for DIY path energy and peak demand savings respectively. Similarly, average line loss factors of 1.096 and 1.135 were obtained for CDI pilot energy and peak demand savings respectively. The line loss factors correspond to the values submitted to the Nova Scotia Utility and Review Board (NSUARB) as part of the 2014 Cost of Service Study Progress Update.⁹

⁹ Nova Scotia Utility and Review Board, *Matter M06555, 2014 Cost of Service Study Progress Update*, Exhibit N-2.09, Appendix I1.

Table 9: Evaluated 2021 SBES Gross Energy and Peak Demand Savings – Audit Path

Measure Category	DHW	HVAC	Lighting	Motors	Pumping	Refrigeration	Compressed Air	Total for All Categories
Energy Savings								
Gross Energy Savings Before Adjustment Ratio – at the Meter (GWh)	0.004	0.057	0.102	0.000	0.002	0.019	0.007	0.191
Adjustment Ratio on Energy Savings	0.925	0.925	0.925	0.925	0.925	0.925	0.925	
Gross Energy Savings – at the Meter (GWh)	0.004	0.053	0.095	0.000	0.002	0.017	0.006	0.177
Line Loss Factor	1.071	1.071	1.071	1.071	1.071	1.071	1.071	
Gross Energy Savings – at the Generator (GWh)	0.004	0.057	0.101	0.000	0.002	0.018	0.007	0.190
Effective Useful Life (years)	10.0	17.9	14.3	15.0	15.0	14.2	15.0	
Gross Lifetime Energy Savings –at the Generator (GWh)	0.042	1.014	1.443	0.003	0.031	0.261	0.100	2.894
Peak Demand Savings								
Gross Peak Demand Savings Before Adjustment Ratio – at the Meter (MW)	0.000	0.012	0.014	0.000	0.000	0.002	0.003	0.031
Adjustment Ratio on Peak Demand Savings	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.012	0.014	0.000	0.000	0.002	0.003	0.031
Line Loss Factor	1.091	1.091	1.091	1.091	1.091	1.091	1.091	
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.013	0.015	0.000	0.000	0.003	0.003	0.034

Table 10: Evaluated 2021 SBES Gross Energy and Peak Demand Savings – DIY Path

Measure Category	Commercial Kitchens	Envelopes	HVAC	Laundry	Lighting	Custom	Refrigeration	Renewable Generation	Agriculture	Total for All Categories
Energy Savings										
Gross Energy Savings Before Adjustment Ratio – at the Meter (GWh)	0.024	0.026	1.042	0.012	8.433	0.050	0.058	0.472	0.121	10.237
Adjustment Ratio on Energy Savings	0.972	0.972	0.972	0.972	0.972	0.972	0.972	0.972	0.972	
Gross Energy Savings – at the Meter (GWh)	0.023	0.025	1.013	0.011	8.196	0.049	0.057	0.458	0.117	9.950
Line Loss Factor	1.070	1.070	1.070	1.070	1.070	1.070	1.070	1.070	1.070	
Gross Energy Savings – at the Generator (GWh)	0.025	0.027	1.083	0.012	8.767	0.052	0.061	0.490	0.126	10.643
Effective Useful Life (years)	12.0	26.0	17.9	11.4	14.3	1.0	14.2	11.7	15.0	
Gross Lifetime Energy Savings – at the Generator (GWh)	0.300	0.704	19.335	0.137	124.939	0.052	0.864	5.752	1.884	153.967
Peak Demand Savings										
Gross Peak Demand Savings Before Adjustment Ratio – at the Meter (MW)	0.004	0.000	0.304	0.009	1.790	0.002	0.007	0.000	0.026	2.143
Adjustment Ratio on Peak Demand Savings	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
Gross Peak Demand Savings – at the Meter (MW)	0.004	0.000	0.304	0.009	1.790	0.002	0.007	0.000	0.026	2.143
Line Loss Factor	1.083	1.083	1.083	1.083	1.083	1.083	1.083	1.083	1.083	
Gross Peak Demand Savings – at the Generator (MW)	0.004	0.000	0.330	0.010	1.938	0.002	0.007	0.000	0.029	2.321

Table 11: Evaluated 2021 SBES Gross Energy and Peak Demand Savings – CDI Pilot

Measure Category	Lighting	Water Heating	Total for All Categories
Energy Savings			
Tracked Gross Energy Savings – at the Meter (GWh)	0.067	0.038	0.105
Adjustment Ratio on Energy Savings*	2.91	1.41	-
Gross Energy Savings – at the Meter (GWh)	0.194	0.054	0.248
Line Loss Factor	1.096	1.096	-
Gross Energy Savings – at the Generator (GWh)	0.213	0.059	0.272
Effective Useful Life (years)	3.2	9.9	-
Gross Lifetime Energy Savings – at the Generator (GWh)	0.688	0.588	1.277
Peak Demand Savings			
Tracked Gross Peak Demand Savings – at the Meter (MW)	0.011	0.006	0.018
Adjustment Ratio on Peak Demand Savings*	2.44	1.57	-
Gross Peak Demand Savings – at the Meter (MW)	0.027	0.010	0.037
Line Loss Factor	1.134	1.134	-
Gross Peak Demand Savings – at the Generator (MW)	0.031	0.011	0.043
* Adjustment ratios in this table are for information purposes only. They correspond to evaluated savings divided by tracked savings and include the differences in unitary savings, the adjustment ratio for A-type lamps, and differences in interactive effects factors that vary for each measure.			

Table 12 summarizes the gross energy and peak demand savings for each path and the SBES program component as a whole.

Table 12: Evaluated 2021 SBES Gross Energy and Peak Demand Savings – All Paths

Program Path	Audit	DIY	CDI Pilot	Total
Energy Savings				
Gross Energy Savings – at the Meter (GWh)	0.177	9.950	0.248	10.376
Line Loss Factor	1.071	1.070	1.096	-
Gross Energy Savings – at the Generator (GWh)	0.190	10.643	0.272	11.105
Average Effective Useful Life (years)	15.3	14.5	4.7	-
Gross Lifetime Energy Savings – at the Generator (GWh)	2.894	153.967	1.277	158.138
Peak Demand Savings				
Gross Peak Demand Savings – at the Meter (MW)	0.031	2.143	0.037	2.211
Line Loss Factor	1.091	1.083	1.135	-
Gross Peak Demand Savings – at the Generator (MW)	0.034	2.321	0.043	2.397

Figure 9 and Figure 10 below compare tracked gross savings to evaluated gross savings for energy and peak demand savings respectively. For both energy and peak demand savings, the differences in tracked savings compared to evaluated savings were due to the changes made to the unitary savings for the CDI pilot.

Figure 9: 2021 SBES Tracked and Evaluated Gross Energy Savings

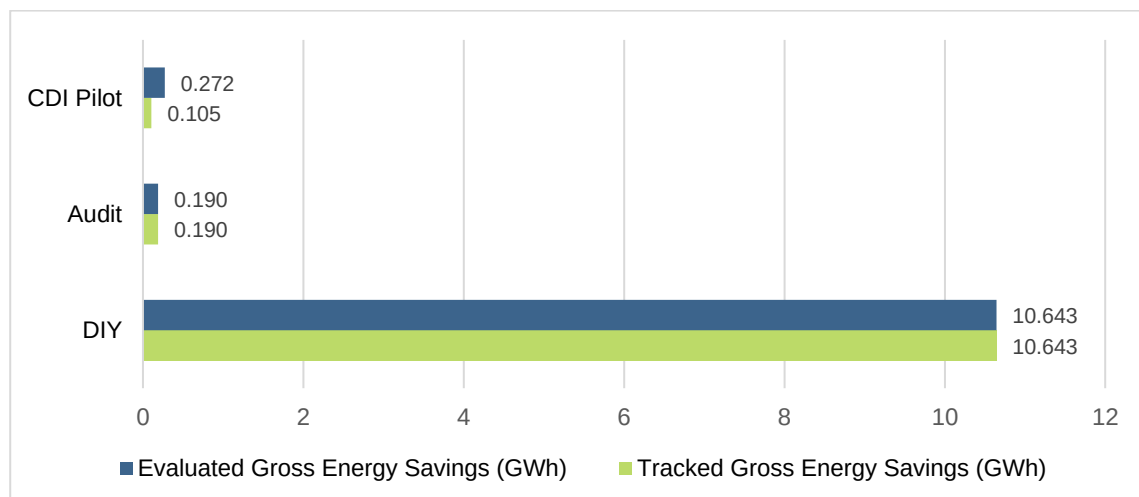
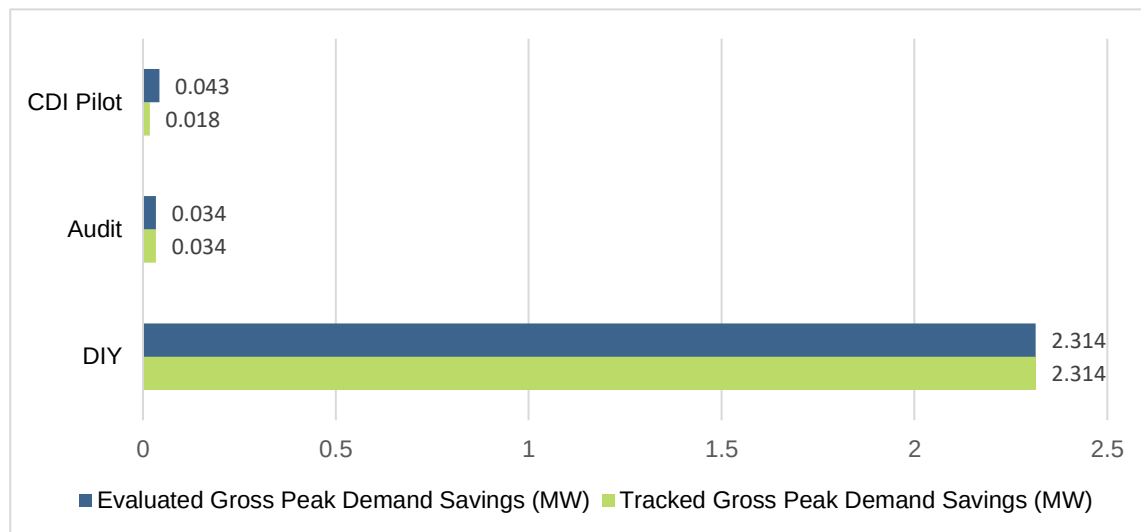


Figure 10: 2021 SBES Tracked and Evaluated Gross Peak Demand Savings



4.3 Net Savings

The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the net-to-gross ratio (NTGR). The Evaluator established the NTGR by accounting for free-ridership and spillover effects that positively or negatively affect the energy savings generated by the program component.

The Evaluator conducted a survey with 50 SBES participants to assess free-ridership. No activity aimed at updating spillover was conducted in 2021.

4.3.1 Free-ridership

Free-ridership occurs when participants would have implemented energy efficiency upgrades in the absence of the program component. The free-ridership levels were assessed using a self-reporting approach that involved asking sampled participants a set of questions during a telephone survey. Three different sets of questions were asked depending on the participant path and type of measures installed: (1) Any measures through the Audit path; (2) lighting measures through the DIY path; and (3) HVAC measures through the DIY path. The questionnaire considers all applicable variables in the decision-making process, including planning, efficiency, timing, and cost.

The feedback collected from the participant survey was converted into an overall free-ridership level using the algorithms presented in Appendix V. Additional questions were also used to determine whether participant decisions to install measures had been influenced by previous participation in an EOne program component or EOne efforts to raise awareness about energy efficiency.

An updated free-ridership level could not be established for the Audit path based on the 2021 participant survey due to the small number of Audit projects (14) and a low response rate. Thus, the Evaluator elected to use the Audit path free-ridership level of 12% established in 2019 since it had an acceptable margin of error.

For the DIY path, the Evaluator determined an overall free-ridership level of 15% with a margin of error 3.7% in 2021. The 2021 free-ridership level for the DIY path represents a considerable increase compared to the 7% established in 2019. Notably, almost two times more participants answered that they would not have postponed by one year or more the installation of energy efficient equipment or have installed standard equipment or kept their old equipment instead of installing energy efficient equipment in the absence of the program.

For the CDI pilot, no activity aimed at establishing a free-ridership level was conducted; thus, the Evaluator assumed no free-ridership. These results are summarized in Table 13.

Table 13: 2021 SBES Free-ridership Level

Project Path	Average Free-ridership Level	Margin of Error
Audit	12%*	6.5%*
DIY	15%	3.7%
CDI Pilot	-	N/A
* Value from the 2019 evaluation.		

4.3.2 Participant Spillover

For SBES, spillover occurs when participants implement eligible energy efficiency measures due to the influence of previously participating in the program component without having received any kind of additional support. With no activity aimed at updating spillover was conducted in 2020 and 2021, the Evaluator relies on the spillover level established in 2019. The 2019 SBES evaluation determined that negligible participant spillover occurred. Therefore, the Evaluator applied a spillover level of nil to the 2021 SBES net savings calculations.

4.3.3 Net-to-gross Ratio Calculation

The NTGR for SBES was calculated using the following equation.

$$NTGR = (1 - \% \text{ Free-ridership} + \% \text{ Participant Spillover}).$$

Based on the DIY path free-ridership levels established for SBES in 2021, the 2019 free-ridership level for the Audit path, and the 2019 spillover level, the NTGRs were estimated at 0.88 for the Audit path and 0.85 for the DIY path, as presented in Table 14. The NTGR for the CDI pilot was assumed to be 1.00.

Table 14: 2021 SBES NTGRs

Project Path	Free-ridership	Participant Spillover	NTGR
Audit	12%	0%	0.88
DIY	15%	0%	0.85
CDI Pilot	-	-	1.00

4.3.4 Evaluated Net Savings

Net savings are defined as the energy use reductions that are specifically attributable to SBES. Program component net impacts were estimated by applying the above NTGRs to the revised gross savings by using the following equation:

$$\text{Net Savings} = \text{Revised Gross Savings} \times \text{NTGR}$$

The net energy and peak demand savings at the generator for the Audit path were 0.167 GWh and 0.030 MW respectively. The net energy and peak demand savings at the generator for the DIY path were 9.046 GWh and 1.972 MW respectively. For the CDI pilot, the net energy and peak demand savings at the generator were 0.272 GWh and 0.043 MW respectively.

In 2021, SBES achieved a total of 9.486 GWh in net energy savings and 2.045 MW in net demand savings at the generator. The equivalent NTGR for the Audit path, DIY path, and pilot combined was 0.85. The net lifetime energy savings were established at 134.696 GWh, resulting in a weighted average EUL value of 14.2 years for net savings. The detailed results are listed in Table 15 below.

Table 15: Evaluated 2021 SBES Net Energy and Peak Demand Savings

Measure Category	Audit	DIY	CDI Pilot	Total
Energy Savings				
Gross Energy Savings – at the Meter (GWh)	0.177	9.950	0.248	10.376
NTGR	0.88	0.85	1.00	-
Net Energy Savings – at the Meter (GWh)	0.156	8.458	0.248	8.862
Line Loss Factor	1.071	1.070	1.096	-
Net Energy Savings – at the Generator (GWh)	0.167	9.046	0.272	9.486
Average Effective Useful Life (years)	15.3	14.5	4.7	-
Net Lifetime Energy Savings – at the Generator (GWh)	2.547	130.872	1.277	134.696
Peak Demand Savings				
Gross Peak Demand Savings – at the Meter (MW)	0.031	2.143	0.037	2.211
NTGR	0.88	0.85	1.00	-
Net Peak Demand Savings – at the Meter (MW)	0.027	1.822	0.037	1.886
Line Loss Factor	1.091	1.083	1.135	-
Net Peak Demand Savings – at the Generator (MW)	0.030	1.972	0.043	2.045

As presented in Table 16, applying the Nova Scotia-specific factor¹⁰ for GHG emissions generated by electricity production to SBES net savings corresponds to a total of 5,541 tonnes of annually avoided CO₂ eq.

Table 16: Evaluated 2021 SBES GHG Emission Reductions

	Total
Net Energy Savings – at the Generator (GWh)	9.486
Nova Scotia-specific GHG Emissions Factor for Electricity Production (kg of CO ₂ eq/kWh)	0.5841
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	5,541

4.4 Realization Rate

Table 17 compares the tracked energy and peak demand savings values with those established by the Evaluator.

Table 17: Comparison of 2021 SBES Tracked and Evaluated Savings at the Generator¹¹

	Gross Savings		NTGR	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	10.937	GWh	0.93	10.169	GWh	93%
Evaluation Results	11.105	GWh	0.85	9.486	GWh	
Peak Demand Savings						
Tracked Savings by EOne	2.365	MW	0.93	2.199	MW	93%
Evaluation Results	2.397	MW	0.85	2.045	MW	

While the evaluated gross energy and peak demand savings were slightly higher than the values tracked by EOne because of the higher unitary savings value established by the Evaluator for the CDI pilot measures, the evaluated net energy and peak demand savings were 7% lower than the values tracked by EOne due to the higher free-ridership established in 2021 for the DIY path.

¹⁰ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources:

Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed November 8, 2021),

Emera inc., *Management's Discussion & Analysis*, as at February 16, 2021

https://s25.q4cdn.com/978989322/files/doc_financials/2020/q4/Emera-Q4-2020-MD-A-FINAL-February-16,-2021.pdf (Last accessed November 8, 2021).

¹¹ The results presented in Table 17 include savings for SBES and the CDI pilot.

5 SBES KEY FINDINGS AND RECOMMENDATIONS

The objectives of the 2021 SBES evaluation were to calculate gross and net SBES results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions. This section presents the Evaluator's key findings related to these objectives. The Evaluator has no new recommendations for SBES in 2021.

2021 SBES-Finding: Net energy savings were within 1% of targets, while peak demand savings fell short of targets.

In 2021, SBES achieved 9.486 GWh and 2.045 MW in net energy and peak demand savings respectively and did not achieve its planned targets of 9.60 GWh in net energy savings and 2.27 MW in peak demand savings.

2021 SBES-Finding: Participation as well as gross energy and peak demand savings considerably increased in 2021 compared to 2020, although participation in the Audit path remained low.

Overall participation in SBES increased by 77% in 2021 compared to 2020, almost reaching the pre-pandemic participation level of 2019. This increase appears to have been driven in large part by the incentive increase motivating more businesses to participate in the program despite the COVID-19 pandemic continuing into 2021. The addition of the CDI pilot also contributed somewhat to the participation increase. While DIY projects continue to be the most popular, representing 82% of all projects, the number of Audit projects reached its lowest level since 2016. Due to the increase in participation and stable level of savings per project, gross energy and peak demand savings almost doubled compared to 2020.

2021 SBES-Finding: Overall satisfaction with SBES is high among participants.

Using a 10-point scale, participants provided an average overall satisfaction rating of 9.1. The levels of satisfaction with all aspects of SBES were high, ranging from 8.8 to 10 on a 10-point scale.

2021 SBES-Finding: The average free-ridership level for DIY participants was established at 15%.

The average free-ridership level for DIY participants was established at 15%, up from 7% in 2019. For Audit participants, the 2019 free-ridership level of 12% was used.

2021 SBES-Finding: The evaluated net energy and peak demand savings determined by the Evaluator were 7% lower than the net savings tracked by EOne.

While the evaluated gross energy and peak demand savings were slightly higher than the values tracked by EOne due to the higher unitary savings value established by the Evaluator for the CDI pilot measures, the evaluated net energy and peak demand savings were 7% lower than the values tracked by EOne due to the higher free-ridership established in 2021 for the DIY path.

CONCLUSION

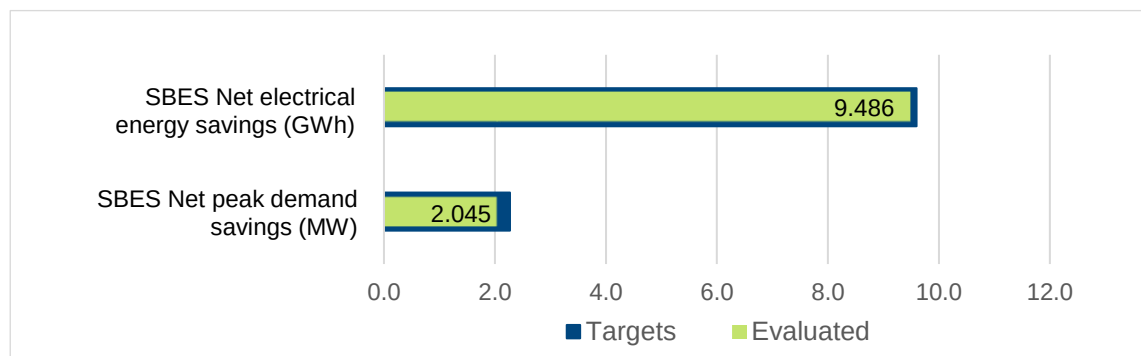
Table 18 summarizes the participation level as well as the gross and net savings for Direct Installation.

Table 18: Overall 2021 Direct Installation Participation and Evaluated Savings¹²

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
SBES							
Energy Savings	512 ¹³	Projects	11.105	GWh	0.85	9.486	GWh
Lifetime Energy Savings			158.138	GWh	0.85	134.696	GWh
Peak Demand Savings			2.397	MW	0.85	2.045	MW

As Figure 11 below illustrates, Direct Installation achieved net energy savings of 9.486 GWh and peak demand savings of 2.045 MW in 2021. Direct Installation was within 1% of its planned energy savings target of 9.60 GWh and 10% below the peak demand savings target of 2.27 MW. Despite the COVID-19 pandemic continuing into 2021, the SBES participation level considerably increased compared to 2020, driven in large part by the incentive increase motivating more businesses to participate in the program.

Figure 11: 2021 Direct Installation Targets and Evaluated Results



¹² The results presented in this table include savings for the SBES program component and the CDI pilot.

¹³ 76 of the 512 projects were CDI pilot projects.

LIST OF APPENDICES

The following are presented in the Direct Installation Program – Appendices document.

Small Business Energy Solutions

Appendix I SBES: Participant Survey Questionnaire

Appendix II SBES: Participant Survey Results

Appendix III SBES: Tracking Sheet Audit

Appendix IV SBES: Commercial Direct Install Pilot - Gross Savings Parameters

Appendix V SBES: Algorithm for Free-ridership Calculation

Appendix VI SBES: 2021 Recommendations



DIRECT INSTALLATION PROGRAM 2021 DSM EVALUATION

EFFICIENCYONE

Appendix Report

March 17, 2022



TABLE OF CONTENTS

APPENDIX I SBES: PARTICIPANT SURVEY QUESTIONNAIRE	1
APPENDIX II SBES: PARTICIPANT SURVEY RESULTS	21
APPENDIX III SBES: TRACKING SHEET AUDIT	38
APPENDIX IV SBES: COMMERCIAL DIRECT INSTALL PILOT - GROSS SAVINGS PARAMETERS.....	44
APPENDIX V SBES: ALGORITHM FOR FREE-RIDERSHIP CALCULATION	50
APPENDIX VI SBES: 2021 RECOMMENDATIONS.....	55

APPENDIX I

SBES: PARTICIPANT SURVEY QUESTIONNAIRE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Telephone survey
Estimated Time to Complete	15 minutes
Target Audience	Participants who have completed SBES projects
Expected Number of Completions	70; 50 DIY participants (20 HVAC and 30 Lighting) and 20 Audit participants
Contact List Source	EfficiencyOne
Fielding Firm	Narrative Research
Estimated Timeline for fielding	November to December

Table 2: Research Objectives and Associated Questions

Research Objectives	Questions
Awareness and Motivations for participating	B1- B6
Free-ridership level for audit path and DIY path	C and D series
Cross-influence	E series
Satisfaction	F1-F3
Recommendations	F4
Barriers	G1
Firmographics	H series

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Black text: instructions for interviewer **[NOTE: xxxx] / [PROBE: xxxx]**

INTRODUCTION

Could I speak with <INSERT NAME>?

1. Yes **[CONTINUE]**
2. No **[SAY “PERHAPS YOU CAN HELP ME ANYWAY.” CONTINUE]**

Hello, my name is _____ and I am calling from Narrative Research, a Halifax-based survey research company. We are performing an evaluation of energy efficiency services and programs provided by Efficiency Nova Scotia. Our records indicate that your business recently participated in Efficiency Nova Scotia’s Small Business Energy Solutions Program. We would appreciate your help in answering questions related to your participation in this program. The information you provide will be used to help Efficiency Nova Scotia evaluate and improve the program. Is this a good time for you?

(IF NEEDED: As part of this program, you received rebates and/or financing for energy efficient upgrades that were installed in your business.)

(IF NEEDED: You may have recently been contacted by Narrative Research or by Efficiency Nova Scotia about your experience with the program. This survey is different as it focuses on other aspects of your participation in the program.)

(IF NEEDED: The survey will take about 15 minutes.)

1. Yes **[CONTINUE]**
2. No, I don’t remember the program / Don’t know **[PROMPT: “Are you sure? The program offers small businesses access to energy efficiency contractors and rebates for the installation of energy efficient upgrades. You would have submitted documentation for approval before purchasing and installing your energy efficient upgrades.” RECODE AS “YES” IF THE PROMPT WORKS; IF RESPONDENT STILL SAYS NO: Is there someone else in your company who would know about having participated in this Efficiency Nova Scotia program?**
 1. Yes **[ASK TO SPEAK TO THEM AND REPEAT INTRODUCTION]**
 2. No **[THANK, TERMINATE, RECORD, AND KEEP DATA]**
 99. Refused **[THANK, TERMINATE, RECORD, AND KEEP DATA]**

[IF REFUSED, ASK “CAN WE SCHEDULE A MORE CONVENIENT TIME FOR YOU TO CONDUCT THIS SURVEY?”]

[SCHEDULED, IF NECESSARY, FOR: _____]

A. Verification and Recall

- A1. **[READ A1 IF PROJECT QTY IN SAMPLE = 1]** According to our information, your business installed **<MEASURE CATEGORY 1, MEASURE CATEGORY 2 >** upgrades in the **<FACILITY NAME>** facility located in **< FACILITY ADDRESS>**. For this project, Efficiency Nova Scotia offered you a **\$<TOTAL ENS REBATE>** rebate **<IF FINANCING=YES>** and provided a loan.
- A2. **[READ A2 IF PROJECT QTY IN SAMPLE > 1]** According to our information, your business participated more than once in the Small Business Energy Solutions Program. Today's questions will be about the project in which you installed **<MEASURE CATEGORY 1, MEASURE CATEGORY 2 >** upgrades at your **<FACILITY NAME>** facility located at **<FACILITY ADDRESS>**. For this project, Efficiency Nova Scotia offered you **<IF REBATE>0>** a **\$<TOTAL ENS REBATE>** rebate **<IF FINANCING=YES>** and provided a loan. When answering the survey questions, please take into account this specific project.

B. Awareness and Motivations for Participating

- B1. How did you learn about Efficiency Nova Scotia's Small Business Energy Solutions Program?
[DO NOT READ. MULTIPLE RESPONSE]
1. From a contractor, equipment vendor, energy consultant
 2. From an Efficiency Nova Scotia account representative
 3. At an event/trade show
 4. Received an email or electronic newsletter
 5. Received an informational brochure
 6. From ENS's website
 7. TV/radio ad
 8. Friends or colleagues
 9. Through experience with the program
 96. Other, please specify: **[OPEN-ENDED RESPONSE]**
 98. Don't know



B2. Who initiated the discussion about participating in the Small Business Energy Solutions program? Would you say . . . **[READ. ACCEPT ONE RESPONSE]**

1. You/your business initiated it
2. Your contractor initiated it
3. The idea arose in discussion between your business and your contractor
4. Someone from Efficiency Nova Scotia suggested the program
96. (Other, please specify: _____)

[VOLUNTEERED]

98. (Don't know)
99. (Refused)

B3. What was the main reason your business was interested in participating in the Small Business Energy Solutions Program? **[DO NOT READ. ACCEPT ONE RESPONSE]**

1. To save money/bill reduction
2. To save energy
3. To be more environmentally-friendly
4. To get information on energy efficiency opportunities through the energy audit
96. (Other, please specify: _____)
98. (Don't know)
99. (Refused)

B4. **[ASK IF PROJECT TYPE IS DIY IN SAMPLE]** The Small Business Energy Solutions Program includes an energy audit option where an auditor assesses the facility to identify energy efficiency opportunities. Which of the following scenarios best applies to you. **[READ AND CODE ONLY ONE]**

1. You did not know that an audit option was available
2. You knew about it but were not interested in it
3. You knew about the audit but thought that your project did not require it
4. Efficiency Nova Scotia said your project did not require an audit
5. Or something else? please specify: _____)

[VOLUNTEERED]

98. (Don't know)
99. (Refused)



B5. Did the impacts of the COVID-19 pandemic have an influence on your business' decision to participate in the Small Business Energy Solutions program?

1. Yes
2. No

[VOLUNTEERED]

98. (Don't know)
99. (Refused)

B6. **[IF B5 = 1]** How did the COVID-19 pandemic influence your decision to participate in the program? **[DO NOT READ]**

1. Incentives made it attractive to participate
2. Business closed so allowed for audit and upgrades
3. Business less busy so allowed for audit and upgrades
96. Other **[RECORD]**
98. (Don't know)
99. (Refused)

C. Free-Ridership for Audit Path

[IF PROJECT TYPE IS AUDIT IN SAMPLE, ASK C1 TO C8; OTHERWISE SKIP TO FREE-RIDERSHIP FOR DIY PATH (SECTION D)]

C1. BEFORE learning about the Small Business Energy Solutions program and having your facility evaluated by a Small Business Energy Auditor, did your business have plans to install the energy-efficient upgrades that were installed as part of the Small Business Energy Solutions program? Did you... **[READ OPTIONS IN ORDER – CODE ONLY ONE]**

1. Have plans to install all of the upgrades
2. Have plans to install some of the upgrades
3. Have no plans to install any of the upgrades

[VOLUNTEERED]

98. (Don't know)
99. (Refused)



C2. **[IF C1=1 or 2]** Just to confirm: before you had your facility evaluated by a Small Business Energy Auditor, you had already made the decision to install **[IF C1=1: all / IF C1=2: some of]** the energy efficiency upgrades that were installed as part of the program?

1. Yes

2. No

[VOLUNTEERED]

98. (Don't know)

99. (Refused)

C3. **[IF FINANCING=NO]** Efficiency Nova Scotia gave a rebate to your business of **\$<TOTAL ENS REBATE>** for the energy-efficient upgrades. If your business had not received this rebate and the free audit, would you have paid for the full cost of the energy-efficient upgrades you installed? Please use a scale of 0 to 10, where 0 means that you "Definitely **Would Not** Have Paid" and 10 means that you "Definitely **Would Have** Paid."

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. (Don't know)

99. (Refused)

C4. **[IF REBATE = YES AND FINANCING=YES]** Efficiency Nova Scotia gave a rebate to your business of **\$<TOTAL ENS REBATE>** and provided you with a loan for the energy-efficient upgrades. If your business had not received the rebate and financing from Efficiency Nova Scotia, as well as the free audit, would you have paid and financed the cost of the energy-efficient upgrades you installed? Please use a scale of 0 to 10, where 0 means that you "Definitely **Would Not** Have Paid and Financed" and 10 means that you "Definitely **Would Have** Paid and Financed."

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. (Don't know)

99. (Refused)

[READ FIRST TIME THROUGH ONLY] I would like to ask you to consider what actions your business would have taken if there was no Small Business Energy Solutions program. For the next questions, answer on a scale of 0 to 10, where 0 is "Very Unlikely," and 10 is "Very Likely."

[DO NOT ACCEPT A RANGE – ASK C5 TO 0.96.97.98 SEQUENCE IN ORDER/DO NOT RANDOMIZE; REPEAT SCALE ONLY AS NECESSARY]



- C5. If there was no program rebate, no financing, and no audit, what is the likelihood that you would have installed standard equipment or that you would have kept your old equipment instead of installing energy-efficient equipment in your facility?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. (Don't know)

99. (Refused)

- C6. **[ASK IF TOTAL MEASURE QTY>1]** If there was no program rebate, no financing, and no audit, what is the likelihood that you would have installed exactly the same number of energy-efficient upgrades that were installed through the Small Business Energy Solutions program?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. (Don't know)

99. (Refused)

- C7. **[ASK IF C3 OR C4 ≥5]** If there was no program rebate, no financing, and no audit, what is the likelihood that you would have postponed making energy efficient upgrades to your facility by at least one year?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. (Don't know)

99. (Refused)

- C8. I would like you to rate the influence of the following factors in your decision to install the energy-efficient upgrades. Use a scale from 0 to 10, where 0 is “No influence” and 10 is “Great influence”. The first factor is... **[READ AND ROTATE FACTORS; DO NOT ACCEPT A RANGE; REPEAT SCALE ONLY AS NECESSARY]**

Factor (READ AND RANDOMIZE)	Responses
a. The free audit	___ Response ___98 Don't Know ___99 Refused
b. Information or advice from the small business energy <u>auditor</u> .	___ Response ___98 Don't Know ___99 Refused
c. [IF REBATE=YES] The program rebate	___ Response ___98 Don't Know ___99 Refused
d. [IF FINANCING =YES] The program on-bill financing	___ Response ___98 Don't Know ___99 Refused
e. Information or advice provided by Efficiency Nova Scotia staff.	___ Response ___98 Don't Know ___99 Refused
f. Information or advice provided by a contractor	___ Response ___98 Don't Know ___99 Refused
g. The availability of a list of contractors through the Efficiency Trade Network	___ Response ___98 Don't Know ___99 Refused

D. Free-Ridership for DIY Path (LIGHTING MEASURES SECTION and HVAC MEASURES SECTION)

INSTRUCTION: RESPONDENTS WILL BE ASKED ABOUT UP TO TWO MEASURE CATEGORIES: LIGHTING AND HVAC. NO RESPONDENT WILL ANSWER ABOUT OTHER MEASURE CATEGORIES IN THE FREE-RIDERSHIP SECTION.

LIGHTING MEASURES SECTION

[IF PROJECT TYPE=DIY AND LIGHTING=YES, ASK D1 TO D9; OTHERWISE SKIP TO HVAC SECTION]

The next questions will be about the **lighting upgrades** that were rebated and/or financed through the Small Business Energy Solutions Program and installed in your facility.

- D1. Had your business **already** decided to install the energy-efficient lighting upgrades BEFORE learning about the Small Business Energy Solutions Program? **[CODE ONE ONLY]**

1. Yes
2. No

[VOLUNTEERED]

98. (Don't know)
99. (Refused)



D2. **[IF D1=YES]** Just to confirm: before you learned about the Small Business Energy Solutions Program and the rebates offered through the program, you had already made the decision to install the energy-efficient lighting upgrades? **[CODE ONE ONLY]**

- 1. Yes
- 2. No

[VOLUNTEERED]

- 98. (Don't know)
- 99. (Refused)

D3. **[IF FINANCING=NO]** Efficiency Nova Scotia provided your business with a rebate of \$**<TOTAL ENS REBATE>** for the energy-efficient lighting upgrades. If your business had not received this rebate, would you have paid the full cost of the lighting upgrades? Please use a scale of 0 to 10, where 0 means that you "Definitely **Would Not** Have Paid" and 10 means that you "Definitely **Would Have** Paid."

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. (Don't know)
- 99. (Refused)

D4. **[IF REBATE = YES AND FINANCING=YES]** Efficiency Nova Scotia provided your business with a rebate of \$**<TOTAL ENS REBATE>** and a loan for the energy-efficient lighting upgrades. If your business had not received the rebate and financing from Efficiency Nova Scotia, would you have paid and financed the cost of the lighting upgrades? Please use a scale of 0 to 10, where 0 means that you "Definitely **Would Not** Have Paid and Financed" and 10 means that you "Definitely **Would Have** Paid and Financed."

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't know
- 99. Refused

D5. Were you aware that the lighting products rebated through the Small Business Energy Solution Program are premium products certified by Design Light Consortium or ENERGY STAR®?

- 1. Yes
- 2. No

[VOLUNTEERED]

- 98. DON'T KNOW
- 99. Refused



[READ FIRST TIME THROUGH ONLY] I would like to ask you to consider what actions your business would have taken if there was no Small Business Energy Solutions program. For the next questions, answer on a scale of 0 to 10, where 0 is “Very Unlikely,” and 10 is “Very likely.”

[DO NOT ACCEPT A RANGE – POSE D6 TO D8 SEQUENCE IN ORDER/DO NOT RANDOMIZE; REPEAT SCALE ONLY AS NECESSARY]

- D6. If there was no program rebate or financing, what is the likelihood that you would have installed the exact same model of lighting products?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know

99. Refused

- D7. **[ASK IF TOTAL LIGHTING QTY>1]** If there was no program rebate or financing, what is the likelihood that you would have installed exactly the same number of lighting products that you installed through the program?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know

99. Refused

- D8. **[ASK IF D3 OR D4 ≥5]** If there was no program rebate or financing, what is the likelihood that you would have postponed installing the lighting upgrades by at least one year?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know

99. Refused

- D9. I would like you to rate the influence of the following factors in your decision to install the energy-efficient lighting upgrades. Use a scale of 0 to 10, where 0 is “No influence” and 10 is “Great influence”. The first factor is... **[READ AND ROTATE FACTORS; DO NOT ACCEPT A RANGE; REPEAT SCALE ONLY AS NECESSARY]**

Factor (READ AND RANDOMIZE)	Responses
a. [ASK IF REBATE=YES] The program rebate	___ Response ___98 Don't Know ___99 Refused
b. [IF FINANCING =YES] The program on-bill financing	___ Response ___98 Don't Know ___99 Refused
c. Information or advice received by Efficiency Nova Scotia staff.	___ Response ___98 Don't Know ___99 Refused
d. Information or advice provided by a contractor	___ Response ___98 Don't Know ___99 Refused
e. The availability of a list of contractors through the Efficiency Trade Network	___ Response ___98 Don't Know ___99 Refused

HVAC MEASURES SECTION

[IF PROJECT TYPE=DIY AND HVAC=YES, ASK D10 TO D16; OTHERWISE SKIP TO E SECTION]

The next questions will be about the heat pumps that were rebated or financed through the Program and installed in your facility.

- D10. Had your business **already** decided to install heat pumps BEFORE learning about the Small Business Energy Solutions Program? **[CODE ONE ONLY]**

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused

- D11. **[IF D10=YES]** Just to confirm: before you learned about the Small Business Energy Solutions Program and the rebates offered through the program, you had already made the decision to install heat pumps? **[CODE ONE ONLY]**

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused

- D12. **[IF FINANCING=NO]** Efficiency Nova Scotia provided your business with a rebate of \$<TOTAL ENS REBATE> for the heat pumps. If your business had not received this rebate, would you have paid the full cost of the heat pumps? Please use a scale of 0 to 10, where 0 means that you “Definitely **Would Not** Have Paid” and 10 means that you “Definitely **Would Have** Paid.” **[PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]**

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't Know
- 99. Refused

- D13. **[IF REBATE =YES AND FINANCING=YES]** Efficiency Nova Scotia provided your business with a rebate of \$<TOTAL ENS REBATE> and a loan for your heat pumps. If your business had not received the rebate and financing from Efficiency Nova Scotia, would you have paid and financed the cost of the heat pumps? Please use a scale of 0 to 10, where 0 means that you “Definitely **Would Not** Have Paid and Financed” and 10 means that you “Definitely **Would Have** Paid and Financed.” **[PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]**

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't Know
- 99. Refused

[READ FIRST TIME THROUGH ONLY] I would like to ask you to consider what actions your business would have taken if there was no Small Business Energy Solutions program. For the next questions, answer on a scale of 0 to 10, where 0 is “Very Unlikely,” and 10 is “Very Likely.”

[DO NOT ACCEPT A RANGE – POSE D14 – D15 SEQUENCE IN ORDER/DO NOT RANDOMIZE; REPEAT SCALE ONLY AS NECESSARY]

- D14. If there was no program rebate or financing, what is the likelihood that you would have installed exactly the same high-efficiency heat pump that were rebated or financed through the Program?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't Know
- 99. Refused



- D15. **[ASK IF D12 OR D13 ≥5]** If there was no program rebate or financing, what is the likelihood that you would have postponed installing the heat pumps by at least one year?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know
99. Refused

- D16. I would like you to rate the influence of the following factors in your decision to install the high-efficiency heat pumps. Use a scale of 0 to 10, where 0 is “No influence” and 10 is “Great influence”. The first factor is... **[READ AND ROTATE FACTORS; DO NOT ACCEPT A RANGE; REPEAT SCALE ONLY AS NECESSARY]**

Factor (READ AND RANDOMIZE)	Responses
a. [IF REBATE=YES] The program rebate	___ Response ___98 Don't Know ___99 Refused
b. [IF FINANCING =YES] The program on-bill financing	___ Response ___98 Don't Know ___99 Refused
c. Information or advice received by Efficiency Nova Scotia staff.	___ Response ___98 Don't Know ___99 Refused
d. Information or advice provided by a contractor	___ Response ___98 Don't Know ___99 Refused
e. The availability of a list of contractors through the Efficiency Trade Network	___ Response ___98 Don't Know ___99 Refused

E. Cross-Influence

READ AND ROTATE (E1 + E2 TO E4) AND (E5 + E6 TO E8) SEQUENCES

- E1. Before participating in the Small Business Energy Solutions program in **<DATE: MONTH, YEAR>**, had your business at any time in the past participated in any Efficiency Nova Scotia programs?

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused

For the following statements, please indicate whether you agree or disagree.

E2. **[IF E1=1]** Your business' previous participation in an Efficiency Nova Scotia program was a major factor in the decision to install energy-efficient upgrades in your facility.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

E3. **[IF E1=1 AND C1=1 OR C1=2 OR D1=1 OR D10=1]** Because of your business' previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, you had asked your contractor/distributor about different energy efficiency options before participating in Small Business Energy Solutions.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

E4. **[IF E1=1]** Because of your business' previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, you took into account the cost-effectiveness of energy efficient upgrades when evaluating different options for the facility.

1. Agree
2. Disagree

[VOLUNTEERED]

98. Don't know
99. Refused

E5. Before participating in the Small Business Energy Solutions program in **<DATE: MONTH, YEAR>**, had you at any time in the past seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?

1. Yes
2. No

[VOLUNTEERED]

98. Don't know
99. Refused



For the following statements, please indicate whether you agree or disagree.

E6. **[IF E5=1]** The promotion of energy efficiency carried out by Efficiency Nova Scotia was a major factor in your business' decision to install energy-efficient upgrades.

- 1. Agree
- 2. Disagree

[VOLUNTEERED]

- 98. Don't know
- 99. Refused

E7. **[IF E5=1 AND C1=1 OR C1=2 OR D1=1 OR D10=1]** The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to consider installing energy efficiency measures in your facility before participating in Small Business Energy Solutions.

- 1. Agree
- 2. Disagree

[VOLUNTEERED]

- 98. Don't know
- 99. Refused

E8. **[IF E5=1]** The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take into account the cost-effectiveness of energy efficient upgrades when evaluating different options for the facility.

- 1. Agree
- 2. Disagree

[VOLUNTEERED]

- 98. Don't know
- 99. Refused

F. Satisfaction with Program

F1. Using a scale from 1 to 10 where 1 is "not at all satisfied" and 10 is "completely satisfied" how would you rate your satisfaction with the program overall?

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't Know
- 99. Refused



- F2. **[IF F1<8]** What is the most important reason you are not more satisfied with the program overall? **[PROBE FOR SPECIFIC REASON. ACCEPT MULTIPLE RESPONSES BUT DO NOT PROBE]**

RECORD VERBATIM: _____

[VOLUNTEERED]

98. Don't know

99. Refused

- F3. On a scale of 1 to 10, where 1 is "not at all satisfied" and 10 is "completely satisfied", how satisfied are you with each of the following? Let me know if you were not involved with any of these aspects. **[DO NOT RANDOMIZE; IF NOT INVOLVED, CODE AS 97]**

- a. **[ASK IF REBATE = YES] THE PROGRAM REBATE**
- b. **[ASK IF FINANCING = YES] THE PROGRAM FINANCING**
- c. **THE PROGRAM FORMS AND DOCUMENTS**
- d. **[IF PROJECT TYPE=AUDIT]** *The usefulness of the audit report*
- e. *The ease of finding a contractor*
- f. *The equipment that was installed*
- g. *The quality of the work performed by the contractor*

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

97. Not applicable

98. Don't Know/Don't recall

99. Refused



F4. Do you have any recommendations for improving the Small Business Energy Solutions program? Probe: Anything else? **[DO NOT READ. ACCEPT MULTIPLE KEEPING CODE 98 AND 99 EXCLUSIVE]**

1. Improve contractors' quality of work
2. Improve communication
3. Simplify the program/Less paperwork
4. Better marketing/awareness
5. Increase rebates
6. Speed up process/receive rebate quicker
7. Offer more measures eligible for rebates
8. Lengthen timeframe to complete work
9. No recommendation)
96. Other [SPECIFY: _____]

[VOLUNTEERED]

98. Don't know
99. Refused

G. Barriers

G1. To what extent do you consider the following as barriers preventing your business from installing energy efficiency upgrades? Use a scale of 1 to 10, where 1 means 'not at all a barrier' and 10 means 'a major barrier'. **[ROTATE]**

- a. Financial challenge, even after rebate, such as lack of funds, taking too long to recoup the investment, and so on.
- b. Time constraint, that is, not having time to hire a contractor and seek bids
- c. Lack of knowledge about energy efficiency incentives or equipment
- d. Not knowing how to get started in relation to planning upgrades and hiring contractors or doing the work internally

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know/Don't recall
99. Refused

H. Firmographics

These final questions are asked for statistical purposes only. The information collected is strictly confidential.

H1. What is your job title or role? **[DO NOT READ, ALLOW MULTIPLE RESPONSE]**

1. President/CEO/Owner
2. Facilities Manager
3. Energy Manager
4. Other facilities management/maintenance position
5. Chief Financial Officer
6. Other financial/administrative position
7. Manager
96. Other, [please specify: _____]

[VOLUNTEERED]

98. (Don't know)
99. (Refused)



H2. What is the main activity of the facility where the energy efficiency improvements were installed under the Small Business Energy Solutions Program? **[DO NOT READ—BUT CONFIRM WITH RESPONDENT THAT THE CATEGORY YOU CHOOSE IS CORRECT]**

1. Education
2. Food Sales (grocery)
3. Food Service (restaurant)
4. Health Care – Inpatient
5. Health Care – Outpatient
6. Lodging
7. Mercantile – Enclosed and Strip Malls
8. Mercantile – Retail (Other than Mall)
9. Office
10. Public Assembly
11. Public Order and Safety
12. Religious Worship
13. Service
14. Warehouse and Storage
15. Manufacturing) (**Identify Industry Type** _____: (e.g., chemical, food, paper, etc.)
16. (Other: please explain _____)
17. Vacant building

[VOLUNTEERED]

98. Don't know
99. Refused



H3. Approximately how many full-time equivalent workers are employed at this facility? **[DO NOT READ, CODE APPROPRIATE CATEGORY] [IF ASKED: Full-time equivalent workers refers to those working 35 hours or more per week.]**

1. Fewer than 5
2. 5 to 9
3. 10 to 19
4. 20 to 49
5. 50 to 99
6. 100 to 249
7. 250 or More

[VOLUNTEERED]

98. (Don't know)
99. (Refused)

H4. Do you own or rent the facility?

1. Own
2. Rent
96. Other: please explain: _____)

[VOLUNTEERED]

98. Don't know
99. Refused

H5. Is your business independent, or part of a larger company?

1. Independent
2. Part of a larger company
96. Other: please explain: _____)

[VOLUNTEERED]

98. (Don't know)
99. (Refused)

H6. How many locations does your business have in Nova Scotia? **[RECORD A NUMBER 1-99; 998 = DON'T KNOW, 999 = REFUSED]**

END: Those are all the questions I have for you. I thank you very much for your time and cooperation and have a nice day!

APPENDIX II

SBES: PARTICIPANT SURVEY RESULTS

The participant survey results are presented in the following tables.

B1. How did you learn about Efficiency Nova Scotia's Small Business Energy Solutions Program?

How Participants Learned About SBES	2019	2021
Sample Size	50	50
From a contractor, equipment vendor, energy consultant	50%	24%
Friends or colleagues	12%	20%
Through experience with the program	8%	14%
Internet (general)	-	12%
From an ENS account representative	22%	10%
Received an email or electronic newsletter	4%	6%
TV/Radio ad	8%	4%
From ENS's website	8%	4%
Received an informational brochure	2%	-
Others	10%	10%
Don't know	4%	2%

B2. Who initiated the discussion about participating in the Small Business Energy Solutions program? Would you say...*

Who Initiated Discussions About Participating in SBES	2017	2019	2021
Sample Size	70	50	50
You/your business initiated it	47%	26%	44%
Your contractor initiated it	29%	32%	28%
The idea arose in discussion between your business and your contractor	17%	20%	16%
Someone from Efficiency Nova Scotia suggested the program	6%	12%	6%
Others	-	6%	4%
Don't know	1%	4%	2%
*Wording change in 2019			

B3. What was the main reason your business was interested in participating in the Small Business Energy Solutions Program?*

Main Reason for Participating in SBES	2019	2021
Sample Size	50	50
To save money/bill reduction	60%	32%
To save energy	22%	26%
To upgrade measures/be more efficient	-	22%
To get rebates	4%	10%
To be more environmentally-friendly	-	6%
Already planning to do upgrades	8%	-
Others	4%	4%
Don't know/Refused	2%	-
*Wording change in 2021		

B4. **[ASK IF PROJECT TYPE IS DIY]** The Small Business Energy Solutions Program includes an energy audit option where an auditor assesses the facility to identify energy efficiency opportunities. Please let me know which of the following scenarios best applies to you?

Awareness of Audit Path and Whether it Applied to DIY Participants	2019	2021
Sample Size	42	49
You did not know that an audit was available	38%	39%
You knew about the audit but thought that your project did not require it	21%	20%
Efficiency Nova Scotia said your project did not require an audit	10%	8%
You knew about it but were not interested in it	10%	6%
Something else/Others	10%	8%
Don't know	12%	18%
Base: DIY participants		

- B5. Did the impacts of the COVID-19 pandemic have an influence on your business' decision to participate in the Small Business Energy Solutions program?

Impacts of COVID-19 Pandemic Influenced Decision to Participate in SBES	2021
Sample Size	50
Yes	10%
No	90%

- B6. How did the COVID-19 pandemic influence your decision to participate in the program?

How COVID-19 Influenced Decision to Participate in SBES	2021
Sample Size	5 (#)
Decision had nothing to do with COVID-19	2
Cost savings/Looking to reduce energy costs	1
Challenges caused us not to participate in the beginning	1
Incentives made it attractive to participate	1
Base: COVID-19 influenced decision to participate in SBES	

Audit Path

- C1. BEFORE learning about the Small Business Energy Solutions program and having your facility evaluated by a Small Business Energy Auditor, did your business have plans to install the energy-efficient upgrades that were installed as part of the Small Business Energy Solutions program? Did you...
- C2. Just to confirm: Before you had your facility evaluated by a Small Business Energy Auditor, you had already made the decision to install [all/some of] the energy efficiency upgrades that were installed as part of the program?*

Already Made Decision to Install Energy Efficient Upgrades Prior to Audit	2017	2019	2021
Sample Size	20	8 (#)	1 (#)
Yes	40%	3	-
No	60%	5	1
Don't know/Refused	-	-	-
Base: Respondents who had an audit			
*Wording change in 2021			

- C3. [IF FINANCING=NO] Efficiency Nova Scotia gave a rebate to your business of \$<TOTAL ENS REBATE> for the energy-efficient upgrades. If your business had not received this rebate and the free audit, would you have paid for the full cost of the energy-efficient upgrades you installed?*
- C4. [IF REBATE = YES AND FINANCING=YES] Efficiency Nova Scotia gave a rebate to your business of \$<TOTAL ENS REBATE> and provided you with a loan for the energy-efficient upgrades. If your business had not received the rebate and financing from Efficiency Nova Scotia, as well as the free audit, would you have paid and financed the cost of the energy-efficient upgrades you installed? Please use a scale of 0 to 10, where 0 means that you “Definitely Would Not Have Paid and Financed” and 10 means that you “Definitely Would Have Paid and Financed.”**

Would Have Paid/Financed Cost of Upgrades	2017		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Would have paid/financed full cost of upgrades	20	3.8	8	5.4	1	10.0
Don't know/Refused excluded from calculations						
*Wording change in 2021						

- C5-C7. I would like to ask you to consider what actions your business would have taken if there was no Small Business Energy Solutions program. For the next questions, answer on a scale of 0 to 10, where 0 is “Very Unlikely,” and 10 is “Very Likely.”***

Actions Taken in Absence of SBES	2017		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Postponed making energy efficient upgrades to your facility by at least one year*	9	7.3	5	5.6	1	10.0
Installed exactly the same number of energy-efficient upgrades that were installed through the Small Business Energy Solutions program**	16	3.0	5	4.8	1	8.0
Installed standard equipment or that you would have kept your old equipment instead of installing energy-efficient equipment in your facility***	20	6.6	8	4.9	1	3.0
Don't know/refused excluded from calculations						
*Base: Respondents who would not likely have paid or financed the cost of the energy-efficient upgrades they installed in absence of SBES (C3-C4 ≥5)						
**Base: Respondents who installed more than one measure						
***Wording change in 2021						

- C8. I would like you to rate the influence of the following factors in your decision to install the energy-efficient upgrades. Using a scale of 0 to 10, where 0 means “No influence” and 10 means “Great influence”, please rate the importance of each of the following in your business’ decision to install the energy-efficient upgrades.

Influence on Decision to Install Energy Efficient Upgrades	2017		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Free audit	20	8.0	8	8.1	1	10.0
Program rebate**	20	8.7	8	7.5	1	10.0
Information or advice provided by a contractor	19	8.0	7	3.7	1	10.0
Availability of a list of contractors through the Efficiency Trade Network	17	3.9	5	3.6	1	0.0
Information or advice received by ENS staff*	19	6.8	7	7.6	1	-
Program on-bill financing***	7	7.4	5	7.0	0	-
Information or advice from the small business energy auditor	20	6.8	8	6.6	1	-
Don't know/Refused excluded from calculations						
*Wording change in 2017						
**Base: Respondents who received a rebate						
***Base: Respondents who received financing						

DIY Path (Lighting only)

- D1. Had your business **already** decided to install the energy-efficient lighting upgrades BEFORE learning about the Small Business Energy Solutions Program?
- D2. Just to confirm: before you learned about the Small Business Energy Solutions Program and the rebates offered through the program, you had already made the decision to install the energy-efficient lighting upgrades?*

Already Made Decision to Install Energy Efficient Lighting Upgrades Prior to SBES	2017	2019	2021
Sample Size	39	37	41
Yes	8%	11%	12%
No	90%	86%	83%
Don't know/Refused	3%	3%	5%
*Wording change in 2021			

- D3. [IF FINANCING=NO] Efficiency Nova Scotia provided your business with a rebate of **\$<TOTAL ENS REBATE>** for the energy-efficient lighting upgrades. If your business had not received this rebate, would you have paid the full cost of the lighting upgrades? Please use a scale of 0 to 10, where 0 means that you “Definitely Would Not Have Paid” and 10 means that you “Definitely Would Have Paid.”?*
- D4. [IF REBATE and FINANCING=YES] Efficiency Nova Scotia provided your business with a rebate of **\$<TOTAL ENS REBATE>** and a loan for the energy-efficient lighting upgrades. If your business had not received the rebate and financing from Efficiency Nova Scotia, would you have paid and financed the cost of the lighting upgrades? Please answer on a scale of 0 to 10, with a 0 indicating that you “Definitely Would Not Have Paid and Financed” and a 10 indicating that you “Definitely Would Have Paid and Financed.”

Would Have Paid/Financed Cost of Lighting Upgrades	2017		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Would have paid/financed full cost of upgrades	37	2.9	36	3.3	40	3.4
Don't know/Refused excluded from calculations *Wording change in 2021						

- D5. Were you aware that the lighting products rebated through the Small Business Energy Solution Program are premium products certified by Design Light Consortium or ENERGY STAR®?

Aware Lighting Products Are Certified by DesignLights Consortium Or ENERGY STAR®	2017	2019	2021
Sample Size	39	37	41
Yes	59%	38%	61%
No	36%	62%	37%
Don't know/Refused	5%	-	2%

D6-D8. I would like to ask you to consider what actions your business would have taken if there was no Small Business Energy Solutions program. For the next questions, answer on a scale of 0 to 10, where 0 is “Very Unlikely,” and 10 is “Very likely.”****

Actions Taken in Absence of SBES	2017		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Postponed installing the lighting upgrades by at least one year*	11	6.9	14	5.9	16	5.4
Installed exactly the same number of lighting products that you installed through the program**	30	3.9	36	3.6	41	4.0
Installed the exact same model of lighting products***	38	2.3	35	2.8	41	3.5
Don't know/Refused excluded from calculations *Base: Respondents who would not likely have paid or financed the full cost of the lighting upgrades in absence of SBES **Base: Respondents who installed more than one lighting measure ***Wording change in 2017 and 2021 ****Wording change in 2021						

D9. I would like you to rate the influence of the following factors in your decision to install the energy-efficient lighting upgrades. Use a scale of 0 to 10, where 0 is “No influence” and 10 is “Great influence”. ***

Influence on Decision to Install Energy Efficient Lighting Upgrades	2017		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Program rebate*	38	8.7	36	9.1	40	8.5
Information or advice received by a contractor	39	7.5	37	7.5	41	8.0
Program on-bill financing**	14	7.7	28	8.5	18	7.4
Information or advice received by ENS staff	35	5.1	35	6.6	37	6.0
The availability of a list of contractors through the Efficiency Trade Network	36	4.0	33	4.4	35	5.0
Don't know/Refused excluded from calculations *Base: Respondents who received a rebate **Base: Respondents who received financing ***Wording change in 2021						

HVAC PATH (DIY Participants)

- D10. Had your business **already** decided to install heat pumps BEFORE learning about the Small Business Energy Solutions Program?*
- D11. Just to confirm: before you learned about the Small Business Energy Solutions Program and the rebates offered through the program, you had already made the decision to install heat pumps?*

Already Made Decision to Install Heat Pumps Prior to Learning About SBES	2017	2019	2021
Sample Size	11 (#)	4 (#)	8 (#)
Yes	8	2	1
No	2	2	7
*Change to question wording in 2019 and 2021			

- D12. Efficiency Nova Scotia provided your business with a rebate of \$<TOTAL ENS REBATE> for the heat pumps. If your business had not received this rebate, would you have paid the full cost of the heat pumps?
- D13. Efficiency Nova Scotia provided your business with a rebate and loan for your heat pumps. If your business had not received the rebate and financing from Efficiency Nova Scotia, would you have paid and financed the cost of the heat pumps?

Please answer on a scale of 0 to 10, with a 0 indicating that you “Definitely Would Not Have Paid and Financed” and a 10 indicating that you “Definitely Would Have Paid and Financed.”

Would Have Paid/Financed Cost of Heat Pumps	2019		2021	
	Sample Size	Mean	Sample Size	Mean
Would have paid/financed full cost of upgrades	4	6.5	8	4.3
Don't know/Refused excluded from calculations				

- D14-D15. I would like to ask you to consider what actions your business would have taken if there was no Small Business Energy Solutions program. For the next questions, answer on a scale of 0 to 10, where 0 is “Very Unlikely,” and 10 is “Very Likely.” If there was no program rebate or financing, what is the likelihood that you would have ...?*

Actions Taken in Absence of SBES	2019		2021	
	Sample Size	Mean	Sample Size	Mean
Postponed installing the heat pumps by at least one year*	3	1.0	4	6.5
Installed exactly the same energy-efficient heat pumps that were rebated or financed through the Program	4	6.3	8	4.6
Don't know/Refused excluded from calculations				
*Base: Respondents who would not likely have paid or financed the full cost of the heat pumps in absence of SBES (D12 or D13 ≥5)				
**Wording change in 2021				

D16. I would like you to rate the influence of the following factors in your decision to install the high-efficiency heat pumps. Use a scale of 0 to 10, where 0 is “No influence” and 10 is “Great influence”. The first factor is....***

Influence on Decision to Install Heat Pumps	2019		2021	
	Sample Size	Mean	Sample Size	Mean
Program on-bill financing*	3	9.3	2	10.0
Program rebate**	4	7.0	8	9.6
Information or advice provided by a contractor	4	8.0	8	6.9
Information or advice received by ENS staff	4	10.0	8	6.8
The availability of a list of contractors through the Efficiency Trade Network	4	5.5	8	4.0
Don't know/refused removed from calculations *Base: Respondents who received financing **Base: Respondents who received a rebate ***Wording change in 2021				

E1. Before participating in the Small Business Energy Solutions program in [DATE], had your business at any time in the past already participated in any other Efficiency Nova Scotia programs?

Previous Participation in Another ENS Program Component	2017	2019	2021
Sample Size	70	50	50
Yes	50%	36%	38%
No	46%	60%	60%
Don't know/Refused	4%	4%	2%

E2. Your business' previous participation in an Efficiency Nova Scotia program was a major factor in the decision to install energy-efficient upgrades in your facility.

Previous Participation in Another ENS Program Component Was a Major Factor on Decision to Make Upgrades	2017	2019	2021
Sample Size	35	18 (#)	19 (#)
Agree	60%	17	16
Disagree	40%	1	3
Base: Respondents who previously participated in another ENS program component			

- E3. Because of your business' previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, you had asked your contractor/distributor about different energy efficiency options before participating in Small Business Energy Solutions.

Previous ENS Program Component Participation Impacted Asking Contractor/Distributor About Different Energy Efficiency Options Before Participating in SBES		2021
Sample Size		3 (#)
Agree		2
Disagree		1
Base: Respondents who previously participated in another ENS program component, and respondents in Audit or DIY path		

- E4. Because of your business' previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, you took into account the cost-effectiveness of energy efficient upgrades when evaluating different options for the facility.

Previous ENS Program Component Participation Impacted Cost-effectiveness Assessment of Upgrades	2017	2019*	2021
Sample Size	35	18 (#)	19 (#)
Agree	77%	18	16
Disagree	17%	-	3
Don't know	6%	-	-
*Wording change in 2019 Base: Respondents who previously participated in another ENS program component			

- E5. Before participating in the Small Business Energy Solutions program in [DATE], had you at any time in the past seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?

Previously Seen Energy Efficiency Promotional Materials Distributed by ENS	2017	2019	2021
Sample Size	70	50	50
Yes	91%	74%	80%
No	7%	26%	20%
Don't know/Refused	1%	-	-

- E6. The promotion of energy efficiency carried out by Efficiency Nova Scotia was a major factor in your business' decision to install energy-efficient upgrades.*

Promotion of Energy Efficiency Carried Out by ENS Was a Major Factor in Decision to Make Upgrades*	2017	2019	2021
Sample Size	64	37	40
Agree	64%	57%	88%
Disagree	36%	41%	13%
Don't know	-	3%	-
Base: Respondents who previously saw ENS energy-efficiency promotional materials			
*Wording change in 2021			

- E7. The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to consider installing energy efficiency measures in your facility before participating in Small Business Energy Solutions.*

Promotion of Energy Efficiency Carried Out by ENS Was a Major Factor in Prompting Consideration of Installing Energy Efficiency Measures*	2017	2019	2021
Sample Size	17(#)	13 (#)	4 (#)
Agree	12	8	2
Disagree	5	4	2
Don't know	-	1	-
Base: Respondents who previously saw ENS energy-efficiency promotional materials and respondents who were part of the DIY path or Audit path			
*Wording change in 2021			

- E8. The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take into account the cost-effectiveness of energy efficient upgrades when evaluating different options for the facility.*

Promotion of Energy Efficiency Carried Out by ENS Was a Major Factor in Taking into Account the Cost-effectiveness Assessment of Upgrades*	2017	2019	2021
Sample Size	64	37	40
Agree	73%	73%	90%
Disagree	25%	27%	10%
Don't know	2%	-	-
Base: Respondents who previously saw ENS energy-efficiency promotional materials			
*Wording change in 2021			

F1. Using a scale from 1 to 10 where 1 is 'not at all satisfied' and 10 is 'completely satisfied', how would you rate your satisfaction with the program overall?

Overall Satisfaction with SBES	2017	2019	2021
Sample Size	70	50	50
Mean	8.8	9.2	9.1
Don't know/Refused excluded from calculations			

F2. What was the most important reason you were not more satisfied with the program overall?

Reasons Not More Satisfied with SBES	2017*	2019	2021
Sample Size	10 (#)	5 (#)	6 (#)
Process/program took too long	-	-	2
I expected more/faster savings	2	2	1
I was expecting to get rebates for equipment installed but did not	-	1	1
Poor communication/hard to contact	-	-	1
I would have liked a higher incentive/Incentive too low	2	2	-
Dissatisfied with the contractor/vendor	2	-	-
Project wasn't cost effective	1	-	-
The administration was disorganized	1	-	-
Audit report could have been more comprehensive	1	-	-
Too much paperwork	1	-	-
Expected more to be done/They didn't replace fixtures	1	-	-
Poor installation/Products not installed properly	1	-	-
The audit took too long	1	-	-
Others	-	-	1
*Multiple responses			
Base: Respondents who were not satisfied with SBES (NOT SATISFIED: F1<8)			

- F3. On a scale of 1 to 10, where 1 is “not at all satisfied” and 10 is “completely satisfied”, how satisfied are you with each of the following? Let me know if you were not involved with any of these aspects.*

Satisfaction with Aspects of SBES	2017		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Mean (1 = ‘Not at all satisfied’, 10 = ‘Completely satisfied’)						
<i>AUDIT: The usefulness of the audit report</i>	20	8.4	7	8.0	1	10.0
<i>The quality of the work performed by the contractor</i>	-	-	50	9.4	48	9.5
<i>FINANCING: The program financing</i>	-	-	-	-	19	9.4
<i>The equipment that was installed</i>	70	9.4	50	9.1	47	9.3
<i>The ease of finding a contractor</i>	65	8.8	41	9.2	47	9.2
<i>REBATE: The program rebate</i>	-	-	-	-	47	9.1
<i>The program forms and documents</i>	-	-	42	9.1	40	8.8
Don't know/Not applicable/Refused excluded from calculations						
*Wording change in 2021						

- F4. Do you have any recommendations for improving the Small Business Energy Solutions program? Anything else?

Participant Recommendations to Improve SBES	2017	2019	2021
Sample Size	70	50	50
Increase rebates	9%	8%	6%
Speed up the process/receive rebate quicker	6%	2%	4%
Offer financing/help with cost	1%	-	4%
Offer more measures eligible for rebates	4%	10%	2%
Better marketing/awareness	11%	4%	2%
Improve communication	10%	4%	2%
Simplify the program/Less paperwork	6%	4%	2%
Improve contractors' quality of work	6%	2%	-
Better indication of what is and is not rebated	-	2%	-
Provide a dedicated person to help see the project through	-	2%	-
More financial support for non-profit organizations	-	2%	-
Lengthen timeframe to complete work	1%	-	-
Others	6%	8%	16%
No recommendations	64%	66%	62%
Don't know/Refused	-	-	-
Multiple responses			

- G1. To what extent do you consider the following as barriers preventing your business from installing energy efficiency upgrades? Use a scale of 1 to 10, where 1 means 'not at all a barrier' and 10 means 'a major barrier'.*

Barriers to Measure Implementation	2017		2019		2021	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Financial challenge, even after rebate, such as lack of funds, taking too long to recoup the investment, etc.	68	5.3	50	5.1	49	4.4
Lack of knowledge about energy efficiency incentives or equipment	69	4.2	48	5.1	50	4.4
Not knowing how to get started in relation to planning upgrades and hiring contractors or doing the work internally	66	3.8	48	4.9	49	3.9
Time constraint, that is, not having time to hire contractor and seek bids	68	3.4	49	4.4	49	3.9
Don't know/Refused excluded from calculations						
*Wording change in 2021						

- H1. What is your job title or role?

Job Title of Respondent	2017	2019	2021
Sample Size	70	50	50
President/CEO/Owner	49%	44%	38%
Manager	19%	22%	18%
Other financial/administrative position	4%	16%	12%
Director	4%	2%	8%
Facilities Manager	9%	4%	2%
Other facilities management/maintenance position	1%	6%	-
Chief Financial Officer	1%	2%	-
Others	14%	14%	26%

H2. What is the main activity of the facility where the energy efficiency improvements were installed under the Business Energy Solutions Program?

Business Type	2017	2019	2021
Sample Size	70	50	50
Mercantile-Retail – Enclosed mall or strip mall	7%	2%	22%
Manufacturing	3%	2%	10%
Mercantile-Retail – Other than mall	29%	22%	6%
Property management	3%	6%	6%
Farming	3%	2%	6%
Religious worship	4%	-	6%
Food service/Restaurant	17%	6%	4%
Service	1%	8%	4%
Maintenance/Depot facility	-	-	4%
Automotive repair	4%	6%	2%
Warehouse and storage	3%	6%	2%
Health care – Outpatient	1%	2%	2%
Recreation centre/Community hall	3%	-	2%
Education	3%	-	2%
Government	-	-	2%
Transportation	-	-	2%
Lodging	3%	8%	-
Food Sales/Grocery	-	4%	-
Non-profit organization	1%	2%	-
Office	1%	2%	-
Health care – Inpatient	-	2%	-
Public assembly	-	-	-
Public order and safety	-	-	-
Others	13%	20%	18%

H3. Approximately how many full-time equivalent workers are employed at this facility?

Full-time Employees	2017	2019	2021
Sample Size	70	50	50
Fewer than 5	41%	46%	32%
5 to 9	17%	28%	22%
10 to 19	19%	12%	18%
20 to 49	19%	10%	18%
50 to 99	3%	2%	2%
100 to 249	-	-	-
Don't know/Refused	1%	2%	8%

H4. Do you own or rent the facility?

Own or Rent	2019	2021
Sample Size	50	50
Own	64%	74%
Rent	34%	22%
Others	2%	4%

H5. Is your business independent, or part of a larger company?

Type of Company	2017	2019	2021
Sample Size	70	50	50
Independent	64%	74%	62%
Part of a larger company	24%	26%	24%
Others	10%	-	14%
Don't know	1%	-	-

H6. How many business locations does your business have in Nova Scotia?

Number of Locations	2017	2019	2021
Sample Size	70	50	50
1	64%	68%	56%
2-10	27%	14%	26%
11-30	4%	8%	8%
More than 30	-	4%	2%
Don't know	4%	6%	8%

APPENDIX III

SBES: TRACKING SHEET AUDIT

This appendix presents the results of the tracking sheet audit performed by the Evaluator, which was aimed at:

- › Verifying that all data fields required for the evaluation were included and properly filled out in the tracking sheet submitted by EOne
- › Ensuring that tracked results were accurate by:
 - Verifying that the parameters used to calculate program results (gross and net energy and peak demand savings at the generator) were consistent with previous evaluation results
 - Validating that all calculation steps were performed consistently

Data Completeness and Accuracy

Table 1 and Table 2 below list all the parameters required for the SBES and the Commercial Direct Install Pilot evaluation. The Evaluator validated whether the data contained in the tracking sheet submitted by EOne were accurate based on previous evaluation results as well as whether the data were complete. Finally, the tables detail the actions carried out by the Evaluator to adjust data when required.

Table 1: Verification of 2021 SBES Data Field Completeness and Accuracy

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Gross Energy Savings at the Meter	Y	N/A	2 rows contained negative savings without any justification. The Evaluator kept these negative savings assuming there was a justification but that it was omitted.
Gross Peak Demand Savings at the Meter	Y	N/A	2 rows contained negative savings without any justification. The Evaluator kept these negative savings assuming there was a justification but that it was omitted. 6 rows had 0 kW in demand savings with no justification. The Evaluator kept these savings at 0 kW since not enough information was available in the tracking sheet to recalculate savings for these rows.
Rate Code	Partial	N/A	9 rows included no rate code. The Evaluator used the global average line loss factors for these rows.
Net-to-gross Ratios	Yes	Yes	N/A

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Effective Useful Life	Partial	Partial	Many rows had no EUL values, although the Evaluator was able to complete the missing values using the “Program Measures” table and the 2020 DSM Measure Assessment report. 2 measures had incorrect tracked EUL values that the Evaluator corrected based on the Measure Assessment report. 2 rows with custom measures had no EUL values. The Evaluator chose EUL values for these rows based on measure descriptions.
Adjustment Ratio	No	No	No adjustment ratio was included in the tracking sheet. The Evaluator assumed that no adjustment ratio had been applied by EOne and used the adjustment ratio from the previous evaluation.

**Table 2: Verification of 2021 Commercial Direct Install Pilot
Data Field Completeness and Accuracy**

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Data for Each Project or Participant			
Gross Energy Savings at the Meter	N	N/A	No columns presenting the total savings per participant were included.
Gross Peak Demand Savings at the Meter	N	N/A	
Building Type	Y	N/A	N/A
Heating System Type	Partial	N/A	One participant had no information tracked for the heating system; the Evaluator assumed an electrical baseboard heating system.
DHW System Type	Partial	N/A	Two participants had no information tracked for the DHW system, although they installed no DHW measures, so no action was needed.
Rate Code	Partial	N/A	Eight participants had no rate code; the average line loss factor from other participants was applied to this participant’s savings.

Data Fields	Complete (Y/N/Partial)	Consistent with Previous Evaluation	If Incomplete or Inconsistent, Action Taken by the Evaluator
Reference Data			
Unitary Energy Savings	Y	Partial	For lighting measures, EOne used the residential unitary savings values, yet three measures had incorrect values. The Evaluator used the 2020 DSM Measure Assessment values. For DHW measures, EOne used values similar to the residential ones but not exactly the same. The Evaluator kept EOne values since they were reasonable; these measures were never evaluated before and EOne might have included adjustment ratios.
Line Loss Factors	N	N/A	No line loss factor was included in the tracking sheet. The Evaluator used the standard line loss factors provided by EOne.
Interactive Effects Factors	N	N/A	No line loss factor was included in the tracking sheet. The Evaluator applied interactive effects factor only to obtain the evaluated savings.
Net-to-gross Ratios	N	N/A	No NTGR was included in the tracking sheet. The Evaluator applied a NTGR of 1 assuming that EOne used this assumption for pilots.
Peak Demand-to-energy Ratios	N	N/A	No peak demand-to-energy ratio was included in the tracking sheet.
Effective Useful Life	N	N/A	No effective useful life values were included in the tracking sheet. This had no impact on the corrected tracked savings and was adjusted through the evaluated savings.

Data Consistency

The second step of the tracking sheet audit involved recreating calculations and comparing related tracking sheet data fields to uncover any potential inconsistencies. Table 3 and Table 4 below list all the data fields of the SBES and Commercial Direct Install Pilot tracking sheets, which were compared to ensure consistency.

Table 3: Verification of 2021 SBES Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Calculated Line Loss Factor (Gross Energy Savings at the Generator / Gross Energy Savings at the Meter)	Tracked Rate Codes	Yes	N/A
Total Gross Energy Savings at the Meter at the Measure Level	Total Gross Energy Savings at the Meter at the Project Level	No	There was an error for 1 project; total gross energy and demand savings at the project level were 0 kWh and 0 kW respectively while there were savings at the measure level. The Evaluator summed the measure level savings to adjust the total project level savings.
Total Gross Peak Demand Savings at the Meter at the Measure Level	Total Gross Peak Demand Savings at the Meter at the Project Level	No	
Verification of Duplicate IDs or Projects	-	Yes	N/A

Table 4: Verification of 2021 Commercial Direct Install Pilot Data Field Consistency

Data Field 1	Data Field 2	Consistent (Y/N)	If Not, Action Taken by the Evaluator
Verification of Duplicate IDs or Projects	-	N	One project was identified by the Evaluator as a duplicate, which was confirmed by EOne. Savings for this project were excluded.

Equations and Compilation

Once the correct values were used (as per Table 1 and Table 2 above), the Evaluator validated that the equations in the tracking sheet correctly calculated each of the main program component results, as presented in Table 5 and Table 6.

Table 5: Verification of 2021 SBES Savings Compilation

Program Component Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	Partial	No adjustment ratios were applied by EOne. The Evaluator applied the adjustment ratios from the 2020 evaluation to tracked energy and demand savings. Otherwise, tracked gross energy and demand savings correctly incorporated the line loss factors.
Gross Peak Demand Savings at the Generator	Partial	
Net Energy Savings at the Generator	Partial	As for the gross savings at the generator, no adjustment ratios were applied to net savings. The Evaluator applied the adjustment ratios from the 2020 evaluation to tracked energy and demand savings. Otherwise, tracked net energy and demand savings correctly incorporated the NTGRs and line loss factors.
Net Peak Demand Savings at the Generator	Partial	

Table 6: Verification of 2021 Commercial Direct Install Pilot Savings Compilation

Program Component Result	Valid Equation? (Y/N)	If Not, Action Taken by the Evaluator
Gross Energy Savings at the Generator	N	- No savings at the generator were included in the tracking sheet. The Evaluator used the rate code to apply the correct line loss factors to obtain savings at the generator. - No peak demand savings were included in the tracking sheet. The Evaluator used the residential peak demand-to-energy ratios to calculate peak demand savings since energy savings were based on residential values. - No net savings were included in the tracking sheet. The Evaluator used a NTGR of 1 to calculate net savings.
Gross Peak Demand Savings at the Generator	N	
Net Energy Savings at the Generator	N	
Net Peak Demand Savings at the Generator	N	

Corrected Tracked Savings

Table 7 presents the corrected tracked savings resulting from all changes made by the Evaluator, as described in this appendix.

Table 7: 2021 SBES Corrected Tracked Savings

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
SBES					
Gross Energy Savings at the Generator	11.099	GWh	10.832	GWh	-2.4%
Gross Peak Demand Savings at the Generator	2.332	MW	2.347	MW	0.7%
Net Energy Savings at the Generator	10.312	GWh	10.065	GWh	-2.4%
Net Peak Demand Savings at the Generator	2.167	MW	2.181	MW	0.7%
Commercial Direct Install Pilot					
Gross Energy Savings at the Generator	0.096	GWh	0.105	GWh	8.7%
Gross Peak Demand Savings at the Generator	-	MW	0.018	MW	-
Net Energy Savings at the Generator	0.096	GWh	0.105	GWh	8.7%
Net Peak Demand Savings at the Generator	-	MW	0.018	MW	-

SBES corrected tracked gross and net energy savings are lower than the values tracked by EOne because the Evaluator incorporated the adjustment ratio in the corrected tracked gross and net values, since EOne had not incorporated the adjustment ratio in neither gross nor net savings. Also, correcting the savings of participants with missing line loss factors slightly increased the corrected tracked savings.

Similarly to energy savings, SBES corrected tracked gross and net peak demand savings were slightly higher than the values tracked by EOne because the Evaluator corrected the savings of participants with missing line loss factors, which slightly increased the corrected tracked savings. The Evaluator also incorporated the adjustment ratio in the corrected tracked gross and net values, although this had no impact on the savings because the peak demand adjustment ratio is equal to 1.

For the Commercial Direct Install Pilot, the main difference between tracked and corrected savings is the application of the line loss factors. A few changes to unitary savings values also had a small impact.

APPENDIX IV

SBES: COMMERCIAL DIRECT INSTALL PILOT - GROSS SAVINGS PARAMETERS

In 2021, EOne launched the Commercial Direct Install pilot. This appendix presents the impact evaluation parameters used by the Evaluator to establish the 2021 gross energy and peak demand savings generated through this pilot.

Table 1 below presents the unitary energy and peak demand savings values as well as the EUL values for each measure of the pilot, while Table 2 below presents the interactive effect factors. The equations and assumptions behind these parameters are presented in the 2020-2022 Measure Assessment.¹

Further below, Table 3 presents the gross energy and peak demand savings obtained based on the gross savings parameters and the information from the 2021 tracking sheet.

**Table 1: SBES Commercial Direct Install Pilot –
Unitary Savings and Effective Useful Life Values**

Measure	Additional Notes	Unitary Energy Savings Value	Unitary Peak Demand Savings Value	EUL Value
	-	(kWh/year)	(W)	(years)
Lighting				
9 W Replacing 25 W	N/A	57.6	9.4	3.0
9 W Replacing 29 W		72.0	11.8	3.6
9 W Replacing 40 W		112	18.3	2.7
9 W Replacing 43 W		122	20.1	4.0
9 W Replacing 60 W		184	30.1	3.0
9 W Replacing 72 W		227	37.2	4.7
9 W Replacing 100 W		328	53.7	3.5
9 W Replacing 150 W		508	83.2	3.2
9.5 W Replacing 25 W		55.8	9.1	3.0
9.5 W Replacing 29 W		70.2	11.5	3.5
9.5 W Replacing 40 W		110	18.0	2.6
9.5 W Replacing 43 W		121	19.8	4.0
9.5 W Replacing 60 W		182	29.8	3.0
9.5 W Replacing 72 W		225	36.9	4.7

¹ The 2020-2022 Measure Assessment is a reference document that provides an in-depth review of all parameters necessary to calculate the annual and lifetime gross energy and peak demand savings of most prescriptive measures and some semi-prescriptive measures offered through EOne's DSM program portfolio. In addition, the Measure Assessment includes effective useful life measures for all measures offered in EOne's program portfolio. For the evaluations conducted during the 2020-2022 DSM cycle, the Evaluator refers to the values presented in the 2020-2022 Measure Assessment.

Measure	Additional Notes	Unitary Energy Savings Value	Unitary Peak Demand Savings Value	EUL Value
	-	(kWh/year)	(W)	(years)
9.5 W Replacing 100 W		326	53.4	3.5
9.5 W Replacing 150 W		506	82.9	3.2
18 W Replacing 75 W		205	33.6	4.1
18 W Replacing 100 W		295	48.4	3.2
7 W Black-out Bulbs Replacing 60 W		191	31.3	4.2
PAR20 7 W Replacing 50 W		155	25.4	3.5
PAR30 8 W Replacing 53 W		162	26.6	3.3
PAR30 8 W Replacing 75 W		241	39.5	3.8
PAR38 15 W Replacing 90 W		270	44.3	3.6
PAR38 15 W Replacing 120 W		378	62.0	4.1
PAR38 15 W Replacing 150 W		486	79.7	3.9
7 W GU10 Replacing 35 W		101	16.5	3.2
7 W GU10 Replacing 50 W		155	25.4	3.5
7 W G25 Replacing 40 W		119	19.5	3.0
5 W Chandeliers E12 Replacing 40 W		126	20.7	3.0
LED Nightlights		29.3	3.95	23
Hot Water				
Low-flow Showerheads	Flow rate reduction of 0.5 gpm	215	41.3	10
	Flow rate reduction of 0.75 gpm	322	61.8	
	Flow rate reduction of 1 gpm	429	82.4	
Faucet Aerators	N/A	269	51.6	10
Thermostatic Shower Valves	1.5 gpm	81	15.5	10
	2.0 gpm	108	20.7	
	2.25 gpm	121	23.3	
	2.5 gpm	135	25.9	
Pipe Insulation	Per ft	12.7	2.44	13
Hot Water Tank Wraps	N/A	159	18.1	7

Table 2: SBES Commercial Direct Install Pilot - Interactive Effect Factors

Measure	Type of Space Heating	Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings
LED Lamps	N/A	-8.3%	-20.9%
LED Nightlights		-8.3%	-20.9%
Low-flow Showerheads		0.0%	0.0%
Faucet Aerators		0.0%	0.0%
Thermostatic Shower Valves		0.0%	0.0%
Pipe Insulation Hot Water Tank Wraps	Heat Pump Heating	-13.0%	-90%
	Electrical Heating	-28.5%	-90%
	No Electrical Heating	0%	0%

Table 3: Evaluated 2021 SBES Commercial Direct Install Pilot Gross Energy and Peak Demand Savings

Product Category	LED Lamps								
	9 W Replacing								9.5 W Replacing 60 W
	25 W	29 W	40 W	43 W	60 W	72 W	100 W	150 W	
Number of Units									
Number of Units	5	0	151	18	561	9	19	5	28
Installation Rate (%)	100%	100%	100%	100%	100%	100%	100%	100%	100%
Number of Units Installed	5	0	151	18	561	9	19	5	28
Energy Savings									
Unitary Energy Savings (kWh)	57.6	72	112	122	184	227	328	508	182
Energy Interactive Effects Factor*	-8.3%	-8.3%	-8.3%	-8.3%	-8.3%	-8.3%	-8.3%	-8.3%	-8.3%
Adjustment Ratio	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Gross Energy Savings – at the Meter (GWh)	0.000	0.000	0.015	0.002	0.091	0.002	0.005	0.002	0.004
Line Loss Factor	1.0964	1.0964	1.0964	1.0964	1.0964	1.0964	1.0964	1.0964	1.0964
Gross Energy Savings – at the Generator (GWh)	0.000	0.000	0.016	0.002	0.100	0.002	0.006	0.002	0.005
Effective Useful Life (years)	3.0	3.6	2.7	4.0	3.0	4.7	3.5	3.2	3.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.001	0.000	0.044	0.008	0.299	0.009	0.021	0.008	0.015
Peak Demand Savings									
Unitary Peak Demand Savings (W)	9.4	11.8	18.3	20.1	30.1	37.2	53.7	83.2	29.8
Peak Demand Interactive Effects Factor*	-20.9%	-20.9%	-20.9%	-20.9%	-20.9%	-20.9%	-20.9%	-20.9%	-20.9%
Adjustment Ratio	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.002	0.000	0.013	0.000	0.001	0.000	0.001
Line Loss Factor	1.1349	1.1349	1.1349	1.1349	1.1349	1.1349	1.1349	1.1349	1.1349
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.002	0.000	0.015	0.000	0.001	0.000	0.001
* The interactive effects factors correspond to the average for each product weighted according to the proportion of each type of home. The factors are obtained by dividing gross savings at the meter by the unitary savings values, installation rates, number of units, and adjustment ratios when applicable.									

* The interactive effects factors correspond to the average for each product weighted according to the proportion of each type of home. The factors are obtained by dividing gross savings at the meter by the unitary savings values, installation rates, number of units, and adjustment ratios when applicable.

Evaluated 2021 SBES Commercial Direct Install Pilot Gross Energy and Peak Demand Savings (Continued)

Product Category	LED Lamps							
	PAR20 7 W Replacing 50 W	PAR38 15 W Replacing		GU10 7 W Replacing		G25 7 W Replacing 40 W	E12 5 W Chandeliers Replacing 40 W	LED Nightlights
		90 W	150 W	35 W	50 W			
Number of Units								
Number of Units	69	41	41	11	45	126	134	22
Installation Rate (%)	100%	100%	100%	100%	100%	100%	100%	100%
Number of Units Installed	69	41	41	11	45	126	134	22
Energy Savings								
Unitary Savings Value (kWh)	155	270	486	101	155	119	126	29.3
Interactive Effects Factor*	-8.3%	-8.3%	-8.3%	-8.3%	-8.3%	-8.3%	-8.3%	-8.3%
Adjustment Ratio	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Gross Energy Savings – at the Meter (GWh)	0.009	0.010	0.018	0.001	0.006	0.013	0.015	0.001
Line Loss Factor	1.0964	1.0964	1.0964	1.0964	1.0964	1.0964	1.0964	1.0964
Gross Energy Savings – at the Generator (GWh)	0.010	0.011	0.019	0.001	0.007	0.014	0.016	0.001
Effective Useful Life (years)	3.5	3.6	3.9	3.2	3.5	3.0	3.0	23.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.036	0.038	0.075	0.003	0.024	0.043	0.049	0.014
Peak Demand Savings								
Unitary Peak Demand Savings (W)	25.4	44.3	79.7	16.5	25.4	19.5	20.7	3.95
Peak Demand Interactive Effects Factor*	-20.9%	-20.9%	-20.9%	-20.9%	-20.9%	-20.9%	-20.9%	-20.9%
Adjustment Ratio	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Gross Peak Demand Savings – at the Meter (MW)	0.001	0.001	0.002	0.000	0.001	0.002	0.002	0.000
Line Loss Factor	1.1349	1.1349	1.1349	1.1349	1.1349	1.1349	1.1349	1.1349
Gross Peak Demand Savings – at the Generator (MW)	0.002	0.002	0.003	0.000	0.001	0.002	0.002	0.000
* The interactive effects factors correspond to the average for each product weighted according to the proportion of each type of home. The factors are obtained by dividing gross savings at the meter by the unitary savings values, installation rates, number of units, and adjustment ratios when applicable.								

Evaluated 2021 SBES Commercial Direct Install Pilot Gross Energy and Peak Demand Savings (Continued)

Product Category	DHW Measures							Total
	Faucet Aerators	Low-flow Showerheads			Thermostatic Shower Valves - 2.5 gpm	Pipe Insulation (per foot)	Hot Water Tank Wraps	
		0.5 gpm Reduction	0.75 gpm Reduction	1.0 gpm Reduction				
Number of Units								
Number of Units	116	8	2	43	4	84	16	1,558
Installation Rate (%)	95%	100%	100%	100%	100%	100%	100%	-
Number of Units Installed	110	8	2	43	4	84	16	1,552
Energy Savings								
Unitary Savings Value (kWh)	269	215	322	429	135	12.7	159	-
Interactive Effects Factor*	0%	0%	0%	0%	0%	-16%	-15%	-
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-
Gross Energy Savings – at the Meter (GWh)	0.030	0.002	0.001	0.018	0.001	0.001	0.002	0.248
Line Loss Factor	1.0964	1.0964	1.0964	1.0964	1.0964	1.0964	1.0964	-
Gross Energy Savings – at the Generator (GWh)	0.033	0.002	0.001	0.020	0.001	0.001	0.002	0.272
Effective Useful Life (years)	10.0	10.0	10.0	10.0	10.0	13.0	7.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	0.325	0.019	0.007	0.202	0.006	0.013	0.017	1.277
Peak Demand Savings								
Unitary Peak Demand Savings (W)	51.6	41.3	61.8	82.4	25.9	2.44	18.1	-
Peak Demand Interactive Effects Factor*	0%	0%	0%	0%	0%	-51%	-51%	-
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-
Gross Peak Demand Savings – at the Meter (MW)	0.006	0.000	0.000	0.004	0.000	0.000	0.000	0.037
Line Loss Factor	1.1349	1.1349	1.1349	1.1349	1.1349	1.1349	1.1349	-
Gross Peak Demand Savings – at the Generator (MW)	0.006	0.000	0.000	0.004	0.000	0.000	0.000	0.043
* The interactive effects factors correspond to the average for each product weighted according to the proportion of each type of home. The factors are obtained by dividing gross savings at the meter by the unitary savings values, installation rates, number of units, and adjustment ratios when applicable.								

APPENDIX V

SBES: ALGORITHM FOR FREE-RIDERSHIP CALCULATION

The figures below present the algorithms for calculating the SBES free-ridership levels for the Audit path and DIY path (lighting and HVAC measures). The participant survey questionnaire included questions designed to assess the planning, quantity, efficiency, timing, cost, and influence of the program component. Each group of questions was transposed into a level of program component attribution, the results of which were then used to calculate the free-ridership level associated with each participant.

Free-ridership – Audit Path

C3/C4. If your business had not received the rebate or financing from ENS as well as the free audit, would you have paid for the full cost of the energy-efficient upgrades you installed? (Scale 0 to 10)	$C3orC4 = \text{Answer} \times 10\%$ IF DK OR REF: C3orC4 = EMPTY
C5. If there was no program rebate, no financing, and no audit, what is the likelihood that you would have installed standard equipment or that you would have kept your old equipment instead of installing energy-efficient equipment in your facility? (Scale 0 to 10)	$C5 = (10 - \text{Answer}) \times 10\%$ IF DK OR REF: C5 = EMPTY
PA1 Score:	MEAN VALUE OF: (C3orC4; C5)
C1. BEFORE learning about the SBES program and having your facility evaluated by a Small Business Energy Auditor, did your business have plans to install the energy-efficient upgrades that were installed as part of the SBES program? Did you... 1. Have plans to install all of the upgrades 2. Have plans to install some of the upgrades 3. Have no plan to install any of the upgrades	IF 1 OR 2: GO TO C2 IF 3 OR DK OR REF: $C2 = 0\%$
C2. [IF C1=1 or 2] Just to confirm: before you had your facility evaluated by a Small Business Energy Auditor, you had already made the decision to install [all / some of] the energy efficiency upgrades that were installed as part of the program?	IF 1. Yes and C1 = 1: $C2 = 100\%$ IF 1. Yes and C1 = 2: $C2 = 25\%$ IF 2. No OR DK OR REF: $C2 = 0\%$
PA2 Score:	C2
C8. Level of influence – 7 factors (Scale 0 to 10)	$C8 = \text{MAX} (a; b; c; d; e; f; g)$
PA3 Score:	$(10 - C8) \times 10\%$
C6. [ASK IF TOTAL MEASURE QTY>1] If there was no program rebate, no financing, and no audit, what is the likelihood that you would have installed exactly the same number of energy-efficient upgrades that were installed through the SBES program? (Scale 0 to 10)	$C6 = \text{Answer} \times 10\%$ IF 98 OR 99: C6 = EMPTY
C7. [ASK IF C3 OR C4 ≥5] If there was no program rebate, no financing, and no audit, what is the likelihood that you would have postponed making energy efficient upgrades to your facility by at least one year? (Scale 0 to 10)	$C7 = (10 - \text{Answer}) \times 10\%$ IF DK OR REF: C7 = EMPTY

PA4 Score:	Min (C6; C7)
Inconsistency Test PA1	IF ABS (C3orC4 – C5) ≥ 50% PA1 = MIN (C3orC4; C5)
Inconsistency Test PA2	IF C2 = 100% AND C3orC4 < 70%: PA2 = EMPTY
Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)
E2/E6. [Your business' previous participation in an ENS program] / [The promotion of energy efficiency carried out by ENS] was a major factor in your business' decision to install energy efficient upgrades in your facility. E3. Because of your business' previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, you had asked your contractor/distributor about different energy efficiency options before participating in SBES. E7. The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to consider installing energy efficiency measures in your facility before participating in SBES. E4/E8. [Because of your business' previous participation in an ENS program and what was learned by participating in that program, you took] / [The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take] into account the cost-effectiveness of energy efficient upgrades when evaluating different options for the facility.	Cross-influence (CI) = IF (E2 OR E6 = Agree; 1) + IF (E3 OR E7 = Agree; 1) + IF (E4 OR E8 = Agree; 1)
Revised Free-Ridership	IF CI = 0 OR 1: Revised FR = FR IF CI = 2: Revised FR = FR*.75 IF CI = 3: Revised FR = FR*.50

Free-ridership – DIY Path: Lighting

D3orD4. If your business had not received the rebate or the financing from ENS, would you have paid for the full cost of the lighting upgrades? (Scale 0 to 10)	D3orD4 = Answer x 10% IF DK OR REF: D3orD4 = EMPTY
D5. Were you aware that the lighting products rebated through the SBES program are premium products certified by Design Light Consortium or ENERGY STAR®?	IF 1. Yes: Use D6 IF 2. No OR DK OR REF: D6 = 0%
D6. If there was no program rebate or financing, what is the likelihood that you would have installed the exact same model of lighting products? (Scale 0 to 10)	D6 = Answer x 10% IF DK OR REF: D6 = EMPTY
PA1 Score:	MEAN VALUE OF: (D3orD4; D6)

D1. Had your business already decided to install the energy-efficient lighting upgrades before learning about SBES?	IF 1. Yes: Use D2 IF 2. No OR DK OR REF: D1 = 0%
D2. [IF D1=1] Just to confirm: before you learned about the SBES program and the rebates offered through the program, you had already made the decision to install the energy-efficient lighting upgrades?	IF 1. Yes: D1 = 100% IF 2. No OR DK OR REF: D1 = 0%
PA2 Score:	D1
D9. Level of influence– 5 factors (Scale 0 to 10)	D9 = MAX (a; b; c; d; e)
PA3 Score:	(10 – D9) x 10%
D7. [IF TOTAL LIGHTING QTY >1] If there was no program rebate or financing, what is the likelihood that you would have installed exactly the same number of lighting products that you installed through the program? (Scale 0 to 10)	D7 = Answer x 10% IF DK OR REF: D7 = EMPTY
D8. [ASK IF D3 or D4 ≥5] If there was no program rebate or financing, what is the likelihood that you would have postponed installing the lighting upgrades by at least one year? (Scale 0 to 10)	D8 = (10 – Answer) x 10% IF DK OR REF: D7 = EMPTY
PA4 Score:	Min (D7; D8)
Inconsistency Test PA1	IF ABS (D3orD4 – D6) ≥ 50% PA1 = MIN (D3orD4; D6)
Inconsistency Test PA2	IF D2 = 100% AND D3orD4 < 70%: PA2 = EMPTY
Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)
E2/E6. [Your business' previous participation in an ENS program] / [The promotion of energy efficiency carried out by ENS] was a major factor in your business' decision to install energy efficient upgrades in your facility. E3. Because of your business' previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, you had asked your contractor/distributor about different energy efficiency options before participating in SBES.	Cross-influence (CI) = IF (E2 OR E6 = Agree; 1) + IF (E3 OR E7 = Agree; 1) + IF (E4 OR E8 = Agree; 1)

E7. The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to consider installing energy efficiency measures in your facility before participating in SBES. E4/E8. [Because of your business' previous participation in an ENS program and what was learned by participating in that program, you took] / [The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take] into account the cost-effectiveness of energy efficient upgrades when evaluating different options for the facility.	
Revised Free-Ridership	IF CI = 0 OR 1: Revised FR = FR IF CI = 2; Revised FR = FR*.75 IF CI = 3; Revised FR = FR*.50

Free-ridership – DIY Path: HVAC

D12orD13. If your business had not received the rebate or the financing from ENS, would you have paid for the full cost of the heat pumps? (Scale 0 to 10)	D12orD13 = Answer x 10% IF DK OR REF: D12orD13 = EMPTY
D14. If there was no program rebate or financing, what is the likelihood that you would have installed exactly the same high-efficiency heat pump that were rebated or financed through the Program?	D14 = Answer x 10% IF DK OR REF: D14 = EMPTY
PA1 Score:	MEAN VALUE OF: (D12orD13; D14)
D10. Had your business already decided to install heat pump before learning about SBES?	IF 1. Yes: Use D11 IF 2. No OR DK OR REF: D10 = 0%
D11. Just to confirm - Before you learned about SBES and the rebates offered through SBES, you had already made the decision to install heat pumps?	IF 1. Yes: D10 = 100% IF 2. No OR DK OR REF: D10 = 0%
PA2 Score:	D10
D16. Level of influence– 5 factors (Scale 0 to 10)	D16 = MAX (a; b; c; d; e)
PA3 Score:	(10 – D16) x 10%
D15. [ASK IF D12 or D13 ≥5] If there was no program rebate or financing, what is the likelihood that you would have postponed installing the heat pumps by at least one year? (Scale 0 to 10)	D15 = (10 – Answer) x 10%
PA4 Score:	D15
Inconsistency Test PA1	IF ABS (D12orD13 – D14) ≥ 50% PA1 = MIN (D12orD13; D14)
Inconsistency Test PA2	IF D11 = 100% AND D12orD13 < 70%: PA2 = EMPTY

Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)
E2/E6. [Your business' previous participation in an ENS program] / [The promotion of energy efficiency carried out by ENS] was a major factor in your business' decision to install energy efficient upgrades in your facility. E3. Because of your business' previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, you had asked your contractor/distributor about different energy efficiency options before participating in SBES. E7. The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to consider installing energy efficiency measures in your facility before participating in SBES. E4/E8. [Because of your business' previous participation in an ENS program and what was learned by participating in that program, you took] / [The promotion of energy efficiency carried out by Efficiency Nova Scotia prompted you to take] into account the cost-effectiveness of energy efficient upgrades when evaluating different options for the facility.	Cross-influence (CI) = IF (E2 OR E6 = Agree; 1) + IF (E3 OR E7 = Agree; 1) + IF (E4 OR E8 = Agree; 1)
Revised Free-Ridership	IF CI = 0 OR 1: Revised FR = FR IF CI = 2; Revised FR = FR*.75 IF CI = 3; Revised FR = FR*.50

APPENDIX VI

SBES: 2021 RECOMMENDATIONS

The Evaluator made no specific recommendation as part of the 2021 SBES evaluation and no past recommendation remains unimplemented.



MARKET TRANSFORMATION AND CODES & STANDARDS 2021 DSM EVALUATION

EFFICIENCYONE

Final Report

March 9, 2022



ABBREVIATIONS

BPA	Bonneville Power Administration
C&S	Codes and Standards
CCE	Commercial Code Enhancement
EOne	EfficiencyOne
IEPEC	International Energy Program Evaluation Conference
MT	Market transformation
NEEA	Northwest Energy Efficiency Alliance
NYSERDA	New York State Energy Research and Development Authority
RPP	Retail Products Platform

DEFINITIONS

Accuracy	Reflects the proximity of measurements to the true value.
Adjustment ratio	The ratio of evaluated results to tracked results. This ratio expresses the adjustment made to tracked savings or other tracked values such as effective useful life.
Baseline	To determine gross savings, a baseline (or base case) is established providing detailed information about the reference (e.g. pre-existing or standard) measure or equipment chosen to be compared with the efficient measure or equipment. For the reference measure or equipment, the baseline may include such information as the hours of operation, wattage and the base consumption.
Bias	Systematic deviations of measurements from the true value.
Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
Displaced wattage	The displaced wattage is defined as the difference between the wattage values of the baseline equipment or product and the efficient equipment or product.
EnerGuide rating	An EnerGuide (official brand of Natural Resources Canada) rating is a standard measure of the home's energy performance. It is a measure of the efficiency of the building only and does not take into account occupant behaviour. It shows how energy efficient the home is through modelled heat losses of the home, based on several factors including building envelope characteristics, heated volume, heating systems and air leakage.
Effective useful life	The period a measure is expected to be in service and provide both energy and peak demand savings. This value combines the equipment life and the measure persistence, which includes factors such as business turnover or early retirement.
Equipment life	The number of years installed equipment will operate before it fails.
Equivalent CO ₂	A unit of measurement indicating the amount of carbon dioxide to which various kinds of emitted greenhouse gases are equivalent in terms of warming effects. In this report, the gases' global-warming potential is estimated over a timescale of 100 years.
Equivalent effective useful life	The number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. This value takes into account variations in annual energy savings throughout the effective useful life due to increased baselines.

Evaluated savings	Gross and net energy or peak demand savings calculated by the Evaluator using the parameters (unitary savings values, installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process. Unless otherwise specified, the evaluated savings are the first-year savings.
Evaluation plan	The evaluation plan summarizes the program description, objectives, base cases, documentation, evaluation methodology, budget and schedule.
First-year savings	The first full year of energy or peak demand savings generated by an energy efficiency measure.
Free-ridership	Percentage of gross savings attributable to participants who would have implemented the same or similar energy efficiency measures, with no change in timing, in the absence of the program.
Gross savings	Change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated.
Induced consumption	Energy consumption of appliances that would have been unplugged and not replaced by participants in the absence of the program.
Interactive effects	Effects on the energy consumption of other systems in the building (such as heating and cooling) due to the installation of an energy efficiency measure.
Participant spillover	Savings attributable to participants who continue to implement the energy efficiency measure introduced by a program after participating in it once, without participating in the program a second time.
In-service rate	The proportion of incentivized products that are installed and operating. This rate is usually applied to programs through which rebates are offered in-store and products are likely to be stored for a certain period before being installed, such as LED lamps.
Installation rate	The proportion of incentivized products reported as installed that remain installed and operating at the time of evaluation. This rate is usually applied to direct install or mail-in rebate programs through which measures are expected to be installed immediately at the time of participation.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for a measure's effective useful life and any increase in the baseline efficiency level (which reduces attributable annual savings) over its lifetime.
Line loss factor	The multiplier to convert savings at the customer meter to savings at the utility generator. It accounts for the electrical losses of the transmission and distribution system.
Margin of error	The amount of random sampling error.
Market effects	The impact of the program on the market (such as increased product availability, practices, and prices) that extends beyond changing the program participants' behaviour. This includes spillover among non-participants.

Net savings	Energy or peak demand savings that can be reliably attributed to a program. This includes effects, such as free-ridership and spillover, that negatively or positively affect the savings attributable to a program.
Net-to-gross ratio	The ratio of net energy savings to gross energy savings.
Non-sampling error	Errors arising during the course of all survey activities other than sampling. Non-sampling errors tend to lead to bias in measurements and are very difficult to quantify.
Peak coincidence factor	The percentage of measure demand savings that coincide in time with the annual peak demand of the entire electricity system.
Peak demand savings	The demand savings that coincide in time with the expected annual peak demand period of the entire electricity system.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	The error in measurement due to the fact that measurements are taken from a subset of the population and not the entire population.
Realization rate	The ratio of evaluated savings to tracked savings.
Sample size	The number of observations or replicates included in a statistical sample.
Secondary market impacts	Energy consumption of appliances that would have been transferred to the secondary market if said appliances had not been retired.
Tracked savings	Gross and net savings calculated based on various parameters such as number of participants or units installed or sold, unitary savings values, installation rates, interactive effects, and the net-to-gross ratio. Those parameters, with the exception of the number of participants or units installed or sold, are obtained from the previous evaluation.
Unitary savings	Energy or peak demand savings established on a unitary basis. This unit can either be a product (e.g., an 8 W LED lamp), a capacity (e.g., one-ton capacity of an air-source heat pump) or a participant (e.g., one participant taking part in a behaviour-based program).

TABLE OF CONTENTS

INTRODUCTION	1
1 METHODOLOGY	2
2 CONTEXT AND BACKGROUND	4
2.1 Growing Interest in Market Transformation Programs	5
3 JURISDICTIONAL SCAN.....	6
3.1 Market Transformation Program Design.....	7
3.1.1 Targeted Markets.....	8
3.1.2 Activities Included in Programs	8
3.2 Evaluation Methodologies for Market Transformation Savings	10
3.3 Regulatory Context	12
CONCLUSION.....	15

LIST OF TABLES

Table 1: Key Differences Between Resource Acquisition and Market Transformation Programs	4
Table 2: Summary of MT Programs for Selected Jurisdictions	6

EXECUTIVE SUMMARY

The Evaluator was tasked with conducting research on the integration of market transformation (MT) programs into traditionally resource-acquisition focussed portfolios and on the treatment of codes and standards (C&S) savings. This research relied on two main activities: (1) A literature review on MT programs and related evaluation best practices; and (2) interviews with program administrators from six jurisdictions that have integrated to various extents MT programs in their portfolio. The Evaluator identified Efficiency Vermont, the Northwest Energy Efficiency Alliance (NEEA) and their main utility funder Bonneville Power Administration (BPA), National Grid Massachusetts, the New York State Energy Research and Development Authority (NYSERDA), ComEd Illinois, and BC Hydro as key actors for this jurisdictional scan.

The literature review was first aimed at defining MT: “The strategic process of intervening in a market to create lasting change in market behaviour by removing identified barriers or exploiting opportunities to accelerate the adoption of all cost-effective energy efficiency as a matter of standard practice.”¹

Elements of MT can be achieved to a certain extent by traditional resource acquisition programs.² However, it is generally implemented using MT programs (also called strategic MT programs). MT programs differ from resource acquisition programs in various ways, with one key element being a demonstrated intention to transform the market with changes that endure (generally documented in a logic model). MT programs also differ from resource acquisition (RA) programs through the information that is tracked for savings evaluation; they must rely on market-level data rather than on participant or project databases.

MT programs are becoming more attractive to certain program administrators for two main reasons. First, as baseline products become increasingly energy efficient, incremental energy savings decrease, thereby challenging the cost-effectiveness of traditional incentive-based programs. Second, the savings achievable through RA might not be sufficient to attain ambitious energy efficiency targets or at least, might not be the most effective way to influence market-level changes.

¹ NEEA, *NEEA 2020–2024 Strategic and Business Plan*, 2018, available at <<https://neea.org/img/documents/NEEA-2020-2024-Strategic-and-Business-Plans.pdf>>

² Market effects are often used to capture some level of market transformation that occurs through resource acquisition programs. Market effects are not the primary objective of those programs, which instead focus on short-term savings, as noted in D. Moran et al., *Paving the Way for New Market Transformation Programs: Building a Bridge from Resource Acquisition*, ACEEE 2018 Summer Study on Energy Efficiency in Buildings, California. Other sources, such as the UMP Chapter 21, also note that market transformation is a subset of market effects, in the sense that market transformation is the substantive and long-lasting effects that are captured by market effects (Violette, D. M. and Rathbun, P. *Chapter 21: Estimating Net Savings—Common Practices: Methods for Determining Energy-Efficiency Savings for Specific Measures*. Golden, CO, National Renewable Energy Laboratory, 2017, available at <<http://www.nrel.gov/docs/fy17osti/68578.pdf>>)

Through the jurisdictional scan, the Evaluator established that some program administrators have portfolios that entirely consist of MT programs, while others only have a few MT programs. There are also some program administrators, such as Efficiency Vermont and National Grid, that do not claim savings from MT programs, although they might include the concept of MT in their program design.

The MT programs administered by the selected jurisdictions covered various technologies from consumer goods such as lighting to complex building systems. Building code programs that target either compliance or new code development are especially common. The Evaluator found various examples of new construction MT programs that included activities such as capacity building through training and tool development, support to code enforcement, and development of marketing tools. The design of market interventions in this sector can therefore be based on proven initiatives.

Several jurisdictions were found to be implementing C&S programs. The Evaluator analyzed the relation between C&S programs and MT programs and found two likely scenarios. MT programs either focus on C&S adoption or enhanced compliance as their main end goal or include C&S as one of many elements in their strategy. This implies that all C&S programs are a form of MT programs and based on the literature review, should be designed and evaluated as such. However, the jurisdictional review showed that C&S programs may be supported by regulators who do not support an MT framework, due to their narrower scope and more predictable and shorter-term savings.

Jurisdictions that claim savings from MT use well-established methodologies. Key evaluation requirements include 1) theory-based evaluation following a logic model that identifies and addresses market barriers to be developed at the program design stage, 2) collection of market data before the program starts and regularly throughout the program, 3) calculation of savings at the market level and 4) assessment of attribution. Although there is consensus in the general evaluation principles, challenges in applying them remain since data collection can be challenging and interpreting this data can be subjective and lead to disagreement among stakeholders. Having a framework that details the evaluation approach and is agreed upon with key stakeholders (including the implementer and the evaluator) has been very helpful in jurisdictions where MT savings have been successfully claimed.

The experience from other jurisdictions indicates that MT programs are becoming increasingly accepted as a cost-effective way to reach larger markets and achieve energy savings. A key challenge in claiming savings from MT programs is establishing an evaluation framework that will satisfy regulatory requirements, which is a consideration for EOne that, until now, has focused their DSM Plans on RA programs only. The jurisdictional scan served to establish that the support of the regulator and stakeholders is a key in establishing such an evaluation framework.

In the Evaluator's opinion, if EOne considers recognizing savings from MT programs, the next step in EOne's process related to MT programs would be to conduct a preliminary assessment of potential markets for MT programs. This assessment would involve identifying markets where one or multiple positive factors are present, such as having some market-level interventions already in place, an upcoming technology for which adoption can be increased or synergy with other regional and national

efforts. The size of Nova Scotia may not allow EOne to have a significant impact on some markets that are driven by larger provinces and states, especially where energy efficiency regulations are under federal jurisdiction and the development of new technologies and distribution of certain goods occur through national channels. However, there may be markets where the main barriers are local (e.g. trained workforce, availability of products through local retailers). The new construction market should be a priority for such an assessment, targeting two programs (New Home Construction and New Construction) for which EOne has been in the market for several years, but where the potential for savings is dwindling due to increasingly stringent codes and standard building practices. With building codes adoption being under provincial jurisdiction, this is a market that is within the range of influence for EOne.

In conducting the preliminary assessment, EOne should consider the following potential paths:

- › Focus on building code programs only: As demonstrated in this report, some jurisdictions claim savings from code development and compliance initiatives despite not recognizing MT frameworks. Although it would still require some work before developing the program, this approach may find easier acceptance from regulators and stakeholders. This approach could have the advantage of providing a proving ground for MT programs. Conversely, it could prevent EOne from implementing other MT programs outside of building codes at least as long as the second approach below is not adopted.
- › Establishing a broader MT framework that allows multiple types of programs: Considering that interest in MT programs is increasing rapidly, it may be preferable to develop an MT framework that would allow MT initiatives for any markets wherein potential has been identified.

INTRODUCTION

As part of the 2021 evaluation, EfficiencyOne has requested that the Evaluator conduct research to inform EfficiencyOne's (EOne) approach to market transformation (MT) and treatment of codes and standards (C&S).³ This exploration occurs while many jurisdictions in North America are reviewing their program design and evaluation approaches to better integrate whole-market interventions into their portfolio.

This research pursues four main objectives:

- › Identifying practices of other jurisdictions concerning MT and C&S attribution in terms of interventions and evaluation approach
- › Understanding the regulatory and legislative context that enables jurisdictions to design and report savings from MT or C&S programs
- › Identifying measures, programs or markets that are likely to be evaluated under an MT framework
- › Providing guidance on which mechanisms, if any, EOne could undertake to evaluate their influence on the new construction market, particularly in the residential sector

The interventions that could be carried out for the residential new construction market and the methodology to measure EOne's influence are of particular interest since stringent new codes are making it difficult to offer a cost-effective incentive program for new homes.

³ Between 2012 and 2020, EfficiencyOne (EOne) engaged the Evaluator to assess the annual incremental energy and peak demand savings that can be achieved as a result of the introduction of federal and provincial codes and standards into the Nova Scotia market. The evaluations served a monitoring purpose and did not count toward EOne targets.

1 METHODOLOGY

To meet the research objectives, the Evaluator conducted a jurisdictional scan of evaluation practises with regard to C&S and MT initiatives. To understand the context in which MT or C&S programs were designed and implemented, as well as the best practices already established for achieving MT, the Evaluator first conducted a review of the literature on the topic of MT in general.

The Evaluator then scanned the literature to identify jurisdictions that have MT and/or C&S initiatives, and to collect information on the design and evaluation approaches used for those initiatives.

A total of six program administrators were selected for further analysis. The Evaluator aimed to include program administrators that have integrated MT programs in their portfolio to varying extents. The selected program administrators were:⁴

- › BC Hydro
- › Northwest Energy Efficiency Alliance (NEEA), and their main utility funder, Bonneville Power Administration (BPA)
- › ComEd Illinois
- › Efficiency Vermont
- › National Grid Massachusetts
- › New York State Energy Research & Development Authority (NYSERDA)

The selected program administrators are generally local utilities or energy efficiency agencies (in the case of Efficiency Vermont) who are responsible for all or a portion of the DSM portfolio for their states. Two program administrators are slightly different. NEEA is a regional organization that regroups over 140 utilities and energy efficiency organizations mainly from the states of Washington, Oregon, Montana and Idaho. It was formed specifically to design and manage MT programs, which are typically not administered by local utilities. The savings resulting from their programs are claimed by funding utilities—each utility treats those savings differently, based on their regulator’s requirements. For its part, NYSERDA is an energy efficiency agency that administers statewide programs and provides information, analysis and technical expertise to advance energy efficiency in New York. NYSERDA reports its program savings to its regulator. Local utilities in its territory also administer energy programs in parallel.

⁴ The state of California was not selected in this review as the Evaluator concluded that this jurisdiction would not be as useful as a point of comparison as other selected jurisdictions due, in part, by California’s complex regulatory context. In late 2019, California approved a new framework and budget specifically for market transformation initiatives, and they are in the process of establishing a unique statewide market transformation program administrator, as described in Walton, R., *California approves new energy efficiency frameworks expected to boost emerging technologies*, December 17, 2019, <https://www.utilitydive.com/news/california-approves-new-energy-efficiency-frameworks-expected-to-boost-emer/569164/> (Last accessed November 19, 2021).

After compiling the information found in the literature, the Evaluator developed an individual interview guide for each jurisdiction and contacted staff members who were involved in developing and evaluating MT or C&S programs. The interviews were used to better understand the regulatory context in which those programs operate and obtain further details on the evaluation methodologies used. The Evaluator successfully conducted interviews with all organizations listed above.

2 CONTEXT AND BACKGROUND

The Evaluator’s literature review first served to better define the notion of MT and MT programs.

MT can be defined as “the strategic process of intervening in a market to create lasting change in market behaviour by removing identified barriers or exploiting opportunities to accelerate the adoption of all cost-effective energy efficiency as a matter of standard practice.”⁵

Elements of MT can be achieved to a certain extent by traditional resource acquisition programs.⁶ However, it is generally implemented using MT programs (also called strategic MT programs). MT programs differ from resource acquisition programs in various ways, with one key element being a demonstrated intention to transform the market with changes that endure (generally documented in a logic model). The table reproduced below, which was presented in a paper prepared for ComEd, summarizes those key differences succinctly.

Table 1: Key Differences Between Resource Acquisition and Market Transformation Programs⁷

	Resource Acquisition	Market Transformation
Scale	Program	Entire defined market
Target	Participants	All consumers
Goal	Near-term savings	Structural changes in the market leading to long-term savings
Approach	Save energy through customer participation	Save energy by mobilizing the market
Scope of Effect	Usually from a single program	Results from effects of multiple programs or interventions
Amount of Program Administrator’s Control	Program administrators can control the pace, scale and geographic location and can identify participants in general	Markets are very dynamic, and the program administrators are only one narrow set of market actors; if, how, where and when the impacts occur are usually well beyond the control of the program administrators
What is Tracked, Measured and Evaluated	Energy savings and number of participants	Interim and long-term indicators of market penetration and structural changes, attribution to the program, and cumulative energy impacts
Timeframe for Cost Effectiveness	Usually based on first year or cycle savings	Usually planned over a 5–10-year timeframe

⁵ NEEA, *NEEA 2020–2024 Strategic and Business Plan*, 2018, available at <<https://neea.org/img/documents/NEEA-2020-2024-Strategic-and-Business-Plans.pdf>>

⁶ Market effects are often used to capture some level of market transformation that occurs through resource acquisition programs. Market effects are not the primary objective of those programs, which instead focus on short-term savings, as noted in D. Moran et al. “Paving the Way for New Market Transformation Programs: Building a Bridge from Resource Acquisition”, Proceedings of the ACEEE 2018 Summer Study on Energy Efficiency in Buildings. Other sources, such as the UMP Chapter 21, also note that market transformation is a subset of market effects, in the sense that market transformation is the substantive and long-lasting effects that are captured by market effects (Violette, D. M. and Rathbun, P. *Chapter 21: Estimating Net Savings—Common Practices: Methods for Determining Energy-Efficiency Savings for Specific Measures*. Golden, CO, National Renewable Energy Laboratory, 2017, available at <<http://www.nrel.gov/docs/fy17osti/68578.pdf>>

⁷ Navigant Consulting, Inc. *Regulatory Spotlight. Estimating Energy Savings From Resource Acquisition and Market Transformation Programs*, Report prepared for ComEd, February 2019, p. 3

Codes and standards are often an integral part of MT programs. The Illinois TRM provides a useful description of the correlation between C&S savings and MT programs: “If an MT initiative can successfully influence the code or standard to incorporate higher levels of efficiency, the initiative can effectively ‘lock-in’ sustained efficiency changes for virtually the entire market. Logic models for MT initiatives will often include activities that are deliberately targeting and driving toward the adoption of enhanced energy codes or standards (C&S). Energy savings that occur following the successful adoption of efficient C&S are often a significant portion of the energy savings claimed.”⁸ However, there are programs that focus on C&S adoption outside of an MT framework, as identified in the jurisdictional scan in Section 2.

2.1 Growing Interest in Market Transformation Programs

MT programs are increasingly being included in DSM portfolios. Based on the literature review the Evaluator conducted, the reason for this is two-fold.

First, the opportunity for traditional RA programs in certain markets is decreasing. As baseline products become increasingly energy efficient, incremental energy savings, and consequently incentive amounts, decrease. Those inferior rebates might not be sufficient to influence a buyer’s decision, and the cost of processing individual rebate claims might become disproportionate.

Second, the savings achievable through RA might not be sufficient to attain ambitious energy efficiency targets or at least, might not be the most effective way to influence market-level changes. Because of the climate crisis, many jurisdictions have increased their energy efficiency targets, which subsequently requires influencing a large proportion of the market. This might not be feasible by influencing individual projects or purchase decisions. For example, BC Hydro mentioned that only a small percentage of builders in the province had taken part in the new construction incentive program after running it for 20 years. In BC Hydro’s case, moving to an MT approach aimed at aggressively advancing the building code allowed them to impact the entire market.

The literature review indicated that some jurisdictions are more favourable to MT than others. A discussion on various regulators’ stances on MT programs and their place in their program administrators’ portfolios is provided below in Section 3.3.

⁸ Illinois Energy Efficiency Stakeholder Advisory Group, *2021 Illinois Statewide Technical Reference Manual for Energy Efficiency*, Version 9.0, Volume 4, September 2020, p. 140.

3 JURISDICTIONAL SCAN

For each of the jurisdictions selected, the Evaluator summarized the MT programs offered and how they are included in the jurisdiction's portfolio. The Evaluator included any program that aims to intervene at the market level (following the broad definition of MT presented in Section 0) even if they are not formally considered as an MT program by their regulator.

For each jurisdiction, Table 2 describes the MT program, explains whether the program is considered as MT by the regulator and indicates whether those programs contribute to their regulated savings targets. This table first lists program administrators who have limited MT programs and then program administrators with higher levels of integration of MT into the DSM portfolio.

Table 2: Summary of MT Programs for Selected Jurisdictions

Program Administrator	Program Description	Considered MT by the Regulator?	Savings Counted Toward Targets?
National Grid Massachusetts	Residential and commercial building code promulgation and compliance program	These programs are not considered MT since MT programs are not permitted by the regulator.	Yes. Detailed baseline studies and attribution evaluations are performed to obtain reliable savings estimates that are acceptable within the resource acquisition framework preferred by the regulator.
Efficiency Vermont	All programs are designed with MT in mind but are not MT programs per se. They also have a building code compliance initiative.	No	No. Reported savings are solely based on a resource-acquisition model. No savings from the building code compliance initiative are claimed or reported toward their performance targets.
BC Hydro	Multiple C&S promulgation programs, including the development of a Step Energy Code for buildings. ⁹ These programs have the intention of MT and are designed using logic models to demonstrate how BC Hydro activities would lead to specific changes in the market and ultimately, MT.	No	Partially. The DSM Regulation allows utilities to attribute a portion of C&S future benefits to demand-side measures that "increase the use of a regulated item" during the period after the standard is proposed or passed into law, but before it comes into force. MT outside of C&S adoption is not recognized.

⁹ The BC Energy Step Code was introduced as a step-by-step building efficiency strategy designed to help meet the Provincial Government's target of all new homes being net-zero energy ready by 2032. It includes five steps, with the first one being aligned with the current province-wide code, and the fifth step indicated the home has been constructed as net-zero energy ready. Local governments can choose to require or incentivize a given step for new home construction in their community. Source: Clean BC Better Homes, *What is the BC Energy Step Code*, <https://betterhomesbc.ca/faqs/what-is-the-bc-energy-step-code/> (Last accessed October 25, 2021)

Program Administrator	Program Description	Considered MT by the Regulator?	Savings Counted Toward Targets?
ComEd Illinois	MT programs for ENERGY STAR® Retail Product Platform (RPP). Investigating the possibility of offering other MT programs such as a building code advocacy program.	Yes	Yes. A framework for claiming savings from MT programs has been part of their technical reference manual since 2019.
NEEA and Bonneville Power Administration	Multiple MT programs that are administered through NEEA, across various sectors.	Yes	Yes. BPA claims their funder's share of NEEA's MT programs.
NYSERDA	Programs under the current Clean Energy Fund Investment Plan are mainly focused on MT and cover 25 markets. ¹⁰	Yes	Yes. Both direct (initiative participants) and indirect (at a market level) impacts are reported and counted toward triennial and longer-term goals set by the Department of Public Services.

As shown in Table 2, several jurisdictions focus only on C&S programs. C&S are thought to be an integral part of MT programs; however, the Evaluator notes that C&S programs are not always considered as MT by the regulator. The interest of these C&S programs by regulators that do not support an MT evaluation framework is further discussed in Subsection 3.3.

The following subsections look at what various MT programs entail, how they are evaluated and the regulatory context that explains how they fit into program administrators' portfolios.

3.1 Market Transformation Program Design

Based on a review of the selected jurisdictions' programs, the Evaluator summarized the types of markets and measures that are commonly found in MT programs, as well as the activities that are part of those MT programs.

¹⁰ NYSERDA, *Clean Energy Fund*, <https://www.nyserda.ny.gov/About/Funding/Clean-Energy-Fund> (Last accessed October 26, 2021).

3.1.1 Targeted Markets

MT programs target a variety of products and technologies. One common MT program across multiple jurisdictions is the ENERGY STAR RPP, which started being developed nationally in the US in 2016¹¹ and is being implemented locally, particularly by ComEd Illinois, NEEA and Efficiency Vermont. The ENERGY STAR RPP is a midstream retail program that offers incentives to retailers to encourage stocking, promoting, and selling a higher percentage of energy efficient products than they otherwise would have. The final objective of the initiative is transforming the market for a selection of products covered through the ENERGY STAR certification, such as clothes dryers, freezers and room air conditioners.

The NEEA has developed multiple MT programs that target specific products and integrated and complex systems, including efficient rooftop units, luminaire level lighting controls, strategic energy management, heat pump water heaters and new constructions. Some of these programs are designed to influence markets for technologies that are only at the early stages of their commercial development, while others focus on marketing and merchandizing efforts for technologies that are well established.

Building code programs that target either compliance or new code development are especially common. As mentioned previously, the predictability and shorter timeframe required for those programs make them attractive, including in jurisdictions where using an MT evaluation framework is not yet permitted by the regulator. Code compliance initiatives may be popular due to the high potential for increased compliance in markets where code enforcement is lacking.

To determine which markets and products or technologies are well suited for an MT approach, local market research is a necessary step. For example, an exploratory workshop conducted for ComEd Illinois identified potential initiatives based on three categories: (1) initiatives that could be started right away, (2) initiatives that leverage existing resource acquisition programs and accelerate new technology adoption and (3) initiatives that leverage regional or national efforts.¹²

3.1.2 Activities Included in Programs

All programs included in this jurisdictional scan used multiple activities to influence a variety of market actors, from the legislator to the end user. Those activities include:

- › Lending specialized staff for code development
- › Training and capacity building for all market actors (designers, builders, contractors, enforcement officials)
- › Supporting code enforcement (funding and lending workforce)

¹¹ Likasiewicz, M. and P. Banwell, *Retail Products Platform – Piloting an Innovative Midstream Energy Efficiency Program Design*, 2016 ACEEE Summer Study on Energy Efficiency in Buildings, California.

¹² Harris, J., *Market transformation : Moving beyond traditional energy efficiency programs to cement change*, July 3, 2019, <https://www.utilitydive.com/news/market-transformation-moving-beyond-traditional-energy-efficiency-programs/557985/>, (Last accessed November 19, 2021).

- › Implementing downstream incentive programs as a way to develop market readiness, increase awareness of the equipment/technology and grow the market
- › Providing midstream incentives to increase the availability of products at retail locations
- › Developing case studies and other marketing activities
- › Developing tools to inform the public (e.g. a web page that compares the various options on the market for a given product, or explains the steps to get that product installed) and help them find a retailer or a contractor and/or rebate programs

Activities to advance residential building codes are similar to the general list provided above. The Evaluator found that NEEA's program, Better Built NW, as well as BC Hydro's approach to furthering the BC Step Code, were both very comprehensive and included many additional activities other than supporting code development. NEEA developed a wide array of tools for both construction professionals and homeowners, which are available at BetterBuiltNW.com. For instance, the website offers professionals live and on-demand courses, links to certification programs, heating, ventilation, and air conditioning sizing tools, case studies and marketing tools and resources to help them promote efficient buildings. BC Hydro used some of its DSM budget to fund local positions for code enforcement.

The Evaluator also notes that new, innovative approaches are emerging to further code advancement. Recently, NEEA has implemented a different strategy for its Commercial Code Enhancement (CCE) initiative. This initiative no longer focuses exclusively on increasing stringency but rather aims to improve the process of code development so that new versions of the code are both more efficient and clearer, which in turn improves compliance, as explained in a conference paper:

"For the first 15 or 20 years of code, stringency by itself worked well. Now, as codes reach the limits of standard building practice, utilities, jurisdictions, and industry have begun to publicly push back on the idea of increasing stringency. In practice, we are losing efficiency because, as codes have become more complex, jurisdictions have stopped enforcing. So good designers that know the code are left to compete with designers that ignore the code and charge less. CCE is a new approach that seeks [... to increase] actual energy savings in buildings post-construction rather than "paper" savings which exist only in code books. This also opens the door to increased support from utilities which are very interested in looking at how they can claim savings by increasing code savings."

Another innovative aspect of the Commercial Code Enhancement initiative is the coordination of all activities to leverage the synergy between the new construction programs and activities and the code development work, and to adapt it to each participating state's regulatory process.¹³

¹³ J. Jennings et al., *Market Transformation Strategies for Commercial Code Enhancement*, 2018 ACEEE Summer Study on Energy Efficiency in Buildings, California.

3.2 Evaluation Methodologies for Market Transformation Savings

As part of this jurisdictional scan, the Evaluator gathered information on how savings were evaluated and reported in each jurisdiction and reviewed reference documentation, white papers and conference proceedings on the topic of MT evaluation. Many reference documents provide useful guidance on the appropriate evaluation methodologies for MT and C&S programs. The Evaluator considers the following as especially pertinent:

- › NYSERDA's guiding document for MT EM&V¹⁴
- › SEEAAction's ENERGY STAR Retail Products Platform (RPP): Conditions and Considerations in Evaluating Market Transformation Programs and Evaluation Guidance for RPP¹⁵
- › Illinois' Technical Reference Manual, which includes a Framework for Counting Market Transformation Savings in Illinois¹⁶
- › A paper presented at the 2015 International Energy Program Evaluation Conference (IEPEC): Effective Practices for the Evaluation of Market Transformation Efforts¹⁷

Among the various reference documents consulted, the Evaluator notes that there is a consensus on the general approach to be used to evaluate MT programs. The following elements are repeated in all documents:

- 1 **Use theory-based evaluation.** As noted in the Illinois TRM: "Theory-based Evaluation starts with a theory of change that explains how an intervention is expected to produce results. This theory of change is embodied in the logic model that is the core of an MT initiative." The logic model must be defined at the program design stage so that interventions and data collection can be planned accordingly.
- 2 **Collect market data before the program starts, and regularly throughout the program.** All documents stress the importance of regular (yearly) data collection, which should be planned as part of program design. For instance, SEEAAction states that "Clear and measurable short-term, mid-term, and long-term indicators should be used as a measure of progress over time."¹⁸ The indicators should be tied to the program logic model.

¹⁴ Clean Energy Advisory Council's Metrics, Tracking & Performance Assessment Working Group, *Market Transformation Metrics and EM&V Coordination Report*, July 12, 2018, 42 p.

¹⁵ Conzemius S. and A. Dunn, *ENERGY STAR Retail Products Platform (RPP): Conditions and Considerations in Evaluating Market Transformation Programs and Evaluation Guidance for RPP*, Report prepared by ILLUME Advising, LLC, for the State and Local Energy Efficiency Action Network, 2018, 38 p.

¹⁶ Illinois Energy Efficiency Stakeholder Advisory Group, *2021 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 9.0*, Volume 4, September 2020, 148 p.

¹⁷ Nevius, M. et al., *Effective Practices for the Evaluation of Market Transformation Efforts*, Proceedings of the 2015 IEPEC, Long Beach, California.

¹⁸ Conzemius S. and A. Dunn, *ENERGY STAR Retail Products Platform (RPP): Conditions and Considerations in Evaluating Market Transformation Programs and Evaluation Guidance for RPP*, Report prepared by ILLUME Advising, LLC, for the State and Local Energy Efficiency Action Network, 2018, 38 p, p. 13.

- 3 **Calculate savings at the market level.** MT savings should be established based on the total market size, and the savings per unit (based on the difference between the baseline and efficient product). For MT programs that are not based on specific products, it may be necessary to change the unit of measurement to estimate savings on a facility basis, for example, for Strategic Energy Management programs.¹⁹ For MT programs that include the adoption of C&S among other MT impacts, C&S savings might be presented as a subcategory from the whole-market savings, but the overall savings calculation method remains the same.
- 4 **Assess attribution.** This can be done through multiple approaches, such as using comparison groups in non-programmatic jurisdictions, structured expert judgment or estimating the non-intervention (or natural) baseline.²⁰

The evaluation of attribution is an important and complex element of an MT program evaluation. Although the general concept of causality is present in all jurisdictions that claim savings from MT programs, the methodology used to establish the resulting savings vary: some jurisdictions apply an attribution percentage, while others use a naturally occurring baseline. BC Hydro and National Grid use the former approach. For BC Hydro, that attribution percentage is selected by the regulator, while for National Grid, it is based on interviews with market actors. The NEEA and Illinois estimate a naturally occurring baseline²¹, and comparing this baseline to the actual market establishes savings considered to be caused by MT activities. In addition, the NEEA also measures the influence of all efficiency organizations who participate in their initiative on the savings achieved—some utilities apply this influence percentage to obtain net savings that they claim toward their regulated targets, while some claim the entire savings amount (which is already considered to be attributable savings by their regulators). The Illinois framework also uses a naturally occurring baseline, which they call the Natural Market Baseline. They mention, however, that “depending on the specifics of the regional policy framework and the individual initiative, further adjustments could be called for. One example would be a situation in which policymakers or stakeholders simply wish to build some conservatism into MT savings claims to reflect the greater uncertainty surrounding attribution compared to RA programs.”

¹⁹ Navigant Consulting, Inc., *Regulatory Spotlight. Estimating Energy Savings From Resource Acquisition and Market Transformation Programs*, Report prepared for ComEd, February 2019, p. 9.

²⁰ Nevius, M. et al., *Effective Practices for the Evaluation of Market Transformation Efforts*, Proceedings of the 2015 IEPEC, Long Beach, California.

²¹ The naturally occurring baseline is determined by the technical advisory committee to the Northwest Power and Conservation Council. Members of this committee are selected from the pool of applicants for their technical expertise and experience. This baseline is used in place of a NTGR approach for resource acquisition programs in the Northwest as well.

Another major consideration that is present in all reference documents is the timeframe for MT program savings to occur. Many documents mention an expected period of at least 5 years and sometimes over 10 years.²² Consequently, savings might not be noticeable for the program's first few years and therefore an RA framework based on a typical 3-year cycle might not allow to capture the benefits of the program. This implies that, while market research should be conducted regularly, savings evaluation and reporting should be postponed by a few years compared to a traditional RA evaluation.

Despite the consensus on the evaluation approach, it should also be noted that putting the methodology into practice presents some challenges. For instance, gathering complete market sales data or interviewing all relevant market actors can be difficult and time-consuming. In addition, there may be disagreements with stakeholders or regulators on the appropriate approach to circumvent data quality issues or the correct interpretation of data. ComEd reported that, despite their rigorous evaluation framework, methodological questions still remain after the first evaluation preliminary report. As discussed in the following section, these challenges can be magnified by program policies that are not adapted to MT. Interestingly, the NEEA and NYSERDA, who have MT as their primary mission, have reported minimal issues with their evaluation approach and reporting.

3.3 Regulatory Context

Although many stakeholders in the energy efficiency industry recognize the importance and potential of MT programs, regulators have different stances on MT, which can support or hinder MT programs in their jurisdictions.

Some regulators recognize the value of MT programs and have implemented a structure that fosters such programs. In Illinois, NEEA, the objective of administering MT programs is part of laws and regulations. BC Hydro does not have such a clear mandate for MT, but their contribution to advancing C&S is recognized in the provincial regulation governing DSM and their regulatory documents. In all those jurisdictions, a public document (in the form of detailed regulations or an evaluation framework for instance) establishes the objectives, the savings that will be counted toward targets and, to a certain extent, the evaluation methodologies that will be used. This document might be subject to comments by stakeholders, based on the consultation processes in place in each jurisdiction. Interviewed jurisdictions indicated that having a formal structure in place to agree on the evaluation methodology and assumptions ahead of the program implementation is a major factor for success.

²² Clean Energy Advisory Council's Metrics, Tracking & Performance Assessment Working Group, *Market Transformation Metrics and EM&V Coordination Report*, July 12, 2018, p. 11.

Jurisdictions that recognize the value of MT initiatives might limit the amount of savings that can be counted toward targets. For instance, the DSM regulation for BC Hydro “allows utilities to attribute a portion of the standard’s future benefits to demand-side measures that ‘increase the use of a regulated item’ during the period after the standard is proposed or passed into law, but before it comes into force.”²³ For this limited period of time, the regulator will allow a percentage of the savings to be claimed toward BC Hydro’s targets, based on the program’s influence on MT. It should be noted that the savings resulting from advancing C&S are also accounted for through other mechanisms. C&S savings are included in the forecasted load of the utility, which has a regulated objective of meeting two-thirds of its new demand through conservation by 2020.²⁴ This creates a strong incentive for BC Hydro to help advance all C&S.

Other regulators are wary of MT programs. One of the main reasons cited by interviewed jurisdictions was that regulators felt that MT savings were too subjective and imprecise, due to the challenges of incomplete market data and the need to rely on expert judgments to establish the influence of the program. The other main reason was that MT programs involve a delay of many years between the initial upfront investment and the future observed savings. This delay is incompatible with a traditional RA framework, and moving to MT requires a complete paradigm shift. This paradigm shift should be integrated into the regulatory and evaluation framework of an MT or risk setting up the program for failure. A conference paper reflecting on lessons learned from the ESRRP programs noted: “Some inaugural ENERGY STAR RPP sponsors have had to defer participation in the program because of the lack of supportive policy. At its core, ENERGY STAR RPP is a MT program. An appropriate policy recognizes and allows for the inclusion of MT benefits in evaluation and measurement of ENERGY STAR RPP.”²⁵

As noted in Section 3, some jurisdictions do not use an MT framework, but still include MT programs in the form of C&S programs. C&S programs are somewhat different from other MT programs, which can lead them to be accepted in jurisdictions that do not use an MT framework (e.g. National Grid MA). These programs will estimate savings based on the difference between a prior standard and a new one; this creates a clear beginning and end point, which is not the case for all MT programs. In addition, knowing the cycle length for C&S upgrades, a program administrator can reasonably anticipate the level of savings that will result from the program and its approximate timing, making the program’s outcome more predictable. For building codes especially, the updates are regular and often on a 3 or 5-year cycle, thereby eliminating the long timeframe of some less defined MT programs. The narrower scope and predictability of those initiatives might make them more appealing to some regulators that do not support an MT framework.

²³ BC Ministry of Energy and Mines, Electricity and Alternative Energy Division, *Guide to the Demand-Side Measures Regulation*, July 2014, 18 p.

²⁴ The C&S savings that are considered in the load forecast are all savings, and not only the savings that are “attributable” to BC Hydro’s influence, as per the regulator’s decision.

²⁵ Harris, J. et al., *Market transformation at a national level: lessons learned from the ENERGY STAR Retail Products Platform (ESRPP)*, 2020 Summer Study on Energy Efficiency in Buildings, p. 2–194 to 2–202, California.

The Evaluator notes that at least one jurisdiction, Efficiency Vermont, design their programs with the objective of MT, even if they are not able to claim market-level savings. Their MT activities are viewed as strategic activities that are necessary to support and achieve RA savings; for instance, to drive awareness and interest in new technologies that are then integrated into an RA portfolio. Their savings targets are achievable within their RA framework since targets are set based on an analysis of potential studies and measure-leveling modeling forecasts that do not currently include savings from market-level impacts.

CONCLUSION

The literature review conducted by the Evaluator first sought to establish a clearer definition of MT programs and their relation to RA programs. RA programs are distinct from MT programs in many ways, but one key element is their main goal, which is to generate near-term savings in the case of RA programs, versus long-term savings through structural changes in the market for MT programs. Although RA programs can generate some level of MT, their design does not generally lead to sustained impacts that endure without interventions. Well-designed MT programs hold the promise of achieving more durable and, in some cases, greater savings than RA programs.

Interest in MT programs is growing in part because the opportunity for traditional RA programs in certain markets is decreasing and because MT is increasingly being seen as a cost-effective way to generate savings in some markets. The jurisdictional scan identified multiple jurisdictions where MT programs are implemented and even demanded by regulators and stakeholders. Those programs encompass various markets, including consumer products, building codes, integrated systems and energy management practices.

MT programs rely on multiple strategies and actions to bring structural change to the market. Incentive-based programs, such as those typically found under an RA framework, are only one of those strategies to transform the market. MT programs can include a variety of tactics, such as C&S development and compliance initiatives, capacity building and midstream incentive programs to increase the availability of targeted products. The Evaluator found various examples of new construction MT programs that included activities such as capacity building through training and tool development, support to code enforcement, and development of marketing tools. The design of market interventions in this sector can therefore be based on proven initiatives.

Several jurisdictions were found to be implementing C&S programs. The Evaluator analyzed the relation between C&S programs and MT programs and found two likely scenarios. MT programs either focus on C&S adoption or enhanced compliance as their main end goal or include C&S as one of many elements in their strategy. This implies that all C&S programs are a form of MT programs and based on the literature review, should be designed and evaluated as such. However, the jurisdictional review showed that C&S programs may be supported by regulators who do not support an MT framework, due to their narrower scope and more predictable and shorter-term savings.

Jurisdictions that claim savings from MT use well-established methodologies. Key evaluation requirements include 1) theory-based evaluation following a logic model that identifies and addresses market barriers to be developed at the program design stage, 2) collection of market data before the program starts and regularly throughout the program, 3) calculation of savings at the market level and 4) assessment of attribution. Although there is consensus in the general evaluation principles, challenges in applying them remain since data collection can be challenging and interpreting this data can be subjective and lead to disagreement among stakeholders. Having a framework that details the

evaluation approach and is agreed upon with key stakeholders (including the implementer and the evaluator) has been very helpful in jurisdictions where MT savings have been successfully claimed.

The experience from other jurisdictions indicates that MT programs are becoming increasingly accepted as a cost-effective way to reach larger markets and achieve energy savings. Some of the main challenges in implementing such programs are convincing the regulator of their validity and establishing an evaluation framework that will satisfy regulatory requirements. This is a critical consideration for EOne who, until now, has focused their DSM Plans on RA programs only.

The jurisdictional scan served to establish that the support of the regulator and stakeholders is a key in establishing such an evaluation framework.

In the Evaluator's opinion, if EOne considers recognizing savings from MT programs, the next step in EOne's process related to MT programs would be to conduct a preliminary assessment of potential markets for MT programs. This assessment would involve identifying markets where one or multiple positive factors are present, such as having some market-level interventions already in place, an upcoming technology for which adoption can be increased or synergy with other regional and national efforts. The size of Nova Scotia may not allow EOne to have a significant impact on some markets that are driven by larger provinces and states, especially where energy efficiency regulations are under federal jurisdiction and the development of new technologies and distribution of certain goods occur through national channels. However, there may be markets where the main barriers are local (e.g. trained workforce, availability of products through local retailers). The new construction market should be a priority for such an assessment, targeting two programs (New Home Construction and New Construction) for which EOne has been in the market for several years, but where the potential for savings is dwindling due to increasingly stringent codes and standard building practices. With building codes adoption being under provincial jurisdiction, this is a market that is within the range of influence for EOne.

In conducting the preliminary assessment, EOne should consider the following potential paths:

- › Focus on building code programs only: As demonstrated in this report, some jurisdictions claim savings from code development and compliance initiatives despite not recognizing MT frameworks. Although it would still require some work before developing the program, this approach may find easier acceptance from regulators and stakeholders. This approach could have the advantage of providing a proving ground for MT programs. Conversely, it could prevent EOne from implementing other MT programs outside of building codes at least as long as the second approach below is not adopted.
- › Establishing a broader MT framework that allows multiple types of programs: Considering that interest in MT programs is increasing rapidly, it may be preferable to develop an MT framework that would allow MT initiatives for any markets wherein potential has been identified.



2020-2022 DSM MEASURE ASSESSMENT

EFFICIENCYONE

2021 Evaluation Edition

March 10, 2022



ABBREVIATIONS

AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ARet	Appliance Retirement program
ASHP	Air-source heat pump
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BER	Business Energy Rebates (program component)
BNI	Business, non-profit, and institutional
CASHP	Central air-source heat pump
CDD	Cooling degree days
CFL	Compact fluorescent lamp
CEE	Consortium for Energy Efficiency
CEF	Combined energy factor
COP	Coefficient of performance
DCV	Demand-controlled ventilation
DEER	Database for Energy Efficiency Resources
DEO	U.S. Department of Energy
DHW	Domestic hot water
DHWT	Domestic hot water timer
DSM	Demand-side management
DWHR	Drain water heat recovery
ECM	Electronically commutated motor
EER	Energy efficiency ratio
EISA	Energy Independence and Security Act
EOne	EfficiencyOne
EMIS	Energy Management Information Systems (program component)
EPI	Efficient Product Installation (program component)
EUL	Effective useful life
IESO	Independent Electricity System Operator
GSHP	Ground-source heat pump
HDD	Heating degree days
HEA	Home Energy Assessment (program component)
HOU	Hours of use
HPS	High-pressure sodium
HPWH	Heat pump water heater

HSPF	Heating seasonal performance factor
HVAC	Heating, ventilation, and air conditioning
IEPEC	International Energy Program Evaluation Conference
ISR	In-service rate
LED	Light-emitting diode
MA	Measure Assessment
MH	Metal halide
MHEEP	Mi'kmaw Home Energy Efficiency Project (program component)
MSHP	Mini-split heat pump
NERHOU	Northeast Residential Lighting Hours-of-Use study
NEEP	Northeast Energy Efficiency Partnership
NHC	New Home Construction (program component)
NRCan	Natural Resources Canada
NYDPS	New York Department of Public Service
NYSESRDA	New York State Energy Research and Development Authority
OPA	Ontario Power Authority
PCF	Peak coincidence factor
PF	Penalty factor
PNS	Province of Nova Scotia
PUC	Pennsylvania Public Utility Commission
RTU	Rooftop unit
SBES	Small Business Energy Solutions (program component)
SEER	Seasonal energy efficiency ratio
SEM	Strategic Energy Management (program component)
TEWH	Three-element water heater
TRM	Technical Reference Manual
UMP	Uniform Methods Project
VFD	Variable frequency drive

TABLE OF CONTENTS

INTRODUCTION	1
1 MEASURE ASSESSMENT SCOPE	4
2 RESIDENTIAL MEASURE GROSS SAVINGS PARAMETERS	7
2.1 Lighting	7
2.1.1 Interactive Effects	7
2.1.2 Peak Demand Savings Factors	11
2.1.3 Lighting Measures	11
(1) LED Lamps	11
(2) LED Fixtures	17
(3) Dimmer Switches	20
(4) Motion Sensors	21
(5) LED Nightlights	24
2.2 Water Heating	25
2.2.1 Interactive Effects	25
2.2.2 Peak Demand Savings Factors	29
2.2.3 Water Heating Measures	29
(1) Drain Water Heat Recovery	29
(2) Solar Domestic Hot Water	31
(3) Heat Pump Water Heater	32
(4) Low-flow Showerheads	36
(5) Faucet Aerators	39
(6) Thermostatic Shower Valve	43
(7) Pipe Insulation	45
(8) Hot Water Tank Wrap	47
2.3 Space Heating	50
2.3.1 Interactive Effects	50
2.3.2 Peak Demand Savings Factors	51
2.3.3 Space Heating Measures	52
(1) Mini-split Heat Pumps	52
(2) Central Air-source Heat Pumps	54
(3) Ground-source Heat Pumps	56
(4) Wood and Pellet Stoves/Fireplace Inserts	60
(5) Wood and Pellet Boilers and Furnaces	64
(6) Solar Air Heating	67
(7) Air Sealing Kits	69
(8) Programmable Thermostats	71
(9) Smart Thermostats for Electric Baseboard	73
2.4 Appliances	75



2.4.1	Interactive Effects	75
2.4.2	Peak Demand Savings Factors	77
2.4.3	Appliance Measures.....	78
(1)	Clotheslines and Outdoor Drying Racks	78
(2)	Refrigerator Retirements/Replacements	80
(3)	Freezer Retirements/Replacements	83
(4)	Room Air Conditioner Retirements.....	86
(5)	Dehumidifier Replacements or Retirements/ENERGY STAR Certified Dehumidifiers 87	
(6)	Clothes Dryer Replacements/ENERGY STAR Certified Clothes Dryers.....	89
(7)	Efficient Clothes Washers	92
(8)	ENERGY STAR Certified Room Air Purifiers.....	96
2.5	Plug Load Controls.....	98
2.5.1	Interactive Effects	98
2.5.2	Peak Demand Savings Factors	99
2.5.3	Plug Load Control Measures.....	99
(1)	Smart Power Controllers for Audiovisual Equipment	99
(2)	Power Bars with Integrated Timer	101
(3)	Heavy-duty Outdoor Timers	103
(4)	ENERGY STAR Certified Pool Pumps	104
2.6	Demand Reduction	105
2.6.1	Interactive Effects	105
2.6.2	Peak Demand Savings Factors	106
2.6.3	Demand Reduction Measures.....	106
(1)	Three-element Water Heaters.....	106
(2)	Domestic Water Heater Timer	107
(3)	Electric Thermal Storage.....	108
(4)	Domestic Water Heater Load Control.....	109
3	BNI MEASURE GROSS SAVINGS PARAMETERS.....	111
3.1	Lighting	111
3.1.1	Interactive Effects	111
3.1.2	Peak Demand Savings Factors.....	112
3.1.3	Lighting Measures.....	112
(1)	LED Lamps	112
(2)	Linear LED Fixtures	116
(3)	Linear LED Lamps	118
(4)	Outdoor LED Fixtures	120
(5)	Directional and Architectural LED Fixtures	122
(6)	Occupancy/Motion Sensors	123
(7)	LED Nightlights	125
3.2	Pumps	127



3.2.1	Interactive Effects	127
3.2.2	Peak Demand Savings Factors	127
3.2.3	Pump Measures	127
(1)	Circulator Pumps	127
(2)	Booster Pumps	129
3.3	Space Heating	132
3.3.1	Interactive Effects	132
3.3.2	Peak Demand Savings Factors	132
3.3.3	Space Heating Measures	132
(1)	Electric Thermal Storage	132
(2)	Advanced Rooftop Unit Controls	133
3.4	Water Heating	137
3.4.1	Interactive Effects	137
3.4.2	Peak Demand Savings Factors	138
3.4.3	Water Heating Measures	140
(1)	Low-flow Showerheads	140
(2)	Faucet Aerators	142
(3)	Thermostatic Shower Valve	144
(4)	Pipe Insulation	146
(5)	Hot Water Tank Wrap	147
4	EFFECTIVE USEFUL LIFE	151
4.1	LED Lamps and Fixtures	151
4.2	Other Measures	155
APPENDIX I VERIFICATION OF CLIMATE VALIDITY FOR INTERACTIVE EFFECTS CALCULATIONS		167
APPENDIX II DETAILED CALCULATIONS OF 2021 EQUIVALENT EUL VALUES FOR LED LAMPS AND FIXTURES		169

LIST OF TABLES

Table 1: Measure Assessment Change Log.....	xi
Table 2: Key Definitions	xiii
Table 3: Included Measures.....	4
Table 4: Interactive Effects Factors for Residential Lighting Products Installed Indoors	7
Table 5: Proportion of Lighting Products Used Indoors	9
Table 6: Overall Interactive Effects Factors for Residential Lighting Measures	10
Table 7: Peak Demand-to-energy Ratios for Residential Lighting Measures	11
Table 8: LED Lamp Measure Summary	12
Table 9: Electrical Unitary Savings Values for LED Lamps	13
Table 10: Electrical Unitary Savings Values for LED Lamps	16
Table 11: EPI LED Lamp Installation Rate	17
Table 12: LED Fixture Measure Summary	18
Table 13: Electrical Unitary Savings Values for LED Fixtures	19
Table 14: Dimmer Switch Measure Summary	20
Table 15: Electrical Unitary Savings Values for Dimmer Switches	21
Table 16: Motion Sensor Measure Summary	21
Table 17: Electrical Unitary Savings Values for Indoor Motion Sensors	22
Table 18: Unitary Savings Values for Indoor Motion Sensors with Dimmer Switch.....	23
Table 19: Unitary Savings Values for Outdoor Motion Sensors	24
Table 20: LED Nightlight Measure Summary	24
Table 21: Electrical Unitary Savings Values for LED Nightlights.....	25
Table 22: EPI LED Nightlight Installation Rate	25
Table 23: Interactive Effects Factors for Pipe Insulation and Hot Water Tank Wraps	27
Table 24: Interactive Effects Factors for Water Heating Measures.....	28
Table 25: Peak Demand-to-energy Ratios for Water Heating Measures	29
Table 26: Drain Water Heat Recovery Measure Summary.....	30
Table 27: Electrical Unitary Energy Savings Values for Drain Water Heat Recovery Systems	31
Table 28: Solar Domestic Hot Water Measure Summary	32
Table 29: Heat Pump Water Heater Measure Summary	33
Table 30: Electrical Unitary Savings Values for Heat Pump Water Heaters.....	35
Table 31: Low-flow Showerhead Measure Summary	36
Table 32: Electrical Unitary Energy Savings Values for Low-flow Showerheads	38
Table 33: EPI Low-flow Showerhead Installation Rate	39
Table 34: Faucet Aerator Measure Summary.....	40
Table 35: Electrical Unitary Savings Values for Faucet Aerators.....	41
Table 36: EPI Faucet Aerator Installation Rate	42
Table 37: Thermostatic Shower Valve Measure Summary.....	43
Table 38: Electrical Unitary Energy Savings Values for Thermostatic Shower Valves.....	44
Table 39: Thermostatic Shower Valve Installation Rate	45
Table 40: Pipe Insulation Measure Summary.....	46
Table 41: Unitary Savings Value for Pipe Insulation.....	46
Table 42: EPI Pipe Insulation Installation Rate.....	46
Table 43: Hot Water Tank Wrap Measure Summary.....	47
Table 44: Electrical Unitary Savings Values for Hot Water Tank Wraps	49
Table 45: EPI Hot Water Tank Wrap Installation Rate.....	50
Table 46: Interactive Effects Factors for Space Heating Measures	50
Table 47: Peak Demand-to-energy Ratios for Space Heating Measures.....	52
Table 48: Mini-split Heat Pump Measure Summary	53
Table 49: Unitary Peak Demand Savings Values for Mini-split Heat Pumps.....	54
Table 50: Central Air-source Heat Pump Measure Summary.....	55

Table 51: Unitary Peak Demand Savings Values for Central Air-source Heat Pumps	56
Table 52: Ground-source Heat Pump Measure Summary	57
Table 53: Electrical Unitary Savings Values for Ground-source Heat Pumps	58
Table 54: Wood and Pellet Stove and Fireplace Insert Measure Summary	60
Table 55: Electrical Unitary Energy Savings Values for Wood and Pellet Stoves	62
Table 56: Unitary Peak Demand Savings Values for Wood and Pellet Stoves and Fireplace Inserts	63
Table 57: Wood and Pellet Boiler and Furnace Measure Summary	64
Table 58: Electrical Unitary Energy Savings Values for Wood and Pellet Boilers and Furnaces....	66
Table 59: Unitary Peak Demand Savings Values for Wood and Pellet Boilers and Furnaces.....	67
Table 60: Solar Air Heating Measure Summary	68
Table 61: Air Sealing Kit Measure Summary	69
Table 62: Savings Values for Air Sealing Kits in Electric Resistance and Heat Pump Heated Homes	70
Table 63: Electrical Unitary Savings Values for Air Sealing Kits in Electric Resistance and Heat Pump Heated Homes	71
Table 64: EPI Air Sealing Kit Installation Rate.....	71
Table 65: Programmable Thermostat Measure Summary	72
Table 66: Electrical Unitary Savings Calculations for Programmable Thermostats.....	73
Table 67: Smart Thermostat for Electric Baseboard Measure Summary	74
Table 68: Billing Analysis Savings Results for Smart Thermostats on Electrical Heating Systems	75
Table 69: Electrical Unitary Savings Calculation for Smart Thermostats for Electric Baseboard...	75
Table 70: Interactive Effects Factors for Appliances.....	77
Table 71: Peak Demand-to-energy Ratios for Appliances	77
Table 72: Clothesline and Outdoor Drying Rack Measure Summary.....	78
Table 73: Electrical Unitary Savings Values for Clotheslines and Outdoor Drying Racks	79
Table 74: Clothesline and Outdoor Drying Rack Installation Rate	79
Table 75: Refrigerator Retirement/Replacement Measure Summary	80
Table 76: Electrical Unitary Savings Values for Refrigerator Retirements/Replacements.....	82
Table 77: Freezer Retirement/Replacement Measure Summary	83
Table 78: Electrical Unitary Savings Values for Freezer Retirements/Replacements	85
Table 79: Room Air Conditioner Retirement Measure Summary	86
Table 80: Electrical Unitary Savings Values for Room Air Conditioner Retirement	87
Table 81: Dehumidifier Replacement or Retirement / ENERGY STAR Certified Dehumidifier Measure Summary.....	88
Table 82: Electrical Unitary Savings Values for Dehumidifier Replacements or Retirements/ ENERGY STAR Certified Dehumidifiers	89
Table 83: Clothes Dryer Replacement Measure Summary.....	90
Table 84: Electrical Unitary Savings Values for Clothes Dryer Replacements.....	92
Table 85: Efficient Clothes Washer Measure Summary	93
Table 86: Clothes Washer Energy Consumption.....	94
Table 87: Energy Consumption Breakdown for Standard and Efficient Clothes Washers.....	94
Table 88: Water Heating Sources for Clothes Washers	95
Table 89: Electricity Consumption for Standard Clothes Washers.....	95
Table 90: Electricity Consumption for Efficient Clothes Washers	96
Table 91: Electrical Unitary Savings Value for Clothes Washer.....	96
Table 92: ENERGY STAR Certified Room Air Purifier Measure Summary.....	97
Table 93: Electrical Unitary Savings Values for ENERGY STAR Certified Room Air Purifiers	98
Table 94: Interactive Effects Factors for Plug Load Control Measures	98
Table 95: Peak Demand-to-energy Ratios for Plug Load Control Measures.....	99
Table 96: Smart Power Controllers for Audiovisual Equipment Measure Summary.....	100
Table 97: Electrical Unitary Savings Values for Smart Power Controller Audiovisual Equipment	101



Table 98: EPI Smart Power Controller for Audiovisual Equipment Installation Rate	101
Table 99: Power Bars with Integrated Timer Measure Summary.....	102
Table 100: Electrical Unitary Savings Value for Power Bars with Integrated Timers.....	103
Table 101: Heavy-duty Outdoor Timer Measure Summary	103
Table 102: Electrical Unitary Savings Values of Heavy-duty Outdoor Timers.....	104
Table 103: ENERGY STAR Certified Pool Pump Measure Summary	105
Table 104: Unitary Savings Values of ENERGY STAR Certified Pool Pumps	105
Table 105: Three-element Water Heater Measure Summary	106
Table 106: Domestic Water Heater Timer Measure Summary	107
Table 107: Electric Thermal Storage Measure Summary	108
Table 108: Domestic Water Heater Load Control Measure Summary	109
Table 109: Domestic Water Heater Load Control Measure Summary	110
Table 110: Interactive Effects for BNI Lighting Measures	111
Table 111: LED Lamp Measure Summary	113
Table 112: Electrical Unitary Savings Values for LED Lamps	114
Table 113: Electrical Unitary Peak Demand Savings Values for LED Lamps	115
Table 114: Linear LED Fixture Measure Summary.....	116
Table 115: Electrical Unitary Savings Values for Linear LED fixtures	117
Table 116: Linear LED Fixture Baseline Wattage.....	117
Table 117: Linear LED Lamp Measure Summary.....	118
Table 118: Electrical Unitary Savings Values for Linear LED Lamps.....	119
Table 119: Linear LED Lamp Baseline Wattage.....	119
Table 120: Outdoor LED Fixture Measure Summary.....	120
Table 121: Electrical Unitary Savings Values for Outdoor LED fixtures	121
Table 122: Wattages per Lumens Output for Outdoor Wall-mounted Area Luminaires	121
Table 123: Wattages per Lumens Output for Architectural Flood and Spot Luminaires	122
Table 124: Directional and Architectural LED Fixture Measure Summary	122
Table 125: Electrical Unitary Savings Values for Directional and Architectural LED Fixtures	123
Table 126: Directional and Architectural LED Fixture Baseline Wattage	123
Table 127: Occupancy/Motion Sensor Measure Summary.....	124
Table 128: Electrical Unitary Savings Values for Occupancy/Motion Sensors.....	125
Table 129: LED Nightlight Measure Summary	126
Table 130: Electrical Unitary Energy Savings Values for LED Nightlights	126
Table 131: Circulator Pump Measure Summary.....	128
Table 132: Electrical Unitary Savings Values for Circulator Pumps.....	128
Table 133: Unitary Peak Demand Savings Values for Circulator Pumps.....	129
Table 134: Booster Pump Measure Summary.....	130
Table 135: Electrical Unitary Savings Values for Booster Pumps.....	131
Table 136: Unitary Peak Demand Savings Values for Booster Pumps.....	131
Table 137: Electric Thermal Storage Measure Summary	132
Table 138: Advanced RTU Control Measure Summary.....	134
Table 139: Electrical Unitary Savings Values for Advanced RTU Controls.....	135
Table 140: Advanced RTU Control Normalized Electrical Cooling Savings per Capacity and Normalized Electrical Heating Savings per Capacity and COP	136
Table 141: Interactive Effects Factors for Pipe Insulation and Hot Water Tank Wraps	138
Table 142: Interactive Effects Factors for Water Heating Measures	138
Table 143: Peak Demand-to-energy Ratio for Water Heating Measures.....	139
Table 144: Water Heating Measure Peak Demand-to-energy Ratio Summary.....	139
Table 145: Low-flow Showerhead Measure Summary	140
Table 146: Electrical Unitary Energy Savings Values for Low-flow Showerheads	141
Table 147: Average Showerhead Usage.....	141
Table 148: EPI Low-flow Showerhead Installation Rate	142

Table 149: Faucet Aerator Measure Summary.....	142
Table 150: Electrical Unitary Savings Values for Faucet Aerators.....	143
Table 151: Average Hot Water Usage per Faucet.....	143
Table 152: SBES Faucet Aerator Installation Rate.....	144
Table 153: Thermostatic Shower Valve Measure Summary.....	144
Table 154: Electrical Unitary Energy Savings Values for Thermostatic Shower Valves.....	145
Table 155: Thermostatic Shower Valve Installation Rate	146
Table 156: Pipe Insulation Measure Summary.....	146
Table 157: Unitary Savings Value for Pipe Insulation.....	147
Table 158: SBES Pipe Insulation Installation Rate.....	147
Table 159: Hot Water Tank Wrap Measure Summary.....	147
Table 160: Electrical Unitary Savings Values for Hot Water Tank Wraps	149
Table 161: SBES Hot Water Tank Wrap Installation Rate	150
Table 162: EUL Values for Residential LED Lamps and Fixtures.....	151
Table 163: EUL Values for BNI LED Lamps and Fixtures	153
Table 164: EUL Values and Sources for Non-LED Lighting Residential Measures.....	156
Table 165: EUL Values and Sources for Non-LED Lighting BNI Measures	161
Table 166: Equipment Life Value per LED Lamp and Fixture Types	169
Table 167: LED Baseline Evolution.....	172
Table 168: Equivalent EUL Calculation Summary for LED A19 Lamps	174
Table 169: Equivalent EUL Calculation Summary for LED Reflector Lamps	175
Table 170: Equivalent EUL Calculation Summary for LED Decorative Lamps.....	176
Table 171: Equivalent EUL Calculation Summary for LED Non-A-type Lamps (R, BR, and Decorative Lamps).....	176
Table 172: Equivalent EUL Calculation Summary for LED Non-A-type Lamps (Excluding R, BR, and Decorative Lamps).....	177
Table 173: Equivalent Effective Useful Life Calculation Summary for LED Recessed Downlight Fixtures.....	177
Table 174: Equivalent Effective Useful Life Calculation Summary for LED Fixtures Without Motion Sensors	178
Table 175: Lifetime Energy Savings for LED Fixtures with Motion Sensors – Reduced Wattage	178
Table 176: Lifetime Energy Savings for LED Fixtures with Motion Sensors – Reduced Hours of Use	178
Table 177: Baseline Evolution During the Effective Useful Life of LED General-use and Decorative Lamps.....	179
Table 178: Baseline Evolution During the Effective Useful Life of LED Reflector Lamps	180
Table 179: Baseline Evolution During the Effective Useful Life of Downlight Fixtures	181
Table 180: Baseline Evolution During the Effective Useful Life of LED Reflector Lamps in Downlight Fixtures.....	181

LIST OF FIGURES

Figure 1: HDD per Day for Trois-Rivières and Halifax	167
Figure 2: CDD per Day for Trois-Rivières and Halifax	168

MEASURE ASSESSMENT CHANGE LOG

Table 1: Measure Assessment Change Log

Change Type	Section	Description	Date
Update	Abbreviation table	Update abbreviation table, including adding program component acronyms.	2022-01-25
Update	Introduction – Development and Review Process	Clarify the parameters to be updated each year, identify the updated specifically for 2021, and identify new measures that were added.	2021-09-23
Update	All sections with EPI measures	Update EPI measure installation rates and calculation parameters based on 2021 EPI on-site visit findings.	2022-01-25
Update	2.1.1 Interactive Effects	Update to the interactive effect factor associated with air conditioning. Update the percentage of indoor fixtures for EPI and Instant Savings.	2022-01-25
New measure	2.1.3(1) LED Lamps	Add LED black out bulbs.	2021-09-23
Update	2.1.3(1) LED Lamps 2.1.3(2) LED Fixtures	Update to the unitary savings and EUL of Instant Savings lighting measures based on information from the 2021 tracking sheet.	2022-01-25
New measure	2.2.3(1) Drain Water Heat Recovery	Add the savings and parameters for MHEEP.	2022-01-25
Update	2.2.3(3) Heat Pump Water Heater	Update the share of electrical water heaters in Nova Scotia by space heating type.	2021-09-23
Update	2.3.3(1) Mini-split Heat Pumps	Update to include MHEEP methodology for energy and peak demand savings calculations.	2022-01-25
Update	2.3.3(2) Central Air-source Heat Pumps	Update HEA peak demand savings methodology. Update Green Heat unitary peak demand savings based on information from the 2021 tracking sheet.	2022-01-25
Update	2.3.3(3) Ground-source Heat Pumps	Update HEA peak demand savings methodology.	2021-09-23
Update	2.3.3(8) Programmable Thermostats	Update to include MHEEP assumptions for energy and peak demand savings.	
Update	2.4.3(2) Refrigerators	Update unitary savings based on 2021 retired appliance characteristics.	2022-01-25
Update	2.4.3(3) Freezers	Update unitary savings based on 2021 retired appliance characteristics.	2022-01-25
Update	2.4.3(5) Dehumidifiers	Update to include dehumidifier retirements for ARet and corresponding assumptions.	2021-09-23
New measure	2.6.3(4) DHW Load Controls	New measure added in 2021.	2022-01-25
Update	3.1.3(6) Occupancy/Motion Sensors	Adjust measure name to include both occupancy and motion sensors.	2022-01-25

Change Type	Section	Description	Date
New measure	3.1 Lighting 3.1.3(1) LED Lamps 3.1.3(7) LED Nightlights 3.4 Water Heating	Add measures from SBES Commercial Direct Install pilot.	2022-01-25
Update	3.2.3(2) Booster Pumps	Update peak demand savings methodology.	2022-01-25
New measure	3.3.3(2) Advanced RTU Controls	New measure added in 2021.	2021-09-23
Update	4.1 LED Lamps and Fixtures	Update the EUL values of lighting measures impacted by upcoming regulation. Add LED blackout bulbs EUL value. Add commercial LED lamps and nightlight EUL values Update High-bay luminaire EUL value.	2022-01-25
Update	4.2 Other Measures	Add a decimal to HEA and MHEEP “space heating” measure since it based on a weighted average. Add residential advanced RTU controls and DHW load control EUL values. Update residential pipe insulation EUL value. Update HEA space heating EUL value. Update Custom New Construction EUL values. Add commercial water heating measure EUL values.	2022-01-25
Update	Appendix II	Update the EUL values of lighting measures and the rational for baseline change.	2022-01-25

KEY DEFINITIONS

Table 2 presents definitions for key terms used throughout the Measure Assessment (MA) document.

Table 2: Key Definitions

Baseline	To determine gross savings, a baseline (or base case) is established to provide detailed information about the reference (e.g. pre-existing or standard) measure or equipment chosen to be compared with the efficient measure or equipment. For the reference measure or equipment, the baseline may include such information as hours of operation, wattage, and base consumption.
Billing calibration	An activity that consists of adjusting the expected energy savings based on the relative difference between the results of energy simulations and the actual energy consumption of a building or system.
Displaced wattage	Displaced wattage is defined as the difference between the wattage values of the baseline equipment or product and the efficient equipment or product.
EnerGuide rating	An EnerGuide (official brand of Natural Resources Canada) rating is a standard measure of home energy performance. It is a measurement of the efficiency of a building only and does not take into account occupant behaviour. It shows how energy efficient a home is through modelled heat losses based on several factors including building envelope characteristics, heated volume, heating systems, and air leakage.
Effective useful life	The period a measure is expected to be in service and provide both energy and peak demand savings. This value combines the equipment life and measure persistence that includes factors such as business turnover or early retirement.
Equipment life	The number of years installed equipment will operate before it fails.
Equivalent effective useful life	The number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. This value takes into account variations in annual energy savings throughout the effective useful life due to increased baselines.
Evaluated savings	Gross and net energy or peak demand savings calculated by the Evaluator using the parameters (unitary savings values, installation rates, interactive effects, net-to-gross ratios, etc.) validated or measured during the evaluation process. Unless otherwise specified, evaluated savings are first-year savings.
Gross savings	Change in energy consumption and/or demand that results directly from program-related actions taken by participants under an efficiency program regardless of why they participated.
In-service rate	The proportion of incentivized products that are installed and operating. This rate is usually applied to programs through which rebates are offered in-store and products are likely to be stored for a certain period before being installed, such as LED lamps.
Installation rate	The proportion of incentivized products reported as installed that remain installed and operating at the time of evaluation. This rate is usually applied to direct install or mail-in rebate programs through which measures are expected to be installed immediately at the time of participation.

Interactive effects	Interactive effects occur when the implementation of energy efficiency products has an impact on the energy consumption of other elements such as heating and cooling.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for the effective useful life of a measure and any increase in the baseline efficiency level (which reduces attributable annual savings) over its lifetime.
Margin of error	The percentage of a random sampling error.
Peak coincidence factor	The percentage of measure demand savings that coincide in time with the annual peak demand of the entire electricity system.
Peak demand savings	The demand savings that coincide in time with the expected annual peak demand period of the entire electricity system.
Portfolio component	Subdivision of the programs funded by the Federal Government via the Province of Nova Scotia.
Program component	Subdivision of EOne demand-side management programs.
Random sampling error	The error in measurement due to the fact that measurements are taken from a subset of the population and not the entire population.
Sample size	The number of observations or replicates included in a statistical sample.
Unitary savings	Energy or peak demand savings established on a unitary basis. This unit can either be a product (e.g. an 8 W LED lamp), a capacity (e.g. one-tonne capacity of an air-source heat pump), or a participant (e.g. one participant taking part in a behaviour-based program).

INTRODUCTION

The 2020-2022 DSM Measure Assessment (MA) presents an in-depth review of all parameters necessary to calculate the annual and lifetime gross energy and peak demand savings of most prescriptive measures and some semi-prescriptive measures offered through EOne's DSM program portfolio.

Purpose

The objective of this document is to:

- › Ensure consistency in gross savings values throughout the three-year DSM cycle and thus improve EOne's ability to define and track targets for energy and peak demand savings.
- › Consolidate EOne's gross savings values into a single reference document, which could easily be referred to by program staff and useful to populate EOne's internal e-TRM.

Use and Application

For the evaluations conducted during the 2020-2022 DSM cycle, the Evaluator will refer to the values presented in the 2020-2022 DSM MA.

The MA includes the following elements:

- › Interactive effects
- › Peak demand-to-energy ratios and peak coincidence factors
- › Installation and in-service rates
- › Unitary savings

In addition to the elements listed above, the MA includes effective useful life measures for all measures offered in EOne's program portfolio.

Development and Review Process

The savings are established using one or more of the following approaches: literature reviews of technical reference manuals; metering studies and evaluation reports; engineering calculations; adjustments based on data collected through participant surveys or site visits; and secondary research about household/facility characteristics such as types of heating and cooling systems.

Most parameters used to calculate savings are based on data from the 2020 evaluation. For example, in the case of low-flow showerheads, parameters such as the number of people per household or the average flow rate of existing showerheads are drawn from the 2020 tracking sheets. Due to the COVID-19 pandemic, 2020 was unlikely a typical year for homes and businesses. Despite this, the savings established in the 2020 DSM MA are representative of a typical year.

The parameters based on data from the 2020 evaluation will be valid throughout the DSM cycle, except for the following parameters that will be updated annually in the Measure Assessment:

- › LED lamps and fixtures for Instant Savings
 - Baseline and efficient wattage
- › Central air-source heat pumps¹
 - Rated heating capacity of the new heat pump at outdoor air temperature of -15°C
 - Coefficient of performance of the new heat pump at -15°C
- › Freezer and refrigerator retirements and replacements²
 - Proportion of units per manufacture-year class
 - Average unit size
- › Solar air heating
 - Average energy savings

The parameters listed above have been updated as part of this edition.

Other parameters may also be updated in 2021 or 2022 based on either applicable comprehensive evaluation results or changes to program offerings or delivery. In the 2021 evaluation edition, the installation rates for EPI have been updated based on 2021 evaluation results.

If new measures are introduced to the portfolio, they will be reviewed as part of the subsequent evaluation, and the Evaluator will update the 2020-2022 MA accordingly. The Evaluator suggests that the MA be completely revised at the beginning of the next DSM cycle. In 2021, LED blackout bulbs were added in the residential LED lamp measure and advanced rooftop unit (RTU) controls were added as a BNI HVAC measure.

Savings Calculations Equations

The savings calculations are based on the following equations:

Electrical Energy Savings

The following equation is used to calculate electrical energy savings.

$$\begin{aligned}
 & \text{Electrical Energy Savings (kWh)} \\
 &= \text{Unitary Energy Savings (kWh)} \\
 &\times (1 + \text{Interactive Effects Factor for Energy Savings (\%)}) \\
 &\times \text{Installation Rate or In-service Rate (\%)}
 \end{aligned}$$

¹ The number of units rebated in 2020 was too low to establish a value for 2021 and 2022.

² The average efficiency level and size of retired equipment are likely to evolve as more recent appliances are replaced.

Peak Demand Savings

Peak demand savings correspond to the demand savings that coincide in time with the peak demand of the electricity system. The projected electricity peak demand period in Nova Scotia is between 5 p.m. and 7 p.m. from December to February on non-holiday weekdays. For the Klondike substation, where a demand reduction pilot program is offered, the peak demand period is between 7 a.m. and 10 a.m. during winter and cold weather periods. The morning peak demand savings for the Klondike substation are considered equal to the evening peak demand savings of the electricity system. This assumption is reasonable since both peak periods are driven by similar human activities and weather, and thus are likely to have similar peak demand savings.

The following equation is used to calculate peak demand savings.

$$\begin{aligned}
 & \text{Peak Demand Savings (W)} \\
 &= \text{Unitary Peak Demand Savings (W)} \\
 &\times (1 + \text{Interactive Effects Factor for Peak Demand Savings (\%)}) \\
 &\times \text{Installation Rate or In-service Rate (\%)}
 \end{aligned}$$

Lifetime Energy Savings

Lifetime energy savings correspond to the savings that occur over the lifetime of the measures installed. The following equation is used to calculate lifetime energy savings.

$$\begin{aligned}
 & \text{Lifetime Energy Savings (kWh)} \\
 &= \text{Electrical Energy Savings (kWh)} \times \text{Effective Useful Life (years)}
 \end{aligned}$$

1 MEASURE ASSESSMENT SCOPE

Table 3 below lists the measures and associated programs included in the 2020-2022 DSM MA. The MA includes all necessary parameters and calculations to obtain gross energy and peak demand savings for most portfolio prescriptive measures. BER Instant Rebates semi-prescriptive measures are also included. In addition, effective useful life values are included for all prescriptive, semi-prescriptive, and custom measures.

For reference, savings calculations for prescriptive measures use fixed assumptions for all participants. The savings are identical for all units installed and represent the average savings for all units. On the contrary, savings calculations for custom measures use inputs that are specific to each unit installed and thus represent the actual savings for each unit. Semi-prescriptive measures use a mix of two previous approaches by using unit-specific inputs as well as certain non-specific inputs to determine savings.

Table 3: Included Measures

	Program Components
Residential	
Lighting	
LED Lamps	EPI
	Instant Savings
LED Fixtures	Instant Savings
Dimmer Switches	Instant Savings
Motion Sensors	Instant Savings
LED Nightlights	EPI
Water Heating	
Drain Water Heat Recovery	HEA
	MHEEP
Solar Domestic Hot Water	HEA
	Green Heat
Heat Pump Water Heater	HEA*
	MHEEP
	Instant Savings
Low-flow Showerhead	EPI
	Instant Savings
Faucet Aerator	EPI
Thermostatic Shower Valve	EPI
Pipe Insulation	EPI
Hot Water Tank Wrap	EPI

	Program Components
Space Heating	
Mini-split Heat Pump	Green Heat
	HEA
	MHEEP
Central-air Source Heat Pump	Green Heat
	HEA
Ground-source Heat Pump	Green Heat
	HEA
Wood Stove/Fireplace Insert	HEA
	Green Heat
Pellet Stove/Fireplace Insert*	HEA
	Green Heat
Wood Furnace/Boiler	HEA
	Green Heat
Pellet Furnace/Boiler	HEA
	Green Heat
Solar Air Heating	Green Heat
Air Sealing Kit	EPI
Programmable Thermostat	Instant Savings
	MHEEP
Smart Thermostat for Electric Baseboard	Instant Savings
Appliances	
Clotheslines and Outdoor Drying Racks	EPI
	Instant Savings
Refrigerator Retirement or Replacement	ARet ³
Freezer Retirement or Replacement	ARet ⁴
Room Air Conditioner Retirement	ARet
Dehumidifier Replacement or Retirement/ENERGY STAR® Certified Dehumidifier	ARet
	Instant Savings
Clothes Dryer Replacement/ENERGY STAR Certified Clothes Dryer	ARet ⁵
	Instant Savings
Efficient Clothes Washers	Instant Savings
ENERGY STAR® Certified Room Air Purifiers	Instant Savings

³ Appliance replacement measures are attributed to ARet, but serve customers referred from HW and MHEEP.

⁴ Ibid.

⁵ Ibid.

	Program Components
Plug Load Controls	
Smart Power Controller for Audiovisual Equipment	EPI
	Instant Savings
Power Bar with Integrated Timer	Instant Savings
Heavy-duty Outdoor Timer	Instant Savings
ENERGY STAR® Certified Pool Pump	Instant Savings
Demand Reduction	
Three-element Water Heater	HEA
	Green Heat
Domestic Water Heater Timer	HEA
	Green Heat
Electric Thermal Storage	HEA
	Green Heat
Domestic Water Heater Load Control	EPI
BNI	
Lighting	
LED Lamps	SBES
LED Linear Fixtures	BER Instant Rebates
LED Linear Lamps	BER Instant Rebates
LED Outdoor Fixtures	BER Instant Rebates
LED Directional and Architectural Fixtures	BER Instant Rebates
Occupancy Sensors	BER Instant Rebates
LED Nightlights	SBES
Pumps	
Circulator Pump	BER Instant Rebates
Booster Pump	BER Instant Rebates, BER Mail-in
Space Heating	
Electric Thermal Storage	BER Mail-in
	SBES
Advanced Rooftop Unit Controls	BER Mail-in
Water Heating	
Low-flow Showerheads	SBES
Faucet Aerators	SBES
Thermostatic Shower Valves	SBES
Pipe Insulation	SBES
Hot Water Tank Wraps	SBES

2 RESIDENTIAL MEASURE GROSS SAVINGS PARAMETERS

The following sections outline all necessary parameters to calculate gross energy savings for prescriptive residential measures.

2.1 Lighting

2.1.1 Interactive Effects

In a home, the implementation of energy efficient lighting products interacts with the energy consumption of other elements such as heating and cooling.

The interactive effects factors for residential lighting products listed in Table 4 below are based on a study conducted by ADS Groupe-Conseil Inc. in 1992 for Hydro-Québec. As presented in Appendix I, the climate data of Nova Scotia and Quebec for the duration of the heating and cooling seasons were analyzed as part of the 2015 evaluation and found to be comparable and thus the study results are applicable for EfficiencyOne (EOne) lighting measures.

Table 4 presents the interactive effects factors for five different types of home based on the presence of electrical space heating and air conditioning. For measures offered through Instant Savings where no participant-specific data on heating and cooling systems are available, the interactive effects are based on the weighted average calculated in Table 4.

Table 4: Interactive Effects Factors for Residential Lighting Products Installed Indoors

Type of Home	% of Homes ⁶	Energy Interactive Effects Factor ⁷	Peak Demand Interactive Effects Factor ⁸
Heat Pump Heating and Air Conditioning	14%	$-58\% / 2.2 + 6.4\% = -20.0\%$	-90.0%
Electrical Heating with Air Conditioning	12%	$-58\% + 3.1\% = -54.9\%$	-90.0%
Electrical Heating Without Air Conditioning	20%	-58.0%	-90.0%
No Electrical Heating with Air Conditioning	30%	3.1%	0%
With Neither Electrical Heating nor Air Conditioning	24%	0%	0%
Weighted Average	100%	-20.1%	-41.4%

Type of Home

The detailed rationale for interactive effects for heating and cooling follows.

⁶ Based on 2018-2019 EPI participants.

⁷ ADS ASSOCIÉS, *Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale*, report presented to Hydro-Québec, 1992.

⁸ Based on the ADS report, it is assumed that 10% of the heat is released through exterior walls and ceilings and does not contribute to interactive effects.

Interactive Effects on Electrical Heating

The Hydro-Québec study found that efficient lighting installed in electrically heated single-family homes without air conditioning results in an interactive effects factor for heating of -58%.

Interactive Effects on Heat Pump Heating

Since the interactive effects factors for electrical heating are based on a heating system efficiency of 100%, some adjustments are necessary for homes that use a heat pump as a primary heating system since the efficiency of this system is superior to 100%. Based on 2018 and 2019 EPI participants, mini-split heat pumps were found to be the most common (77%) type of heat pump in use.

The interactive effects factor for heating (-58.0%) is divided by 2.2, the COP of a standard mini-split heat pump based on a HSPF Region V of 7.4. The HSPF of a standard mini-split heat pump is assumed to correspond to the minimum requirement for CEE Tier 0 split air-source heat pumps, which also corresponds to the average HSPF value cited by NRCAN for air-source heat pumps.⁹ This yields an interactive effects factor of -26.4% for heating.

Interactive Effects on Air Conditioning

The Hydro-Québec study found that efficient lighting installed in homes with air-conditioning units results in an interactive effects factor for cooling of 3.6%. By analyzing the Hydro-Québec study, the Evaluator deduced that the 3.6% was obtained using the following formula.

$$IE_{cooling} = \frac{22\%}{COP} \times \% \text{ Conditioned Home Area}$$

The value of 22% corresponds to the proportion of the energy savings that occurs during the cooling period and affects the cooling load. It was not possible to extract the exact values used by Hydro-Québec for the COP and the percentage of conditioned home area, but the Evaluator found that a COP for cooling of 2.5 (corresponding to an EER of 8.5) and a percentage of conditioned home area of 40% would be reasonable values. Since the efficiency level of air-conditioning units has increased since the Hydro-Québec study, the Evaluator made an adjustment to increase the COP of 2.5 (EER of 8.5) to a COP of 2.9 (EER of 10), which results in an interactive effects factor for air conditioning of 3.1%.

Interactive Effects on Heat Pump Cooling

As for cases where cooling is provided by a heat pump, the Evaluator adjusted the cooling interactive effects by dividing the 22% value by the efficiency ratio of mini-split heat pumps and AC units (COP 3.5/2.5). The cooling factor is also multiplied by the ratio of conditioned home area (100%/40%) to account for whole-home conditioning, which is typical of heat pumps. This yields an interactive effects factor of 6.4% for cooling.

⁹ NRCAN, *Air-source Heat Pumps*, <https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about-energy-star-canada/energy-star-announcements/publications/heating-cooling-heat-pump/air-source-heat-pumps/6831> (Last accessed September 24, 2020).

Peak Demand

The Hydro-Québec report assumes that 10% of the heat is released through exterior walls and ceilings and does not contribute to interactive effects. Since the peak demand period occurs during the heating period when lighting and heating systems are assumed to be on, the interactive effects factor for peak demand savings in electrically heated homes is -90%. This factor also applies to homes with heat pumps based on the assumption that heat pumps have a 100% efficiency when operating in very cold conditions, which is typical during peak period conditions.

Indoor Usage

Lighting products cause interactive effects only if installed indoors. To account for this and obtain an overall interactive effects factor for all lighting products, the percentage of products installed indoors, listed in Table 5, is multiplied by the corresponding interactive effects factor.

Table 5: Proportion of Lighting Products Used Indoors

Type of Product	Program Component	% Indoor	Source
A-type LED Lamps ¹⁰	EPI	97%	2021 EPI Tracking Sheet
Reflector and Decorative LED Lamps ¹¹ (Except PAR38)		100%	2021 EPI Evaluation (on-site visits)
PAR38 LED Lamps		0%	
LED Nightlights		100%	Assumption
Reflector and Decorative LED Lamps ¹²	Instant Savings	92%	2016 Nova Scotia Socket Study ¹³
ENERGY STAR Certified LED Recessed Downlight Fixtures		100%	Assumption
ENERGY STAR Certified LED Fixtures		91%	2021 Instant Savings tracking sheet (10 most popular products)
ENERGY STAR Certified LED Fixtures with Motion Sensors		2%	2021 Instant Savings tracking sheet (10 most popular products)
Motion Sensors		100%	Assumption
Dimmer Switches		100%	

Summary

Combining the values presented in Table 4 and Table 5, Table 6 summarizes the interactive effects factor established for each lighting measure.

¹⁰ Including 9 W, 9.5 W, 10 W, 18 W, and 7 W black-out bulb LED lamps installed through EPI.

¹¹ Including PAR20, PAR30, GU10, G25, and chandelier E12 LED lamps installed through EPI.

¹² Including ENERGY STAR certified non-A-type lamps rebated through Instant Savings.

¹³ Corporate Research Associates Inc., *2016 Socket Study*, Final Report prepared for Efficiency Nova Scotia, December 2016.

Table 6: Overall Interactive Effects Factors for Residential Lighting Measures

Measure	Type of Home	Interactive Effects Factors	
		Energy Savings	Peak Demand Savings
LED A-type Lamps ¹⁴	Heat Pump Heating and Air Conditioning	-20.0% x 97% = -19.4%	-90% x 97% = -87.3%
	Electrical Heating with Air Conditioning	-54.9% x 97% = -53.3%	90% x 97% = -87.3%
	Electrical Heating Without Air Conditioning	-58% x 97% = -56.3%	90% x 97% = -87.3%
	No Electrical Heating with Air Conditioning	3.1% x 97% = 3.0%	0% x 97% = 0%
	With Neither Electrical Heating nor Air Conditioning	0% x 97% = 0%	0% x 97% = 0%
Reflector and Decorative LED Lamps and LED Nightlights ¹⁵ (Except PAR38)	Heat Pump Heating and Air Conditioning	-20.0% x 100% = -20.0%	-90% x 100% = -90%
	Electrical Heating with Air Conditioning	-54.9% x 100% = -54.9%	-90% x 100% = -90%
	Electrical Heating Without Air Conditioning	-58% x 100% = -58%	-90% x 100% = -90%
	No Electrical Heating with Air Conditioning	3.1% x 100% = 3.1%	0% x 100% = 0%
	With Neither Electrical Heating nor Air Conditioning	0% x 100% = 0%	0% x 100% = 0%
PAR38 LED Lamps	Outdoor	0% x 100% = 0%	0% x 100% = 0%
Reflector and Decorative LED Lamps and LED Nightlights ¹⁶	Weighted Average	-20.1% x 92% = -18.5%	-41.4% x 92% = -38.1%
ENERGY STAR Certified LED Recessed Downlight Fixtures	Weighted Average	-20.1% x 100% = -20.1%	-41.4% x 100% = -41.4%
ENERGY STAR Certified LED Fixtures	Weighted Average	-20.1% x 91% = -18.3%	-41.4% x 91% = -37.7%
ENERGY STAR Certified LED Fixtures with Motion Sensors	Weighted Average	-20.1% x 2% = -0.4%	-41.4% x 2% = -0.8%
Dimmer Switches	Weighted Average	-20.1% x 100% = -20.1%	-41.4% x 100% = -41.4%
Motion Sensors	Weighted Average	-20.1% x 100% = -20.1%	-41.4% x 100% = -41.4%

¹⁴ Including 9 W, 9.5 W, 10 W, 18 W, and 7 W black-out bulb LED lamps installed through EPI.

¹⁵ Including PAR20, PAR30, GU10, G25, chandelier E12 LED lamps, and LED nightlights installed through EPI.

¹⁶ Including ENERGY STAR certified Non-A-type lamps rebated through Instant Savings.

2.1.2 Peak Demand Savings Factors

For all indoor and outdoor LED lamps, nightlights, and fixtures, the peak demand-to-energy ratio is based on the Northeast Residential Lighting Hours-of-Use (NERHOU)¹⁷ study, which established a peak-demand-to-energy ratio of 0.162 W/kWh with a peak coincidence factor (PCF) of 16% and 2.7 hours of use per day. The former value is very close to the 0.161 W/kWh established by the EPI Residential Lighting Metering Study,¹⁸ which consisted of a metering study conducted in 2016 and 2017 among 75 households in Nova Scotia to assess the daily hours of operation. Since the margin of error in the NERHOU study was lower and included outdoor lamps in its sample, the Evaluator recommends using 0.162 W/kWh.

For dimmer switches and motion sensors, peak demand savings were calculated using the peak demand-to-energy ratios developed by Navigant in the 2016-2018 DSM Plan. These ratios were established for various product categories based on modelled system-coincident peak demand savings and energy savings for a projected deployment of products. Navigant used local data to establish the ratios applicable for 2016-2018. The Evaluator recommends using the same ratios during the 2020-2022 DSM cycle.

Table 7 summarizes the peak demand-to-energy ratios established for each lighting measure.

Table 7: Peak Demand-to-energy Ratios for Residential Lighting Measures

Measure	Peak Demand-to-energy Ratio (W/kWh)	Source
LED Lamps	0.162	Northeast Residential Lighting Hours-of-Use Study
LED Fixtures		
LED Nightlights		
Dimmer Switches		
Motion Sensors	0.000	RES-Lighting-Control-OccSensors, Navigant 2016-2018 DSM Plan

2.1.3 Lighting Measures

(1) LED Lamps

Summary

Table 8 presents a summary of the values used to calculate A-type, reflector, and decorative LED lamp savings. The detailed methodology follows.

¹⁷ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

¹⁸ Econoler, *Residential Lighting Metering Study*, December 14, 2017.

Table 8: LED Lamp Measure Summary

Parameter	EPI	Instant Savings		Reference
Measure Description and Identification				
Measure Description	LED Lamps to reduce electricity consumption.			N/A
Additional Notes	A-type, Reflector, and Decorative LED Lamps	ENERGY STAR Certified LED Non-A-type Lamps (R, BR, and Decorative)	ENERGY STAR Certified LED Non-A-type Lamps (excluding R, BR, and Decorative)	
General Parameters				
Installation Rate	94%	100%		See details below under Installation Rates
Effective Useful Life [years]	Varies depending on replaced and installed wattages as well as lamp type	4.2	5.0	See Subsection 4.1
Electrical Savings Parameters				
Unitary Energy Savings [kWh/year]	Vary depending on replaced and installed wattages. See Table 9 below	47.2	45.7	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.162			See Subsection 2.1.2
Unitary Peak Demand Savings [W]	Vary depending on replaced and installed wattages. See Table 10 below	7.65	7.40	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	Calculation based on home heating and air-conditioning systems for each installed unit	-20.1%	-20.1%	See Subsection 2.1.1
Interactive Effects Factor for Peak Demand Savings		-41.4%	-41.4%	

Electrical Unitary Energy Savings

The equation below determines the unitary savings values of LED lamps for each pairing of old and new wattages. Table 9 lists the parameters and corresponding values used in the equation and the resulting unitary savings values.

$$\text{Energy Savings} \left[\frac{kWh}{yr} \right] = \frac{(\text{Old Wattage} - \text{New Wattage})[W] \times HOU \left[\frac{h}{day} \right] \times 365 \left[\frac{day}{yr} \right]}{1,000 \left[\frac{W}{kW} \right]}$$

Table 9: Electrical Unitary Savings Values for LED Lamps

Type of LED	Old Wattage (W)	New Wattage (W)	Displaced Wattage (W)	Operating Hours (hrs/day)	Unitary Savings Value (kWh/year)
EPI					
9 W Replacing 25 W	25	9	16	2.7	15.8
9 W Replacing 29 W	29	9	20		19.7
9 W Replacing 40 W	40	9	31		30.6
9 W Replacing 43 W	43	9	34		33.5
9 W Replacing 60 W	60	9	51		50.3
9 W Replacing 72 W	72	9	63		62.1
9 W Replacing 100 W	100	9	91		89.7
9 W Replacing 150 W	150	9	141		139
9.5 W Replacing 25 W	25	9.5	15.5		15.3
9.5 W Replacing 29 W	29	9.5	19.5		19.2
9.5 W Replacing 40 W	40	9.5	30.5		30.1
9.5 W Replacing 43 W	43	9.5	33.5		33.0
9.5 W Replacing 60 W	60	9.5	50.5		49.8
9.5 W Replacing 72 W	72	9.5	62.5		61.6
9.5 W Replacing 100 W	100	9.5	90.5		89.2
9.5 W Replacing 150 W	150	9.5	140.5		138
18 W Replacing 75 W	75	18	57		56.2
18 W Replacing 100 W	100	18	82		80.8
7 W Black-out Bulbs Replacing 60 W	60	7	53		52.2
PAR20 7 W Replacing 50 W	50	7	43		42.4
PAR30 8 W Replacing 53 W	53	8	45		44.3
PAR30 8 W Replacing 75 W	75	8	67		66.0
PAR38 15 W Replacing 90 W	90	15	75		73.9
PAR38 15 W Replacing 120 W	120	15	105		103
PAR38 15 W Replacing 150 W	150	15	135		133
7 W GU10 Replacing 35 W	35	7	28		27.6
7 W GU10 Replacing 50 W	50	7	43		42.4
7 W G25 Replacing 40 W	40	7	33		32.5
5 W Chandelier E12 Replacing 40 W	40	5	35		34.5
Instant Savings					
ENERGY STAR Certified LED Non-A-type Lamps (R, BR, and Decorative)	49.7	5.1	44.6	2.9	47.2
ENERGY STAR Certified LED Non-A-type Lamps (excluding R, BR, and Decorative)	50.0	6.8	43.2	2.9	45.7

Displaced Wattage

For EPI, displaced wattage is defined as the difference between the real wattage value of the old lamp and that of the new LED lamp. Both these values are available in the EPI tracking sheet. Previous evaluations confirmed that installed LED lamps had a light output wattage equivalent to that of the replaced lamps for almost all replacements. In other cases, the savings calculations are still based on the difference in real wattage values.

For Instant Savings, the average displaced wattage values for the two product categories were established for two types of baselines, namely early replacement, and replace-on-burn-out baselines. For the early replacement scenario, the lamps being replaced are the baseline, while the replace-on-burn-out scenario uses the energy efficiency regulation requirements as the baseline. This methodology is recommended in the principles of the Uniform Methods Project (UMP)¹⁹ to better represent the real baseline wattages for LED lamps.

Importantly, for non-A-type lamps, the baseline for both scenarios is the same. Since R, BR, and decorative lamps are only available in incandescent and LED, it was assumed that all LED R, BR, and decorative LED lamps replaced incandescent lamps. Since other non-A-type lamps are only available in halogen and LED, it was assumed that all LED lamps replaced halogen lamps for this product category.

The equivalent incandescent and halogen wattage values were obtained by researching the recommended equivalencies for the 10 most popular products for each category of LED lamps.

Hours of Operation

The daily hours of operation value is based on the Northeast Residential Lighting Hours-of-use (NERHOU)²⁰ study, which found that the average runtime is 2.7 hours/day for all types of bulbs and 2.9 hours per day for efficient bulbs given the absence of a snapback effect.²¹

The Residential Lighting Evaluation Protocol of the Uniform Methods Project (UMP)²² recommends that each jurisdiction conduct a metering study to determine their specific hours of use (HOU). In 2016 and 2017, the Evaluator conducted a metering study among 75 households to assess the daily hours of operation. The overall average daily HOU was established at 2.48 hours/day with a margin of error of ± 0.24 hours/day. Since the NERHOU study was conducted on a much larger sample of 848 households and the data and findings therein fall within the Evaluator's metering study margin of error, the values from the NERHOU study are the most appropriate value for LED lamps installed in Nova Scotia.

¹⁹ National Renewable Energy Laboratory, *Uniform Methods Protocol Chapter 6: Residential Lighting Evaluation Protocol*, February 2014, pp. 6-20.

²⁰ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

²¹ The snapback effect is an increase in usage following the installation of an efficient product because the operating cost is lower.

²² NREL, *Uniform Methods Project Chapter 6: Residential Lighting Evaluation Protocol*, February 2014, pp. 6-20.

The NERHOU Study concludes that the HOU are 2.7 hours/day for all types of bulbs, while the HOU are 3.0 hours/day for efficient bulbs. In other words, a variation of 0.3 hours/day between both HOU values is observed. Three theories have been put forward to explain why efficient bulbs are used over a greater number of hours, as follows.

- › Differential socket selection: the assumption is that the most used sockets in a household are selected to install efficient bulbs;
- › Shifting usage: the assumption is that once an efficient bulb is installed, it is favoured over other sockets containing inefficient bulbs; and
- › Snapback effect: the assumption is that there is a tendency to use an efficient product more than a replaced inefficient product.

Since there is no indication that one theory overrides the others, each theory is assumed to represent an additional usage of 0.1 hours per day.

Two theories, differential socket selection and shifting usage, apply to bulbs purchased as part of Instant Savings since participants are likely to buy only a limited quantity of bulbs rather than changing every bulb in the house. As for the snapback effect, it is not taken into account in the HOU assessment since this usage would not have occurred if an incandescent or halogen (base case) had been installed in the absence of the program. To avoid overestimating savings by making calculations based on higher operating hours than those of the base case, the Evaluator included an additional usage of 0.2 hours in the daily HOU value determined in the NERHOU Study for all bulb types, thereby increasing the HOU from 2.7 hours to 2.9 hours per day.

For EPI, the HOU are 2.7 hours per day since none of the theories explains a higher HOU for efficient bulbs. Differential socket selection and shifting usage do not apply to EPI since all eligible bulbs are replaced in participants' homes. As in Instant Savings, the snapback effect is not considered to avoid overestimating savings by making calculations based on higher operating hours than those of the base case. The NERHOU study concluded that there was no difference in HOU between single-family homes and apartments. Thus, the HOU applied to obtain unitary savings for both dwelling types are identical.

Unitary Peak Demand Savings

Unitary peak demand savings are calculated by multiplying the unitary savings value by the peak demand-to-energy ratio.

Table 10: Electrical Unitary Savings Values for LED Lamps

Type of LED	Unitary Energy Savings Value (kWh/year)	Peak Demand-to-energy Ratio (W/kWh)	Unitary Peak Demand Savings Value (W/year)
EPI			
9 W Replacing 25 W	15.8	0.162	2.56
9 W Replacing 29 W	19.7		3.19
9 W Replacing 40 W	30.6		4.96
9 W Replacing 43 W	33.5		5.43
9 W Replacing 60 W	50.3		8.15
9 W Replacing 72 W	62.1		10.1
9 W Replacing 100 W	89.7		14.5
9 W Replacing 150 W	139		22.5
9.5 W Replacing 25 W	15.3		2.50
9.5 W Replacing 29 W	19.2		3.11
9.5 W Replacing 40 W	30.1		4.88
9.5 W Replacing 43 W	33.0		5.35
9.5 W Replacing 60 W	49.8		8.07
9.5 W Replacing 72 W	61.6		9.98
9.5 W Replacing 100 W	89.2		14.5
9.5 W Replacing 150 W	138.5		22.4
18 W Replacing 75 W	56.2		9.10
18 W Replacing 100 W	80.8		13.1
7 W Black-out Bulbs Replacing 60 W	52.2		8.46
PAR20 7 W Replacing 50 W	42.4		6.87
PAR30 8 W Replacing 53 W	44.3		7.18
PAR30 8 W Replacing 75 W	66.0		10.7
PAR38 15 W Replacing 90 W	73.9		12.0
PAR38 15 W Replacing 120 W	103		16.7
PAR38 15 W Replacing 150 W	133		21.5
7 W GU10 Replacing 35 W	27.6		4.47
7 W GU10 Replacing 50 W	42.4		6.87
7 W G25 Replacing 40 W	32.5		5.27
5 W Chandelier E12 Replacing 40 W	34.5		5.59
Instant Savings			
ENERGY STAR Certified LED Non-A-type Lamps (R, BR, and Decorative)	47.2	0.162	7.65
ENERGY STAR Certified LED Non-A-type Lamps (excluding R, BR, and Decorative)	45.7		7.40

Installation Rates

Table 11 lists the installation rate for EPI LED Lamps.

Table 11: EPI LED Lamp Installation Rate

Installation Rate	Margin of Error	Source
94%	2.1%	2021 EPI evaluation (on-site visits)

For upstream programs like Instant Savings, the UMP makes the following recommendation:

“In-service rates should be calculated through an in-home audit. Since program bulbs cannot be easily identified, the in-service rate can be calculated as the number of installed bulbs purchased in a recent 12-month period divided by the total number of bulbs purchased in the same 12-month period. If the sample size of homes with bulbs purchased in the recent 12-month period is insufficient to provide the necessary levels of confidence and precision, a long-term in-service rate can be used for all bulbs regardless of the time of purchase.”

The UMP provides examples from five recent studies that applied first-year in-service rates to LED upstream programs in the United States. These in-service rates varied between 84% and 99%, with four in-service rates being 95% or higher.

The UMP also mentions three main factors that cause in-service rates below 100%, notably: (1) deeply discounted prices; (2) program inclusion of LED multipacks; and (3) consumers waiting for bulbs to burn out before replacing them. Despite the rebate offered and the large majority (85%) of LED lamps purchased through Instant Savings in 2020 being in packs of two or more, the Evaluator considers it unlikely that most purchased LED lamps are left unused since more than 48% of participants interviewed during the fall online survey mentioned that they purchased lamps to replace functional lamps. The Evaluator also believes that it would not be accurate to use an in-service rate from a program that has a different context and design than Instant Savings.

First-year in-service rates measure the proportion of LED lamps installed within the first year after they are purchased although in-service rates do not capture LED lamps that are installed after that first year. Therefore, if an in-service rate were applied to LED lamp savings, some adjustment would need to be made to account for LED lamps installed after the first year, and the Evaluator believes that the savings deduction would be too low to be considered.

For the abovementioned reasons, in-service rates are not applied to LED lamps and all savings are claimed in the year during which LED lamps were purchased.

(2) LED Fixtures

Summary

Table 12 presents a summary of the values used to calculate the savings for motion sensors. The detailed methodology follows.

Table 12: LED Fixture Measure Summary

Parameter	Instant Savings			Reference
	ENERGY STAR Certified LED Recessed Downlight Fixtures	ENERGY STAR Certified LED Fixtures	ENERGY STAR Certified LED Fixtures with Motion Sensors	
Measure Description and Identification				
Measure Description	LED fixtures to reduce electricity consumption			N/A
Additional Notes	-	-	-	
General Parameters				
Installation Rate	100%			See details below under Installation Rates
Effective Useful Life [years]	4.6	7.4	8.1	See Subsection 4.1
Electrical Savings Parameters				
Unitary Energy Savings [kWh/year]	55.3	67.8	128	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio (W/kWh)	0.162			See Subsection 2.1.2
Unitary Peak Demand Savings [W]	8.96	11.0	20.8	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	-20.1%	-18.3%	-0.4%	See Subsection 2.1.1
Interactive Effects Factor for Peak Demand Savings	-41.4%	-37.7%	-0.8%	See Subsection 2.1.1

Electrical Unitary Energy Savings

The equation below determines the unitary savings values of LED fixtures. Table 13 lists the parameters and corresponding values used in the equation and the resulting unitary savings values.

$$\begin{aligned}
 & \text{Energy Savings} \left[\frac{kWh}{yr} \right] \\
 &= \frac{\left(\text{Wattage}_{\text{average equivalent}} [W] \times HOU_{\text{old}} \left[\frac{hrs}{day} \right] - \text{Wattage}_{\text{average}} [W] \times HOU_{\text{new}} \left[\frac{hrs}{day} \right] \right) \times 365 \left[\frac{day}{yr} \right]}{1,000 \left[\frac{W}{kW} \right]}
 \end{aligned}$$

Table 13: Electrical Unitary Savings Values for LED Fixtures

Type of LED Fixture	Average Wattage (W)	Average Equivalent Wattage (W)	Displaced Wattage (W)	Old Operating Hours (hrs/day)	New Operating Hours (hrs/day)	Unitary Savings Value (kWh/year)
ENERGY STAR Certified LED Recessed Downlight Fixtures	11.1	63.3	52.2	2.9	2.9	55.3
ENERGY STAR Certified LED Fixtures	22.4	86.5	64.1			67.8
ENERGY STAR Certified LED Fixtures with Motion Sensors	22.2	88.3	66.1	4.72	2.92	128

Displaced Wattage

To establish the displaced wattage of each category of lighting fixture offered under Instant Savings, the Evaluator identified the 10 best-selling models listed in the 2021 tracking sheet. Wattage value data as well as incandescent or halogen wattage equivalents for these models were then gathered from participating retailer websites (as recommended by manufacturers). These values were then converted into wattage values that meet the current Canadian energy efficiency regulation for general service lamps.

Hours of Operation

The value for the daily hours of operation is based on the Northeast Residential Lighting Hours-of-Use Study (NERHOU),²³ which established an average use of 2.9 hours per day for efficient bulbs given the absence of a snapback effect.²⁴

The UMP Residential Lighting Evaluation Protocol recommends that each jurisdiction conduct a metering study to determine specific hours of use (HOU). In 2016 and 2017, the Evaluator conducted a metering study among 75 households to assess daily hours of operation. The overall average daily HOU was established at 2.48 hours/day with a margin of error of ± 0.24 hours/day. Since the NERHOU Study was conducted on a much larger scale with 848 households and the study data and findings are closely aligned with the Evaluator's metering study margin of error, the Evaluator decided that the values established by the NERHOU Study are still the most appropriate for LED lamps installed through Instant Savings. Again for 2020, the Evaluator used the average hours of operation value for efficient lamps without a snapback value, which is 2.9 hours per day.

For 2021, the Evaluator found that 98% of LED fixtures equipped with a motion sensor are designed for outdoor usage. For LED fixtures installed outdoors, the old and new hours of operation used are 4.75 and 2.95 hours per day respectively. For LED fixtures installed indoors, the old and new hours of operation used are 2.7 and 1.24 hours per day respectively. When accounting for the weight of indoor and outdoor fixtures, the average old and new hours of operation were established at 4.72 and 2.72 respectively.

²³ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

²⁴ The snapback effect is an increase in usage following the installation of an efficient product because the operating cost is lower.

Installation Rates

The installation rate is assumed to be 100%.

(3) Dimmer Switches

Summary

Table 14 presents a summary of the values used to calculate dimmer switch savings. The detailed methodology follows.

Table 14: Dimmer Switch Measure Summary

Parameter	Instant Savings	Reference
Measure Description and Identification		
Measure Description	Dimmer switches to reduce electricity consumption	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	10	See Subsection 4.1
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	17.0	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.162	See Subsection 2.1.2
Unitary Peak Demand Savings [W]	2.75	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	-20.1%	See Subsection 2.1.1
Interactive Effects Factor for Peak Demand Savings	-41.4%	See Subsection 2.1.1

Electrical Unitary Energy Savings

The unitary savings value for dimmer switches is based on the general lighting equation adapted as follows to consider the effect of dimming on energy consumption.

$$Energy\ Savings\ \left[\frac{kWh}{yr}\right] = \frac{(Average\ Wattage)[W] \times \%Dimmed \times HOU\left[\frac{h}{day}\right] \times 365\left[\frac{day}{yr}\right]}{1,000\left[\frac{W}{kW}\right]}$$

The value for each parameter and resulting unitary savings value are summarized in Table 15.

Table 15: Electrical Unitary Savings Values for Dimmer Switches

Parameter	Value	Source
Average Wattage [W]	2 x 43 W = 86 W	As per Canadian regulation, the wattage of general-service lamps with a luminous flux in the range of 750 and 1,050 lumens must not exceed 43 W ²⁵
Dimmed Wattage [%]	20%	2011 OPA Prescriptive Measures and Assumptions List ²⁶
Daily Hours of Operation	2.7	NERHOU, 2011 ²⁷
Unitary Energy Savings [kWh/year]	17.0	Calculation

Installation Rates

The installation rate is assumed to be 100%.

(4) Motion Sensors

Summary

Table 16 presents a summary of the values used to calculate the savings for motion sensors. The detailed methodology follows.

Table 16: Motion Sensor Measure Summary

Parameter	Instant Savings			Reference
	Indoor Motion Sensor	Indoor Motion Sensor with Dimmer Switch	Outdoor Motion Sensor	
Measure Description and Identification				
Measure Description	Motion sensors to reduce electricity consumption			N/A
Additional Notes	-	-	-	
General Parameters				
Installation Rate	100%			See details below under Installation Rates
Effective Useful Life [years]	10			See Subsection 4.2
Electrical Savings Parameters				
Unitary Energy Savings [kWh/year]	45.8	53.6	159	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio (W/kWh)	0.000			See Subsection 2.1.2
Unitary Peak Demand Savings [W]	0.00	0.00	0.00	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	-20.1%		N/A	See Subsection 2.1.1
Interactive Effects Factor for Peak Demand Savings	-41.4%		N/A	See Subsection 2.1.1

²⁵ Government of Canada. (2019). *General Service Lamps and Modified Spectrum Incandescent Lamps*. <https://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869> (last accessed July 31, 2020).

²⁶ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

²⁷ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

Electrical Unitary Energy Savings

Different unitary savings values apply according to the location of the motion sensor and additional devices.

Indoor Motion Sensors

The unitary savings value for indoor motion sensors is based on the general lighting equation adapted as follows to consider the effect of motion sensing on energy consumption.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{(\text{Average Wattage})[\text{W}] \times \text{HOU} \left[\frac{\text{h}}{\text{day}} \right] \times \% \text{HOU Reduction} \times 365 \left[\frac{\text{day}}{\text{yr}} \right]}{1,000 \left[\frac{\text{W}}{\text{kW}} \right]}$$

The value for each parameter and resulting unitary savings value are summarized in Table 17.

Table 17: Electrical Unitary Savings Values for Indoor Motion Sensors

Parameter	Value	Source
Average Wattage [W]	2 x 43 W = 86 W	As per Canadian regulation, the wattage of general-service lamps with a luminous flux in the range of 750 and 1,050 lumens must not exceed 43 W ²⁸
Daily Hours of Operation	2.7	NERHOU, 2011 ²⁹
Daily Reduction of Hours of Operation	54%	2011 OPA Prescriptive Measures and Assumptions List ³⁰
Unitary Energy Savings [kWh/year]	45.8	Calculation

Indoor Motion Sensors with Dimmer Switch

The unitary savings value for indoor motion sensors is based on the general lighting equation adapted as follows to consider the effects of motion sensing and dimming on energy consumption. The annual energy savings corresponds to the difference between the base consumption and the reduced consumption occurring with the motion sensor and dimmer switch.

²⁸ Government of Canada. (2019). *General Service Lamps and Modified Spectrum Incandescent Lamps*. <https://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869> (last accessed July 31, 2020).

²⁹ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

³⁰ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \text{Base Consumption} - \text{Reduced Consumption}$$

$$\text{Base Consumption} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{(\text{Average Wattage})[W] \times \text{HOU} \left[\frac{\text{h}}{\text{day}} \right] \times 365 \left[\frac{\text{day}}{\text{yr}} \right]}{1,000 \left[\frac{W}{kW} \right]}$$

$$\begin{aligned} \text{Reduced Consumption} \left[\frac{\text{kWh}}{\text{yr}} \right] \\ = \frac{(\text{Average Wattage})[W] \times (1 - \% \text{Dimmed}) \times \text{HOU} \left[\frac{\text{h}}{\text{day}} \right] \times (1 - \% \text{HOU Reduction}) \times 365 \left[\frac{\text{day}}{\text{yr}} \right]}{1,000 \left[\frac{W}{kW} \right]} \end{aligned}$$

The value for each parameter and resulting unitary savings value are summarized in Table 18.

Table 18: Unitary Savings Values for Indoor Motion Sensors with Dimmer Switch

Parameter	Value	Source
Average Wattage [W]	2 x 43 W = 86 W	As per Canadian regulation, the wattage of general-service lamps with a luminous flux in the range of 750 and 1,050 lumens must not exceed 43 W. ³¹
Dimmed Wattage [%]	20%	2011 OPA Prescriptive Measures and Assumptions List ³²
Daily Hours of Operation	2.7	NERHOU, 2011 ³³
Daily Reduction of Hours of Operation	54%	2011 OPA Prescriptive Measures and Assumptions List ³⁴
Unitary Energy Savings [kWh/year]	53.6	Calculation

Outdoor Motion Sensors

The unitary savings value for outdoor motion sensors is based on the general lighting equation adapted as follows to consider the effect of motion sensing on energy consumption.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{(\text{Average Wattage})[W] \times (\text{Old HOU} - \text{New HOU}) \left[\frac{\text{h}}{\text{day}} \right] \times 365 \left[\frac{\text{day}}{\text{yr}} \right]}{1,000 \left[\frac{W}{kW} \right]}$$

The value for each parameter and resulting unitary savings value are summarized in Table 19.

³¹ Government of Canada. (2019). *General Service Lamps and Modified Spectrum Incandescent Lamps*. <https://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869> (last accessed July 31, 2020).

³² Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

³³ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

³⁴ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

Table 19: Unitary Savings Values for Outdoor Motion Sensors

Parameter	Value	Source
Average Wattage [W]	$(85\% \times 275.6 \text{ W}) + (15\% \times 55.5 \text{ W}) = 242.6 \text{ W}$	Assumption: 85% of outdoor lighting is for security spotlights with an average wattage of 275.6 W ³⁵ and the remaining 15% is for porch lighting, which has an average wattage of 55.5 W
Old Operating Time [hrs/day]	4.75	2011 OPA Prescriptive Measures and Assumptions List ³⁶
New Operating Time [hrs/day]	2.95	2011 OPA Prescriptive Measures and Assumptions List ³⁷
Unitary Energy Savings [kWh/year]	159	Calculation

Installation Rates

The installation rate is assumed to be 100%.

(5) LED Nightlights

Summary

Table 20 presents a summary of the values used to calculate savings for LED nightlights. The detailed methodology follows.

Table 20: LED Nightlight Measure Summary

Parameter	EPI	Reference
Measure Description and Identification		
Measure Description	LED nightlights to reduce electricity consumption	N/A
Additional Notes	-	
General Parameters		
Installation Rate	94%	See details below under Installation Rates
Effective Useful Life [years]	23	See Subsection 4.1
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	29.3	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.162	See Subsection 2.1.2
Unitary Peak Demand Savings [W]	4.75	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	Calculation based on home heating and air-conditioning systems for each installed unit	See Subsection 2.1.1
Interactive Effects Factor for Peak Demand Savings		

³⁵ Representative lamp mix: $(85\% \times 2 \times 150 \text{ W incandescent}) + (10\% \times 2 \times 90 \text{ W halogen}) + (5\% \times 2 \times 26 \text{ W CFL}) = 275.6 \text{ W}$.

³⁶ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

³⁷ Ibid.

Electrical Unitary Energy Savings

Table 21 lists the parameters and corresponding values used in the equation below for LED nightlights and the resulting unitary values. The values for displaced wattages and hours of operation are consistent with the values used by other jurisdictions such as the State of Pennsylvania.³⁸

$$\text{Energy Savings} \left[\frac{kWh}{yr} \right] = \frac{(\text{Old Wattage} - \text{New Wattage})[W] \times HOU \left[\frac{h}{day} \right] \times 365 \left[\frac{day}{yr} \right]}{1,000 \left[\frac{W}{kW} \right]}$$

Table 21: Electrical Unitary Savings Values for LED Nightlights

Parameter	Value	Source
Old Wattage [W]	7.0	Assumption based on the typical wattage value of an incandescent nightlight
New Wattage [W]	0.3	Wattage value of the LED nightlight installed through EPI (EOne)
Average Displaced Wattage [W]	6.7	Calculation
Hours of Operation [hrs/day]	12	Assumption based on the average length of night
Unitary Energy Savings [kWh/year]	29.3	Calculation

Installation Rates

Table 22 lists the installation rate for EPI LED nightlights.

Table 22: EPI LED Nightlight Installation Rate

Installation Rate	Margin of Error	Source
94%	2.1%	2021 EPI evaluation (on-site visits)

2.2 Water Heating

2.2.1 Interactive Effects

Hot Water Insulation Measures

For hot water insulation measures, namely pipe insulation and hot water tank wraps, the interactive effects factors are based on engineering calculations to account for the duration of the heating and cooling seasons, cooling and heating system efficiency, and the percentage of heat generated inside the heated portion of the building envelope.

³⁸ Pennsylvania Public Utility Commission, Technical Reference Manual – State of Pennsylvania, August 2019, p. 7.

This section contains the detailed methodology for calculating interactive effects as well as the rationale for interactive effects for single-family homes and apartments. The distinction between interactive effects for these two types of dwellings comes from the assumption that domestic hot water (DHW) insulation measures are more likely to be installed in conditioned spaces in apartments than in single-family homes.

Single-family Homes

Based on site visit results from the 2015 evaluation³⁹ and accounting for the proportion of DHW insulation measures installed in conditioned spaces, the average number of months during which heating interactive effects occur in a single-family home is 3.8 months. It is assumed that the impact of DHW on cooling loads is negligible since most measures were installed in basements or garages, which might be heated but are rarely air-conditioned. Similarly to lighting measures, it is assumed that 10% of the heat released by the pipes and DHW is lost through exterior walls and ceilings and does not contribute to the interactive effects.

For single-family homes with heat pump heating, since the interactive effects factors are based on a heating system efficiency of 100%, some adjustments are necessary for homes that use a heat pump as a primary heating system because the efficiency of such systems is superior to 100%. To do so, the interactive effects factor for heating (-28.5%) is divided by 2.2, the COP of a standard mini-split heat pump based on a heating seasonal performance factor (HSPF) Region V of 7.4, which is the value for a standard split heat pump as defined by the Federal Energy Efficiency Regulations.⁴⁰

Apartments

Based on the assumption that DHW insulation measures are installed in conditioned spaces, a heating period of eight months was used as the average number of months during which heating interactive effects occur in an apartment. Similarly, cooling interactive effects occur for the duration of the cooling period, which is two months.

To adjust the potential interactive effects on air-conditioning systems, the Evaluator used an average COP of 3.5 for apartments with heat pumps and a COP of 2.9 for apartments with air conditioning.⁴¹

Table 23 summarizes the interactive effects factors for DHW insulation measures.

Peak Demand

As for the impact on peak demand savings, it is assumed that all the DHW tanks in a conditioned or semi-conditioned space create interactive effects. Therefore, similar to lighting products, the interactive effects factor for peak demand savings in electrically heated homes is -90%.

³⁹ Econoler, *Residential Direct Install 2015 Evaluation*, March 3, 2016.

⁴⁰ Minister of Justice, Canada, *Energy Efficiency Regulations, 2016*, <http://laws-lois.justice.gc.ca/PDF/SOR-2016-311.pdf> (Last accessed December 5, 2019).

⁴¹ Refer to Subsection 2.1.1 for more details on COP assumptions.

Table 23: Interactive Effects Factors for Pipe Insulation and Hot Water Tank Wraps

Parameter		Energy Interactive Effects During Heating Period	Energy Interactive Effects During Cooling Period	Total Energy Interactive Effects	Peak Demand Interactive Effects
Single-family Homes	Heat Pump Heating	$-90\% \times 3.8 / 12 / 2.2 = -13.0\%$	0.0%	-13.0%	-90%
	Electrical Heating	$-90\% \times 3.8 / 12 = -28.5\%$	0.0%	-28.5%	-90%
	No Electrical Heating	0.0%	0.0%	0.0%	0%
Apartments	Heat Pump Heating and Cooling	$-90\% \times 8 / 12 / 2.2 = -27.3\%$	$90\% / 3.5 \times 2 / 12 = +4.3\%$	-23.0%	-90%
	Electrical Heating, with Air Conditioning	$-90\% \times 8 / 12 = -60.0\%$	$90\% / 2.9 \times 2 / 12 = +5.2\%$	-54.8%	-90%
	Electrical Heating, without Air Conditioning	$-90\% \times 8 / 12 = -60.0\%$	0.0%	-60.0%	-90%
	No Electrical Heating, with Air Conditioning	0.0%	$90\% / 2.9 \times 2 / 12 = +5.2\%$	+5.2%	0%
	With Neither Electrical Heating nor Air Conditioning	0.0%	0.0%	0.0%	0%

Other DHW Measures

For the remaining DHW measures, interactive effects are nil, with the exception of HPWHs. For HPWH measures, interactive effects are already included in the engineering equation used to calculate the unitary savings value. Therefore, no additional interactive effects factor is applied to those savings.

Summary

Table 24 summarizes the interactive effects factors established for each water heating measure.

Table 24: Interactive Effects Factors for Water Heating Measures

Measure	Type of Home	Interactive Effects Factors for Energy Savings	Interactive Effects Factors for Peak Demand Savings	Source
Drain Water Heat Recovery	N/A	0%	0%	Assumption
Solar Domestic Hot Water				
Heat Pump Water Heater		0%	0%	Included in engineering equation – refer to Subsection 2.2.3(3)
Low-flow Showerhead		0%	0%	Assumption
Faucet Aerator				
Thermostatic Shower Valve				
Pipe Insulation Hot Water Tank Wrap	Single-family Homes, Heat Pump Heating	-13.0%	-90%	Calculation
	Single-family Homes, Electrical Heating	-28.5%	-90%	
	Single-family Homes, no Electrical Heating	0%	0%	
	Apartments, Heat Pump Heating with Air Conditioning	-23.0%	-90%	
	Apartments, Electrical Heating with Air Conditioning	-54.8%	-90%	
	Apartments, Electrical Heating Without Air Conditioning	-60.0%	-90%	
	Apartments, no Electrical Heating with Air Conditioning	+5.2%	0%	
	Apartments with Neither Electrical Heating nor Air Conditioning	0%	0%	

2.2.2 Peak Demand Savings Factors

For most water heating measures, peak demand savings are calculated using the peak demand-to-energy ratios developed by Navigant in the 2016-2018 DSM Plan. These ratios were established for various product categories based on modelled system-coincident peak demand savings and electrical energy savings for a projected deployment of products. Navigant used local data to establish the ratios applicable for the 2016-2018 period. The Evaluator recommends using the same ratios during the 2020-2022 DSM cycle.

For solar domestic hot water (DHW), the peak demand-to-energy ratio is nil. Solar DHW systems provide no peak demand savings because the sun has set during the peak demand period.

Table 25 summarizes the peak demand-to-energy ratios established for each water heating measure.

Table 25: Peak Demand-to-energy Ratios for Water Heating Measures

Measure	Peak Demand-to-energy Ratio (W/kWh)	Source
Drain Water Heat Recovery	0.162	RES-Water Heat, Navigant 2016-2018 DSM Plan
Heat Pump Water Heater		
Low-flow Showerhead		
Faucet Aerator		
Thermostatic Shower Valve		
Pipe Insulation		
Hot Water Tank Wrap		
Solar Domestic Hot Water	0.000	Solar DHW systems provide no peak demand savings because the sun has set during the peak demand period.

2.2.3 Water Heating Measures

(1) Drain Water Heat Recovery

Summary

Table 26 presents a summary of the values used to calculate drain water heat recovery (DWHR) savings. The detailed methodology follows.

Table 26: Drain Water Heat Recovery Measure Summary

Parameter	HEA, MHEEP	Reference
Measure Description and Identification		
Measure Description	Drain water heat recovery for high-efficiency water heating	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	20	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	805	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.162	See Subsection 2.2.2
Unitary Peak Demand Savings [W]	130	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	See Subsection 2.2.1
Interactive Effects Factor for Peak Demand Savings	0%	See subsection 2.2.1

Electrical Unitary Energy Savings

The DWHR unitary savings value is determined using the online calculator from the Centre for Energy Advancement through Technology Innovation,⁴² which considers the variables in Table 27 below.

⁴² Centre for Energy Advancement through Technology Innovation (CEATI), *Drain Water Heat Recovery Energy Savings Calculator*, <http://www.ceati.com/calculator/> (Last accessed November 15, 2017).

Table 27: Electrical Unitary Energy Savings Values for Drain Water Heat Recovery Systems

Parameter	HEA, MHEEP	Source
Number of Persons per Household [person]	2.5	2020 HEA Participant Survey
Number of Showers per Person per Day [shower]	0.67	Mayer, Oreo et al. ⁴³
Number of Showers per Household per Day ⁴⁴ [shower/household]	2	Calculated
Average Shower Duration ⁴⁵ [minutes]	8	DeOreo et al. ⁴⁶
Shower Flow Rate [litres/minute]	9.5	2019 Connecticut TRM ⁴⁷
Shower Temperature [Celsius]	41	Assumption
System Configuration	DWHR	Assumption
DWHR Unit Model	R3-60	Assumption (meets minimum HEA efficiency requirements and is included in the list of NRCan eligible models)
Unitary Energy Savings [kWh/year]	805	Calculated

Installation Rates

Installation rates for drain water heat recovery systems are estimated at 100% due to their relatively high cost.

(2) Solar Domestic Hot Water

Summary

Table 28 presents a summary of the values used to calculate solar domestic hot water (solar DHW) savings. The detailed methodology follows.

⁴³ Mayer, P. W., Oreo W. B. et al., *Residential End Uses of Water*, published by the AWWA Research Foundation, 1999, pp. 99-102.

⁴⁴ The calculator rounds numbers to the nearest digit.

⁴⁵ Ibid.

⁴⁶ DeOreo et al. (2016). *Residential End Uses of Water*, Version 2: Executive Report, published by Water Research Foundation, <http://www.waterrf.org/PublicReportLibrary/4309A.pdf> (March 16, 2017), pp. 5-8.

⁴⁷ United Illuminating Company and Connecticut Light & Power Company, *Connecticut Program Savings Document*, 15th Edition for 2019 Program Year, March 2019.

Table 28: Solar Domestic Hot Water Measure Summary

Parameter	HEA	Green Heat	Reference
Measure Description and Identification			
Measure Description	Solar domestic hot water heating for water heating from renewable energy		N/A
Additional Notes	-		
General Parameters			
Installation Rate	100%		See details below under Installation Rates
Effective Useful Life [years]	20		See Subsection 4.2
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	2,736	N/A (Calculated using RETScreen)	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0	0	See Subsection 2.2.2
Unitary Peak Demand Savings [W]	0	0	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	0%	See Subsection 2.2.1
Interactive Effects Factor for Peak Demand Savings	0%	0%	See Subsection 2.2.1

Electrical Unitary Energy Savings

The unitary savings value for solar DHW systems installed through HEA corresponds to the average savings value of the solar DHW systems installed through Green Heat between 2018 and 2020, which is evaluated at 2,736 kWh per year.

Unitary Peak Demand Savings

Solar DHW systems provide no peak demand savings because the sun has set during the peak demand period.

Installation Rates

Installation rates for solar DHW systems are estimated at 100% due to their relatively high cost.

(3) Heat Pump Water Heater

Summary

Table 29 presents a summary of the values used to calculate heat pump water heater (HPWH) savings. The detailed methodology follows.

Table 29: Heat Pump Water Heater Measure Summary

Parameter	HEA, MHEEP		Instant Savings	Reference
Measure Description and Identification				
Measure Description	Heat pump water heater for high-efficiency water heating			N/A
Additional Notes	Value for electric resistance space heating	Value for heat pump space heating	Average value for non-electrical, electric resistance, and heat pump space heating	
General Parameters				
Installation Rate	100%			See details below under Installation Rates
Effective Useful Life [years]	10			See Subsection 4.2
Electrical Savings Parameters				
Unitary Energy Savings [kWh/year]	865	1,360	907	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio (W/kWh)	0.162			See Subsection 2.2.2
Unitary Peak Demand Savings [W]	140	220	147	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%			Included in engineering equation. See details under Electrical Unitary Savings
Interactive Effects Factor for Peak Demand Savings	0%			

Electrical Unitary Energy Savings

The unitary savings for HPWHs are calculated based on the equations below. The savings without the interactive effects parameter ($Savings_{\frac{W}{0}}IE$) is obtained using a weighted average of unitary savings from six studies presented in a paper from the International Energy Program Evaluation Conference (IEPEC).⁴⁸ The heating penalty factor (PF) is based on the 2018 Efficiency Vermont TRM and is applied to take into account the conversion of the initial heating system of the home to water heating.⁴⁹

⁴⁸ Kathryn Parlin, Matthew Deslauriers and Laura Martel, *Covering the Waterfront: Direct Measurement of Heat Pump Water Heaters*, 2019 International Energy Program Evaluation Conference, Denver, United States.

⁴⁹ Efficiency Vermont, *Technical Reference Manual (TRM): Measure Savings Algorithms and Cost Assumptions*, December 2018, p. 131

$$Energy\ Savings_{kWh} = Savings \frac{W}{O} IE \times (1 - PF) \times \%ElectDWH$$

$$PF = WHHF/COP$$

Table 30 below lists the equation parameters and corresponding values, as well as the resulting unitary savings values.

Table 30: Electrical Unitary Savings Values for Heat Pump Water Heaters

Parameter	Symbol	HEA, MHEEP		Instant Savings			Source
		Electric Resistance Space Heating	Heat Pump Space Heating	Non-Electrical Space Heating	Electric Resistance Space Heating	Heat Pump Space Heating	
Savings Without Interactive Effects	<i>Savings w/o IE</i>	1,772					2019 IEPEC paper
Portion of Reduced Waste Heat that Results in Increased Heating	<i>WHHF</i>	0.512		N/A	0.512		2018 Vermont TRM
Coefficient of Performance of Space Heating	<i>COP</i>	1	2.2	N/A	1	2.2	Assumption ⁵⁰
Heating Penalty Factor from Conversion of Home to Water Heat	<i>PF</i>	0.512	0.233	N/A	0.512	0.233	Calculation
Share of Electrical Water Heaters in Nova Scotia	<i>%ElectDWH</i>	N/A		52%	97%	90%	Based on 2018, 2019 and 2020 EPI tracking sheets ⁵¹
Unitary Energy Savings [kWh/year]	<i>Savings_{kWh}</i>	865	1,360	921	839	1,224	Calculation
Share of Space Heating Systems in Nova Scotia	-	N/A		58%	24%	14%	Statistics Canada ^{52,53}
Average Unitary Energy Savings [kWh/year]	-	865	1,360	907			Calculation

⁵⁰ Assuming a COP of 1 for electric resistance and a COP of 2.2 for heat pumps based on an average HSPF of 7.4 for Region V, which corresponds to the HSPF specification for CEE Tier 0 split air-source heat pumps for Region IV divided by 1.15 (https://library.cee1.org/system/files/library/9570/CEE_ResHVAC_CAC_ASHP_Specifications_1January2015.pdf) and the average HSPF value cited by NRCAN for air-source heat pumps (<https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about-energy-star-canada/energy-star-announcements/publications/heating-cooling-heat-pump/air-source-heat-pumps/6831>).

⁵¹ The proportions of electrical water heating published by NRCAN are not consistent and significantly lower than the value obtained from EPI participants. Therefore, the proportion of electrical water heating is based on EPI tracking sheet data.

⁵² Statistics Canada, *Table 153-0145 - Households and the Environment Survey, Primary Heating System, Canada, Provinces and Census Metropolitan Areas, 2017*, CANSIM, November 27, 2019.

⁵³ Data provided by Statistics Canada do not add to 100%.

Installation Rates

Installation rates for heat pump water heaters are estimated at 100% due to their relatively high cost.

(4) Low-flow Showerheads

Summary

Table 31 presents a summary of the values used to calculate low-flow showerhead savings. The detailed methodology follows.

Table 31: Low-flow Showerhead Measure Summary

Parameter	EPI						IS	Reference
Measure Description and Identification								
Measure Description	Low-flow showerheads to reduce domestic hot water consumption						All rebated units	N/A
Additional Notes	Single-family homes			Apartments				
	Flow rate reduction of 0.5 gpm	Flow rate reduction of 0.75 gpm	Flow rate reduction of 1 gpm	Flow rate reduction of 0.5 gpm	Flow rate reduction of 0.75 gpm	Flow rate reduction of 1 gpm		
General Parameters								
Installation Rate	96%						100%	See details below under Installation Rates
Effective Useful Life [years]	10							See Subsection 4.2
Electrical Savings Parameters								
Unitary Energy Savings [kWh/year]	187	281	374	227	341	455	134	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.162							See Subsection 2.2.2
Unitary Peak Demand Savings [W]	30.3	45.5	60.6	36.8	55.2	73.7	21.7	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%							See Subsection 2.2.1
Interactive Effects Factor for Peak Demand Savings	0%							See Subsection 2.2.1



Electrical Unitary Energy Savings

The equations below are used to determine the annual unitary savings values for low-flow showerheads. The reduction in domestic hot water consumption is established by the difference between the base and efficient domestic hot water consumption levels, as presented in the second equation.

$$\begin{aligned}
 \text{Energy Savings} \left[\frac{kWh}{year} \right] &= \text{DHW Reduction} \left[\frac{gal}{day} \right] \times \frac{1}{\eta} \times Cp_{H2O} \left[\frac{Btu}{lb \cdot ^\circ F} \right] \times \rho_{H2O} \left[\frac{lb}{ft^3} \right] \times \Delta T_{H2O} [^\circ F] \times n_{days} \left[\frac{days}{year} \right] \\
 &\times UC1 \left[\frac{kWh}{Btu} \right] \times UC2 \left[\frac{ft^3}{gal} \right] \times \%DWH_{elec}
 \end{aligned}$$

$$\begin{aligned}
 \text{DHW Reduction} \left[\frac{gal}{day} \right] &= (q_{base} - q_{low}) [gpm] \times \frac{n_{people} [person]}{n_{showerheads}} \times \%_{DHW} \times t_{shower} \left[\frac{min}{shower} \right] \times n_{shower} \left[\frac{shower}{day \cdot person} \right]
 \end{aligned}$$

Table 32 below lists the parameters and corresponding values applied in the equations above for low-flow showerheads and the resulting unitary savings values.

Table 32: Electrical Unitary Energy Savings Values for Low-flow Showerheads

Parameter	Symbol	Value for EPI		Value for Instant Savings	Source
		Single-family Homes	Apartments		
Baseline Flow Rate [gpm]	q_{base}	Variable (2.0 gpm, 2.25 gpm, or 2.5 gpm)	Variable (2.0 gpm, 2.25 gpm, or 2.5 gpm)	2	<u>EPI</u> : EPI tracking sheet <u>Instant Savings</u> : Based on the average flow rates of standard products sold at retailers in 2020
Low-flow Rate [gpm]	q_{low}	1.5		1.5	<u>EPI</u> : 2021 EPI Program Manual <u>Instant Savings</u> : Average flow-rate of all models rebated under 2020 Instant Savings
Number of People per Household [person]	n_{people}	2.5	1.9	2.3	<u>EPI</u> : 2020 EPI November tracking sheet <u>Instant Savings</u> : Statistics Canada 2016 Census ⁵⁴
Average Number of Showers per Day per Person [shower/day/person]	n_{shower}	0.67			Mayer and Oreo ⁵⁵
Number of Showerheads per Household [showers]	$n_{showerheads}$	1.6	1	1.5	<u>EPI</u> : 2021 EPI Evaluation (on-site visits) <u>Instant Savings</u> : 2017 EPI Evaluation (on-site visits) ⁵⁶
Average Shower Time per Person [min/shower]	t_{shower}	7.8			DeOreo et al. ⁵⁷
Percentage of Hot Water Used in Showers	$\%_{DHW}$	63%			DeOreo et al. ⁵⁸
Number of Days per Year [days/year]	n_{days}	365			Convention
Specific Heat of Water [BTU/lb°F]	C_{pH_2O}	1			Convention
Density of Water [lb/ft ³]	ρ_{H_2O}	62.43			Convention

⁵⁴ Statistics Canada. (2016). Census Profile, 2016 Census, <https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/Page.cfm> (Last accessed November 27, 2019).

⁵⁵ Mayer, P. W., Oreo W. B. et al., *Residential End Uses of Water*, published by the AWWA Research Foundation, 1999, pp. 99-102.

⁵⁶ Econoler, *Existing Residential Program 2017 DSM Evaluation*, March 15, 2018.

⁵⁷ DeOreo et al. (2016). *Residential End Uses of Water*, Version 2: Executive Report, published by Water Research Foundation, <http://www.waterrf.org/PublicReportLibrary/4309A.pdf> (March 16, 2017), pp. 5-8.

⁵⁸ Obtained based on the total domestic water consumption level in showers per household (28.1 gpd) and the hot water use for showers (17.8 gpd) in DeOreo et al. (2016). *Residential End Uses of Water*, Version 2: Executive Report, published by Water Research Foundation, <http://www.waterrf.org/PublicReportLibrary/4309A.pdf> (March 16, 2017), p. 5.

Parameter	Symbol	Value for EPI		Value for Instant Savings	Source
		Single-family Homes	Apartments		
Temperature Rise in Electrical Water Heater [°F]	ΔT_{H2O}	79			2011 OPA
Electrical Water Heater Efficiency	η	97%			Pennsylvania Public Utility Commission TRM ⁵⁹
Unit Conversion #1 [kWh/BTU]	UC1	0.000293083			Convention
Unit Conversion #2 [ft ³ /gal]	UC2	0.1337			Convention
Share of Participants with Electrical Water Heaters	%DHW _{elec}	100%		73%	<u>EPI</u> : Units claimed in DSM savings are installed in homes with electrical water heaters. <u>Instant Savings</u> : Based on 2018 and 2019 EPI tracking sheets ⁶⁰
Unitary Energy Savings [kWh/year]	Flow rate reduction of 0.5 gpm	187	227	134	Calculation
	Flow rate reduction of 0.75 gpm	281	341		Calculation
	Flow rate reduction of 1 gpm	374	455		Calculation

Installation Rates

Table 33 lists the installation rate for EPI low-flow showerheads.

Table 33: EPI Low-flow Showerhead Installation Rate

Installation Rate	Margin of Error	Source
96%	5.1%	2021 EPI Evaluation (on-site visits)

For Instant Savings, the installation rate is assumed to be 100%.

(5) Faucet Aerators

Summary

Table 34 presents a summary of the values used to calculate faucet aerator savings. The detailed methodology follows.

⁵⁹ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

⁶⁰ The proportions of electrical water heating published by NRCAN are not consistent and significantly lower than the value obtained from EPI participants. Therefore, the proportion of electrical water heating is based on EPI tracking sheet data.

Table 34: Faucet Aerator Measure Summary

Parameter	EPI		Reference
Measure Description and Identification			
Measure Description	Faucet aerators to reduce domestic hot water consumption		N/A
Additional Notes	Single-family homes	Apartments	
General Parameters			
Installation Rate	85%		See details below under Installation Rates
Effective Useful Life [years]	10		See Subsection 4.2
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	110	130	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.162		See Subsection 2.2.2
Unitary Peak Demand Savings [W]	17.8	21.1	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%		See Subsection 2.2.1
Interactive Effects Factor for Peak Demand Savings	0%		See Subsection 2.2.1

Electrical Unitary Energy Savings

The equation below is used to calculate the annual unitary savings value for faucet aerators.

$$\begin{aligned}
 & \text{Energy Savings} \left[\frac{kWh}{yr} \right] \\
 &= \frac{(DHW_{base} - DHW_{efficient}) \left[\frac{gal}{day} \right] \times Cp_{H_2O} \left[\frac{BTU}{lb^{\circ}F} \right] \times \rho_{H_2O} \left[\frac{lb}{ft^3} \right] \times \Delta T_{H_2O} [^{\circ}F] \times n_{days} \left[\frac{days}{yr} \right] \times UC1 \left[\frac{kWh}{BTU} \right] \times UC2 \left[\frac{ft^3}{gal} \right]}{\eta}
 \end{aligned}$$

The base domestic hot water consumption value (DHW_{base}) is calculated with the equation below:

$$DHW_{base} \left[\frac{gal}{day} \right] = \frac{DW_{person} \left[\frac{gal}{day \cdot person} \right] \times n_{people} [person] \times \%_{DHW}}{n_{faucets}}$$

The efficient domestic hot water consumption value ($DHW_{efficient}$) is calculated by using the baseline flow rate (q_{base}), low-flow rate (q_{low}), and base domestic hot water consumption value, as illustrated in the equation below:

$$DHW_{efficient} \left[\frac{gal}{day} \right] = DHW_{base} \left[\frac{gal}{day} \right] \times \left(1 - \frac{q_{base} - q_{low}}{q_{base}} \right)$$

Table 35 lists the parameters and values applied in the three equations above for faucet aerators and the resulting unitary savings values.

Table 35: Electrical Unitary Savings Values for Faucet Aerators

Parameter	Symbol	Value for Single-family Homes	Value for Apartments	Source
Baseline Flow Rate [gpm]	q_{base}	1.39	1.39	DeOreo et al. in <i>Residential End Uses of Water Study Update</i> , as cited in Illinois Commerce Commission (2016) ⁶¹
Low-flow Rate [gpm]	q_{low}	0.94	0.94	DeOreo et al. in <i>Residential End Uses of Water Study Update</i> , as cited in Illinois Commerce Commission (2016) ^{62,63}
Number of People per Household [person]	n_{people}	2.5	1.9	2020 EPI November tracking sheet
DW Used per Person [gpd]	DW_{person}	9.9		DeOreo et al. ⁶⁴
Percentage of Hot Water Used by Faucet Aerator	$\%_{DHW}$	59%		DeOreo et al. ⁶⁵
Number of Faucets per Household	$n_{faucets}$	3.1	2.0	Single-family homes: EPI 2021 on-site visits Apartments: assumption
Specific Heat of Water [BTU/lb°F]	C_{pH_2O}	1		Convention
Density of Water [lb/ft ³]	ρ_{H_2O}	62.43		Convention
Temperature Rise in Electrical Water Heater [°F]	ΔT_{H_2O}	79		2011 OPA
Electrical Water Heater Efficiency	η	97%		Pennsylvania TRM ⁶⁶
Number of Days per Year [days/year]	n_{days}	365		Convention
Unit Conversion #1 [kWh/BTU]	UC1	0.000293083		Convention
Unit Conversion #2 [ft ³ /gal]	UC2	0.1337		Convention
Unitary Energy Savings [kWh/year]	-	110	130	Calculation

⁶¹ Illinois Commerce Commission (2016). *Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 5.0 – Volume 3: Residential Measures*, p. 175.

⁶² Ibid.

⁶³ Ibid.

⁶⁴ Obtained based on the total domestic water consumption through faucets per household (26.3 gpd) and the average number of people per participating household (2.65) in DeOreo et al. (2016). *Residential End Uses of Water, Version 2: Executive Report*, published by Water Research Foundation, <http://www.waterrf.org/PublicReportLibrary/4309A.pdf> (March 16, 2017), pp. 5-8.

⁶⁵ Obtained based on the total domestic water consumption through faucets per household (26.3 gpd) and the hot water use through faucets (15.4 gpd) in DeOreo et al. (2016). *Residential End Uses of Water, Version 2: Executive Report*, published by Water Research Foundation, <http://www.waterrf.org/PublicReportLibrary/4309A.pdf> (March 16, 2017), p. 5.

⁶⁶ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

Installation Rates

Table 36 lists the installation rate for EPI faucet aerators.

Table 36: EPI Faucet Aerator Installation Rate

Installation Rate	Margin of Error	Source
85%	6.8%	2021 EPI Evaluation (on-site visits)

(6) Thermostatic Shower Valve

Summary

Table 37 presents a summary of the values used to calculate thermostatic shower valve savings. The detailed methodology follows.

Table 37: Thermostatic Shower Valve Measure Summary

Parameter	EPI								Reference
Measure Description and Identification									
Measure Description	Thermostatic shower valves to reduce domestic hot water consumption								N/A
Additional Notes	Single-family homes				Apartments				
	Flow rate of 1.5 gpm	Flow rate of 2.0 gpm	Flow rate of 2.25 gpm	Flow rate of 2.5 gpm	Flow rate of 1.5 gpm	Flow rate of 2.0 gpm	Flow rate of 2.25 gpm	Flow rate of 2.5 gpm	
General Parameters									
Installation Rate	88%								See details below under Installation Rates
Effective Useful Life [years]	10								See Subsection 4.2
Electrical Savings Parameters									
Unitary Energy Savings [kWh/year]	71	94	106	118	86	114	129	143	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.162								See Subsection 2.2.2
Unitary Peak Demand Savings [W]	11.5	15.2	17.2	19.1	13.9	18.5	20.9	23.2	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%								See Subsection 2.2.1
Interactive Effects Factor for Peak Demand Savings	0%								See Subsection 2.2.1

Electrical Unitary Energy Savings

The equation below is used to determine the annual unitary savings values for thermostatic shower valves. Energy savings are established by calculating the reduction in domestic hot water usage, as presented in the second equation below.

$$\text{Energy Savings} \left[\frac{kWh}{year} \right] = \frac{DHW \text{ Reduction} \left[\frac{gal}{year} \right] \times C_{p_{H2O}} \left[\frac{Btu}{lb \cdot ^\circ F} \right] \times \rho_{H2O} \left[\frac{lb}{ft^3} \right] \times \Delta T_{H2O} [^\circ F] \times n_{days} \left[\frac{days}{year} \right] \times UC1 \left[\frac{kWh}{Btu} \right] \times UC2 \left[\frac{ft^3}{gal} \right]}{\eta}$$

$$DHW \text{ Reduction} \left[\frac{gal}{year} \right] = q \left[\frac{gal}{min} \right] \times n_{people} [person] \times \%_{DHW} \times t_w \left[\frac{min}{shower} \right] \times n_{shower} \left[\frac{shower}{day \cdot person} \right] \times \frac{1}{n_{showerhead}}$$

Table 38 below lists the parameters and corresponding values applied to the two equations above and the resulting unitary savings values for thermostatic shower valves.

Table 38: Electrical Unitary Energy Savings Values for Thermostatic Shower Valves

Parameter	Symbol	Value for Single-family Homes	Value for Apartments	Source
Flow Rate [gpm]	q	Variable (1.5 gpm for low-flow showerheads, otherwise: 2.0 gpm, 2.25 gpm, or 2.5 gpm)	Variable (1.5 gpm for low-flow showerheads, otherwise: 2.0 gpm, 2.25 gpm, or 2.5 gpm)	EPI tracking sheet
Number of People per Household [person]	η_{people}	2.5	1.9	2020 EPI November tracking sheet
Average Number of Showers per Day per Person [shower/day/person]	η_{shower}	0.67		Mayer and Oreo ⁶⁷
Average Number of Showerheads per Household [showerhead]	$\eta_{showerheads}$	1.6	1.0	Single-family homes: 2021 EPI on-site visits Apartments: assumption
Behavioural Waste Time [min/shower]	t_w	0.98		Pennsylvania Public Utility Commission TRM ⁶⁸ Maine TRM ⁶⁹
Percentage of Hot Water Used in Showers	$\%_{DHW}$	63%		DeOreo et al. ⁷⁰

⁶⁷ Mayer, P. W., W. B. Oreo et al., *Residential End Uses of Water*, published by the AWWA Research Foundation, 1999, pp. 99-102.

⁶⁸ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 133.

⁶⁹ Efficiency Maine, *Retail/Residential Technical Reference Manual Version 2019.1*, July 2018.

⁷⁰ Obtained based on the total domestic water consumption level in showers per household (28.1 gpd) and the hot water use for showers (17.8 gpd) in DeOreo et al. (2016). *Residential End Uses of Water, Version 2: Executive Report*, published by Water Research Foundation, <http://www.waterrf.org/PublicReportLibrary/4309A.pdf> (March 16, 2017), p. 5.

Parameter	Symbol	Value for Single-family Homes	Value for Apartments	Source
Number of Days per Year [days/year]	n_{days}	365		Convention
Specific Heat of Water [BTU/lb·°F]	$C_{p_{\text{H}_2\text{O}}}$	1		Convention
Density of Water [lb/ft ³]	$\rho_{\text{H}_2\text{O}}$	62.43		Convention
Temperature Rise in Electrical Water Heater [°F]	$\Delta T_{\text{H}_2\text{O}}$	79		2011 OPA
Unit Conversion #1 [kWh/BTU]	UC1	1 / 3,412		Convention
Unit Conversion #2 [ft ³ /gal]	UC2	0.1337		Convention
Electrical Water Heater Efficiency	η	97%		Pennsylvania Public Utility Commission TRM ⁷¹
Unitary Energy Savings [kWh/year]	Flow rate of 1.5 gpm	71	86	Calculation
	Flow rate of 2.0 gpm	94	114	Calculation
	Flow rate of 2.25 gpm	106	129	Calculation
	Flow rate of 2.5 gpm	118	143	Calculation

Installation Rates

Table 39 lists the installation rate for thermostatic shower valves.

Table 39: Thermostatic Shower Valve Installation Rate

Installation Rate	Margin of Error	Source
88%	13.2%	2021 EPI Evaluation (on-site visits)

(7) Pipe Insulation

Summary

Table 40 presents a summary of the values used to calculate pipe insulation savings. The detailed methodology follows.

⁷¹ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

Table 40: Pipe Insulation Measure Summary

Parameter	EPI	Reference
Measure Description and Identification		
Measure Description	Pipe insulation to reduce domestic hot water consumption	N/A
Additional Notes	-	
Installation Rate		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	15	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings (per ft) [kWh/year]	12.7	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.162	See Subsection 2.2.2
Unitary Peak Demand Savings [W]	2.06	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	Calculation based on home heating and air-conditioning systems for each installed unit	See Subsection 2.2.1
Interactive Effects Factor for Peak Demand Savings		

Electrical Unitary Energy Savings

As presented in Table 41, the annual unitary savings value for pipe insulation was identified through Ontario Power Authority (OPA) 2011⁷² values and amounts, established at 12.7 kWh per linear foot.

Table 41: Unitary Savings Value for Pipe Insulation

Parameter	EPI
Unitary Energy Savings (per ft) [kWh/year]	12.7

Installation Rates

Table 42 lists the installation rate for EPI pipe insulation.

Table 42: EPI Pipe Insulation Installation Rate

Installation Rate	Margin of Error	Source
100%	N/A	Assumption

⁷² Ontario Power Authority (OPA), *OPA Prescriptive Measures and Assumptions List*, December 2010.

(8) Hot Water Tank Wrap

Summary

Table 43 presents a summary of the values used to calculate hot water tank wrap savings. The detailed methodology follows.

Table 43: Hot Water Tank Wrap Measure Summary

Parameter	EPI		Reference
Measure Description and Identification			
Measure Description	Hot water tank wrap to reduce domestic hot water consumption		N/A
Additional Notes	Single-family homes	Apartments	
General Parameters			
Installation Rate	100%		See details below under Installation Rates
Effective Useful Life [years]	7		See Subsection 4.2
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	159	118	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.162		See Subsection 2.2.2
Unitary Peak Demand Savings [W]	25.8	19.1	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	Calculation based on home heating and air-conditioning systems for each installed unit		See Subsection 2.2.1
Interactive Effects Factor for Peak Demand Savings			

Electrical Unitary Energy Savings

The following equations are used to determine the annual unitary savings associated with hot water tank wraps. The energy savings are equal to the difference in heat losses associated with tank circumference (Q_{tank}) before and after adding the tank wrap ($Q_{\text{tank+RSI 1.21}}$). The heat losses are calculated using the following formulas of heat transfer in an insulated cylinder:

$$R_{layer} = \frac{\ln(r_e/r_i)}{2\pi k}$$

$$R_{cyl} = R_{layer1} + R_{layer2}$$

$$Q_{cyl} = \frac{T_i - T_e}{R_{cyl}} L$$

$$Q_{top} = \frac{A_{top} \times (T_i - T_e)}{R_{top}}$$

$$Q_{total} = Q_{cyl} + Q_{top}$$

$$Energy\ Savings_{kWh} = \frac{(Q_{total}) \cdot HOU}{\eta_{heater}}$$

The calculation considers a typical domestic tank with a capacity of 60 imperial gallons and a hot water tank wrap with a thermal resistance of 1.21 m²·°C/W.

Table 44 lists the values applied in equations presented above to obtain the unitary savings for tank wraps.

Table 44: Electrical Unitary Savings Values for Hot Water Tank Wraps

Parameter	Symbol	Value for Single-family Homes	Value for Apartments	Source
Layer 1: Interior Insulation of Tank				
External Radius of the Layer [m]	r_e	0.300	0.280	Giant ⁷³
Internal Radius of the Layer [m]	r_i	0.249	0.229	Ibid
Thermal Conductivity of the Layer [W/m·°C]	k	0.024		Ibid
Thermal Resistance of the Layer of Material in the Cylinder (e.g. insulation inside the tank and tank wrap) [m·°C/W]	R_{layer}	1.228	1.333	Calculation
Thermal Resistance of the Top of the Tank [m·°C/W]	R_{Top}	2.113		Giant ⁷⁴
Layer 2: Tank Wrap				
External Radius of the Layer [m]	r_e	0.351	0.331	Estimated from Frost King Insulation Blanket Specifications ⁷⁵
Internal Radius of the Layer [m]	r_i	0.300	0.280	Giant ⁷⁶
Thermal Conductivity of the Layer [W/m·°C]	k	0.042		Estimated from Frost King Insulation Blanket Specifications
Thermal Resistance of the Layer of Material Inside the Cylinder (e.g. insulation inside the tank and tank wrap) [m·°C/W]	R_{layer}	1.823	1.965	Calculation
Thermal Resistance of the Top of the Tank [m·°C/W]	R_{Top}	3.323		Sum of R-values of the insulation inside the tank and tank wrap
Heat Transfer				
Length of the Cylinder [m]	L	1.52	1.22	Giant ⁷⁷
Area of the Top of the Tank [m²]	A_{top}	0.283	0.246	Calculated from Giant tank dimensions
Temperature at the External Radius of the Cylinder [°C]	T_e	21		Assumption for standard ambient indoor temperature
Temperature at the Internal Radius of the Cylinder [°C]	T_i	60		OPA Prescriptive Measures and Assumptions 2011
Hours of Use [h/year]	HOU	8,760		Assumption
Thermal Efficiency of Heating Element	η_{heater}	97%		Pennsylvania Public Utility Commission ⁷⁸
Heat Transfer Through the Tank [W]	Q_{total}	53.5	40.2	Calculation
Heat Transfer Through the Insulated Tank [W]	Q_{total}	35.9	27.1	Calculation
Unitary Energy Savings for Tank Wrap [kWh/year]	-	159	118	Calculation

Installation Rates

Table 45 lists the installation rate for EPI hot water tank wraps.

Table 45: EPI Hot Water Tank Wrap Installation Rate

Installation Rate	Margin of Error	Source
100%	0%	2021 EPI Evaluation (on-site visits)

2.3 Space Heating

2.3.1 Interactive Effects

Since space heating measures target heating and cooling loads directly, the impact of these measures on heating and cooling is considered in the unitary savings. Therefore, as presented in Table 46, the interactive effects factors for each space heating measure are assumed to be nil.

Table 46: Interactive Effects Factors for Space Heating Measures

Measure	Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings	Source
Mini-split Heat Pump	0%	0%	No interactive effects for space heating measures since impact on heating and cooling is included in unitary savings.
Central Air-source Heat Pump			
Ground-source Heat Pump			
Wood Stove/Fireplace Insert			
Pellet Stove/Fireplace Insert			
Wood Furnace/Boiler			
Pellet Furnace/Boiler			
Solar Air Heating			
Air Sealing Kit			
Programmable Thermostat			
Smart Thermostat for Electrical Baseboards			

⁷³ Giant Inc., *Engineering Submittal Data Sheet 172ETE Models*, <http://www.giantinc.com/tech-data/FT-172E-An.pdf> (Last accessed February 18, 2015).

⁷⁴ Ibid.

⁷⁵ Frost King Weatherization Products, *Water Heater Insulation Blanket*, <http://www.frostking.com/water-heater-insulation-blanket/> (Last accessed January 4, 2014).

⁷⁶ Giant Inc., *Engineering Submittal Data Sheet 172ETE Models*, 16.

⁷⁷ Ibid., 16.

⁷⁸ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

2.3.2 Peak Demand Savings Factors

For most space heating measures, peak demand savings are not calculated using a peak demand-to-energy ratio. For more details, refer to Subsection 2.3.3(1) for mini-split heat pumps, Subsection 2.3.3(2) for central- air-source heat pumps, Subsection 2.3.3(3) for ground-source heat pumps, Subsection 2.3.3(4) for wood and pellet stoves and fireplace inserts, and Subsection 2.3.3(5) for wood and pellet boilers and furnaces.

For air sealing kits, peak demand savings are calculated using a peak demand-to-energy ratio developed by Navigant in the 2016-2018 DSM Plan. These ratios were established for various product categories based on modelled system-coincident peak demand savings and electrical energy savings for a projected deployment of products. Navigant used local data to establish the ratios applicable for the 2016-2018 period. The Evaluator recommends using the same ratios during the 2020-2022 DSM cycle.

For programmable thermostats, several studies demonstrate peak demand savings when there are specific interventions to adjust heating operating times to minimize redundancy with the system peak. However, when there is no specific intervention related to the installation of programmable thermostats, the impact on the system peak is often assumed to be nil. Only one study was referenced with winter peak demand savings, but these demand savings were very low and difficult to replicate to the Nova Scotia market. Therefore, the peak demand-to-energy ratio for programmable thermostats is established at 0 kW/kWh.

For solar air heating, the peak demand-to-energy ratio is nil. Solar systems provide no peak demand savings because the sun has set during the peak demand period.

For smart thermostats, similar to programmable thermostats, the impact on the system peak is assumed to be nil since no specific intervention to minimize redundancy of operation with the system peak is in place. Therefore, the peak demand-to-energy ratio for smart thermostats is established at 0 W/kWh.

A literature review of programmable and smart thermostat peak demand savings found that nil peak demand savings is the most common assumption among other jurisdictions when thermostats are installed with no specific demand response intervention. In other words, peak demand savings for thermostats are assumed to be nil unless participants are taking part in a demand response program.

Table 47 summarizes the peak demand-to-energy ratios established for each space heating measure.

Table 47: Peak Demand-to-energy Ratios for Space Heating Measures

Measure	Peak Demand-to-energy Ratio (W/kWh)	Source
Mini-split Heat Pump	N/A	N/A
Central Air-source Heat Pump		
Ground-source Heat Pump		
Wood Stove/Fireplace Insert		
Pellet Stove/Fireplace Insert		
Wood Furnace/Boiler		
Pellet Furnace/Boiler		
Solar Air Heating	0.000	Assumption
Air Sealing Kit	0.283	RES-Elec-Space Heat&Cool, Navigant 2016-2018 DSM Plan
Programmable Thermostat	0.000	Assumption based on literature review findings
Smart Thermostat		

2.3.3 Space Heating Measures

(1) Mini-split Heat Pumps

Summary

Table 48 presents a summary of the values used to calculate mini-split heat pump (MSHP) savings. The detailed methodology follows.

Table 48: Mini-split Heat Pump Measure Summary

Parameter	Green Heat		HEA	MHEEP	Reference
Measure Description and Identification					
Measure Description	Mini-split heat pumps for high-efficiency space heating				N/A
Additional Notes	Fully electrically heated households	Mainly electrically heated households	-		
General Parameters					
Installation Rate	100%				See details below under Installation Rates
Effective Useful Life [years]	18				See Subsection 4.2
Electrical Savings Parameters					
Unitary Energy Savings [kWh/year]	0.179 kWh/BTU/h multiplied by the heating capacity of each installed system	0.060 kWh/BTU/h multiplied by the heating capacity of each installed system	Calculated using HOT2000 modelling		See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	N/A				
Unitary Peak Demand Savings [W]	Calculation based on specification data for each installed system			0.129 W/Btu/h multiplied by the heating capacity of each installed system	See details below under Unitary Peak Demand Savings
Interactive Effects Factor for Energy Savings	0%				See Subsection 2.3.1
Interactive Effects Factor for Peak Demand Savings	0%				See Subsection 2.3.1

Electrical Unitary Energy Savings

The electrical unitary energy savings for MSHPs are based on the billing analysis results of the 2017 Green Heat evaluation, which yielded savings per units of capacity both for homes that were fully electrically heated and for homes that were only partially electrically heated (e.g. that had secondary non-electrical heating systems such as wood stoves). The billing analysis results yield unitary savings values of 0.179 kWh/BTU/h for fully electrically heated households and 0.060 kWh/BTU/h for partially electrically heated homes. The appropriate unitary savings value is then multiplied by the heating capacity of the MSHP (found in the tracking sheet) and is used to calculate an energy savings value specific to each MSHP.

Unitary Peak Demand Savings

For Green Heat and HEA, the unitary peak demand unitary savings for MSHPs are calculated using the variables defined and listed in the equation and Table 49 below.

$$Peak\ Demand\ Savings_W = \frac{1,000}{3.412} \times HC_{min} \times \left(\frac{1}{COP_{base\_min}} - \frac{1}{COP_{ee\_min}} \right)$$

Table 49: Unitary Peak Demand Savings Values for Mini-split Heat Pumps

Variable	Symbol	Green Heat	Source
Rated heating capacity of the new heat pump at outdoor air temperature of -15°C [kBTU/h]	HC_{min}	Specification data for each installed system	AHRI certified value
Coefficient of performance of the assumed baseline equipment (electric resistance) at -15°C [kW/kW]	COP_{base_min}	1	Assumed COP for electric resistance
Coefficient of performance of the new heat pump at -15°C [kW/kW]	COP_{ee_min}	Specification data for each installed system	AHRI certified value
Conversion factor [BTU/W·h]	3.412	3.412	Convention
Conversion factor [W/kW]	1,000	1,000	Convention

For some models, the availability of a heating capacity and COP at -15°C is limited. For those models, peak demand savings are considered nil if the specification sheets indicate a cut-off temperature below -15°C, otherwise ratios are applied to the rated COP and heating capacity at 47°F to obtain values considering average performance reductions as per simulation software (DOE- 2) performance curves shared by NRCAN. The two following equations are used to obtain the adjusted values.

$$COP_{ee\_min} = 53.78\% \times \text{Rated COP at } 47^{\circ}\text{F}$$

$$HC_{min} = 37.46\% \times \text{Rated Capacity at } -47^{\circ}\text{F}$$

For MHEEP, unitary peak demand savings are established by multiplying the average unitary peak demand savings per capacity obtained from the mini-split heat pump measures installed under Green Heat by the capacity of each system installed under MHEEP.

Installation Rates

Installation rates for MSHPs are estimated at 100% due to their relatively high cost.

(2) Central Air-source Heat Pumps

Summary

Table 50 presents a summary of the values used to calculate central air-source heat pump (CASHP) savings. The detailed methodology follows.

Table 50: Central Air-source Heat Pump Measure Summary

Parameter	Green Heat	HEA	Reference
Measure Description and Identification			
Measure Description	Central air-source (air-to-air and air-to-water) heat pumps for high-efficiency space heating		N/A
Additional Notes	-		
General Parameters			
Installation Rate	100%		See details below under Installation Rates
Effective Useful Life [years]	18		See Subsection 4.2
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	0.101 kWh/BTU/h multiplied by the heating capacity of each installed system	Calculated using HOT2000 modelling	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	N/A	0.283	N/A
Unitary Peak Demand Savings [W]	3,930	Calculated by multiplying the energy savings by the peak demand-to-energy ratio	See details below under Unitary Peak Demand Savings
Interactive Effects Factor for Energy Savings	0%	0%	See Subsection 2.2.1
Interactive Effects Factor for Peak Demand Savings	0%	0%	See Subsection 2.2.1

Electrical Unitary Energy Savings

The electrical unitary energy savings for CASHPs are based on the billing analysis results of the 2017 Green Heat evaluation, which yielded savings per units of capacity of 0.101 kWh/BTU/h. The unitary savings value is then multiplied by the heating capacity of the CASHP (found in the tracking sheet) and is used to calculate an energy savings value specific to each CASHP.

Unitary Peak Demand Savings

For CASHPs installed under Green Heat, rated heating capacity and COP at -15°C are not always available. The Evaluator looked into the specification details of CASHPs installed through Green Heat in 2021 and was able to identify those parameters for 15 models. The average unitary peak demand savings for CASHPs were then calculated using the variables defined and listed in the equation and Table 51 below.

$$Peak\ Demand\ Savings_W = \frac{1,000}{3.412} \times HC_{min} \times \left(\frac{1}{COP_{base\_min}} - \frac{1}{COP_{ee\_min}} \right)$$

Table 51: Unitary Peak Demand Savings Values for Central Air-source Heat Pumps

Variable	Symbol	Value	Source
Rated heating capacity of the new heat pump at outdoor air temperature of -15°C [BTU/h]	HC_{min}	25,976	Average specification data for 15 models in the 2021 Green Heat tracking sheet
Coefficient of performance of the assumed baseline equipment (electric resistance) at -15°C [kW/kW]	COP_{base_min}	1	Assumed COP for electric resistance
Coefficient of performance of the new heat pump at -15°C [kW/kW]	COP_{ee_min}	2.067	Average specification data for 15 models in the 2021 Green Heat tracking sheet
Conversion factor [BTU/W·h]	3.412	3.412	Convention
Unitary Peak Demand Savings [W]	<i>Peak Demand Savings</i>	3,930	Calculation

Installation Rates

Installation rates for CASHPs are estimated at 100% due to their relatively high cost.

(3) Ground-source Heat Pumps

Summary

Table 52 presents a summary of the values used to calculate ground-source heat pump (GSHP) savings. The detailed methodology follows.

Table 52: Ground-source Heat Pump Measure Summary

Parameter	Green Heat	HEA	Reference
Measure Description and Identification			
Measure Description	Ground-source heat pumps for high-efficiency space heating		N/A
Additional Notes	-		
General Parameters			
Installation Rate	100%		See details below under Installation Rates
Effective Useful Life [years]	25		See Subsection 4.2
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	Calculation based on specification data for each installed system	Calculated using HOT2000 modelling	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	N/A	0.283	N/A
Unitary Peak Demand Savings [W]	Calculation based on specification data for each installed system	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio	See details below under Unitary Peak Demand Savings
Interactive Effects Factor for Energy Savings	0%	0%	See Subsection 2.2.1
Interactive Effects Factor for Peak Demand Savings	0%	0%	See Subsection 2.2.1

Electrical Unitary Energy Savings

The electrical unitary energy savings for GSHPs are calculated using the variables defined and listed in the equation and Table 53 below.

$$\begin{aligned}
 \text{Energy Savings}_{kWh} &= \text{Heating Savings} + \text{Cooling Savings or Penalty} \\
 &= \left(\frac{HC}{1,000} \times \left(\frac{1}{HSPF_{base}} - \frac{1}{COP_{ee} \times DRF \times 3.412} \right) \times FLH_{heat} \right) \\
 &\quad + \left(\frac{CC}{1,000} \times \left(\frac{1}{SEER_{base}} \times AC - \frac{1}{EER_{ee} \times DRF \times GSER} \right) \times FLH_{cool} \right)
 \end{aligned}$$

Table 53: Electrical Unitary Savings Values for Ground-source Heat Pumps

Parameter	Symbol	Value	Source
Rated heating capacity of the new heat pump [BTU/h]	HC	Specification data for each installed system	AHRI certified value
Rated cooling capacity of the new heat pump [BTU/h]	CC	Specification data for each installed system	AHRI certified value
Heating seasonal performance factor of the baseline equipment [BTU/W·h]	$HSPF_{base}$	Elec. resistance: 3.412 MSHP/CASHP: 7.4	Assumptions ⁷⁹
Coefficient of performance of the new heat pump [kW/kW]	COP_{ee}	Specification data for each installed system	AHRI certified value
Derating factor of the new heat pump	DRF	0.885	2019 PUC TRM ⁸⁰
Factor used to determine the SEER of a GSHP based on its EER [BTU/W·h]	$GSER$	1.02	2019 PUC TRM
Energy efficiency ratio of the existing AC system [BTU/W·h]	$SEER_{base}$	Room AC: 11.4 Central AC: 13.5 MSHP/CASHP: 14.5	Assumptions ⁸¹
Energy efficiency ratio of the new heat pump [BTU/h]	EER_{ee}	Specification data for each installed system	AHRI certified value
Full heating load hours [h/year]	FLH_{heat}	1,384	GSHP billing analysis from the 2017 evaluation ⁸²
Full cooling load hours [h/year]	FLH_{cool}	213	2020 Minnesota TRM ⁸³
Cooling penalty modifier	AC	AC in baseline = 1 No AC in baseline = 0	Assumptions
Conversion factor [BTU/W·h]	3.412	3.412	Convention
Conversion factor [W/kW]	1,000	1,000	Convention

Unitary Peak Demand Savings

The unitary peak demand savings for GSHPs installed under Green Heat are established using the equation below. All variables from this equation are defined in Table 53. Since standard MSHPs and CASHPs are assumed to operate exclusively on the electric resistance backup in the air handler during peak periods, the value of the $HSPF_{base}$ variable in the formula below is the electrical baseline value regardless of the actual baseline equipment.

$$Peak\ Demand\ Savings_W = \left(1,000 \times HC \times \left(\frac{1}{HSPF_{base}} - \frac{1}{COP_{ee} \times DRF \times 3.412} \right) \right)$$

⁷⁹ Assuming a HSPF of 3.412 for electric resistance and an average HSPF of 7.4 for Region V, which corresponds to the HSPF specification for CEE Tier 0 split air source heat pumps for Region IV divided by 1.15 (https://library.cee1.org/system/files/library/9570/CEE_ResHVAC_CAC_ASHP_Specifications_1January2015.pdf) and the average HSPF value cited by NRCAN for air-source heat pump (<https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about-energy-star-canada/energy-star-announcements/publications/heating-cooling-heat-pump/air-source-heat-pumps/6831>).

⁸⁰ Pennsylvania Public Utility Commission (PUC), *Technical Reference Manual*, August 2019, Subsection 2.2 – HVAC.

Installation Rates

Installation rates for GSHPs are estimated at 100% due to their relatively high cost.

⁸¹ Assumptions based on the average efficiency values cited by NRCAN for room air conditioners (average EER of 10 divided by 0.875) and central air conditioners (average SEER of 13.5) (<https://www.nrcan.gc.ca/energy/publications/efficiency/residential/air-conditioning/6051#room>) and a SEER of 14.5 for CEE Tier 0 split air source heat pumps. (https://library.cee1.org/system/files/library/9570/CEE_ResHVAC_CAC_ASHP_Specifications_1January2015.pdf).

⁸² Econoler, *Existing Residential Program – 2017 DSM Evaluation*, Final Report presented to Efficiency Nova Scotia, March 15, 2018.

⁸³ Minnesota Department of Commerce Division of Energy Resources, *State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs Version 3.1*, January 2020.

(4) Wood and Pellet Stoves/Fireplace Inserts

Summary

Table 54 presents a summary of the values used to calculate wood and pellet stove and fireplace insert savings. The detailed methodology follows.

Table 54: Wood and Pellet Stove and Fireplace Insert Measure Summary

Parameter		Green Heat				HEA				Reference
Measure Description and Identification										
Measure Description		Wood and pellet stoves and fireplace inserts for space heating from renewable fuel								N/A
Additional Notes	Fuel	Wood	Pellet	Wood	Pellet	Wood	Pellet	Wood	Pellet	
	Baseline	Electrical		Heat pump		Electrical		Heat pump		
General Parameters										
Installation Rate		100%								See details below under Installation Rates
Effective Useful Life [years]		18								See Subsection 4.2
Electrical Savings Parameters										
Unitary Energy Savings [kWh/year]		10,443	8,959	4,747	4,072	10,443	8,959	$\frac{10,443}{COP_{base\_hp}}$	$\frac{8,959}{COP_{base\_hp}}$	See details below under Electrical Energy Unitary Savings
Peak Demand-to-energy Ratio [W/kWh]		N/A								N/A
Unitary Peak Demand Savings [W]		4,000								See details below under Unitary Peak Demand Savings
Interactive Effects Factor for Energy Savings		0%								See Subsection 2.3.1
Interactive Effects Factor for Peak Demand Savings		0%								See Subsection 2.3.1

Electrical Unitary Energy Savings

The electrical unitary savings values for wood and pellet stoves and fireplace inserts are based on HOT2000 energy models.⁸⁴ The baseline of the models uses electric resistance heating as the primary heat source and is calibrated to account for the historical electrical consumption of participants.

For participants who have ASHPs, as their primary heating system instead of electric resistance heating, unitary savings values are calculated using the equation below.

$$Energy\ Savings_{kWh\ (base\_hp)} = Energy\ Savings_{kWh\ (base\_elec)} \times \frac{COP_{base\_elec}}{COP_{base\_hp}}$$

For HEA, the baseline heat pump COP value specified in the tracking sheet is used, while for Green Heat, the COP of a standard mini-split heat pump based on a HSPF Region V of 7.4 is used.⁸⁵ The unitary energy savings values are presented in Table 55 below.

⁸⁴ The HOT2000 energy models were developed as part of the 2013 evaluation.

⁸⁵ The HSPF of a standard mini-split heat pump is assumed to correspond to the minimum requirement for CEE Tier 0 split air-source heat pumps, which also corresponds to the average HSPF value cited by NRCAN for air-source heat pump (<https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about-energy-star-canada/energy-star-announcements/publications/heating-cooling-heat-pump/air-source-heat-pumps/6831>).

Table 55: Electrical Unitary Energy Savings Values for Wood and Pellet Stoves

Parameter	Symbol	Green Heat		HEA		Source
		Wood Stove/Fireplace Insert	Pellet Stove/Fireplace Insert	Wood Stove/Fireplace Insert	Pellet Stove/Fireplace Insert	
Coefficient of performance of the baseline electric resistance [kW/kW]	COP_{base_elec}	1				Convention
Coefficient of performance of the baseline heat pump [kW/kW]	COP_{base_hp}	2.2		Specification data for each installed system		Green Heat: Assumption ⁸⁵ HEA: AHRI certified value
Unitary Energy Savings with Electrical Baseline [kWh/year]	$Energy\ Savings_{kWh\ (base\_elec)}$	10,443	8,959	10,443	8,959	2013 Evaluation HOT2000 Energy Models
Unitary Energy Savings with Heat Pump Baseline [kWh/year]	$Energy\ Savings_{kWh\ (base\_hp)}$	4,747	4,072	$\frac{10,443}{COP_{base\_hp}}$	$\frac{8,959}{COP_{base\_hp}}$	Calculation

Unitary Peak Demand Savings

Unitary peak demand savings for wood and pellet stoves and fireplace inserts are based on program design data.⁸⁶ It is assumed that during the peak demand period, existing ASHPs operate exclusively on the electric resistance backup in the air handler. Thus, the peak demand savings for wood and pellet stoves and fireplace inserts with ASHP baselines are identical to the peak demand savings of wood and pellet stoves and fireplace inserts with electric resistance baselines. The unitary peak demand savings values are presented in Table 56.

Table 56: Unitary Peak Demand Savings Values for Wood and Pellet Stoves and Fireplace Inserts

Parameter	Green Heat, HEA				Source
	Wood stove/ Fireplace Insert with electrical baseline	Pellet stove/ Fireplace Insert with electrical baseline	Wood stove/ Fireplace Insert with ASHP baseline	Pellet stove/ Fireplace Insert with ASHP baseline	
Unitary Peak Demand Savings [W]	4,000				2013 Evaluation HOT2000 Energy Models

Installation Rates

Installation rates for wood and pellet stoves are estimated at 100% due to their relatively high cost.

⁸⁶ Dunskey Energy Consulting, *Residential Fuel Substitution Pilot Program*, Final Report, December 2010.

(5) Wood and Pellet Boilers and Furnaces

Summary

Table 57 presents a summary of the values used to calculate wood and pellet boiler and furnace savings. The detailed methodology follows.

Table 57: Wood and Pellet Boiler and Furnace Measure Summary

Parameter		Green Heat				HEA				Reference
Measure Description and Identification										
Measure Description		Wood and pellet boilers and furnaces for space heating from renewable fuel								N/A
Additional Notes	Fuel	Wood	Pellet	Wood	Pellet	Wood	Pellet	Wood	Pellet	
	Baseline	Electrical		Heat pump		Electrical		Heat pump		
General Parameters										
Installation Rate		100%								See details below under Installation Rates
Effective Useful Life [years]		18								See Subsection 4.2
Electrical Savings Parameters										
Unitary Energy Savings [kWh/year]		13,804	13,765	6,275	6,257	13,804	13,765	$\frac{13,804}{COP_{base\_hp}}$	$\frac{13,765}{COP_{base\_hp}}$	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]		N/A								N/A
Unitary Peak Demand Savings [W]		7,660	7,750	7,660	7,750	7,660	7,750	7,660	7,750	See details below under Unitary Peak Demand Savings
Interactive Effects Factor for Energy Savings		0%								See Subsection 2.3.1
Interactive Effects Factor for Peak Demand Savings		0%								See Subsection 2.3.1

Electrical Unitary Energy Savings

The electrical unitary savings values for wood and pellet boilers and furnaces are based on HOT2000 energy models.⁸⁷ The baseline of the models used electric resistance heating as the primary heat source and was calibrated to account for the historical electrical consumption of participants.

For participants who have ASHPs, as their primary heating system instead of electric resistance heating, unitary savings values are calculated using the equation below.

$$Energy\ Savings_{kWh\ (base_{hp})} = Energy\ Savings_{kWh\ (base_{elec})} \times \frac{COP_{base_{elec}}}{COP_{base_{hp}}}$$

For HEA, the baseline heat pump COP value specified in the tracking sheet is used, while for Green Heat, the COP of a standard mini-split heat pump based on a HSPF Region V of 7.4 is used.⁸⁸ The unitary energy savings values are presented in Table 58 below.

⁸⁷ The HOT2000 energy models were developed as part of the 2013 evaluation.

⁸⁸ The HSPF of a standard mini-split heat pump is assumed to correspond to the minimum requirement for CEE Tier 0 split air-source heat pumps, which also corresponds to the average HSPF value cited by NRCAN for air-source heat pump (<https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about-energy-star-canada/energy-star-announcements/publications/heating-cooling-heat-pump/air-source-heat-pumps/6831>).

Table 58: Electrical Unitary Energy Savings Values for Wood and Pellet Boilers and Furnaces

Parameter	Symbol	Green Heat		HEA		Source
		Wood Furnace or Boiler	Pellet Furnace or Boiler	Wood Furnace or Boiler	Pellet Furnace or Boiler	
Coefficient of performance of the baseline electric resistance [kW/kW]	COP_{base_elec}	1				Convention
Coefficient of performance of the baseline heat pump [kW/kW]	COP_{base_hp}	2.2		Specification data for each installed system		Green Heat: Assumption ⁸⁵ HEA: AHRI certified value
Unitary Energy Savings with Electrical Baseline [kWh/year]	$Energy\ Savings_{kWh\ (base\_elec)}$	13,804	13,765	13,804	13,765	2013 Evaluation HOT2000 Energy Models
Unitary Energy Savings with Heat Pump Baseline [kWh/year]	$Energy\ Savings_{kWh\ (base\_hp)}$	6,275	6,257	$\frac{13,804}{COP_{base\_hp}}$	$\frac{13,765}{COP_{base\_hp}}$	Calculation

Unitary Peak Demand Savings

Unitary peak demand savings are based on program design data.⁸⁹ It is assumed that during the peak demand period, existing ASHPs operate exclusively on the electric resistance backup in the air handler. Thus, the peak demand savings for wood and pellet boiler and furnace measures with an ASHP baseline are identical to the peak demand savings with an electric resistance baseline.

The unitary peak demand savings values are presented in Table 59 below.

Table 59: Unitary Peak Demand Savings Values for Wood and Pellet Boilers and Furnaces

Parameter	Green Heat, HEA			
	Wood Furnace or Boiler with Electrical Baseline	Pellet Furnace or Boiler with Electrical Baseline	Wood Furnace or Boiler with ASHP Baseline	Pellet Furnace or Boiler with ASHP Baseline
Unitary Peak Demand Savings [W]	7,660	7,750	7,660	7,750

Installation Rates

Installation rates for wood and pellet boilers and furnaces are estimated at 100% due to their relatively high cost.

(6) Solar Air Heating

Summary

Table 60 presents a summary of the values used to calculate solar air heating savings. The detailed methodology follows.

⁸⁹ Dunskey Energy Consulting, *Residential Fuel Substitution Pilot Program*, Final Report, December 2010.

Table 60: Solar Air Heating Measure Summary

Parameter	Green Heat	HEA	Reference
Measure Description and Identification			
Measure Description	Solar air heating systems	N/A	
Additional Notes	-		
General Parameters			
Installation Rate	100%	See details below under Installation Rates	
Effective Useful Life [years]	20	See Subsection 4.2	
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	N/A (Calculated using RETScreen)	594	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	N/A	N/A	See Subsection 2.3.2
Unitary Peak Demand Savings [W]	0	0	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	0%	See Subsection 2.2.1
Interactive Effects Factor for Peak Demand Savings	0%	0%	See Subsection 2.2.1

Electrical Unitary Energy Savings

The unitary savings value for solar DHW systems installed through HEA corresponds to the average savings value of the solar air heating systems installed through Green Heat in 2020, which is evaluated at 594 kWh per year.

Installation Rates

Installation rates for solar air heating are estimated at 100% due to their relatively high cost.

(7) Air Sealing Kits

Summary

Table 61 presents a summary of the values used to calculate air sealing kit savings. The detailed methodology follows.

Table 61: Air Sealing Kit Measure Summary

Parameter	EPI								Reference
Measure Description and Identification									
Measure Description	Air sealing kits to reduce space heating consumption								N/A
Additional Notes	Electrical resistance heated homes				Heat pump heated homes				
	10 foam gaskets	1 door sweep	15 feet of window air sealing	17 feet of door weather stripping	10 foam gaskets	1 door sweep	15 feet of window air sealing	17 feet of door weather stripping	
General Parameters									
Installation Rate	31%	100%	84%	84%	31%	100%	84%	84%	See details below under Installation Rates
Effective Useful Life [years]	15								See Subsection 4.2
Electrical Savings Parameters									
Unitary Energy Savings [kWh/year]	90	173	149	196	40.9	78.6	67.7	89.1	See details below under Installation Rates
Peak Demand-to-energy Ratio [W/kWh]	0.283								See Subsection 2.3.2
Unitary Peak Demand Savings [W]	25.5	49.0	42.2	55.5	11.6	22.2	19.2	25.2	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%								See Subsection 2.3.1
Interactive Effects Factor for Peak Demand Savings	0%								See Subsection 2.3.1

Electrical Unitary Energy Savings

The electrical unitary energy savings values are based on the results of an evaluation of a residential weatherization program conducted in Connecticut by KEMA in 2010.⁹⁰ Based on post-retrofit blower door tests on sampled homes, which included single-family homes as well as apartments, the KEMA evaluation report provides per-foot unitary savings values for window air sealing and door weather stripping, as well as per-unit unitary savings for foam gaskets and door sweeps.

Table 62 summarizes the savings for each measure included in air sealing kits for electric resistance.

Table 62: Savings Values for Air Sealing Kits in Electric Resistance and Heat Pump Heated Homes

Measure	Electric Resistance Heated Homes	Source
Annual Energy Savings from Foam Gaskets [kWh/gasket]	9	<u>Electric Resistance</u> : Connecticut TRM ⁹¹ <u>Heat Pump</u> : Calculation
Annual Energy Savings from Door Sweeps [kWh/door]	173	<u>Electric Resistance</u> : Connecticut TRM <u>Heat Pump</u> : Calculation
Annual Energy Savings from Window Air Sealing [kWh/foot]	9.9	<u>Electric Resistance</u> : Connecticut TRM <u>Heat Pump</u> : Calculation
Annual Energy Savings from Door Weather Stripping [kWh/foot]	11.5	<u>Electric Resistance</u> : Connecticut TRM <u>Heat Pump</u> : Calculation

EOne considers a package of 10 foam gaskets to be a single unit, one unit of window air sealing to be 15 feet, and one unit of door weather stripping to be 17 feet. Therefore, the savings established in Table 62 are multiplied by the quantity of foam gaskets or length in feet assumed per unit to establish the unitary savings as per the equation below.

$$\begin{aligned}
 \text{Energy Savings} \left[\frac{\text{kWh}}{\text{year}} \right] \\
 = \text{Quantity Assumed per Unit} * \text{Energy Savings per Quantity} \left[\frac{\text{kWh}}{\text{quantity}} \right]
 \end{aligned}$$

For heat pump heating systems, the savings from electric resistance are divided by 2.2, the COP of a standard mini-split heat pump based on a HSPF Region V of 7.4.

Table 63 presents the unitary savings established for this measure for electric resistance and heat pump heating systems.

⁹⁰ United Illuminating Company and Connecticut Light & Power Company, *Connecticut Program Savings Document*, 15th Edition for 2019 Program Year, March 2019.

⁹¹ Ibid.

Table 63: Electrical Unitary Savings Values for Air Sealing Kits in Electric Resistance and Heat Pump Heated Homes

Measure	EOne Unitary Assumptions	Electric Resistance Heated Homes [kWh/year]	Heat Pump Heated Homes [kWh/year]
Annual Energy Savings from Foam Gaskets	10 gaskets	90	40.9
Annual Energy Savings from Door Sweeps	1 door	173	78.6
Annual Energy Savings from Window Air Sealing	15 feet	149	67.7
Annual Energy Savings from Door Weather Stripping	17 feet	196	89.1

Installation Rates

Table 64 lists the installation rate for EPI air sealing kits.

Table 64: EPI Air Sealing Kit Installation Rate

Measure Description	Installation Rate	Margin of Error	Source
Foam Gasket	31%	N/A	2021 EPI Evaluation (on-site visits)
Door Sweep	100%	0%	2021 EPI Evaluation (on-site visits)
Window Air Sealing	84%	11.2%	2021 EPI Evaluation (on-site visits)
Door Weather Stripping	84%	11.2%	2021 EPI Evaluation (on-site visits)

(8) Programmable Thermostats

Summary

Table 65 presents a summary of the values used to calculate programmable thermostat savings. The detailed methodology follows.

Table 65: Programmable Thermostat Measure Summary

Parameter	Instant Savings, MHEEP	Reference
Measure Description and Identification		
Measure Description	Programmable thermostats to reduce electricity consumption	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	10	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	221	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0	See Subsection 2.3.2
Unitary Peak Demand Savings [W]	0	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	See Subsection 2.3.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 2.3.1

Electrical Unitary Energy Savings

For programmable thermostats, the electrical unitary energy savings are based on the results from a Hydro-Québec 2009 program evaluation of electronic thermostats in residential new construction.⁹² The savings values include energy savings generated by the thermostat's accuracy and temperature setback for three types of dwellings: single-detached units, duplex/triplex/townhouses, and apartments. As defined by the equation below, the unitary savings values are calculated through a weighted average based on the proportion of each dwelling type in Nova Scotia's residential market, as defined in the 2016 Census Profile of Statistics Canada.⁹³

$$Energy\ Savings_{kWh} = \left(\sum Dwelling\ Proportion \times Total\ Savings \right)$$

Table 66 presents the parameters used to calculate unitary energy savings for programmable thermostats installed through Instant Savings.

⁹² Econoler, *Évaluation du programme thermostats électroniques – Volet nouvelle construction au marché résidentiel*, Final Report presented to Hydro-Québec, February 9, 2009.

⁹³ Statistics Canada. (2016). Census Profile, 2016 Census, <https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/Page.cfm> (Last accessed November 27, 2019).

Table 66: Electrical Unitary Savings Calculations for Programmable Thermostats

Parameters	Symbol	Instant Savings			Source
		Single-detached	Duplex/Triplex/Townhouse	Apartment	
Proportion of Each Dwelling Type	<i>Dwelling Proportion</i>	69%	11%	20%	Statistics Canada 2016 Census
Gross Energy Savings per Thermostat					
Unitary Savings for Electronic Thermostat Accuracy [kWh]	<i>Thermostat Savings</i>	121	94	61	2009 Econoler
Unitary Savings for Temperature Setback [kWh]	<i>Temp. Setback Savings</i>	100	201	118	2009 Econoler
Total Savings per Dwelling Type [kWh]	<i>Total Savings</i>	221	295	179	Calculation
Average Weighted Unitary Energy Savings [kWh]	<i>Energy Savings_{kWh}</i>	221			Calculation

For MHEEP, the 221 kWh value is used since almost all MHEEP participants are in single-detached houses.

Installation Rates

For Instant Savings, the installation rate is assumed to be 100%.

(9) Smart Thermostats for Electric Baseboard

Summary

Table 67 presents a summary of the values used to calculate smart thermostat savings. The detailed methodology follows.

Table 67: Smart Thermostat for Electric Baseboard Measure Summary

Parameter	Instant Savings	Reference
Measure Description and Identification		
Measure Description	Smart thermostats to reduce electric baseboard space heating consumption	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	10	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	348	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0	See Subsection 2.3.2
Unitary Peak Demand Savings [W]	0	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	
Interactive Effects Factor for Peak Demand Savings		See Subsection 2.3.1

Electrical Unitary Energy Savings

Some models of smart thermostats sold through Instant Savings are compatible with electric baseboards. They operate by connecting to a single baseboard as opposed to a central heating system. The equation below is used to calculate the unitary savings value for smart thermostats compatible with electrical baseboards and installed through Instant Savings.

$$Energy\ Savings_{kWh} = \frac{Heating\ Energy \times \%Savings}{Number\ of\ Rooms}$$

Since no studies specific to smart thermostats connected to electric baseboards were identified, the percentage of heating load saved by thermostats is based on available studies for smart thermostats compatible with central heating systems, which have essentially the same features. Table 68 presents two billing analyses conducted for Nest smart thermostats installed on central electrical heating systems (rather than natural gas or oil heating systems). Both analyses assessed the savings for smart thermostats installed to replace both programmable and non-programmable thermostats, which is a reasonable baseline. In both studies, heating consumption savings of 12% were evaluated for central air-source heat pumps, which is the closest heating system to electric baseboards among Nest compatible systems.

Table 68: Billing Analysis Savings Results for Smart Thermostats on Electrical Heating Systems

Jurisdiction	Measure	Sample Size	Heating Consumption Savings
Oregon ⁹⁴	Nest thermostats	185	12% (for ASHPs)
Bonneville Power Administration ⁹⁵	Nest thermostats	176	12% (for ASHPs)

As previously mentioned, electric baseboards are individually paired to a unique compatible smart thermostat. Therefore, the savings are divided by the average number of electrical baseboards within a dwelling, assuming there is one baseboard per room.

Table 69 presents the variables used for the unitary savings calculation and the resulting value.

Table 69: Electrical Unitary Savings Calculation for Smart Thermostats for Electric Baseboard

Parameter	Symbol	Instant Savings	Source
Average heating energy consumption of a home [kWh/year]	<i>Heating Energy</i>	18,854	2018, 2019, and 2020 HEA tracking sheet ⁹⁶
Percentage of heating load saved by smart thermostats	<i>%Savings</i>	12%	Literature review of billing analyses
Average number of rooms per dwelling	<i>No. of rooms</i>	6.5	Statistics Canada 2016 Census ⁹⁷
Unitary Energy Savings [kWh/year]	-	348	Calculation

Installation Rates

For Instant Savings, the installation rate is assumed to be 100%.

2.4 Appliances

2.4.1 Interactive Effects

Retiring old appliances causes an increase in the heating load in the winter and a decrease in the cooling load in the summer since compressors on old appliances release significantly more waste heat than newer, more efficient models. If an inefficient appliance is retired without being replaced, interactive effects are greater.

⁹⁴ Apex Analytics LLC, *Energy Trust of Oregon Nest Thermostat Heat Pump Control Pilot Evaluation*, October 10, 2014, 123 p.

⁹⁵ Bonneville Power Administration, *Nest Learning Thermostat Pilot Program Savings Assessment Bonneville Power Administration & Franklin Public Utility District*, November 16, 2016.

⁹⁶ Based on the average modelled heating energy consumption of HEA participants both before and after their home retrofit, including 100% electrically heated participants with no heat pumps and adjusted to take into account HOT2000 overestimation ratios. The averages of each year were weighted according to the number of projects.

⁹⁷ Statistics Canada, Census Profile, 2016 Census, <https://www12.statcan.gc.ca/census-recensement/2016/dp-prof/details/Page.cfm?Lang=E&Geo1=PR&Code1=12&Geo2=&Code2=&Data=Count&SearchType=Begin&SearchP=R=01&B1=All> (last accessed December 3, 2019).

The heating load period in Nova Scotia lasts about eight months, while the cooling load period is relatively short, lasting approximately two months. The annual total interactive effects due to the retirement or replacement of old appliances are therefore expected to be negative, pushing the savings generated by such retirements or replacements downward.

Several other factors can also affect the interactive effects of EOne appliance measures:

- › Close to all appliance measures are accounted for in EOne DSM savings and thus the focus is on electricity savings for appliances. In Nova Scotia, fewer than 27% of households use electricity as their primary heating source.⁹⁸ Therefore, the negative interactive effects on the heating load only affect approximately one-third of participating households.
- › A significant number of appliances targeted through EOne programs, such as refrigerators and freezers, are built into or leaned against an exterior wall. Rather than contributing to building heat loads, this results in more heat loss through the building envelope and through the appliance back wall, thereby reducing interactive effects.
- › In Nova Scotia, one third of households (34%)⁹⁹ use air conditioning. For these households, positive interactive effects occur during the cooling period, which cancel a portion of the negative interactive effects.
- › Most jurisdictions that offer refrigerator and freezer programs do not consider interactive effects for those appliances.¹⁰⁰

Considering all these factors, the interactive effects for appliances are negligible and, therefore, the interactive effects factors for energy and peak demand savings are 0%.

Table 70 summarizes the interactive effectors factors established for appliances.

⁹⁸ Statistics Canada, *Residential Sector, Nova Scotia, Table 14: Total Households by Building Type and Energy Source* <http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=ns&rn=14&page=4>, (Last accessed September 9, 2020).

⁹⁹ Statistics Canada, *Table 38-10-0019-01 – Air conditioners*, <https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3810001901> (Last accessed December 3, 2019).

¹⁰⁰ The TRMs for California Municipal Utilities, Connecticut, Illinois, Maine, Massachusetts, Minnesota, Mid-Atlantic, New York, Northwest Power and Conservation Council, Ohio, Pennsylvania, Vermont, and Wisconsin were consulted. Only Northwest Power and Conservation Council and New York apply interactive effects factors for freezers and refrigerators (although only for new rebated appliances and not for recycled appliances).

Table 70: Interactive Effects Factors for Appliances

Measure	Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings	Source
Clotheslines and Outdoor Drying Rack	0%	0%	Assumption (see text above this table)
Refrigerator Retirement/ Replacement			
Freezer Retirement/ Replacement			
Room Air Conditioner Retirement			
Dehumidifier Replacement or Retirement/ ENERGY STAR® Certified Dehumidifier			
Clothes Dryer Replacement/ ENERGY STAR® Certified Clothes Dryer			
Efficient Clothes Washer			
ENERGY STAR® Certified Room Air Purifier			

2.4.2 Peak Demand Savings Factors

For most appliances, peak demand savings are calculated using the peak demand-to-energy ratios developed by Navigant in the 2016-2018 DSM Plan. These ratios were established for various product categories based on modelled system-coincident peak demand savings and electrical energy savings for a projected deployment of products. Navigant used local data to establish the ratios applicable for the 2016-2018 period. The Evaluator recommends using the same ratios during the 2020-2022 DSM cycle.

The Evaluator assumes a peak demand-to-energy ratio of zero for clotheslines, outdoor drying racks, and retired air room conditioners since these products are not likely used on cold winter days when peak conditions occur.

Table 71 summarizes the peak demand-to-energy ratios established for appliances.

Table 71: Peak Demand-to-energy Ratios for Appliances

Measure	Peak Demand-to-energy Ratio (W/kWh)	Source
Clothesline and Outdoor Drying Rack	0.000	Calculated by the Evaluator
Refrigerator Retirement/ Replacement	0.138	RES-Appliance-Fridge, Navigant 2016-2018 DSM Plan
Freezer Retirement/ Replacement	0.138	RES-Appliance-Fridge, Navigant 2016-2018 DSM Plan
Room Air Conditioner Retirement	0.000	Calculated by the Evaluator
Dehumidifier Replacement or Retirement/ ENERGY STAR Certified Dehumidifier	0.335	RES-Appliance-Dehumidifier, Navigant 2016-2018 DSM Plan
Clothes Dryer Replacement/ ENERGY STAR Certified Clothes Dryer	0.138	RES-Appliance-CW, Navigant 2016-2018 DSM Plan
Efficient Clothes Washer	0.138	RES-Appliance-CW, Navigant 2016-2018 DSM Plan
ENERGY STAR Certified Room Air Purifier	0.171	Calculated by the Evaluator

2.4.3 Appliance Measures

(1) Clotheslines and Outdoor Drying Racks

Summary

Table 72 presents a summary of the values used to calculate clothesline and outdoor drying rack savings. The detailed methodology follows.

Table 72: Clothesline and Outdoor Drying Rack Measure Summary

Parameter	EPI	Instant Savings	Reference
Measure Description and Identification			
Measure Description	Clotheslines and outdoor drying racks to reduce electricity consumption of dryers		N/A
Additional Notes	-		
General Parameters			
Installation Rate	86%	100%	See details below under Installation Rates
Effective Useful Life [years]	10		See Subsection 4.2
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	104		See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.000		See Subsection 2.4.2
Unitary Peak Demand Savings [W]	0		Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%		See Subsection 2.4.1
Interactive Effects Factor for Peak Demand Savings	0%		See Subsection 2.4.1

Electrical Unitary Energy Savings

The savings from this measure are due to avoided clothes dryer loads. The following equation is used to establish the unitary savings associated with clotheslines and outdoor drying racks.

$$\begin{aligned}
 \text{Energy Savings} & \left[\frac{\text{kWh}}{\text{year}} \right] \\
 &= \text{Annual Laundry Loads} \left[\frac{\text{load}}{\text{year}} \right] \\
 &\times \text{Proportion of Loads Dried on Clotheslines or Outdoor Drying Racks} [\%] \\
 &\times \text{Energy Consumption per Load} \left[\frac{\text{kWh}}{\text{load}} \right]
 \end{aligned}$$

Table 73 below lists the parameters and corresponding values applied in the equation above for clotheslines and outdoor drying racks installed and the resulting unitary savings values.

Table 73: Electrical Unitary Savings Values for Clotheslines and Outdoor Drying Racks

Parameter	Value	Source
Number of Laundry Loads per Year [loads/year]	290	Hydro-Québec ¹⁰¹
Proportion of Loads Dried on Clotheslines [%]	16.3%	OPA 2011 ¹⁰²
Energy Consumption per Load [kWh/load]	2.2	OPA 2011 ¹⁰³
Unitary Energy Savings [kWh/year]	104	Calculation

Installation Rates

For EPI, Table 74 lists the installation rate for clotheslines and outdoor drying racks.

Table 74: Clothesline and Outdoor Drying Rack Installation Rate

Installation Rate	Margin of Error	Source
86%	8.1%	EPI 2018 DSM and 2018/19 PNS Surveys ¹⁰⁴

For Instant Savings, the installation rate is assumed to be 100%.

¹⁰¹ Ad Hoc Recherche. *Marché résidentiel: Rapport d'évaluation. Programme: Produits Mieux Consommer – Électroménagers ENERGY STAR*. September 2011.

¹⁰² Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

¹⁰³ Ibid.

¹⁰⁴ The 2021 EPI site visits did not include enough participants with clotheslines or outdoor drying racks to update the installation rate for this measure.

(2) Refrigerator Retirements/Replacements

Summary

Table 75 presents a summary of the values used to calculate refrigerator retirement and replacement savings. The detailed methodology follows.

Table 75: Refrigerator Retirement/Replacement Measure Summary

Parameter	ARet			Reference
Measure Description and Identification				
Measure Description	Retirement of old refrigerators to reduce electricity consumption		Replacement of old refrigerators to reduce electricity consumption	N/A
Additional Notes	Full-sized refrigerators – 10 ft. ³ and more	Small refrigerators – less than 10 ft. ³	-	
General Parameters				
Installation Rate	N/A		100%	See details below under Installation Rates
Effective Useful Life [years]	4		5	See Subsection 4.2
Electrical Savings Parameters				
Unitary Energy Savings [kWh/year]	671	164	660	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.138			See Subsection 2.4.2
Unitary Peak Demand Savings [W]	92.6	22.6	91.1	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%			See Subsection 2.4.1
Interactive Effects Factor for Peak Demand Savings	0%			See Subsection 2.4.1

Electrical Unitary Energy Savings

The following equations are used to determine the electrical unitary energy savings value of retired and replaced refrigerators.

$$\text{Energy Savings}_{kWh} = \text{AvgConsumptionPerSize} \times \text{AvgSize} \times \text{OAR} \times \text{PuF} - \text{NewConsumption}$$

$$\text{AvgConsumptionPerSize} = \sum (\text{ConsumptionPerSize} \times \% \text{ManufactureSplit})$$

For regular and small refrigerators retired through ARet, the average annual per-cubic-foot energy consumption is calculated using 2017 metering activity results,¹⁰⁵ classified by manufacture-year class^{106,107,108} and weighted based on the 2021 tracking sheet data. The occupant adjustment factor is based on the metering protocol of the New York Department of Public Service¹⁰⁹ and the part-use factor is calculated based on the 2018 participant survey data.¹¹⁰

For refrigerators replaced through HomeWarming and MHEEP, the unitary savings value is based on the average annual per-cubic-foot energy consumption of refrigerators manufactured in 1994 and earlier because eligible refrigerators correspond to this age category. It is assumed that all replaced refrigerators are primary refrigerators since it is a program component criterion and therefore no part-use factor is applied. The energy consumption of installed new refrigerators is calculated based on the 2021 HomeWarming and MHEEP tracking sheet data and the energy consumption rating of each model as labeled by EnerGuide and retrieved using ENERGY STAR's Product Finder Tool.¹¹¹

Table 76 below presents the parameters of the above equations as well as the unitary savings calculations for the refrigerator retirement and replacement measures.

¹⁰⁵ Econoler, *Residential Efficient Product Rebates Program – 2017 DSM Evaluation*, Final Report presented to Efficiency Nova Scotia, March 15, 2018.

¹⁰⁶ U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Energy Conservation: Program for Consumer Products: Energy Conservation Standards for Refrigerators, Refrigerator-Freezers and Freezers*, 10 CFR Part 430, April 28, 1997.

¹⁰⁷ Natural Resources Canada, *Refrigerators, Refrigerators-Freezers and Wine Chillers - Energy Efficiency Regulations*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6877> (Last accessed January 17, 2019).

¹⁰⁸ Natural Resources Canada, *Registration and Publication of Regulations Amending Canada's Energy Efficiency Regulations*, <https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-regulations/regulatory-announcements/amendment-13/18419> (Last accessed October 1, 2020).

¹⁰⁹ New York Department of Public Service, *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs - Residential, Multi-Family, and Commercial/Industrial Measures*, April 15, 2019, p. 29.

¹¹⁰ Econoler, *Residential Efficient Product Rebates Program – 2018 DSM Evaluation*, Final Report presented to Efficiency Nova Scotia, March 15, 2019.

¹¹¹ ENERGY STAR, *Product Finder Tool*, <https://www.energystar.gov/productfinder/product/certified-residential-freezers/results?SetLanguage=English&NRCAN=on> (Last accessed September 3, 2020).

Table 76: Electrical Unitary Savings Values for Refrigerator Retirements/Replacements

Parameter	Symbol	Manufacture-year Class	ARet (Retirement)		ARet (Replacement)	Source
			Full-sized Refrigerators (≥ 10 ft. ³)	Small Refrigerators (< 10 ft. ³)		
Annual Consumption per Size [kWh/ft ³]	<i>ConsumptionPerSize</i>	2002 and later	49.2			2017 metering activities, 1997 USDE, NRCan EE Regulations
		1995-2001	41.1			
		1994 and earlier	58.9			
Proportion of Refrigerators in 2021	<i>%ManufactureSplit</i>	2002 and later	45%	66%	0%	2021 tracking sheet
		1995-2001	29%	13%	0%	
		1994 and earlier	26%	20%	100%	
Average Annual Consumption per Size [kWh/ft ³]	<i>AvgConsumptionPerSize</i>	-	49.4	49.6	58.9	Calculation
Average Refrigerator Size [ft ³]	<i>AvgSize</i>	-	17.5	7.1	15.3	2021 tracking sheet
Occupant Adjustment Ratio	<i>OAR</i>	-	1.11			2019 NYDPS
Part-use Factor	<i>PuF</i>	-	0.70	0.42	N/A	2018 survey data
Consumption of the New Refrigerator [kWh]	<i>NewConsumption</i>	-	N/A		340	Average from 2021 tracking sheet
Unitary Energy Savings [kWh/year]	<i>Energy Savings_{kWh}</i>	-	671	164	660	Calculation

Installation Rates

The installation rates are assumed to be 100%.

(3) Freezer Retirements/Replacements

Summary

Table 77 presents a summary of the values used to calculate freezer retirement and replacement savings. The detailed methodology follows.

Table 77: Freezer Retirement/Replacement Measure Summary

Parameter	ARet			Reference
Measure Description and Identification				
Measure Description	Retirement of old freezers to reduce electricity consumption		Replacement of old freezers to reduce electricity consumption	N/A
Additional Notes	Full-sized freezers – 7 ft. ³ and more	Small freezers – less than 7 ft. ³	-	
General Parameters				
Installation Rate	N/A		100%	See details below under Installation Rates
Effective Useful Life [years]	4		4	See Subsection 4.2
Electrical Savings Parameters				
Unitary Energy Savings [kWh/year]	862	240	1,077	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.138			See Subsection 2.4.2
Unitary Peak Demand Savings [W]	119	33.1	149	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%			See Subsection 2.4.1
Interactive Effects Factor for Peak Demand Savings	0%			See Subsection 2.4.1

Electrical Unitary Energy Savings

To determine the electrical unitary energy savings value of retired (ARet) and replaced (HW, MHEEP) freezers the following equations are used.

$$Energy\ Savings_{kWh} = AvgConsumptionPerSize \times AvgSize \times OAR \times PuF - NewConsumption$$

$$AvgConsumptionPerSize = \sum (ConsumptionPerSize \times \%ManufactureSplit)$$

For regular and small freezers retired through ARet, the average annual per-cubic-foot energy consumption is calculated using 2017 metering activity results,¹¹² classified by manufacture-year class^{113,114,115} and weighted based on the 2021 tracking sheet data. The occupant adjustment factor is based on the metering protocol of the New York Department of Public Service¹¹⁶ and the part-use factor is calculated based on the 2018 participant survey data.¹¹⁷

For freezers replaced through HomeWarming and MHEEP, the unitary savings value is based on the average annual per-cubic-foot energy consumption of freezers manufactured in 1994 and earlier because eligible freezers correspond to this age category. It is assumed that all retired freezers are primary freezers since it is a program component criterion and therefore no part-use factor is applied. The energy consumption of installed new freezers is calculated based on the 2021 HomeWarming and MHEEP tracking sheet data and the energy consumption rating of each model as labeled by EnerGuide and retrieved using ENERGY STAR's Product Finder Tool.¹¹⁸

Table 78 below presents the parameters of the above equations as well as the unitary savings calculations for the freezer retirement and replacement measures.

¹¹² Econoler, *Residential Efficient Product Rebates Program – 2017 DSM Evaluation*, Final Report presented to Efficiency Nova Scotia, March 15, 2018.

¹¹³ U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Energy Conservation: Program for Consumer Products: Energy Conservation Standards for Refrigerators, Refrigerator-Freezers and Freezers*, 10 CFR Part 430, April 28, 1997.

¹¹⁴ Natural Resources Canada, *Refrigerators, Refrigerators-Freezers and Wine Chillers - Energy Efficiency Regulations*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6877> (Last accessed January 17, 2019).

¹¹⁵ Natural Resources Canada, *Registration and Publication of Regulations Amending Canada's Energy Efficiency Regulations*, <https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-regulations/regulatory-announcements/amendment-13/18419> (Last accessed October 1, 2020).

¹¹⁶ New York Department of Public Service, *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs - Residential, Multi-Family, and Commercial/Industrial Measures*, April 15, 2019, p. 29.

¹¹⁷ Econoler, *Residential Efficient Product Rebates Program – 2018 DSM Evaluation*, Final Report presented to Efficiency Nova Scotia, March 15, 2019.

¹¹⁸ ENERGY STAR, *Product Finder Tool*, <https://www.energystar.gov/productfinder/product/certified-residential-freezers/results?SetLanguage=English&NRCAN=on> (Last accessed September 3, 2020).

Table 78: Electrical Unitary Savings Values for Freezer Retirements/Replacements

Parameter	Symbol	Manufacture-year Class	ARet (Retirement)		ARet (Replacement)	Source
			Regular Freezers (≥ 7 ft. ³)	Small Freezers (< 7 ft. ³)		
Annual Consumption per Size [kWh/ft ³]	ConsumptionPerSize	1995 and later	56.2			2017 metering activities, 1997 USDE, NRCan EE Regulations
		1994 and earlier	117.8			
Proportion of Freezers in 2021	%ManufactureSplit	1995 and later	50%	72%	0%	2021 tracking sheet
		1994 and earlier	50%	28%	100%	
Average Annual Consumption per Size [kWh/ft ³]	AvgConsumptionPerSize	-	87.0	73.4	117.8	Calculation
Average Freezer Size [ft ³]	AvgSize	-	12.4	7.0	10.1	2021 tracking sheet
Occupant Adjustment Ratio	OAR	-	1.11			2019 NYDPS
Part-use Factor	PuF	-	0.72	0.42	N/A	2018 survey data
Consumption of the New Freezer [kWh]	NewConsumption	-	N/A		244	Average from 2021 tracking sheet
Unitary Energy Savings [kWh/year]	Energy Savings _{kWh}	-	862	240	1,077	Calculation

Installation Rates

The installation rates are assumed to be 100%.

(4) Room Air Conditioner Retirements

Summary

Table 79 presents a summary of the values used to calculate room air conditioner retirement savings. The detailed methodology follows.

Table 79: Room Air Conditioner Retirement Measure Summary

Parameter	ARet	Reference
Measure Description and Identification		
Measure Description	Retirement of old room air conditioners to reduce electricity consumption	N/A
Additional Notes	-	
General Parameters		
Installation Rate	N/A	N/A
Effective Useful Life [years]	3	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	257	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.000	See Subsection 2.4.2
Unitary Peak Demand Savings [W]	0	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	See Subsection 2.4.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 2.4.1

Electrical Unitary Energy Savings

The electrical unitary energy savings of retired room air conditioners are calculated using the equations below.

$$Energy\ Savings_{kWh} = \frac{Q \times HOU}{SEER \times 1,000}$$

$$SEER = EER \times RACER$$

The retired unit average capacity variable is calculated using the 2020 tracking sheet data.

The hours of operation variable is based on NRCan's EnerGuide Room Air Conditioner Directory,¹¹⁹ which provides local data for four cities in Nova Scotia, namely Halifax, Yarmouth, Sydney, and Greenwood, and is calculated by taking into account the proportion of those participants who retired a room air conditioner in each of the regions of these four cities in 2020. The participants' postal codes recorded in the ARet tracking sheet were used to determine their locations. The following formula was used to calculate the weighted average hours of operation across the province.

¹¹⁹ NRCan's Office of Energy Efficiency, *EnerGuide Room Air Conditioner Directory 2012*, May 2012, p. 88.

$$\begin{aligned}
 \text{Annual Hours of Operation } \left[\frac{\text{hr}}{\text{yr}} \right] &= (\%_{\text{people}} \times HOU)_{\text{Halifax}} + (\%_{\text{people}} \times HOU)_{\text{Yarmouth}} + (\%_{\text{people}} \times HOU)_{\text{Sydney}} \\
 &+ (\%_{\text{people}} \times HOU)_{\text{Greenwood}}
 \end{aligned}$$

It is assumed that most air conditioners retired through ARet meet the energy efficiency ratio (EER) of 8.0 as per Canada's Energy Efficiency Regulations introduced in 1995 and, to account for seasonal temperature changes, the EER of 8.0 should be multiplied by a factor of 1.11 in accordance with the Ecox Technical Information Bulletin on SEER.¹²⁰

Table 80 below presents the parameters of the above equations as well as the unitary savings calculations for the room air conditioner retirement measure.

Table 80: Electrical Unitary Savings Values for Room Air Conditioner Retirement

Parameter	Symbol	ARet	Source
Average Capacity of the Retired Equipment [BTU/h]	Q	6,527	2020 tracking sheet
Annual Hours of Use [h/year]	HOU	349	Calculated
Energy Efficiency Ratio of the Retired Equipment [BTU/W*h]	EER	8.0	2003 NRCan ¹²¹
Factor Used to Determine the SEER of a Room Air Conditioner Based on its EER	$RACER$	1.11	Ecox Bulletin No. E-004-EN
Seasonal Energy Efficiency Ratio of the Retired Equipment [BTU/W*h]	$SEER$	8.9	Calculated
Conversion Factor [W/kW]	1,000	1,000	Convention
Unitary Energy Savings [kWh/year]	$Energy Savings_{kWh}$	257	Calculation

(5) Dehumidifier Replacements or Retirements/ENERGY STAR Certified Dehumidifiers

Summary

Table 81 presents a summary of the values used to calculate dehumidifier replacement or retirement and ENERGY STAR certified dehumidifier savings. The detailed methodology follows.

¹²⁰ Ecox, Technical Information Bulletin No. E-004-EN: SEER, www.ecoxline.com (Last accessed March 3, 2016).

¹²¹ NRCan's Office of Energy Efficiency. Air Conditioning Your Home, 2003, p. 15.

**Table 81: Dehumidifier Replacement or Retirement /
ENERGY STAR Certified Dehumidifier Measure Summary**

Parameter	ARet	Instant Savings	Reference
Measure Description and Identification			
Measure Description	Replacement or retirement of old dehumidifiers to reduce electricity consumption	ENERGY STAR certified dehumidifiers to reduce electricity consumption	N/A
Additional Notes	-		
General Parameters			
Installation Rate	100%		See details below under Installation Rates
Effective Useful Life [years]	5	12	See Subsection 4.2
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	636	45.2	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.335		See Subsection 2.4.2
Unitary Peak Demand Savings [W]	213	15.1	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%		See Subsection 2.4.1
Interactive Effects Factor for Peak Demand Savings	0%		See Subsection 2.4.1

Electrical Unitary Energy Savings

For both ARet and Instant Savings, dehumidifier electrical unitary energy savings are calculated using the equation below.

$$Energy\ Savings_{kWh} = AWRC \times AOD \times \left(\frac{1}{EF_{base}} - \frac{1}{EF_{new}} \right)$$

For ARet, the baseline energy factor is based on the 2011 Ontario Power Authority (OPA) Prescriptive Measures and Assumptions report.¹²² The new energy factor is based on the 2020 ARet tracking sheet and the ENERGY STAR guidelines for dehumidifiers.¹²³ While ARet drop-off events offer an opportunity to retire a dehumidifier without necessarily replacing it, the Evaluator assumed that participants replaced their unit since it is unlikely that a home stopped needing dehumidification.

¹²² Ontario Power Authority (OPA). 2011 Prescriptive Measures and Assumptions, Released Version 1, March 2011.

¹²³ ENERGY STAR, ENERGY STAR® Program Requirements Product Specification for Dehumidifiers – Eligibility Criteria V5.0,

<https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Dehumidifiers%20Version%205.0%20Program%20Requirements.pdf> (Last accessed September 3, 2020).

For Instant Savings, the base energy factor corresponds to the minimum energy factor required by Canadian regulations¹²⁴ for the average water removal capacity of the 10 most rebated products in 2020. The new energy factor is based on the 2020 Instant Savings tracking sheet and the ENERGY STAR guidelines for dehumidifiers.

For both program components, the average water removal capacity and the average operating days are based on the 2011 Ontario Power Authority (OPA) Prescriptive Measures and Assumptions report.

Table 82 below presents the parameters of the above equations as well as the unitary savings calculations for the dehumidifier replacement and ENERGY STAR certified dehumidifier measures.

Table 82: Electrical Unitary Savings Values for Dehumidifier Replacements or Retirements/ ENERGY STAR Certified Dehumidifiers

Parameter	Symbol	A _{Ret} (A _{Ret} , HW, MHEEP)	Instant Savings	Source
Average Water Removal Capacity [L/day]	$AWRC$	3.87		2011 OPA
Average Operating Days [days/year]	AOD	168		2011 OPA
Energy Factor of the Baseline Dehumidifier [L/kWh]	EF_{base}	0.66	1.6	A _{Ret} 2011 OPA Instant Savings 2019 NRCAN Regulation
Energy Factor of the New ENERGY STAR Certified Dehumidifier [L/kWh]	EF_{new}	1.86	1.8	2019 ENERGY STAR Guidelines A _{Ret} 2020 A _{Ret} tracking sheet Instant Savings 2020 Instant Savings tracking sheet
Unitary Energy Savings [kWh/year]	$Energy Savings_{kWh}$	636	45.2	Calculation

Installation Rates

The installation rates are assumed to be 100%.

(6) Clothes Dryer Replacements/ENERGY STAR Certified Clothes Dryers

Summary

Table 83 presents a summary of the values used to calculate clothes dryer replacement savings. The detailed methodology follows.

¹²⁴ Natural Resources Canada, *Regulations and Standards – Dehumidifiers*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6889> (Last accessed September 3, 2020).

Table 83: Clothes Dryer Replacement Measure Summary

Parameter	A _{Ret}	Instant Savings	Reference
Measure Description and Identification			
Measure Description	Replacement of old clothes dryers to reduce electricity consumption	ENERGY STAR certified clothes dryers to reduce electricity consumption	N/A
Additional Notes	-		
General Parameters			
Installation Rate	100%		See details below under Installation Rates
Effective Useful Life [years]	5	12	See Subsection 4.2
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	252	151	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.138		See Subsection 2.4.2
Unitary Peak Demand Savings [W]	34.8	20.8	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%		See Subsection 2.4.1
Interactive Effects Factor for Peak Demand Savings	0%		See Subsection 2.4.1

Electrical Unitary Energy Savings

The electrical unitary energy savings of the clothes dryer replacement measure are calculated using the equations below.

$$Energy\ Savings_{kWh} = APDL \times AWL \times ALW \times \left(\frac{1}{CEF_{base}} - \frac{1}{CEF_{new}} \right)$$

$$APDL = (UsgDist \times UsgFreq)_{Every\ Time} + (UsgDist \times UsgFreq)_{Sometimes} + (UsgDist \times UsgFreq)_{Infrequently}$$

$$CEF_{base\ (A_{Ret})} = CEF_{new} \times \frac{AvgConsumption_{new}}{AvgConsumption_{old}}$$

The average proportion of dried loads (APDL) using a clothes dryer is calculated using the clothes dryer usage distribution data from ENERGY STAR's 2011 Scoping Report¹²⁵ and the assumptions on usage frequency highlighted in the table further below.

The combined energy factor (CEF) of the baseline unit replaced through ARet (MHEEP) is based on the CEF of the new unit and the average clothes dryer energy consumption values as reported in NRCan's Energy Consumption Trend Report for the 1990-2011 period.¹²⁶ The CEF of the base unit replaced through Instant Savings corresponds to the baseline prescribed by the U.S Department of Energy (DEO).¹²⁷

The CEF of the new units installed through ARet is the factor of the only model available through this program component. For Instant Savings, the CEF of the new units is based on the weighted average CEF of the 10 most installed models in 2020.

Table 84 below presents the parameters of the above equations as well as the unitary savings calculations for the clothes dryer replacement measure.

¹²⁵ ENERGY STAR. *ENERGY STAR Market & Industry Scoping Report, Residential Clothes Dryers, November 2011*. Available at:

https://www.energystar.gov/sites/default/files/asset/document/ENERGY_STAR_Scoping_Report_Residential_Clothes_Dryers.pdf (Last accessed on January 17, 2020).

¹²⁶ Natural Resources Canada. *ENERGY CONSUMPTION of Major Household Appliances Shipped in Canada, Summary Report, Trends for 1990-2011*. Available at:

<http://oee.nrcan.gc.ca/publications/statistics/aham/2011/pdf/aham2011.pdf> (Last accessed on January 17, 2020).

¹²⁷ The U.S Department of Energy (DOE). *Energy Conservation Program: Energy Conservation Standards for Residential Clothes Dryers*, March 2015. Available at: <https://www.govinfo.gov/content/pkg/FR-2015-03-27/pdf/2015-07058.pdf>

Table 84: Electrical Unitary Savings Values for Clothes Dryer Replacements

Parameter	Symbol	ARet (HW, MHEEP)	Instant Savings	Source
Clothes Dryer Usage Distribution	$UsgDist$	Used Every Time: 82.4% Used Sometimes: 15.3% Used Infrequently: 2.3%		2011 ENERGY STAR Report
Clothes Dryer Usage Frequency Assumption	$UsgFreq$	Used Every Time: 100% Used Sometimes: 50% Used Infrequently: 25%		Assumption
Average Proportion of Dried Loads Using Clothes Dryer [load/load]	$APDL$	91%		Calculation
Average Washed Loads per Year [load/year]	AWL	290		2011 Hydro-Québec ¹²⁸
Average Load Weight [lbs/load]	ALW	8.45		2019 PUC TRM ¹²⁹
Combined Energy Factor of New Unit [lbs/kWh]	CEF_{new}	3.93	3.94	<u>ARet</u> CEF of the model offered <u>Instant Savings</u> 2020 tracking sheet
Average Energy Consumption of New Unit [kWh/L]	$AvgConsumption_{new}$	4.78	N/A	2011 NRCan Report
Average Energy Consumption of Old Unit [kWh/L]	$AvgConsumption_{old}$	6.08	N/A	2011 NRCan Report
Combined Energy Factor of Baseline Unit [lbs/kWh]	CEF_{base}	2.72	3.11	<u>ARet</u> Calculation <u>Instant Savings</u> DOE, 2015
Unitary Energy Savings [kWh/year]	$Energy Savings_{kW}$	252	151	Calculation

Installation Rates

The installation rates are assumed to be 100%.

(7) Efficient Clothes Washers

Summary

Table 85 presents a summary of the values used to calculate efficient clothes washer savings. The detailed methodology follows.

¹²⁸ Ad Hoc Recherche. *Marché résidentiel: Rapport d'évaluation. Programme: Produits Mieux Consommer – Électroménagers ENERGY STAR*, September 2011, p.18.

¹²⁹ Pennsylvania Public Utility Commission (PUC), *Technical Reference Manual*, August 2019, Subsection 2.4 – Appliances.

Table 85: Efficient Clothes Washer Measure Summary

Parameter	Instant Savings	Reference
Measure Description and Identification		
Measure Description	Efficient clothes washers to reduce electricity consumption	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	11	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	165	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.138	See Subsection 2.4.2
Unitary Peak Demand Savings [W]	22.8	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	See Subsection 2.4.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 2.4.1

Electrical Unitary Energy Savings

For efficient clothes washers, the electrical unitary savings value is determined by comparing standard and efficient clothes washer annual energy consumption values, adjusted to consider the proportion of electrically heated hot water used by the appliance.

Energy Consumption Calculation

First, the energy consumption values of both standard and efficient clothes washers are determined using the following equation.

$$\text{Clothes Washer Energy Consumption [kWh]} = \frac{\text{Number of Loads} \left[\frac{\text{Loads}}{\text{Year}} \right] * \text{Capacity}[L]}{\text{IMEF} \left[\frac{L}{\text{kWh}} \right]}$$

Table 86 below lists the parameters and corresponding values applied in the equations above for efficient and standard clothes washers and their resulting energy consumption.

Table 86: Clothes Washer Energy Consumption

Parameter	Value for Standard Clothes Washer	Value for Efficient Clothes Washer	Source
Number of Loads [Loads/Year]	290		Hydro-Québec ¹³⁰
Capacity [L]	127		Weighted average capacity based on 10 most rebated models in 2020 and ENERGY STAR Certified Clothes Washers database ¹³¹
Integrated Modified Energy Factor (IMEF) [L/kWh/cycle]	58.6	83.2	Standard: NRCAN ¹³² Efficient: Weighted average capacity based on 10 most rebated models in 2020 and ENERGY STAR Certified Clothes Washers database
Clothes Washer Energy Consumption [kWh/year]	629	443	Calculation

Water Heating Adjustment

Both energy consumption values do not take into account the proportion of hot water for clothes washers produced with electricity in Nova Scotia, nor the use of cold water for washing. Therefore, the energy consumption of both standard and efficient clothes washers is broken down for each stage of the washing process, as presented in Table 87, to apply correction factors separately at each stage.

Table 87: Energy Consumption Breakdown for Standard and Efficient Clothes Washers

Energy Consumption Breakdown for Clothes Washers	Proportion of Overall Consumption ¹³³	Standard Clothes Washer Electricity Consumption (kWh/year)	Efficient Clothes Washer Electricity Consumption (kWh/year)
Water Heating System	24.8%	156	110
Clothes Dryer	68.1%	428	302
Clothes Washer Drum	7.1%	45	31
Total	100.0%	629	443

¹³⁰ Ad Hoc Recherche. *Marché résidentiel: Rapport d'évaluation. Programme: Produits Mieux Consommer – Électroménagers ENERGY STAR*. September 2011.

¹³¹ ENERGY STAR, *ENERGY STAR Certified Residential Clothes Washers*, <https://www.energystar.gov/productfinder/product/certified-clothes-washers/> (Last accessed December 21, 2018).

¹³² Natural Resources Canada, *Search: Clothes Washers | Energy Efficiency Ratings*, <http://oee.nrcan.gc.ca/pml-imp/index.cfm?action=app.search-recherche&appliance=CLOTHESWASHERS> (Last accessed August 19, 2020).

¹³³ Ad Hoc Recherche, *Rapport d'évaluation, Programme : Produits Mieux Consommer – Électroménagers Energy Star (Années 2008 et 2009)*, p. 18.

To estimate the savings attributable to water heating system energy consumption, the percentage of electrically heated water is calculated, as presented in Table 88 below. First, the percentage of non-ENERGY STAR Most Efficient 2020 clothes washers with an internal electrical heater is obtained from the Energy Efficiency Ratings directory. This same percentage is applied to efficient clothes washers. Where an internal heater is present, it is assumed that 100% of the water heating savings are to be claimed.

For clothes washers using a domestic hot water (DHW) tank as a heating source, the proportion of electrical DHW tanks in Nova Scotia is used to calculate the overall proportion of electrically heated water for both standard and efficient clothes washers. The proportion of electrical DHW tanks in Nova Scotia is based on participant data collected in the 2018 and 2019 EPI tracking sheets.

Table 88: Water Heating Sources for Clothes Washers

Source of Hot Water for Clothes Washers	Clothes Washer Water Heating	DHW Tank Type	Proportion	Clothes Washer Energy Source
Internal Electrical Heater	30%	-	-	30.0%
DHW Tank	70%	Electrical	72%	50.4%
		Non-electrical	28%	19.6%
Proportion of Electrical Water Heating				80.4%

By adding the proportion of internal electrical heaters to the proportion of electrical DHW tanks, the proportion of electrical water heating was established at 80.4% of total water heating energy consumption by clothes washers.

For water heating consumption, an adjustment factor for cold water washing is applied. Thus, to account for the usage of cold water for washing, the water heating energy consumption value is multiplied by a factor of 0.67, which is based on a survey conducted by Hydro-Québec that found that 67% of washes are done in heated water.¹³⁴

Adjusted Energy Consumption

Table 89 and Table 90 present the calculations of total electricity consumption for standard and efficient clothes washers respectively.

Table 89: Electricity Consumption for Standard Clothes Washers

Energy Consumption Component	Energy Consumption (kWh/year)	Adjustment Factor for Electrical Water Heating	Adjustment Factor for Cold Water Usage	Adjusted Energy Consumption (kWh/year)
Water Heating System	156	0.804	0.67	84
Internal Clothes Dryer	428	-	-	428
Washing Machine Drum	45	-	-	45
Total	629	-	-	557

¹³⁴ Ad Hoc Recherche, *Rapport d'évaluation, Programme : Produits Mieux Consommer – Électroménagers Energy Star (Années 2008 et 2009)*, p. 19.

Table 90: Electricity Consumption for Efficient Clothes Washers

Energy Consumption Component	Energy Consumption (kWh/year)	Adjustment Factor for Electrical Water Heating	Adjustment Factor for Cold Water Usage	Adjusted Electricity Consumption (kWh/year)
Water Heating System	110	0.804	0.67	59
Internal Clothes Dryer	302	-	-	302
Washing Machine Drum	31	-	-	31
Total	443	-	-	392

Therefore, the unitary energy savings value is established using the energy consumption between standard and efficient clothes washers, as presented in Table 91.

Table 91: Electrical Unitary Savings Value for Clothes Washer

Parameters	Value
Adjusted Energy Consumption of Standard Clothes Washer [kWh/year]	557
Adjusted Energy Consumption of Efficient Clothes Washer [kWh/year]	392
Unitary Energy Savings [kWh/year]	165

Installation Rates

The installation rate is assumed to be 100%.

(8) ENERGY STAR Certified Room Air Purifiers

Summary

Table 92 presents a summary of the values used to calculate ENERGY STAR certified room air purifier savings. The detailed methodology follows.

Table 92: ENERGY STAR Certified Room Air Purifier Measure Summary

Parameter	Instant Savings	Reference
Measure Description and Identification		
Measure Description	ENERGY STAR certified room air purifiers to reduce electricity consumption	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	9	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	435	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.171	See Subsection 2.4.2
Unitary Peak Demand Savings [W]	74.4	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	See Subsection 2.4.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 2.4.1

Electrical Unitary Energy Savings

The electrical unitary energy savings value is determined by using the following equation for ENERGY STAR certified room air purifiers.

$$\begin{aligned}
 \text{Energy Savings} \left[\frac{kWh}{year} \right] &= \left[CADR[cfm] \times \left(\frac{1}{EF_{base}} - \frac{1}{EF_{eff}} \right) \left[\frac{W}{cfm} \right] \times HOU \left[\frac{hours}{year} \right] \right. \\
 &\quad \left. + (SBP_{base} - SBP_{eff})[W] \times (8,760 - HOU) \left[\frac{hours}{year} \right] \right] \times \frac{1 kW}{1,000 W}
 \end{aligned}$$

Table 93 below lists the parameters and corresponding values applied in the equation above and the resulting unitary savings values. Most values are based on the 10 most sold models under Instant Savings in 2020, which represent 73% of air purifier sales under the program component. Other values are based on the Savings Calculator for ENERGY STAR Qualified Appliances since the Canadian government currently has no minimum requirements for room air purifiers.

Table 93: Electrical Unitary Savings Values for ENERGY STAR Certified Room Air Purifiers

Parameter	Symbol	Value	Source
Clean Air Delivery Rate [cfm]	$CADR$	115	Weighted average of the 10 most sold models
Efficiency for Baseline Unit [cfm/W]	EF_{base}	1.00	Savings Calculator for ENERGY STAR Qualified Appliances ¹³⁵
Efficiency for Efficient Unit [cfm/W]	EF_{eff}	2.81	Weighted average of the 10 most sold models
Annual Operating Hours [hours/year]	HOU	5,840	Savings Calculator for ENERGY STAR Qualified Appliances
Standby Power for Baseline Unit [W]	SBP_{base}	1.00	Savings Calculator for ENERGY STAR Qualified Appliances
Standby Power for Efficient Unit [W]	SBP_{eff}	0.25	Weighted average of the 10 most sold models
Unitary Energy Savings [kWh/year]	$Energy\ Savings_{kWh}$	435	Calculation

Installation Rates

The installation rate is assumed to be 100%.

2.5 Plug Load Controls

2.5.1 Interactive Effects

No interactive effects factors are calculated for power bars and outdoor devices because they are assumed to be negligible.

Table 94 summarizes the interactive effects factors for plug load control measures.

Table 94: Interactive Effects Factors for Plug Load Control Measures

Measure	Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings	Source
Smart Power Controller for Audiovisual Equipment	0%	0%	Assumption
Power Bar with Integrated Timer			
Heavy-duty Outdoor Timer			
ENERGY STAR Certified Pool Pump			

¹³⁵ ENERGY STAR, Savings Calculator for ENERGY STAR Qualified Appliances, https://www.energystar.gov/sites/default/files/asset/document/appliance_calculator.xlsx, (Last accessed December 1, 2019).

2.5.2 Peak Demand Savings Factors

For most plug load control measures, peak demand savings are calculated using the peak demand-to-energy ratios developed by Navigant in the 2016-2018 DSM Plan. These ratios were established for various product categories based on modelled system-coincident peak demand savings and electrical energy savings for a projected deployment of products. Navigant used local data to establish the ratios applicable for the 2016-2018 period. The Evaluator recommends using the same ratios during the 2020-2022 DSM cycle.

As for ENERGY STAR certified variable speed pool pumps, the Evaluator assumes a peak demand-to-energy ratio of zero since these products are not likely used on cold winter days when peak conditions occur.

Table 95 summarizes the peak demand-to-energy ratios established for each plug load control measure.

Table 95: Peak Demand-to-energy Ratios for Plug Load Control Measures

Measure	Peak Demand-to-energy Ratio (W/kWh)	Source
Smart Power Controller for Audiovisual Equipment	0.000	RES-Plug Load Controls, Navigant 2016-2018 DSM Plan
Power Bar with Integrated Timer		
Heavy-duty Outdoor Timer		
ENERGY STAR Certified Pool Pump	0.000	Calculated by the Evaluator

2.5.3 Plug Load Control Measures

(1) Smart Power Controllers for Audiovisual Equipment

Summary

Table 96 presents a summary of the values used to calculate smart power controllers for audiovisual equipment savings. The detailed methodology follows.

Table 96: Smart Power Controllers for Audiovisual Equipment Measure Summary

Parameter	EPI	Instant Savings	Reference
Measure Description and Identification			
Measure Description	Smart power controllers for audiovisual equipment to reduce electricity consumption		N/A
Additional Notes	Tier 2 power strip	Tier 1 power strip	
General Parameters			
Installation Rate	57%	100%	See details below under Installation Rates
Effective Useful Life [years]	4		See Subsection 4.2
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	207	53.8	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.000		See Subsection 2.5.2
Unitary Peak Demand Savings [W]	0.00	0.00	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%		See Subsection 2.5.1
Interactive Effects Factor for Peak Demand Savings	0%		See Subsection 2.5.1

Electrical Unitary Energy Savings

Smart power bars rebated under EPI are classified as Tier 2, while those rebated under Instant Savings are classified as Tier 1. Tier 1 smart power bars have a master outlet that switches off other outlets when the master device is turned off. Tier 2 smart power bars have the same functionality as Tier 1 yet will additionally switch devices off when they are not used. A sensor will sense the engagement of the user. Based on those differences, a specific electrical unitary savings is defined for each program component.

The electrical unitary savings energy value associated with the use of Tier 2 smart power controllers for audiovisual equipment installed under EPI is based on a metering study, published in 2019, of 133 households across Massachusetts.¹³⁶ This study represents the most up-to-date research using treatment and control sites with a significantly large sample size.

¹³⁶ NMR Group Inc., RLPNC 17-3: Advanced Power Strip Metering Study, March 18, 2019.

As for Instant Savings, the unitary savings value is based on information provided in the 2016 Pennsylvania Public Utility Commission Technical Reference Manual (TRM),¹³⁷ which cites documents produced by the New York State Energy Research and Development Authority (NYSERDA) and Energy Center of Wisconsin.¹³⁸ The TRM provides specific values for Tier 1 five-plug and seven-plug smart power controller audiovisual equipment, which are 48.9 kWh and 58.7 kWh respectively. Since the number of plugs on smart power controller may vary according to the models, the unitary savings value for this product corresponds to the average values for five-plug and seven-plug devices.

Table 97 presents the annual unitary savings values for EPI and for Instant Savings and the source of those values.

**Table 97: Electrical Unitary Savings Values
for Smart Power Controller Audiovisual Equipment**

Parameter	EPI	Instant Savings	Source
Unitary Energy Savings [kWh/year]	207	53.8	EPI: NMR Group, 2019 ¹³⁹ Instant Savings: Pennsylvania TRM ¹⁴⁰

Installation Rates

For EPI, Table 98 lists the installation rate for smart power controllers for audiovisual equipment.

Table 98: EPI Smart Power Controller for Audiovisual Equipment Installation Rate

Installation Rate	Margin of Error	Source
57%	10.6%	2017 EPI on-site visits ¹⁴¹

For Instant Savings, the installation rate is assumed to be 100%.

(2) Power Bars with Integrated Timer

Summary

Table 99 presents a summary of the values used to calculate power bar with integrated timer savings. The detailed methodology follows.

¹³⁷ Pennsylvania Public Utility Commission, *Technical Reference Manual*, February 2017.

¹³⁸ NYSERDA, *Advanced Power Strip Research Report*, August 2011, and Energy Center of Wisconsin, *Energy Savings Opportunities with Home Electronics and Other Plug-Load Devices: Results from a Minnesota Field Study*, 2010.

¹³⁹ NMR Group Inc., *RLPNC 17-3: Advanced Power Strip Metering Study*, March 18, 2019.

¹⁴⁰ Pennsylvania Public Utility Commission, *Technical Reference Manual*, February 2017.

¹⁴¹ The installation rate was not updated through the 2021 EPI site visits since this measure is no longer offer in EPI.

Table 99: Power Bars with Integrated Timer Measure Summary

Parameter	IS	Reference
Measure Description and Identification		
Measure Description	Power bars with integrated timer to reduce electricity consumption	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	4	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	53.7	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.000	See Subsection 2.5.2
Unitary Peak Demand Savings [W]	0.00	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	See Subsection 2.5.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 2.5.1

Electrical Unitary Energy Savings

Table 100 below presents the parameters used in equation below to calculate the electrical unitary savings resulting from the installation of power bars with integrated timers. The methodology and parameters used were drawn from the 2011 OPA Prescriptive Measures and Assumptions List,¹⁴² with a minor adjustment to the number of days used per year; notably, the total 12-month period was set at 365 days instead of 12 times 30 days (360 days).

$$\begin{aligned}
 \text{Energy Savings } \left[\frac{\text{kWh}}{\text{year}} \right] &= \text{Average Standby Wattage [W]} * (\text{Old Operating Time} - \text{New Operating Time}) \left[\frac{\text{hrs}}{\text{day}} \right] \\
 &\quad * \text{Number of Days} * \frac{\text{kWh}}{1,000 \text{ W}}
 \end{aligned}$$

¹⁴² Ontario Power Authority (OPA), 2011 Prescriptive Measures and Assumptions Version 1, March 2011.

Table 100: Electrical Unitary Savings Value for Power Bars with Integrated Timers

Parameter	Entertainment Centre	Computer System	Lighting	Other
Proportion	40.3%	15.7%	19.4%	24.6%
Average Standby Wattage	38.1 W	28 W	60 W	28 W
Old Operating Time	9 hrs/day	14 hrs/day	6 hrs/day	11 hrs/day
New Operating Time – with Timer	5 hrs/day	8 hrs/day	3 hrs/day	4 hrs/day
Number of Days	365	365	259	262
Calculated Unitary Energy Savings [kWh/year]	55.6	61.3	46.6	51.4
Weighted Unitary Energy Savings [kWh/year]	53.7			

Installation Rates

The installation rate is assumed to be 100%.

(3) Heavy-duty Outdoor Timers

Summary

Table 101 below presents a summary of the values used to calculate heavy-duty outdoor timer savings. The detailed methodology follows.

Table 101: Heavy-duty Outdoor Timer Measure Summary

Parameter	Instant Savings	Reference
Measure Description and Identification		
Measure Description	Heavy-duty outdoor timers to reduce electricity consumption	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	10	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	122	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.000	See Subsection 2.5.2
Unitary Peak Demand Savings [W]	0.00	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	See Subsection 2.5.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 2.5.1

Electrical Unitary Energy Savings

For heavy-duty outdoor timers, the electrical unitary energy savings value of 122 kWh is based on the results of the OPA 2012 Consumer Program Evaluation.¹⁴³ The survey conducted for that evaluation states that heavy-duty outdoor timers sold through the OPA biannual coupon program are used for outdoor lighting, pool pumps, and car block heaters, all of which correspond to possible usages for heavy-duty outdoor timers sold through Instant Savings.

Table 102 presents the annual unitary savings value for Instant Savings.

Table 102: Electrical Unitary Savings Values of Heavy-duty Outdoor Timers

Parameter	Value	Source
Unitary Energy Savings [kWh/year]	122	OPA, 2012 ¹⁴⁴

Installation Rates

The installation rate is assumed to be 100%.

(4) ENERGY STAR Certified Pool Pumps

Summary

Table 103 presents a summary of the values used to calculate heavy-duty outdoor timer savings. The detailed methodology follows.

¹⁴³ Research into Action, *Final Report: 2012 Consumer Program Evaluation*, Report presented to OPA, October 11, 2013, p. 154.

¹⁴⁴ Research into Action, *Final Report: 2012 Consumer Program Evaluation*, Report presented to OPA, October 11, 2013, p. 154.

Table 103: ENERGY STAR Certified Pool Pump Measure Summary

Parameter	Instant Savings	Reference
Measure Description and Identification		
Measure Description	ENERGY STAR certified pool pumps to reduce electricity consumption	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	10	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	530	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.000	See Subsection 2.5.2
Unitary Peak Demand Savings [W]	0.00	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	See Subsection 2.5.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 2.5.1

Electrical Unitary Energy Savings

For ENERGY STAR certified pool pumps, the unitary savings value of 530 kWh is based on the results of the NEEP Technical Reference Manual that considers 10 hours of pump operation per day over a period of 100 days.¹⁴⁵

Table 104 presents the annual unitary savings value for Instant Savings.

Table 104: Unitary Savings Values of ENERGY STAR Certified Pool Pumps

Parameter	Value	Source
Unitary Energy Savings [kWh/year]	530	NEEP, 2017 ¹⁴⁶

Installation Rates

The installation rate is assumed to be 100%.

2.6 Demand Reduction

2.6.1 Interactive Effects

For demand reduction measures, interactive effects are assumed to be nil.

¹⁴⁵ Northeast Energy Efficiency Partnership (NEEP), *Mid-Atlantic Technical Reference Manual*, October 2017, p.250.

¹⁴⁶ Northeast Energy Efficiency Partnership (NEEP), *Mid-Atlantic Technical Reference Manual*, October 2017, p.250.

2.6.2 Peak Demand Savings Factors

For demand reduction measures, peak demand savings are not determined using a peak demand-to-energy ratio since they do not generate energy savings. For more details, refer to Subsections 2.6.3(1), 2.6.3(2), 2.6.3(3), and 2.6.3(4).

2.6.3 Demand Reduction Measures

(1) Three-element Water Heaters

Summary

Table 105 presents a summary of the values used to calculate three-element water heater (TEWH) savings. The detailed methodology follows.

Table 105: Three-element Water Heater Measure Summary

Parameter	HEA	Green Heat	Reference
Measure Description and Identification			
Measure Description	Three-element water heaters to reduce peak demand water heating load		N/A
Additional Notes	-		
General Parameters			
Installation Rate	100%		See details below under Installation Rates
Effective Useful Life [years]	12		See Subsection 4.2
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	N/A		N/A
Peak Demand-to-energy Ratio [W/kWh]	N/A		N/A
Unitary Peak Demand Savings [W]	200		See details below under Unitary Peak Demand Savings
Interactive Effects Factor for Energy Savings	N/A		See Subsection 2.6.1
Interactive Effects Factor for Peak Demand Savings	0%		See Subsection 2.6.1

Electrical Unitary Energy Savings

No energy savings are expected from this measure.

Unitary Peak Demand Savings

The unitary peak demand savings for three-element water heaters (TEWHs) were drawn from a Hydro-Québec study¹⁴⁷ that established the peak demand savings of 200 W based on tests performed on TEWHs during the 2007/2008 heating season. The results of that study were used since it was the only study found on TEWHs, the methodology is sound, and peak periods observed in the study include the Nova Scotia peak period.

¹⁴⁷ Hydro-Québec. *Essais terrain 2007-2008 d'un nouveau concept de chauffe-eau électrique à 3 éléments*, Provided by Hydro-Québec - Not publicly available, March 15, 2011.

Installation Rates

Installation rates for three-element water heaters are estimated at 100% due to their relatively high cost.

(2) Domestic Water Heater Timer

Summary

Table 106 presents a summary of the values used to calculate domestic water heater timer (DWHT) savings. The detailed methodology follows.

Table 106: Domestic Water Heater Timer Measure Summary

Parameter	HEA	Green Heat	Reference
Measure Description and Identification			
Measure Description	Domestic water heater timers to reduce peak demand water heating load		N/A
Additional Notes	-		
General Parameters			
Installation Rate	100%		See details below under Installation Rates
Effective Useful Life [years]	15		See Subsection 4.2
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	N/A		See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	N/A		N/A
Unitary Peak Demand Savings [W]	500		See details below under Unitary Peak Demand Savings
Interactive Effects Factor for Energy Savings	N/A		See Subsection 2.6.1
Interactive Effects Factor for Peak Demand Savings	0%		See Subsection 2.6.1

Electrical Unitary Energy Savings

No energy savings are expected from this measure.

Unitary Peak Demand Savings

Since no information could be found in the literature, the peak demand savings of DWHTs were based on Nova Scotia Power estimates in their 2019 Load Forecast Report.¹⁴⁸

¹⁴⁸ Nova Scotia Power. 2019 Load Forecast Report - Redacted, April 30, 2019, p. 28.

In that report, the average peak contribution is estimated at 0.57 kW per tank. Therefore, shutting down the hot water system results in 0.57 kW in peak demand savings. This value is based on internal research on metered hot water tanks for which no details are available, except that the average tank power is approximately 3 kW and the coincident system peak of water heaters indicates that approximately one in five water heaters is on.

To account for uncertainties around this value, the peak demand savings were rounded down to 500 W. This value was deemed acceptable and conservative since it is lower than the baseline peak demand in the Hydro-Québec study for three-element water heaters.

Installation Rates

Installation rates for DWHTs are estimated at 100% since they are installed and programmed by certified installers. In addition, the programming is locked after installation, meaning that participants need to contact the installer or Nova Scotia Power to prevent their interruption, leaving little room for savings to end prematurely.

(3) Electric Thermal Storage

Summary

Table 107 presents a summary of the values used to calculate electric thermal storage savings. The detailed methodology follows.

Table 107: Electric Thermal Storage Measure Summary

Parameter	HEA, Green Heat	Reference
Measure Description and Identification		
Measure Description	Electric thermal storage systems to reduce peak demand space heating load	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	18	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	N/A	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	N/A	N/A
Unitary Peak Demand Savings [W]	Maximum storage capacity in eight hours divided by 16 hours	See details below under Unitary Peak Demand Savings
Interactive Effects Factor for Energy Savings	0%	See Subsection 2.6.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 2.6.1

Electrical Unitary Energy Savings

No energy savings are expected from this measure.

Unitary Peak Demand Savings

For electric thermal storage, an eight-hour charging period is assumed based on the residential off-peak period in Nova Scotia Power's time of day rate. It is also assumed that the stored heat is provided equally throughout the remaining 16 hours of the day.

Therefore, the unitary peak demand unitary savings for electric thermal storage are calculated using the equation below where the maximum storage capacity is drawn from manufacturer specification sheets and is the lowest value between either the maximum system storage capacity or the maximum amount of energy the system can store in eight hours.

$$\text{Peak Demand Savings}_W = \text{Maximum Storage Capacity in 8h} / 16\text{h}$$

Installation Rates

Installation rates for electric thermal storage systems are estimated at 100% due to their relatively high cost.

(4) Domestic Water Heater Load Control

Summary

Table 108 presents a summary of the values used to calculate domestic water heater load control savings. The detailed methodology follows.

Table 108: Domestic Water Heater Load Control Measure Summary

Parameter	EPI	Reference
Measure Description and Identification		
Measure Description	Direct load control for domestic water heaters	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	1	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	N/A	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	N/A	N/A
Unitary Peak Demand Savings [W]	545	See details below under Unitary Peak Demand Savings
Interactive Effects Factor for Energy Savings	0%	See Subsection 2.6.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 2.6.1

Electrical Unitary Energy Savings

No energy savings are expected from this measure.

Unitary Peak Demand Savings

For the first year of the Water Heater Direct Load Control pilot program, a deemed unitary savings value of 545 W per water heater per load reduction event was used. This value was obtained by averaging the savings values for similar programs from various jurisdictions in the North-East Region of the United States and Canada, as summarized in Table 109 below.

Table 109: Domestic Water Heater Load Control Measure Summary

Jurisdiction	Value (W)	Source
PJM Region (Northeastern U.S.A.)	640	Deemed Savings Estimates for Legacy AC and Water Heating Direct Load Control Programs in PJM Region ¹⁴⁹
Minnesota	731	Demand Response, Snapback and Energy Savings? ¹⁵⁰ Evaluating Demand Response in Minnesota
Newfoundland and Labrador	500	Newfoundland Power and Newfoundland and Labrador Hydro. DSM Jurisdictional Scan ¹⁵¹
Missouri	310	City Utilities Demand Response Program ¹⁵²
Unitary Peak Demand Savings	545	Calculations

After the events, and after analyzing the results, the peak event performance data for a sample of participants will be reviewed to quantify the achieved unitary peak demand reductions.

Installation Rates

The installation rate is assumed to be 100%.

¹⁴⁹ Ernest Orlando Lawrence Berkeley National Laboratory. *Deemed Savings Estimates for Legacy Air Conditioning and Water Heating Direct Load Control Programs in PJM Region* – Redacted April 2007, p. xiv.

¹⁵⁰ Michaels Energy. *Demand Response, Snapback and Energy Savings? Evaluating Demand Response in Minnesota* - Redacted December 10, 2013, p.18.

¹⁵¹ Newfoundland Power and Newfoundland and Labrador Hydro. *DSM Jurisdictional Scan* - Redacted November 5, 2019, p.14.

¹⁵² City Utilities. *City Utilities Demand Response Program*. 2017, p.13.

3 BNI MEASURE GROSS SAVINGS PARAMETERS

The following sections outline all necessary parameters to calculate gross energy savings for BER Instant Rebates semi-prescriptive measures as well as measures added to the BER Mail-in and SBES offering during the 2020-2022 period.

3.1 Lighting

3.1.1 Interactive Effects

For indoor lighting measures offered through BER Instant Rebates, the interactive effects factors for energy and peak demand savings used are based on the average values of indoor lighting products installed through BER Mail-in and SBES in 2019, since no customer specific information is available for BER Instant Rebates. In SBES and Mail-in, a standardized approach based on a methodology published in the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Journal¹⁵³ is used to calculate the interactive effects for lighting projects on a per building-type basis. The average interactive effects factors are -6.4% and -15% for energy savings and peak demand savings, respectively.

For indoor lighting measures offered through SBES, the interactive effects factors used for energy and peak demand savings are based on the average values of indoor lighting products installed through SBES in 2019. The average interactive effects factors are -8.3% and -20.9% for energy savings and peak demand savings respectively.

Additionally, the interactive effects factors are multiplied by 57% to consider the limited contribution of recessed fixtures;¹⁵⁴ this factor applies to lighting measure categories that include recessed fixtures, namely LED linear fixtures and LED linear lamps.

For outdoor lighting measures, interactive effects are nil.

Table 110 summarizes the interactive effects factors established for each lighting measure.

Table 110: Interactive Effects for BNI Lighting Measures

Measure		Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings
LED Lamps		-8.3%	-20.9%
Linear LED Fixtures	Recessed	$-6.4\% \times 57\% = -3.6\%$	$-15\% \times 57\% = -8.6\%$
	Non-recessed	-6.4%	-15%
Linear LED Lamps	Recessed	$-6.4\% \times 57\% = -3.6\%$	$-15\% \times 57\% = -8.6\%$
	Non-recessed	-6.4%	-15%
Outdoor LED Fixtures		0%	0%
Directional and Architectural LED Fixtures		-6.4 %	-15%
Occupancy Sensors		-6.4 %	-15%
LED Nightlights		-8.3%	-20.9%

¹⁵³ Rundquist, Robert A. et al., "Calculating Lighting and HVAC Interactions," ASHRAE Journal, November 1993, pp. 28-37.

¹⁵⁴ Chantrasrisalai and Fisher, "Lighting heat gain parameters: Experimental results" in *HVAC&R Research*, 12(2), pp. 305-324.

3.1.2 Peak Demand Savings Factors

Peak demand savings correspond to the demand savings that coincide in time with the peak demand of the electricity system. The projected electricity peak demand period in Nova Scotia is between 5 p.m. and 7 p.m. from December to February on non-holiday weekdays.

Peak Coincidence Factor

For indoor lighting measures offered through Instant Rebates, the peak coincidence factor (PCF) for indoor products is based on the average PCF value of indoor lighting products installed through BER Mail-in and SBES in 2019 since no customer specific information is available for BER Instant Rebates. The average PCF is 71%.

For indoor lighting measures offered through SBES, the PCF is based on the average PCF value of indoor lighting products installed through SBES in 2019. The average PCF is 59%.

For outdoor lighting measures, since lighting is typically turned on between 5 p.m. and 7 p.m. throughout December, January, and February, a PCF of 100% is applied.

Unitary Peak Demand Savings Calculations

Peak demand savings are calculated by multiplying the unitary demand savings value by the peak coincidence factor as detailed in the equation below.

$$\begin{aligned} \text{Unitary Peak Demand Savings (W)} \\ &= \text{Unitary Demand Savings (W)} \times \text{Peak Coincidence Factor (\%)} \end{aligned}$$

The unitary demand savings value corresponds to the unitary energy savings divided by the hours of use (HOU), as presented in the equation below.

$$\text{Unitary Demand Savings (W)} = \frac{\text{Unitary Energy Savings (kWh)} \times 1,000}{\text{HOU (h)}}$$

3.1.3 Lighting Measures

(1) LED Lamps

Summary

Table 111 presents a summary of the values used to calculate A-type, reflector, and decorative LED lamp savings. The detailed methodology follows.

Table 111: LED Lamp Measure Summary

Parameter	SBES	Reference
Measure Description and Identification		
Measure Description	LED lamps to reduce electricity consumption.	N/A
Additional Notes	A-type, reflector, and decorative LED lamps	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	Varies depending on replaced and installed wattages as well as lamp type	See Subsection 4.1
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	Vary depending on replaced and installed wattages. See Table 112 below	See details below under Electrical Unitary Energy Savings
Peak Coincidence Factor [%]	59%	See Subsection 3.1.2
Unitary Peak Demand Savings [W]	Vary depending on replaced and installed wattages. See Table 112 below	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	-8.3%	See Subsection 2.1.1
Interactive Effects Factor for Peak Demand Savings	-20.9%	

Electrical Unitary Energy Savings

The equation below is used to determine the unitary savings values of LED lamps for each pairing of old and new wattages. Table 112 further below lists the parameters and corresponding values used in the equation and the resulting unitary savings values.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{(\text{Old Wattage} - \text{New Wattage})[\text{W}] \times \text{Operating Hours} \left[\frac{\text{h}}{\text{yr}} \right]}{1,000 \left[\frac{\text{W}}{\text{kW}} \right]}$$

Table 112: Electrical Unitary Savings Values for LED Lamps

Type of LED	Old Wattage (W)	New Wattage (W)	Displaced Wattage (W)	Operating Hours (hrs/year)	Unitary Savings Value (kWh/year)
9 W Replacing 25 W	25	9	16	3,600	57.6
9 W Replacing 29 W	29	9	20		72.0
9 W Replacing 40 W	40	9	31		112
9 W Replacing 43 W	43	9	34		122
9 W Replacing 60 W	60	9	51		184
9 W Replacing 72 W	72	9	63		227
9 W Replacing 100 W	100	9	91		328
9 W Replacing 150 W	150	9	141		508
9.5 W Replacing 25 W	25	9.5	15.5		55.8
9.5 W Replacing 29 W	29	9.5	19.5		70.2
9.5 W Replacing 40 W	40	9.5	30.5		110
9.5 W Replacing 43 W	43	9.5	33.5		121
9.5 W Replacing 60 W	60	9.5	50.5		182
9.5 W Replacing 72 W	72	9.5	62.5		225
9.5 W Replacing 100 W	100	9.5	90.5		326
9.5 W Replacing 150 W	150	9.5	140.5		506
18 W Replacing 75 W	75	18	57		205
18 W Replacing 100 W	100	18	82		295
7 W Black-out Bulbs Replacing 60 W	60	7	53		191
PAR20 7 W Replacing 50 W	50	7	43		155
PAR30 8 W Replacing 53 W	53	8	45		162
PAR30 8 W Replacing 75 W	75	8	67		241
PAR38 15 W Replacing 90 W	90	15	75		270
PAR38 15 W Replacing 120 W	120	15	105		378
PAR38 15 W Replacing 150 W	150	15	135		486
7 W GU10 Replacing 35 W	35	7	28		101
7 W GU10 Replacing 50 W	50	7	43		155
7 W G25 Replacing 40 W	40	7	33		119
5 W Chandelier E12 Replacing 40 W	40	5	35		126

Displaced Wattage

For SBES, displaced wattage is defined as the difference between the real wattage value of the old lamp and that of the new LED lamp. Both the old and new wattage values are available in the SBES tracking sheet for LED lamps. Previous evaluations confirmed that installed LED lamps had a light output wattage equivalent to that of the replaced lamps for almost all replacements. In other cases, the savings calculations are still based on the difference in real wattage values.

The equivalent incandescent and halogen wattage values were assumed to be the same as those for the residential sector, as presented in Subsection 2.1.3 (1).

Hours of Operation

Average hours of operation of 3,600 hours were used for SBES indoor lighting products. These hours of operation are based on the average values of indoor lighting products installed through SBES in 2019.

Unitary Peak Demand Savings

Unitary peak demand savings are calculated as described in Subsection 3.1.2.

Table 113: Electrical Unitary Peak Demand Savings Values for LED Lamps

Type of LED	Displaced Wattage (W)	Peak Coincidence Factor (%)	Unitary Peak Demand Savings Value (W)
9 W Replacing 25 W	16	59%	9.4
9 W Replacing 29 W	20		11.8
9 W Replacing 40 W	31		18.3
9 W Replacing 43 W	34		20.1
9 W Replacing 60 W	51		30.1
9 W Replacing 72 W	63		37.2
9 W Replacing 100 W	91		53.7
9 W Replacing 150 W	141		83.2
9.5 W Replacing 25 W	15.5		9.1
9.5 W Replacing 29 W	19.5		11.5
9.5 W Replacing 40 W	30.5		18.0
9.5 W Replacing 43 W	33.5		19.8
9.5 W Replacing 60 W	50.5		29.8
9.5 W Replacing 72 W	62.5		36.9
9.5 W Replacing 100 W	90.5		53.4
9.5 W Replacing 150 W	140.5		82.9
18 W Replacing 75 W	57		33.6
18 W Replacing 100 W	82		48.4
7 W Black-out Bulbs Replacing 60 W	53		31.3
PAR20 7 W Replacing 50 W	43		25.4
PAR30 8 W Replacing 53 W	45		26.6
PAR30 8 W Replacing 75 W	67		39.5
PAR38 15 W Replacing 90 W	75		44.3
PAR38 15 W Replacing 120 W	105		62.0
PAR38 15 W Replacing 150 W	135		79.7
7 W GU10 Replacing 35 W	28		16.5
7 W GU10 Replacing 50 W	43		25.4
7 W G25 Replacing 40 W	33		19.5
5 W Chandelier E12 Replacing 40 W	35		20.7

In-service Rates

For SBES, an in-service rate of 100% was assumed since no activity to measure the in-service rate of LED lamps installed through SBES has been conducted. Also, SBES LED lamps are currently only offered through a direct install service, and such services typically have installation rates close to 100% for lighting products.

(2) Linear LED Fixtures

Summary

Table 114 presents a summary of the values used to calculate linear LED fixture savings, followed by the detailed methodology.

Table 114: Linear LED Fixture Measure Summary

Parameter	BER Instant Rebates		Reference
Measure Description and Identification			
Measure Description	Linear LED fixtures		N/A
Additional Notes	-		
General Parameters			
In-service Rate	100%		See details below under In-service Rate
Effective Useful Life [years]	Effective useful life based on type of Linear LED Fixture		See Subsection 4.1
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	Calculation based on specification data for each rebated unit		See details below under Electrical Unitary Energy Savings
Peak Coincidence Factor [%]	71%		See Subsection 3.1.2
Unitary Peak Demand Savings [W]	Calculation based on specification data for each rebated unit		Calculated by multiplying the demand savings value by the peak coincidence factor
Interactive Effects Factor for Energy Savings	Recessed	-3.6%	See Subsection 3.1.1
	Non-recessed	-6.4%	
Interactive Effects Factor for Peak Demand Savings	Recessed	-8.6%	See Subsection 3.1.1
	Non-recessed	-15%	

Electrical Unitary Energy Savings

Table 115 lists the parameters and corresponding values used in the equation below to calculate unitary energy savings for LED linear fixtures.

$$\text{Energy Savings} \left[\frac{kWh}{yr} \right] = \frac{(\text{Baseline Wattage} - \text{New Wattage})[W] \times HOU \left[\frac{h}{day} \right] \times 365 \left[\frac{day}{yr} \right]}{1,000 \left[\frac{W}{kW} \right]}$$

Table 115: Electrical Unitary Savings Values for Linear LED fixtures

Parameter	Value	Source
Baseline Wattage [W]	N/A	Based on specification data for each rebated unit. See Table 116 below
New Wattage [W]	N/A	Based on wattage listed in tracking sheet for each rebated unit
Hours of Operation [hrs/day]	4,300	Average HOU for indoor lighting products installed through BER Mail-in and SBES in 2019
Unitary Savings [kWh/year]	N/A	Calculation based on specification data for each rebated unit

The linear LED fixtures category contains four subcategories of products eligible under Instant Rebates. Table 116 presents the baseline wattage used to calculate the energy savings for each of these subcategories based on lumens output.

Table 116: Linear LED Fixture Baseline Wattage

Subcategory	Lumens Output (lm)	Baseline Wattage (W)
1 x 4 Luminaires	1,500 – 3,500	61.00
	≥ 3,500	83.25
2 x 2 Luminaires & Retrofit Kits	1,500 – 4,500	61.00
	≥ 4,500	84.00
2 x 4 Luminaires & Retrofit Kits	3,000 – 6,500	88.00
	≥ 6,500	128.50
Linear Ambient and Low-bay Luminaires	< 2,500	29.50
	2,500 – 5,000	58.00
	5,000 – 10,000	112.00
	≥ 10,000	200.00

In-Service Rate

The in-service rate for linear LED fixtures is estimated at 100% since it is unlikely that participants would purchase fixtures for stocking purposes.

(3) Linear LED Lamps

Summary

Table 117 presents a summary of the values used to calculate linear LED lamps savings. The detailed methodology follows.

Table 117: Linear LED Lamp Measure Summary

Parameter	BER Instant Rebates	Reference	
Measure Description and Identification			
Measure Description	Linear LED lamps	N/A	
Additional Notes	-		
General Parameters			
In-service Rate	85%	See details below under In-service Rate	
Effective Useful Life [years]	11.6	See Subsection 4.1	
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	Calculation based on specification data for each rebated unit	See details below under Electrical Unitary Energy Savings	
Peak Coincidence Factor [%]	71%	See Subsection 3.1.2	
Unitary Peak Demand Savings [W]	Calculation based on specification data for each rebated unit	Calculated by multiplying the demand savings value by the peak coincidence factor	
Interactive Effects Factor for Energy Savings	Recessed	-3.6%	See Subsection 3.1.1
	Non-recessed	-6.4%	
Interactive Effects Factor for Peak Demand Savings	Recessed	-8.6%	See Subsection 3.1.1
	Non-recessed	-15%	

Electrical Unitary Energy Savings

Table 118 lists the parameters and corresponding values used in the equation below to calculate unitary energy savings for LED linear lamps.

$$\begin{aligned}
 & \text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] \\
 &= \frac{(\text{Baseline Wattage [W]} \times \text{Ballast Factor} \times \text{Baseline Quantity} - \text{New Wattage [W]} \times \text{New Quantity}) \times \text{HOU} \left[\frac{\text{h}}{\text{day}} \right] \times 365 \left[\frac{\text{day}}{\text{yr}} \right]}{1,000 \left[\frac{\text{W}}{\text{kW}} \right]}
 \end{aligned}$$

Table 118: Electrical Unitary Savings Values for Linear LED Lamps

Parameter	Value	Source
Baseline Wattage [W]	N/A	Based on specification data for each rebated unit. See Table 119 below
Ballast Factor	0.88	Assumption for normal ballast factor
Baseline Quantity	N/A	Based on quantity listed in tracking sheet for each rebated unit
New Wattage [W]	N/A	Based on wattage listed in tracking sheet for each rebated unit
New Quantity	N/A	Based on quantity listed in tracking sheet for each rebated unit
Hours of Operation [hrs/day]	4,300	Average HOU for indoor lighting products installed through BER Mail-in and SBES in 2019
Unitary Savings [kWh/year]	N/A	Calculation based on specification data for each rebated unit

The linear LED lamp category contains six subcategories of products eligible under Instant Rebates. Table 119 presents the baseline wattage used to calculate the energy savings based on the Duke Energy Fixture Wattage Table.¹⁵⁵

Table 119: Linear LED Lamp Baseline Wattage

Subcategory	Baseline Wattage (W)
2-foot Replacement Lamps	17
3-foot Replacement Lamps	25
4-foot Replacement Lamps	32
8-foot Replacement Lamps	59
U-bend Replacement Lamps	31
4-foot High Output Replacement Lamps	49

In-Service Rate

Based on a study conducted by DNV-GL for the Massachusetts Energy Efficiency Program Administrators,¹⁵⁶ an in-service rate (ISR) of 85% is applied to LED lamps, which corresponds to the proportion of in-service fluorescent and LED lighting technologies installed three years after their purchase through an instant rebates program.

¹⁵⁵ Duke Energy Progress. Fixture Wattage Table. <http://www.ahutton.com/LED/Progress%20wattages.pdf>, (Last accessed November 21, 2018).

¹⁵⁶ DNV-GL, *Massachusetts Commercial and Industrial Upstream Lighting Program: "In Storage" Lamps Follow-up Study*, March 2015.

(4) Outdoor LED Fixtures

Summary

Table 120 presents a summary of the values used to calculate outdoor LED fixture savings. The detailed methodology follows.

Table 120: Outdoor LED Fixture Measure Summary

Parameter	BER Instant Rebates	Reference
Measure Description and Identification		
Measure Description	Outdoor LED fixtures	N/A
Additional Notes	-	
General Parameters		
In-service Rate	100%	See details below under In-service Rate
Effective Useful Life [years]	Effective useful life based on type of outdoor LED fixture	See Subsection 4.1
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	Calculation based on specification data for each rebated unit	See details below under Electrical Unitary Energy Savings
Peak Coincidence Factor [%]	100%	See Subsection 3.1.2
Unitary Peak Demand Savings [W]	Calculation based on specification data for each rebated unit	Calculated by multiplying the demand savings value by the peak coincidence factor
Interactive Effects Factor for Energy Savings	0%	See Subsection 3.1.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 3.1.1

Electrical Unitary Energy Savings

Table 121 lists the parameters and corresponding values used in the equation below to calculate unitary energy savings for outdoor LED fixtures.

$$Energy\ Savings\ \left[\frac{kWh}{yr}\right] = \frac{(Baseline\ Wattage - New\ Wattage)[W] \times HOU\ \left[\frac{h}{day}\right] \times 365\ \left[\frac{day}{yr}\right]}{1,000\ \left[\frac{W}{kW}\right]}$$

Table 121: Electrical Unitary Savings Values for Outdoor LED fixtures

Parameter	Value	Source
Baseline Wattage [W]	N/A	Based on specification data for each rebated unit. See Table 122 for wall-mounted area luminaires and Table 123 for architectural and flood spot luminaires
New Wattage [W]	N/A	Based on wattage listed in tracking sheet for each rebated unit
Hours of Operation [hrs/day]	4,380	Assumption. Based on fixtures being used 12 hours per day
Unitary Savings [kWh/year]	N/A	Calculation based on specification data for each rebated unit

The outdoor LED fixture category contains outdoor wall-mounted area luminaires as well as the architectural flood and spot luminaire subcategories.

Both subcategories are divided into groups by lumens output to assign the correct baseline wattages, and the baseline technology used for each subcategory differs. Weighted averages of 50% metal halide (MH) and 50% high-pressure sodium (HPS) fixture system wattages are used to determine the baseline wattage values for outdoor full-cut-off, semi-cut-off, and non-cut-off wall-mounted area luminaires, as presented in Table 122.

Table 122: Wattages per Lumens Output for Outdoor Wall-mounted Area Luminaires

Lumens Range	MH Baseline Fixture Wattage (W)	HPS Baseline Fixture Wattage (W)	Weighted Average Baseline Wattage (W)
≥ 300 and < 2,000	43	46	44.5
≥ 2,000 and < 5,000	95	95	95.0
≥ 5,000 and < 15,000	295	250	272.5
≥ 15,000 and < 25,000	458	465	461.5
≥ 25,000	850	930	890

The architectural flood and spot luminaire subcategory is divided into six ranges according to the baseline lamp technology. The typical lumens output of these fixtures is grouped into ranges to be able to select the appropriate efficient LED fixture depending on the required light output. A summary of the savings calculation parameters is provided in Table 123 below. The baseline technologies were derived from the Duke Energy Fixture Wattage Table.¹⁵⁷

¹⁵⁷ Duke Energy, *Fixture Wattage Table*, <http://www.ahutton.com/LED/Progress%20wattages.pdf> (Last accessed, January 10, 2018).

Table 123: Wattages per Lumens Output for Architectural Flood and Spot Luminaires

Lumens Range of Efficient Luminaires	Baseline Fixture	Baseline Wattage (W)
≥ 250 and < 1,000	Halogen	37
≥ 1,000 and < 5,000	MH (70 W)	95
≥ 5,000 and < 15,000	MH (250 W)	295
≥ 15,000 and < 30,000	MH (250 W x 2)	590
≥ 30,000 and < 50,000	MH (1,000 W)	1,080
≥ 50,000	MH (1,500 W)	1,610

In-Service Rate

The in-service rate for outdoor LED fixtures is estimated at 100% since it is unlikely that participants would purchase fixtures for stocking purposes.

(5) Directional and Architectural LED Fixtures

Summary

Table 124 presents a summary of the values used to calculate directional and architectural LED fixture savings. The detailed methodology follows.

Table 124: Directional and Architectural LED Fixture Measure Summary

Parameter	BER Instant Rebates	Reference
Measure Description and Identification		
Measure Description	Directional and architectural LED fixtures	N/A
Additional Notes		
General Parameters		
In-service Rate	100%	See details below under In-service Rate
Effective Useful Life [years]	11.6	See Subsection 4.1
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	Calculation based on specification data for each rebated unit	See details below under Electrical Unitary Energy Savings
Peak Coincidence Factor [%]	71%	See Subsection 3.1.2
Unitary Peak Demand Savings [W]	Calculation based on specification data for each rebated unit	Calculated by multiplying the demand savings value by the peak coincidence factor
Interactive Effects Factor for Energy Savings	-6.4%	See Subsection 3.1.1
Interactive Effects Factor for Peak Demand Savings	-15%	See Subsection 3.1.1

Electrical Unitary Energy Savings

Table 125 lists the parameters and corresponding values used in the equation below to calculate unitary energy savings for directional and architectural LED fixtures.

$$\text{Energy Savings} \left[\frac{kWh}{yr} \right] = \frac{(\text{Baseline Wattage} - \text{New Wattage}) [W] \times HOU \left[\frac{h}{day} \right] \times 365 \left[\frac{day}{yr} \right]}{1,000 \left[\frac{W}{kW} \right]}$$

Table 125: Electrical Unitary Savings Values for Directional and Architectural LED Fixtures

Parameter	Value	Source
Baseline Wattage [W]	N/A	Based on specification data for each rebated unit. See Table 126 below
New Wattage [W]	N/A	Based on wattage listed in tracking sheet for each rebated unit
Hours of Operation [hrs/day]	4,300	Average HOU for indoor lighting products installed through BER Mail-in and SBES in 2019.
Unitary Savings [kWh/year]	N/A	Calculation based on specification data for each rebated unit

The directional and architectural LED fixture category contains track or mono-point directional luminaires. The baseline technology is halogen lamps generating 17 lumens/W. Table 126 presents the baseline wattage used to calculate the energy savings based on lumens output.

Table 126: Directional and Architectural LED Fixture Baseline Wattage

Category	Lumens	Baseline Wattage (W)
Track or Mono-point Directional Luminaires	≥ 250	60.4

In-Service Rate

The in-service rate for directional and architectural LED fixtures is estimated at 100% since it is unlikely that participants would purchase fixtures for stocking purposes.

(6) Occupancy/Motion Sensors

Summary

Table 127 presents a summary of the values used to calculate occupancy/motion sensor savings. The detailed methodology follows.

Table 127: Occupancy/Motion Sensor Measure Summary

Parameter	BER Instant Rebates			Reference
Measure Description and Identification				
Measure Description	Occupancy/Motion sensors			N/A
Additional Notes	Ceiling or wall remote-mounted	Fixture mounted or wall switch	Exterior	
General Parameters				
In-service Rate	100%			See details below under In-service Rate
Effective Useful Life [years]	10			See Subsection 4.2
Electrical Savings Parameters				
Unitary Energy Savings [kWh/year]	201	117	118	See details below under Electrical Unitary Energy Savings
Peak Coincidence Factor [%]	71%			See Subsection 3.1.2
Unitary Peak Demand Savings [W]	37.6	21.9	31.1	Calculated by multiplying the demand savings value by the peak coincidence factor
Interactive Effects Factor for Energy Savings	-6.4%		0%	See Subsection 3.1.1
Interactive Effects Factor for Peak Demand Savings	-15%		0%	See Subsection 3.1.1

Electrical Unitary Energy Savings

Table 128 lists the parameters and corresponding values used in the equation below for outdoor LED fixtures and the resulting unitary values.

$$Energy\ Savings\ \left[\frac{kWh}{yr}\right] = Connected\ Wattage\ (W) \times Savings\ Factor\ (\%) \times OTF \times HOU/1,000$$

Table 128: Electrical Unitary Savings Values for Occupancy/Motion Sensors

Parameter	Type of Occupancy Sensor	Value	Source
Connected Wattage (W)	Ceiling or Wall Remote-Mounted	220	Average connected wattage for occupancy/motion sensors installed through BER Mail-in and SBES from 2018 to 2020
	Fixture Mounted or Wall Switch	128	
	Exterior	76	
Savings Factor (%)	Ceiling or Wall Remote-Mounted	24%	2015 Efficiency Vermont TRM ¹⁵⁸
	Fixture Mounted		
	Wall Switch		
	Exterior	41%	
Operational Testing Factor (OTF)	-	1	
Hours of Operation (HOU) [hrs/day]	-	3,799	
Unitary Energy Savings [kWh/year]	Ceiling or Wall Remote-mounted	201	Calculated
	Fixture Mounted or Wall Switch	117	
	Exterior	118	

The connected wattage for occupancy/motion sensors is mostly based on the average connected wattage for units installed through BER Mail-in and SBES from January 2018 to July 2020. The only exception is for exterior motion sensors since none was installed under these programs during that period. The connected wattage for exterior motion sensors is based on the value presented in the 2015 Efficiency Vermont TRM.

The energy savings factors and the HOU are also based on the metering study referenced in the 2015 Efficiency Vermont TRM.

In-Service Rate

The in-service rate for occupancy/motion sensors is assumed to be 100%.

(7) LED Nightlights

Summary

Table 129 presents a summary of the values used to calculate savings for LED nightlights. The detailed methodology follows.

¹⁵⁸ Efficiency Vermont, *Technical Reference User Manual Measure Savings Algorithms and Cost Assumptions*, March 2015.

Table 129: LED Nightlight Measure Summary

Parameter	SBES	Reference
Measure Description and Identification		
Measure Description	LED nightlights to reduce electricity consumption	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	23	See Subsection 4.1
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	29.3	See details below under Electrical Unitary Energy Savings
Peak Coincidence Factor [%]	59%	See Subsection 3.1.2
Unitary Peak Demand Savings [W]	3.95	Calculated by multiplying the demand savings value by the peak coincidence factor
Interactive Effects Factor for Energy Savings	Calculation based on home heating and air-conditioning systems for each installed unit	See Subsection 2.1.1
Interactive Effects Factor for Peak Demand Savings		

Electrical Unitary Energy Savings

Table 130 lists the parameters and corresponding values used in the equation below for LED nightlights and the resulting unitary values. The values for displaced wattages and hours of operation are consistent with the values used by other jurisdictions such as the State of Pennsylvania.¹⁵⁹

$$Energy\ Savings\ \left[\frac{kWh}{yr}\right] = \frac{(Old\ Wattage - New\ Wattage)[W] \times HOU\ \left[\frac{h}{day}\right] \times 365\ \left[\frac{day}{yr}\right]}{1,000\ \left[\frac{W}{kW}\right]}$$

Table 130: Electrical Unitary Energy Savings Values for LED Nightlights

Parameter	Value	Source
Old Wattage [W]	7.0	Assumption based on the typical wattage value of an incandescent nightlight
New Wattage [W]	0.3	Wattage value of the LED nightlight installed through SBES (EOne)
Average Displaced Wattage [W]	6.7	Calculation
Hours of Operation [hrs/day]	12	Assumption based on the average length of night
Unitary Energy Savings [kWh/year]	29.3	Calculation

¹⁵⁹ Pennsylvania Public Utility Commission, Technical Reference Manual – State of Pennsylvania, August 2019, p. 7.

Unitary Peak Demand Savings

Unitary peak demand savings are calculated as described in Subsection 3.1.2.

Installation Rates

For SBES, an in-service rate of 100% was assumed since no activity to measure the in-service rate of LED nightlight installed through SBES has been conducted. Also, SBES LED nightlights are currently only offered through a direct install service; such services typically have installation rates close to 100% for lighting products.

3.2 Pumps

3.2.1 Interactive Effects

For pumps, interactive effects are assumed to be nil.

3.2.2 Peak Demand Savings Factors

For pumps, the methodology used to determine peak demand savings is detailed in the measure-specific sections below.

3.2.3 Pump Measures

(1) Circulator Pumps

Summary

Table 131 presents a summary of the values used to calculate circulator pump savings. The detailed methodology follows.

Table 131: Circulator Pump Measure Summary

Parameter	BER Instant Rebates			Reference
Measure Description and Identification				
Measure Description	Variable speed electronically commutated motor (ECM) circulator pumps			N/A
Additional Notes	Max input power < 150 W	Max input power ≥ 150 W and < 500 W	Max input power ≥ 500 W and < 2,500 W	
General Parameters				
Installation Rate	100%			See details below under Installation Rates
Effective Useful Life [years]	15			See Subsection 4.2
Electrical Savings Parameters				
Unitary Energy Savings [kWh/year]	412	800	1,974	See details below under Electrical Energy Unitary Savings
Peak Coincidence Factor [%]	100%			See details below under Peak Coincidence Factor
Unitary Peak Demand Savings [W]	67.5	95.3	127	See details below under Unitary Peak Demand Savings
Interactive Effects Factor for Energy Savings	0%			See Subsection 3.2.1
Interactive Effects Factor for Peak Demand Savings	0%			See Subsection 3.2.1

Electrical Energy Unitary Savings

The electrical energy unitary savings for circulator pumps are calculated using the equation below and savings data from Vermont adapted to Nova Scotia using each jurisdiction's average operating hours. Although the max input power tiers defined in the Vermont TRM and those defined by EOne differ, the difference is considered minimal, thus EOne's tiers have been used in the savings assumptions for this measure. Table 132 below lists the parameters used for the calculation of electrical energy unitary savings.

Table 132: Electrical Unitary Savings Values for Circulator Pumps

Parameters	BER Instant Rebates			Source
	Max Input Power < 150 W	Max Input Power ≥ 150 W and < 500 W	Max Input Power ≥ 500 W and < 2,500 W	
Vermont Average Unitary Energy Savings [kW/year]	401	780	1,924	2018 Vermont TRM
Vermont Average Operating Hours [hours/year]	4,684			
Nova Scotia Average Operating Hours [hours/year]	4,805			Assumption ¹⁶⁰
Unitary Energy Savings [kWh/year]	412	800	1,974	Calculation

¹⁶⁰ Assuming operation between October 1 and April 30 when outside air temperature is below 55 °F (12.8 °C)

Peak Coincidence Factor

Since circulator pumps are typically used as part of residential and commercial hydronic heating system applications, it is assumed that they operate continuously during the coldest days of winter. Thus, a PCF of 100% is applied to this measure category.

Unitary Peak Demand Savings

Peak demand savings are calculated by multiplying the unitary demand savings value by the peak coincidence factor as detailed in the equation below.

$$\begin{aligned} \text{Unitary Peak Demand Savings [W]} \\ = \text{Unitary Demand Savings [W]} \times \text{Peak Coincidence Factor [(\%)]} \end{aligned}$$

The unitary demand savings value corresponds to the unitary energy savings divided by the HOU, as presented in the equation below.

$$\text{Unitary Demand Savings [W]} = \frac{\text{Unitary Energy Savings [kWh]}}{\text{HOU [h]} \times 1,000}$$

The unitary peak demand unitary savings for circulator pumps are calculated using the parameters listed in Table 133.

Table 133: Unitary Peak Demand Savings Values for Circulator Pumps

Parameters	BER Instant Rebates			Source
	Max Input Power < 150 W	Max Input Power ≥ 150 W and < 500 W	Max Input Power ≥ 500 W and < 2,500 W	
Average Demand Savings [kW]	0.0675	0.0953	0.1270	2018 Vermont TRM
Peak Coincidence Factor	1.000			Assumption
Unitary Peak Demand Savings [W]	67.5	95.3	127	Calculation

Installation Rates

Installation rates for circulator pumps are estimated at 100% due to their relatively high cost.

(2) Booster Pumps

Summary

Table 134 presents a summary of the values used to calculate booster pump savings. The detailed methodology follows.

Table 134: Booster Pump Measure Summary

Parameter	BER-MI	BER-IR	Reference
Measure Description and Identification			
Measure Description	High efficiency booster pumps		N/A
Additional Notes	-		
General Parameters			
Installation Rate	100%		See details below under Installation Rates
Effective Useful Life [years]	15		See Subsection 4.2
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	Calculation based on specification data for each installed system	657	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	N/A		N/A
Unitary Peak Demand Savings [W]	Calculation based on specification data for each installed system	88.8	See details below under Unitary Peak Demand Savings
Interactive Effects Factor for Energy Savings	0%		Assumption
Interactive Effects Factor for Peak Demand Savings	0%		Assumption

Electrical Unitary Energy Savings

The electrical unitary energy savings for booster pumps are calculated using the variables defined and listed in the equation and Table 135 below.

$$Energy\ Savings_{kWh} = 891.20 \times HP_{ee} + 3523.08 \times \Delta HP_{sys}$$

Table 135: Electrical Unitary Savings Values for Booster Pumps

Parameter	Symbol	BER-MI	BER-IR	Source
Rated horsepower of the new booster pump or pumping system [HP]	HP_{ee}	Based on specification data for each installed system	0.7376	MI: 2020 BER-MI tracking sheet IR: Rated power of the only rebated model
Reduction in the total rated horsepower of the system [HP]	ΔHP_{sys}	Based on specification data for each installed system	0	MI: 2020 BER-MI tracking sheet IR: Assumption
Annual unitary energy savings per rated horsepower from the use of a VFD booster pump [kWh/HP]	891.20	891.20		2020 Hawaii TRM
Annual unitary energy savings per rated horsepower reduced [kWh/HP]	3,523.08	3,523.08		
Unitary Energy Savings [kWh/year]	$Energy Savings_{kWh}$	Calculated based on specification data for each installed system	657	Calculation

Unitary Peak Demand Savings

The unitary peak demand savings for booster pumps are calculated using the variables defined and listed in the equation and Table 136 below, as well as variables from Table 135 above.

$$Peak\ Demand\ Savings_W = (172 \times HP_{ee} + 671 \times \Delta HP_{sys}) \times PCF$$

Table 136: Unitary Peak Demand Savings Values for Booster Pumps

Parameter	Symbol	BER-MI	BER-IR	Source
Annual unitary demand savings per rated horsepower from the use of a VFD booster pump [W/HP]	172	172		2020 Hawaii TRM
Annual unitary demand savings per rated horsepower reduced [W/HP]	671	671		
Peak Coincidence Factor	PCF	0.7		Average value calculated using project data from eight Custom Retrofit booster pump projects
Unitary Peak Demand Savings [W]	$Peak Demand Savings_W$	Calculated based on specification data for each installed system	88.8	Calculation

Installation Rates

Installation rates for booster pumps are estimated at 100% due to their relatively high cost.

3.3 Space Heating

3.3.1 Interactive Effects

For HVAC measures, interactive effects are assumed to be nil.

3.3.2 Peak Demand Savings Factors

For electric thermal storage, peak demand savings are not calculated using a peak demand-to-energy ratio since they do not generate energy savings. For more details, refer to Subsection 3.3.3(1).

For advanced rooftop unit (RTU) controls, peak demand savings are not calculated using a peak demand-to-energy ratio. For more details, refer to Subsection 3.3.3 (2).

3.3.3 Space Heating Measures

(1) Electric Thermal Storage

Summary

Table 137 presents a summary of the values used to calculate electric thermal storage savings. The detailed methodology follows.

Table 137: Electric Thermal Storage Measure Summary

Parameter	BER Mail-in	SBES	Reference
Measure Description and Identification			
Measure Description	Electric thermal storage systems to reduce peak demand space heating load	N/A	
Additional Notes			
General Parameters			
Installation Rate	100%	See details below under Installation Rates	
Effective Useful Life [years]	18	See Subsection 4.2	
Electrical Savings Parameters			
Unitary Energy Savings [kWh/year]	N/A	See details below under Electrical Unitary Energy Savings	
Peak Demand-to-energy Ratio [W/kWh]	N/A	N/A	
Unitary Peak Demand Savings [W]	Maximum storage capacity in eight hours divided by 16 hours	See details below under Unitary Peak Demand Savings	
Interactive Effects Factor for Energy Savings	0%	See Subsection 3.3.1	
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 3.3.1	

Electrical Unitary Energy Savings

No energy savings are expected from this measure.

Unitary Peak Demand Savings

For electric thermal storage, an eight-hour charging period is assumed based on the residential off-peak period in Nova Scotia Power's time of day rate. It is also assumed that the stored heat will be provided equally throughout the remaining 16 hours of the day.

Therefore, the unitary peak demand unitary savings for electric thermal storage are calculated using the equation below where the maximum storage capacity is drawn from manufacturer specification sheets and is either the maximum system storage capacity or the maximum amount of energy the system can store in eight hours.

$$\text{Peak Demand Savings}_W = \text{Maximum Storage Capacity in 8h/16h}$$

Installation Rates

Installation rates for electric thermal storage systems are estimated at 100% due to their relatively high cost.

(2) Advanced Rooftop Unit Controls

Summary

Table 138 presents a summary of the values used to calculate advanced rooftop unit (RTU) control savings. The detailed methodology follows.

Table 138: Advanced RTU Control Measure Summary

Parameter	BER Mail-in	Reference
Measure Description and Identification		
Measure Description	Advanced RTU controls that include demand-controlled ventilation (DCV) and an optional variable frequency drive (VFD)	N/A
Additional Notes		
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	10	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	Calculation based on specification data for each installed system	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	N/A	N/A
Unitary Peak Demand Savings [W]	N/A	See details below under Unitary Peak Demand Savings
Interactive Effects Factor for Energy Savings	0%	See Subsection 3.3.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 3.3.1

Electrical Unitary Energy Savings

The electrical unitary energy savings for advanced RTU controls are calculated using the variables defined and listed in the equation below as well as in Table 139 and Table 140 below.

$$\begin{aligned}
 \text{Energy Savings}_{kWh} &= \frac{1}{12,000} \\
 &\times \left(AC \times Capacity_{cool} \times PerCapacitySavings_{cool} \right. \\
 &\quad \left. + ElecHeat \times \frac{Capacity_{heat} \times PerCapacitySavings_{heat}}{COP_{heat}} \right)
 \end{aligned}$$

Table 139: Electrical Unitary Savings Values for Advanced RTU Controls

Parameter	Symbol	BER-MI	Source
Indicator of cooling in the RTU	AC	RTU with AC: 1 RTU without AC: 0	
Indicator of electrical heating in the RTU	$ElecHeat$	RTU with electrical heating: 1 RTU without electrical heating: 0	
Rated cooling capacity of the cooling equipment [BTU/h]	$Capacity_{cool}$	Specification data for each system	BER-MI TS
Rated heating capacity of the heating equipment [BTU/h]	$Capacity_{heat}$	Specification data for each system	
Coefficient of performance (COP) of the heating equipment [kW/kW]	COP_{heat}	RTU with electrical resistance: 1 RTU with heat pump: Specification data (if unknown, assume 2.1)	AHRI certified value or assumption ¹⁶¹
Normalized electrical cooling savings per capacity [kWh/tonne]	$PerCapacitySavings_{cool}$	Values from Table 140	2021 Illinois TRM, ¹⁶² 2021 New York TRM, ¹⁶³ Canada Historical Climate Data, ¹⁶⁴ 2016 BER Evaluation ¹⁶⁵
Normalized electrical heating savings per capacity and COP [kWh/tonne]	$PerCapacitySavings_{heat}$		
Conversion factor [BTU/tonne·h]	12,000	12,000	Convention

¹⁶¹ Assuming a COP of 1 for electric resistance and an average COP of 2.1, which corresponds to the average HSPF value cited by NRCAN for air-source heat pumps converted from BTU/W·h to kW/kW (<https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about/energy-star-announcements/publications/heating-and-cooling-heat-pump/6817>).

¹⁶² Illinois Energy Efficiency Stakeholder Advisory Group, 2021 *Illinois Statewide Technical Reference Manual for Energy Efficiency Version 9.0, Volume 2*, September 2020, p. 393.

¹⁶³ New York Department of Public Service, *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs - Residential, Multi-Family, and Commercial/Industrial Measures*, July 31, 2020, p. 596.

¹⁶⁴ Government of Canada, Historical Climate Data. Retrieved from https://climate.weather.gc.ca/historical_data/search_historic_data_e.html.

¹⁶⁵ Econoler, *Efficient Product Rebates 2016 DSM Evaluation*, March 8, 2017.

Table 140: Advanced RTU Control Normalized Electrical Cooling Savings per Capacity and Normalized Electrical Heating Savings per Capacity and COP¹⁶⁶

Facility Type	Electrical Cooling Energy Savings per Cooling System Capacity [kWh.h/BTU]		Electrical Heating Energy Savings per Heating System Capacity and COP ¹⁶⁷ [kWh.h/BTU]	
	DCV Only	DCV and VFD	DCV Only	DCV and VFD
Convenience Store	22	425	1,287	928
Education - Community College/University	24	192	1,885	1,736
Education - Primary ¹⁶⁸	10	81	2,289	2,107
Education - Secondary ¹⁶⁸	17	136	2,448	2,254
Health/Medical – Clinic ¹⁶⁹	4	263	233	29
Health/Medical - Hospital ¹⁶⁸	5	313	262	33
Lodging ¹⁶⁹	4	263	233	29
Manufacturing	4	351	117	88
Multi-family ¹⁶⁸	2	150	225	28
Office - Low Rise	7	492	729	204
Office - Mid Rise ¹⁶⁸	11	715	812	227
Office - High Rise ¹⁶⁸	19	1,282	797	223
Restaurant	6	266	729	467
Retail - Large Dept. Store	15	326	671	321
Retail - Strip Mall	14	335	613	438
Warehouse	2	176	658	269
Other/Miscellaneous ¹⁷⁰	10	360	874	586

¹⁶⁶ Normalized savings per capacity values were calculated based on the normalized savings per capacity values for Chicago (2021 Illinois TRM), as well as on the cooling and heating-degree days from Chicago (842 and 6,342 °F·day, 2021 NY TRM) and Halifax (204 and 3,746 °C·day, Canada Historical Climate Data).

¹⁶⁷ Normalized heating savings per capacity were multiplied by the COP assumption of 2.3 (2021 Illinois TRM) to obtain normalized heating savings per capacity and COP.

¹⁶⁸ Normalized savings per capacity values for primary and secondary education facilities were calculated based on the ratio of their full load heating and cooling hours (from the 2016 BER evaluation) and those of community college/university facilities. Similarly, the savings per capacity for hospitals were derived from the values for clinics, those for multi-family facilities were derived from the values for lodging facilities, and those for mid-rise and high-rise offices were derived from the values for low-rise offices.

¹⁶⁹ Normalized savings per capacity values for assisted living facilities were used for clinics and lodging facilities since they were assumed to be similar.

¹⁷⁰ Normalized savings per capacity values for the Other/Miscellaneous category were estimated to be the average values of all other categories.

Unitary Peak Demand Savings

No empirical unitary peak demand savings values based on metering data were found in the literature for winter peaking utilities. Furthermore, since commercial RTUs have significantly different loads, hours of operation, and occupancy profiles during peak periods (even within a given facility type), no unitary peak demand savings equation could be devised under a simple prescriptive approach. Thus, no peak demand savings are claimed for this measure.

Installation Rates

Installation rates for advanced RTU controls are estimated at 100% due to their relatively high cost.

3.4 Water Heating

3.4.1 Interactive Effects

Interactive effects are assumed to be nil for all water heating measures except for hot water insulation measures.

Hot Water Insulation Measures

For hot water insulation measures, namely pipe insulation and hot water tank wraps, the interactive effects factors are based on engineering calculations to account for the duration of the heating and cooling seasons, cooling and heating system efficiency, and percentage of heat generated inside the heated portion of the building envelope.

For SBES, since no information is currently available on the proportion of water heating systems that are located inside the heated portion of the building for small businesses, the Evaluator assumed that it is similar to those of single-family homes. As presented in Subsection 2.2.1, based on site visit results from the 2015 evaluation¹⁷¹ and accounting for the proportion of DHW insulation measures installed in conditioned spaces, the average number of months during which heating interactive effects occur in a single-family home is 3.8 months. It is assumed that the impact of DHW on cooling loads is negligible since most measures are installed in a location that might be heated but not likely air-conditioned. Similar to lighting measures, it is assumed that 10% of the heat released by the pipes and DHW is lost through exterior walls and ceilings and does not contribute to the interactive effects, meaning 90% of heating contributes to interactive effects.

For buildings with heat pump heating, since the interactive effects factors are based on a heating system efficiency of 100%, some adjustments are necessary for buildings that use a heat pump as a primary heating system because the efficiency of such systems is superior to 100%. To do so, the interactive effects factor for heating (-28.5%) is divided by 2.2, the COP of a standard mini-split heat pump based on a heating seasonal performance factor (HSPF) Region V of 7.4, which is the value for a standard split heat pump as defined by the Federal Energy Efficiency Regulations.¹⁷²

¹⁷¹ Econoler, *Residential Direct Install 2015 Evaluation*, March 3, 2016.

¹⁷² Minister of Justice, Canada, *Energy Efficiency Regulations*, 2016, <http://laws-lois.justice.gc.ca/PDF/SOR-2016-311.pdf> (Last accessed December 5, 2019).

Peak Demand

As for the impact on peak demand savings, it is assumed that all hot water tanks in a conditioned or semi-conditioned space create interactive effects. Therefore, similar to lighting products, the interactive effects factor for peak demand savings in electrically heated buildings is -90%.

Table 141 summarizes the interactive effects factors for water heating insulation measures.

Table 141: Interactive Effects Factors for Pipe Insulation and Hot Water Tank Wraps

Space Heating	Energy Interactive Effects During Heating Period	Energy Interactive Effects During Cooling Period	Total Energy Interactive Effects	Peak Demand Interactive Effects
Heat Pump Heating	$-90\% \times 3.8/12 / 2.2 = -13.0\%$	0.0%	-13.0%	-90%
Electrical Heating	$-90\% \times 3.8/12 = -28.5\%$	0.0%	-28.5%	-90%
No Electrical Heating	0.0%	0.0%	0.0%	0%

Summary

Table 142 summarizes the interactive effects factors established for each water heating measure.

Table 142: Interactive Effects Factors for Water Heating Measures

Measure	Type of Space Heating	Interactive Effects Factors for Energy Savings	Interactive Effects Factors for Peak Demand Savings	Source
Low-flow Showerheads	N/A	0%	0%	Assumption
Faucet Aerators				
Thermostatic Shower Valves				
Pipe Insulation Hot Water Tank Wraps	Heat Pump Heating	-13.0%	-90%	Calculation
	Electrical Heating	-28.5%	-90%	
	No Electrical Heating	0%	0%	

3.4.2 Peak Demand Savings Factors

Peak demand savings correspond to the demand savings that coincide in time with the peak demand of the electricity system. The projected electricity peak demand period in Nova Scotia is between 5 p.m. and 7 p.m. from December to February on non-holiday weekdays.

Peak Demand-to-energy Ratio

For hot water tank wraps, energy savings are assumed to occur all the time since the tank always exchanges heat with the space around it. Therefore, peak demand savings for this measure correspond to the average demand savings throughout the year and were established by dividing the energy savings by 8,760 hours, which correspond to a peak demand-to-energy ratio of 0.114 W/kWh.

For other water heating measures, since commercial DHW was not an end use included in the peak demand-to-energy ratios developed by Navigant in the 2016-2018 DSM Plan, the Evaluator relied on load shapes from the Illinois TRM to establish a peak demand-to-energy ratio for this end use. Those load shapes rely on simulations to identify what portion of the energy savings is generated during the winter peak, which is defined for Illinois as between 8 a.m. and 11 p.m. on non-holiday weekdays from October to April. While that peak period differs from the one defined in Nova Scotia, those load shapes account for the fact that most water usage happens during the day on weekdays, thus providing a better estimate than spreading savings evenly throughout the year. Therefore, using those load shapes, the Evaluator established a peak demand-to-energy ratio by dividing the energy savings occurring during the peak period by the length of the peak period, as presented in the equations below.

$$\text{Peak Demand-to-energy Ratio} = \frac{\%kWh_{WP} \times 1,000 \text{ kW/W}}{Hours_{WP}}$$

$$Hours_{WP} = (Days_{WP} \times \%Weekdays - Holidays_{WP}) \times \text{Daily Peak Hours}$$

Table 143 lists the parameters and corresponding values applied in the above equations and the resulting peak demand-to-energy ratio.

Table 143: Peak Demand-to-energy Ratio for Water Heating Measures

Parameter	Symbol	Value	Source
Portion of energy savings occurring during winter peak hours	$\%kWh_{WP}$	40.5%	Illinois TRM
Number of days during winter peak season	$Days_{WP}$	211	Illinois TRM
Portion of weekdays in a week	$\%Weekdays$	71%	Convention
Number of holidays during winter peak period	$Holidays_{WP}$	10	Assumption
Number of peak hours per day	Daily Peak Hours	15	Illinois TRM
Number of winter peak hours per year	$Hours_{WP}$	2,111	Calculation
Peak Demand-to-energy Ratio		0.192	Calculation

Table 144 summarizes the peak demand-to-energy ratio for water heating measures.

Table 144: Water Heating Measure Peak Demand-to-energy Ratio Summary

Measure	Peak Demand-to-energy Ratio (W/kWh)
Low-flow Showerheads	0.192
Faucet Aerators	
Thermostatic Shower Valves	
Pipe Insulation	
Hot Water Tank Wraps	0.114

3.4.3 Water Heating Measures

(1) Low-flow Showerheads

Summary

Table 145 presents a summary of the values used to calculate low-flow showerhead savings. The detailed methodology follows.

Table 145: Low-flow Showerhead Measure Summary

Parameter	SBES			Reference
Measure Description and Identification				
Measure Description	Low-flow showerheads to reduce hot water consumption			
Additional Notes	Flow rate reduction of 0.5 gpm	Flow rate reduction of 0.75 gpm	Flow rate reduction of 1 gpm	
Installation Rate	100%			Assumption
Effective Useful Life [years]	10			See Subsection 4.2
Unitary Energy Savings [kWh/year]	215	322	429	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.192			See Subsection 3.4.2
Unitary Peak Demand Savings [W]	41.3	61.8	82.4	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%			See Subsection 3.4.1
Interactive Effects Factor for Peak Demand Savings	0%			See Subsection 3.4.1

Electrical Unitary Energy Savings

The equations below are used to determine the annual unitary savings values for low-flow showerheads. The reduction in hot water consumption is established by the difference between the base and efficient hot water consumption levels, as presented in the second equation.

$$Energy\ Savings\ \left[\frac{kWh}{year}\right] = \%ElectricDHW \times \Delta Gallons\ \left[\frac{gal}{year}\right] \times EPG_{electric}\ \left[\frac{kWh}{gal}\right]$$

$$\Delta Gallons\ \left[\frac{gal}{year}\right] = (GPM_{base} - GPM_{low})\ \left[\frac{gal}{min}\right] \times SH_{time}\ \left[\frac{min}{year}\right] \times \%_{DHW}$$

$$EPG_{Electric}\ \left[\frac{kWh}{gal}\right] = (\rho_{H2O}\ \left[\frac{lb}{ft^3}\right] \times Cp_{H2O}\ \left[\frac{BTU}{lb^{\circ}F}\right] \times \Delta T_{H2O}\ [^{\circ}F] \times UC1\ \left[\frac{kWh}{BTU}\right] \times UC2\ \left[\frac{ft^3}{gal}\right]) / \eta$$

Table 146 below lists the parameters and corresponding values applied in the above equations for low-flow showerheads and the resulting unitary savings values.

Table 146: Electrical Unitary Energy Savings Values for Low-flow Showerheads

Parameter	Symbol	SBES			Source
Proportion of Water Heating Supplied by Electric Resistance Heating	%ElectricDHW	100%			Electrical energy savings will only be claimed for participants with electrical water heating
Baseline Flow Rate [gpm]	GPM _{base}	2	2.25	2.5	SBES tracking sheet
Low-flow Rate [gpm]	GPM _{low}	1.5			EPI Program Manual
Annual Minutes per Showerhead [min/year]	SH _{time}	3,419			See Table 147 below
Percentage of Hot Water Used in Showers	% _{DHW}	63%			DeOreo et al.
Energy per Gallon of Hot Water Supplied by Electricity for Resistance Units [kWh/gal]	EPG _{Electric}	0.19924			Calculation
Electric Water Heater Efficiency	η	97%			Pennsylvania Public Utility Commission TRM
Temperature Rise in Electric Water Heater [°F]	ΔT_{H2O}	79			2011 OPA
Specific Heat of Water [BTU/lb°F]	Cp _{H2O}	1			Convention
Density of Water [lb/ft ³]	ρ_{H2O}	62.43			Convention
Unit Conversion #1 [kWh/BTU]	UC1	0.00029308			Convention
Unit Conversion #2 [ft ³ /gal]	UC2	0.1337			Convention
Unitary Energy Savings [kWh/year]		215	322	429	Calculation

Table 147 presents the annual minutes per showerhead by building type, the weight of each building type, and the resulting average annual minutes per showerhead for SBES.

Table 147: Average Showerhead Usage

Building Type	Annual Minutes per Showerhead (SH _{time})	Weight	Source
Hospitality	3,509	86%	Annual minutes per showerhead: Iowa Energy Efficiency TRM – 2021
Health	2,528	0%	
Education	2,057	0%	
Commercial - Employee Shower	1,894	2%	
Other Commercial Except Fitness Center	3,029	12%	Weight: SBES 2021 tracking sheet
Fitness Center	56,893	0%	
Weighted Average [Min/year]	3,419	-	Calculation

Installation Rates

Table 148 lists the installation rate for SBES low-flow showerheads.

Table 148: EPI Low-flow Showerhead Installation Rate

Installation Rate	Source
100%	Assumption

(2) Faucet Aerators

Summary

Table 149 presents a summary of the values used to calculate faucet aerator savings. The detailed methodology follows.

Table 149: Faucet Aerator Measure Summary

Parameter	SBES	Reference
Measure Description and Identification		
Measure Description	Faucet aerators to reduce hot water consumption	N/A
Additional Notes	Bathroom	
General Parameters		
Installation Rate	95%	See details below under Installation Rates
Effective Useful Life [years]	10	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	269	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.192	See Subsection 3.4.2
Unitary Peak Demand Savings [W]	51.6	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	See Subsection 3.4.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 3.4.1

Electrical Unitary Energy Savings

The equations below are used to calculate the annual unitary savings value for faucet aerators.

$$DHW\ Savings\ \left[\frac{L}{year}\right] = DHW_{base}\ \left[\frac{gal}{year}\right] \times \frac{(q_{base} - q_{low})}{q_{base}} \times UC1\ \left[\frac{L}{gal}\right]$$

$$Unitary\ Savings\ \left[\frac{kWh}{year}\right] = \frac{DHW\ Savings[L] \times Cp\ \left[\frac{lb}{ft^3}\right] \times \rho\ \left[\frac{btu}{lb^{\circ}F}\right] \times \Delta T[^{\circ}F] \times UC2\ \left[\frac{kWh}{btu} \times \frac{ft^3}{L}\right]}{\eta}$$

Table 150 below lists the parameters and values applied in the two above equations for faucet aerators and the resulting unitary savings values.

Table 150: Electrical Unitary Savings Values for Faucet Aerators

Parameter	Symbol	Value	Source
Baseline Flow Rate [gpm]	q _{base}	1.39	DeOreo et al. in <i>Residential End Uses of Water Study Update</i> , as cited in Illinois Commerce Commission (2021) ¹⁷³
Low-flow Rate [gpm]	q _{low}	0.94	
Baseline Hot Water Consumption [US gallons/year]	DHW _{base}	4,163	See Table 151 below
Specific Heat of Water [BTU/lb°F]	C _{pH2O}	1	Convention
Density of Water [lb/ft ³]	ρ _{H2O}	62.43	Convention
Temperature Rise in Electrical Water Heater [°F]	ΔT _{H2O}	79	2011 OPA
Electrical Water Heater Efficiency	η	97%	Pennsylvania TRM ¹⁷⁴
Unit Conversion #1 [L/US gallon]	UC1	3.79	Convention
Unit Conversion #2 [(kWh/BTU)×(ft ³ /L)]	UC2	0.00001035	Convention
Unitary Energy Savings [kWh/year]		269	Calculation

Table 151 presents the average hot water usage per faucet by building type, the weight of each building type, and the resulting average annual hot water usage per faucet for SBES.

Table 151: Average Hot Water Usage per Faucet

Building Type	DHW Consumption per Faucet (Gallons)	Weight	Source
Small Office	2,500	12%	Consumption: 2021 Illinois Statewide TRM
Restaurant	15,768	6%	
Retail	3,650	3%	
Lodging	1,825	36%	Weight: SBES 2021 tracking sheet
Other	5,000	43%	
Weighted Average [Min/year]	4,163	-	Calculation

¹⁷³ Illinois Commerce Commission (2020). *2021 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 9.0 – Volume 2: Commercial and Industrial Measures*, p. 131.

¹⁷⁴ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

Installation Rates

Table 152 lists the installation rate for SBES faucet aerators.

Table 152: SBES Faucet Aerator Installation Rate

Installation Rate	Margin of Error	Source
95%	N/A	2021 Illinois Statewide TRM

(3) Thermostatic Shower Valve

Summary

Table 153 presents a summary of the values used to calculate thermostatic shower valve savings. The detailed methodology follows.

Table 153: Thermostatic Shower Valve Measure Summary

Parameter	SBES				Reference
Measure Description and Identification					
Measure Description	Thermostatic shower valves to reduce hot water consumption				N/A
Additional Notes	Flow rate of:				
	1.5 gpm	2.0 gpm	2.25 gpm	2.5 gpm	
General Parameters					
Installation Rate	100%				See details below under Installation Rates
Effective Useful Life [years]	10				See Subsection 4.2
Electrical Savings Parameters					
Unitary Energy Savings [kWh/year]	81	108	121	135	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.192				See Subsection 3.4.2
Unitary Peak Demand Savings [W]	15.5	20.7	23.3	25.9	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%				See Subsection 3.4.1
Interactive Effects Factor for Peak Demand Savings	0%				See Subsection 3.4.1

Electrical Unitary Energy Savings

The equations below are used to determine the annual unitary savings values for thermostatic shower valves. Energy savings are established by calculating the reduction in hot water usage, as presented in the second equation below.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{year}} \right] = \text{DHW Reduction} \left[\frac{\text{gal}}{\text{year}} \right] \times \text{EPG}_{\text{electric}} \left[\frac{\text{kWh}}{\text{gal}} \right]$$

$$\text{DHW Reduction} \left[\frac{\text{gal}}{\text{year}} \right] = q \left[\frac{\text{gal}}{\text{min}} \right] \times \%_{\text{DHW}} \times t_w \left[\frac{\text{min}}{\text{shower}} \right] \times \frac{SH_{\text{time}} \left[\frac{\text{min}}{\text{year}} \right]}{t_{\text{shower}} \left[\frac{\text{min}}{\text{shower}} \right]}$$

$$\text{EPG}_{\text{Electric}} \left[\frac{\text{kWh}}{\text{gal}} \right] = (\rho_{\text{H}_2\text{O}} \left[\frac{\text{lb}}{\text{ft}^3} \right] \times C_{p_{\text{H}_2\text{O}}} \left[\frac{\text{BTU}}{\text{lb}^\circ\text{F}} \right] \times \Delta T_{\text{H}_2\text{O}} [^\circ\text{F}] \times \text{UC1} \left[\frac{\text{kWh}}{\text{BTU}} \right] \times \text{UC2} \left[\frac{\text{ft}^3}{\text{gal}} \right]) / \eta$$

Table 154 lists the parameters and corresponding values applied to the two above equations and the resulting unitary savings values for thermostatic shower valves.

Table 154: Electrical Unitary Energy Savings Values for Thermostatic Shower Valves

Parameter	Symbol	SBES	Source
Flow Rate [gpm]	q	Variable (1.5 gpm for low-flow showerhead, otherwise: 2.0 gpm, 2.25 gpm, or 2.5 gpm)	SBES tracking sheet
Annual Minutes per Showerhead [min/year]	SH _{time}	3,419	Value drawn from the low-flow showerhead measure; see Subsection 3.4.3 (1)
Average Shower Time per Person [min/shower]	t _{shower}	7.8	DeOreo et al.
Behavioural Waste Time [min/shower]	t _w	0.98	Pennsylvania Public Utility Commission TRM
Percentage of Hot Water Used in Showers	% _{DHW}	63%	DeOreo et al.
Specific Heat of Water [BTU/lb°F]	C _{p_{H2O}}	1	Convention
Density of Water [lb/ft³]	ρ _{H2O}	62.43	Convention
Temperature Rise in Electric Water Heater [°F]	ΔT _{H2O}	79	2011 OPA
Unit Conversion #1 [kWh/BTU]	UC1	0.000293083	Convention
Unit Conversion #2 [ft³/gal]	UC2	0.1337	Convention
Electric Water Heater Efficiency	η	97%	Pennsylvania Public Utility Commission TRM
Unitary Energy Savings [kWh/year]	Flow rate of 1.5 gpm	81	Calculation
	Flow rate of 2.0 gpm	108	Calculation
	Flow rate of 2.25 gpm	121	Calculation
	Flow rate of 2.5 gpm	135	Calculation

Installation Rates

Table 155 lists the installation rate for thermostatic shower valves.

Table 155: Thermostatic Shower Valve Installation Rate

Installation Rate	Source
100%	Assumption

(4) Pipe Insulation

Summary

Table 156 presents a summary of the values used to calculate pipe insulation savings. The detailed methodology follows.

Table 156: Pipe Insulation Measure Summary

Parameter	SBES	Reference
Measure Description and Identification		
Measure Description	Pipe insulation to reduce hot water consumption	N/A
Additional Notes	-	
Installation Rate		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	13	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings (per ft) [kWh/year]	12.7	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.192	See Subsection 3.4.2
Unitary Peak Demand Savings [W]	2.44	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	Calculation based on building heating systems for each installed unit	See Subsection 3.4.1
Interactive Effects Factor for Peak Demand Savings		

Electrical Unitary Energy Savings

As presented in Table 157, the annual unitary savings value for pipe insulation was identified through Ontario Power Authority (OPA) 2011¹⁷⁵ values and was established at 12.7 kWh per linear foot. While this value is for residential usage, it was assumed that water heating systems in small businesses would be used for a similar amount of time as a home.

¹⁷⁵ Ontario Power Authority (OPA), *OPA Prescriptive Measures and Assumptions List*, December 2010.

Table 157: Unitary Savings Value for Pipe Insulation

Parameter	SBES
Unitary Energy Savings (per ft) [kWh/year]	12.7

Installation Rates

Table 158 lists the installation rate for SBES pipe insulation.

Table 158: SBES Pipe Insulation Installation Rate

Installation Rate	Source
100%	Assumption

(5) Hot Water Tank Wrap

Summary

Table 159 presents a summary of the values used to calculate hot water tank wrap savings. The detailed methodology follows.

Table 159: Hot Water Tank Wrap Measure Summary

Parameter	SBES	Reference
Measure Description and Identification		
Measure Description	Hot water tank wrap to reduce hot water consumption	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	7	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	159	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.114	See Subsection 3.4.2
Unitary Peak Demand Savings [W]	18.1	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	Calculation based on building heating systems for each installed unit	See Subsection 3.4.1
Interactive Effects Factor for Peak Demand Savings		

Electrical Unitary Energy Savings

The following equations are used to determine the annual unitary savings associated with hot water tank wraps. The energy savings are equal to the difference in heat losses associated with tank circumference (Q_{tank}) before and after adding the tank wrap ($Q_{\text{tank+RSI 1.21}}$). The heat losses are calculated using the following formulas of heat transfer in an insulated cylinder.

$$R_{\text{layer}} = \frac{\ln(r_e/r_i)}{2\pi k}$$

$$R_{\text{cyl}} = R_{\text{layer1}} + R_{\text{layer2}}$$

$$Q_{\text{cyl}} = \frac{T_i - T_e}{R_{\text{cyl}}} L$$

$$Q_{\text{top}} = \frac{A_{\text{top}} \times (T_i - T_e)}{R_{\text{top}}}$$

$$Q_{\text{total}} = Q_{\text{cyl}} + Q_{\text{top}}$$

$$\text{Energy Savings}_{\text{kWh}} = \frac{(Q_{\text{total}}) \cdot \text{HOU}}{\eta_{\text{heater}}}$$

It is assumed that small businesses use similar hot water tanks as single-family homes. Thus, the calculation considers a typical residential tank with a capacity of 60 imperial gallons and hot water tank wrap with a thermal resistance of 1.21 m²·°C/W.

Table 160 below lists the values applied in the above equations to obtain the unitary savings for tank wraps.

Table 160: Electrical Unitary Savings Values for Hot Water Tank Wraps

Parameter	Symbol	Value	Source
Layer 1: Interior Insulation of Tank			
External Radius of the Layer [m]	r_e	0.300	Giant ¹⁷⁶
Internal Radius of the Layer [m]	r_i	0.249	Ibid
Thermal Conductivity of the Layer [W/m·°C]	k	0.024	Ibid
Thermal Resistance of the Layer of Material in the Cylinder (e.g. insulation inside the tank and tank wrap) [m·°C/W]	R_{layer}	1.228	Calculation
Thermal Resistance of the Top of the Tank [m·°C/W]	R_{Top}	2.113	Giant ¹⁷⁷
Layer 2: Tank Wrap			
External Radius of the Layer [m]	r_e	0.351	Estimated from Frost King Insulation Blanket Specifications ¹⁷⁸
Internal Radius of the Layer [m]	r_i	0.300	Giant ¹⁷⁹
Thermal Conductivity of the Layer [W/m·°C]	k	0.042	Estimated from Frost King Insulation Blanket Specifications
Thermal Resistance of the Layer of Material Inside the Cylinder (e.g. insulation inside the tank and tank wrap) [m·°C/W]	R_{layer}	1.821	Calculation
Thermal Resistance of the Top of the Tank [m·°C/W]	R_{Top}	3.323	Sum of R-values of the insulation inside the tank and tank wrap
Heat Transfer			
Length of the Cylinder [m]	L	1.52	Giant ¹⁸⁰
Area of the Top of the Tank [m ²]	A_{top}	0.283	Calculated from Giant tank dimensions
Temperature at the External Radius of the Cylinder [°C]	T_e	21	Assumption for standard ambient indoor temperature
Temperature at the Internal Radius of the Cylinder [°C]	T_i	60	OPA Prescriptive Measures and Assumptions 2011
Hours of Use [h/year]	HOU	8,760	Assumption
Thermal Efficiency of Heating Element	η_{heater}	97%	Pennsylvania Public Utility Commission ¹⁸¹
Heat Transfer Through the Tank [W]	Q_{total}	53.4	Calculation
Heat Transfer Through the Insulated Tank [W]	Q_{total}	35.8	Calculation
Unitary Energy Savings for Tank Wrap [kWh/year]	-	159	Calculation

¹⁷⁶ Giant Inc., *Engineering Submittal Data Sheet 172ETE Models*, <http://www.giantinc.com/tech-data/FT-172E-An.pdf> (Last accessed February 18, 2015).

¹⁷⁷ Ibid.

¹⁷⁸ Frost King Weatherization Products, *Water Heater Insulation Blanket*, <http://www.frostking.com/water-heater-insulation-blanket/> (Last accessed January 4, 2014).

¹⁷⁹ Giant Inc., *Engineering Submittal Data Sheet 172ETE Models*, 16.

¹⁸⁰ Ibid., 16.

¹⁸¹ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

Installation Rates

Table 161 lists the installation rate for SBES hot water tank wraps.

Table 161: SBES Hot Water Tank Wrap Installation Rate

Installation Rate	Source
100%	Assumption

4 EFFECTIVE USEFUL LIFE

This section outlines the effective useful life (EUL) values used to calculate gross lifetime energy savings.

4.1 LED Lamps and Fixtures

To establish lifetime energy savings for LED lamps and fixtures, the equipment life is determined using rated lifetimes identified in product specification sheets and annual HOU, as described in the equation below.

$$\text{Equipment Life [Years]} = \frac{\text{Rated Lifetime [Hours]}}{\text{Annual HOU [Hours]}}$$

Since regulatory changes will cause the baseline to increase over the lifetime of LEDs and thus decrease annual savings over the lifetime of the product, an equivalent EUL is necessary to determine lifetime savings. The equivalent EUL is multiplied by first-year savings to obtain lifetime energy savings. Since the equivalent EUL is based on upcoming regulatory changes, it must be updated annually to take into account the changing duration of each baseline. The detailed assumptions and calculations to obtain equivalent EUL values are presented in Appendix II.

Table 162 and Table 163 summarize the equivalent EUL values for residential and BNI LED lamps and fixtures respectively.

Table 162: EUL Values for Residential LED Lamps and Fixtures

Measure	Program Component	Average Rated Lifetime (hours)	Annual HOU (hours/year)	Equipment Life (years)	2021 Equivalent EUL (years)
LED A19 Lamps					
9 W Replacing 25 W	EPI	25,000	986	25	3.0
9 W Replacing 29 W					6.3
9 W Replacing 40 W					4.4
9 W Replacing 43 W					8.8
9 W Replacing 60 W					6.2
9 W Replacing 72 W					12.4
9 W Replacing 100 W					8.9
9 W Replacing 150 W					9.5
9.5 W Replacing 25 W					3.0
9.5 W Replacing 29 W					6.3
9.5 W Replacing 40 W					4.4
9.5 W Replacing 43 W					8.8

Measure	Program Component	Average Rated Lifetime (hours)	Annual HOU (hours/year)	Equipment Life (years)	2021 Equivalent EUL (years)
9.5 W Replacing 60 W					6.2
9.5 W Replacing 72 W					12.4
9.5 W Replacing 100 W					8.9
9.5 W Replacing 150 W					9.5
18 W Replacing 75 W					12.4
18 W Replacing 100 W					8.9
7 W Blackout Bulbs Replacing 60 W					6.2
LED Reflector Lamps					
PAR20 7 W Replacing 50 W	EPI	25,000	986	25	4.5
PAR30 8 W Replacing 53 W					4.0
PAR30 8 W Replacing 75 W					5.6
PAR38 15 W Replacing 90 W					5.1
PAR38 15 W Replacing 120 W					6.4
PAR38 15 W Replacing 150 W					5.9
GU10 7 W Replacing 35 W					3.8
GU10 7 W Replacing 50 W					4.5
LED Decorative Lamps					
7 W G25	EPI	15,000	986	15	3.0
5 W Chandelier E12					
Other LED Lighting					
LED Nightlights	EPI	100,000	4,380	23	23
LED Non-A-type Lamps					
ENERGY STAR Certified LED Non-A-type Lamps (R, BR, and Decorative)	Instant Savings	15,952	1,059	15	4.2
ENERGY STAR Certified LED Non-A-type Lamps (Excluding R, BR, and Decorative)		25,000		24	5.0
LED Fixtures					
ENERGY STAR Certified LED Recessed Downlight Fixtures	Instant Savings	35,400	1,059	33	4.6
ENERGY STAR Certified LED Fixtures without Motion Sensors		50,000	1,059	47	7.4
ENERGY STAR Certified LED Fixtures with Motion Sensors		49,044	1,066	46	8.1

Table 163: EUL Values for BNI LED Lamps and Fixtures

Measure	Program Component	Average Rated Lifetime (hours)	Annual HOU (hours/year)	Equipment Life	2021 Equivalent EUL
LED Linear Fixtures					
1 x 4 Luminaires	BER Instant Rebates, BER Mail-in, SBES	50,000	4,300	11.6	11.6
2 x 2 Luminaires and Retrofit Kits	BER Instant Rebates, BER Mail-in, SBES	50,000	4,300	11.6	11.6
2 x 4 Luminaires and Retrofit Kits	BER Instant Rebates, BER Mail-in, SBES	50,000	4,300	11.6	11.6
Linear Ambient and Low-bay Luminaires	BER Instant Rebates, BER Mail-in, SBES	50,000	4,300	11.6	11.6
High-bay Luminaires	BER Mail-in, SBES	100,000	4,300	23.3	23.3
Troffers	BER Instant Rebates, BER Mail-in, SBES	90,000	4,300	20.9	20.9
LED Linear Lamps					
2-foot Replacement Lamps	BER Instant Rebates, BER Mail-in, SBES	50,000	4,300	11.6	11.6
3-foot Replacement Lamps	BER Instant Rebates, BER Mail-in, SBES	50,000	4,300	11.6	11.6
4-foot Replacement Lamps	BER Instant Rebates, BER Mail-in, SBES	50,000	4,300	11.6	11.6
8-foot Replacement Lamps	BER Instant Rebates, BER Mail-in, SBES	50,000	4,300	11.6	11.6
U-bend	BER Instant Rebates, BER Mail-in, SBES	50,000	4,300	11.6	11.6
LED General-use and Decorative Lamps					
LED Decorative (Chandelier)	SBES	25,000	3,600	6.9	3.4
LED Omnidirectional (A-lamp and Globe)	SBES	25,000	3,600	6.9	3.4
Four Pin-base Replacement Lamps for CFLs	BER Mail-in, SBES	50,000	4,300	11.6	11.6
9 W Replacing 25 W	SBES	25,000	3,600	6.9	3.0
9 W Replacing 29 W					3.6
9 W Replacing 40 W					2.7
9 W Replacing 43 W					4.0
9 W Replacing 60 W					3.0
9 W Replacing 72 W					4.7
9 W Replacing 100 W					3.5
9 W Replacing 150 W					3.2

Measure	Program Component	Average Rated Lifetime (hours)	Annual HOU (hours/year)	Equipment Life	2021 Equivalent EUL
9.5 W Replacing 25 W					3.0
9.5 W Replacing 29 W					3.5
9.5 W Replacing 40 W					2.6
9.5 W Replacing 43 W					4.0
9.5 W Replacing 60 W					3.0
9.5 W Replacing 72 W					4.7
9.5 W Replacing 100 W					3.5
9.5 W Replacing 150 W					3.2
18 W Replacing 75 W					4.1
18 W Replacing 100 W					3.2
7 W Blackout Bulbs Replacing 60 W					4.2
LED Reflector Lamps					
Small LED Reflector Lamps - PAR, MR, MRX 16	SBES	25,000	3,600	6.9	3.8
Small LED Reflector Lamps - PAR, R 20	SBES	25,000	3,600	6.9	3.8
Large LED Reflector Lamps - PAR, BR, R 30/30L	SBES	25,000	3,600	6.9	3.8
Large LED Reflector Lamps - PAR, BR, R 38/40	SBES	25,000	3,600	6.9	3.8
LED Downlight Fixtures					
LED Recessed	SBES	50,000	3,600	13.9	5.1
LED Ceiling Mount, LED Surface Mount, LED Solid State Retrofit, LED Inseparable Solid State Luminaire, LED Wall Sconces, LED Wall Sconce Retrofits	SBES	50,000	3,600	13.9	6.2
LED Outdoor Fixtures					
Outdoor Full-cut-off Wall-mounted Area Luminaires	BER Instant Rebates, BER Mail-in, SBES	75,000	4,380	17.1	17.1
Flood and Spot Luminaires	BER Instant Rebates, BER Mail-in, SBES	75,000	4,380	17.1	17.1
Fuel Pump Canopy Luminaires	BER Mail-in, SBES	50,000	4,380	11.4	11.4
LED Replacements for High-Intensity Discharge Lamps	BER Mail-in, SBES	50,000	4,380	11.4	11.4
Non-cut-off and Semi-cut-off Wall-mounted Area Luminaires	BER Instant Rebates, BER Mail-in, SBES	100,000	4,380	22.8	22.8

Measure	Program Component	Average Rated Lifetime (hours)	Annual HOU (hours/year)	Equipment Life	2021 Equivalent EUL
Pole/Arm-mounted Area Luminaires	BER Mail-in, SBES	60,000	4,380	13.7	13.7
Pole/Arm-mounted Decorative Luminaires	BER Mail-in, SBES	100,000	4,380	22.8	22.8
Parking Garage Luminaires	BER Mail-in, SBES	100,000	4,380	22.8	22.8
Case Lighting for Sign Retrofit Applications	BER Mail-in, SBES	50,000	4,300	11.6	11.6
LED Directional and Architectural Fixtures					
Track or Mono-point Directional Luminaires, LED Wall Wash Luminaires	BER Instant Rebates, BER Mail-in, SBES	50,000	4,300	11.6	11.6
Other LED Lighting					
Refrigerated Case Luminaires	BER Mail-in, SBES	70,000	4,300	16.3	16.3
LED Nightlights	SBES	100,000	4,380	22.8	22.8

4.2 Other Measures

The EUL values for non-LED lighting measures were established by conducting a literature review of the most recent sources, notably technical reference manuals (TRMs) and studies, used in other jurisdictions.

Table 164 and Table 165 summarize the EUL values and their source for residential and BNI measures respectively.

Table 164: EUL Values and Sources for Non-LED Lighting Residential Measures

Measure Name	Program Component	EUL Value	Source
Lighting			
Dimmer Switches	Instant Savings	10	IESO PMA List, 2019 (Value for dimmer switches)
Motion Sensors	Instant Savings	10	GDS, 2007 ¹⁸² (Table 1 – Residential Measures, value for occupancy sensors)
Water Heating			
Drain Water Heat Recovery	HEA	20	Minnesota TRM, 2020 (Value for residential hot water – drainpipe heat exchangers)
Solar Domestic Hot Water	HEA, Green Heat	20	ENERGY STAR Residential Water Heaters: Draft Criteria Analysis ¹⁸³ (Table 1, value for solar water heaters)
Heat Pump Water Heaters	NHC, HEA, MHEEP, Instant Savings	10	DEER, 2014 ¹⁸⁴ (Value for heat pump water heaters) Oak Ridge National Laboratory, “Durability Testing of a Drop-In Heat Pump Water Heater”, April 2004
Low-flow Showerheads	EPI, Instant Savings	10	DEER, 2014 (Value for low-flow showerheads)
Faucet Aerators	EPI	10	DEER, 2014 (value for faucet aerators)
Thermostatic Shower Valves	EPI	10	Efficiency Maine TRM, 2019 New York TRM, 2019: UPC certification under the International Association of Plumbing and Mechanical Officials Standard IGC 244-2007a. A standard that includes a lifecycle test consisting of 10,000 cycles without fail. 10,000 cycles is the equivalent of three users showering daily for more than nine years.
Pipe Insulation	EPI	13	DEER, 2014 (Value for pipe insulation – electric water heater)
Hot Water Tank Wraps	EPI	7	DEER, 2014 (Value for water heater tank wraps)

¹⁸² GDS Associates. Measure Life Report Residential and Commercial/Industrial Lighting and HVAC Measures. prepared for The New England State Program Working Group (SPWG). June 2007.

¹⁸³ Retrieved from https://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterDraftCriteriaAnalysis.pdf.

¹⁸⁴ California Public Utilities Commission. DEER 2014. *EUL table* update, Excel spreadsheet (version 2014) downloadable via READI <http://www.deeresources.com/index.php/23-deer-versions/27-deer-2014> (Last accessed June 16, 2020).

Measure Name	Program Component	EUL Value	Source
Space Heating			
Mini-split Heat Pumps	Green Heat, HEA	18	GDS, 2007 (Table 1 – Residential Measures, value for AC/heat pumps)
Central Air-source Heat Pumps	Green Heat, HEA	18	GDS, 2007 (Table 1, value for AC/heat pumps)
Ground-source Heat Pumps	Green Heat, HEA	25	Life expectancy estimated by the U.S. Department of Energy ¹⁸⁵ (up to 24 years for the inside component and more than 50 years for the ground loop) and by Natural Resources Canada ¹⁸⁶ (about 20 to 25 years).
Wood Stoves/Fireplace Inserts	Green Heat, HEA	18	GDS, 2007 (Table 1 – Residential Measures, value for replacement/retrofit of heating and cooling systems)
Pellet Stoves/Fireplace Inserts	Green Heat, HEA	18	GDS, 2007 (Table 1 – Residential Measures, value for replacement/retrofit of heating and cooling systems)
Wood Furnaces/Boilers	Green Heat, HEA	18	GDS, 2007 (Table 1 – Residential Measures, value for replacement/retrofit of heating and cooling systems)
Pellet Furnaces/Boilers	Green Heat, HEA	18	GDS, 2007 (Table 1 – Residential Measures, value for replacement/retrofit of heating and cooling systems)
Solar Air Heating	Green Heat, HEA	20	ENERGY STAR Residential Water Heaters: Draft Criteria Analysis ¹⁸⁷ (Table 1, value for solar water heaters) No information specific to solar air heating was available in the literature. The EUL of solar air heating systems is at least equivalent to that of solar DHW systems because solar air heating has very few mobile mechanical components.
Air Sealing Kits	EPI	15	GDS, 2007 (Table 1 – Residential Measures, value for air sealing)
Programmable Thermostats	EPI, Instant Savings, MHEEP	10	GDS, 2007 (Table 1 – Residential Measures; value for residential programmable thermostats)
Smart Thermostats for Electrical Baseboards	Instant Savings	10	Various EUL values are used among jurisdictions. The common practice is to use the same EUL value as for programmable thermostats.

¹⁸⁵ Retrieved from <https://energy.gov/energysaver/heat-and-cool/heat-pump-systems/geothermal-heat-pumps#306534-tab-1>.

¹⁸⁶ Retrieved from <https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about-energy-star-canada/energy-star-announcements/publications/heating-cooling-heat-pump/ground-source-heat-pumps-earth-energy-systems/6833>.

¹⁸⁷ Retrieved from https://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterDraftCriteriaAnalysis.pdf.

Measure Name	Program Component	EUL Value	Source
Appliances			
Clotheslines and Outdoor Drying Racks	EPI, Instant Savings	10	IESO PMA List, 2019 (Value for indoor clothes drying racks, retractable clotheslines or drying racks)
Indoor Drying Racks	EPI	10	IESO, PMA List, 2019 (Value for indoor clothes drying racks, retractable clotheslines or drying racks)
Refrigerator Retirements	ARet	4	ENERGY STAR Calculator, Appliance Magazine Market Research Report, 2011 Calculation based on the assumption that the EUL of the retired appliance (4 years) corresponds to one third of the EUL of a new appliance (12 years). An equivalent EUL is calculated to account for the baseline increase occurring over the lifetime of the measure
Refrigerator Replacements	ARet (HW, MHEEP)	5	ENERGY STAR Calculator, Appliance Magazine Market Research Report, 2011 Calculation based on the assumption that the EUL of the retired appliance (4 years) corresponds to one third of the EUL of a new appliance (12 years). An equivalent EUL is calculated to account for the baseline increase occurring over the lifetime of the measure.
Freezer Retirements/ Replacements	ARet	4	ENERGY STAR Calculator, Appliance Magazine Market Research Report, 2011 Calculation based on the assumption that the EUL of the retired appliance (4 years) corresponds to one third of the EUL of a new appliance (12 years). An equivalent EUL is calculated to account for the baseline increase occurring over the lifetime of the measure.
Room Air-conditioner Retirements	ARet	3	DEER, 2014 (Value for room air conditioner recycling)
Dehumidifier Replacements	ARet (HW, MHEEP)	5	ENERGY STAR Calculator, Appliance Magazine Market Research Report, 2011 Calculation based on the assumption that the EUL of the retired appliance (4 years) corresponds to one third of the EUL of a new appliance (12 years). An equivalent EUL is calculated to account for the baseline increase occurring over the lifetime of the measure.
ENERGY STAR Certified Dehumidifiers	Instant Savings	12	ENERGY STAR Calculator, 2016 (Value for dehumidifiers)
Clothes Dryer Replacements	ARet (MHEEP)	5	ENERGY STAR Calculator, Appliance Magazine Market Research Report, 2011 Calculation based on the assumption that the EUL of the retired appliance (4 years) corresponds to one third of the EUL of a new appliance (12 years). An equivalent EUL is calculated to account for the baseline increase occurring over the lifetime of the measure.
ENERGY STAR Certified Clothes Dryers	Instant Savings	12	ENERGY STAR Calculator, 2016 (Value for clothes dryers)

Measure Name	Program Component	EUL Value	Source
Efficient Clothes Washers	Instant Savings	11	ENERGY STAR Calculator, 2016 (Value for clothes washers) DOE, Building Energy Data Book, 2011, Table 5.7.15 (Value for clothes washers) DEER, 2014 (Value for high efficiency clothes washers)
ENERGY STAR Certified Room Air Purifiers	Instant Savings	9	ENERGY STAR Calculator, 2016 (Value for air purifiers)
Plug Load Controls			
Smart Power Controllers for Audiovisual Equipment/Load Sensing Power Bars (Smart Strips)	EPI, Instant Savings	4	David Rogers, PowerSmart Engineering "Smart Strip Electrical Savings Usability." October 2008, p. 22
Power Bars with Integrated Timer	Instant Savings	4	David Rogers, PowerSmart Engineering "Smart Strip Electrical Savings Usability." October 2008, p. 22
Heavy-duty Outdoor Timers	Instant Savings	10	IESO PMA List, 2019 (Value for heavy duty plug-in timers)
ENERGY STAR Certified Pool Pumps	Instant Savings	10	ENERGY STAR Calculator, 2016 (Value for pool pumps) CEE, High Efficiency Residential Swimming Pool Initiative, 2012
Demand Reduction			
Three-element Water Heaters	Green Heat, HEA	12	Hydro-Québec, 2011 ¹⁸⁸
Domestic Water Heater Timers	Green Heat, HEA	15	GDS, 2007 (Appendix C – Additional Documentation on Targeted Measures and Preliminary Measure Life Value Data for Other Residential and C&I End-Use Equipment, Value for Water Heater Controls)
Electric Thermal Storage	Green Heat, HEA	18	The EUL is expected to be comparable to other heating systems. The EUL therefore corresponds to the value used for stoves, furnaces/boilers, and air-source heat pumps.
Domestic Water Heater Load Control	EPI	1	Savings will persist throughout participation. The average participation length is yet to be established since this is the first year of a pilot. Thus, a conservative value of 1 year was used.

¹⁸⁸ Hydro-Québec. *Essais terrain 2007-2008 d'un nouveau concept de chauffe-eau électrique à 3 éléments*, Provided by Hydro-Québec - Not publicly available, March 15, 2011.

Measure Name	Program Component	EUL Value	Source
Other			
New Homes	NHC	30 (Tier 1 & 2) 36 (Tier 3)	The EUL values were established by calculating the weighted average EUL of insulation, heating system, and lighting measures. The difference in EUL between Tier 1 & 2 and Tier 3 houses is attributed to a higher weight being given to insulation measures for Tier 3 houses. The literature review did not reveal any specific EUL being used for high-performance houses in other jurisdictions. The EUL values established as part of the 2017 evaluation were therefore considered still valid.
Space Heating	HEA, MHEEP	20.8	The EUL value of 20.8 years for building envelope measures and space heating equipment simulated in HOT2000 was established by calculating the weighted average of EUL values associated with building envelope and space heating measures, as well as wood or pellet stoves, wood or pellet furnaces/boilers, and solar air equipment installed under HEA in 2021.

Table 165: EUL Values and Sources for Non-LED Lighting BNI Measures

Measure Name	Program Component	EUL Value	Source
Lighting			
Occupancy Sensors	BER Instant Rebates, BER Mail-in, SBES	10	GDS, 2007 (Table 2 – Commercial & Industrial Measures, value for occupancy sensors in new constructions)
Agricultural			
Agriculture Heat Pads	BER Mail-in, SBES	10	IESO PMA List, 2019 (Value for single creep heat pads)
Dairy Scroll Compressors	BER Mail-in, SBES	15	IESO PMA List, 2019 (Value for milk scroll compressors) KEMA, 2009 ¹⁸⁹ (Value for scroll compressors for dairy refrigeration)
Energy Efficient Ventilation and Circulation Fans	BER Mail-in, SBES	15	GDS, 2007 (Appendix C) KEMA, 2009 (Value for ventilation fans, high efficiency)
Heat Reclaimer Units	BER Mail-in, SBES	15	Pennsylvania TRM, 2016 KEMA, 2009 (Value for process heat recovery)
High-volume Low-speed Fans	BER Mail-in, SBES	15	IESO PMA List, 2019 (Value for high-volume low-speed fans) KEMA, 2009 (Value for high-volume low-speed fans) DEER, 2008 (Value for two-speed fans)
Low Energy and Zero Energy Livestock Waterers	BER Mail-in, SBES	10	KEMA, 2009 (Value for energy efficient livestock waterers) IESO PMA List, 2019 (Value for low-energy livestock waterers)
Milk Pre-coolers	BER Mail-in, SBES	15	KEMA, 2009 (Value for well water pre-coolers)
Natural and Dual Ventilation	BER Mail-in, SBES	15	IESO PMA List, 2019 (Value for dual and natural exhaust ventilation systems)
Tractor Engine-block Heater Timers	BER Mail-in, SBES	5	Minnesota TRM, 2020 (Value for agriculture – engine block heater timers) IESO PMA List, 2019 (Value for engine block heater timers)
VFD for Milk Vacuum Pumps	BER Mail-in, SBES	15	KEMA, 2009 (Value for VFD on milk vacuum pumps) DEER, 2008 (Value for milking vacuum pump variable speed drives)
VFD for Milk Transfer Pumps	BER Mail-in, SBES	15	DEER, 2014 (Value for milking transfer pump variable speed drives)

¹⁸⁹ KEMA. Focus on Energy Evaluation Business Programs: Measure Life Study. Prepared for PA Consulting Group Inc., August 2009.

Measure Name	Program Component	EUL Value	Source
Compressed Air			
Air Entraining Air Nozzles	BER Mail-in, SBES	15	KEMA, 2009 (Value for compressed air nozzles)
Cycling Air Dryers	BER Mail-in, SBES	10	KEMA, 2009 (Value for cycling air dryers)
No-loss Drains	BER Mail-in, SBES	15	ERS, 2005 ¹⁹⁰ (Table 1-2, value for compressed air)
HVAC			
Air-source Heat Pumps Greater Than or Equal to 65,000 BTU/hr	BER Mail-in, SBES	15	GDS, 2007 (Table 2 – Commercial & Industrial Measures, value for packaged AC/HP)
Air-source Heat Pumps Less Than 65,000 Btu/hr (Excluding Air-to-water)	BER Mail-in, SBES	18	GDS, 2007 (Table 1 – Residential Measures, value for AC/heat pump, assuming air-source heat pumps of smaller capacities, mostly mini-split systems, have operating conditions closer to residential)
Air-to-water Heat Pumps	BER Mail-in, SBES	15	GDS, 2007 (Table 2 – Commercial & Industrial Measures, value for packaged AC/HP) ERS, 2005 (Table 4-7, value for packaged AC/HP)
Dual-enthalpy Economizer Controls	BER Mail-in, SBES	10	GDS, 2007 (Table 2 – Commercial & Industrial Measures, value for enthalpy economizers) ERS, 2005 (value for enthalpy economizers)
Ground-source Heat Pumps	BER Mail-in, SBES	25	Life expectancy estimated by the U.S. Department of Energy ¹⁹¹ (up to 24 years for the inside component and more than 50 years for the ground loop) and by Natural Resources Canada ¹⁹² (about 20 to 25 years).
HVAC Hotel Occupancy Sensors	BER Mail-in, SBES	8	DEER, 2014 (Value for occupancy sensors)
Packaged Terminal Heat Pumps (PTHPs)	BER Mail-in, SBES	15	GDS, 2007 (Table 2 – Commercial & Industrial Measures, value for packaged AC/HP)
Water-source Heat Pumps	BER Mail-in, SBES	15	GDS, 2007 (Table 2 – Commercial & Industrial Measures, value for packaged AC/HP) ERS, 2005 (Value for WSHP) DEER 2014 (Value for high-efficiency water source heat pumps)
Electric Thermal Storage	BER Mail-In, SBES	18	The EUL is expected to be comparable to other heating systems. The EUL therefore corresponds to the value used for stoves, furnaces/boilers, and air-source heat pumps.
Advanced RTU Controls	BER Mail-In	10	Illinois TRM, 2021 (Value for advanced RTU controls)

¹⁹⁰ ERS. Measure Life Study. Prepared for the Massachusetts Joint Utilities. November 2005.

¹⁹¹ Retrieved from <https://energy.gov/energysaver/heat-and-cool/heat-pump-systems/geothermal-heat-pumps#306534-tab-1>.

¹⁹² Retrieved from <https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about-energy-star-canada/energy-star-announcements/publications/heating-cooling-heat-pump/ground-source-heat-pumps-earth-energy-systems/6833>.

Measure Name	Program Component	EUL Value	Source
Kitchen			
Demand-controlled Kitchen Exhausts	BER Mail-in, SBES	15	Efficiency Maine TRM, 2019 (Value for demand control kitchen ventilation) DEER, 2014 (Value for variable speed drives controlled by CO2 sensors)
Dishwashers	BER Mail-in, SBES	Under-counter: 10 Door-type: 15 Conveyor or: 20	William Goetzler et al., Energy Savings Potential and RD&D Opportunities for Commercial Building Appliances, U.S. Department of Energy, June 2016 Koeller and Company and H.W. Hoffman & Associates, LLC. 2010. "A Report on Potential Best Management Practices – Commercial Dishwashers," Prepared for the California Urban Water Conservation Council (CUWCC) by Koeller and Company and H.W. Hoffman & Associates, LLC. June 2010
Freezers/Refrigerators	BER Mail-in, SBES	12	DEER 2014 (Value for commercial reach-in refrigerator/freezers) DOE, 2011 Buildings Energy Data Book, Table 5.7.15 (Value for refrigerators)
Fryers	BER Mail-in, SBES	12	DEER 2014 (Value for fryers)
Griddles	BER Mail-in, SBES	12	DEER 2014 (Value for griddles)
Hot Food Holding Cabinets	BER Mail-in, SBES	12	DEER 2014 (Value for commercial insulated holding cabinets)
Ice Machines	BER Mail-in, SBES	10	DEER 2014 (Value for ice machines) KEMA, 2009 (Value for ice machines)
Ovens	BER Mail-in, SBES	12	DEER 2014 (Value for combination ovens or convection ovens)
Steam Cookers	BER Mail-in, SBES	12	DEER 2014 (Value for steam cookers)
Laundry			
Commercial Clothes Dryers (NG Conversion)	BER Mail-in, SBES	12	Vermont TRM, 2018 (Value for clothes dryers) DOE, 2011 Buildings Energy Data Book, Table 5.7.15 (Value for clothes dryers)
Commercial Heat Pump Clothes Dryers	BER Mail-in, SBES	12	Vermont TRM, 2018 (Value for clothes dryers) DOE, 2011 Buildings Energy Data Book, Table 5.7.15 (Value for clothes dryers)
Commercial Washing Machines	BER Mail-in, SBES	11	DEER 2011 (Value for high efficiency clothes washers) William Goetzler et al., Energy Savings Potential and RD&D Opportunities for Commercial Building Appliances, U.S. Department of Energy, June 2016 DOE, 2011 Buildings Energy Data Book, Table 5.7.15 (Value for clothes washers)

Measure Name	Program Component	EUL Value	Source
Motors and VFDs			
Energy Efficient Motors	BER Mail-in, SBES	15	DEER, 2014 (Value for HVAC fan motors)
Variable Frequency Drives	BER Mail-in, SBES	15	DEER, 2008 (Value for VSD supply fan motors) ERS, 2005 (Value for VFDs on fans) Navigant. Incremental Cost Study Phase Two Final Report. Burlington, MA, 2013
Pumping			
Circulator Pumps	BER Mail-in, BER Instant Rebates, SBES	15	KEMA, 2009 (Value for well and pump)
Booster Pumps	BER Mail-in, BER Instant Rebates	15	KEMA, 2009 (Value for well and pump)
Refrigeration			
Brushless DC Motors	BER Mail-in, SBES	15	KEMA, 2009 (Value for NEMA motors) ERS, 2005 (Table 4-7, value for motors) DEER, 2008 (Value for premium-efficiency motors)
Cooler Night Covers/Display Case Strip Curtains	BER Mail-in, SBES	4	DEER, 2014 (Value for strip curtains for walk-ins)
Door Heater Controls	BER Mail-in, SBES	12	KEMA, 2009 (Value for anti-sweat heater controls) ERS, 2005 (Table 4-7, value for door heater controls)
Efficient Refrigeration Compressors	BER Mail-in, SBES	15	DEER, 2014 (Value for refrigeration upgrades, variable speed compressors) ERS, 2005 (Table 4-7, value for commercial refrigeration compressors)
Evaporator Fan Motor Controls	BER Mail-in, SBES	10	ERS, 2005 (Value for motor controls)
Intelligent Freezer Defrost Controls	BER Mail-in, SBES	10	ERS, 2005 (Value for motor controls)
Refrigerated Vending Machine Controllers	BER Mail-in, SBES	5	DEER, 2008, 2014 (Value for vending machine controllers) ERS, 2005 (Table 1-1, value for vending machine controllers)
Refrigeration Economizers	BER Mail-in, SBES	15	Illinois TRM, 2019 (Value for refrigeration economizers)
Vertical Refrigeration Open-to-closed Cooler Conversion	BER Mail-in, SBES	12	DEER, 2008 (Value for reach-in refrigerators/freezers)
Zero Energy Doors	BER Mail-in, SBES	12	DEER 2014 (Value for zero heat reach-in glass doors) KEMA, 2009 (Value for no-energy doors)

Measure Name	Program Component	EUL Value	Source
Water Heating			
Electrical-to-natural Gas Water Heating	BER Mail-in, SBES	15	KEMA, 2009 (Value for water heaters, Ag only)
Heat Pump Water Heaters	BER Mail-in, SBES	10	DEER, 2008, 2014 (Value for heat pump water heaters)
Low-flow Showerheads	SBES	10	DEER, 2014 (Value for low-flow showerheads)
Faucet Aerators		10	DEER, 2014 (Value for faucet aerators)
Thermostatic Shower Valves		10	Efficiency Maine TRM, 2019
Pipe Insulation		13	DEER, 2014 (Value for pipe insulation – electric water heater)
Hot Water Tank Wraps		7	DEER, 2014 (Value for water heater tank wrap)
Solar			
Solar Water Heaters	BER Mail-in, SBES	20	ENERGY STAR, Save Money and More with ENERGY STAR Qualified Solar Water Heaters ¹⁹³
Solar Space Heating Systems	BER Mail-in, SBES	20	ENERGY STAR, Save Money and More with ENERGY STAR Qualified Solar Water Heaters
Pool			
Efficient Pool Pumps	BER Mail-in, SBES	10	DEER, 2014 (Value for high-efficiency pool pumps)
IT & Datacenters			
Server-based Power Management Software	BER Mail-in, SBES	5	DEER 2014 (Value for power management software)
Server Virtualization and Decommissioning	BER Mail-in, SBES	4	Pennsylvania TRM, 2019 (Value for server virtualization)
ENERGY STAR Uninterruptible Power Supplies	BER Mail-in, SBES	10	California TRM, 2017 (Value for ENERGY STAR uninterrupted power supply)
New Construction (NC)			
For NC projects, since the savings calculation is based on a modelling approach, the EUL values are established by end-use categories found in the simulation software. The EUL values are determined by considering the most reasonable and common measures for each end-use category and, in most cases, correspond to the values used for the other BNI program components (referenced above).			
DHW Measures	Custom NC	10	Based on the EUL value of heat pump water heaters and several other DHW measures such as faucet aerators, low-flow showerheads, and thermostatic shower valves.
DHW Solar Thermal	Custom NC	20	Based on the EUL value of solar water heaters
Cooling Measures	Custom NC	18	Based on the EUL value of air-source heat pumps less than 65,000 Btu/hr
Heating Measures	Custom NC		

¹⁹³ Retrieved from: https://www.energystar.gov/products/water_heaters/water_heater_solar/benefits_savings.

Measure Name	Program Component	EUL Value	Source
Ventilation Measures	Custom NC	20	Based on the EUL value of heat recovery ventilators
Motor Equipment	Custom NC	15	Based on the EUL value of energy efficient motors
Other	Custom NC	15	Reasonable average EUL value for any measures outside of the defined categories
Refrigeration	Custom NC	15	Based on the EUL value of efficient refrigeration compressors
Renewable Power Generation (Solar)	Custom NC	25	NREL, Useful Life. ¹⁹⁴ (Most conservative value for photovoltaics)
Renewable Power Generation (Wind)	Custom NC	20	NREL, Useful Life ¹⁹⁵ (Value for wind)
Building Optimization (BOpt)			
Changes to Control Parameters	Custom BOpt	3	SBW Consulting, 2010 ¹⁹⁶
Equipment Repairs	Custom BOpt	8	SBW Consulting, 2010 ¹⁹⁷
New Equipment Installations	Custom BOpt	12	SBW Consulting, 2010 ¹⁹⁸
Energy Management			
Energy Management Information System	EMIS	N/A	Calculated by project based on the remaining time in the program plus an additional 1 year of persistency. The remaining time in the program is estimated for each participant based on their participation history and intent.
Strategic Energy Management	SEM	N/A	Calculated by project based on average participation length in SEM (1.5 years), year of participation, and an additional 1 year of persistency: 1 st year of participation = 2.5 years 2 nd year of participation = 1.5 years

¹⁹⁴ NREL. *Useful Life*. Retrieved from <https://www.nrel.gov/analysis/tech-footprint.html>.

¹⁹⁵ NREL. *Useful Life*. Retrieved from <https://www.nrel.gov/analysis/tech-footprint.html>.

¹⁹⁶ Roberts J. and Tso B. (SBW Consulting), *Do Savings from Retrocommissioning Last? Results from an Effective Useful Life Study*, ACEEE Summer Study on Energy Efficiency in Buildings, 2010.

¹⁹⁷ Ibid.

¹⁹⁸ Ibid.

APPENDIX I

VERIFICATION OF CLIMATE VALIDITY FOR INTERACTIVE EFFECTS CALCULATIONS

The climate data of Nova Scotia and Quebec for the duration of the heating and cooling seasons were analyzed as part of the 2015 evaluation and found to be comparable, and thus the 1992 ADS study results are applicable for EfficiencyOne (EOne) lighting measures. This appendix presents the analysis conducted in 2015.

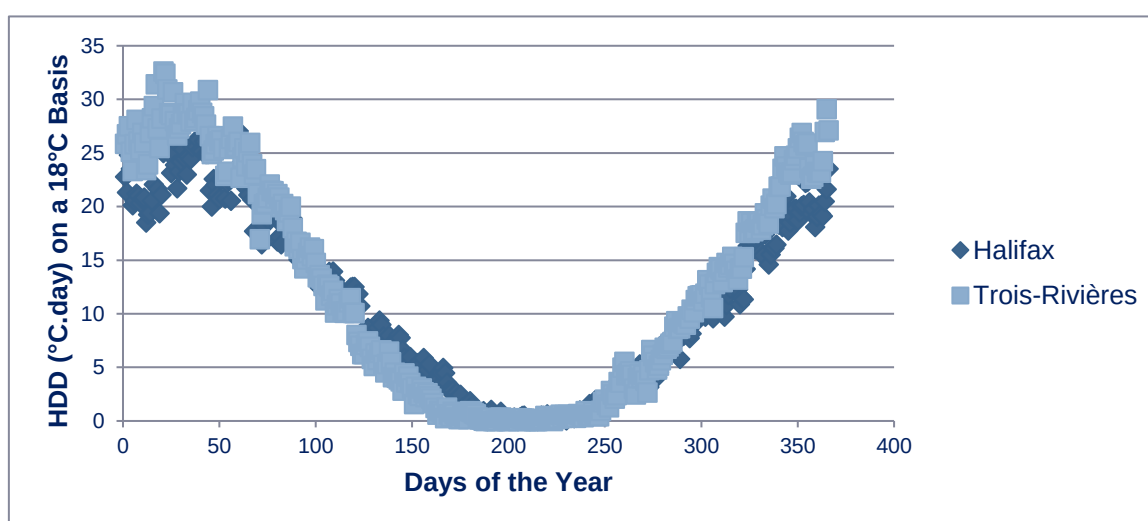
Verification of Climate Data Validity

Considering that the 1992 ADS study remains the only well-documented study for cold climates, it is still used to establish interactive effects. To ensure that the findings of the ADS study are valid and applicable to Nova Scotia, Nova Scotia's climate characteristics were compared with those of Quebec to determine whether it is appropriate to use the weather data used in the ADS study in the impact evaluation of Nova Scotia's programs.

This analysis was conducted on the basis of the assumption that internal gains (from lighting, DHW or any other appliances) reduce the heating load as long as the outdoor temperature is below the balance temperature of the building (and the opposite during the cooling season). This would mean that the most significant variable involved in calculating the interactive effect factors is the duration of the heating and cooling seasons, rather than the total heating and cooling degree days in a given climate.

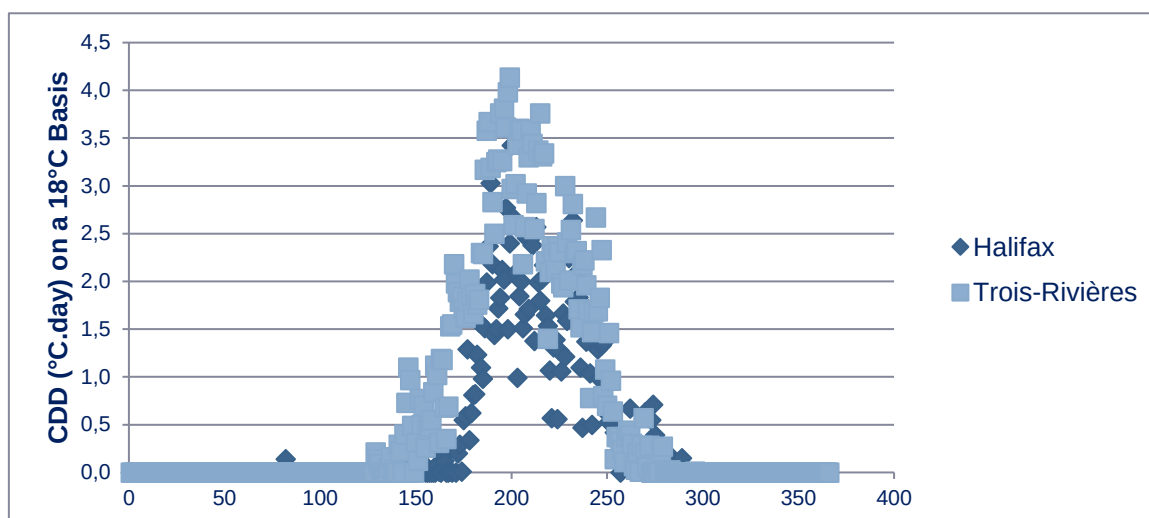
The following two figures show the average heating degree days (HDD) and cooling degree days (CDD) per day over a full year in Trois-Rivières¹⁹⁹ and Halifax, respectively.

Figure 1: HDD per Day for Trois-Rivières and Halifax



¹⁹⁹ Since this city is located about halfway between Montreal and Quebec City, it is representative of the climate used in the ADS study.

Figure 2: CDD per Day for Trois-Rivières and Halifax



In the case of HDD, Figure 1 shows that Trois-Rivières' heating season ends about 15 days earlier than Halifax (based on the assumption that heating is turned on when there are around 5 HDD per day). Indeed, the heating season ends around May 20 in Trois-Rivières and around June 4 in Halifax. In both cities, the heating season starts around the 270th day of the year, which roughly falls on September 28. As for the cooling season, Figure 2 indicates that it starts around the 160th day and the 180th day in Trois-Rivières and Halifax respectively, and ends around the 250th day in both cities.

In conclusion, the heating season is about 6% shorter in Trois-Rivières than in Halifax, while the former cooling season is about 22% longer than the latter. This means that the interactive effect factors based on the ADS study slightly underestimate the negative interactive effects occurring during the heating season in Nova Scotia; however, the Evaluator considers this 6% difference not significant. The overestimation of the cooling season also results in a positive impact on the interactive effects; nevertheless, because of the very small impact of cooling on the interactive effects (3.6% according to the ADS study), the overestimation is considered negligible. Therefore, the Evaluator concludes that the findings of the ADS study are still applicable to Nova Scotia.

APPENDIX II

DETAILED CALCULATIONS OF 2021 EQUIVALENT EUL VALUES FOR LED LAMPS AND FIXTURES

This appendix presents how the equivalent effective useful life (EUL) of LED lamps and fixtures were calculated for applicable measures in the EPI, Instant Savings, BER, and SBES program components. An equivalent EUL corresponds to the number of years by which the first-year savings need to be multiplied to obtain the lifetime savings.

The Evaluator first calculated the equipment life of each type of lamp and fixture, as presented in Table 166. The equipment life was calculated as the ratio between the manufacturer rated lifetime for the lamps and fixtures installed under the program components and the annual HOU values used to calculate unitary savings values.

Table 166: Equipment Life Value per LED Lamp and Fixture Types

LED Lamp and Fixture Type	Program Component	Average Rated Lifetime Hours (hours) ²⁰⁰	Annual HOU (hours/year) ²⁰¹	Equipment Life (years)
LED A19 Lamps	EPI	25,000	986	25
LED Reflector Lamps		25,000	986	25
LED Decorative Lamps		15,000	986	15
LED Non-A-type Lamps (R, BR, and Decorative)	Instant Savings	15,952	1,059	15
LED Non-A-type Lamps (Excluding R, BR, and Decorative)		25,000	1,059	24
LED Recessed Downlight Fixtures		37,400	1,059	33
LED Fixtures Without Motion Sensors		50,000	1,059	47
LED Fixtures with Motion Sensors		49,044	1,066	46
LED General-use and Decorative Lamps	SBES	25,000	3,600	6.9
Reflector Lamps		25,000	3,600	6.9
Non-recessed Downlight Fixtures		50,000	3,600	13.9
Recessed Downlight Fixtures		50,000	3,600	13.9

²⁰⁰ Based on manufacturer specification sheets for the most popular models installed through EPI in 2017.

²⁰¹ Based on the unitary savings review.

Rationale for Using an Equivalent EUL

The LED market is evolving rapidly, driven in part by government regulations. LED products installed today are likely to become the baseline before the end of their rated lifetime since LED technologies are developing quickly and prices are falling. Some jurisdictions have already applied a reduced equivalent EUL to their lighting savings by adopting a higher baseline to represent savings in future years. In other words, their baseline increases over the lifetime of the product, which in turns reduces the equivalent EUL applied to first-year savings to obtain lifetime energy savings. The baseline is informed by government regulations as well as LED market information.

In terms of government regulations, the U.S. Energy Independence and Security Act (EISA) 2020 requiring a minimum efficiency level for CFLs, also known as the EISA backstop, continues to be a key consideration.²⁰² The previous administration decided to eliminate the EISA backstop on inefficient lighting products. However, six states passed their own state legislation to implement the efficient lighting standards on January 1, 2020 regardless of what happened nationally. In 2021, the Biden administration put general service lighting back on the regulatory agenda, and it was expected to restore the lighting standards for the extended definition of general service lamps (including decorative and reflector lamps) to the 45 lm/W efficiency standard before the end of 2021.²⁰³ As of December 2021, the regulation had not yet been adopted, but it should be imminent. The standards could still take some time to take effect, and there remains uncertainty as to the amount of time the DOE would allow between the adoption of the standards and compliance enforcement with some observers estimating that the standard will be in effect in 2023.²⁰⁴

In Canada, lighting is not currently on Natural Resources Canada's Forward Regulatory Plan for 2021-2023, although typically Canadian regulations follow the U.S. within approximately two years.

While the upcoming regulation is set to establish a minimum efficiency level corresponding to a CFL, recent studies²⁰⁵ indicate that the market is rapidly moving away from CFL lamps and toward LED lamps. The evolving market toward LEDs has important implications on the baseline.

For example, LED lamp savings are considered nil after 10 years in Illinois, and baselines are adjusted throughout the product lifetime to match changes in regulations. For instance, a 60 W incandescent baseline is raised to a 43 W halogen incandescent after the end of useful life of incandescent lamps and will be raised again to the planned minimum efficiency CFL level required by the Energy Independence and Security Act (EISA) 2020.²⁰⁶

²⁰² Illinois Energy Efficiency Stakeholder Advisory Group, *Illinois Statewide Technical Reference Manual for Energy Efficiency Version 8.0, Volume 3*, October 2019, p. 258.

²⁰³ Apex Analytics. *LED Market Update: LEDs Continue to Gain Market Share, Biden Administration Exploring Options for EISA Backstop*, August 26, 2021.

²⁰⁴ Ibid.

²⁰⁵ Ibid.

²⁰⁶ Illinois Energy Efficiency Stakeholder Advisory Group, *Illinois Statewide Technical Reference Manual for Energy Efficiency Version 8.0, Volume 3*, October 2019, p. 258.

Massachusetts also uses a similar methodology that takes into account baseline increases that will occur because of EISA 2020.²⁰⁷ When the previous US government decided to eliminate the EISA 2020 backstop on inefficient lighting products,²⁰⁸ Illinois and Massachusetts did not make changes to their equivalent EUL methodology and assumptions.

Like the approach used in Illinois and Massachusetts and depending on the type of bulb, the Evaluator applied either a double or triple baseline for products beyond their equipment life to establish their equivalent EUL. The Evaluator kept the 2020 assumptions that all lamps are subject to a baseline increase starting in 2024. While this may be earlier than the expected date of Canadian regulations, it reflects the fact that over time the baseline will shift to LEDs. The Evaluator recommends using insights gained in the market evolution analysis planned in 2021 to revisit the LED baseline. The baselines for A-type and non-A-type lamps are outlined in Table 167 below.

²⁰⁷ Massachusetts Electric and Gas Energy Efficiency Program Administrators, *Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures, 2016-2018 Program Years – Plan Version*, October 2015, p. 151.

²⁰⁸ Apex Analytics, *DOE Issues Final Rule Designed to Eliminate EISA Backstop: Analysis of the Rule and Implications for Energy Efficiency Programs*, 2019.

Table 167: LED Baseline Evolution

Baseline	Minimum Wattage Requirement	Years	Rationale
A-type			
Incandescent Baseline	N/A	2021 (1,000 hours)	Since incandescent lamps may no longer be replaced by incandescent lamps, there is a first increase in the baseline upon burnout. Incandescent light lamps have a typical rated life expectancy of 1,000 to 2,000 hours. ²⁰⁹ The remaining useful life of replaced functional incandescent light lamps is assumed to be half the rated life expectancy.
Halogen Incandescent Baseline – Canadian Legislation ^{210,211}	General service lamps with a luminous flux < 750 lumens: ≤29 W	2021-2023	The current Canadian regulation bans imports on 60 W, 75 W, and 100 W light lamps, imposes a minimum efficiency to be achieved by efficient incandescent light lamps (also called halogen incandescent light lamps), and reflects U.S. federal legislation.
	General service lamps with a luminous flux ≥750 lumens and <1,050 lumens: ≤43 W		
	General service lamps with a luminous flux ≥1,490 lumens: ≤72 W		
CFL Equivalent Baseline – American Legislation ²¹²	45 lumens/W	2024 - end of product life	See rationale above.

²⁰⁹ Lighting Research Center - Rensselaer Polytechnic Institute, *Lighting Patterns for Homes. Light Bulb Features*, www.lrc.rpi.edu/patternbook/resources/lamp_features.asp (Last accessed October 1, 2020).

²¹⁰ Natural Resources Canada, *Energy Efficiency Regulations. General Service Lamps and Modified Spectrum Incandescent Lamps*, www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869 (Last accessed January 24, 2018).

²¹¹ Also equivalent to Incandescent Equivalent 1st Tier EISA 2007.

²¹² As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

Baseline	Minimum Wattage Requirement	Years	Rationale
Reflector (R, BR) and Decorative Lamps			
Halogen Incandescent Baseline	N/A	2021-2023	Reflector lamps (R, BR) and decorative lamps are not affected by current Canadian regulations. Therefore, the first baseline corresponds to the baseline product, namely halogen incandescent lamps.
CFL Equivalent Baseline – American Legislation ²¹³	45 lumens/W	2024 - end of product life	See rationale above.
Reflector (GU, PAR, MR) Lamps			
Halogen Baseline	N/A	2021-2023	Reflector lamps (GU, PAR, MR) are not affected by current Canadian regulations. Therefore, the first baseline corresponds to the baseline product, namely halogen lamps.
CFL Equivalent Baseline – American Legislation ²¹⁴	45 lumens/W	2024 - end of product life	See rationale above.

²¹³ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

²¹⁴ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

Using the baseline evolution presented above, the following sections present the detailed calculations and resulting values for all LED lighting products.

EPI

LED A19 Lamps

LED A19 lamps installed under EPI replace incandescent lamps. The calculation is based on 9 W lamps because they are the most common A19 type installed through EPI and the first baseline increase occurs one year following the anticipated burnout of incandescent lamps.²¹⁵ Importantly, given their rated life of 25,000 hours and corresponding equipment life of 25 years, the baseline is affected by the change in regulation occurring in 2024. Starting in 2024 and for the remaining lifetime of the lamp (22 years), the baseline will be a CFL equivalent lamps. The following equation is used to establish the equivalent EUL presented in Table 168.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Incandescent}} \times 1 \text{ Year} + \Delta W_{\text{Halogen}} \times 2 \text{ Years} + \Delta W_{\text{CFL}} \times 22 \text{ Years}}{\Delta W_{\text{Incandescent}}}$$

Table 168: Equivalent EUL Calculation Summary for LED A19 Lamps

Replaced Lamp (W)	Typical Efficient Lamp (W)	Incandescent Baseline 1 Year (2021)		Halogen Incandescent Baseline – Canadian Legislation ^{216,217} 2 Years (2022-2023)		CFL Equivalent Baseline – American Legislation ²¹⁸ 22 Years (2024-2045)		Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	Baseline Wattage ²¹⁹	Displaced Wattage	
40	9	40	31	29	20	12	3	4.4
60	9	60	51	43	34	18	9	6.2
100	9	100	91	72	63	36	27	8.9

²¹⁵ Assuming the remaining lifetime is 1,000 hours for incandescent lamps and that they are used 2.7 hours per day, they will burnout in approximately one year.

²¹⁶ Natural Resources Canada, *Energy Efficiency Regulations. General Service Lamps and Modified Spectrum Incandescent Lamps*, www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869 (Last accessed January 24, 2018).

²¹⁷ Also equivalent to Incandescent Equivalent 1st Tier EISA 2007.

²¹⁸ As imposed by US federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

²¹⁹ Baseline wattage values were established based on the minimum efficiency level of 45 lumens/watt dictated by the EISA regulation and on the assumed levels of 550 lumens for 40 watt lamps, 800 lumens for 60 watt lamps, and 1,600 lumens for 100 watt lamps.

Reflector Lamps

For reflector lamps, only the second and third baselines apply. While reflector lamps are not impacted by current Canadian regulations, they will be affected by the requirements of upcoming regulation (Amendment 17). Starting in 2024, the baseline wattage is therefore increased to match the minimum efficiency level of 45 lumens/watt for all models for which an equivalent CFL technology exists, which is the case for the GU and PAR lamps installed under EPI. The following equation is used to establish the equivalent EUL presented in Table 169.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen}} \times 3 \text{ Years} + \Delta W_{\text{CFL}} \times 22 \text{ Years}}{\Delta W_{\text{Halogen}}}$$

Table 169: Equivalent EUL Calculation Summary for LED Reflector Lamps

Replaced Lamp (W)	Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Baseline 3 Years (2021-2023)		CFL Equivalent Baseline – American Legislation ²²⁰ 22 Years (2024-2045)		Equivalent EUL (years)
			Baseline Wattage	Displaced Wattage	Baseline Wattage ²²¹	Displaced Wattage	
PAR20	50	7	50	43	10	3	4.5
PAR30	53	8	53	45	10	2	4.0
PAR30	75	8	75	67	16	8	5.6
PAR38	90	15	90	75	22	7	5.1
PAR38	120	15	120	105	31	16	6.4
PAR38	150	15	150	135	33	18	5.9
GU10	35	7	35	28	8	1	3.8
GU10	50	7	50	43	10	3	4.5

Decorative Lamps

As for decorative lamps (G25 and chandelier lamps), the same approach and equation as for reflector lamps are applied. While G25 lamps have an equivalent CFL technology, the baseline wattage value calculated to match the minimum efficiency level of 45 lumens/watt is equal to the efficient lamp wattage value and, therefore, results in a nil displaced wattage for the period starting in 2024. As for E12 chandelier lamps, no equivalent CFL technology exists, so as of 2024 the baseline wattage value corresponds to that of LED technology. Table 170 presents the recommended equivalent EUL of LED decorative lamps.

²²⁰ As imposed by US federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

²²¹ Baseline wattage values were established based on the minimum efficiency level of 45 lumens/watt dictated by the EISA regulation and on the assumed levels of 350 lumens for 35 watt lamps, 430 lumens for 50 watt lamps, 1,000 lumens for 90 watt lamps, 1,400 lumens for 120 watt lamps, and 1,500 lumens for 150 watt lamps.

Table 170: Equivalent EUL Calculation Summary for LED Decorative Lamps

Lamp Type	Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Incandescent Baseline 3 Years (2021-2023)		CFL Equivalent Baseline – American Legislation ²²² 12 Years (2024-2035)		Equivalent EUL (years)
			Baseline Wattage	Displaced Wattage (W)	Baseline Wattage ²²³	Displaced Wattage (W)	
G25	40	7	40	33	7	0	3.0
E12 Chandelier	40	5	40	35	5	0	3.0

Instant Savings

LED Non-A-type Lamps

For LED non-A-type lamps sold through Instant Savings, lifetime energy savings values were established for the different types of lamps replaced, which mostly included reflector (R, BR, GU, PAR, MR) and decorative lamps. Reflector and decorative lamps are not impacted by the current Canadian regulation, although they are impacted by EISA 2020. Therefore, starting in 2024, the baseline wattage is increased to match the minimum efficiency level of 45 lumen/W for models for which an equivalent CFL technology exists. Otherwise, the baseline wattage value corresponds to that of LED technology as of 2024. Table 171 and Table 172 below present the resulting equivalent EUL for R, BR, and decorative lamps as well as other non-A-type lamps respectively. For each category, the 10 most popular models were analyzed.

Table 171: Equivalent EUL Calculation Summary for LED Non-A-type Lamps (R, BR, and Decorative Lamps)

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline 3 Years (2021-2023)		Compact Fluorescent Lamp (CFL) Equivalent Baseline – American Legislation ²²⁴ 12 Years (2024-2035)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage		
49.7	5.1	49.7	44.6	9.6	4.5	199	4.2

²²² As imposed by US federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

²²³ Based on the minimum efficiency level of 45 lumens/watt dictated by the EISA regulation and on the assumed levels of 300 lumens for 40 watt lamps for models for which an equivalent CFL technology exists.

²²⁴ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

**Table 172: Equivalent EUL Calculation Summary for LED Non-A-type Lamps
(Excluding R, BR, and Decorative Lamps)**

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Baseline 3 Years (2021-2023)		CFL Equivalent Baseline – American Legislation ²²⁵ 21 Years (2024-2044)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage		
50	6.8	50	43.2	11.0	4.2	231	5.0

LED Fixtures

As for LED fixtures, the equivalent EUL is analyzed in the same manner as for replace-on-burn-out lamps since the energy consumption of these fixtures is the consumption of the lamps provided with them. Therefore, the baseline is a fixture with lamps meeting current energy efficiency standards. Moreover, the lifetime of LED fixtures is capped at 25 years (2045), as outlined in Table 166 above, because it is very unlikely that these products produce savings throughout their entire equipment life considering factors such as early replacement.

Table 173 presents the resulting equivalent EUL for LED recessed downlight fixtures.

**Table 173: Equivalent Effective Useful Life Calculation Summary
for LED Recessed Downlight Fixtures**

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline – Canadian Legislation 3 Years (2021-2023)		CFL Equivalent Baseline – American Legislation ²²⁶ 22 Years (2024-2045)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage		
63.3	11.1	63.3	52.2	15.0	3.9	257	4.6

For LED fixtures without motion sensors, the baseline for the 10 most popular models is mostly one, two, or three general service halogen incandescent lamps. Therefore, the same methodology as for non-A-type lamps was used, the results of which are presented in Table 174 below.

²²⁵ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

²²⁶ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

**Table 174: Equivalent Effective Useful Life Calculation Summary
for LED Fixtures Without Motion Sensors**

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline – Canadian Legislation 3 Years (2021-2023)		CFL Equivalent Baseline – American Legislation ²²⁷ 22 Years (2024-2045)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage		
86.5	22.4	86.5	64.1	35.1	12.7	500	7.4

For LED fixtures with motion sensors, the lifetime energy savings are calculated by first considering the reduced wattage and then the reduction in hours of use due to the motion sensor. The baseline for LED fixtures with motion sensors is reflector lamps for the majority (96%) of units sold. Therefore, based on the average daily HOU of 4.72, the same methodology as for LED non-A-type lamps is applied, as presented in Table 175.

Table 175: Lifetime Energy Savings for LED Fixtures with Motion Sensors – Reduced Wattage

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline – Canadian Legislation 3 Years (2021-2023)		CFL Equivalent Baseline – American Legislation ²²⁸ 22 Years (2024-2045)		Lifetime Energy Savings (kWh)
		Baseline Wattage	Displaced Wattage	Baseline Wattage ²²⁹	Displaced Wattage	
88.3	22.2	88.3	66.1	36.8	14.6	895

Then, the difference in hours of operation generated by the motion sensors was taken into account, as presented in Table 176.

Table 176: Lifetime Energy Savings for LED Fixtures with Motion Sensors – Reduced Hours of Use

Old Average Hours of Use (hours per day)	New Average Hours of Use (hours per day)	Average Wattage of Efficient Lamp	Measure Life (years)	Lifetime Energy Savings (kWh)
4.72	2.92	22.2	10.0	146

The total lifetime energy savings of 1,041 kWh were divided by the first-year savings of 128 kWh to obtain an equivalent EUL of 8.1 years.

²²⁷ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

²²⁸ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

²²⁹ Baseline wattage values were established based on the minimum efficiency level of 45 lumen/W, as dictated by the EISA 2020.

SBES

LED General-use and Decorative Lamps

The methodology used for establishing the equivalent EUL of general-use and decorative lamps is based on the information presented in Table 177 and the equation below. The equivalent EUL calculation is based on 9 W LED lamps. The baseline technology is assumed to be a mix of 60 W incandescent lamps and 43 W halogen incandescent lamps, which yields an average baseline of 52 W.

Since incandescent lamps can no longer be replaced by incandescent lamps, there is a first baseline increase upon burnout. These lamps are assumed to have a remaining lifetime of 1,000 hours, which translates to 0.23 years with an annual HOU of 4,300 hours. Since SBES target commercial participants, it is assumed that some participants might have incandescent lamps stocked and therefore the duration of this baseline was increased to a full year.

As outlined in Table 166 above, the equipment life of this product is 6.9 years, meaning the corresponding baseline will be affected by the change in legislation occurring in 2024. In other words, a second baseline increase will occur in 2024 (after changing from a baseline mix of 43 W halogen incandescent lamps and 60 W incandescent lamps to a 43 W halogen incandescent baseline in 2022). Starting in 2024 and for the remaining lifetime of the fixture (3.9 years), the baseline will be a 18 W compact fluorescent lamp (CFL) equivalent.²³⁰ With the information presented in Table 177, the following equation served to set the equivalent EUL of general-use and decorative lamps at 3.4 years.

Equivalent EUL

$$= \frac{\Delta W_{\text{Halogen Incandescent and Incandescent}} \times 1 \text{ Year} + \Delta W_{\text{Halogen Incandescent}} \times 2 \text{ Years} + \Delta W_{\text{CFL}} \times 3.9 \text{ Years}}{\Delta W_{\text{Halogen Incandescent and Incandescent}}}$$

Table 177: Baseline Evolution During the Effective Useful Life of LED General-use and Decorative Lamps

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Incandescent and Incandescent Baseline 1 Year (2021)		Halogen Incandescent Baseline – Canadian Legislation ^{231,232} 2 Years (2022-2023)		CFL Equivalent Baseline – American Legislation ²³³ 3.9 Years (2024-2027)		Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
52	9	52	43	43	34	18	9	3.4

²³⁰ The baseline wattage value was established based on the minimum efficiency level of 45 lumen/watt dictated by the EISA regulation and on the assumed level of 800 lumens for 60 W incandescent lamps.

²³¹ Natural Resources Canada, *Energy Efficiency Regulations. General Service Lamps and Modified Spectrum Incandescent Lamps*, www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869 (Last accessed January 24, 2018).

²³² Also equivalent to Incandescent Equivalent 1st Tier EISA 2007.

²³³ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

Reflector Lamps

LED reflector lamps typically replace halogen lamps. As outlined in Table 166 above, their average rated life is estimated at 25,000 hours, which translates into an equipment life of 6.9 years. With the regulation planned to impact reflector lamps in 2024, the baseline wattage will be reduced starting in 2024 and for the remaining lifetime of the fixture (3.9 years). The equivalent EUL calculation is based on the typical case 12 W LED reflector lamp replacing a 43 W halogen lamp. The equivalent EUL was calculated at 3.8 years based on the following equation and the information presented in Table 178.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen}} \times 3 \text{ Years} + \Delta W_{\text{CFL}} \times 3.9 \text{ Years}}{\Delta W_{\text{Halogen}}}$$

Table 178: Baseline Evolution During the Effective Useful Life of LED Reflector Lamps

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Baseline 3 Years (2021-2023)		CFL Equivalent Baseline - American Legislation ²³⁴ 3.9 Years (2024-2027)		Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
43	12	43	31	18	6	3.8

Non-recessed Downlight Fixtures

Since non-recessed LED downlight fixtures replace fixtures using A-type lamps, the methodology for establishing their equivalent EUL is similar to that of A-type lamps in EPI. The equivalent EUL calculation is based on the typical case of 9 W LED lamps and the first baseline increase occurs one year following the anticipated burnout of incandescent lamps. Importantly, given their rated life of 50,000 hours and corresponding equipment life of 13.9 years, the baseline is affected by the change in regulation occurring in 2024. Starting in 2024 and for the remaining lifetime of the fixture (10.9 years), the baseline will be an 18 W CFL equivalent lamp. The equation and Table 179 below, present the information used to calculate the equivalent EUL of 6.2 years.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen Incandescent and Incandescent}} \times 1 \text{ Year} + \Delta W_{\text{Halogen Incandescent}} \times 2 \text{ Years} + \Delta W_{\text{CFL}} \times 10.9 \text{ Years}}{\Delta W_{\text{Halogen Incandescent and Incandescent}}}$$

²³⁴ Idem.

Table 179: Baseline Evolution During the Effective Useful Life of Downlight Fixtures

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Incandescent and Incandescent Baseline 1 Year (2021)		Halogen Incandescent Baseline – Canadian Legislation ^{235,236} 2 Years (2022-2023)		CFL Equivalent Baseline - American Legislation ²³⁷ 10.9 Years (2024-2034)		Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
52	9	52	43	43	34	18	9	6.2

Recessed Downlight Fixtures

Since LED recessed downlight fixtures replace fixtures typically housing reflector lamps for which the baseline technology is halogen lamps, the methodology for establishing their equivalent EUL is similar to that of reflector lamps. The EUL of LED recessed downlight fixtures is established at 13.9 years based on a rated life of 50,000 hours. The equivalent EUL calculation is based on the typical case 12 W LED reflector lamp replacing a 43 W halogen lamp. With the regulation planned to impact reflector lamps in 2024, 43 W halogen lamps will be the baseline technology for three years, after which 18 W CFL equivalent lamps will become the baseline for the remaining lifetime of LED recessed downlight fixtures (10.9 years). The equivalent EUL was calculated at 5.1 years based on the information presented in Table 180.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen}} \times 3 \text{ Years} + \Delta W_{\text{CFL}} \times 10.9 \text{ Years}}{\Delta W_{\text{Halogen}}}$$

Table 180: Baseline Evolution During the Effective Useful Life of LED Reflector Lamps in Downlight Fixtures

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Baseline 3 Years (2021-2023)		CFL Equivalent Baseline - American Legislation ²³⁸ 10.9 Years (2024-2034)		Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
43	12	43	31	18	6	5.1

²³⁵ Natural Resources Canada, *Energy Efficiency Regulations. General Service Lamps and Modified Spectrum Incandescent Lamps*, www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869 (Last accessed January 24, 2018).

²³⁶ Also equivalent to Incandescent Equivalent 1st Tier EISA 2007.

²³⁷ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

²³⁸ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

