



EfficiencyOne

2023 DSM PROGRAMS EVALUATION REPORTS

Final DSM Reports

March 28, 2024

In collaboration with:





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EfficiencyOne

2023 DSM PROGRAMS EVALUATION

Final Report

EXECUTIVE SUMMARY

March 22, 2024

In collaboration with:



ABBREVIATIONS

ARet	Appliance Retirement
BER	Business Energy Rebates
BNI	Business, non-profit and institutional
CASHP	Central air-source heat pump
CGH Grant	Canada Greener Homes Grant
DHW	Domestic hot water
DIY	Do-it-yourself
DR	Demand Response
DSM	Demand-side management
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
EUL	Effective useful life
GHG	Greenhouse gas
GSHP	Ground-source heat pump
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
NS Power	Nova Scotia Power
NSUARB	Nova Scotia Utility and Review Board
NTGR	Net-to-gross ratio
ORs	Overestimation ratios
P4P	Pay-for-Performance
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.
Available Demand Response Capacity	The capacity which is available to NSP to reduce system peak demand. This capacity is calculated based on the first two hours of all events called between December and February, excluding weekends and holidays. If an event is shorter than two hours, only the first hour is used to measure the available DR capacity. Available DR capacity is evaluated on a per-participant basis, based on the average demand reduction observed for each event that the participant was scheduled to participate in. E1's total available DR capacity is the sum of each participant's available DR capacity.
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 base consumption.
Bias	Systematic deviations of measurements from the true value.
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.
Confidence interval	The estimated range of values that is likely to include unknown population parameters.
Demand response	Demand response measures generate savings in the form of available capacity or load reduction in response to events called by the electric utility (Nova Scotia Power) to reduce the load at strategic moments. These events can be called at any time and for any duration, although they are usually called for one to three hours during peak periods.
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 home 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 a home is through modelled home 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 equipment life and 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 CO₂	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, gas 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 ratios, etc.) validated or measured during the evaluation process. Unless otherwise specified, evaluated savings are 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 a building (such as heating and cooling) due to the installation of an energy efficiency measure.
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 and 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 a program on the market (such as increased product availability, practices, and prices) that extends beyond changing program participant behaviours. 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. For industrial participants on an interruptible rate, peak demand savings may include savings on non-firm loads, i.e. loads that may be interrupted when Nova Scotia Power's 10-minute reserve is low
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	An 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.
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.
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 net-to-gross ratios. 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. A 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).



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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 its 2023 DSM program portfolio.

To carry out these services, Econoler collaborated with Equilibrium Engineering (a brand under the LMMW Group Ltd.), 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.¹ Equilibrium Engineering conducted desk reviews, on-site visits, and follow-up interviews.² Narrative Research conducted interviews and surveys with participants and partners³ as well as analyzed and reported on the data collected from those activities. Throughout this report, this team is referred to as the Evaluator.

The evaluation confirmed that the EOne DSM program portfolio achieved a total of 131.569 GWh in net electrical energy savings, 27.577 MW in net peak demand savings at the generator, and 2.423 MW in available capacity in 2023. These net savings represent 72,613 tonnes of CO₂ eq in terms of annually avoided GHG emissions. Total net lifetime electrical energy savings at the generator amounted to 1,913.059 GWh.

¹ For the 2023 evaluation, Bouthillette Parizeau conducted desk reviews of Custom New Construction projects, while Richard Patterson conducted desk reviews of Custom Retrofit and Building Optimization projects.

² For the 2023 evaluation, Equilibrium Engineering conducted desk reviews complemented by on-site visits or phone interviews for SBES projects as well as on-site visits for SEM projects.

³ For the 2023 evaluation, Narrative Research conducted surveys with Instant Savings, HEA, Green Heat, and SBES participants as well as interviews with Instant Savings retailers, Green Heat contractors and distributors, Custom and SEM Business Development Managers, Custom participants and consultants, SEM participants and service providers and SBES participants and contractors.



1 Evaluation Scope and Objectives

The 2023 Portfolio Evaluation Plan was based on the Evaluation Schedule outlined in the Overall Strategic Evaluation Plan⁴ that provides the framework and approach to guide evaluation planning and implementation for the 2023-2025 demand-side management (DSM) activities. The Evaluator is responsible for designing annual evaluation plans that meet the evaluation goals and principles and conducting a third-party 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 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 be more highly prioritized 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).

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 2023 Portfolio Evaluation Plan. The table also indicates the scopes of the impact evaluations (comprehensive or condensed), which are further detailed in the following subsection.

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, Pay-for-Performance, and Building Optimization services as well as for the Business Energy Rebates component comprised of two services, namely Application Rebates and Instant Rebates.

⁴ Econoler, Overall Strategic Evaluation Plan, October 2023.

Table 1: 2023 Portfolio Evaluation Plan

Program Components	PY2023		
	Impact	Process	Market
Residential DSM Program Components			
Appliance Retirement	Condensed		
Instant Savings	Comprehensive		
Home Energy Assessment	Comprehensive		
Green Heat	Condensed	x	x
Efficient Product Installation	Condensed		
Mi'kmaw Home Energy Efficiency Project	Condensed		
Affordable Multifamily Housing	Condensed		
Affordable Single-family Homes	Condensed		
New Home Construction	Condensed		
BNI DSM Program Components			
Business Energy Rebates	Condensed		
Custom	Comprehensive	x- Retrofit	
Strategic Energy Management	Comprehensive	x	
Small Business Energy Solutions	Comprehensive	x	
Demand Response Program			
Residential Demand Response	Comprehensive		
BNI Demand Response	Comprehensive		

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) values of program measures
- › Gross and net lifetime electrical energy savings at the generator
- › Quantification of avoided greenhouse gas (GHG) emissions linked to evaluated gross and net electrical savings
- › Available Demand Response (DR) Capacity

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 of 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 of 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 is 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 evaluations, factors driving uncertainty include:

- › Program maturity and the 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.

Measure Assessment

The impact evaluation scope for 2023 also included an update of the Measure Assessment (MA) document. The MA was updated to include new products added to program offerings,⁵ remove products that are no longer offered,⁶ update products that are offered in a different program component or format,⁷ and update new savings parameters in cases for which a comprehensive impact evaluation is planned (i.e. unitary savings from domestic water heater load controls as per the results of the Demand Response Program). In addition, the following parameters, which are planned to be updated annually in the Measure Assessment, were updated in 2023:

- › LED lighting
 - › Baseline and efficient wattages
- › Freezer and refrigerator retirements and replacements
 - › Proportion of units per manufacture-year class
 - › Average unit size

For all other measures, the unitary savings were based on the values presented in the 2022 edition of the MA. The document also includes an update to add the EUL values for any new measures in the portfolio.

⁵ The following product was added in 2023: ENERGY STAR certified dishwashers (Instant Savings).

⁶ The following products were removed in 2023: Drain water heat recovery (for Home Energy Assessment only), solar air heating and solar DHW (for Home Energy Assessment only), low-flow showerheads (for Instant Savings only), three-element water heaters, domestic water heater timers, electric thermal storage (for Home Energy Assessment only), clothes dryer replacements (Appliance Retirement), and booster pumps (for Business Energy Rebates - Instant Rebates only).

⁷ Refrigerator replacement and freezer replacement are now offered under HomeWarming and the Mi'kmaw Home Energy Efficiency Project in place of Appliance Replacement, and air sealing kits are now air sealing products, reported individually.



1.2 Process and Market Evaluation Objectives and Scope

A market evaluation was completed in 2023 for mini-split heat pumps (MSHPs) under Green Heat.

Market evaluation activities were aimed at achieving the following objective:

- › Analyze the market evolution of MSHPs.

Results from the Market evaluation in Green Heat are presented further below in this document in Section 5.

A total of four process evaluations were completed for Green Heat, Custom Retrofit, Strategic Energy Management, and Small Business Energy Solutions respectively.

Process evaluation activities were aimed at achieving the following objectives:

- › Collect information on participant and partner perspectives;
- › Review the Custom-Retrofit program service logic model;
- › Review the SEM program logic model.

Process evaluation results are presented in the relevant evaluation reports.



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.

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, on-site visits, as well as other data-collection activities and analyses. The following subsections describe the steps that were followed to conduct the impact evaluations.

2.1.1 Tracking Sheet Audits

The final tracking sheets submitted to the Evaluator by EOne contained both data for all completed projects for 2023 and the tracked results required to calculate final savings. The final tracking sheets were audited to assess the consistency and completeness of 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 of each program component. Therefore, the tracked savings results presented in the evaluation reports refer to the corrected tracked savings obtained by the Evaluator as a result of the tracking sheet audits.

2.1.2 Data-collection Tool Development and Sampling Strategy

Data-collection tool development and sampling were carried out for Instant Savings, Home Energy Assessment, Green Heat, Small Business Energy Solutions, Custom, 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 select market evaluation activities.

2.1.3 Data Collection

Surveys and Interviews

This subsection describes the data-collection activities conducted for 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 with the exception of an online survey conducted for Instant Savings. Between August and December 2023 inclusively, the Evaluator conducted surveys with 392 participants. Table 2 below lists the surveys completed for each program component and the number of respondents to each survey.

Table 2: 2023 Participant Surveys

Program Component	Participants
Residential	
Instant Savings	122
Home Energy Assessment	100
Green Heat	124
BNI	
Small Business Energy Solutions	46
Total	392

- › **In-depth interviews** with program staff, participants, and partners were conducted as part of impact evaluation activities to collect data on free-ridership and spillover. Between August 2023 and January 2024 inclusively, the Evaluator conducted 121 interviews with various market actors and stakeholders. The number of completed interviews for each program component is presented in Table 3 below.

Table 3: 2023 Interviews Completed

Program Component	Program Manager ¹ / EOne Staff/Business Development Manager	Service Provider/ Distributors/ Contractors	Participants	Dropped Out or Overdue Participants	Retailers
Residential					
Appliance Retirement	2	-	-	-	-
Instant Savings	2	-	-	-	4
Home Energy Assessment	2	-	-	-	-
Green Heat	2	25	-	-	-
Efficient Product Installation	2	-	-	-	-
Mi'kmaw Home Energy Efficiency Project	2	-	-	-	-
Affordable Multifamily Housing	2	-	-	-	-
Affordable Single-family Homes	2	-	-	-	-
New Home Construction	2	-	-	-	-
BNI					
Business Energy Rebates	2	-	-	-	-
Custom	6 ²	8 ⁴	28 ³	-	-
Strategic Energy Management	3 ⁵	1	9	-	-
Small Business Energy Solutions	3	9	-	5	-
Total	32	43	37	5	4
¹ Two rounds were performed with the program manager (round 1 in May 2023 and round 2 in September 2023). ² Custom: Four program manager interviews were conducted (two for Retrofit and Building Optimization, and two for New Construction) and two EOne Business Development Manager interviews (for Retrofit and Building Optimization). ³ Custom: 28 interviews were conducted with participants (13 for Retrofit, six solar PV and nine for New Construction). ⁴ Custom: Eight interviews were conducted with Retrofit consultants. ⁵ SEM: One interview was conducted with the EOne Business Development Manager.					

Project Reviews with Follow-up Site Visits or Interviews

The Evaluator performed a total of 74 project reviews during the summer and fall of 2023, 51 of which were complemented through site visits and 23 were complemented through phone interviews.

For Small Business Energy Solutions, site visits were preferred when possible. The objective 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 Custom and Strategic Energy Management, the Evaluator carried out full technical reviews of project documentation followed up by telephone interviews or site visits with participants to finalize the 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. For two new Strategic Energy Management participants, site visits were also conducted.

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

Table 4: 2023 Project Reviews with Follow-up Site Visits or Interviews

Program Component	Project Reviews Followed by Site Visits	Project Reviews Followed by Phone Interviews	Total Project Reviews
BNI			
Small Business Energy Solutions	42	-	42
Strategic Energy Management	2	4	6
Custom	7	19	26*
Demand Response			
BNI Demand Response	-	8	8
Total	51	31	82
* Custom: 26 project reviews were conducted (20 for Retrofit and six for Building Optimization).			

Energy Model Reviews

The Evaluator performed energy model reviews for the 12 Custom New Construction projects to verify the accuracy of energy models. After the initial file reviews, the Evaluator concluded that the available documentation was sufficient and virtual site visits or follow-up phone interviews were not required. The energy model reviews involved comparing energy models against as-built drawings and project documentation. 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.



Unitary Savings Review

For program components with unitary savings values - namely Appliance Retirement, Instant Savings, Home Energy Assessment, Green Heat, Efficient Product Installation, the Mi'kmaw Home Energy Efficiency Project, the Business Energy Rebates Instant Rebates 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 2020-2023 Measure Assessment. As part of the 2023 evaluation, parameters or calculation methodologies for select measures were updated based on comprehensive evaluation findings, including a new unitary savings value for domestic hot water load controllers based on metering data. Moreover, one new measure introduced in 2023 was added to the Measure Assessment, namely ENERGY STAR® certified dishwashers. 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.

Water Heater Controller Meter Data Analysis

One of the main objectives of the Residential Demand Response 2023 evaluation was to update the baseline methodology and, as data permit, to improve the accuracy of 2022 unitary available DR capacity. To review the baseline methodology, the Evaluator used an in-house tool that serves to compare the predicted baseline to the actual baseline on days when no events were called. Building on the analysis conducted in 2022, the Evaluator analyzed 2022 and 2023 meter data from DHW Direct Load Control participants and performed several analyses to determine the average DR capacity per controller made available during DR events called by NS Power. The Evaluator analyzed several baseline definitions to determine the baseline that provides the most accurate prediction of the baseline. With this updated baseline, the Evaluator developed new unitary available DR capacity for this program.

Meter Data Analysis with Project Reviews and Follow-up Phone Interviews

For each BNI DR project, the Evaluator reviewed how tracked available DR capacities were established. The Evaluator reviewed the baseline methodology based on both data analysis results and findings from a literature review. The project reviews included eight short interviews with participants to validate implemented measures. The Evaluator also used this activity to analyze the available DR capacity per hour as well as during morning and evening events.

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. The resulting EUL values were included in the 2020-2023 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 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 in a program. 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 along 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 on participant 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 project reviews and follow-up interviews to calculate interactive effects that are representative not only of the Nova Scotia climate, but also participating homes and facilities.
- › **Peak demand savings** were calculated from gross electrical energy savings based on the projected electricity peak demand period in Nova Scotia.⁸ For residential program components, peak demand savings were calculated using peak demand-to-energy ratios established for EOne in the 2016-2018 DSM Plan prepared by Navigant. Engineering calculations were used for products generating significant peak demand savings and for which load profiles during peak hours could be estimated (e.g. electric thermal storage, heat pumps, prescriptive commercial lighting). For semi-prescriptive measures from BNI program components, peak demand savings were calculated for a 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.

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 self-report 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. The self-report approach consisted of asking questions to participants to assess factors such as planning, quantity, efficiency, period, and cost as well as the influence of a program component. For the midstream BER Instant Rebates program component, 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 2023 evaluation, free-ridership levels were updated for Instant Savings, Home Energy Assessment, Green Heat, Small Business Energy Solutions, as well as Custom Retrofit and New Construction.

The free-ridership levels from past evaluations were used for Appliance Retirement, Efficient Product Installation, New Home Construction, Business Energy Rebates Instant Rebates and Application Rebates, as well as Building Optimization.

⁸ 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 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 or site visits during project reviews. In all cases, participants were asked if they had implemented additional energy efficiency measures without receiving additional 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 participation process.

As part of the 2023 evaluation, the spillover levels were updated for Instant Savings, Home Energy Assessment, Small Business Energy Solutions, and Custom. The spillover levels from past evaluations were used for Appliance Retirement, Efficient Product Installation, New Home Construction, as well as Business Energy Rebates Instant Rebates and Application Rebates. In addition, the unconverted D assessment spillover from the past evaluation was used for Home Energy Assessment.

In 2023, the Evaluator reassessed the assumption that the Strategic Energy Management NTGR was equal to 1. Based on an analysis of the measures implemented and interview results, the Evaluator concluded that the assumption was still valid. The Evaluator does not recommend reassessing this assumption in the next five years unless program component design or results change significantly.

The Evaluator did not establish free-ridership and spillover levels for measures and program components offered to low-income participants and Mi'kmaw communities as they were 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 generated through all program components. Avoided GHG emissions were estimated by using a Nova Scotia-specific factor⁹ 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.

2.2 Process and Market Evaluation

The process and market evaluations were conducted using a range of activities such as program component documentation as well as secondary data reviews, logic model reviews, and in-depth interviews with program staff, stakeholders, and participants. The following subsections describe the key tasks the Evaluator carried out to execute the market evaluations for Green Heat and the process evaluations for Custom Retrofit, Strategic Energy Management, Green Heat and Small Business Energy Solutions.

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 program 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 evaluation types where possible. For instance, interview guides included questions for 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 integrated to collect impact, process, and market information.

- › **Secondary data** were used to assess and follow up on MSHP market indicators such as market shares.
- › **In-depth interviews** were conducted with program staff, Business Development Managers, participants, partners, and trade allies to collect data on their involvement in a given 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 is presented in Table 3 Subsection 2.1.3 above.

⁹ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO₂ eq tonnes) and total electricity generation (10,456 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 December 1st, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22'23.pdf (Last accessed December 1st, 2023).

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- › **Participant surveys** conducted by phone between October and November 2023 with Green Heat participants served to collect information on their perspective on the program. The number of completed surveys is presented in Table 2, Subsection 2.1.3 above.

Logic Model Update

The Evaluator reviewed the Custom Retrofit and Strategic Energy Management logic models to determine whether they were achieving their goals in the way anticipated at the time of design. To do so, the Evaluator compared the logic model assumptions to the findings of the multiple data-collection activities and reviewed the connections to relevant offers and Custom Incentives program components or services.

Analysis

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

3 Impact Evaluation Results

This section presents an analysis of the impact evaluation results for all program components by comparing 2023 tracked energy and peak demand savings with evaluated energy and peak demand savings. Evaluated NTGRs, lifetime energy savings, and GHG emission reductions are also presented in the subsections below.

3.1 Individual Impact Evaluation Results

Table 5 and Table 6 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 2023. 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.¹⁰

¹⁰ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 5: Comparison of 2023 Evaluated and Tracked Energy Savings at the Generator ^a

DSM Program	Program Component	Tracked Results		Evaluated Results				Net Realization Rate
		Annual Gross Savings (GWh)	Annual Net Savings (GWh)	Annual Gross Savings (GWh)	NTGR ^b	Annual Net Savings (GWh)	Lifetime Net Energy Savings (GWh)	
Residential								
Residential Efficient Product Rebates	Appliance Retirement	2.773	1.565	3.010	0.56	1.698	6.776	109%
	Instant Savings	15.409	13.290	15.512	0.74	11.476	79.470	86%
Existing Residential ^c	Home Energy Assessment	30.584	24.018	30.581	0.85	25.966	600.938	108%
	Green Heat	5.561	3.352	5.561	0.52	2.918	52.526	87%
	Efficient Product Installation ^d	9.481	9.308	9.481	0.99	9.357	66.977	101%
	Mi'kmaw Home Energy Efficiency Project	0.575	0.575	0.577	1.00	0.577	11.663	100%
	Affordable Multifamily Housing	1.462	1.462	1.460	1.00	1.460	25.465	100%
	Affordable Single-family Homes	1.439	1.439	1.444	1.00	1.444	28.992	100%
	New Residential	New Home Construction	5.868	5.340	5.868	0.90	5.281	162.658
Residential Subtotal		73.152	60.348	73.493	0.82	60.177	1,035.466	100%
BNI								
Efficient Products Rebates	Business Energy Rebates	48.166	38.907	48.045	0.81	38.814	556.298	100%
Custom Incentives	Custom	29.112	22.400	28.377	0.77	21.746	189.031	97%
	Strategic Energy Management	3.391	3.391	3.381	1.00	3.381	18.443	100%
Direct Installation	Small Business Energy Solutions ^e	8.915	7.629	9.180	0.81	7.451	113.821	98%
BNI Subtotal		89.584	72.327	88.982	0.80	71.392	877.594	99%
Portfolio Total		162.736	132.674	162.476	0.81	131.569	1,913.059	99%

^a Numbers may not add up due to rounding.

^b Subtotal NTGR values represent average values for the Residential and BNI portfolios. The Portfolio Total NTGR value represents an average value for all programs.

^c Residential Behaviour was not launched in 2023 and therefore did not generate any savings.

^d Evaluated gross and net savings at the generator include 0.037 GWh generated by the Smart Thermostats for Electric Baseboard pilot.

^e Evaluated gross and net energy savings at the generator include 0.243 GWh generated by the Commercial Direct Install pilot.

Table 6: Comparison of 2023 Evaluated and Tracked Peak Demand Savings at the Generator ^a

DSM Program	Program Component	Tracked Results			Evaluated Results				Net Realization Rate
		Annual Gross Savings (MW)	Annual Net Savings (MW)	Available Capacity (MW)	Annual Gross Savings (MW)	NTGR ^b	Annual Net Savings (MW)	Available Capacity (MW)	
Residential									
Residential Efficient Product Rebates	Appliance Retirement	0.396	0.223	N/A	0.430	0.56	0.243	N/A	109%
	Instant Savings	1.969	1.693	N/A	1.989	0.73	1.459	N/A	86%
Existing Residential	Home Energy Assessment	8.446	6.893	N/A	8.446	0.93	7.820	N/A	113%
	Green Heat	4.668	2.949	N/A	4.668	0.55	2.561	N/A	87%
	Efficient Product Installation	0.942	0.913	N/A	0.942	0.98	0.920	N/A	101%
	Mi'kmaw Home Energy Efficiency Project	0.373	0.373	N/A	0.373	1.00	0.373	N/A	100%
	Affordable Multifamily Housing	0.706	0.706	N/A	0.741	1.00	0.741	N/A	105%
	Affordable Single-family Homes	0.624	0.624	N/A	0.627	1.00	0.627	N/A	100%
New Residential	New Home Construction	2.121	1.930	N/A	2.121	0.90	1.909	N/A	99%
Residential Subtotal		20.246	16.305	N/A	20.339	0.82	16.653	N/A	102%
BNI									
Efficient Products Rebates	Business Energy Rebates	7.476	6.025	N/A	7.463	0.81	6.014	N/A	100%
Custom Incentives	Custom	4.744	3.366	N/A	4.108	0.74	3.053	N/A	91%
	Strategic Energy Management	0.272	0.272	N/A	0.366	1.00	0.366	N/A	134%
Direct Installation	Small Business Energy Solutions ^c	1.825	1.559	N/A	1.840	0.81	1.491	N/A	96%
BNI Subtotal		14.318	11.223	N/A	13.777	0.79	10.924	N/A	97%
Demand Response (DR) Program									
Residential Demand Response		N/A	N/A	0.073	N/A	N/A	N/A	0.058	79%
BNI Demand Response		N/A	N/A	2.254	N/A	N/A	N/A	2.365	105%
DR Program Subtotal		N/A	N/A	2.327	N/A	N/A	N/A	2.423	104%
Portfolio Total		34.564	27.528	2.327	34.115	0.81	27.577	2.423	100% ^d
^a Numbers may not add up due to rounding. ^b Subtotal NTGR values represent average values for the Residential and BNI portfolios. The Portfolio Total NTGR value represents an average value for all programs. ^c Evaluated gross and net peak demand savings at the generator include 0.039 MW generated by the Commercial Direct Install pilot. ^d This net realization rate doesn't include DR Program.									



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 2023, Residential Efficient Product Rebates achieved net electrical energy and peak demand savings of 13.174 GWh and 1.702 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

- › Program participation in 2023 decreased by 19% and energy savings decreased by 15% compared to 2022, with refrigerator and freezer retirements remaining the largest drivers of participation and savings.
- › The evaluated net energy and peak demand savings were both 9% higher than the values tracked by EOne due to updated unitary savings being higher than the values tracked because of changes in characteristics, namely age and size, of the appliances retired in 2023.

Instant Savings

- › Instant Savings maintained a high level of participation with an increase (9%) in overall products sold in 2023 compared to 2022.
- › The free-ridership level for LED lamps increased by 8% and LED fixtures increased by 2% in 2023 compared to 2022.
- › The spillover level for LED fixtures decreased by 30% in 2023.
- › The evaluated net energy savings and peak demand savings determined by the Evaluator were 14% lower than the initial net savings tracked by EOne.
- › Most of the gross savings (54%) continued to be generated from LED lighting products in 2023, a market that is reaching maturity.

Existing Residential

In 2023, the net energy savings of Existing Residential reached 41.722 GWh while the net peak demand savings amounted to 13.042 MW at the generator. Existing Residential is comprised of Home Energy Assessment, Green Heat, Efficient Product Installation, the Mi'kmaw Home Energy Efficiency Project, Affordable Multifamily Housing, and Affordable Single-family Homes. The results of these six program components are discussed below.

Home Energy Assessment

- › HEA saw an increase in participation of 47% and an increase in average gross savings per home of 57% compared to 2022, likely driven by the integration of the Canada Greener Homes Grant (CGH Grant).
- › Free-ridership levels were measured as part of the 2023 evaluation; for energy efficiency upgrades, the survey revealed a free-ridership level of 17% compared to 26% determined in 2020. Solar PV measures were surveyed separately and resulted in a free-ridership level of 26% compared to 29% in 2022.
- › The evaluated energy and peak demand savings were respectively 8% and 13% higher than the savings tracked by EOne due to lower free-ridership levels measured as part of the 2023 evaluation.

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- › The Evaluator undertook a billing analysis in 2023 to determine overestimation ratios (ORs) for modelled savings. The billing analysis results were inconclusive and require further exploration. As a result, the ORs established in 2018 were maintained for the 2023 evaluation.

Green Heat

- › Green Heat participation levels decreased by 11% compared to 2022, particularly for MSHPs (22% decrease). Conversely, MSHP installations incented through HEA increased over the same period (116% increase) due in large part to the integration of the CGHG.
- › Free-ridership levels increased for Green Heat measures, particularly for MSHPs (48% in 2023 compared to 39% in 2022). Free-ridership for biomass measures was evaluated at 47% (41% in 2022) and for new demand reduction measures at 9%.
- › The net evaluated energy and peak demand savings were lower than the savings tracked by EOne due to the update of NTGRs for biomass, MSHP, and demand reduction measures as part of the 2023 evaluation.

Efficient Product Installation

- › Participation in 2023 increased by 16% and energy savings increased by 12% compared to 2022, with LED lamps, and smart thermostats for MSHPs being the most popular measures.
- › The differences between evaluated net peak demand savings determined by the Evaluator and the net savings tracked by EOne were minimal.

Mi'kmaw Home Energy Efficiency Project

- › With a 10% increase in average savings per participant and the highest number of participants since inception, MHEEP achieved 52% more energy savings and 92% more peak demand savings in 2023 compared to 2022 levels.
- › The evaluated net energy and peak demand savings determined by the Evaluator were the same as the net savings tracked by EOne.

Affordable Multifamily Housing

- › Affordable Multifamily Housing continued to grow and achieved its highest level of participation since its launch in 2018 (a 61% increase compared to 2022), largely driven by an increase in prescriptive projects (68 projects in 2023 compared to 37 in 2022).
- › The evaluated net energy savings determined by the Evaluator were the same as the savings tracked by EOne, while the evaluated net peak demand savings were 5% higher than the savings tracked by EOne.

Affordable Single-family Homes

- › In 2023, 242 homes receiving upgrades generated electrical savings through Affordable Single-family Homes.
- › The gross and net energy and peak demand savings determined by the Evaluator were slightly higher (<1%) than the initial savings tracked by EOne due to a revision to the prescriptive unitary savings values for appliance replacement measures.



New Residential

New Residential is comprised of one program component: New Home Construction.

- › In 2023, New Home Construction achieved net energy savings of 5.281 GWh and net peak demand savings of 1.909 MW at the generator.
- › New Home Construction participation decreased by 11% in 2023 compared to 2022 as remaining participants completed their projects ahead of program closure.
- › Evaluated gross savings were identical to the savings tracked by EOne, while net evaluated savings were slightly lower (<1%).

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 Application Rebates and Instant Rebates. In 2023, Business Energy Rebates achieved 38.814 GWh in net energy savings and 6.014 MW in net peak demand savings at the generator.

Business Energy Rebates

- › Instant Rebates participation increased by 19% in 2023. While Application Rebates participation decreased by 21% in 2023, its net energy savings per participant increased by 11% compared to 2022.
- › Evaluated net energy savings were less than 1% lower than the values tracked by EOne for Application Rebates, while peak demand savings were identical. Both evaluated net energy and peak demand savings were less than 1% higher than tracked results for Instant Rebates.

Custom Incentives

In 2023, Custom Incentives achieved 25.127 GWh in net energy savings and 3.419 MW in net peak demand savings at the generator through its two components, namely Custom and Strategic Energy Management. Custom comprises four services, Retrofit, Pay-for-Performance, New Construction, and Building Optimization. In 2023, the Retrofit Operational Demand Reduction offer was removed.

Custom

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

- › Compared to 2022, Custom participation decreased in 2023 due in part to the lack of participation in the Pay-for-Performance (P4P) service and the removal of the Retrofit Operational Demand Reduction offer.
- › Following the project reviews, the Evaluator adjusted the energy and peak demand savings for Retrofit, New Construction, and Building Optimization.
- › Retrofit free-ridership levels increased for regular Retrofit and solar PV projects, and was established at 25% and 38% respectively. New Construction free-ridership decreased compared to the 2022 level, although it remained relatively high at 31%.
- › Evaluated net energy and peak demand savings determined by the Evaluator were respectively 3% and 9% lower than the savings tracked by EOne. This result was mainly due to adjustments made by the Evaluator during project reviews.

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

- › Custom-specific adjustment ratios for solar PV projects were established at 1.101 for projects modelled with PV Watts and 0.942 for those modelled with RETScreen Expert.

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

- › Free-ridership continued to remain relatively high in 2023 at 31%, and several participants reported factors outside of New Construction being significant motivators for constructing energy efficient buildings.

Strategic Energy Management

- › The SEM participation level has remained stable over the past five years. Energy savings per participant were similar to those in 2022.
- › The M&V methodologies applied to quantify savings were generally appropriate and accurate, and the Evaluator made no major adjustments to energy savings. Peak demand savings were increased by 34% due to projects whose peak demand savings had not been calculated.
- › The assumption that the NTGR is equal to 1 remained valid despite the evolution of the program component.
- › Evaluated net energy savings were 1% lower than the values tracked by EOne, while peak demand savings were 34% higher than the tracked values.

Direct Installation

Direct Installation consists of one program component, namely Small Business Energy Solutions. In 2023, Direct Installation achieved 7.451 GWh in net energy savings and 1.491 MW in net peak demand savings at the generator.

Small Business Energy Solutions

- › The number of completed projects in Small Business Energy Solutions decreased by 27% in 2023, while average gross energy savings per project remained flat compared to 2022.
- › Following the desk reviews and site visits, the Evaluator made minor adjustments to the energy and peak demand savings of all measure categories. For lighting, an adjustment ratio of 1.070 and 0.917 were established for energy peak demand savings respectively. For MSHPs, adjustment ratios of 0.980 and 1.009 were established for energy and peak demand savings respectively.
- › The free-ridership level for the DIY path increased by 5% in 2023 (20% in 2023 compared to 15% in 2021) mainly due to an increase in free-ridership among lighting projects.
- › The evaluated gross and net energy savings were slightly different (2%) than the savings tracked by EOne.

3.2 Net-to-gross Ratio

The NTGRs outlined in Table 7 below were applied to gross savings to estimate net savings. NTGRs were established based on the free-ridership levels and spillover in some cases. 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 2023 evaluation.

Table 7 summarizes the free-ridership and spillover levels used in the 2023 evaluation as well as the resulting NTGRs for each program component.

Table 7: 2023 Free-ridership, Spillover, and NTGRs

Program Component and Measure Type		Free-ridership Levels	Spillover Levels	NTGR
Residential				
Appliance Retirement	Refrigerators	43%	0%	0.57
	Freezers	45%		0.55
	Air Conditioners	47%		0.53
	Small Refrigerators	32%		0.68
	Small Freezers	32%		0.68
	Dehumidifiers	0%		1.00
Instant Savings	LED Lamps	59%	9%	0.50
	LED Fixtures	49%	2%	0.53
	All Other Products	-	-	1.00
Home Energy Assessment	Solar PV Measures	26%	1%	0.75
	Other Measures	17%	1%	0.84
Green Heat	MSHPs	48%	-	0.52
	Demand Reduction	9%		0.91
	Solar and Biomass Measures	47%		0.53
	CASHPs and GSHPs	33%		0.67
Efficient Product Installation	LED Lighting – Non-low-income Participants	25%	10%	0.85
	LED Lighting – Low-income Participants	0%	0%	1.00
	Low-flow Showerheads – Non-low-income Participants	10%	10%	1.00
	Low-flow Showerheads – Low-income Participants	0%	0%	1.00
	Other Products – Non-low-income Participants	0%	10%	1.10
	Other Products – Low-income Participants	0%	0%	1.00
Mi'kmaw Home Energy Efficiency Project		-	-	1.00
Affordable Multifamily Housing		-	-	1.00
Affordable Single-family Homes		-	-	1.00
New Home Construction		24%	14%	0.90

Program Component and Measure Type		Free-ridership Levels	Spillover Levels	NTGR
BNI				
Business Energy Rebates – Application Rebates		26%	0%	0.74
Business Energy Rebates – Instant Rebates	LED Linear Fixtures	14%	-	0.86
	LED Outdoor Fixtures	18%		0.82
	LED Linear Lamps	27%		0.73
	Other Measures	-		1.00
Custom Retrofit	Regular Retrofit Projects	25%	2%	0.77
	Solar PV Projects	38%	1%	0.63
	Compressed Air Leak Audit Projects ^a	16%	0%	0.84
Custom Pay-for-Performance ^a		14%	-	0.86
Custom New Construction		31%	-	0.69
Custom Building Optimization ^a		9%	0%	0.91
Strategic Energy Management		-	-	1.00
Small Business Energy Solutions	Audit Path ^a	12%	0%	0.88
	DIY Path	20%	0%	0.80
	Commercial Direct Install Pilot	-	-	1.00
^a Net-to-gross ratios were determined based on the results of past evaluations.				

3.3 Lifetime Energy Savings

The Evaluator reviewed the EUL values of all measures offered by EOne and their associated lifetime energy savings. The Evaluator found that the DSM portfolio generated 1,913.059 GWh in lifetime net energy savings. As presented in Table 8 below, the weighted average EUL of measures offered in the EOne portfolio is 14.5 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, Home Energy Assessment has an average EUL of 23.1 years and, while it contributes to 20% of annual energy savings, it generates 31% 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 measures.

Table 8: 2023 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)	Share of Annual Net Energy Savings (%)	Share of Lifetime Net Energy Savings (%)
Residential						
Residential Efficient Product Rebates	Appliance Retirement	1.698	6.776	4.0	1%	0%
	Instant Savings	11.476	79.470	6.9	9%	4%
Existing Residential	Home Energy Assessment	25.966	600.938	23.1	20%	31%
	Green Heat	2.918	52.526	18.0	2%	3%
	Efficient Product Installation	9.357	66.977	7.2	7%	4%
	Mi'kmaw Home Energy Efficiency Project	0.577	11.663	20.2	0%	1%
	Affordable Multifamily Housing	1.460	25.465	17.4	1%	1%
	Affordable Single-family Homes	1.444	28.992	20.1	1%	2%
New Residential	New Home Construction	5.281	162.658	30.8	4%	9%
Residential Subtotal		60.177	1,035.466	17.2	46%	54%
BNI						
Efficient Product Rebates	Business Energy Rebates	38.814	556.298	14.3	30%	29%
Custom Incentives	Custom	21.746	189.031	8.7	17%	10%
	Strategic Energy Management	3.381	18.443	5.5	3%	1%
Direct Installation	Small Business Energy Solutions	7.451	113.821	15.3	6%	6%
BNI Subtotal		71.392	877.594	12.3	54%	46%
Portfolio Total		131.569	1,913.059	14.5	100%	100%
* 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 72,613 tonnes of CO₂eq in terms of annually avoided net GHG emissions. Table 9 presents the GHG emission reductions of each program component in 2023 as well as those for the portfolio as a whole.

Table 9: 2023 Evaluated GHG Emission Reductions

DSM Program	Program Component	Gross Avoided GHG Emissions in CO ₂ eq Tonnes	Net Avoided GHG Emissions in CO ₂ eq Tonnes
Residential Efficient Product Rebates	Appliance Retirement	1,661	937
	Instant Savings	8,561	6,333
Existing Residential	Home Energy Assessment	16,877	14,330
	Green Heat	3,069	1,611
	Efficient Product Installation	5,233	5,164
	Mi'kmaw Home Energy Efficiency Project	318	318
	Affordable Multifamily Housing	806	806
	Affordable Single-family Homes	797	797
New Residential	New Home Construction	3,238	2,915
Residential Subtotal		40,561	33,211
Efficient Product Rebates	Business Energy Rebates	26,516	21,421
Custom Incentives	Custom	15,661	12,002
	Strategic Energy Management	1,866	1,866
Direct Installation	Small Business Energy Solutions	5,066	4,112
BNI Subtotal		49,109	39,401
Portfolio Total		89,670	72,613

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.

4.1 Participant and Partner Satisfaction

The 2023 evaluation revealed high participant satisfaction with EOne and its programs. Home Energy Assessment, Green Heat, Custom (regular Retrofit and Solar PV), SEM, and Small Business Energy Solutions received average participant satisfaction scores of eight or higher. The Evaluator interviewed program partners for three program components and one program service. Program partners were generally satisfied with the program components or services. Green Heat contractors were less satisfied with the program component. Table 10 presents the 2023 average participant and partner satisfaction scores for program components for which this metric was measured.

Table 10: 2023 Satisfaction Results

DSM Program	Program Component	Participant Satisfaction	Partner Satisfaction
Residential			
Residential Efficient Product Rebates	Instant Savings	-	8.8
Existing Residential	Home Energy Assessment	8.3	-
	Green Heat	7.8 – MSHP 8.4 – Biomass	6.6
BNI			
Custom Incentives	Retrofit	8.0 – Regular Retrofit 8.8 – Solar PV	7.4
	Strategic Energy Management	8.0	-
Direct Installation	Small Business Energy Solutions	8.8	7.4

4.2 Annual Savings Performance by Program Component

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

¹¹ EfficiencyOne's 2023 Q1 Demand-Side Management (DSM) Report (M11148) on page 3, Table 1: 2023 Approved Plan, Mid-Course Adjustments and Q1 Results [filed May 25, 2023].

Table 11: 2023 Planned Net Savings and Evaluated Results

Program Component and DSM Program	Planned Savings*			Evaluated Results**			Variance	
	Net Energy Savings (GWh)	Net Peak Demand Savings (MW)	Available DR Capacity (MW)	Net Energy Savings (GWh)	Net Peak Demand Savings (MW)	Available DR Capacity (MW)	GWh (%)	MW (%)
Residential								
Residential Efficient Product Rebates	11.388	1.260		13.174	1.702		16%	35%
Appliance Retirement	2.024	0.280		1.698	0.243		-16%	-13%
Instant Savings	9.364	0.980		11.476	1.459		23%	49%
Existing Residential	38.526	11.550		41.722	13.042		8%	13%
Home Energy Assessment	14.910	6.340		25.966	7.820		74%	23%
Green Heat	3.629	2.920		2.918	2.561		-20%	-12%
Efficient Product Installation	8.268	0.760		9.357	0.920		13%	21%
Mi'kmaw Home Energy Efficiency Project	0.608	0.300		0.577	0.373		-5%	24%
Affordable Multifamily Housing	1.247	0.340		1.460	0.741		17%	118%
Affordable Single-family Homes	3.496	0.890		1.444	0.627		-59%	-30%
Residential Behaviour ***	6.370	-		-	-		-	-
New Residential	3.146	1.060		5.281	1.909		68%	80%
New Home Construction	3.146	1.060		5.281	1.909		68%	80%
Residential Subtotal	53.060	13.870		60.177	16.653		13%	20%
BNI								
Efficient Product Rebates	30.007	5.340		38.814	6.014		29%	13%
Business Energy Rebates	30.007	5.340		38.814	6.014		29%	13%
Custom Incentives	25.732	5.623		25.127	3.419		-2%	-39%
Custom	22.730	5.280		21.746	3.053		-4%	-42%
Strategic Energy Management	3.002	0.343		3.381	0.366		13%	7%
Direct Installation	11.897	2.070		7.451	1.491		-37%	-28%
Small Business Energy Solutions	11.897	2.070		7.451	1.491		-37%	-28%
BNI Subtotal	67.636	13.033		71.392	10.924		6%	-16%
Demand Response (DR) Program								
Demand Response			3.000			2.423		-19%
Residential Demand Response			-			0.058		-
BNI Demand Response			3.000			2.365		-21%
DR Program Subtotal			3.000			2.423		-19%
Portfolio Total	120.697	26.903	3.000	131.569	27.577	2.423	9%	3%
* Planned savings correspond to EOne's mid-course adjustments. ** Numbers may not add up due to rounding. *** Residential Behaviour was not launched in 2023 and therefore did not generate any savings.								



The EOne portfolio of DSM program components achieved 131.569 GWh in total net electrical energy savings and 27.577 MW in total net peak demand savings at the generator, representing 9% higher savings than planned energy savings and 3% higher savings than planned peak demand savings for 2023. Residential Efficient Product Rebates, Existing Residential, New Residential and Efficient Product Rebates exceeded their planned energy and peak demand targets in 2023, while Custom Incentives and Direct Installation fell short of targets.

Residential programs achieved 60.177 GWh in net energy savings and 16.653 MW in net peak demand savings at the generator. Residential energy savings were 13% higher than planned, with all programs exceeding their target. The results were as follows: New Residential, Residential Efficient Product Rebates, and Existing Residential surpassed their target by 68%, 16%, and 8% respectively. All residential programs also exceeded their peak demand savings target, with New Residential exceeding the target by 80%, Residential Efficient Product Rebates by 35%, and Existing Residential by 13%. As a result, residential net peak demand savings were 20% above the planned values.

EOne BNI programs achieved 71.392 GWh in net energy savings and 10.924 MW in net peak demand savings at the generator in 2023, thus exceeding planned energy savings by 6% and falling short of planned peak demand savings by 16%. Custom Incentives narrowly missed its energy savings target by 2%, while Direct Installation missed its energy savings target by 37%. Efficient Product Rebates exceeded its target by 29%.

4.3 Historical Portfolio Analysis

This subsection presents year-over-year program performance and the contribution of individual program components to portfolio savings. Table 12 and Table 13 below provide a historical overview of component performance and changes in DSM portfolio composition from 2019 to 2023.

Table 12: Evaluated Net Energy Savings at the Generator, 2018-2023

DSM Program ^a	Program Component	Energy Savings (GWh)					Energy Savings (%)				
		2019	2020	2021	2022	2023	2019	2020	2021	2022	2023
Residential											
Residential Efficient Product Rebates	Appliance Retirement	2.545	2.111	2.474	2.051	1.698	2%	2%	2%	2%	1%
	Instant Savings	13.148	10.533	14.314	13.741	11.476	11%	11%	13%	11%	9%
Existing Residential	Home Energy Assessment	5.455	3.823	3.481	11.377	25.966	4%	4%	3%	9%	20%
	Green Heat	5.196	5.407	6.795	3.755	2.918	4%	6%	6%	3%	2%
	Efficient Product Installation	11.956	7.402	7.812	8.315	9.357	10%	8%	7%	7%	7%
	Mi'kmaw Home Energy Efficiency Project	0.284	0.088	0.316	0.380	0.577	0%	0%	0%	0%	0%
	Affordable Multifamily Housing	0.255	0.676	0.402	0.920	1.460	0%	1%	0%	1%	1%
New Residential	New Home Construction	5.214	5.867	5.683	6.479	5.281	4%	6%	5%	5%	4%
Residential Subtotal		43.798	35.908	41.276	47.019	60.177	35%	38%	38%	39%	46%
BNI											
Efficient Product Rebates	Business Energy Rebates	48.012	33.687	33.491	37.046	38.814	39%	35%	31%	30%	30%
Custom Incentives	Custom ^b	19.281	17.790	23.293	23.588	21.746	15%	19%	21%	19%	17%
	Strategic Energy Management	1.949	2.120	1.845	3.177	3.381	2%	2%	2%	3%	3%
Direct Installation	Small Business Energy Solutions	10.934	5.415	9.486	11.069	7.451	9%	6%	9%	9%	6%
BNI Subtotal		80.754	59.616	68.142	74.880	71.392	65%	62%	62%	61%	54%
Portfolio Total		124.552	95.524	109.418	121.899	131.569	100%	100%	100%	100%	100%
^a Affordable Single-family Homes and the DR Program are not included since they were offered for the first time in 2023.											
^b Custom includes four services: Retrofit, Pay-for-Performance, New Construction, and Building Optimization.											

Table 13: Evaluated Net Peak Demand Savings at the Generator, 2018-2023

DSM Program ^a	Program Component	Peak Demand Savings (MW)					Peak Demand Savings (%)				
		2019	2020	2021	2022	2023	2019	2020	2021	2022	2023
Residential											
Residential Efficient Product Rebates	Appliance Retirement	0.382	0.309	0.357	0.298	0.243	2%	1%	1%	1%	1%
	Instant Savings	0.842	1.206	1.629	1.771	1.459	4%	6%	6%	6%	5%
Existing Residential	Home Energy Assessment	1.599	1.823	1.495	6.703	7.820	7%	9%	5%	21%	28%
	Green Heat	4.438	4.741	6.451	3.424	2.561	19%	22%	23%	11%	9%
	Efficient Product Installation	1.505	1.007	1.098	0.864	0.920	7%	5%	4%	3%	3%
	Mi'kmaw Home Energy Efficiency Project	0.084	0.026	0.147	0.194	0.373	0%	0%	1%	1%	1%
	Affordable Multifamily Housing	0.076	0.181	0.186	0.447	0.741	0%	1%	1%	1%	3%
	Affordable Single-family Homes	-	-	-	-	0.627	-	-	-	-	2%
New Residential	New Home Construction	1.545	2.397	2.285	2.358	1.909	7%	11%	8%	8%	7%
Residential Subtotal		10.396	11.689	13.649	16.059	16.653	46%	55%	50%	51%	60%
BNI											
Efficient Product Rebates	Business Energy Rebates	7.742	5.711	5.401	5.762	6.014	34%	27%	20%	18%	22%
Custom Incentives	Custom ^b	2.071	2.427	6.105	6.931	3.053	9%	11%	22%	22%	11%
	Strategic Energy Management	0.099	0.241	0.282	0.373	0.366	0%	1%	1%	1%	1%
Direct Installation	Small Business Energy Solutions	2.370	1.120	2.045	2.222	1.491	10%	5%	7%	7%	5%
BNI Subtotal		12.396	9.500	13.832	15.288	10.924	54%	45%	50%	49%	40%
Portfolio Total		22.793	21.189	27.481	31.347	27.577	100%	100%	100%	100%	100%
^a DR Program is not included.											
^b Custom includes four services: Retrofit, Pay-for-Performance, New Construction, and Building Optimization.											

In 2023, EOne achieved a total of 131.569 GWh in net energy savings and 27.577 MW in net peak demand savings at the generator. While net energy savings increased compared to 2022, net peak demand savings decreased. Residential programs experienced increases for both its net energy and peak demand savings of 28% and 4% respectively compared to 2022, whereas BNI programs experienced 5% and 29% decreases in net energy and peak demand savings respectively.

In 2023, the residential sector accounted for 46% of net energy savings and the BNI sector accounted for 54% of net energy savings. The share of BNI sector energy savings has been trending downward since a high point in 2019. Compared to 2022, the share of lighting in overall portfolio savings slightly decreased from 41% to 36% in 2023.

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 and introducing, in 2023, two demand response program components. In 2023, the program components that generated the largest shares in peak demand savings were Home Energy Assessment (28%), Business Energy Rebates (22%), Custom (11%), and Green Heat (9%). The Demand Reduction Program introduced in 2023 resulted in 2.423 MW in available capacity.



5 Market Evaluation Results

For the 2023 evaluation, the Evaluator conducted a market evaluation for Green Heat, focused on mini-split heat pumps (MSHPs).

Green Heat: Mini-split Heat Pumps

To understand the evolution of the MSHP market for the residential sector in Nova Scotia since the last evaluation in 2021, the Evaluator spoke to heat pump distributors in the province regarding high-efficiency and standard MSHP sales and trends in the market.

The key finding specific to the Green Heat market evaluation was as follows:

› **The MSHP market is in a sustained growth phase.**

NS Power data indicated a marked increase in annual incremental heat pump installations in 2022 and forecasted that 40% of Nova Scotia households used a heat pump in 2023. Heat pump distributors reported sales increases over the 2022-2023 period driven by strong consumer interest in MSHPs and the rising cost of fossil fuels. The availability of financial assistance for MSHP installations, particularly under the Canada Greener Homes Grant, was also said by distributors and contractors to be a strong driver to market growth.

That being said, some distributors mentioned that, as the market matures, it may be moving toward more heat pump repairs and replacement systems than new installations, which would mean lower participation levels in Green Heat.

Furthermore, many of the remaining Nova Scotian households without heat pumps manage with only low or moderate-income or have homes with additional challenges that need to be addressed. Those households will be unable to have an MSHP installed without additional means or higher incentives.

CONCLUSIONS AND RECOMMENDATIONS

Overall savings achieved in 2023 were above mid-course adjusted target levels, with the portfolio surpassing both its energy savings and its peak demand savings targets by 9% and 3% respectively.

The Evaluator did not make any cross-cutting recommendations for 2023. The Evaluator's recommendations on individual program components are outlined in individual reports as well as in Table 14 Table 15below.

Table 14: 2023 Recommendations on Residential Program Components

No.	Recommendation
Instant Savings – R1	Review the incented models in the LED non-A type lamps (R, BR, Decorative) category and phase out in 2024 any models that are no longer pertinent for the program component given regulations and the market availability of non-LED replacements.
HEA – R1	Continue exploring the factors potentially responsible for the inconclusive billing analysis results, one being related to billing data interpretation, and work with the Evaluator to define the impact evaluation approach to be taken in 2024. Depending on the answers obtained through the exploration process, options other than a billing analysis may need to be considered for the 2024 evaluation. Given the change in the characteristics of participants entering the program component since 2018, the Evaluator does not consider it acceptable to use the current OR beyond 2023.
GH – R1	It would be in EOne's best interest to ensure that Green Heat marketing materials are available to contractors and participants. It may be worthwhile to highlight the differences between Green Heat and Home Energy Assessment/the CGH Grant in marketing materials.
GH – R2	Ensure that the Green Heat website is as user-friendly as possible by making sections, links, eligibility criteria, and eligible equipment lists clear, simple to understand, and easy to navigate. It may be worthwhile to highlight the differences between Green Heat and Home Energy Assessment/the CGH Grant.
GH – R3	Investigate how communications between EOne and contractors and participants could be improved. Ensure that EOne provides timely responses or feedback to questions from contractors and participants.
GH – R4	Consider offering increased incentives to low and moderate-income households and incentivizing heat pump replacements for those households. This recommendation is aimed at increasing Green Heat participation in two ways: (1) Through households that do not have a heat pump; and (2) through households that need to purchase a replacement heat pump but are not eligible under Green Heat. As noted above, many Nova Scotian households have installed heat pumps, but 60% of households still do not have one. It is likely that a proportion of the remaining population that has yet to participate in Green Heat has less disposable income to purchase a heat pump. To continue the progression of heat pumps beyond the late majority stage of market evolution, an incentive covering a larger proportion of the measure cost might be required. Increasing the incentive specifically for low to moderate-income households might help reach that goal if EOne can do so while maintaining cost effectiveness. The other factor that might reduce participation in the next few years is the increasing proportion of heat pumps purchased in Nova Scotia and that will be used to replace heat pumps that are at the end of life; incentives are currently not available for heat pump replacements. To address this, EOne might allow heat pump replacements under Green Heat specifically for low to moderate-income households only. While it might not be necessary to incentivize higher-income households to replace their heat pumps at the end of life, it is possible that some low-income households will not replace their heat pump without an incentive.

Table 15: 2023 Recommendations on Business, Non-profit, and Institutional Program Components

No.	Recommendation
SBES – R1	Consider improvements to the Customer Information System, notably by reviewing how missing entries are treated and extracting more information from the Customer Information System to allow validating automated calculations.
SBES – R2	Consider implementing communication strategies for participants who are approaching their project expiration date.
Retrofit – R1	EOne should update the Custom Retrofit logic model to address current barriers and document links to other program offers such as SEM and On-site Energy Managers (OEMs).
SEM – R1	Consider including plant-level KPIs and their progression since program inception in participant reporting. This addition could benefit participants and be used to better advertise the success of SEM.
SEM – R2	Track the number of projects implemented by SEM participants and the resulting savings from capital projects incented in BER or Custom.
SEM – R3	Better communicate the value of energy management to both participants and non-participants, including its potential for decarbonization. Getting participants to value energy management might be an effective solution to the two barriers that are not fully addressed by SEM. An angle that could be used to promote strategic energy management is its usefulness in achieving decarbonization targets (even in facilities that are fully supplied by electricity); many participants indicated that this was an objective for their organization or that they expected it would become one soon due to market pressure. The value of energy management could also be communicated by sharing success stories about current participants to prospective participants. Current participants are likely to contribute to this communication effort since they are highly satisfied with the services offered by SEM. Compiling improvements through energy performance indicators over multiple years of SEM engagement would also enable making a compelling case for energy management as a way to increase competitiveness.

LIST OF APPENDICES

The following are presented in the 2023 DSM Programs Evaluation Executive Summary – Appendices document.

Appendix I: Bibliography

Appendix II: Calculation of Margins of Error

Appendix III: NTGR Calculations



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com





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2023 DSM PROGRAMS EVALUATION

Appendix Report

EXECUTIVE SUMMARY

March 22, 2024

In Collaboration with





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APPENDIX II

Calculation of Margins of Errors

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 2023 Home Energy Assessment (HEA) evaluation. For the adjustment ratio margins of error, the example is drawn from the 2023 Small Business Energy Solutions (SBES) Do-It Yourself (DIY) path evaluation. For the free-ridership level margins of error, the example is drawn from the 2023 Green Heat (GH) mini-split heat pump (MSHP) evaluation.

Survey Margins of Error

The 2023 HEA 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 100. Therefore, assuming a confidence level of 90%, a $Z\alpha$ coefficient of 1.660 is used, as presented in Table 1.

Table 1: Distribution of Coefficients t

Sample size	Confidence Level		
	95%	90%	80%
2	12.710	6.314	3.078
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
30	2.045	1.699	1.311
100	1.984	1.660	1.290
∞^*	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 HEA participants of 4,805, the margin of error was established at 8.2%.

$$\text{Margin of Error} = 1.645 \times \sqrt{\frac{0.50 \times (1 - 0.50)}{100}} \times \sqrt{\frac{4,085 - 100}{4,085 - 1}} = 8.2\%$$

In 2023, 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 energy savings example from the 2023 SBES evaluation. 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 SBES DIY HVAC measures.

$$\text{Weighted Average AR} = \frac{\sum_{i=1}^n \text{Adjustment Ratio}_i \times \text{Tracked Energy Savings}_i}{\text{Total Tracked Energy Savings}} = 0.980$$

In this calculation, n is the number of reviewed measures (23) and represents each individual evaluated measure; the Evaluator established a weighted average adjustment ratio of 0.980.

Calculation of the Standard Error

Since the overall adjustment ratio is based on a weighted average, the Evaluator also calculated a weighted standard error of the adjustment ratio instead of a simple standard error. The following formula is taken from the Uniform Methods Project (UMP) Chapter 11¹ and is applicable to a ratio that is obtained from a random sample.

$$\text{Standard Error AR} = \frac{1}{n} \sqrt{\sum_{i=1}^n \left(\frac{\text{Revised Savings}_i - \text{Weighted Average AR} \times \text{Tracked Savings}_i}{\text{Average Tracked Savings per Measure} \times (n - 1)} \right)^2} = 0.0406$$

In this calculation, the average tracked savings per measure is for the entire population. The weighted standard error for the adjustment ratio of energy savings for DIY HVAC measures was established at 0.0406.

Calculation of the Margins of Error

The margin of error on the adjustment ratio of SBES DIY HVAC measure energy savings was established by using the following formula that is the general equation linking that standard error to the margin of error.

¹ Khawaja, M.S., Rushton, J. and Keeling, J., Chapter 11: Sample Design Cross-Cutting Protocol, The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures. Golden, CO; National Renewable Energy Laboratory. NREL/ SR-7A40-68567, 2017.

$$\text{Margin of Error AR} = \text{Standard Error} \times t \times \text{Finite Population Correction Factor}$$

$$= \text{Standard Error} \times t \times \sqrt{\frac{N-n}{N-1}} = 0.0406 \times 1.717 \times \sqrt{\frac{169-23}{169-1}} = 4.4\%$$

In this calculation, N represents the total number of SBES DIY HVAC measures in 2023, which is 169. The coefficient *t* was calculated for a sample size of 23 and a level of confidence of 90%, which yields 1.717. By using the above formula, the margin of error for the adjustment ratio applied to the energy savings generated by SBES measures was established at 4.4%.

In 2023, this calculation was performed for the savings adjustment ratios of SBES and Custom. Sometimes, such as for smaller measure categories or small programs (like Strategic Energy Management - SEM), a census approach was used, meaning that all projects were reviewed and that calculating a margin of error on the adjustment ratio was unnecessary.

Free-ridership Level Margin of Error

The Evaluator used the margin of error calculation of the free-ridership level for Green Heat MSHP in 2023 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.

$$\text{Weighted Average FR} = \frac{\sum_{i=1}^n \text{Free-ridership Level}_i \times \text{Revised Gross Energy Savings}_i}{\text{Total Revised Gross Energy Savings}} = 14\%$$

In this calculation, *n* is the number of surveyed participants who installed a MSHP, and *i* represents each individual participant surveyed. The Evaluator established the weighted average free-ridership level at 14%.

Calculation of the Standard Error

Since the free-ridership level is based on a weighted average, the Evaluator also calculated a weighted standard error of the free-ridership level instead of a simple standard error. The same formula as for the adjustment ratio standard error was applied, as described below.

$$\text{Standard Error FR} = \frac{1}{n} \sqrt{\sum_{i=1}^n \left(\frac{\text{FR Savings}_i - \text{Weighted Average FR} \times \text{Gross Savings}_i}{\text{Average Gross Savings per Participant} \times (n-1)} \right)^2} = 0.0344$$

In this calculation, *n* is the sample size (the number of surveyed participants) and *FR Savings_i* is the free-ridership percentage measured for a given participant *i* multiplied by the gross savings of that participant. The average gross savings per participant is calculated for all participants who installed a MSHP in 2023.

Calculation of the Margins of Error

The margin of error on the adjustment ratio of the Green Heat MSHP free-ridership level was established by using the following formula that is the general equation linking that standard error to the margin of error.

$$\text{Margin of Error FR} = \text{Standard Error} \times t \times \text{Finite Population Correction Factor}$$

$$= \text{Standard Error} \times t \times \sqrt{\frac{N-n}{N-1}} = 0.0343 \times 1.662 \times \sqrt{\frac{1132-90}{1132-1}} = 5.5\%$$



In this calculation, N represents the total number of participants who installed a MSHP in 2023, which is 1,132. The coefficient t was calculated for a sample size of 90 and a level of confidence of 90%, which yields 1.662. By using the above formula, the margin of error for the free-ridership level for Green Heat MSHPs was established at 5.5%.

In 2023, this calculation was performed for the free-ridership ratios of HEA, Instant Savings, Green Heat, SBES, and Custom.

APPENDIX III

NTGR Calculations

This appendix provides an example of net-to-gross ratio (NTGR) calculations. The example details the calculations of participant free-ridership levels and resulting NTGR for GH Biomass. The Evaluator used a similar approach in assessing the NTGR of other program components. More details can be found in the evaluation reports of individual program components.

NTGR Calculations

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
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)	IF DK OR REF: D3 - EMPTY						
	D3 - Answer x 10%	5	50%	10	100%	10	100%
D4. 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)	IF DK OR REF: D4 - EMPTY						
	D4 - (10 - Answer) x 10%	0	100%	0	100%	0	100%
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)	IF DK OR REF: D5 - EMPTY						
	D5 - (10 - Answer) x 10%	10	0%	0	100%		
PA1 Score:	MEAN VALUE OF: (D3; MIN(D4; D5))	50%		100%		100%	
D1. Had you already decided to install a <EQUIPMENT> before you heard about the Green Heat program?	IF 2. No OR DK OR REF: D1 - 0%	0%		100%		0%	
	IF 1. Yes: Use D2						
D2. (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 2. No OR DK OR REF: E2 - 0%	0%				0%	
	IF 1. Yes: D2 - 100%			100%			
PA2 Score:	D1	0%		100%		0%	
D7. Level of influence (Scale 0 to 10)	D7 - MAX(D7a; D7b)	10		1		5	
PA3 Score:	(10 - D7) x 10%	0%		90%		50%	
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?	IF DK OR REF: D6 - EMPTY						
	D6 - (10 - Answer) x 10%	20%		100%		100%	
PA4 Score:	D6	20%		100%		100%	
Inconsistency Test PA1	IF ABS (D3 - MIN (D4; D5)) = 50%	0%		0%		0%	
	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	3%		97%		50%	
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.	Gross-Influence (CI) - IF (F2 OR F6 - Agree; 1) + IF (F3 OR F7 - Agree; 1) + IF (F4 OR F5 - Agree; 1)	0		0		1	
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.							
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.							
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.							
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.							
F8. (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.							
Revised Participant Free-Ridership	IF CI = 0 OR 1, Revised FR - FR IF CI = 2, Revised FR - FR*.75 IF CI = 3, Revised FR - FR*.50	3%		97%		50%	

Overall free-ridership level (%)
for Biomass

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

FR = 47%

NTGR for Biomass

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

NTGR = 0.53



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com





EfficiencyOne

RESIDENTIAL EFFICIENT PRODUCT REBATES PROGRAM

Final Report

2023 DSM EVALUATION

March 6, 2024

In collaboration with:





ABBREVIATIONS

ARCA	ARCA Canada Inc.
ARet	Appliance Retirement
ASFH	Affordable Single-family Homes
BNI	Business, non-profit and institutional
DA	Delivery agent
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
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.
Available Demand Response Capacity	The capacity which is available to NSP to reduce system peak demand. This capacity is calculated based on the first two hours of all events called between December and February, excluding weekends and holidays. If an event is shorter than two hours, only the first hour is used to measure the available DR capacity. Available DR capacity is evaluated on a per-participant basis, based on the average demand reduction observed for each event that the participant was scheduled to participate in. E1's total available DR capacity is the sum of each participant's available DR capacity.
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 base consumption.
Bias	Systematic deviations of measurements from the true value.
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.
Confidence interval	The estimated range of values that is likely to include unknown population parameters.
Demand response	Demand response measures generate savings in the form of available capacity or load reduction in response to events called by the electric utility (Nova Scotia Power) to reduce the load at strategic moments. These events can be called at any time and for any duration, although they are usually called for one to three hours during peak periods.
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 home 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 a home is through modelled home 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 equipment life and 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 CO2	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, gas 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 ratios, etc.) validated or measured during the evaluation process. Unless otherwise specified, evaluated savings are 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 a building (such as heating and cooling) due to the installation of an energy efficiency measure.
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 and 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 a program on the market (such as increased product availability, practices, and prices) that extends beyond changing program participant behaviours. 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. For industrial participants on an interruptible rate, peak demand savings may include savings on non-firm loads, i.e. loads that may be interrupted when Nova Scotia Power's 10-minute reserve is low.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	An 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.
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.
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 net-to-gross ratios. 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. A 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).
Secondary market impacts	Reflects the proximity of measurements to the true value.
Spillover	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.
Tracked savings	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 base consumption.
Unitary savings	Systematic deviations of measurements from the true value.





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EXECUTIVE SUMMARY

This report presents the 2023 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 types of evaluation conducted for each program component and the corresponding methodology.

Table 1: Summary of 2023 Residential Efficient Product Rebates Program Evaluation

Program Component	Evaluation Type			Methodology
	Impact	Process	Market	
Appliance Retirement	Condensed			› Tracking sheet audit › Unitary savings review › Calculations using evaluation results › Use of 2022 NTGR results › Avoided GHG emission reduction calculations
Instant Savings	Comprehensive			› Tracking sheet audit › Participant online survey › Retailer interviews › Unitary savings review › EUL update › Calculations using evaluation results › Avoided GHG emission reduction calculations

Program Performance

Table 2 presents the participation levels, net-to-gross ratios (NTGRs), evaluated gross and net savings at the generator, annual GHG emission reductions, as well as effective useful life (EUL) values for each program component and for Residential Efficient Product Rebates as a whole.

Table 2: Overall 2023 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	4,260	Appliances	3.010	GWh	0.56	1.698	GWh
Lifetime Energy Savings			12.008	GWh	0.56	6.776	GWh
Peak Demand Savings			0.430	MW	0.56	0.243	MW
Annual GHG Emission Reductions			1,661	Tonnes of CO2 eq	0.56	937	Tonnes of CO2 eq
EUL			4.0	Years		4.0	Years
Instant Savings							
Energy Savings	217,125	Products sold	15.512	GWh	0.74	11.476	GWh
Lifetime Energy Savings			87.619	GWh	0.91	79.470	GWh
Peak Demand Savings			1.989	MW	0.73	1.459	MW
Annual GHG Emission Reductions			8,561	Tonnes of CO2 eq	0.74	6,333	Tonnes of CO2 eq
EUL			5.6	Years		6.9	Years
Total							
Energy Savings			18.522	GWh		13.174	GWh
Lifetime Energy Savings			99.628	GWh		86.245	GWh
Peak Demand Savings			2.419	MW		1.702	MW
Annual GHG Emission Reductions			10,222	Tonnes of CO2 eq		7,268	Tonnes of CO2 eq
EUL			5.4	Years		6.5	Years

Residential Efficient Product Rebates was aimed at achieving 11.388 GWh in net electrical energy savings and 1.260 MW in net peak demand savings at the generator for 2023. The program exceeded the net electrical energy savings target by 16% and peak demand savings target by 35%, mostly driven by Instant Savings, which remains the largest contributor to both total program net energy and peak demand savings.

The following subsections present findings and recommendations at the program component level.

ARet Findings and Recommendations

This subsection presents the key findings from the ARet evaluation. The Evaluator has no specific recommendation for ARet.

2023 ARet Finding: ARet net electrical energy and peak demand savings both fell short of the targets of 2.024 GWh and 0.280 MW by 16% and 13% respectively.

2023 ARet Finding: Program participation levels in 2023 decreased by 19% compared to 2022 levels and were the lowest since 2012, with refrigerator and freezer retirements remaining the largest drivers of participation and savings.



2023 ARet Finding: The evaluated net energy and peak demand savings were both 9% higher than the values tracked by EOne due to updated unitary savings being higher than the values tracked.

Instant Savings Findings and Recommendations

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

2023 Instant Savings Finding: Instant Savings achieved both of its energy savings and its peak demand savings targets.

2023 Instant Savings Finding: Instant Savings maintained a high level of participation with an increase (9%) in overall products sold in 2023 compared to 2022.

2023 Instant Savings Finding: Retailers continue to be satisfied with Instant Savings overall.

2023 Instant Savings Finding: The free-ridership level for both LED lamps and LED fixtures increased in 2023.

2023 Instant Savings Finding: The spillover level for LED fixtures decreased significantly in 2023.

2023 Instant Savings Finding: The evaluated net energy savings and peak demand savings determined by the Evaluator were both 14% lower than the initial net savings tracked by EOne due to updates to spillover and free-ridership levels.

2023 Instant Savings Finding: Most of the savings continued to come from light emitting diode (LED) lighting products in 2023, a market reaching maturity.

Recommendation #1: Review the incented models in the LED Non-A type lamps (R, BR, Decorative) category and phase out in 2024 any models that are no longer pertinent for the program component given regulation and market availability of non-LED replacements.

Program Tracked and Evaluated Savings

Table 3 below compares EOne tracked energy and peak demand savings to Evaluated savings at the generator. The realization rate and NTGR are also presented and 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 other sections.

Table 3: Comparison of 2023 Tracked and Evaluated Savings at the Generator

		Gross Savings		NTGR	Net Savings		Realization Rate
		Value	Unit		Value	Unit	
ARet	Energy Savings						
	Tracked Savings by EOne	2.773	GWh	0.56	1.565	GWh	109%
	Evaluation Results	3.010	GWh	0.56	1.698	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	0.396	MW	0.56	0.223	MW	109%
	Evaluation Results	0.430	MW	0.56	0.243	MW	
Instant Savings	Energy Savings						
	Tracked Savings by EOne	15.409	GWh	0.86	13.290	GWh	86%
	Evaluation Results	15.512	GWh	0.74	11.476	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	1.969	MW	0.86	1.693	MW	86%
	Evaluation Results	1.989	MW	0.73	1.459	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.							

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 2023 DSM program portfolio.

This evaluation report relates to the Residential Efficient Product Rebates program comprised of two components: Appliance Retirement (ARet) and Instant Savings. Table 4 below lists the Residential Efficient Product Rebates program components and the types of evaluations conducted for 2023. 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 4: Types of Evaluations Conducted for Each Program Component, 2023

Program	Program Component	2023		
		Process	Market	Impact
Residential Efficient Product Rebates	ARet			Condensed
	Instant Savings			Comprehensive

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

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

1 ARet Overview

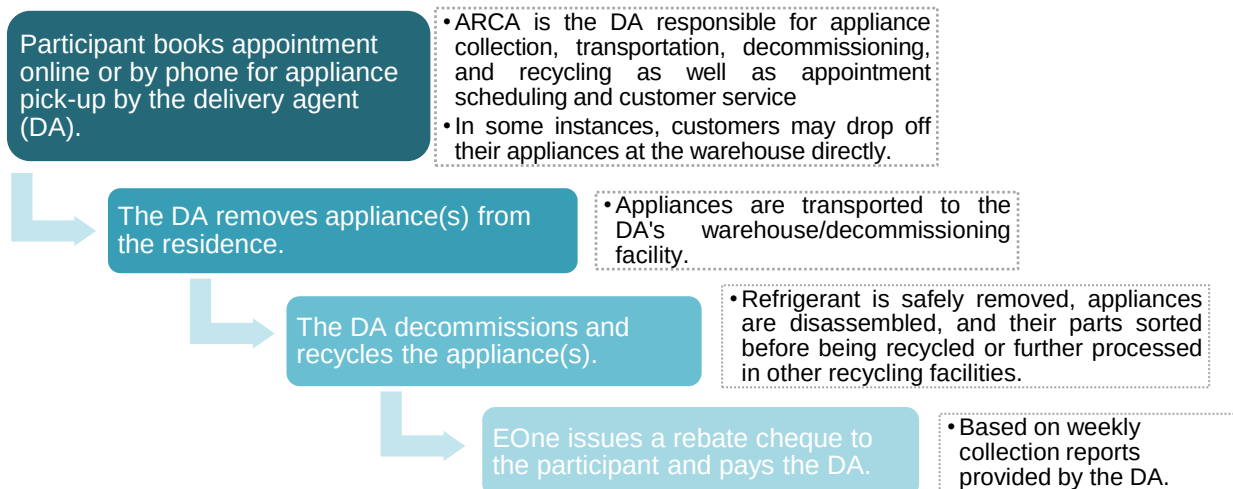
This section describes the ARet program component, follows up on past evaluation recommendations, and provides an overview of participation history.

1.1 ARet Description

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

In addition to removing old appliances from participants' homes, ARet transports them to a local recycling depot where over 95% of components are decommissioned and responsibly recycled. ARCA Canada Inc. (ARCA) is the delivery agent (DA) responsible for appliance collection, transportation, decommissioning, and recycling. To have appliances picked up, participants must call a toll-free number or register online using the booking portal available on the EOne website, both of which are managed by the DA. All website booking, scheduling, and maintenance activities are the responsibility of the DA. Figure 1 outlines the main steps of the ARet participation process.

Figure 1: ARet Participation Process Summary



Eligible appliances must be in working condition and be 10 years of age or older. In 2023, this meant that eligible appliances had to be manufactured before 2013. 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 as well as small refrigerators and freezers are only picked up when a participant retires a full-sized refrigerator or full-sized freezer at the same time. Also, dehumidifiers are only included as a drop-off appliance at the warehouse directly. To participate in ARet, participants must own the appliance(s) to be retired.

The following rebates are offered through ARet:

- › \$50 for each retired full-sized refrigerator²
- › \$50 for each retired full-sized freezer³
- › \$10 for each retired room air conditioner
- › \$10 for each retired small refrigerator or freezer
- › \$10 for each retired dehumidifier

ARet was aimed at achieving 2.024 GWh in net electricity energy savings and 0.280 MW in net peak demand savings at the generator in 2023.

1.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator issued improvement recommendations in previous years. No major recommendations were made in 2022, and only one recommendation from 2018 remains under review. Table 5 provides a summary of the implementation status of the 2018 recommendation that has been carried forward.

Table 5: Implementation Status of Past Recommendation for ARet

#	Past Recommendations	Status	Comments
2018 ARet -R1	Continue to perform the metering activity and ensure the metering protocol is followed.	Not recommended for action	EOne agrees with this recommendation although, due to facility restrictions, they were unable to perform a metering study in 2022. Since no metering activity could be conducted, the Evaluator developed a new methodology applicable to the appliances manufactured in 2002 or later during the 2022 evaluation and updated the savings accordingly. The same methodology will be applied for ensuing evaluations. For appliances manufactured before 2002, results from 2017 metering activities were used for the 2022 and 2023 evaluations because they comply with the Uniform Methods Project.

The Evaluator understands this recommendation will not be implemented and will no longer consider it in future evaluations.

1.3 Participation History

Since 2012, ARet has retired or replaced a total of 71,755 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 2023, appliance replacements were no longer reported under ARet and were included in the Affordable Single-family Homes (ASFH) and Mi'kmaw Home Energy Efficiency Project (MHEEP) reports. As outlined in Figure 2 below and unlike in previous years, only appliances retired in 2023 through ARet were counted, and 4,260 appliances were retired through the program component. Specifically, a total of 2,837 refrigerators, 1,126 freezers, 186 air-conditioning units, and 111 small refrigerators or freezers were retired. No dehumidifiers were retired in 2023.

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

³ Ibid.

In 2023, 19% fewer appliance retirements were recorded compared to 2022. The removal of appliance replacement reporting had a negligible impact on this decrease since it represented only a small portion of ARet participation levels in 2022 (<2%). The reduction was mainly due to a drop in participation, and 2023 had the lowest participation level since 2012.

Figure 3 below provides an overview of the evolution of ARet gross energy and peak demand savings from 2012 to 2023. The 2023 results represent decreases of 15% and 16% in gross energy and peak demand savings respectively compared to 2022.

Figure 2: Overview of ARet Participation, 2012-2023

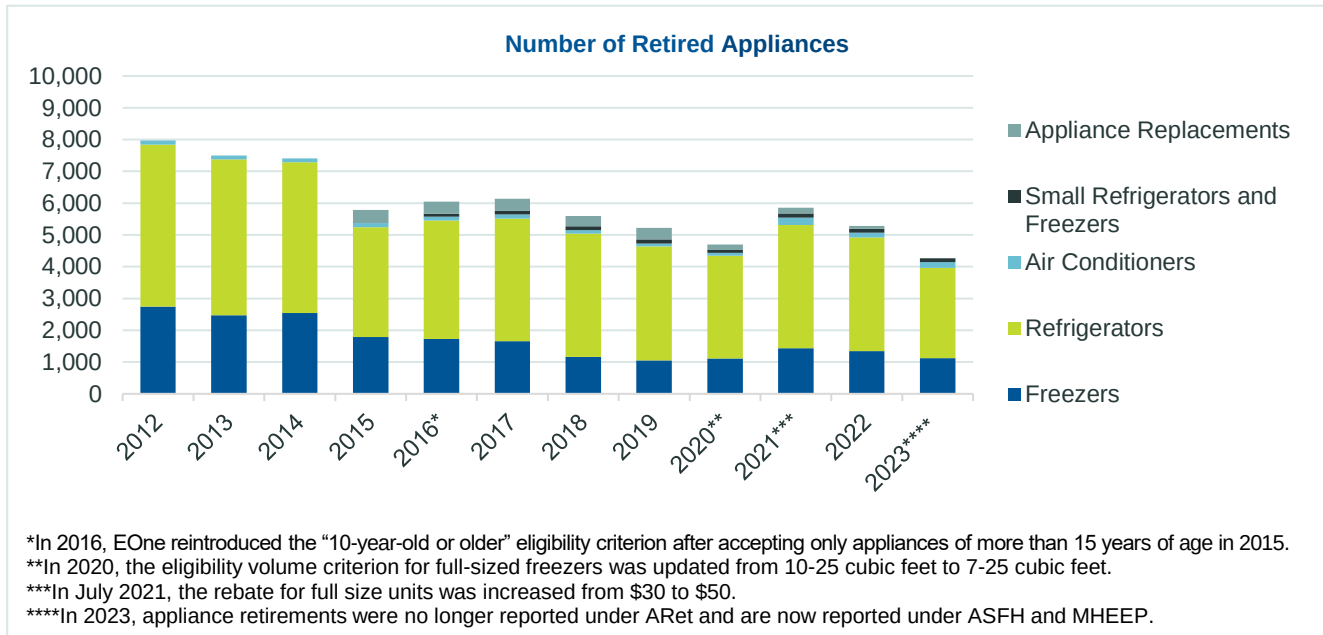
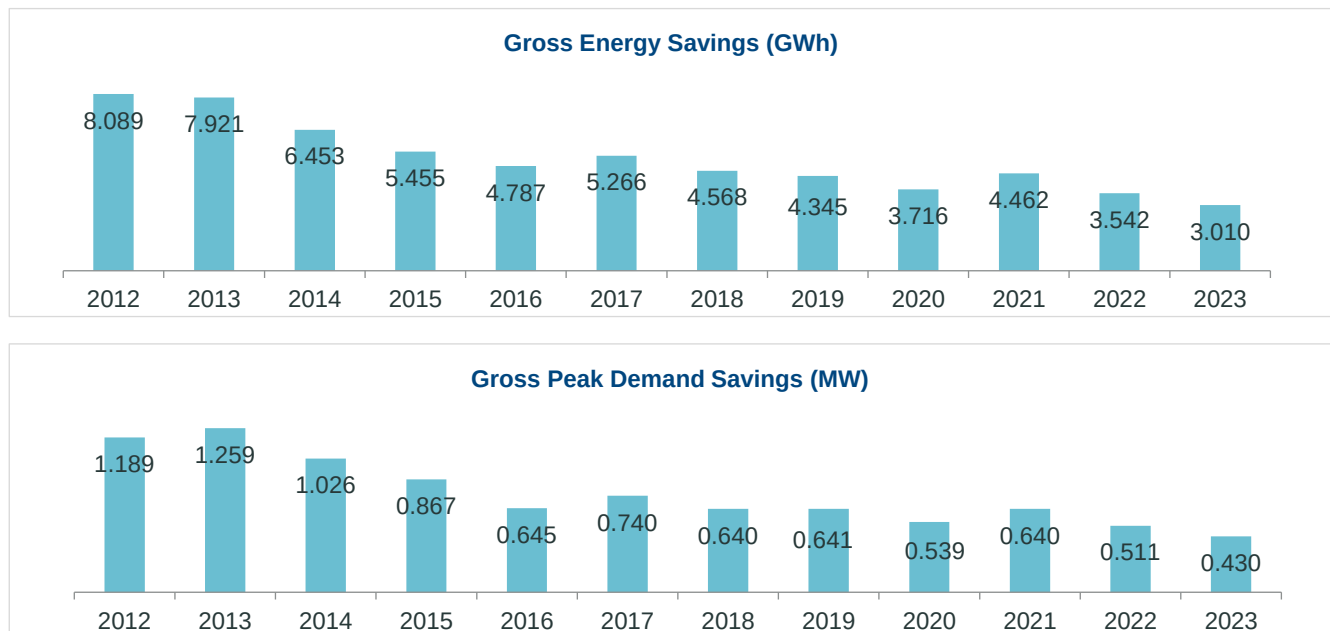


Figure 3: Evolution of ARet Gross Savings, 2012-2023



2 ARet Evaluation Approach

The 2023 ARet evaluation involved a condensed impact evaluation. The main objectives were as follows:

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

The Evaluator identified key research questions aimed at achieving the above objectives. Table 6 outlines the evaluation objectives and maps them to the research questions and methods established by the Evaluator.

Table 6: 2023 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 › Unitary Savings 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?	› Use of 2022 NTGR results › Calculations using evaluation results › Avoided GHG emission reduction calculations

Tracking Sheet Audit

Prior to performing the unitary savings review, the Evaluator performed an audit of the final 2023 tracking sheet to ensure it was complete and the entered data were consistent. 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 and then updated the 2020-2023 Measure Assessment⁴ accordingly.

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 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 Nova Scotia Power (NS Power) data.

⁴ The 2020-2023 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 and for the first year of the 2023-2025 DSM cycle, the Evaluator refers to the values presented in the 2020-2023 Measure Assessment.

3 ARet Impact Evaluation

This section presents the findings of the 2023 impact evaluation aimed at determining gross and net electrical energy and peak demand savings.

3.1 Tracking Sheet Audit

To ensure program 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 as well as correcting the tracked savings as needed. The results are provided 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 both why they participated and what they would have done if the program had not been available.⁵

As part of the 2023 evaluation, the Evaluator updated the unitary savings values for freezer and refrigerator retirements based on the proportion of units per manufacture-year class and average unit size found in the 2023 ARet tracking sheet. Unitary savings values from the 2022 evaluation were used for other measures.

Detailed descriptions of the unitary savings calculations are presented in the 2020-2023 Measure Assessment.

3.2.1 Unitary Energy Savings

Table 7 below presents the tracked and evaluated energy savings for each type of appliance retired through ARet.

For both full-sized and small refrigerator and freezer retirements, higher unitary savings values are due to changes in characteristics, namely age and size, of the appliances retired in 2023.

Table 7: 2023 ARet Tracked and Evaluated Unitary Energy Savings

Appliance	Tracked Unitary Energy Savings [kWh/year]	Evaluated Unitary Energy Savings [kWh/year]	Difference (%)
ARet – Retirement			
Refrigerators	622	654	5%
Freezers	644	752	17%
Air Conditioners	164	No change	No change
Small Refrigerators	116	164	41%
Small Freezers	141	176	25%
Dehumidifiers	603	No change	No change

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

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 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 2020-2023 Measure Assessment.

Table 8 below lists the tracked and evaluated unitary peak demand savings for each category of appliance retired through ARet in 2023. Although the Evaluator used the same peak demand-to-energy ratio as in previous years, there are variations in unitary peak demand savings because the Evaluator made changes to the unitary energy savings values presented in Subsection 3.2.1 above.

Table 8: 2023 ARet Tracked and Evaluated Unitary Peak Demand Savings

Appliance	Tracked Unitary Peak Demand Savings [W]	Evaluated Unitary Peak Demand Savings [W]	Difference (%)
ARet – Retirement			
Refrigerators	85.8	90.3	5%
Freezers	88.9	104	17%
Air Conditioners	0	No change	No change
Small Refrigerators	16.0	22.6	41%
Small Freezers	19.5	24.3	25%
Dehumidifier	202	No change	No change

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 and 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 short and lasts approximately two months. Total annual interactive effects due to the retirement of old appliances are therefore expected to be negative, pushing the savings generated by such retirements downward.

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

- › The focus of this ARet evaluation was on electricity savings. In Nova Scotia, 53% of households use electricity as their primary heating source.⁶ Therefore, the negative interactive effects on the heating load only affect approximately one-half of participating households.
- › Many appliances retired through ARet, such as refrigerators and freezers, are built into or leaned against an exterior wall. Rather than contributing to building heating loads, this results in more heat loss through the building envelope and through the appliance back wall, thereby reducing interactive effects.
- › In Nova Scotia, slightly more than one-third of households (41%)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 appliance types.⁸

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

3.2.4 Effective Useful Life

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 retired.

For the 2023 evaluation, the Evaluator relied on the EUL values presented in the 2020-2023 Measure Assessment. Table 9 below summarizes the equivalent EUL values for each type of appliance. The equivalent EUL values were applied to the gross and net first-year energy savings of each product to obtain gross and net lifetime energy savings (see Subsections 3.2.5 and 3.3.4). The weighted average EUL value is 4.0 years.^{3.2.53.3.4}

Table 9: 2023 ARet Equivalent EUL and Gross Lifetime Unitary Savings Values

Appliance	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]	Evaluated Gross Lifetime Unitary Savings [kWh]
ARet – Retirement			
Refrigerators	4	No change	2,616
Freezers	4	No change	3,008
Air Conditioners	3	No change	492
Small Refrigerators	4	No change	656
Small Freezers	4	No change	704
Dehumidifiers	5	No change	3,015

⁶ Statistics Canada, Residential Sector, Nova Scotia, Table 14: Total Households by Building Type and Energy Source, <https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=ns&year=2020&rn=14&page=0> (Last accessed January 19, 2024).

⁷ Statistics Canada, Table 38-10-0019-01 – Air conditioners, <https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3810001901> (Last accessed January 19, 2024).

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).



3.2.5 Evaluated Gross Savings

The gross energy and peak demand savings resulting from the retirement of appliances through ARet are listed in Table 10 below.

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 The proportion of residential participants versus that of commercial participants was calculated using 2023 tracking sheet data. For appliances retired through ARet, gross savings at the generator were estimated by using a line loss factor of 1.0942 and 1.1451 for energy and peak demand savings respectively¹⁰.

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

¹⁰ For municipal utility participants, the line loss factor of the most similar NS Power rate code was assumed.

Table 10: Evaluated 2023 ARet Gross Energy and Peak Demand Savings

Measure Category	Appliance Retirement					
	Refrigerators	Freezers	Room Air Conditioners	Small Refrigerators	Small Freezers	Total
Number of Units Retired or Replaced	2,837	1,126	186	84	27	4,260
Energy Savings						
Unitary Energy Savings (kWh)	654	752	164	164	176	-
Gross Energy Savings – at the Meter (GWh)	1.855	0.847	0.031	0.014	0.005	2.751
Line Loss Factor	1.0942	1.0942	1.0942	1.0942	1.0942	-
Gross Energy Savings – at the Generator (GWh)	2.030	0.927	0.033	0.015	0.005	3.010
Equivalent Effective Useful Life (years)	4.0	4.0	3.0	4.0	4.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	8.121	3.706	0.100	0.060	0.021	12.008
Peak Demand Savings						
Unitary Peak Demand Savings (W)	90.3	104	0	22.6	24.3	-
Gross Peak Demand Savings – at the Meter (MW)	0.256	0.117	0.000	0.002	0.001	0.376
Line Loss Factor	1.1451	1.1451	1.1451	1.1451	1.1451	-
Gross Peak Demand Savings – at the Generator (MW)	0.293	0.134	0.000	0.002	0.001	0.430

Figure 4 compares the tracked and evaluated gross energy savings, while Figure 5 further below compares the tracked and evaluated gross peak demand energy savings. The two measures generating the majority of first-year energy savings were refrigerator retirements (67%) and freezer retirements (31%).

Figure 4: 2023 Tracked and Evaluated Gross Energy Savings at the Generator

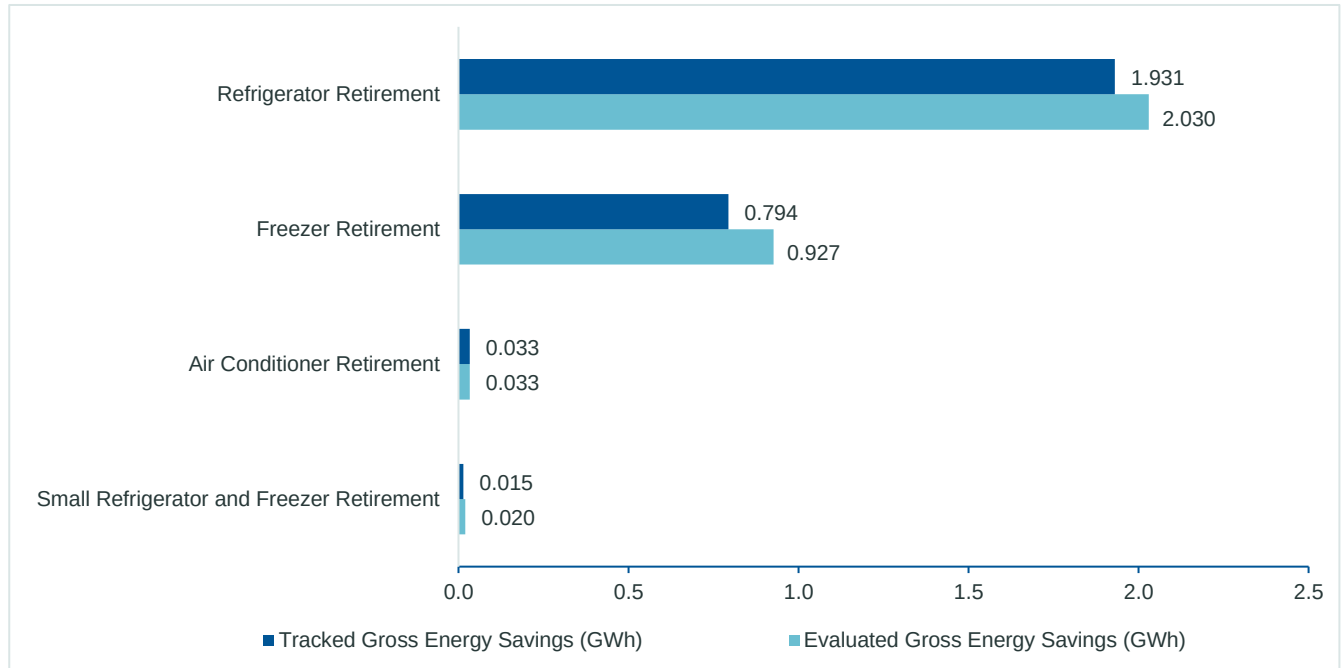
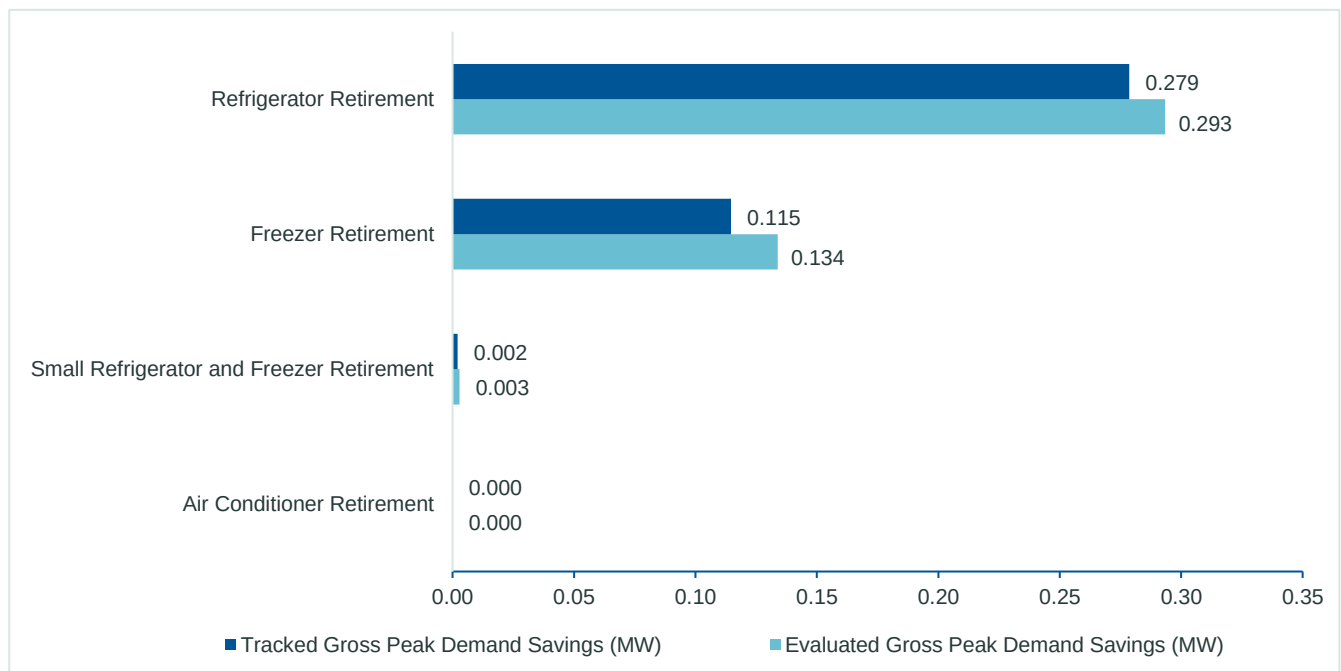


Figure 5: 2023 Tracked and Evaluated Gross Peak Demand Savings at the Generator



As presented in Table 11, gross GHG emission reductions were calculated by applying the Nova Scotia-specific factor¹¹ for GHG emissions generated by electricity production to ARet gross savings.

Table 11: Evaluated 2023 ARet Gross GHG Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	3.010
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonne of CO2 eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO2 eq)	1,661

3.3 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 the program component, by establishing the NTGR for each appliance type. For ARet, the NTGR was established by considering the free-ridership and secondary market impacts that negatively affect energy savings as well as spillover that positively affects energy savings.

For appliance retirements, the NTGR assessment was based on a methodology that complies with the general guidelines of the Uniform Methods Project (UMP) for refrigerator recycling evaluations.¹² This methodology involves considering the full energy consumption of retired appliances as gross unitary energy savings; then, net savings (without spillover) are obtained by deducting the energy impacts from free-ridership and secondary market scenarios. From these results, average free-ridership levels (including secondary market impacts) are calculated, while spillover is determined by calculating the energy impacts of all appliance retirements influenced by the program component but not achieved through the latter as a percentage of ARet gross energy savings.

3.3.1 Free-ridership and Secondary Market Impacts

For appliance retirements, free-ridership corresponds to the energy consumption of appliances that would have been disposed of in the absence of the program, and secondary market impacts correspond to the consumption of those appliances that would have been transferred to other owners.

Since no data collection was conducted in 2023, the 2022 free-ridership and secondary market impact levels were used for full-sized refrigerators and freezers. These levels were assessed during the 2022 evaluation using a self-reporting approach based on a participant telephone survey. Participants were asked questions to assess the likelihood that their appliance would have been kept, transferred, or destroyed in the absence of ARet.¹³ The participation levels for the retirement of other appliance types were too low to reliably assess free-ridership using the 2022 survey; thus, for air conditioners and small appliances, the free-ridership levels from the 2018 evaluation were used.

¹¹ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO₂ eq tonnes) and total electricity generation (10,456 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 December 1st, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22'23.pdf (Last accessed December 1st, 2023).

¹² NREL, The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. Chapter 7: Refrigerator Recycling Evaluation Protocol, prepared by the Cadmus Group, September 2017.

¹³ Data for the discard scenario proportions for freezer retirements were not collected in 2022; therefore 2018 data were used. For further details on how the discard scenario proportions are incorporated into the free-ridership calculation, please refer to Appendix IV.

The algorithm underlying the free-ridership and secondary market impact calculations is presented in Appendix II. The resulting average free-ridership levels, including secondary market impacts, are presented in Table 12 for each appliance type.

Table 12: 2023 ARet Free-ridership Levels

Appliance Type	Free-ridership (with Secondary Market Impacts)	
	Level	Margin of Error
Refrigerators	43%	6.3%
Freezers	45%	5.5%
Air Conditioners	47%	13.0%
Small Refrigerators	32%	10.3%
Small Freezers	32%	10.3%
Dehumidifiers	0%	N/A

3.3.2 Participant Spillover

The retirement of appliances may have occurred due to the influence of ARet even if no application was submitted. This influence can be due to a number of factors such as better awareness about the energy impacts from keeping the appliances. These retirements should be attributed to the program as a form of spillover.

The methodology used to calculate spillover is presented in Appendix III. It consists of estimating the energy impacts as a percentage of ARet gross energy savings for all appliance retirements influenced by the program component but not made through it.

There was no change in spillover since the last evaluation for ARet; hence, the spillover level was still considered to be nil.

3.3.3 Net-to-gross Ratio Calculation

NTGR values were calculated using the following equation.

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

Using the average free-ridership levels established for each appliance type, the Evaluator calculated corresponding NTGR values, the results of which are presented in Table 13.

Table 13: 2023 ARet Effects and NTGR

Appliance Type	Average Free-ridership (with Secondary Market Impacts)	Spillover	NTGR
Refrigerators	43%	0%	0.57
Freezers	45%		0.55
Air Conditioners	47%		0.53
Small Refrigerators	32%		0.68
Small Freezers	32%		0.68
Dehumidifiers	0%		1.00



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:

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

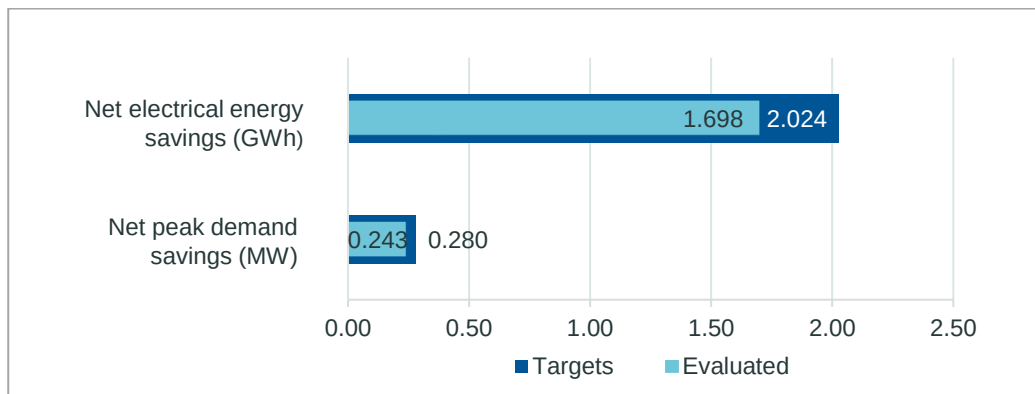
The detailed savings results are outlined in Table 14 below. The net energy savings resulted in 937 tonnes of CO₂ eq in net annual GHG emission reductions.

Table 14: Evaluated 2023 ARet Net Energy and Peak Demand Savings

Measure Category	Appliance Retirement					
	Refrigerators	Freezers	Room Air Conditioners	Small Refrigerators	Small Freezers	Total
Energy Savings						
Gross Energy Savings – at the Meter (GWh)	1.855	0.847	0.031	0.014	0.005	2.751
NTGR	0.57	0.55	0.53	0.68	0.68	-
Net Energy Savings – at the Meter (GWh)	1.058	0.466	0.016	0.009	0.003	1.552
Line Loss Factor	1.0942	1.0942	1.0942	1.0942	1.0942	-
Net Energy Savings – at the Generator (GWh)	1.157	0.510	0.018	0.010	0.004	1.698
Equivalent Effective Useful Life (years)	4.0	4.0	3.0	4.0	4.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	4.629	2.038	0.053	0.041	0.014	6.776
Peak Demand Savings						
Gross Peak Demand Savings – at the Meter (MW)	0.256	0.117	0.000	0.002	0.001	0.376
NTGR	0.57	0.55	0.53	0.68	0.68	-
Net Peak Demand Savings – at the Meter (MW)	0.146	0.064	0.000	0.001	0.000	0.212
Line Loss Factor	1.1451	1.1451	1.1451	1.1451	1.1451	-
Net Peak Demand Savings – at the Generator (MW)	0.167	0.074	0.000	0.001	0.001	0.243

As outlined in Figure 6, ARet missed both its electrical energy and peak demand savings targets by 16% and 13% respectively.

Figure 6: 2023 ARet Targets and Evaluated Savings



3.4 Realization Rate

Table 15 below compares ARet total tracked and evaluated savings. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 15: Comparison of 2023 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	2.773	GWh	0.56	1.565	GWh	109%
Evaluation Results	3.010	GWh	0.56	1.698	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.396	MW	0.56	0.223	MW	109%
Evaluation Results	0.430	MW	0.56	0.243	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 net energy and peak demand savings were both 9% above the values tracked by EOne due to updated unitary savings being higher than previous values used for tracked savings, because of changes in characteristics, namely age and size, of the appliances retired in 2023.



4 ARet Key Findings and Recommendations

The 2023 ARet evaluation included 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 the above objectives. The Evaluator has no specific recommendation for ARet.

2023 ARet Finding: ARet fell short of its net electrical energy savings and peak demand savings targets by 16% and 13% respectively.

ARet achieved 1.698 GWh in net electrical energy savings and 0.243 MW in net peak demand savings at the generator in 2023, thus falling short of the planned net electrical energy savings and net peak demand savings of 2.024 GWh and 0.280 MW.

2023 ARet Finding: Program participation levels in 2023 were the lowest since 2012, with refrigerator and freezer retirements remaining the largest drivers of participation and savings.

Full-sized refrigerators and freezers continue to be the largest contributors to participation and savings for the program component, generating over 98% of 2023 savings. After a slight decrease in 2022, participation decreased again by 19% in 2023, thus recording the lowest program participation levels since 2012. While appliance replacements stopped being reported under ARet in 2023, the impact on participation levels was minor as it represented only 2% in 2022.

2023 ARet Finding: The evaluated net energy savings and peak demand savings determined by the Evaluator were slightly higher than the net savings tracked by EOne.

The evaluated net energy and peak demand savings were both 9% higher than the values tracked by EOne due to updated unitary savings being higher than tracked savings, because of changes in characteristics, namely age and size, of the appliances retired in 2023.



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 delivered with the help of one Delivery Agent (DA), Summerhill Group Inc., as well as national and independent retailers that offer instant rebates on energy-efficient products at over 150 locations across Nova Scotia. To respond to online shopping trends, EOne introduced online retailers to their list of participating retailers in 2019 and online purchasing of select products directly from manufacturers in 2020.

Rebates on eligible products were offered during the following periods:

- › Spring campaign from March 31 to May 29, 2023
- › Fall campaign from September 29 to November 26, 2023
- › Year-round on selected products from January 1 to December 31, 2023

In 2023, rebates were added for two new products: ENERGY STAR® certified dishwashers and ENERGY STAR certified most-efficient bathroom and utility fans¹⁴.

Table 16 below 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) for each retail partner is maintained and approved by EOne.

¹⁴ There were no sales of ENERGY STAR certified most-efficient bathroom and utility fans in 2023.

Table 16: List of 2023 Rebates by Product

Products Offered During Campaigns	Rebate During Spring Campaign	Rebate During Fall Campaign
ENERGY STAR Certified LED Non-A-type Lamps (single & multipacks)	\$9/unit or up to 65% off package price	\$9/unit or up to 65% off package price
Dimmer Switches or Wi-Fi Enabled Switches (single pack and multipack)	\$3/unit or up to 65% off package price	\$3/unit or up to 65% off package price
Indoor Motion Sensors	\$5	\$5
Outdoor Motion Sensors	\$8	\$8
Power Bars with Integrated Timers	\$5	\$5
Smart Power Strips (load sensing power strips only)	\$10	\$10
Heavy-duty Outdoor Timers	\$10/unit or up to 65% off package price	\$10/unit or up to 65% off package price
Programmable or Wi-Fi Enabled Thermostats for Electrical Baseboard Heaters (single & multipacks)	\$25/unit or up to 65% off package price*	\$25/unit or up to 65% off package price*
Products Offered Year-Round		
ENERGY STAR Certified LED Fixtures Without Motion Sensors	\$15/unit or up to 65% off package price	
ENERGY STAR Certified LED Fixtures with Motion Sensors (+ solar option if available)	\$20/unit or up to 65% off package price	
Outdoor Clothesline Kits and Outdoor Drying Racks	\$5	
ENERGY STAR Certified LED Recessed Downlight Fixtures (single & multipacks)	\$10/unit or up to 65% off package price*	
Select Smart Thermostats (with occupancy sensors) for Electrical Heating: Electrical Baseboards, Mini-Split Heat Pumps, and In-Floor Radiant Heat	\$35/unit (Jan-Aug)	\$45/unit (Sept-Dec)*
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 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 Efficient Combined Washer/Dryer (qualifying models must meet the efficiency requirements for washer and dryer components separately. Models must be pre-approved by Efficiency Nova Scotia prior to offering rebates)	\$150	
ENERGY STAR Certified Variable Speed Pool Pumps	\$200	
ENERGY STAR Certified Air-Source Heat Pump Hot Water Heaters	\$400	
Dishwashers (qualifying models must be ENERGY STAR certified and use less than or equal 250 kWh per year)	\$75**	
Bathroom and Utility Room Fans (no light) (qualifying models are on the ENERGY STAR Most Efficient list) ¹⁵	Up to \$25**	
* Represents a change in incentive from 2022.		
** Represents new rebates that were introduced during the 2023 year-round campaign.		

¹⁵ No bathroom fans were rebated in 2023.

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, online, and outdoor advertising. 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.

Instant Savings was aimed at achieving 9.364 GWh in net electrical energy savings and 0.980 MW in net peak demand savings at the generator in 2023.

5.2 Follow-up on Past Evaluation Report Recommendations

No recommendations were made for Instant Savings in 2022.

5.3 Participation History

In 2023, a total of 217,125 eligible products were sold in participating stores across Nova Scotia, which represents an increase of 9% compared to 2022, and an increase of 8% compared to 2021.

As presented in Table 17 below, the sales of ENERGY STAR certified non-A-type LED lamps increased by 17% compared to 2022, returning to just above 2021 levels after the decrease observed in 2022. LED fixtures stayed relatively stable from 2022. While solar fixtures saw a 93% decrease in sales, sales of other LED fixture products, which make up a higher portion of sales, counterbalanced this large decrease. Sales of control products in 2023 increased 30% compared to 2022, driven largely by increased sales in dimmer switches and outdoor motion sensors. Despite this increase, 2023 control product sales remained lower (41%) than 2021 levels. Moreover, hardwired indoor motion sensors, power bars, and programmable thermostats all saw lower sales in 2023 than in 2022.

Sales in the appliance product category increased by 18%, mostly driven by a significant increase in units sold for ENERGY STAR dehumidifiers (254%) and the sale of dishwashers, a new product for 2023. Total 2023 sales in the appliance product category were only slightly higher (5% increase) than 2021.

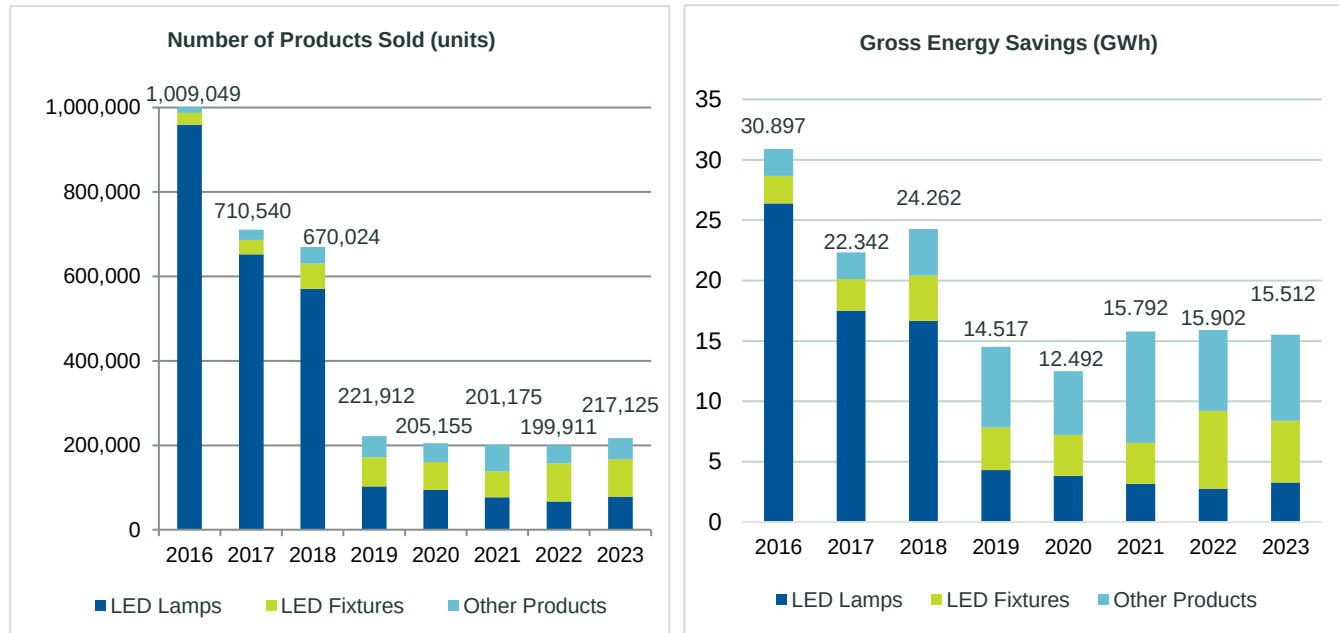
Table 17: Number of Rebated Products Sold Through Instant Savings, 2022–2023

Product Category	2022	2023	Variation	
ENERGY STAR Certified Non-A-type LED Lamps	66,840	78,438	↑	17%
ENERGY STAR Certified LED Fixtures ^a	90,305	88,337	↓	-2%
Controls ^b	14,886	19,299	↑	30%
Clothesline Kits and Outdoor Drying Racks	3,511	2,463	↓	-30%
Appliances ^c	24,152	28,406	↑	18%
Energy STAR Certified Air-source Heat Pump Hot Water Heaters	163	141	↓	-13%
ENERGY STAR Certified Variable Speed Pool Pumps	53	41	↓	-23%
Total	199,911	217,125	↑	9%
^a Including ENERGY STAR certified LED fixtures with and without motion sensors, ENERGY STAR certified LED recessed downlight fixtures, and solar fixtures. ^b Including dimmer switches, indoor and outdoor motion sensors, heavy-duty outdoor timers, power bars with timers, programmable thermostats, smart thermostats for electrical heat and in-floor heating, and smart power bars. ^c ENERGY STAR certified clothes washers and dryers, ENERGY STAR certified dishwashers, ENERGY STAR certified dehumidifiers, and ENERGY STAR certified room air purifiers				

As illustrated in Figure 7 below, LED fixtures surpassed lamps in the number of products sold with 41% of sales, with LED fixtures without motion sensors and recessed downlight fixtures each representing roughly 20% of total sales. LED lamps followed fixtures with 36% of sales.

Instant Savings gross energy savings remained relatively stable (2% decrease) compared to 2022 levels. Gross savings from lighting products decreased by 9%, with LED lamps and fixtures comprising 54% of gross savings. Savings from non-lighting products increased by 6%. Products other than LED lamps and fixtures constituted 46% of gross energy savings, with ENERGY STAR certified room air purifiers (16%) and smart thermostats for electrical baseboards (7%) being top drivers of gross energy savings.

Figure 7: Overview of Participation in Instant Savings, 2016–2023



6 Instant Savings Evaluation Approach

The 2023 Instant Savings evaluation included a comprehensive impact evaluation whereby NTGRs and market effects were updated respectively through a participant online survey and retailer interviews. The main objectives of the 2023 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 emissions.

The Evaluator identified key research questions aimed at achieving these objectives. Table 18 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 18: 2023 Instant Savings Evaluation Approach

Evaluation Objective	Research Question	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? › How satisfied are retailers with Instant Savings?	› Participant online survey › Retailer interviews
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › What are the unitary savings and EULs for LED lamps and fixtures? › What are the unitary savings for new products? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Unitary savings review › EUL Update › Calculations using evaluation results
Calculate net results	› What is the Instant Savings free-ridership level for 2023? › What is the Instant Savings spillover level for 2023? › 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 Instant Savings?	› Participant online survey › Retailer interviews › Calculations using evaluation results › Avoided GHG emission reduction calculations

Participant Online Survey

Narrative Research staff conducted a participant online survey with 81 consumers who purchased qualifying non-A-type LED lamps, and 41 consumers who purchased qualifying LED fixtures during the fall 2023 campaign, for a total sample size of 122 survey participants.

The online survey was conducted throughout the 2023 fall campaign via the use of cards with a survey link distributed to consumers at participating retail locations, with completed surveys being collected from a sampling of Costco¹⁶, Canadian Tire, Kent, Home Hardware, and Home Depot store locations.

¹⁶ Since there were only 9 respondents from Costco, 2022 free-ridership results were used for Costco participants. See Section 8.3.3 for further details.



The length of the survey was nine minutes. The questionnaire is presented in Appendix V, with complete participant survey results in Appendix VI. The online survey sample of 122 participants yields a maximum margin of error of $\pm 7.4\%$ at a 90% confidence level.

Retailer Interviews

During the fall of 2023, Narrative Research staff conducted in-depth interviews with four of the largest participating retailers. Instant Savings collaborates with 11 national retailers and the list of participating retailers was provided by EOne. The guide used for the interviews is provided in Appendix VII.

Tracking Sheet Audit

The Evaluator performed an audit of the final 2023 tracking sheet to ensure it was complete and the entered data were consistent. The results obtained are presented in Appendix VIII.

Unitary Savings Review

The unitary savings review concerned only new products and LED lamps and fixtures. The Evaluator conducted a literature review to establish unitary savings for ENERGY STAR Certified dishwashers. In addition, given the rapid evolution of the lighting market, the unitary savings values of LED lamps and fixtures were reviewed as part of the 2023 evaluation. The Evaluator reviewed tracking sheet data for all LED lamp and fixture products. The 2020–2023 Measure Assessment¹⁷ was updated accordingly.

EUL Update

As part of the 2020–2023 Measure Assessment activities, the Evaluator updated 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 the first-year and lifetime energy and peak demand savings as per the calculation methodology presented in Section 4 below.

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.

¹⁷ The 2020–2023 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 and for the first year of the 2023–2025 DSM cycle, the Evaluator refers to the values presented in the 2020–2023 Measure Assessment.

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 ten percentage points above or below the percentage reported 90% of the time. Thus, the margin of error indicates the relative level of precision¹⁸ of a measurement, while its associated confidence level indicates the probability of a measurement falling within the margin of error.¹⁹

As part of the Instant Savings evaluation, the Evaluator calculated the margins of error for free-ridership levels. 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 2023 DSM Programs Evaluation Executive Summary.

¹⁸ Precision refers to how reproducible a set of measurements is. It does not consider how close the measured values are to the true values since this would refer to accuracy.

¹⁹ 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 Retailer Perspectives

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

7.1 Participant Perspectives

An online survey was conducted as part of the Instant Savings evaluation. A total of 122 surveys were completed with LED bulb or fixture purchasers during the 2023 fall campaign. A distinction was made between consumers who purchased LED bulbs (n=81) and those who purchased LED fixtures (n=41).

Two-thirds (65%) of non-A-type LED bulb purchasers or LED fixture purchasers had heard of Instant Savings. In-store promotions (48%) remain the main source of awareness. This is followed by store personnel (25%), an ENS representative during an in-store engagement event (23%) and the ENS website (13%).

Among non-A-type LED bulb purchasers, 53% were aware of the in-store promotion, while 49% were aware of the discount before paying. Six in ten (60%) said they would have bought LED bulbs without the promotion.

Among LED fixture purchasers, 76% were aware of the in-store promotion, while 73% were aware of the discount before paying. Half (50%) said they would have bought LED fixtures without the promotion.

The average number of non-A-type LED bulbs purchased was 4.5 per person. This is notably lower than the 9.1 average recorded in 2022, and more in line with 2021 results (4.3). It should be noted that in 2022, only Costco consumers were targeted for the online survey, which can explain the higher number of non-A-type LED bulbs purchased per person. 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, marginally higher than the 73% in 2022. Participants who planned to replace existing LED lamps mostly did so to replace bulbs once they burn out (76%).

Among those who purchased LED fixtures, the average number of LED fixtures purchased was 2.8 per person, up from 2.1 in 2022. The primary motivation for fixture purchases was largely to replace an existing fixture that was still functional (71%).

Half of the surveyed participants indicated they had benefited from other ENS programs in the past. Of these, two thirds (66%) agreed their previous experience with ENS programs was a contributing factor in their purchase decision, and eight in ten (82%) agreed their previous experience led them to consider the savings on their energy bill when choosing different lighting options for their home.

Two-thirds (64%) of the surveyed participants confirmed they had seen previous promotional materials from ENS promoting the benefits of LEDs. Of these, two thirds (64%) agreed these materials had a role in their purchase decision.

7.2 Retailer Perspectives

As part of the Instant Savings evaluation, four interviews were conducted with retailers. The following subsection presents the satisfaction 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 8.8 on a scale where 0 means “not at all satisfied” and 10 means “completely satisfied”. Two retailers’ satisfaction stem from positive interactions with Summerhill and EOne, their ability to answer questions, the program driving sales, and the program increasing consumer knowledge. Another retailer mentioned the program process being straightforward. This retailer had some discontent with the inability to offer the rebate to contractors and this presented some confusion for staff. One last retailer indicated that, although there was a lack of store signage for some products, they were satisfied overall with Summerhill’s responsiveness.

Retailers are highly satisfied with their interactions with the program delivery representatives from Summerhill, with an average satisfaction score of 9.3 using the same 0–10 scale. Satisfaction stems from their responsiveness, being easy to work with, and being knowledgeable. One noted limitation was that the representatives changed frequently, which can lead to challenges knowing who to contact.

Table 19 provides an overview of the average satisfaction ratings with Instant Savings over the past years.

Table 19: Retailer Satisfaction with Instant Savings, 2020–2023²⁰

	2020		2021		2023	
	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size
Overall satisfaction with Instant Savings	8.8	8	8.0	6	8.8	4
Satisfaction with interactions with the program component delivery representatives from Summerhill	8.5	8	8.7	6	9.3	4
Scale: 2020 to 2021: 1 = Not at all satisfied; 10 = Completely satisfied / 2023: 0=Not at all satisfied; 10=Completely satisfied Base: Retailers who provided a rating						

²⁰ No retailer interviews were performed in 2022.



8 Instant Savings Impact Evaluation

The objectives of the 2023 Instant Savings impact evaluation were to determine gross and net electrical energy and peak demand savings.

8.1 Tracking Sheet Audit

To ensure program results were compiled reliably, the Evaluator first performed a tracking sheet audit designed to verify the completeness and consistency of the data submitted by EOne as well as correcting the tracked savings as needed. The results are provided in Appendix VIII. The tracked savings results presented in this report therefore 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.²¹

8.2.1 Installation Rates

The installation rates of products sold under Instant Savings are assumed to be 100%. Please refer to the 2020–2023 Measure Assessment for details.

8.2.2 Unitary Energy Savings

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 2023. It should be noted that for R, BR, and decorative lamps, the most popular lamp type in that category (ST19 lamps) is required to meet the Energy Efficiency Regulations on general service lamps²². The Evaluator considered this regulation as well as market availability when selecting replacement wattage. For example, the regulation sets a maximum wattage at 43 W for a 60 W equivalent ST19 lamp, however, 43 W ST19 lamps are not available on the market. Therefore, like previous years, the Evaluator selected to use incandescent decorative lamps as the baseline. The Evaluator noted this year, while looking for equivalent lamps, that incandescent decorative lamps were very difficult to find on major retailers' websites. While there might still be participants that replace incandescent lamps early, it is likely at this point that most incandescent lamps have already been replaced (since the standard has been in effect for 9 years). In the absence of non-LED options on the market, the Evaluator recommends that EOne review this category of lamps in the context of the regulation and market availability to consider phasing out select models in 2024.

In addition, unitary savings values were developed for ENERGY STAR certified dishwashers, the sole new measure for the program component. An updated unitary savings calculation was developed for this measure with an updated baseline based on the current list of available models on the Canadian market and updated parameters based on the characteristics of the dishwashers rebated in 2023. The unitary savings remain unchanged for all other products. Detailed descriptions of inputs, references, and unitary savings for all products are provided in the 2020–2023 Measure Assessment.

²¹ Definition adapted from: National Renewable Energy Laboratory, The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices, September 2014, p. 3.

²² NRCAN, *General service lamps and modified spectrum incandescent lamps*, <https://natural-resources.canada.ca/energy/regulations-codes-standards/products/6869> (Last accessed January 25, 2024).

Table 20 below summarizes the tracked and evaluated energy savings values for each product category rebated through Instant Savings in 2023.

Table 20: 2023 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)	47.1	49.2
ENERGY STAR Certified LED Non-A-type Lamps (excluding R, BR, and Decorative)	45.6	42.2
ENERGY STAR Certified LED Recessed Downlight Fixtures	59.6	51.0
ENERGY STAR Certified LED Fixtures	63.0	73.5
ENERGY STAR Certified LED Fixtures with Motion Sensors	136	204.6
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
Solar Fixtures	478	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
Smart Thermostats for Mini-Split Heat Pumps	514	No Change
Smart Thermostats for Electrical In-Floor Heating	348	No Change
Clotheslines and Outdoor Drying Racks	71.0	No Change
Efficient Clothes Washers	125	No Change
Efficient Clothes Dryers	113	No Change
Efficient Combined Clothes Washers and Dryers	236	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	907	922
ENERGY STAR Certified Dishwashers	36.6	14.2

EOne identified the eligible products that are smart devices²³ in the tracking sheet. Excluding smart thermostats, since they are already tracked separately, 23,057 products were identified as smart devices. All product categories included products identified as smart devices, with ENERGY STAR LED lights and fixtures constituting the majority of the smart products sold, followed by Energy Star Dehumidifiers. The number of smart devices made up a significant portion of eligible products sold (44%).

²³ Smart devices are products that can be connected to other devices or networks using wireless protocols. They also include products that use artificial intelligence to learn behavioural patterns.

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 2020–2023 Measure Assessment.

Table 21 below summarizes the tracked and evaluated unitary peak demand savings values for each product installed through Instant Savings in 2023.

Table 21: 2023 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)	7.63	7.97
ENERGY STAR Certified LED Non-A-type Lamps (excluding R, BR, and Decorative)	7.39	6.84
ENERGY STAR Certified LED Recessed Downlight Fixtures	9.66	8.26
ENERGY STAR Certified LED Fixtures	10.2	11.9
ENERGY STAR Certified LED Fixtures with Motion Sensors	22.0	33.15
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
Solar Fixtures	77.4	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
Smart Thermostats for Mini-Split Heat Pumps	0.00	No Change
Smart Thermostats for Electrical In-Floor Heating	0.00	No Change
Clotheslines and Outdoor Drying Racks	0.00	No Change
Efficient Clothes Washers	17.3	No Change
Efficient Clothes Dryers	15.6	No Change
Efficient Combined Clothes Washers and Dryers	32.6	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	147	149
ENERGY STAR Certified Dishwashers	3.00	1.30

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 2020–2023 Measure Assessment activities and considered the various types of space heating and cooling found in Nova Scotia homes. Table 22 presents the interactive effects factors for LED products.

Table 22: 2023 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)	-20.10%	-41.40%	92%	8%	-18.50%	-38.10%
ENERGY STAR Certified LED Non-A-type Lamps (excluding R, BR, and Decorative)			92%	8%	-18.50%	-38.10%
ENERGY STAR Certified LED Recessed Downlight Fixtures			100%	0%	-20.10%	-41.40%
ENERGY STAR Certified LED Fixtures			100%	0%	-15.70%	-32.30%
ENERGY STAR Certified LED Fixtures with Motion Sensors			2%	98%	-0.40%	-0.80%
Indoor Motion Sensors			100%	0%	-20.10%	-41.40%
Indoor Motion Sensors with Dimmers			100%	0%	-20.10%	-41.40%
Dimmer Switches			100%	0%	-20.10%	-41.40%
Solar Fixtures	0%	0%	0%	100%	0%	0%

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 2020–2023 Measure Assessment. The EUL values are used in the calculation of electrical energy savings that are expected to persist over time. The baseline for LED lamps reflect the changes made to the baseline as part of the 2022 Evaluation, which assumed LED lamps as the baseline starting in 2025 given the indications that the market is rapidly moving away from compact fluorescent lamps. This is discussed in further detail in Appendix II of the 2020–2023 Measure Assessment.

Table 23 below summarizes the tracked and evaluated equivalent EUL values. The evaluated equivalent EUL values were applied to the gross and net first-year energy savings of each product to obtain gross and net lifetime energy savings (see Subsections 8.2.6 and 8.3.4 below). The weighted average gross EUL value is 5.6 years and the weighted average net EUL value is 6.9 years.8.2.68.3.4

Table 23: 2023 Instant Savings Equivalent EUL and Gross Lifetime Unitary Savings 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)	3.0	2.0	98.4
ENERGY STAR Certified LED Non-A-type Lamps (Excluding R, BR, and Decorative)	3.0	2.0	84.4
ENERGY STAR Certified LED Recessed Downlight Fixtures	3.0	2.0	102
ENERGY STAR Certified LED Fixtures Without Motion Sensors	3.0	2.0	147
ENERGY STAR Certified LED Fixtures with Motion Sensors	3.0	2.0	409
Dimmer Switches	10	No change	170
Indoor Motion Sensors	10	No change	458
Indoor Motion Sensors with Dimmer Switches	10	No change	536
Outdoor Motion Sensors	10	No change	1,590
Solar Fixtures	3.6	No change	1,720
Power Bars with Integrated Timers	4	No change	215
Load Sensing Power Bars (smart strips)	4	No change	215
Heavy-duty Outdoor Timers	10	No change	1,220
Programmable Thermostats	10	No change	2,210
Smart Thermostats for Electrical Baseboards	10	No change	3,480
Smart Thermostats for Mini-Split Heat Pumps	10	No change	5,140
Smart Thermostats for In-Floor Heating	10	No change	3,480
Clotheslines and Outdoor Drying Racks	10	No change	710
Efficient Clothes Washers	11	No change	1,375
Efficient Clothes Dryers	12	No change	1,356
Efficient Combined Clothes Washers and Dryers	12	No change	2,832
ENERGY STAR Certified Room Air Purifiers	9	No change	3,915
ENERGY STAR Certified Dehumidifiers	12	No change	542
ENERGY STAR Certified Variable Speed Pool Pumps	10	No change	5,300
ENERGY STAR Certified Heat Pump Water Heaters	10	No change	9,220
ENERGY STAR Certified Dishwashers	-	10	142

8.2.6 Evaluated Gross Savings

The annual gross savings are based on the evaluated unitary savings values established for each product sold in 2023. The results are presented in Table 24 below.

The gross savings at the generator were estimated by using a line loss factor of 1.0947 and 1.1466 for energy and peak demand savings respectively²⁴. The line loss factors were updated in 2019 and correspond to the values submitted to the Utility and Review Board as part of the 2014 Cost of Service Study Progress Update²⁵.

²⁴ For municipal utility participants, the line loss factor of the most similar NS Power rate code was assumed.

If a municipal utility participant did not have any specific rate code, the average of participants for which the line loss was known was used.

²⁵ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 24: Evaluated 2023 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	Outdoor Motion Sensors
	R, BR, and Decorative	Others		Without Motion Sensors	With Motion Sensors	Solar Fixtures			
Number of Units									
Number of Units – Spring	24,142	9,625	-	-	-	-	2,744	143	646
Number of Units – Fall	26,475	18,196	-	-	-	-	5,588	202	2,732
Number of Units – Year-Round	-	-	45,126	42,527	487	197	-	-	-
Total Number of Units	50,617	27,821	45,126	42,527	487	197	8,332	345	3,378
Energy Savings									
Unitary Energy Savings Value (kWh)	49.2	42.2	51.0	73.5	204.6	478.0	17.0	45.8	159.0
Energy Interactive Effects Factor	-18.5%	-18.5%	-20.1%	-15.7%	-0.4%	0.0%	-20.1%	-20.1%	0.0%
Gross Energy Savings – at the Meter (GWh)	2.030	0.957	1.839	2.635	0.099	0.094	0.113	0.013	0.537
Line Loss Factor	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	2.222	1.047	2.013	2.885	0.109	0.103	0.124	0.014	0.588
Effective Useful Life (years)	2.0	2.0	2.0	2.0	2.0	3.6	10.0	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	4.444	2.095	4.026	5.769	0.217	0.371	1.239	0.138	5.880
Peak Demand Savings									
Unitary Peak Demand Savings (W)	7.97	6.84	8.26	11.91	33.15	77.40	2.75	0.00	0.00
Peak Demand Interactive Effects Factor	-38.1%	-38.1%	-41.4%	-32.3%	-0.8%	0.0%	-41.4%	-41.4%	0.0%
Gross Peak Demand Savings – at the Meter (MW)	0.250	0.118	0.218	0.343	0.016	0.015	0.013	0.000	0.000
Line Loss Factor	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.286	0.135	0.250	0.393	0.018	0.017	0.015	0.000	0.000

Evaluated 2023 Instant Savings Gross Energy and Peak Demand Savings (Continued)

Product Category	Power Bars with Timers	Smart Power Bars	Heavy-Duty Outdoor Timers	Programmable Thermostats	Smart Thermostats			Clotheslines	Efficient Clothes Washers
					Electric baseboards	MSHPs	In-Floor Heating		
Number of Units									
Number of Units – Spring	56	67	368	252	-	-	-	-	-
Number of Units – Fall	(13)	42	2,748	702	-	-	-	-	-
Number of Units – Year-round	-	-	-	-	2,947	56	19	2,463	3,227
Total Number of Units	43	109	3,116	954	2,947	56	19	2,463	3,227
Energy Savings									
Unitary Energy Savings Value (kWh)	53.7	53.8	122.0	221.0	348.0	514.0	348.0	71.0	125.0
Energy Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Gross Energy Savings – at the Meter (GWh)	0.002	0.006	0.380	0.211	1.026	0.029	0.007	0.175	0.403
Line Loss Factor	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.003	0.006	0.416	0.231	1.123	0.032	0.007	0.191	0.442
Effective Useful Life (years)	4.0	4.0	10.0	10.0	10.0	10.0	10.0	10.0	11.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.010	0.026	4.162	2.308	11.227	0.315	0.072	1.914	4.858
Peak Demand Savings									
Unitary Peak Demand Savings (W)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.30
Peak Demand Interactive Effects Factor	0.0%	0.0%	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	0.000	0.056
Line Loss Factor	1.1466	1.1466	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	0.000	0.064

Evaluated 2023 Instant Savings Gross Energy and Peak Demand Savings (Continued)

Product Category	Efficient Clothes Dryers	Efficient Combined Washers/Dryers	Room Air Purifiers	Dehumidifiers	Pool Pumps	Heat Pump Water Heaters	High-Efficiency Dishwashers	Total for All Products
Number of Units								
Number of Units – Spring	-	-	-	-	-	-	-	38,043
Number of Units – Fall	-	-	-	-	-	-	-	56,672
Number of Units – Year-round	4,183.0	123	5,238	14,867	41	141	768	122,410
Total Number of Units	4,183.0	123	5,238	14,867	41	141	768	217,125
Energy savings								
Unitary Energy Savings Value (kWh)	113.0	236.0	435.0	45.2	530.0	922.0	14.2	-
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)	0.473	0.029	2.279	0.672	0.022	0.130	0.011	14.170
Line Loss Factor	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	-
Gross Energy Savings – at the Generator (GWh)	0.517	0.032	2.494	0.736	0.024	0.142	0.012	15.512
Effective Useful Life (years)	10.0	10.0	9.0	12.0	10.0	10.0	10.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	5.174	0.318	22.449	8.828	0.238	1.423	0.119	87.619
Peak Demand savings								
Unitary Peak Demand Savings (W)	15.60	32.60	74.40	15.10	0.00	149.00	1.30	-
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)	0.065	0.004	0.390	0.224	0.000	0.021	0.001	1.735
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)	0.075	0.005	0.447	0.257	0.000	0.024	0.001	1.989

Figure 8 and Figure 9 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 the figures, 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 Fixtures.

Figure 8: 2023 Instant Savings Tracked and Evaluated Gross Savings

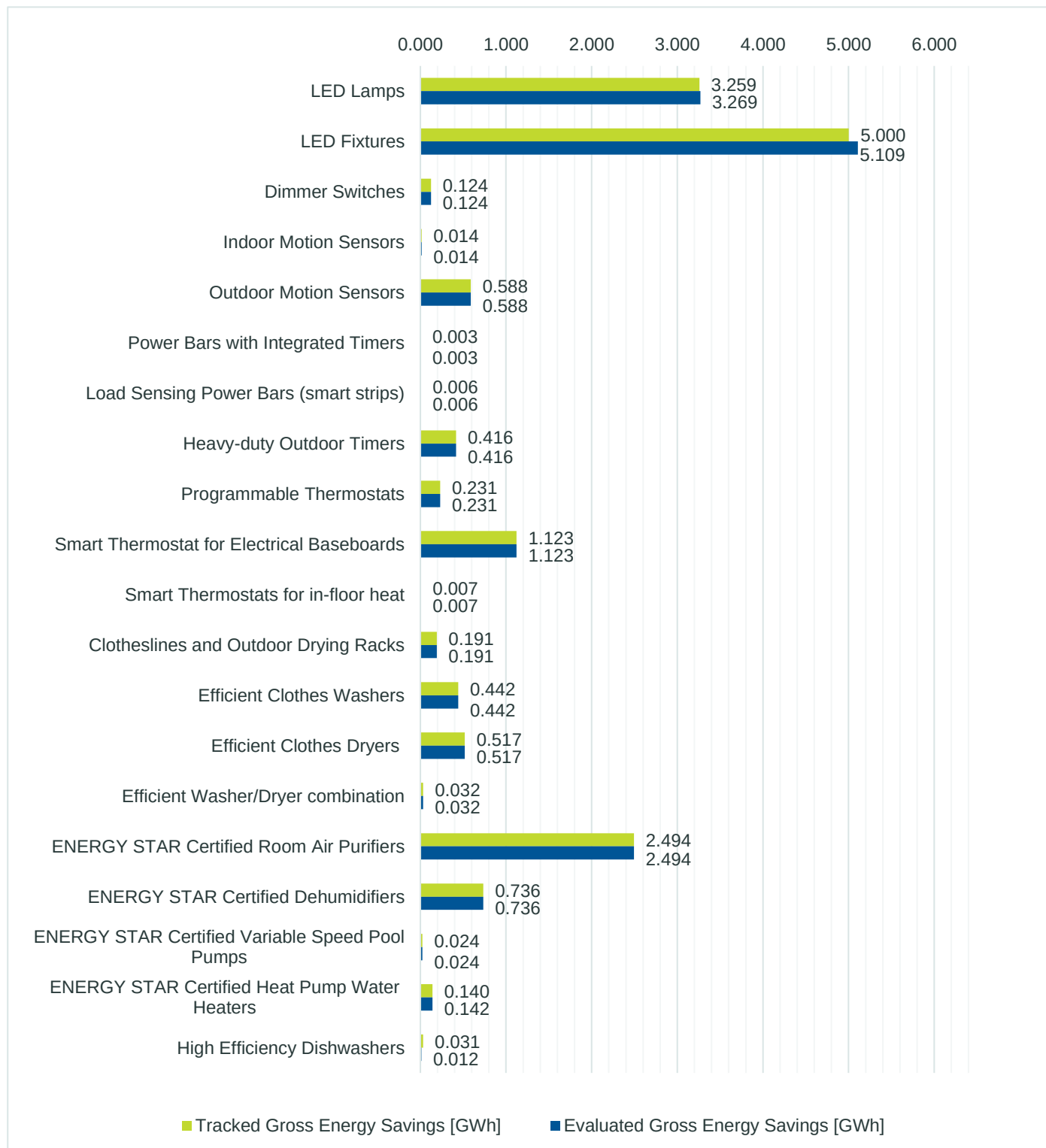
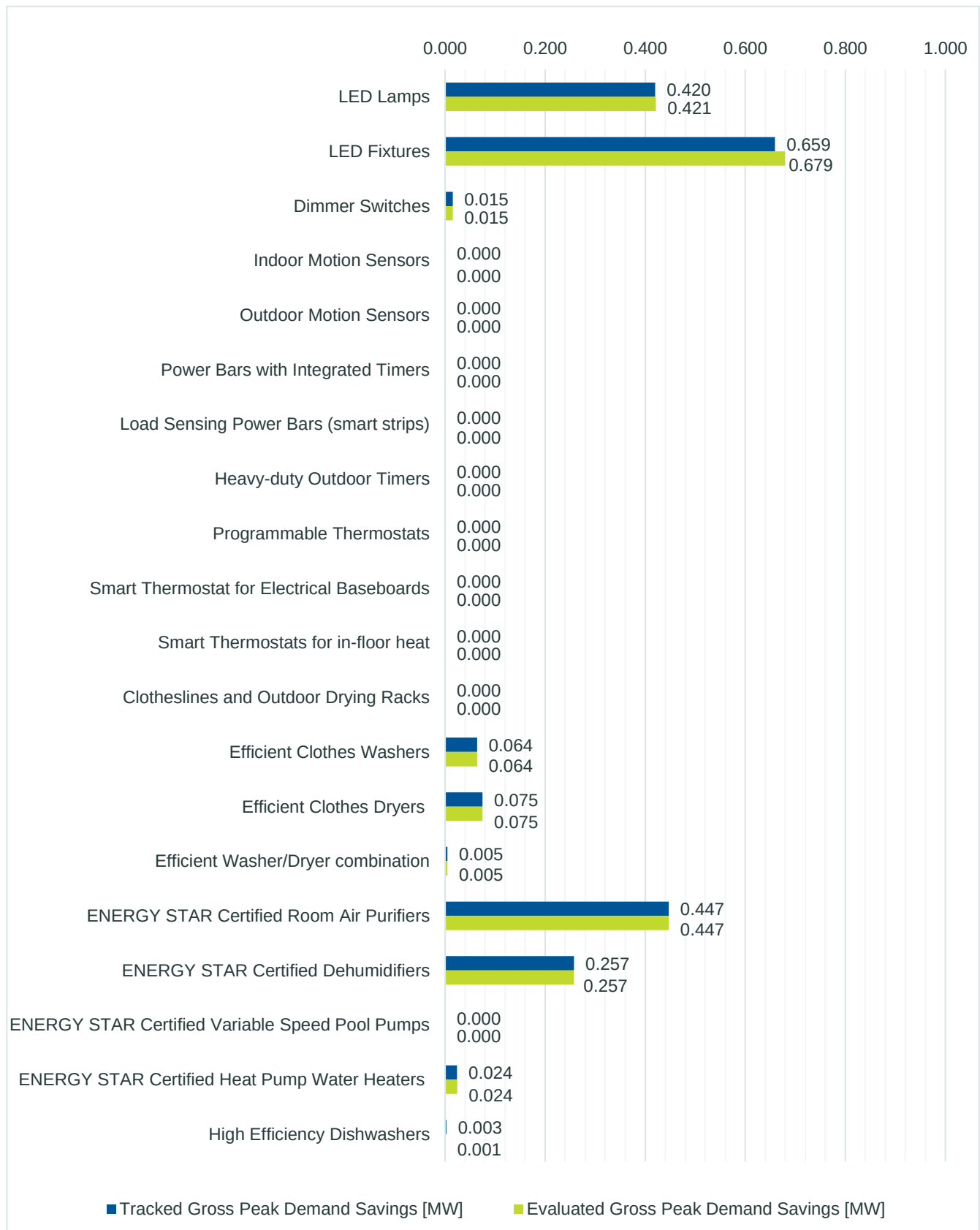


Figure 9: 2023 Instant Savings Tracked and Evaluated Gross Peak Demand Savings



As presented in Table 25, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor²⁶ for GHG emissions generated by electricity production to Instant Savings gross savings.

Table 25: Evaluated 2023 Instant Savings Gross GHG Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	15.512
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO ₂ eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	8,561

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. Those products were selected since they remain the best-selling product categories of the program component, accounting for 54% 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 are 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.

Costco accounts for 44% of lighting product sales for Instant Savings; however, the 2023 online survey did not serve to collect sufficient responses from participants making purchases at Costco. Therefore, the Evaluator decided to calculate a free-ridership level associated with non-Costco participants and use 2022 data to establish a free-ridership level associated with Costco purchasers. Similar methodologies were used in both the 2020 and 2021 evaluation. 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 26 below.

²⁶ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO₂ eq tonnes) and total electricity generation (10,456 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 on December 1, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22'23.pdf (Last accessed on December 1, 2023).

Table 26: 2023 Instant Savings Free-ridership for Non-Costco Participants

Product Category	Free-ridership	
	Level	Margin of Error
LED Lamps	70%	6.3%
LED Fixtures	48%	10.3%
All Other Products	-	-

For non-Costco participants, the intercept survey revealed a free-ridership level of 70% for LED lamps sold through Instant Savings in 2023. This level is higher than the 64% obtained for non-Costco participants during the 2021 evaluation, the last time data was collected for non-Costco participants. Similarly, the free-ridership level of 48% obtained for non-Costco participants for LED fixtures was slightly higher than the 45% obtained in 2021²⁷.

As for all other types of products rebated through Instant Savings, the Evaluator considered the free-ridership values to be nil.

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 consumers may have different behaviours than consumers at other retailers, the Evaluator established a free-ridership level associated with Costco consumers of LED lamps and LED fixtures based on 2022 data. The 2022 results are based on an online survey of Costco participants that used the same questions and algorithms for LED lamps and fixtures as in 2023. The results are presented in Table 27 below.

Table 27: 2023 Instant Savings Free-ridership Levels for Costco Participants

Product Category	Free-Ridership	
	Level	Margin of Error
LED Lamps	36%	8.2%
LED Fixtures	50%	5.0%

Overall 2023 Free-Ridership Levels

The overall free-ridership levels for LED lamps and fixtures correspond to the average of the 2022 Costco free-ridership levels and the free-ridership of the non-Costco consumers obtained in 2023, weighted by the number of units sold in 2023 for each product category.

Table 28 outlines the free-ridership levels for LED lamps and fixtures.

²⁷ A free-ridership of 56% for LED recessed downlight fixtures and 33% for other LED fixtures was established in 2021 for non-Costco participants. When considered together, a free-ridership level of 45% for LED fixtures was established.

Table 28: 2023 Instant Savings Free-Ridership for LED Lamps and Fixtures

Product Category	Retailer	Evaluation Period	Free-ridership		Number of Units Sold in 2023	Weighted Average Free-Ridership	
			Level	Margin of Error		Level	Margin of Error
LED Lamps	Costco	2022	36%	8.2%	25,145	59%	5.9%
	Non-Costco	2023	70%	6.3%	53,293		
LED Fixtures	Costco	2022	50%	5.0%	48,019	49%	6.0%
	Non-Costco	2023	48%	10.3%	40,121		

As for all other types of products rebated through Instant Savings, the Evaluator considered the free-ridership values to be nil. Table 29 below outlines the free-ridership levels for products sold through Instant Savings in 2021.

Table 29: 2023 Instant Savings Free-Ridership

Product Category	Free-Ridership	
	Level	Margin of Error
LED Lamps	59%	5.9%
LED Fixtures	49%	6.0%
All Other Products	0	0

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. Retailers were asked to estimate 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 in 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 83% of non-A-type lamp sales and 82% of LED fixture sales.

A market effects level of 9% was measured for non-A-type LED lamps. This means that the portion of non-rebated retailer sales that are attributable to Instant Savings is equivalent to 9% of 2023 rebated LED non-A-type sales. This result represents no change from the market effects level last estimated in 2021 for LED non-A-type sales (also 9%).

A market effects level of 2% was measured for LED fixtures for 2023, down from the level established in 2021 (32%). The market effects in 2021 were largely driven by one large retailer that reported a sizable amount of non-rebated sales in 2021 combined with attributing a relatively high influence to EOne's program, notably on the quantity of fixtures stocked in stores. In 2023, that same retailer reported very few non-rebated sales, resulting in a much lower market effects level.

For each product, Table 30 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 30: 2023 Instant Savings Spillover Levels

Product Category	Spillover Level
LED Lamps	9%
LED Fixtures	2%
All Other Products	-

8.3.3 Net-to-Gross Ratio Calculations

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 0.50 and 0.53 respectively, as presented in Table 31 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 make it more difficult to reach those consumers through an online survey or general population survey. A margin of error is not presented for spillover since it was established by census. Table 31 summarizes the NTGR of each product based on their respective free-ridership and spillover levels.

Table 31: 2023 Instant Savings Net-to-Gross Ratios

Product Category	Free-Ridership		Spillover	Net-to-Gross Ratio
	Level	Margin of Error		
LED Lamps	59%	5.9%	9%	0.50
LED Fixtures	49%	6.0%	2%	0.53
All Other Products	0	0	0	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 detailed results are presented in Table 32 below. The net energy savings resulted in 6,331 tonnes of CO₂ eq in net annual GHG emission reductions.

Table 32: Evaluated 2023 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	Outdoor Motion Sensors
	R, BR, and Decorative	Others		Without Motion Sensors	With Motion Sensors	Solar Fixtures			
Energy Savings									
Gross Energy Savings – at the Meter (GWh)	2.030	0.957	1.839	2.635	0.099	0.094	0.113	0.013	0.537
NTGR	0.50	0.50	0.53	0.53	0.53	0.53	1.00	1.00	1.00
Net Energy Savings – at the Meter (GWh)	1.015	0.478	0.975	1.397	0.053	0.050	0.113	0.013	0.537
Line Loss Factor	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947
Net Energy Savings – at the Generator (GWh)	1.111	0.524	1.067	1.529	0.058	0.055	0.124	0.014	0.588
Effective Useful Life (years)	2.0	2.0	2.0	2.0	2.0	3.6	10.0	10.0	10.0
Net Lifetime Energy Savings – at the Generator (GWh)	2.222	1.047	2.134	3.058	0.115	0.197	1.239	0.138	5.880
Peak Demand Savings									
Gross Peak Demand Savings – at the Meter (MW)	0.250	0.118	0.218	0.343	0.016	0.015	0.013	0.000	0.000
NTGR	0.50	0.50	0.53	0.53	0.53	0.53	1.00	1.00	1.00
Net Peak Demand Savings – at the Meter (MW)	0.125	0.059	0.116	0.182	0.008	0.008	0.013	0.000	0.000
Line Loss Factor	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466
Net Peak Demand Savings – at the Generator (MW)	0.143	0.068	0.133	0.208	0.010	0.009	0.015	0.000	0.000

Evaluated 2023 Instant Savings Net Energy and Peak Demand Savings (Continued)

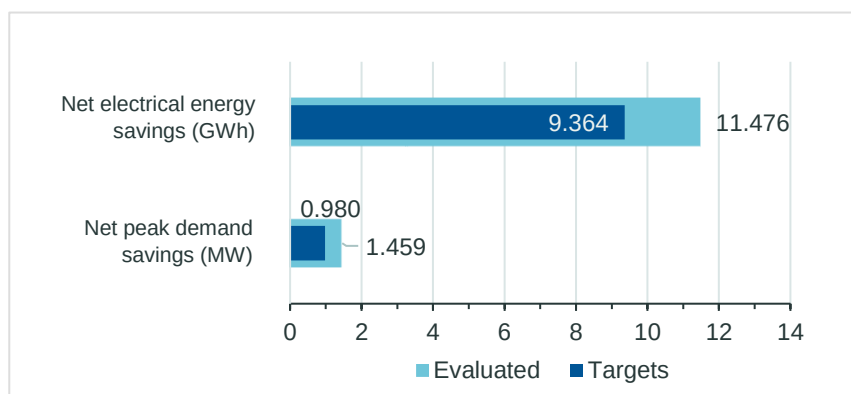
Product Category	Power Bars with Timers	Smart Power Bars	Heavy-Duty Outdoor Timers	Programmable-Thermostats	Smart Thermostats			Clotheslines	Efficient Clothes Washers
					EBB	MSHPs	In-Floor Heating		
Energy Savings									
Gross Energy Savings – at the Meter (GWh)	0.002	0.006	0.380	0.211	1.026	0.029	0.007	0.175	0.403
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net Energy Savings – at the Meter (GWh)	0.002	0.006	0.380	0.211	1.026	0.029	0.007	0.175	0.403
Line Loss Factor	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947
Net Energy Savings – at the Generator (GWh)	0.003	0.006	0.416	0.231	1.123	0.032	0.007	0.191	0.442
Effective Useful Life (years)	4.0	4.0	10.0	10.0	10.0	10.0	10.0	10.0	11.0
Net Lifetime Energy Savings – at the Generator (GWh)	0.010	0.026	4.162	2.308	11.227	0.315	0.072	1.914	4.858
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	0.000	0.056
NTGR	1.00	1.00	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	0.000	0.056
Line Loss Factor	1.1466	1.1466	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	0.000	0.064

Evaluated 2023 Instant Savings Net Energy and Peak Demand Savings (Continued)

Product Category	Efficient Clothes Dryers	Efficient Combined Washers/Dryers	Room Air Purifiers	Dehumidifiers	Pool Pumps	Heat Pump Water Heaters	High Efficiency Dishwashers	Total for All Products
Energy Savings								
Gross Energy Savings – at the Meter (GWh)	0.473	0.029	2.279	0.672	0.022	0.130	0.011	14.170
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-
Net Energy Savings – at the Meter (GWh)	0.473	0.029	2.279	0.672	0.022	0.130	0.011	10.483
Line Loss Factor	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947	-
Net Energy Savings – at the Generator (GWh)	0.517	0.032	2.494	0.736	0.024	0.142	0.012	11.476
Effective Useful Life (years)	10.0	10.0	9.0	12.0	10.0	10.0	10.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	5.174	0.318	22.449	8.828	0.238	1.423	0.119	79.470
Peak Demand Savings								
Gross Peak Demand Savings – at the Meter (MW)	0.065	0.004	0.390	0.224	0.000	0.021	0.001	1.735
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-
Net Peak Demand Savings – at the Meter (MW)	0.065	0.004	0.390	0.224	0.000	0.021	0.001	1.273
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)	0.075	0.005	0.447	0.257	0.000	0.024	0.001	1.459

As outlined in Figure 10 below, Instant Savings exceeded both its electrical energy and peak demand savings targets by 23% and 49%, respectively.

Figure 10: 2023 Instant Savings Targets and Evaluated Results



8.4 Realization Rate

Table 33 compares the energy and peak demand savings established through this evaluation to those tracked by EOne. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 33: Comparison of 2023 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	15.409	GWh	0.86	13.290	GWh	86%
Evaluation Results	15.512	GWh	0.74	11.476	GWh	
Peak Demand Savings						
Tracked Savings by EOne	1.969	MW	0.86	1.693	MW	86%
Evaluation Results	1.989	MW	0.73	1.459	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 were lower than the value tracked by EOne (14%). The evaluated gross savings were slightly higher than those tracked by EOne due to updates in the unitary savings values for Non-A-type LED lamps and LED fixtures. However, this was counter-balanced with a reduction in the NTGR, due to an increase in free-ridership for LED lamps and a significantly decreased spillover level for LED fixtures.

The evaluated net peak demand savings were also 14% lower than those tracked by EOne for the same reasons.



9 Instant Savings Key Findings and Recommendations

As mentioned previously, the main objectives of the 2023 Instant Savings evaluation were as follows:

- › Collect information on participant and partner perspectives.
- › Calculate gross and net 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.

2023 Instant Savings Finding: Instant Savings achieved both its energy savings and its peak demand savings targets.

Instant Savings achieved 11.476 GWh in net electrical energy savings and 1.459 MW in net peak demand savings at the generator in 2023, thus surpassing the target net energy and peak demand savings of 9.364 GWh and 0.980 MW, respectively.

2023 Instant Savings Finding: Instant Savings maintained a high level of participation with an increase (9%) in overall products sold in 2023 compared to 2022.

Controls had the most significant increase (30%) compared to 2022, followed by Appliances (18%). Controls saw increased sales in dimmer switches and outdoor motion sensors, while appliance sales were mostly driven by a significant increase in units sold for ENERGY STAR dehumidifiers (254%) and sales of dishwashers, a new product for 2023.

2023 Instant Savings Finding: Retailers continue to be satisfied with Instant Savings overall.

Using a 10-point scale, retailers provided a score of 8.8 for their satisfaction with the program component and a score of 9.3 for their satisfaction with the program component delivery representatives from Summerhill.

2023 Instant Savings Finding: Most savings continued to come from LED lighting products in 2023, a market reaching maturity.

LED lighting products maintained significant share of the gross energy savings (54%) in 2023; however, products other than lighting did see an increase in savings in 2023, contributing 6% more to gross energy savings than in 2022. It is expected that, in 2025, the new baseline for lighting will be LED, making 2024 the last year with savings for the majority of residential LED lighting technologies. However, for select LED lamp models (e.g. ST19), non-LED replacement technologies are no longer available.

Recommendation #1: Review the incented models in the LED Non-A type lamps (R, BR, Decorative) category and phase out in 2024 any models that are no longer pertinent for the program component given regulation and market availability of non-LED replacements.

2023 Instant Savings Finding: The free-ridership level for both LED lamps and LED fixtures increased in 2023.

In 2023, the free-ridership level for LED lamps was established at 70% for non-Costco participants, compared to the 64% established in the 2021 evaluation. The free-ridership level for LED fixtures for non-Costco participants was 48% compared to 45% in 2022. Combining these results with the 2022 results for Costco participants resulted in an overall free-ridership of 59% for non-A type lamps and 49% for LED fixtures.

2023 Instant Savings Finding: The spillover level for LED fixtures decreased significantly in 2023.

Market effects were established at 2%, compared to 32% established when last measured in 2021. The market effects in 2021 were largely driven by a large retailer that reported a sizable number of sales outside of the campaigns combined with attributing a relatively high influence to EOne's program, notably on the quantity of fixtures stocked in stores. In 2023, that same retailer reported very few sales outside the campaign period, resulting in a much lower market effects level.

2023 Instant Savings Finding: The evaluated net energy savings and peak demand savings determined by the Evaluator were lower than the initial net savings tracked by EOne.

The evaluated net energy and peak demand savings were 14% lower than the values tracked by EOne. This was due to lower NTGR established for LED lamps and fixtures in 2023.

CONCLUSION

Table 34 presents the participation levels, NTGRs, evaluated gross and net savings at the generator, annual GHG emission reductions, as well effective useful life (EUL) values for each Residential Efficient Product Rebates program component and for the program as a whole.

Table 34: Overall 2023 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	4,260	Appliances	3.010	GWh	0.56	1.698	GWh
Lifetime Energy Savings			12.008	GWh	0.56	6.776	GWh
Peak Demand Savings			0.430	MW	0.56	0.243	MW
Annual GHG Emission Reductions			1,661	Tonnes of CO2 eq	0.56	937	Tonnes of CO2 eq
EUL			4.0	Years		4.0	Years
Instant Savings							
Energy Savings	217,125	Products sold	15.512	GWh	0.74	11.471	GWh
Lifetime Energy Savings			87.619	GWh	0.74	79.461	GWh
Peak Demand Savings			1.989	MW	0.73	1.459	MW
Annual GHG Emission Reductions			8,561	Tonnes of CO2 eq	0.74	6,331	Tonnes of CO2 eq
EUL			5.6	Years		6.9	Years
Total							
Energy Savings			18.522	GWh		13.174	GWh
Lifetime Energy Savings			99.628	GWh		86.245	GWh
Peak Demand Savings			2.419	MW		1.702	MW
Annual GHG Emission Reductions			10,222	Tonnes of CO2 eq		7,271	Tonnes of CO2 eq
EUL			5.4	Years			6.5

Figure 11 and Figure 12 below illustrate the net electrical energy and peak demand savings targets respectively for each program component, for Residential Efficient Product Rebates. Residential Efficiency Product Rebates as a whole achieved the targets in 2023. Residential Efficient Product Rebates was aimed at achieving 11.388 GWh in net electrical energy savings and 1.260 MW in net peak demand savings at the generator for 2023. The program exceeded the net electrical energy savings target by 16% and peak demand savings target by 35%, mostly driven by Instant Savings, which remains the largest contributor to both total program net energy and peak demand savings.

Figure 11: 2023 Residential Efficient Product Rebates Program Targeted and Evaluated Net Energy Savings

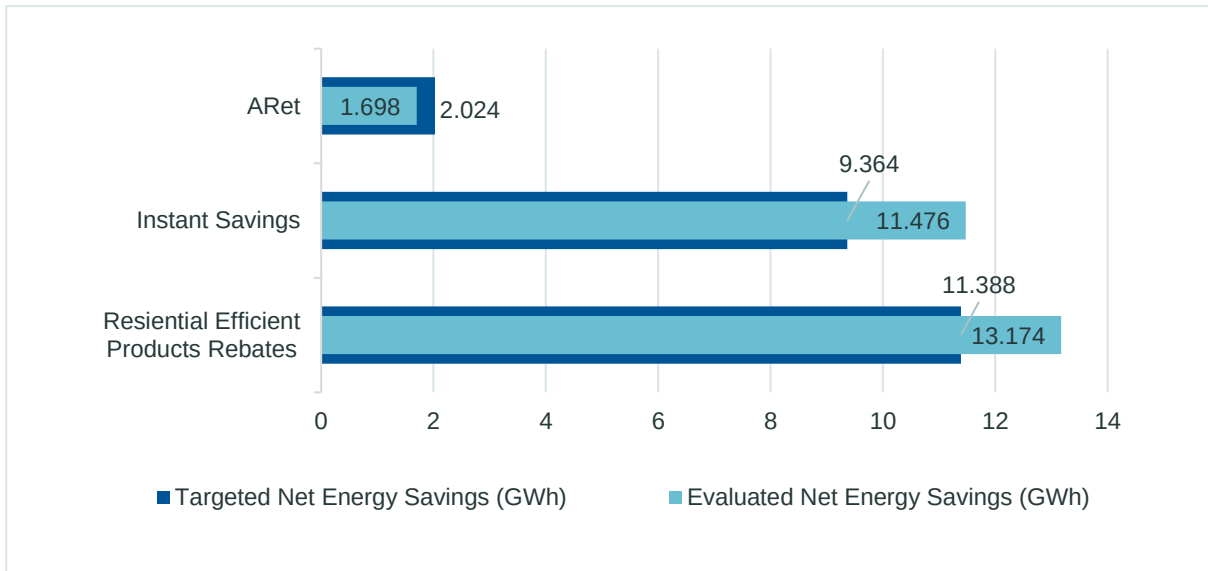
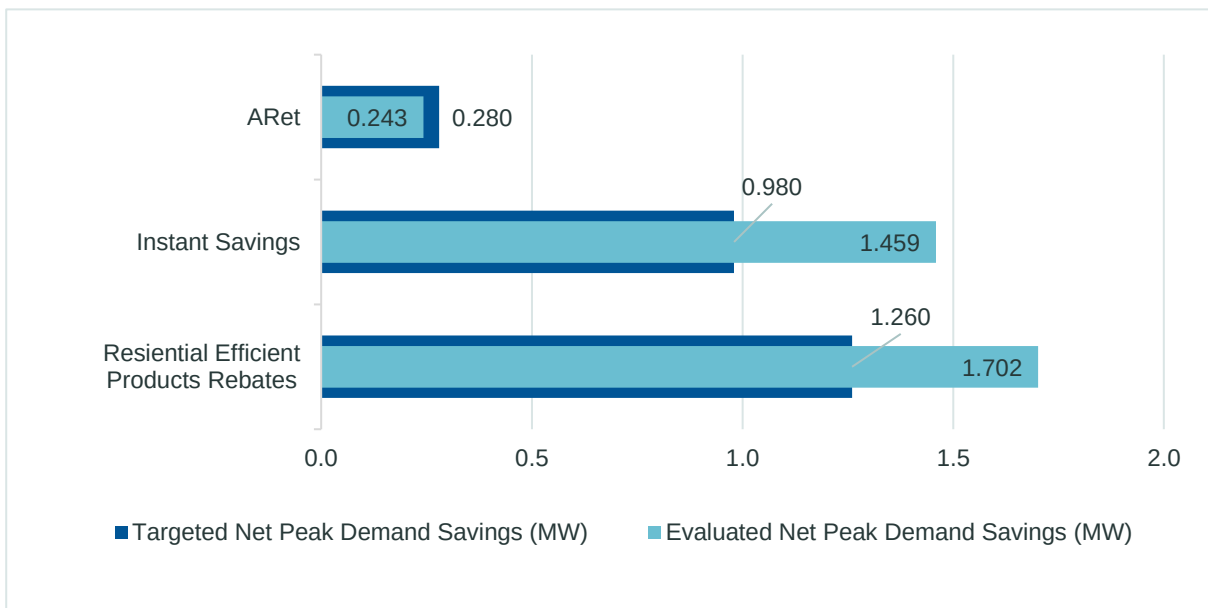


Figure 12: 2023 Residential Efficient Product Rebates Program Targeted and Evaluated Net Peak Demand Savings



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

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PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

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EfficiencyOne

RESIDENTIAL EFFICIENT PRODUCT REBATES PROGRAM

Appendix Report

2023 DSM EVALUATION

March 6, 2024

In collaboration with:





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APPENDIX I

ARet Tracking Sheet Audit

This appendix presents the main 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

Table 1 presents the corrected tracked savings resulting from all changes made by the Evaluator.

Table 1: 2023 ARet Corrected Tracked Savings

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
ARet					
Gross Energy Savings at the Generator	2.773	GWh	2.773	GWh	-0.03%
Gross Peak Demand Savings at the Generator	0.396	MW	0.396	MW	-0.03%
Net Energy Savings at the Generator	1.564	GWh	1.565	GWh	0.08%
Net Peak Demand Savings at the Generator	0.223	MW	0.223	MW	0.08%

Overall, the difference between tracked and corrected values is minor. The difference in gross energy and peak demand savings is mainly due to a few incorrect equations. A few incorrect net-to-gross ratios (NTGRs) also had a small impact on net energy and savings. Finally, the different rounding method used by the Evaluator for the peak demand-to-energy ratio had a negligible impact on the relative difference between tracked and corrected values.

APPENDIX II

ARet Algorithm for Free-ridership and Secondary Market Impact Calculations

This appendix presents the ARet free-ridership and secondary market impacts algorithm.

Algorithm – Appliance Retirement	
Section 1 – Would have kept or discarded the unit without the program	
F1. Had you already planned to dispose of this [appliance] before you heard about Efficiency Nova Scotia's Appliance Retirement Program? 1. Yes 2. No 98. (Don't know) 99. (Refused)	IF 2. No: END. OTHERWISE: GO TO F2
F2. Now, suppose that the Appliance Retirement Program had not been available. Would you have disposed of your [appliance] even if the program had not been available? 1. Yes, would have disposed of it 2. No, would not have disposed of it 98. (Don't know) 99. (Refused)	IF 1. Yes: GO TO F4 OTHERWISE: END
Proportions of those who would have kept the unit	$Prp_{keep} = \frac{SUM(F1 = 2 \text{ OR } F2 \neq 1)}{n}$
Section 2 – Discard scenarios	
F4. How would you have disposed of the [appliance] if the program had not been available? Would you... 1. Have sold it or given it to a private party 2. Have left it on the curb with a "free" sign 3. Have had it removed by the dealer supplying your new appliance 4. Have taken it to a dump or recycling center 5. Have had it picked up by the waste management company during collection day 96. Or have disposed of it in some other way: Specify: _____ 98. (Don't know) 99. (Refused)	Answer used to identify discard scenarios
Proportions for the discard scenarios¹	$Prp_{transfer} = \frac{SUM(F4 = 1 \text{ OR } 2)}{n}$ $Prp_{destroy} = \frac{SUM(F4 = 3, 4 \text{ OR } 5)}{n}$

¹ Data for the discard scenario proportions for freezer retirements were not collected in 2022; therefore 2018 data were used.

Algorithm – Appliance Retirement

Net energy savings calculation without spillover (for each appliance)²

Would Have Kept the Unit		Discard Scenario		Would-Be Acquirer Finds an Alternative Unit		Alternative Type		Overall Proportion	Final Energy Consumption (kWh)		Net Unitary Savings (kWh)
									Without ARet	With ARet	
Yes	42%							42%	622	0	622
No	58%	Transfer	44%	Yes	50%	Old Unit	50%	6%	622	622	0
						New Unit	50%	6%	622	371	251
				No	50%			13%	622	0	622
		Destroy	56%					32%	0	0	0
Weighted Average (kWh/unit)											357

Overall Free-ridership Calculation

$$FR = 100\% - \frac{\text{SUM(Net Energy Savings)}}{\text{SUM(Gross Energy Savings)}}$$

² The table is presented as an example and includes the 2022 proportions for refrigerator retirements.

APPENDIX III

ARet Spillover Methodology

This appendix presents the ARet spillover algorithm.

Algorithm – Appliance Retirement	
H1. Since participating in Appliance Retirement program component, have you disposed of other appliances without the help of the program component?	IF H1 = 1. Yes: CONTINUE OTHERWISE: END.
H2. How many of each of the [appliances] have you disposed of without the help of Appliances Retirement since participating in the program component?	Record answer for each appliance type
H3. How did you dispose of this appliance? Did you...? 1. Sell it or give it to a private party 2. Leave it on the curb with a “free” sign 3. Have it removed by the dealer supplying your new appliance 4. Take it to a dump or recycling center yourself 5. Have it picked up by the waste management company during spring or fall large collection day 96. Or dispose of it some other way? (Specify: _____) 98. (Don’t know) 99. (Refused)	FOR EACH APPLIANCE IN H2: IF H3 = 3, 4 OR 5: CONTINUE OTHERWISE: END
H4. [ASK FOR EACH ANSWER GIVEN TO H2] Was this [appliance] still in working order at the moment of its disposal?	FOR EACH APPLIANCE IN H2: IF H4 = 1. Yes: CONTINUE OTHERWISE: END
H5. [ASK H5 FOR EACH OF H2a-f > 0 AND H3=3, 4 or 5] What would you have done with this [INSERT RESPONSE FROM H2] if you had not previously participated in Appliance Retirement? Would you have...? 1. Recycled it or taken it to the dump 2. Kept using it 3. Kept it at home without using it 4. Sold it or given it away 96. (Other, specify) 98. (Don’t know) 99. (Refused)	FOR EACH APPLIANCE IN H2: IF H5 = 2: Gross unitary savings of each appliance IF H5 = 4: Savings associated with transfer scenario OTHERWISE: 0
Additional Non-incented Savings (for each participant)	$SO_i = \text{SUM}(H5)$
Overall Spillover Calculation	$SO = \frac{\text{SUM}(SO_i)}{\text{SUM}(\text{Gross Energy Savings})}$



APPENDIX IV

ARet 2023 Recommendations

The Evaluator made no specific recommendation as part of the 2023 evaluation of ARet.

APPENDIX V

Instant Savings Participant Online Survey Questionnaire

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Participant Intercept Survey with Online Option
Estimated Time to Complete	5 min
Target Audience	Instant Savings participants who have purchased LED non-A type bulbs, OR LED fixtures during the fall 2023 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	October – November

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
Introduction and Screening Respondent	A
Number of LED lamps / LED fixtures purchased and who is using them	B and E
Free-Ridership for non-A type LED lamps	C
Free-Ridership for LED fixtures	D
Cross-Influence	H
Participant perspectives on Instant Savings awareness	C and F
Demographics	I

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. Identification and Screening of Respondent

Thank you for taking the time to answer the following short survey about energy efficiency. We are gathering information from customers who purchased certain energy-efficient LED bulbs or LED fixtures between September 29th and November 26th. 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
5. Home Hardware

A2. 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.

A3. If you purchased more than one package of LED bulbs, please enter the SKU number for a package of non-pear-shaped LED bulbs, such as those 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	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)**[ALLOW ONE RESPONSE ONLY]**
1. I purchased them for my own use
 96. Other, please specify [_____]
- B4. Are there any non-pear-shaped LED bulbs currently installed in your home (other than those you just bought)? **[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 (IF CORRECT) OR B2.2 > 1 (MORE THAN 1 BULB)]** You bought **[INSERT NUMBER OF LEDS FROM B1 (IF CORRECT) OR B2.2]** LED bulbs. How many, if any, of these **[INSERT NUMBER OF LEDS FROM B1 (IF CORRECT) OR B2.2]** LED bulbs will be installed... **[TOTAL NUMBER OF BULBS RECORDED CAN'T BE HIGHER THAN COUNT IN B1 (IF CORRECT) OR B2.2] [ALL CATEGORIES (EXCEPT 'OTHER') NEED A NUMBER, ADD IN ZEROS FOR ANY THAT WERE NOT SELECTED]**

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. In-store promotions
5. Store flyer
6. Store personnel
7. Efficiency Nova Scotia website
8. Social Media (e.g., Facebook, Twitter/X, Instagram, Snapchat, TikTok, YouTube, etc.)
9. Online advertisement on smart phone, computer or tablet
10. YouTube video
11. Billboards, digital billboards and other outdoor advertising
12. Word of mouth
13. Through an Efficiency Nova Scotia representative during an in-store engagement event
14. 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 signs or posters 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 29th, 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 these LEDs										Definitely Would Have Bought these LEDs
0	1	2	3	4	5	6	7	8	9	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
6. Would not have purchased them at all **[SKIP TO H SECTION]**



D9. **[ASK IF B1 (IF CORRECT) 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)? **[ALLOW ONE RESPONSE ONLY]**
1. I purchased them for my own use
 96. Other, please specify [_____]
- E4. Are there any LED fixtures currently installed in your home (other than those you just bought)? **[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 (IF CORRECT) OR E2.2 > 1 FIXTURE]** Both
 96. Other **[SPECIFY:_____]**

E6. **[IF E1 (IF CORRECT) 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/burnt out bulb
3. To install in a place that did not have a fixture before
96. Other [SPECIFY:_____]

E7. **[ASK IF E1 (IF CORRECT) OR E2.2 > 1 (MORE THAN 1 FIXTURE)]** You bought **[INSERT NUMBER FROM E1 (IF CORRECT) OR E2.2]** LED fixtures. How many, if any, of these **[INSERT NUMBER FROM E1 (IF CORRECT) OR E2.2]** LED fixtures will be installed... **[TOTAL NUMBER OF FIXTURES RECORDED CAN'T BE HIGHER THAN COUNT IN E1 (IF CORRECT) OR E2.2]**

[NOTE TO PROGRAMMER: ALL CATEGORIES NEED A NUMBER (EXCEPT 'OTHER'), 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/burn out bulb
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= EXCLUSIVELY 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; RANDOMIZED]**

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 promotions
5. Store flyer
6. Store personnel
7. Efficiency Nova Scotia website
8. Social Media (e.g., Facebook, Twitter/X, Instagram, Snapchat, TikTok, YouTube, etc.)
9. Online advertisement on smart phone, computer or tablet
10. YouTube video
11. Billboards, digital billboards and other outdoor advertising
12. Word of mouth
13. Through an Efficiency Nova Scotia representative during an in-store engagement event
14. 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 signs or posters 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 OR 98)]** 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
4. You were not looking to purchase lighting fixtures
96. 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 these LED fixtures 0	1	2	3	4	5	6	7	8	9	Definitely Would Have Bought these 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
6. Would not have purchased them at all **[SKIP TO H SECTION]**

G8. **[ASK IF E1 (IF CORRECT) 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: _____]
 97. Prefer not to say
- I2. 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]**
 97. 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. Which of the following income categories best describes your total annual household income before taxes last year? **[ACCEPT ONLY ONE CODE]**
1. Less than \$28,000
 2. At least \$28,000 but less than \$39,000
 3. At least \$39,000 but less than \$47,000
 4. At least \$47,000 but less than \$54,000
 5. At least \$54,000 but less than \$61,000
 6. At least \$61,000 but less than \$100,000
 7. \$100,000 or more
 98. Don't know
 99. Prefer not to answer
15. How many individuals, including yourself, are part of your immediate household?
- DO NOT ACCEPT RANGE – NUMBER MUST BE AT LEAST 1**
- Record Number:** _____
99. Prefer not to say
16. What is your gender? **[ACCEPT ONLY ONE CODE]**
1. Male
 2. Female
 3. Non-binary
 96. Other, please specify: _____
 99. Prefer not to say

END

This concludes the survey. As a thank you for your time, we will provide you with a \$10 e-transfer. Please provide your full name and email address to receive the e-transfer. This information will be kept confidential. Incentives will be distributed at the end of the study in November.

- › Full name:
- › Email Address:
- › I don't wish to receive a e-transfer.
- › Do not have an email address (**DISPLAY THE FOLLOWING ONLY IF “Do not have an email address” RESPONSE IS SEELCTED:** Mailing address for \$10 cheque: _____)

APPENDIX VI

Instant Savings Participant Survey Results

The tables below present the survey results for Instant Savings from 2021 to 2023. As outlined in the results to A1, respondents in 2021 and 2023 were predominantly participants shopping at non-Costco retailers, whereas 2022 results were from Costco alone. This context should be kept in mind when comparing results across years.

A. Identification and Screening of Respondent

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

	2023	2022	2021
Sample Size	122	177	120
The Home Depot	36%	0%	55%
Kent	51%	0%	16%
Canadian Tire	5%	0%	25%
Costco	7%	100%	3%
Home Hardware	1%	0%	2%

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

	2023	2022	2021
Sample Size	122	177	120
LED fixture(s)	34%	72%	44%
LED bulb(s)	66%	28%	56%

B. Purchase – LED Bulbs

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

	2023	2022	2021
Sample Size	81	49	67
1-2	21%	10%	39%
3-4	48%	0%	24%
5-7	15%	16%	25%
8-10	10%	43%	7%
11 or more	6%	31%	4%
MEAN	4.5	9.1	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)?

	2023	2022	2021
Sample Size	81	49	67
I purchased them for my own use	96%	98%	100%
Other	4%	2%	0%

Base: Respondents who purchased LED bulbs only

B4. Are there any non-pear-shaped LED bulbs currently installed in your home (other than those you just bought)?

	2023	2022	2021
Sample Size	81	49	67
Yes	79%	73%	79%
No	16%	16%	19%
Don't know	5%	10%	1%

Base: Respondents who purchased LED bulbs only

B5. You bought one LED bulb. Do you plan on installing it...

B8. [ASK IF B1 (MORE THAN 1 BULB)] You bought [INSERT NUMBER OF LEDS FROM B1] LED bulbs? How many, if any, of these [INSERT NUMBER OF LEDS FROM B1] LED bulbs will be installed...

	2023	2022	2021
Sample Size	81	49	67
To replace another LED bulb	28%	30%	20%
To replace a bulb that was not LED	25%	49%	59%
Into a new lamp or light fixture	40%	20%	22%

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 this LED bulb...

	2023	2022	2021
Sample Size	34	28	19 (#)
To replace an LED bulb once it burns out	76%	71%	11
To replace an LED bulb that is still working	18%	21%	8
Other	6%	4%	-
Don't know	-	4%	-

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 this LED bulb ...

	2023	2022	2021
Sample Size	28	24	32
To replace a bulb once it burns out	46%	46%	28%
To replace a bulb that is still working	46%	54%	66%
Other	-	-	6%
Don't know	7%	-	-

Base: Respondents who purchased LED bulbs to replace existing LED bulbs

B11. Why do you plan on replacing LED bulbs that are still working?

	2023	2022	2021
Sample Size	5 (#)	5(#)	8(#)
Dislike lighting of these bulbs	2	3	7
Want bulbs to match	1	0	0
Bulbs burn too fast	0	0	1
Other	2	3	0

Base: Respondents who purchased LED bulbs to replace existing LED bulbs that are still working

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

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?

	2023	2022	2021
Sample Size	122	177	120
Yes	65%	65%	58%
No	35%	35%	42%

C2 / F2. How did you find out about this program?

	2023	2022	2021
Sample Size	79	115	70
In-store promotions	48%	45%	46%
Store personnel	25%	22%	29%
Through an Efficiency Nova Scotia representative during an in-store engagement event	23%	24%	11%
Efficiency Nova Scotia website	13%	8%	13%
Word of mouth	10%	9%	9%
Social Media (e.g., Facebook, Twitter/X, Instagram, Snapchat, TikTok, YouTube, etc.)	7%	4%	3%
Through another Efficiency Nova Scotia program	6%	6%	6%
Radio ads	6%	3%	4%
Store flyer	5%	8%	6%
Print ads	4%	3%	3%
Online advertisement on smart phone, computer or tablet	3%	5%	3%
TV ads	3%	2%	1%
Billboards and other outdoor advertising	-	1%	-
Other	4%	1%	1%
Don't know	-	1%	1%

Base: Respondents who were aware of Instant Savings

Multiple responses

- C3. The day you recently bought the LED bulb(s), did you see signs or posters in the light bulb section of the store promoting the discount offered on LED bulbs?

	2023	2022	2021
Sample Size	81	49	67
Yes	53%	69%	55%
No	40%	27%	40%
Don't know	7%	4%	4%

Base: Respondents who purchased non-A-type LED bulbs that were aware of discount prior to purchase

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?

- D2. To confirm, you did not know about the discount on specific LED bulbs before paying at the register?

	2023	2022	2021
Sample Size	81	49	67
Yes, was aware of discount before paying	48%	67%	52%
No, was aware of discount before paying	52%	33%	48%

Base: Respondents who purchased non-A-type LED bulbs

- D3. Before the beginning of the rebate campaign on September 29th, were you aware that discounts on LED bulbs would be offered this fall?

	2023	2022	2021
Sample Size	40	33	35
Yes	13%	24%	6%
No	88%	76%	94%

Base: Respondents who purchased non-A-type LED bulbs who were aware of discount prior to purchase

- D4. Did you postpone your purchase of LEDs to take advantage of the discount?

	2023	2022	2021
Sample Size	5 (#)	8 (#)	2 (#)
Yes	3	4	-
No	2	4	2

Base: Respondents who purchased non-A-type LED bulbs 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...

	2023	2022	2021
Sample Size	40	33	35
Bought LEDs anyway	60%	45%	89%
Bought another type of bulb	23%	6%	3%
Not bought any bulbs	18%	48%	9%

Base: Respondents who purchased non-A-type LED bulbs who were aware of discount

D6. Which type(s) of bulb would you have purchased instead?

	2023	2022	2021
Sample Size	9 (#)	2 (#)	1 (#)
Halogen	5	-	-
Incandescent	4	1	-
CFL	-	1	1

Base: Respondents who purchased non-A-type LED bulbs 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 Rebate	2023	2022	2021
Sample Size	40	33	35
MEAN	5.5	4.9	7.3

Base: Respondents who purchased non-A-type LED bulbs 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 LED bulbs that you did?

	2023	2022	2021
Sample Size	40	33	35
Earlier	0%	0%	0%
Definitely on the same day	23%	21%	60%
Probably on the same day	28%	9%	20%
Probably at a later date	23%	33%	11%
Definitely at a later date	10%	24%	6%
Would not have purchased them at all	18%	12%	3%

Base: Respondents who purchased non-A-type LED bulbs that were aware of discount prior to purchase

- D9. 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?

	2023	2022	2021
Sample Size	29	29	32
Definitely the same number	31%	10%	50%
Probably the same number	21%	17%	31%
Probably fewer	24%	41%	13%
Definitely fewer	24%	31%	6%

Base: Respondents who purchased non-A-type LED bulbs that were aware of discount prior to purchase and would have purchased bulbs at some point without discount

E. Purchase – LED Fixtures

- E1. How many LED fixtures did you purchase?

	2023	2022	2021
Sample Size	41	128	53
1-2	54%	79%	64%
3-4	34%	13%	13%
5-7	7%	5%	6%
8-10	2%	2%	9%
11 or more	2%	1%	8%
MEAN	2.8	2.1	3.3

Base: Respondents who purchased LED fixtures

- E3. Did you purchase these fixtures for your own use (for example, for your home or cottage)?

	2023	2022	2021
Sample Size	41	128	53
I purchased them for my own use	98%	97%	96%
I purchased them for a client or project outside of my organization	-	0%	2%
Both	-	2%	0%
Other	2%	1%	2%

Base: Respondents who purchased LED fixtures

The wording slightly changes in 2023

E4. Are there any LED fixtures currently installed in your home (other than those you just bought)?

	2023	2022	2021
Sample Size	41	128	53
Yes	80%	84%	77%
No	15%	14%	17%
Don't know	5%	2%	6%
Base: Respondents who purchased LED fixtures			

E5. Will the LED fixture(s) you bought be installed indoor or outdoor?

	2023	2022	2021
Sample Size	41	128	53
Indoor	95%	91%	89%
Outdoor	2%	4%	8%
Both	2%	5%	4%
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 [INSERT NUMBER FROM E1] LED fixtures. How many, if any, of these [INSERT NUMBER FROM E1] LED fixtures will be installed...

	2023	2022	2021
Sample Size	41	128	53
To replace a fixture that was still functional	58%	72%	45%
To replace a fixture that was broken	8%	5%	7%
To install in a place that did not have a fixture before	34%	18%	49%
Other	0%	1%	0%
Base: Respondents who purchased LED fixtures			

E8. What types of bulbs were installed in the fixtures that you plan on replacing?

	2023	2022	2021
Sample Size	32	104	38
LED bulbs	38%	41%	37%
CFL bulbs	31%	19%	11%
Standard incandescent bulbs	28%	32%	32%
Efficient incandescent bulbs	16%	5%	-
Halogen bulbs	6%	8%	18%
Fluorescent tube	-	3%	3%
Others	-	3%	5%

Base: Respondents who replaced existing fixtures

Multiple responses

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

F3. The day you recently bought the LED light fixture(s), did you see signs or posters in the light fixture section of the store promoting the discount offered on LED fixtures?

	2023	2022	2021
Sample Size	41	128	53
Yes	76%	37%	62%
No	20%	52%	30%
Don't know	5%	11%	8%

Base: Respondents who purchased LED fixtures

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?

G2. [DO NOT ASK IF 'YES' IN G1] To confirm, you did not know about the discount on specific LED fixtures before paying at the register?

	2023	2022	2021
Sample Size	41	128	53
Yes, were aware of the discount before paying	71%	43%	66%
No, were not aware of the discount before paying	27%	57%	34%
Don't know	2%	-	-

Base: Respondents who purchased LED fixtures

G3. Thinking about your purchase of LED fixtures, what best describes your situation?

	2023	2022	2021
Sample Size	41	128	53
You were looking to purchase LED fixtures before you were aware of the discount offered by Efficiency Nova Scotia	51%	54%	55%
You were not looking to purchase lighting fixtures	10%	31%	0%
You were looking to purchase lighting fixtures but not specifically LED	29%	13%	25%
You came to the store to purchase LED fixtures because of the discount offered by Efficiency Nova Scotia	10%	2%	19%
Other	0%	0%	2%

Base: Respondents who purchased LED fixtures

G4. If the discount on LED fixtures had NOT been offered, what would you have bought? Would you have...

	2023	2022	2021
Sample Size	30	55	35
Bought LED fixtures anyway	50%	38%	57%
Bought another type of fixture without LEDs	13%	7%	11%
Not bought any fixtures	37%	55%	31%

Base: Respondents who were aware of discount prior to purchase

G5. If you were going to purchase a fixture without LED lighting, what type of bulbs would you have installed?

	2023	2022	2021
Sample Size	4 (#)	4 (#)	4 (#)
Incandescent	2	3	-
CFL	1	1	1
Halogen	-	-	3
Other	1	-	-

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 that you “Definitely Would Have Bought these LED fixtures.”

Likelihood of Buying LEDs without Discount	2023	2022	2021
Sample Size	30	55	35
MEAN	6.2	5.7	6.2

Base: Respondents who purchased LED fixtures who were aware of discount prior to purchase

Don't know/refused excluded from calculations

- G7. If the discount had NOT been offered, when would you have purchased the LED fixtures that you did?

	2023	2022	2021
Sample Size	30	55	35
Earlier	2%	-	-
Definitely on the same day	20%	11%	20%
Probably on the same day	17%	16%	14%
Probably at a later date	30%	25%	37%
Definitely at a later date	20%	35%	14%
Would not have purchased them at all	13%	11%	14%

Base: Respondents who purchased LED fixtures who were aware of discount prior to purchase

- 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?

	2023	2022	2021
Sample Size	17	24	20
Definitely the same number	29%	13%	25%
Probably the same number	29%	42%	15%
Probably fewer	24%	21%	45%
Definitely fewer	18%	25%	15%

Base: Respondents who purchased LED fixtures who were aware of discount prior to purchase and would have purchased bulbs at some point without discount

H. Cross-Influence

- 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?

	2023	2022	2021
Sample Size	122	176	118
Yes	50%	57%	56%
No	50%	43%	44%

Base: Respondents who purchased non-A-type LED bulbs or LED fixtures

- H2. Your previous experience with Efficiency Nova Scotia programs was a major factor in your decision to purchase [LED BULBS/FIXTURES].

	2023	2022	2021
Sample Size	61	100	66
Agree	66%	65%	70%
Disagree	34%	35%	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.

	2023	2022	2021
Sample Size	61	100	66
Agree	82%	83%	92%
Disagree	18%	17%	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?

	2023	2022	2021
Sample Size	122	177	120
Yes	64%	67%	65%
No	22%	24%	24%
Don't know	14%	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].

	2023	2022	2021
Sample Size	78	118	78
Agree	64%	64%	62%
Disagree	36%	36%	38%

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.

	2023	2022	2021
Sample Size	78	118	78
Agree	79%	76%	81%
Disagree	21%	24%	19%

Base: Respondents who had previously seen ENS promotional materials

I. Demographics

- I1. What type of residence do you live in?

	2023	2022	2021
Sample Size	122	177	120
Detached single-family house	86%	84%	91%
Semi-detached house	7%	5%	3%
Townhouse or duplex which share adjacent walls	2%	3%	3%
Apartment or condo building that has fewer than five stories	2%	2%	2%
Apartment or condo building that has five or more stories	2%	3%	1%
Prefer not to say	1%	2%	0%
Other	0%	1%	1%
Mobile home or house trailer	0%	1%	0%

- I2. Do you own or rent this residence?

	2023	2022	2021
Sample Size	122	177	120
Own/buying	95%	93%	95%
Rent/lease	4%	6%	3%
Prefer not to say	1%	1%	2%

13. Do you or does your landlord pay the electric bills for your residence?

	2023	2022	2021
Sample Size	5 (#)	11 (#)	4 (#)
I pay the electric bills	5	11	3
My landlord pays the electric bills	-	-	1
Base: Respondents who rent their home			

14. Which of the following income categories best describes your total annual household income before taxes last year?

	2023
Sample Size	122
Less than \$28,000	2%
At least \$28,000 but less than \$39,000	4%
At least \$39,000 but less than \$47,000	4%
At least \$47,000 but less than \$54,000	1%
At least \$54,000 but less than \$61,000	8%
At least \$61,000 but less than \$100,000	25%
\$100,000 or more	39%
Prefer not to answer	17%
New question in 2023	

15. How many individuals, including yourself, are part of your immediate household?

	2023
Sample Size	122
1	10%
2	45%
3	21%
4	11%
5	4%
7	1%
Prefer not to say	7%
New question in 2023	

I6. What is your gender?

	2023	2022	2021
Sample Size	122	177	120
Male	53%	55%	53%
Female	43%	44%	43%
Prefer not to say	4%	1%	4%

APPENDIX VII

Instant Savings Retailer Interview Guide

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview guide
Estimated Time to Complete	25 min
Target Audience	Head office retailers
Expected Number of Completions	8
Contact List Source	EOne
Fielding Firm	Narrative Research
Estimated Timeline for fielding	November - December

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
Identification and screening of respondent	A
Non A-type LED bulbs	B
Instant Savings program's impact – Non A-type LED bulbs	C
LED fixtures	D
Instant Savings program's impact – LED fixtures	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]**



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.

Could I speak with **[INSERT NAME]**?

1. Yes
2. No **[SAY “Perhaps you can help me anyway.”]**

My name is _____ from Narrative Research, and we are conducting an evaluation of Efficiency Nova Scotia’s Appliance Retirement program.

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?

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 CORPORATE MANAGER - CONTINUE]**
98. Don’t know **[CONTINUE INTERVIEW WITH CORPORATE MANAGER - CONTINUE]**
99. 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 2023, 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 campaign was held from March 31 to May 28 and the fall campaign started on September 29 and will end on November 26. In addition, LED fixtures are eligible for a year-round incentive.



[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 just the models eligible for an Instant Savings rebate. Also consider only your Nova Scotia sales.

B. Non-A-Type LED Bulbs

OPTION A [ASK IF TOTAL SALES = NO AND IF REBATE ELIGIBLE TOTAL SALES = YES]

According to data you provided to Efficiency Nova Scotia through Summerhill, 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.

- B1. Do you anticipate selling **[READ RESPONSES]** Non A-type LED bulbs eligible for an Instant Savings rebate during the fall campaign, as compared to the spring campaign?
1. Fewer
 2. About the same; or
 3. More
- B2. **[IF B1 = FEWER]** You said sales of Instant Savings rebate eligible Non A type LED bulbs will be lower during the fall campaign 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
- B3. **[IF B1 = MORE]** 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

- B4. This means that you expect to sell approximately **[ESTIMATE OF REBATE ELIGIBLE NON A-TYPE TOTAL SALES FOR 2023 BASED ON RESPONSE TO B2 OR B3]** NON A-TYPE LED BULBS THIS YEAR DURING THE INSTANT SAVINGS FALL AND SPRING CAMPAIGNS COMBINED . Roughly what percentage of all Non A-type LED bulbs you anticipate selling in 2023, including all SKUs regardless of rebates, 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. Over 80%
- B5. This means that you expect to sell approximately **[INSERT: ESTIMATE OF 2023 REBATE ELIGIBLE NON A-TYPE SALES/B4 % ANSWER]** Non-A type LED bulbs in 2023. Is that a good estimation of your annual unit sales for 2023?
- B6. **[IF B5=NO, ASK]** What would be a better estimate of the total number of Non-A-type LED bulbs you anticipate selling for the entire year in 2023?



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 over the years ...

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 2023 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

C3. **[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 = 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 2023. This represents **[REBATE ELIGIBLE SALES - UNITS]** LED fixtures that received a rebate.

- D1. Compared to the first half of 2023, 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
- D2. **[IF D1 = 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
- D3. **[IF D1 = 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

- D4. So based on your forecast, you expect to sell **[ESTIMATE OF REBATE ELIGIBLE SALES FOR 2023 BASED ON RESPONSE TO D2 OR D3]** REBATE ELIGIBLE LED fixtures IN 2021. Roughly what proportion of the total number of LED fixtures you expect to sell in 2023 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%
- D5. This means that you expect to sell approximately **[INSERT: ESTIMATE OF 2023 REBATE ELIGIBLE LED FIXTURES SALES/D4 % ANSWER]** LED fixtures in 2023. Is that a good estimation of your annual unit sales for 2023?
- D6. **[IF D5=NO, ASK]** What would be a better estimate of the total number of LED fixture you anticipate selling for the entire year in 2023?

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 over the years...
- 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 2023 outside of those that received a rebate?

1. Do you think that Efficiency Nova Scotia's programs and promotion will have ...
2. 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.
3. A slightly positive influence
4. A moderately positive influence
5. A very positive influence

E3. **[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. Satisfaction

[ASK TO ALL]

F1. On a scale of 0 to 10, where 0 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?

F2. On a scale of 0 to 10, where 0 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 VIII

Instant Savings Tracking Sheet Audit

This appendix presents the main 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

Table 1 presents the corrected tracked savings resulting from all changes made by the Evaluator.

Table 1: 2023 Instant Savings Corrected Tracked Savings

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
Instant Savings					
Gross Energy Savings at the Generator	15.346	GWh	15.409	GWh	0.41%
Gross Peak Demand Savings at the Generator	1.939	MW	1.969	MW	1.55%
Net Energy Savings at the Generator	13.264	GWh	13.290	GWh	0.20%
Net Peak Demand Savings at the Generator	1.669	MW	1.693	MW	1.44%

The difference in gross energy and peak demand savings is largely attributed to the Evaluator correcting the product type and measure code for a number of solar products, which had a positive impact on gross savings. Corrections to measure codes were also made for one other lighting product, which had a minor negative impact on gross energy and peak demand savings. Finally, a correction made to net savings formula in “2023 Tracked Savings inputs” corresponding to ENERGY STAR® certified clothes dryers also had a minor negative impact on net energy savings.

APPENDIX IX

Instant Savings Algorithms for Free-ridership Calculations

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?	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 29th, 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
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 would you have been to buy 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)
D8. If the discount had NOT been offered, when would you have purchased the LEDs that you did? Would it have been...? 1. Definitely today 2. Probably today 3. Probably at a later date 4. 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%
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 ≥ 70% AND D5-D6 = 0%: PA4 = EMPTY
Inconsistency Test #2	IF D7 ≤ 30% AND D9 ≥ 50%: PA6 = EMPTY

Free-Ridership Level (after inconsistency tests) for regular participants	MEAN VALUE OF: (PA4 ; PA5 ; PA6)
H2/H5. [Your previous participation With ENS programs]/[The ENS promotional materials you saw] was a major factor in your decision to purchase a [LED BULBS] 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

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 LEDs fixtures?	IF Yes : GO TO Section 2 IF No OR REF: GO TO G2
G2. [ASK IF G1=2, DK] To confirm, 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 would you have been to buy 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 fixture 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)
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 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 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
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 $G6 \geq 70\%$ AND $G4-G5 = 0\%$: PA4 = EMPTY
Inconsistency Test #2	IF $G6 \leq 30\%$ AND $G8 \geq 50\%$ PA6 = EMPTY
Free-Ridership Level (after inconsistency tests) for regular participants	MEAN VALUE OF: (PA4 ; PA5 ; PA6)
H2/H5. [Your previous participation With ENS programs]/[The ENS promotional materials you saw] was a major factor in your decision to purchase a [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) = $IF(H2 \text{ OR } H5=Agree; 1) +$ $IF(H3 \text{ OR } H6=Agree; 1)$
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

Instant Savings Algorithms for Market Effects Calculations

Algorithm – LED Bulbs

Total Non-A Type Sales	
Non-A type LED bulbs sold from January – December 2023 (extrapolated from retailer data if available and responses in interview)	#LED _{Jan-Dec}
LED Sales During Instant Savings' Campaigns	
LED Bulb Sales during Instant Savings' Spring and Fall Campaigns (from the tracking sheet)	#LED _{IS}
Program Influence	
C3. 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?	%influence
Final Market Effects (LEDs) = ((#LED _{Jan-Dec} - #LED _{IS}) x %influence) / #LED _{IS}	

Algorithm – LED Fixtures

Total LED Fixture Sales	
LED fixtures sold from January – December 2023 (extrapolated from retailer data if available and responses in interview)	#LED fixtures _{Jan-Dec}
LED Fixture Sales During Instant Savings' Campaigns	
LED Fixture Sales during Instant Savings' Spring and Fall Campaigns (from the tracking sheet)	#LED fixtures _{IS}
Program Influence	
E3. 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?	%influence
Final Market Effects (LED fixtures) = ((#LED fixture _{Jan-Dec} - #LED fixture _{IS}) x %influence) / #LED fixture _{IS}	



APPENDIX XI

Instant Savings 2023 Recommendations

This appendix summarizes all the recommendations made by the Evaluator as part of the 2023 Instant Savings evaluation.

Section	Recommendations
Executive Summary	Recommendation #1: Review the incented models in the LED Non-A type lamps (R, BR, Decorative) category and phase out in 2024 any models that are no longer pertinent for the program component given regulation and market availability of non-LED replacements.



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com



ECONOLÉR



EfficiencyOne

EXISTING RESIDENTIAL PROGRAM

Final Report

2023 DSM EVALUATION

March 11, 2024

In collaboration with:





ABBREVIATIONS

AMH	Affordable Multifamily Housing
ASFH	Affordable Single-family Homes
BNI	Business, non-profit, and institutional
CASHP	Central air-source heat pump
CGH Grant	Canada Greener Homes Grant
CIS	Customer Information System
COP	Coefficient of performance
DA	Delivery agent
DHW	Domestic hot water
DSM	Demand-side management
EA	Energy auditor
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
EPI	Efficient Product Installation
ESA	Energy Solutions Advisor
ETS	Electric thermal storage
EUL	Effective useful life
GHG	Greenhouse gas
GSHP	Ground-source heat pump
HEA	Home Energy Assessment
HM	Housing manager
HPWH	Heat pump water heater
HSPF	Heating seasonal performance factor
HVAC	Heating, ventilation, and air-conditioning
LCEF	Low Carbon Economy Fund
MA	Measure Assessment
MHEEP	Mi'kmaw Home Energy Efficiency Project
MSHP	Mini-split heat pumps
NEEP	Northeast Energy Efficiency Partnerships
NPS	Net Promotor Score
NRCan	Natural Resources Canada
NREL	National Renewable Energy Laboratory



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
PV	Photovoltaic
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.
Available Demand Response Capacity	The capacity which is available to NSP to reduce system peak demand. This capacity is calculated based on the first two hours of all events called between December and February, excluding weekends and holidays. If an event is shorter than two hours, only the first hour is used to measure the available DR capacity. Available DR capacity is evaluated on a per-participant basis, based on the average demand reduction observed for each event that the participant was scheduled to participate in. E1's total available DR capacity is the sum of each participant's available DR capacity.
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 base consumption.
Bias	Systematic deviations of measurements from the true value.
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.
Confidence interval	The estimated range of values that is likely to include unknown population parameters.
Demand response	Demand response measures generate savings in the form of available capacity or load reduction in response to events called by the electric utility (Nova Scotia Power) to reduce the load at strategic moments. These events can be called at any time and for any duration, although they are usually called for one to three hours during peak periods.
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 home 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 a home is through modelled home 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 equipment life and 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 CO2	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, gas 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 ratios, etc.) validated or measured during the evaluation process. Unless otherwise specified, evaluated savings are 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 a building (such as heating and cooling) due to the installation of an energy efficiency measure.
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 and 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 a program on the market (such as increased product availability, practices, and prices) that extends beyond changing program participant behaviours. 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 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. For industrial participants on an interruptible rate, peak demand savings may include savings on non-firm loads, i.e. loads that may be interrupted when Nova Scotia Power's 10-minute reserve is low.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	An error in measurement because 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.
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.
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 net-to-gross ratios. Those parameters, except 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. A 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).



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EXECUTIVE SUMMARY

This report presents the 2023 demand-side management (DSM) results of the Existing Residential program administered by EfficiencyOne (EOne). This program is comprised of six components: (1) Home Energy Assessment (HEA); (2) Green Heat; (3) Efficient Product Installation (EPI); (4) Mi'kmaw Home Energy Efficiency Project (MHEEP); (5) Affordable Multifamily Housing (AMH); and (6) Affordable Single-family Homes (ASFH). 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 2023 Existing Residential 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 types of evaluation conducted for each program component and the corresponding methodology.

Table 1: Summary of 2023 Existing Residential Program Evaluation

Program Component	Evaluation Type			Methodology
	Impact	Process	Market	
HEA	Comprehensive			› Participant survey › Tracking sheet audit › Billing analysis › Solar photovoltaic (PV) savings calculation review › Use of previous parameters for unconverted D assessment spillover › Calculations using evaluation results › Avoided GHG emission reduction calculations
Green Heat	Condensed	X	X	› Participant survey › Contractor interviews › Distributor interviews › Tracking sheet audit › Calculations using evaluation results › Avoided GHG emission reduction calculations › Market evolution and characterization study
EPI	Condensed			› Tracking sheet audit › Unitary savings review Use of 2021 NTGR results › Calculations using evaluation results › Avoided GHG emission reduction calculations
MHEEP	Condensed			› Tracking sheet audit › Unitary savings review › Calculations using evaluation results
AMH	Condensed			› Tracking sheet audit › Calculations using evaluation results › Avoided GHG emission reduction calculations
ASFH	Condensed			› Tracking sheet audit › Savings calculation review › Unitary savings review › Calculations using evaluation results › Avoided GHG emission reduction calculations

Program Performance

Table 2 presents the participation levels, net-to-gross ratios (NTGRs), evaluated gross and net savings at the generator, annual GHG emission reductions, as well effective useful life (EUL) values for each program component and for Existing Residential as a whole.

Table 2: Overall 2023 Existing Residential Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value*	Value	Unit
HEA							
Energy Savings	4,085	Participants	30.581	GWh	0.85	25.966	GWh
Lifetime Energy Savings			717.412	GWh	0.84	600.938	GWh
Peak Demand Savings			8.446	MW	0.93	7.820	MW
Annual GHG Emission Reductions			16,877	Tonnes of CO2 eq	0.85	14,330	Tonnes of CO2 eq
EUL			23.5	Years		23.1	Years
Green Heat							
Energy Savings	1,783	Measures installed	5.561	GWh	0.52	2.918	GWh
Lifetime Energy Savings			100.103	GWh	0.52	52.526	GWh
Peak Demand Savings			4.668	MW	0.55	2.561	MW
Annual GHG Emission Reductions			3,069	Tonnes of CO2 eq	0.52	1,611	Tonnes of CO2 eq
EUL			18.0	Years		18.0	Years
EPI							
Energy Savings	9,763	Participants	9.481	GWh	0.99	9.357	GWh
Lifetime Energy Savings			65.685	GWh	1.02	66.977	GWh
Peak Demand Savings			0.942	MW	0.98	0.920	MW
Annual GHG Emission Reductions			5,233	Tonnes of CO2 eq	0.99	5,164	Tonnes of CO2 eq
EUL			6.9	Years		7.2	Years
MHEEP							
Energy Savings	162	Participants	0.577	GWh	1.00	0.577	GWh
Lifetime Energy Savings			11.663	GWh	1.00	11.663	GWh
Peak Demand Savings			0.373	MW	1.00	0.373	MW
Annual GHG Emission Reductions			318	Tonnes of CO2 eq	1.00	318	Tonnes of CO2 eq
EUL			20.2	Years		20.2	Years
AMH							
Energy Savings	79	Projects	1.460	GWh	1.00	1.460	GWh
Lifetime Energy Savings			25.465	GWh	1.00	25.465	GWh
Peak Demand Savings			0.741	MW	1.00	0.741	MW



	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value*	Value	Unit
Annual GHG Emission Reductions			806	Tonnes of CO2 eq	1.00	806	Tonnes of CO2 eq
EUL			17.4	Years		17.4	Years
ASFH							
Energy Savings	242	Participants	1.444	GWh	1.00	1.444	GWh
Lifetime Energy Savings			28.992	GWh	1.00	28.992	GWh
Peak Demand Savings			0.627	MW	1.00	0.627	MW
Annual GHG Emission Reductions			797	Tonnes of CO2 eq	1.00	797	Tonnes of CO2 eq
EUL			20.1	Years		20.1	Years
Total							
Energy Savings			49.104	GWh		41.722	GWh
Lifetime Energy Savings			949.321	GWh		786.562	GWh
Peak Demand Savings			15.798	MW		13.042	MW
Annual GHG Emission Reductions			27,100	Tonnes of CO2 eq		23,026	Tonnes of CO2 eq
EUL			19.3	Years		18.9	Years
* The average NTGR values presented in this table correspond to the ratios of net savings to gross savings by program component and then for the entire program.							

Existing Residential was aimed at achieving 38.526 GWh in net electrical energy savings and 11.550 MW in net peak demand savings at the generator for 2023. The program was able to achieve planned energy and peak demand savings. Green Heat, MHEEP, and ASFH fell below their energy targets, while HEA, EPI and AMH exceeded theirs. All program components except Green Heat and ASFH exceeded their peak demand savings targets. HEA, MHEEP, and AMH participation levels reached their highest point in 2023, while ASFH was launched in 2023. HEA was the largest contributor to total program net energy (62%) and peak demand savings (60%).

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

HEA Findings and Recommendations

2023 HEA Finding: Both HEA net electrical energy and demand savings exceeded targets.

2023 HEA Finding: The significant increase in participation and average gross savings per home observed since the introduction of the Canada Greener Homes Grant (CGH) continues and was more significant in 2023.

2023 HEA Finding: HEA is still highly appreciated among participants, especially the recommendations from Energy Auditors (EAs).

2023 HEA Finding: The evaluated energy and peak demand savings were higher than the savings tracked by EOne due to lower free-ridership levels measured as part of the 2023 evaluation.



2023 HEA Finding: Billing analysis results were inconclusive and the Evaluator kept the overestimation ratios (ORs) established in 2018 for the 2023 evaluation.

Recommendation #1: Continue exploring the factors potentially responsible for the inconclusive billing analysis results, one being related to billing data interpretation, and work with the Evaluator to define the impact evaluation approach to be taken in 2024. Depending on the answers obtained through the exploration process, options other than a billing analysis may need to be considered for the 2024 evaluation. Given the change in the characteristics of participants entering the program component since 2018, the Evaluator does not consider it acceptable to use the current OR beyond 2023.

Green Heat Findings and Recommendations

This subsection presents the key findings from the Green Heat evaluation.

2023 Green Heat-Finding: Green Heat fell short of its net savings targets in 2023, achieving 80% of its net energy savings target and 88% of its net peak demand savings target.

2023 Green Heat-Finding: Both the evaluated gross energy and peak demand savings were identical to the savings tracked by EOne.

2023 Green Heat Finding: Green Heat participation levels decreased by 11% compared to 2022, particularly for mini-split heat pumps (MSHPs, 22% drop). Conversely, MSHP installations incented through HEA increased over the same period (116% increase) due in large part to the integration of the Canada Greener Homes Grant (CGH Grant).

2023 Green Heat-Finding: Most customers prefer to participate in HEA and the CGH Grant over Green Heat because of the far greater financial support offered for similar measures. Green Heat is a good option for a minority that want a simpler process that provides rebates quickly without the need for multiple MSHP units or a home energy assessment.

2023 Green Heat-Finding: Contractors/installers play an important role in recommending EOne programs. They currently recommend HEA and the CGH Grant more often than Green Heat mainly because of the higher incentives offered.

2023 Green Heat-Finding: There is confusion among customers about the differences between Green Heat and the CGH Grant. Many apply to HEA and the CGH Grant first and, upon learning they do not qualify, apply to Green Heat instead.



2023 Green Heat-Finding: Participants (particularly MSHP participants) and contractors are less satisfied with the following components of the Green Heat program: the rebate, the Green Heat website, communications with EOne, a lack of marketing materials, and the list of eligible equipment.

Recommendation #1: Ensure that Green Heat program marketing materials are available to contractors and participants.

Recommendation #2: Ensure that the Green Heat website is as user-friendly as possible by making sections, links, eligibility criteria, and eligible equipment lists clear, simple to understand, and easy to navigate.

Recommendation #3: Investigate how communications between EOne and contractors and participants could be improved. Ensure that EOne provides timely responses or feedback to questions from contractors and participants.

2023 Green Heat-Finding: Participant and contractor satisfaction with the rebate amount is low, exacerbated by increases in average system costs (for MSHPs) as well as comparisons to the CGH Grant incentives.

2023 Green Heat-Finding: The Green Heat application form is generally easy to complete, but some customers find it difficult to take photos correctly and attach/upload documents.

2023 Green Heat-Finding: MSHP participant awareness of time-of-day rates is relatively high (78%), but there is still room to increase awareness about electric thermal storage (ETS) (61%). Awareness has not yet translated into participation in Green Heat.

2023 Green Heat Finding: Free-ridership levels increased for Green Heat measures, particularly for MSHPs (48% in 2023). Free-ridership for biomass measures was evaluated at 47% and for demand reduction measures at 9%.

2023 Green Heat-Finding: The MSHP market is in a sustained growth phase driven by strong consumer interest, the rising cost of fossil fuels, and incentive programs. Some distributors mention that as the market matures it may be moving towards heat pump repairs and replacement systems rather than new installations. That said, many of the remaining Nova Scotian households without heat pumps are managing with only a low or moderate-income or have homes with additional challenges that need to be addressed and will be unable to install a MSHP without additional means or higher incentives.

Recommendation #4: Consider offering increased incentives to low and moderate-income households that do not yet have a heat pump and incentivizing heat pump replacements for such households if it is cost-effective to do so.

EPI Findings and Recommendations

This subsection presents the key findings from the EPI evaluation. The Evaluator has no specific recommendation for EPI.

2023 EPI Finding: With 9.357 GWh in net electrical energy savings and 0.920 MW in net peak demand savings at the generator in 2023, EPI net electrical energy and peak demand savings exceeded targets by 13% and 21% respectively. Gross energy savings were the highest since 2019, before the COVID-19 pandemic.

2023 EPI Finding: With participation increasing by 16% in 2023, EPI generated 12% more energy savings and 6% more peak demand savings than in 2022. While LED lamps continued to be the most popular EPI measure, smart thermostats for mini-split heat pumps (MSHP) were also very popular.

2023 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.



MHEEP Findings and Recommendations

This subsection presents the key findings from the MHEEP evaluation. The Evaluator has no specific recommendation for MHEEP.

2023 MHEEP-Finding: In 2023, MHEEP net electrical energy and peak demand savings respectively amounted to 0.577 GWh and 0.373 MW at the generator, thus falling short of the 0.608 GWh energy savings target while exceeding the 0.300 MW peak demand savings target.

2023 MHEEP-Finding: With increases in average savings per participant and the number of participants, MHEEP achieved 52% more energy savings and 92% more peak demand savings in 2023 compared to 2022 levels.

2023 MHEEP-Finding: The evaluated net energy and peak demand savings determined by the Evaluator were nearly the same as the net savings tracked by EOne.

AMH Findings and Recommendations

This subsection presents the key findings from the AMH evaluation. The Evaluator has no specific recommendation for AMH.

2023 AMH-Finding: AMH net electrical energy and peak demand savings exceeded targets by 17% and 118% respectively.

2023 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.

2023 AMH-Finding: The evaluated net energy savings determined by the Evaluator were nearly the same as the savings tracked by EOne, while the evaluated net peak demand savings were 5% higher than the savings tracked by EOne.

ASFH Findings and Recommendations

This subsection presents the key findings from the ASFH evaluation. The Evaluator has no specific recommendation for ASFH.

2023 ASFH-Finding: In 2023, ASFH net electrical energy and peak demand savings respectively amounted to 1.444 GWh and 0.627 MW at the generator, thus falling short of the 3.496 GWh energy savings target and 0.890 MW peak demand savings target.

2023 ASFH-Finding: In 2023, 242 participants generated electrical savings through ASFH.

2023 ASFH-Finding: The energy and peak demand savings determined by the Evaluator were slightly higher than the initial savings tracked by EOne due to a revision to the prescriptive unitary savings values for appliance replacement measures.

Program Tracked and Evaluated Savings

Table 3 below compares EOne tracked energy and peak demand savings to evaluated savings at the generator. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings. Furthermore, the NTGRs are also presented and correspond to the rounded averages obtained by dividing net savings by gross savings, which explains why the values are different from those presented in the other sections.



Table 3: Comparison of 2023 Tracked and Evaluated Savings at the Generator

		Gross Savings		NTGR	Net Savings		Realization Rate
		Value	Unit		Value	Unit	
HEA	Energy Savings						
	Tracked Savings by EOne	30.584	GWh	0.79	24.018	GWh	108%
	Evaluation Results	30.581	GWh	0.85	25.966	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	8.446	MW	0.82	6.893	MW	113%
	Evaluation Results	8.446	MW	0.93	7.820	MW	
GH	Energy Savings						
	Tracked Savings by EOne	5.561	GWh	0.60	3.352	GWh	87%
	Evaluation Results	5.561	GWh	0.52	2.918	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	4.668	MW	0.63	2.949	MW	87%
	Evaluation Results	4.668	MW	0.55	2.561	MW	
EPI	Energy Savings						
	Tracked Savings by EOne	9.481	GWh	0.98	9.308	GWh	101%
	Evaluation Results	9.481	GWh	0.99	9.357	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	0.942	MW	0.97	0.913	MW	101%
	Evaluation Results	0.942	MW	0.98	0.920	MW	
MHEEP	Energy Savings						
	Tracked Savings by EOne	0.575	GWh	1.00	0.575	GWh	100%
	Evaluation Results	0.577	GWh	1.00	0.577	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	0.373	MW	1.00	0.373	MW	100%
	Evaluation Results	0.373	MW	1.00	0.373	MW	
AMH	Energy Savings						
	Tracked Savings by EOne	1.462	GWh	1.00	1.462	GWh	100%
	Evaluation Results	1.460	GWh	1.00	1.460	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	0.706	MW	1.00	0.706	MW	105%
	Evaluation Results	0.741	MW	1.00	0.741	MW	
ASFH	Energy Savings						
	Tracked Savings by EOne	1.439	GWh	1.00	1.439	GWh	100%
	Evaluation Results	1.444	GWh	1.00	1.444	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	0.624	MW	1.00	0.624	MW	100%
	Evaluation Results	0.627	MW	1.00	0.627	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 demand-side management (DSM) for Nova Scotians. EOne provides energy efficiency, demand response and carbon mitigation services through the Efficiency Nova Scotia (ENS) franchise. Regulatory oversight is provided by the Nova Scotia Utility and Review Board (NSUARB). EOne receives funding for its electricity 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 ENS franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2023 DSM program portfolio.

This evaluation report relates to the Existing Residential program, which comprised six components: Home Energy Assessment (HEA); Green Heat; Efficient Product Installation (EPI); Mi'kmaw Home Energy Efficiency Project (MHEEP); Affordable Multifamily Housing (AMH); and Affordable Single-family Homes (ASFH). Table 4 below lists the Existing Residential program components and the types of evaluations conducted for 2023. 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) 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 net-to-gross ratios (NTGRs) to provide evaluated results.

Table 4: Types of Evaluations Conducted for Each Program Component, 2023

Program	Program Component	2023		
		Process	Market	Impact
Existing Residential	HEA			Comprehensive
	Green Heat	X	X	Condensed
	EPI			Condensed
	MHEEP			Condensed
	AMH			Condensed
	ASFH			Condensed

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

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

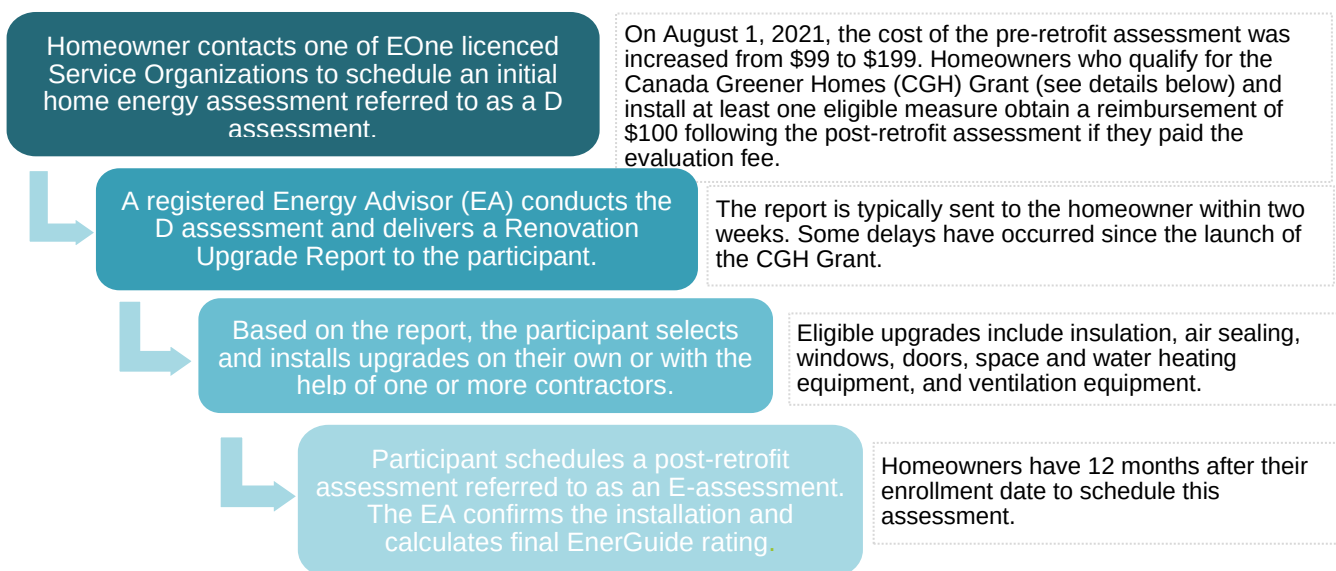
1 HEA Overview

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. HEA uses the EnerGuide home evaluation framework and is administered in collaboration with Natural Resources Canada (NRCAN). Figure 1 illustrates the participation process along with details about the program component.

Figure 1: HEA Participation Process Summary



Since 2018, HEA offers the same services to non-electrically heated homes. This report presents the evaluation results for electrical measures only.

In May 2021, the federal government announced the launch of the CGH Grant. The initiative offers grants of up to \$5,000 to help homeowners implement energy efficiency retrofits in their primary residence. In Nova Scotia, the CGH Grant is co-delivered by EOne through HEA. Homeowners must register under HEA to receive the CGH Grant in addition to HEA rebates. To qualify for the CGH Grant, homeowners must verify that their home meets program eligibility requirements and must 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 program eligible and recommended in the assessment report to receive the CGH Grant. Only qualifying measures implemented on or after December 1, 2020 are eligible for the CGH Grant. In addition to resiliency measures (batteries for solar PV, roofing membranes, foundation water proofing, and moisture proofing), two new energy saving measures were added to HEA, namely solar PV systems and smart thermostats. The incentive for resiliency measures, solar PV, and smart thermostats are solely funded by the CGH Grant while HEA infrastructure costs such as assessments, marketing, and program support are shared or funded by demand-side management (DSM) funds. Low uptake measures that are not also a part of the CGH Grant were removed at the end of 2022 (air-to-water heat pumps, solar air equipment, and drain water heat recovery). Rebates for these measures are honoured for customers who enrolled prior to this change taking effect.

HEA was aimed at achieving 14.910 GWh in net electrical energy savings and 6.340 MW in net peak demand savings at the generator in 2023.

1.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated HEA in previous years and issued improvement recommendations. Table 5 below provides a summary of the implementation status of past recommendations that were carried forward. The Evaluator notes that all remaining recommendations are in progress.

Table 5: Implementation Status of Past Recommendations for HEA

#	Past Recommendations	Status	Comments
2018 HEA-R1	Conduct a billing analysis to review overestimation ratios (ORs) when a sufficient participant sample becomes available.	In progress	A billing analysis was planned for 2022 to reassess the overestimation ratio. The billing analysis was deferred in 2022 due to the number of participants with sufficient billing data being too low to establish reliable overestimation ratio values for subcategories of participants. In 2022, the Evaluator researched potential changes to the billing analysis approach and the savings calculation methodology to produce more robust savings values in future evaluations and simplify savings calculations. The proposed new billing analysis approach is further described in this report. A billing analysis using the above mentioned new approach was performed by the Evaluator in 2023, although the results of the billing analysis were inconclusive. The Evaluator and EOne will further explore the results of the 2023 billing analysis in 2024 and develop a new impact evaluation approach for the 2024 evaluation. Depending on the outcome of this further exploration, an alternate approach to a billing analysis may be required in 2024.
2020 HEA-R1	Update the unconverted D assessment spillover calculation assumptions to reflect the current participation mix and obtain more representative results.	In progress	In 2022, the Evaluator analyzed the evolution of the average savings per electrical participant to determine if an adjustment to the savings value per unconverted D assessment should be applied to align with changes in HEA since the unconverted D assessment spillover study was conducted. The analysis revealed that no adjustment was needed, but the Evaluator still recommends that new activities be conducted to reassess all parameters used to calculate unconverted D assessment spillover savings. EOne plans to have the Evaluator update these parameters in 2024 and results will be presented in the 2024 Existing Residential Evaluation Report.
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.	Complete	In 2021, EOne updated heat pump information using information from HOT2000 and clarified HOT2000 procedures for Energy Advisors to ensure this information is consistently tracked and shared with EOne. In 2022, EOne started tracking the actual coefficient of performance (COP) at -15 °C, installed heat pump capacities, AHRI certification numbers, and indoor and outdoor heat pump models in the tracking sheet to allow for a more precise calculation of peak demand savings. In 2023, EOne updated the tracking sheet with the mini-split heat pump demand savings formula recommended in the 2022 evaluation report. This calculation is also used to determine demand savings for central-air source heat pumps. Also in 2023, EOne completed changes to the HEA tracking sheet to better track heat pump parameters, as recommended.
2021- HEA-R1	Update and simplify the tracking sheet in time for next year's evaluation to minimize the risk of calculation errors.	Complete	In 2023, EOne completed updates to the HEA participant tracking sheet to include co-delivery of the Canada Greener Homes Grant. Updates included the reorganization of columns to follow the calculation steps from gross savings at the meter to net savings at the generator in that order, the simplification of formulas to the greatest extent possible, and the removal of unused or obsolete information and references.

1.3 Participation History

As presented in Figure 2 below, 2023 HEA participation increased by 47% compared to 2022 levels that had already almost tripled compared to 2021. This increase in participation since 2022 is likely due to the introduction of the Canada Greener Homes (CGH) Grant.²

Average gross energy savings per participant also continue to increase. In 2022, an increase of 26% was observed compared to 2021. For 2023, the increase was 57% compared to 2022. Similar to 2022, this escalation is mainly explained by solar PV measures (representing 64% of gross energy savings in 2023) that were offered through HEA as a result of integrating the CGH Grant. The 2023 average gross savings per participant is among the highest level in program history. It should be noted that, prior to July 2018, HEA was only offered to electrically heated homes and thus generated more electrical energy savings. Since then, the proportion of DSM participants generating both non-electrical savings and electrical savings had continuously increased (representing 67% in 2023).

Figure 2: Overview of HEA Participation, 2014-2023

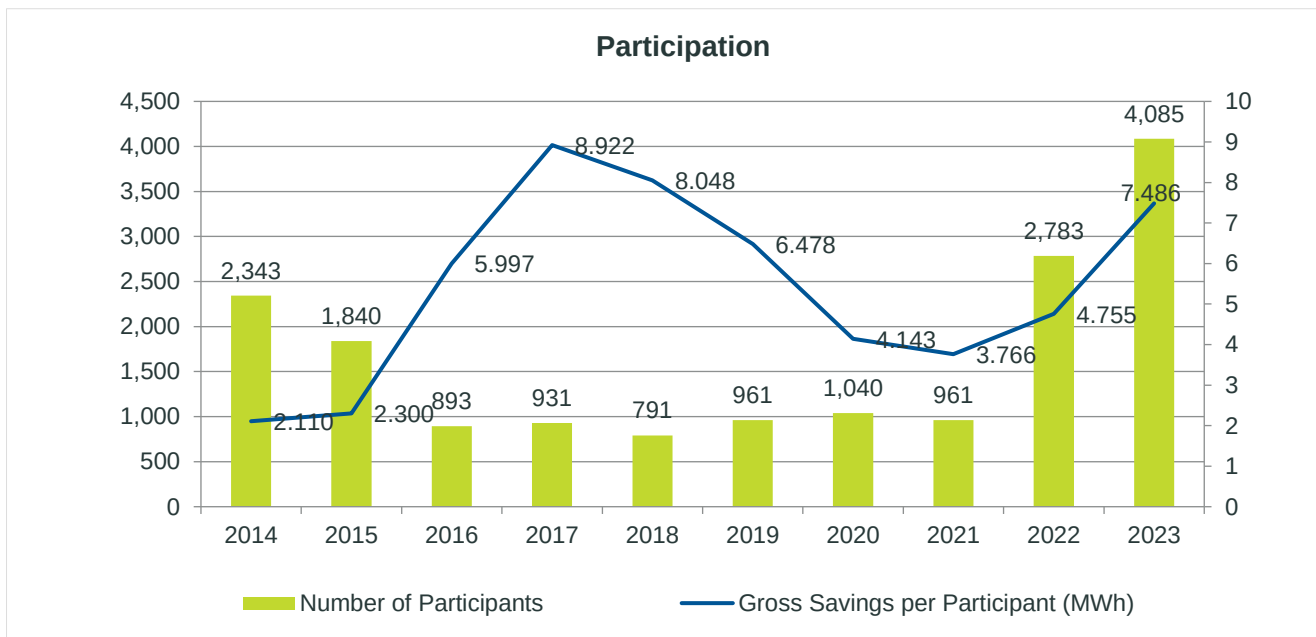
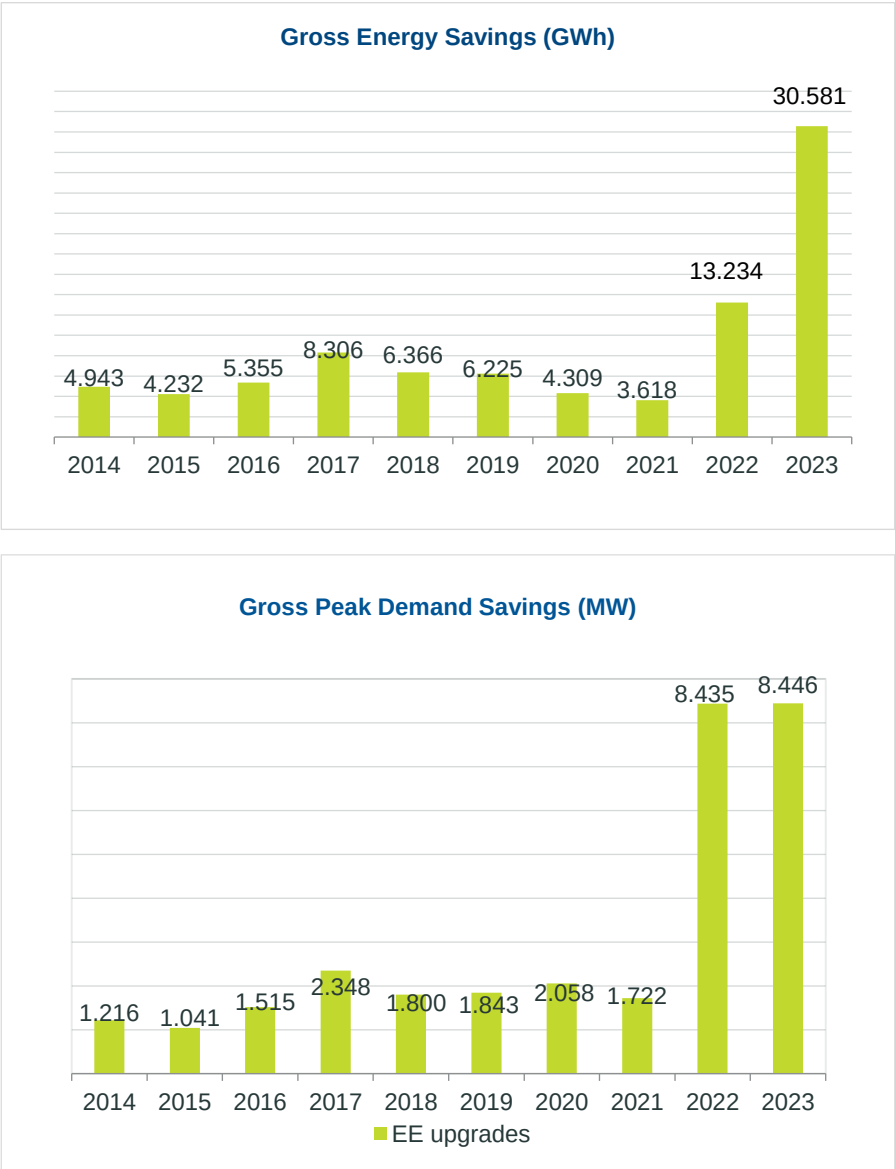


Figure 3 below provides an overview of the evolution of HEA gross energy and peak demand savings from 2014 to 2023. In 2023, an increase of 131% was observed for gross energy savings compared to 2022, a year in which record savings were also achieved. As for peak demand savings, they remained similar to 2022 considering that solar PV measures do not generate peak demand savings.

² In this DSM evaluation report, the number of participants refers to those participants whose projects generated electrical savings regardless of whether their homes are primarily electrically heated.



Figure 3: Evolution of HEA Gross Savings, 2014-2023



2 HEA Evaluation Approach

The 2023 HEA evaluation comprised a comprehensive impact evaluation.

The main objectives of the 2023 HEA evaluation were to:

- › Collect information on participant perspectives³
- › Calculate gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided greenhouse gas (GHG) emissions

The Evaluator identified key research questions aimed at achieving the above objectives. Table 6 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 6: 2023 HEA Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Collect information on participant perspectives	› What is the level of satisfaction among participants? › What participants suggest for improving the component?	› Participant survey
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › What are the appropriate savings calculations or values for energy efficiency upgrades? › What is the appropriate savings calculation approach for solar PV? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Billing analysis › Solar PV savings calculation review › Calculations using evaluation results
Calculate net results	› What is the free-ridership level for the component? › What is the participant spillover level? › What is the unconverted D assessment spillover level? › 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?	› Participant survey › Use of previous parameters for unconverted D assessment spillover › Calculations using evaluation results › GHG emission reduction calculations

Participant Survey

In Fall 2023, Narrative Research conducted a telephone survey with a total of 100 participants. The average length of the survey was 15.7 minutes. The questionnaire is presented in Appendix I, while complete survey results are outlined in Appendix II. Drawing a random sample of 100 from a population of 4,085 yields a margin of error of 8.2% at a 90% confidence level.

Tracking Sheet Audit

Prior to conducting the savings calculation review, the Evaluator performed an audit of the final 2023 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.

³ As a participant survey was performed to assess the NTGR, the Evaluator also added some satisfaction questions that were not part of the annual evaluation plan.



Billing Analysis

A billing analysis was conducted to establish adjustment ratios to be directly applied to the savings estimates obtained from HOT2000.

Solar PV Savings Calculation Review

To determine the appropriate savings calculation approach for solar PV systems installed through HEA, Econoler analyzed the information available in the tracking sheet and reviewed the tracked unitary savings values established by EOne based on savings results from SolarHomes. The 2020-2023 Measure Assessment⁴ 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 4 below.

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 for GHG emissions generated by electricity production. This factor was established using NS Power data.

⁴ The 2020-2023 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 and for the first year of the 2023-2025 DSM cycle, the Evaluator refers to the values presented in the 2020-2023 Measure Assessment.

3 HEA Participant Perspective

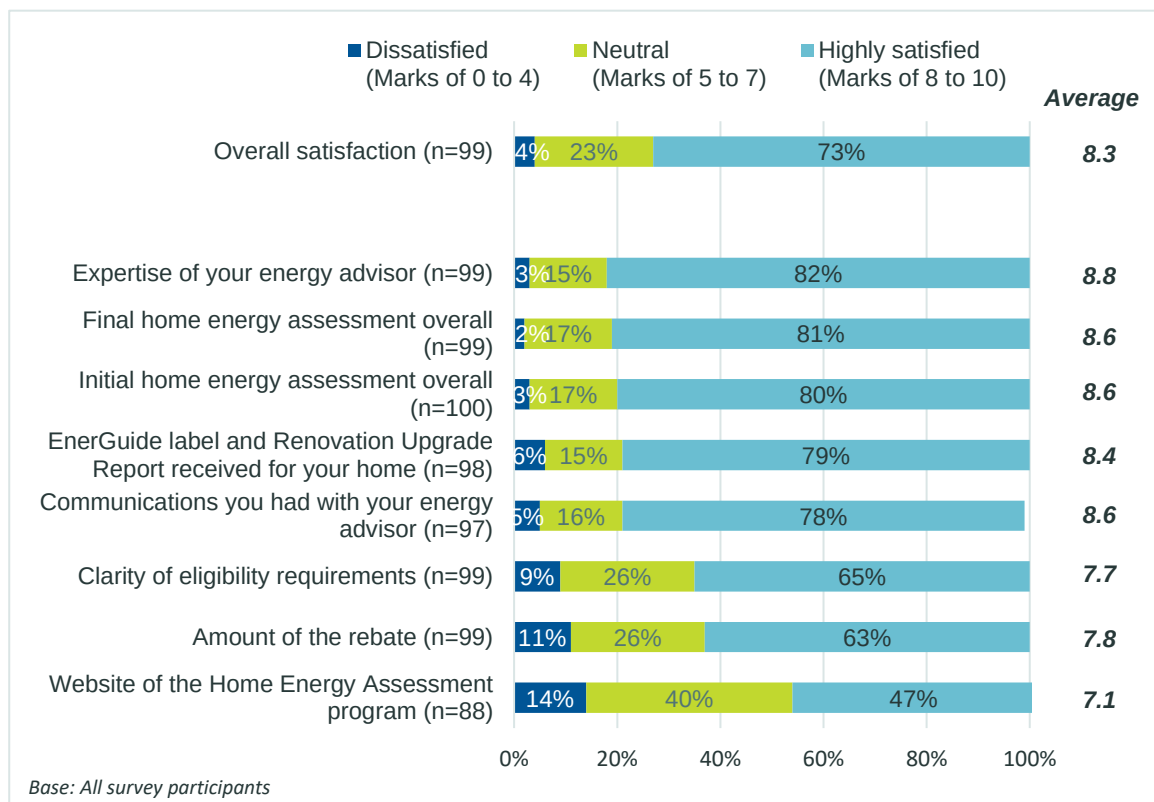
A survey was conducted with 100 HEA participants as part of the HEA evaluation. In addition to the questions designed for impact evaluation purposes, survey participants were asked questions regarding satisfaction and recommendations.

3.1 Satisfaction with HEA

There was a high level of satisfaction with HEA overall, with an average rating of 8.3.⁵ Participants who were less satisfied (27%) mentioned that it took too long to receive their rebate (44%), which was likely due to the delays experienced by the introduction and co-delivery of the CGH Grant since this issue was not mentioned when satisfaction was assessed as part of the 2020 evaluation. Other reasons included difficulty obtaining information from the website or ENS (22%), program component or eligibility requirements being unclear (15%), the process taking too long between the first and final energy assessments (15%), problems receiving the rebate (11%), disagreeing with issued recommendations (11%), or the rebate being too small (11%).

Participants also indicated high satisfaction with various aspects of HEA. Satisfaction was highest with the expertise of the energy advisor with an average rating of 8.8 and was lowest with the HEA website (7.1).

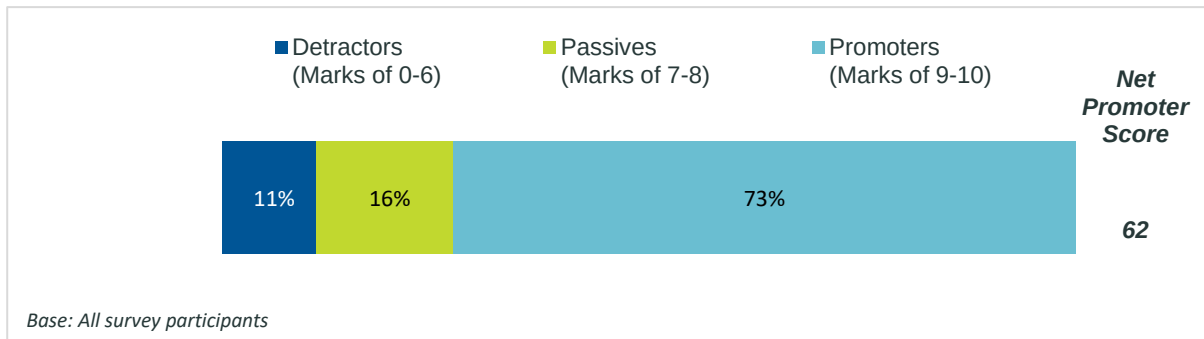
Figure 4: Satisfaction With HEA



⁵ On a scale of 0 to 10, where 0 indicates "Not at all satisfied" and 10 indicates "Completely satisfied".

As illustrated in Figure 5 below, the Net Promoter Score (NPS) is a tool that measures customer experience with and overall perceptions of a brand or program. It is calculated by subtracting the “Promoters” (who provide a score of nine or ten and who will refer others and fuel growth) from the “Detractors” (who provide a score of 0 to 6 and who can impede growth through negative word of mouth). The NPS can range from a maximum score of 100 (if everyone is a “Promoter”) to a minimum score of -100 (if everyone is a “Detractor”). The higher the NPS score, the better. The overall NPS for HEA was 62, a result suggesting that program participants are likely to recommend HEA to a friend or colleague. This score indicates that the proportion of HEA Promoters exceeds the proportion of Detractors by a wide margin.

Figure 5: Likelihood to Recommend HEA



3.2 Suggestions for Improvement

Although close to one-half (46%) of participants did not provide any recommendations to improve HEA, the remainder provided a variety of suggestions. HEA participants recommended speeding up the process (17%) followed by simplifying the program application, forms, and associated paperwork (12%). All other recommendations were mentioned on average by fewer than one in 10 participants, including improving communication or follow-up, improving the website, offering more information on products or recommended measures, and increasing the rebate.

- › Participants were highly satisfied with HEA overall, offering an average satisfaction rating of 8.3.
- › Less satisfied participants (27%) mention that it took too long to receive their rebate (44%) or difficulty obtaining information from the HEA website or ENS (22%).
- › Satisfaction was highest with the expertise of the energy advisor with an average rating of 8.8 and lowest with the HEA website (7.1).
- › The NPS for HEA was 62, a result suggesting that program participants are likely to recommend HEA to a friend or colleague.



4 HEA Impact Evaluation

The objectives of the 2023 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.

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 obtained by the Evaluator.

As mentioned in Subsection 1.2 above, a new tracking sheet was developed in 2023 to make most of the calculated fields clearer and enhance readability for ease of use. There are still a few improvements that can be implemented in the tracking sheet to render it more user-friendly and avoid mistakes (e.g. increasing the accuracy of mini-split heat pump model numbers, adding fields to enter the number of units installed, making sure calculation fields are updated when manual changes occur in input fields), although the Evaluator notes the significant progress that has been made.

4.2 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.⁶ The following subsections describe how gross savings are calculated for HEA and how each parameter of the methodology was determined.

4.2.1 Installation Rates

Installation rates represent the proportion of products recorded in the tracking sheet that remain installed in participants' homes. Based on the 2020-2023 Measure Assessment, installation rates for all HEA measures were estimated at 100% due to their relatively high costs.

4.2.2 Energy Savings

The following subsections detail how energy savings are calculated for HEA, i.e. based on HOT2000 simulation results for space heating energy savings and unitary savings values for all other energy efficiency upgrades and solar PV systems.

⁶ Definition adapted from: National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

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.

$$\begin{aligned} \text{Gross Space Heating Savings (kWh)} = & \frac{[(\text{Elec\_Heating}_D(\text{MJ}) \times (1 - \text{OR}_D)) - (\text{Elec\_Heating}_E(\text{MJ}) \times (1 - \text{OR}_E))]}{3.6 \text{ MJ/kWh}} \\ & + \text{Non-modelled Space Heating Energy Savings (kWh)} \end{aligned}$$

Where:

- › Elec_Heating_D and Elec_Heating_E correspond to the modelled electrical space heating consumption levels respectively obtained in HOT2000 during the D and E assessments.
- › 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 Ratios

The savings calculations are 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. For the 2023 evaluation, the Evaluator conducted a new billing analysis to review not only the ORs, but the entire savings calculation approach.

The billing analysis consisted of calculating the change in electrical energy consumption by comparing levels before and after participation in HEA for a group of recent participants (treatment group). To account for variations in electrical energy consumption due to factors other than HEA participation, the Evaluator selected a control group and deducted the change in electrical energy consumption observed for that group over the same period. Subtracting the change in control group electrical energy consumption (i.e. a change that is not linked to the program) from that of the treatment group ensures that only savings attributable to HEA are captured and avoids capturing other effects that can have an impact on energy consumption (e.g. the COVID-19 pandemic) because both the treatment and control groups are impacted by such effects. The details on the billing analysis methodology and results are presented in Appendix IV.

In the end, the results could not be used for the 2023 evaluation as they were inconclusive. Results tend to demonstrate that savings are not as significant as expected, but other factors are also potentially responsible for these results, one being related to the billing data used for the analysis, while the other relates to participant behaviour potentially driven by HEA (which means not offset by the control group). Without knowing the potential impacts of the billing data on the results obtained, it is difficult to conclude how HEA impacts participant behaviour.

Considering the inconclusive results of the billing analysis, further exploration will be necessary in the next few months to consider an appropriate impact evaluation approach for the next evaluation. In the interim, given the inconclusive results obtained through the billing analysis performed as part of this evaluation, the Evaluator considers it appropriate to have used the current savings calculation methodology and ORs established in 2018 for the 2023 evaluation. These values are presented in Table 7.

Table 7: 2023 HEA Overestimation Ratios

Scenario	ORD Assessment		ORE 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, solar air, and smart thermostat 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 2020-2023 Measure Assessment.

Table 8 below lists the tracked and evaluated unitary energy savings values for each category of non-modelled space heating measure implemented through HEA in 2023. As indicated, no changes were made to the tracked savings in 2023.

As for smart thermostats that are now available in HEA as a result of integrating the CGH Grant into the component, the Evaluator confirmed that this measure had no impact on the space heating consumption values obtained from HOT2000. Therefore, the savings associated with smart thermostats need to be calculated using a unitary savings value. Considering the relatively high risk of double-counting with Instant Savings given smart thermostats are also incented through that program component and the rebate is offered year-round, the Evaluator recommends not claiming the savings from this measure under HEA. This approach may be revisited in future years.

Table 8: 2023 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 Stoves with Electric Resistance Baseline	10,443	No change
Wood Stoves with Heat Pump Baseline	10,443 / Heat Pump Annual COP*	No change
Pellet Stoves with Electric Resistance Baseline	8,959	No change
Pellet Stoves with Heat Pump Baseline	8,959 / Heat Pump Annual COP	No change
Wood Furnaces/Boilers with Electric Resistance Baseline	13,804	No change
Wood Furnaces/Boilers with Heat Pump Baseline	13,804 / Heat Pump Annual COP	No change
Pellet Furnaces/Boilers with Electric Resistance Baseline	13,765	No change
Pellet Furnaces/Boilers with Heat Pump Baseline	13,765/ Heat Pump Annual COP	No change
Smart Thermostats	0**	0**
* Coefficient of Performance		
** No savings are claimed for smart thermostats under HEA because of the high risk of double counting with Instant Savings.		

Domestic Hot Water Energy Savings

Savings for domestic hot water (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 9 below lists the tracked and evaluated unitary energy savings values for each DHW measure implemented through HEA in 2023. The detailed savings calculations are presented in the 2020-2023 Measure Assessment. Savings values were updated in 2023 for heat pump water heaters installed through HEA to align with the values established as part of the development of a new heat pump water heater pilot design being explored by EOne.

Table 9: 2023 HEA Tracked and Evaluated Unitary Energy Savings for DHW Measures

Measure	Tracked Savings [kWh/year]	Evaluated Savings [kWh/year]
DHW Heating		
Solar DHW	2,908	No change
Heat Pump Water Heaters – with Electric Resistance Baseline	865	1,179
Heat Pump Water Heaters – with Heat Pump Baseline	1,360	1,280

Solar PV Energy Savings

For solar PV measures introduced through HEA with the CGH Grant, savings correspond to an offset from the electricity grid and are calculated by using a tracked unitary savings value of **1,086 kWh per kW** (size of the solar PV system). This value was drawn from the average savings per kW from SolarHomes participants in 2021/22, which was obtained by dividing the total modelled production (kWh) by the total system size (kW) and using the average.

Considering that solar PV measures were recently added to HEA and are not modelled in HOT2000, the Evaluator determined that a unitary savings approach is appropriate for this evaluation. The Evaluator also reviewed the value used by EOne based on the most recent SolarHomes evaluation results.

The Evaluator considers that the solar PV systems installed through HEA can be compared with those installed through SolarHomes. The participant rate codes are residential. The capacity ranges are similar for both programs.

As part of the 2022/23 SolarHomes evaluation, the Evaluator conducted a calibration study by comparing tracked savings, i.e. modelled production levels obtained from the National Renewable Energy Laboratory (NREL) tool PVWatts, for estimating the solar PV production of grid-connected systems to actual production data from a sample of 100 solar PV installations. The study resulted in a calibration ratio of 1.009 to be applied to the tracked savings of all SolarHomes participants.

Therefore, to obtain a unitary savings value for solar PV savings, the Evaluator calculated the average tracked savings per kW of the solar PV systems installed through SolarHomes for the past two years (2021/2022 and 2022/2023) and applied the calibration ratio of 1.009.

Table 10: Solar PV Savings Values Obtained from SolarHomes

Program Year	Number of Installations	Tracked Savings (from PVWatts)	Calibrated Savings (multiplied by 1.009)
2021/2022	2,751	1,086 kWh/kW	1,097 kWh/kW
2022/2023	2,056	1,062 kWh/kW	1,072 kWh/kW
Average	-	1,076 kWh/kW	1,086 kWh/kW

The average calibrated savings value obtained is **1,086 kWh/kW**, therefore no adjustment to the tracked savings value used by EOne is required.

Reporting Requirements

HEA incentives originate from three sources of funding: Nova Scotia Power ratepayers for DSM, the Province of Nova Scotia, and the CGH Grant. The incorporation of the CGH Grant, as a co-funder of the energy assessments and measures for both DSM and Province of Nova Scotia funding, has not changed anything in EOne's evaluation reporting structure. Therefore, HEA savings are reported to two different parties, the NSUARB and the Province of Nova Scotia, via the DSM evaluation and the Province of Nova Scotia (PNS) evaluation reports.

The DSM evaluation is focused on reporting electrical savings achieved with electrical DSM investments, while the PNS evaluation reporting requirements for HEA are focused on participation and GHG emission reductions achieved with government funding regardless of the type of fuel. To avoid double-counting and determine the most appropriate way to report associated savings, equations for each possible scenario were developed. The equations and their rationales are presented in Appendix VII.

As for the solar PV measures newly introduced through HEA with the CGH Grant, since solar PV generation offsets electricity use, i.e. resulting in savings to the electric grid, solar PV measure savings are included in the DSM Evaluation Report for HEA regardless of participant heating source.

4.2.3 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 conducted 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 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 to calculate separately the unitary peak demand savings of mini-split heat pumps. 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 with that of Green Heat. As a result, mini-split heat pump peak demand savings were calculated based on the 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 outlined in Table 11 below.

Table 11: 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
Conversion factor [W/kW]	-	1,000

For space heating measures that are not modelled in HOT2000, specific peak demand savings values were used (instead of applying a peak demand-to-energy ratio) to be consistent with Green Heat. The detailed calculations are presented in the 2020-2023 Measure Assessment.

Table 12: 2023 HEA Tracked and Evaluated Unitary Peak Demand Savings for Non-modelled Space Heating Measures

Measure	Tracked Savings [W]	Evaluated Savings [W]
Non-modelled Space Heating		
Wood or Pellet Stoves with Electric Resistance or Heat Pump Baseline	4,000	No change
Wood Furnaces/Boilers with Electric Resistance or Heat Pump Baseline	7,660	No change
Pellet Furnaces/Boilers with Electric Resistance or Heat Pump Baseline	7,750	No change

Domestic Hot Water Peak Demand Savings

Unitary peak demand savings for DHW measures are presented in Table 13 below. The detailed calculations are presented in the 2020-2023 Measure Assessment.

Table 13: 2023 HEA Tracked and Evaluated Unitary Peak Demand Savings for DHW Measures

Measure	Tracked Savings [W]	Evaluated Savings [W]
DHW Measures		
Solar DHW	0	No change
Heat Pump Water Heaters – with Electric Resistance Baseline	140	191
Heat Pump Water Heaters – with Heat Pump Baseline	220	207

Solar PV Peak Demand Savings

Peak demand savings for solar PV are assumed to be nil (**0 W**) because PV systems in Nova Scotia do not receive direct sunlight during the peak demand period.

Demand Reduction Measures

Incentives were offered for demand reduction measures through HEA, namely electric thermal storage (ETS) units and DHW heater timers. For these measures, separate peak demand savings values were established. The detailed calculations are presented in the 2020-2023 Measure Assessment.

Table 14 summarizes the tracked and evaluated peak demand savings values established for each category of demand reduction measures.

Table 14: 2023 HEA Tracked and Evaluated Unitary Peak Demand Savings for Demand Reduction Measures

Measure		Tracked Savings [W]	Evaluated Savings [W]
Demand Reduction Measures			
ETS Units	Maximum Storage Capacity in 8 Hours / 16 Hours		No change
Three-element Water Heaters	200		No change
DHW Heater Timers	500		No change

4.2.4 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 the vast majority of HEA energy efficiency upgrades target heating and cooling loads directly (heat pumps, insulation measures, etc.), the impact of these upgrades on heating and cooling are already considered in the savings calculations. Therefore, no additional interactive effects factors are applied to the savings for energy efficiency upgrades. As for solar PV systems, savings are not impacted by interactive effects.

4.2.5 Effective Useful Life

As part of 2020-2023 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 for water heating measures are directly applied to the unitary savings value. For space heating measures, the average EUL value was established by calculating the weighted average of EUL values associated with building envelope measures and space heating equipment installed under HEA in 2021. All EUL values used remained the same as in the 2022 evaluation, and the weighted average gross EUL value is 23.5 years.



4.2.6 Evaluated Gross Savings

The annual gross savings for each category of measure installed through HEA in 2023 are listed in Table 15 below.

The gross savings at the generator were estimated by using residential line loss factors of 1.095 and 1.147 for energy and peak demand savings respectively. The residential line loss factors correspond to the values submitted to the NSUARB as part of the 2014 Cost of Service Study Progress Update.⁷ Residential line loss factors were used for all participants since municipal rate codes only represent a very small portion of participants (less than 1%).

Note that an adjustment was made to the 2023 savings results to account for the difference between the actual and estimated savings of 420 participants whose E assessment files had been submitted to NRCan in 2022 and were only processed and sent to EOne in 2023 due to significant delays at NRCan. In the 2022 evaluation, the number of participants with E assessment data not received by EOne was multiplied by the average electrical energy and peak demand savings values per participant based on the projects completed in 2022. In the 2023 evaluation, the Evaluator calculated the actual participant savings using the E assessment data that were then available and deducted the estimated net savings claimed in 2022.

⁷ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 15: Evaluated 2023 HEA Gross Energy and Peak Demand Savings

Measure Category	Space Heating*	HPWHs – Electric Resistance Baseline	HPWHs – Heat Pump Baseline	Electrical Thermal Storage	Sub-Total – Energy Efficiency Upgrades	Solar PV Measures	Adjustment for 2022 Estimated Savings	Total
Number of Participants**	3,976	-	-	-	3,995	1,520	(420)	4,085
Number of Units	-	1	41	13	-	-	-	-
Total Installed Capacity (kW)	-	-	-	-	-	16,491	-	-
Evaluated Energy Savings								
Unitary Energy Savings (kWh)	-	1,179	1,280	-	-	1,086	4,320	-
Gross Energy Savings Without Overestimation Ratio (OR) – at the Meter (GWh)	15.731	0.001	0.052	-	15.785	17.910	-	-
Gross Energy Savings with OR – at the Meter (GWh)	11.779	0.001	0.052	-	11.832	17.910	(1.814)	27.928
Line Loss Factor	1.095	1.095	1.095	-	1.095	1.095	1.095	1.095
Gross Energy Savings with OR – at the Generator (GWh)	12.898	0.001	0.057	-	12.956	19.611	(1.987)	30.581
Effective Useful Life (years)	20.8	10.0	10.0	-	20.8	25.0	21.0	23.5
Gross Lifetime Energy Savings – at the Generator (GWh)	268.272	0.013	0.575	-	268.859	490.275	(41.722)	717.412
Peak Demand Savings								
Unitary Peak Demand Savings Value (W)	-	191	207	-	-	-	3,850	-
Gross Peak Demand Savings – at the Meter (MW)	8.968	0.000	0.008	0.003	8.980	-	(1.617)	7.363
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)	10.287	0.000	0.010	0.004	10.301	-	(1.855)	8.446
*Space heating includes building envelope and space heating equipment, such as wood or pellet stoves, boilers, and furnaces that are not modelled in HOT2000.								
**The number of participants who install space heating measures, other energy efficiency upgrades, and solar PV measures is not mutually exclusive.								

As presented in Table 16, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor⁸ for GHG emissions generated by electricity production to HEA net savings.

Table 16: Evaluated 2023 HEA Gross GHG Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	30.581
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO ₂ eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	16,887

4.3 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, which 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.

4.3.1 Free-ridership

For HEA, free-ridership occurs when participants would have implemented energy efficiency upgrades and/or solar PV systems in the absence of the program component.

Free-ridership was assessed as part of this evaluation using a self-reporting approach (n=100). During a telephone survey, 77 participants were asked a series of questions regarding their decision-making process to install energy efficiency upgrades, including planning, cost, timing, and quantity. A similar series of questions was asked to those who installed a solar PV system (n=29). The algorithms underlying the free-ridership calculations are presented in Appendix V.

For energy efficiency upgrades, the survey revealed a free-ridership level of 17% compared with the tracked value of 26% measured in 2020, indicating a decrease in the free-ridership level that could be attributable to the introduction of the CGH Grant and probably leading customers to participate that would not have done so otherwise. However, a comparison with the 2020 result must be taken with caution as the algorithm used to measure free-ridership was modified in 2023 to take into account the increasing proportion of heat pumps installed and the fact that it is the only measure installed by several participants. Questions similar to those asked in Green Heat for heat pump measures were added to the HEA questionnaire while keeping questions specific to the HEA context, i.e. the influence of the home energy assessment and EA recommendations on the decision-making process and overall program influence. Interestingly, cross influence questions, which measure the influence of previous participation in other programs or general information provided by EOne regarding energy efficiency had an impact on HEA free-ridership.

⁸ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO₂ eq tonnes) and total electricity generation (10,456 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 December 1, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22%2723.pdf (Last accessed December 1, 2023).

For solar PV measures, a free-ridership of 26% was measured through the survey. In 2022, free-ridership was assumed to be 29% for solar PV measures based on results of the participant survey conducted as part of the 2021/22 SolarHomes evaluation.

Table 17 outlines the free-ridership levels measured for HEA for 2023 along with the survey parameters.

Table 17: 2023 HEA Free-ridership Level

Measure	Average Free-ridership Level	Sample Size	Population Size	Margin of Error
Energy Efficiency Upgrades	17%	77	3,995	4.20%
Solar PV Measures	26%	29	1,520	6.50%

4.3.2 Participant Spillover

For HEA, participant spillover occurs when participants implement additional measures recommended in their initial energy assessments after their participation in the program component, i.e. after having completed the final energy assessment and due to the influence of having participated in the program component without receiving any additional support from the program component.

Similarly to free-ridership, spillover was measured for 2023 through the participant survey. A total of 11 participants revealed having implemented additional energy efficiency upgrades recommended in their initial energy assessments after their participation in the program component, and a spillover level of 1% was established. In comparison, the same spillover level of 1%, measured through the 2020 HEA participant survey, was used for tracking.

Table 18 below outlines the 2023 participant spillover level measured for HEA along with the survey parameters.

Table 18: 2023 HEA Participant Spillover Level

Measure	Number of Participants Generating Spillover	Average Participant Spillover Level
All Measures	11	1%

4.3.3 Net-to gross Ratio Calculation

The NTGR is calculated using the following equation.

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

The NTGR values calculated with the free-ridership and spillover levels established through the 2023 HEA participant survey are presented in Table 19.

Table 19: 2023 HEA NTGR

Measure	Free-ridership	Participant Spillover	NTGR
Energy Efficiency Upgrades	17%	1%	0.84
Solar PV Measures	26%		0.75

4.3.4 Unconverted Assessment Spillover

The unconverted D assessment savings spillover effect corresponds to the savings associated with those measures implemented by electrical 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). It should be noted that only expired participants who use electricity as their primary heating source are considered in the analysis. Their savings are added to gross savings as a form of spillover.

Table 20 below outlines the parameters used to establish the unconverted D assessment spillover level. A total of 1,441 unconverted D assessment participants who use electricity as their primary heating source were included in the 2023 tracking sheet. Total unconverted D assessment spillover savings were calculated by multiplying the number of unconverted D assessment participants by both the proportion of participants who completed at least one upgrade (54%) and the associated savings (2,283 kWh). The 54% figure is based on the results of a survey conducted in 2016 and the 2,283 kWh of electrical energy savings that were influenced by EOne were determined with on site visits conducted in 2014 and 2015 and HOT2000 simulations. To better represent unconverted D assessment spillover savings 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 20: 2023 HEA Unconverted D Assessment Spillover

2023 Results	
Total Number of Unconverted D Assessment Participants	1,441
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	778
Average Electrical Savings per Participant in kWh (with influence from EOne)	2,283
Total Unconverted D Assessment Spillover Energy Savings – at the Meter (GWh)	1.776
Demand-to-energy Ratio (MW/GWh)	0.283
Total Unconverted D Assessment Spillover Peak Demand Savings – at the Meter (MW)	0.503

As mentioned in Subsection 1.2 above, a recommendation was made as part of the 2020 HEA evaluation to update the unconverted D assessment participant parameters. Considering all the changes made to HEA since these parameters were determined and the increasing number of expired participants, it will be important to conduct these activities no later than in 2024.

4.3.5 Green Heat and EPI Savings Deductions

Several measures are offered under both HEA and Green Heat. In addition, Efficient Product Installation (EPI) introduced air sealing measures 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 HEA and Green Heat/EPI during the same period.

Customer IDs are not used uniformly in the different tracking sheets to easily identify participation overlaps. To identify participants who participated in HEA and Green Heat or EPI during the same period, EOne created a tool which use different customer information fields to find matches in the relevant tracking sheets. The Evaluator considers that the tool developed by EOne allows identifying most overlaps, which are rare since delays with NRCAN are resolved and EOne is able to intercept overlaps between HEA and Green Heat prior to finalizing the participation process in Green Heat.

Table 21: 2023 Savings Overlap to Deduct from HEA

Overlap	Net Energy Savings at Generator (GWh)	Net Peak Demand Savings at Generator (MW)
Overlap with Green Heat	0.043	0.012
Overlap with EPI	0.038	0.007
Total	0.081	0.019

4.3.6 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:

$$\text{Net Savings} = \text{Gross Savings} \times \text{NTGR} + \text{Unconverted D Assessment Spillover Savings} - \text{Green Heat Net Savings Deductions} - \text{EPI Net Savings Deductions}$$

The detailed net savings results are presented in Table 22. The net energy savings resulted in 14,330 tonnes of CO₂ eq in net annual GHG emission reductions.

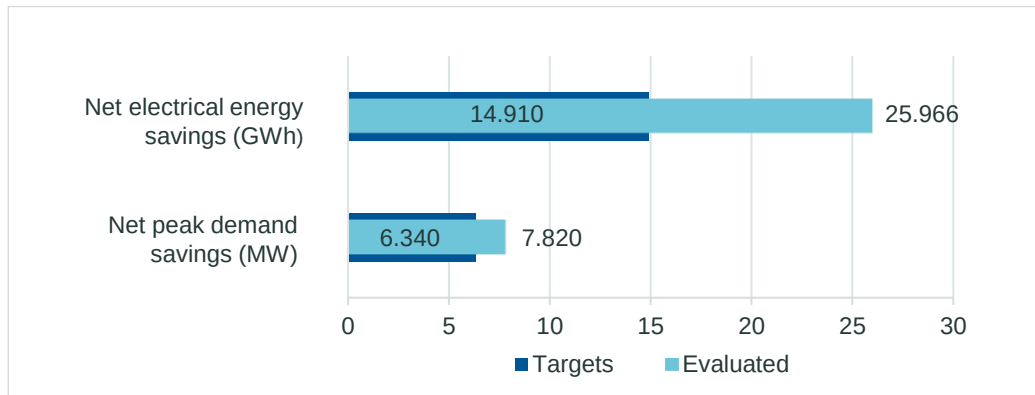
Table 22: Evaluated 2023 HEA Net Energy and Peak Demand Savings

	Energy Efficiency Upgrades	Solar PV Measures	Adjustment for 2022 Estimated Savings	Total
Energy Savings				
Gross Energy Savings – at the Meter (GWh)	11.832	17.910	(1.814)	27.928
Unconverted D Assessment Spillover Energy Savings (GWh)	1.776	-	-	1.776
NTGR	0.84	0.75	0.75*	-
Net Energy Savings Without Savings Deductions – at the Meter (GWh)	11.716	13.432	(1.361)	23.787
Line Loss Factor	1.095	1.095	1.095	-
Green Heat and EPI Net Energy Savings Deductions (GWh)	(0.081)	-	-	(0.081)
Net Energy Savings with Savings Deductions – at the Generator (GWh)	12.747	14.708	(1.490)	25.966
Effective Useful Life (years)	20.8	25.0	21.0	23.1
Net Lifetime Energy Savings – at the Generator (GWh)	264.523	367.707	(31.292)	600.938
Peak Demand Savings				
Gross Peak Demand Savings – at the Meter (MW)	8.980	-	(1.617)	7.363
NTGR	0.84	-	0.75*	-
Unconverted D Assessment Spillover Peak Demand Savings (MW)	0.503	-	-	0.503
Net Peak Demand Savings Without Savings Deductions – at the Meter (MW)	8.046	-	(1.213)	6.834
Line Loss Factor	1.147	-	1.147	-
Net Peak Demand Savings Without Savings Deductions – at the Generator (MW)	9.229	-	(1.391)	7.838
Green Heat and EPI Net Peak Demand Savings Deductions (MW)	(0.019)	-	-	(0.019)
Net Peak Demand Savings – at the Generator (MW)	9.211	-	(1.391)	7.820
*The NTGR and EUL values used for the adjustment for 2022 estimated savings correspond to the values used in 2022 for energy efficiency upgrades.				



As outlined in Figure 6, HEA surpassed its targets by 174% and 123% for energy and peak demand savings respectively.

Figure 6: 2023 HEA Targets and Evaluated Savings



4.4 Realization Rate

Table 23 below compares the energy and peak demand savings established through this evaluation to those calculated in the 2023 tracking sheet. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 23: Comparison of 2023 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	30.584	GWh	0.79	24.018	GWh	108%
Evaluation Results	30.581	GWh	0.85	25.966	GWh	
Peak Demand Savings						
Tracked Savings by EOne	8.446	MW	0.82	6.893	MW	113%
Evaluation Results	8.446	MW	0.93	7.820	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 higher than the net results tracked by EOne. The differences are due to the new NTGRs evaluated as part of this evaluation, which rose from 0.75 to 0.84 for energy efficiency upgrades and from 0.71 to 0.75 for solar PV measures. A smaller difference is also observed between the tracked and evaluated gross savings due to the revised unitary savings values for heat pump water heaters.



5 HEA Key Findings and Recommendations

As mentioned previously, the main objectives of the 2023 HEA 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 emissions

This section provides the Evaluator's key findings in relation to the above objectives.

2023 HEA Finding: Both HEA net electrical energy and demand savings exceeded targets.

HEA achieved 25.966 GWh in net electrical energy savings and 7.820 MW in net peak demand savings at the generator in 2023, thus exceeding the planned net electrical energy savings of 14.910 GWh and the planned net peak demand savings of 6.340 MW.

2023 HEA Finding: The increase in participation and average gross savings per home observed since the introduction of the CGH Grant continues and was more significant in 2023.

With 4,085 projects, the 2023 participation level was the highest observed for HEA since the program component was launched. The average gross energy savings per home was 7,486 kWh, an increase of 57% compared to 2022. The integration of the CGH Grant into HEA likely contributed to these increases. More specifically, one of the main contributors was the addition of solar PV measures in the HEA offering.

2023 HEA Finding: HEA is still highly appreciated among participants, especially the recommendations from EAs.

Overall satisfaction with HEA is high with an average rating of 8.3 out of 10 among participants. Participants provided the highest level of satisfaction for the expertise of EAs (8.8) and the lowest for the HEA website (7.1). A new source of dissatisfaction was also observed among certain less satisfied participants who mentioned that it took too long to receive their rebate, which was likely due to the delays engendered by the introduction of the CGH Grant.

2023 HEA Finding: The evaluated energy and peak demand savings were higher than the savings tracked by EOne due to lower free-ridership levels measured as part of the 2023 evaluation.

Free-ridership and spillover were measured as part of the 2023 evaluation through a participant survey. Both free-ridership levels measured for energy efficiency upgrades and solar PV measures were lower than the values tracked by EOne. For energy efficiency upgrades, the survey revealed a free-ridership level of 17% compared with the tracked value of 26% measured in 2020. For solar PV measures, a free-ridership level of 26% was measured through the survey compared with a tracked value of 29% drawn from the 2021/22 SolarHomes evaluation.



2023 HEA Finding: Billing analysis results were inconclusive and the Evaluator kept the ORs established in 2018 for the 2023 evaluation.

The Evaluator conducted a billing analysis as part of the 2023 evaluation to review not only the parameters used to adjust the savings obtained from HOT2000 models, but also the savings calculation methodology. However, the billing analysis results were inconclusive and further exploration will be necessary to understand the factors that contributed to obtaining inconclusive results and then refine the impact evaluation approach for the 2024 evaluation.

Recommendation #1: Continue exploring the factors potentially responsible for the inconclusive billing analysis results, one being related to billing data interpretation, and work with the Evaluator to define the impact evaluation approach to be taken in 2024. Depending on the answers obtained through the exploration process, options other than a billing analysis may need to be considered for the 2024 evaluation. Given the change in the characteristics of participants entering the program component since 2018, the Evaluator does not consider it acceptable to use the current OR beyond 2023.

6 Green Heat Overview

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

6.1 Green Heat Description

The Green Heat component of the Existing Residential program 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 7 outlines the main steps of the Green Heat participation process. In October 2021, incentives were increased and a midstream incentive component pilot was added for electric thermal storage (ETS); the pilot terminated at the end of 2022.

Figure 7: Green Heat Participation Process Summary

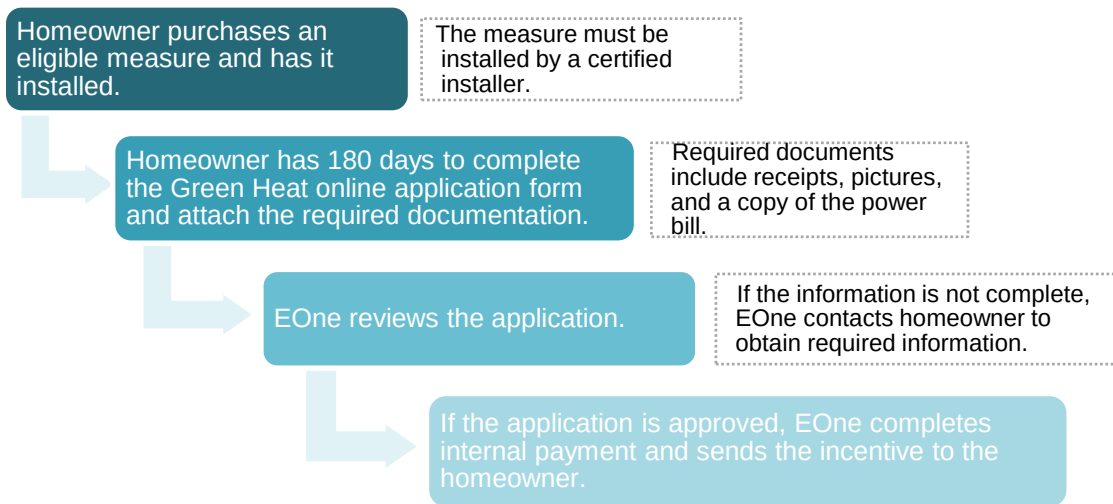


Table 24 below summarizes current Green Heat incentives for each type of eligible system.

Table 24: 2023 Green Heat Incentives

Measure	Incentive
Heat Pumps	
Ductless Mini-split Heat Pumps	\$200/Refrigeration Tonne
Centrally Ducted Air-source Heat Pumps	\$400/Refrigeration Tonne
Air-to-water Heat Pumps	\$400/Refrigeration Tonne
Ground-source Heat Pumps	\$500/Refrigeration Tonne
Biomass	
Wood/Pellet Stoves or Fireplace Inserts	\$500/Unit
Wood/Pellet Boilers or Centrally Ducted Forced Air Furnaces	\$1,000/Unit
Solar Thermal	
Solar Thermal: Air Heating	\$400/Unit
Solar Domestic Hot Water (DHW)	\$1,000/Unit
Demand Reduction	
Electric Thermal Storage (ETS, listed room unit)	\$316-\$1,600/Unit*
Electric Thermal Storage (unlisted room unit)	\$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 nine eligible ETS room units offered through Green Heat. The incentive level varied depending on the model.	

Since July 2018, through the addition of funds from the federal Low Carbon Economy Fund (LCEF) and provincial Green Fund, 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.

Green Heat was aimed at achieving net electrical energy savings of 3.629 GWh and 2.920 MW in net peak demand savings at the generator in 2023.

6.2 Follow-up on Past Evaluation Report Recommendations

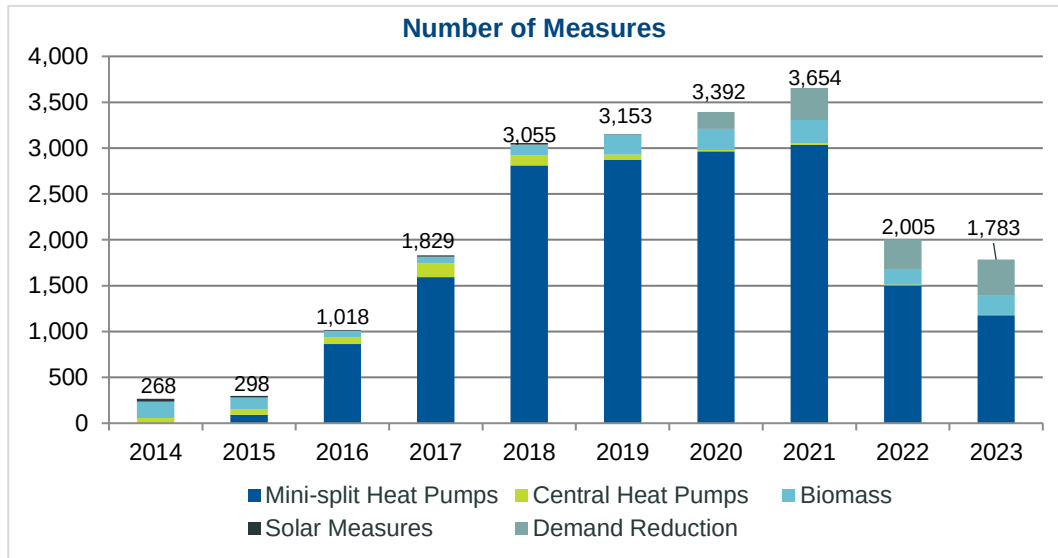
The Evaluator evaluated Green Heat in previous years and issued improvement recommendations. However, there were no new recommendations in 2022 and the past recommendations that were not yet implemented are no longer relevant; hence, there are no remaining past recommendations that require follow-up.

6.3 Participation History

In 2023, the number of Green Heat measures installed decreased by 11% compared to 2022 levels, primarily due to a 22% drop in the number of installed MSHPs, as illustrated in Figure 8 below. The launch of the Canada Greener Homes Grant (CGH Grant) by the federal government in May 2021 contributed to this decline. A portion of participants opted to enroll in HEA and the CGH Grant rather than Green Heat to access higher federal incentives, as highlighted by the increase in HEA participants accessing MSHP incentives in 2023 (see Table 37 in Subsection 10.2).

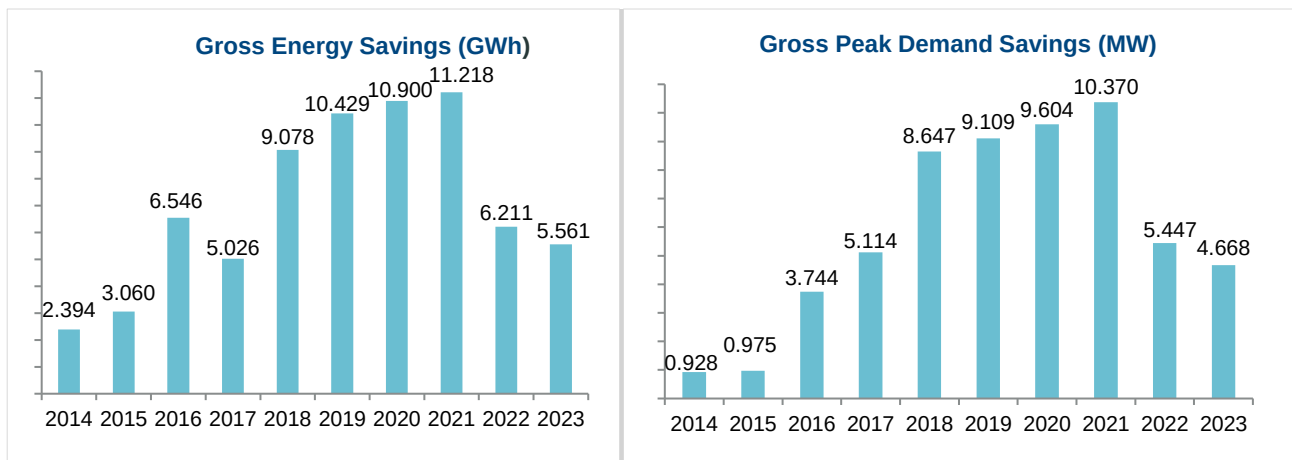
Introduced in Green Heat in 2020, demand reduction measures have remained stable since 2021 with 186 ETS units, 54 domestic hot water heater timers, and 146 three-element water heaters being incented under the program component.

Figure 8: Overview of Green Heat Participation, 2014-2023



As indicated in Figure 9 below, in 2023, Green Heat recorded its lowest savings levels since 2017, 10% lower than in 2022. This was mostly due to the lower number of measures installed, including MSHPs that represented 61% of gross energy savings in 2023.

Figure 9: Evolution of Green Heat Gross Savings, 2014-2023



7 Green Heat Evaluation Approach

The 2023 Green Heat evaluation comprised a condensed impact evaluation as well as process, and market evaluations.

The main objectives of the evaluations were as follows:

- › Collect information on participant and partner perspectives
- › Calculate gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions
- › Analyze the market evolution of mini-split heat pumps (MSHPs)

The Evaluator had intended to perform a billing analysis to update the unitary savings for the most popular measure, MSHPs. However, upon manipulating billing data for the HEA billing analysis, the Evaluator had reasons to believe that billing data could be misinterpreted and therefore excluded the billing analysis from the 2023 Green Heat evaluation. The issues with billing data are still under review with the hope of reaching a resolution to update the unitary savings through an analysis in 2024. The Evaluator identified key research questions aimed at achieving the above objectives. Table 25 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 25: 2023 Green Heat Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Collect information on participant and partner perspectives	› What is the level of satisfaction with the component among participants and contractors, including the online portal and application process? › Why do participants provide incomplete applications/documentation? › How well do distributors, participants, and contractors understand the differences between Green Heat and HEA? › Under what conditions do contractors recommend either Green Heat or HEA to their clients? › Why do participants choose Green Heat or HEA (e.g. cost, wait times, confusion, eligible rebates)? › What works well and what are the key challenges for the component? › How can EOne improve the component and participant process?	› Participant survey › Contractor interviews › Distributor interviews
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 › Calculations using evaluation results
Calculate net results	› What is the free-ridership level for the component, considering MSHPs, biomass, and ETS measures? › 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?	› Participant survey › Calculations using evaluation results › GHG emission reduction calculations
Analyze the market evolution of MSHPs	› How has the market evolved since 2021? › What has changed since the announcement of the CGH Grant?	› Heat pump distributor interviews › Market evolution and characterization study

Participant Survey

A total of 124 Green Heat participants composed of n=90 MHSP participants, n=29 biomass participants, and n=5 ETS participants took part in a telephone survey in October and November 2023. The average interview duration was 17 minutes. The aim of the survey was to provide inputs for the calculation of free-ridership and spillover and understand participant perspectives on the program component. The survey questionnaire is presented in Appendix IX, and complete survey results are outlined in Appendix X.

Table 26 presents the total number of Green Heat participants, sample sizes, as well as the corresponding margins of error at a 90% confidence level for the 2023 telephone survey. It should be noted that the margin of error for Biomass was high and that for ETS was particularly high due to low population sizes.

Table 26: 2023 Green Heat Survey Sample Sizes and Margins of Error

Measure	Final Population	Population at Time of Survey	Sample Size	Sampling Margins of Error at 90% Confidence Level
MSHPs	1,132	858	90	±5.5%
Biomass	213	176	29	±8.2%
ETS	314	64	5	±13.4%
Total	1,659	1,098	124	±9.0%

Contractor Interviews

In October and November 2023, Narrative Research conducted 20 interviews with contractors involved in Green Heat to obtain their perspectives on the component and their feedback on the Nova Scotia MSHP market. The guide used for the contractor interviews is presented in Appendix XI.

Distributor Interviews

In November 2023, Narrative Research conducted five interviews with distributors that sell and install heating, ventilation, and air-conditioning (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 XII.

Tracking Sheet Audit

Prior to performing the savings review, the Evaluator performed an audit of the final 2023 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 XIII.

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 8.7 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.

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 precision⁹ of a measurement, while its associated confidence level indicates the probability of a measurement falling within the margin of error¹⁰.

As part of the Green Heat evaluation, the Evaluator calculated the margins of error for free-ridership levels. 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 2023 DSM Programs Evaluation Executive Summary.

⁹ 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.

¹⁰ 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.



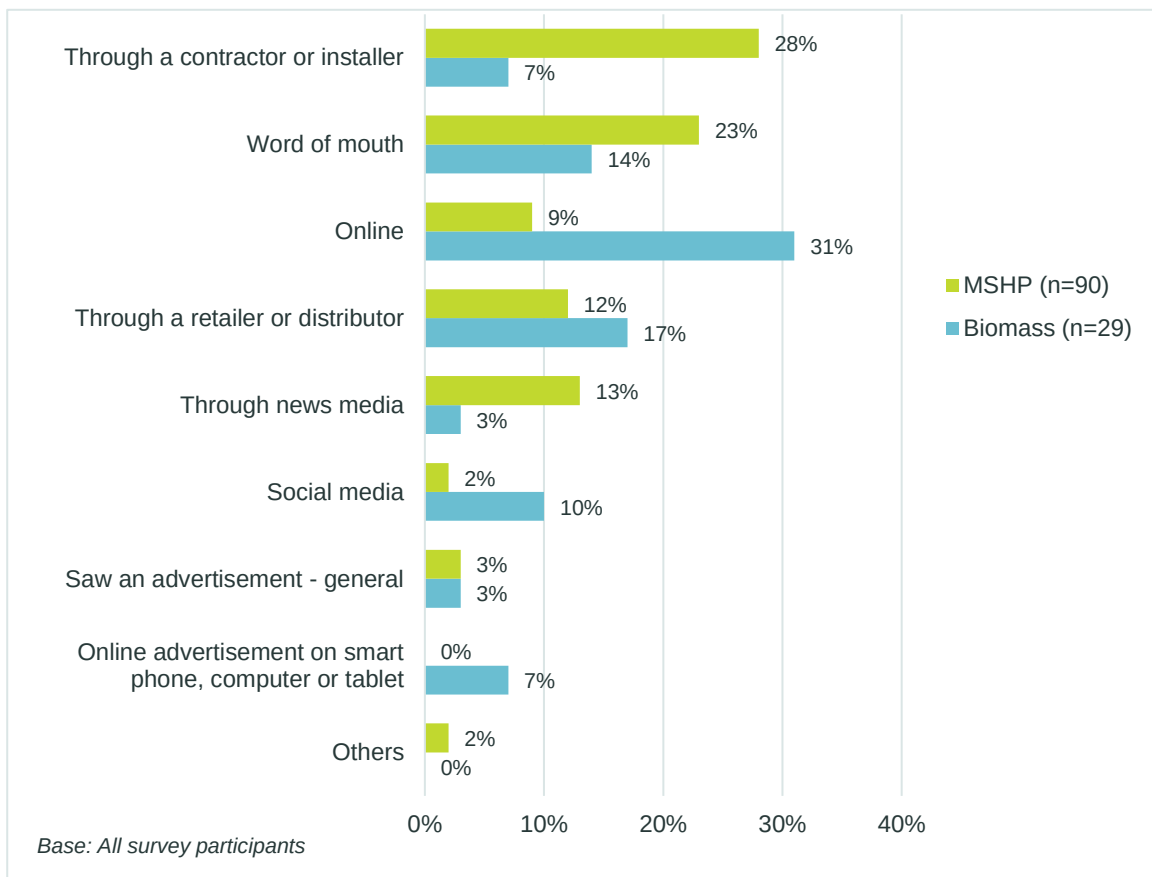
8 Green Heat Stakeholder Perspectives

This section presents an analysis of stakeholder perspectives on Green Heat. Stakeholders include Green Heat MSHP, biomass, and ETS participants, MSHP and ETS contractors, and MSHP distributors. It should be noted that, due to the sample size for Green Heat ETS participants (n=5), results are only presented when pertinent and are provided as numbers of participants rather than percentages.

8.1 Awareness About Green Heat and Motivations for Participating

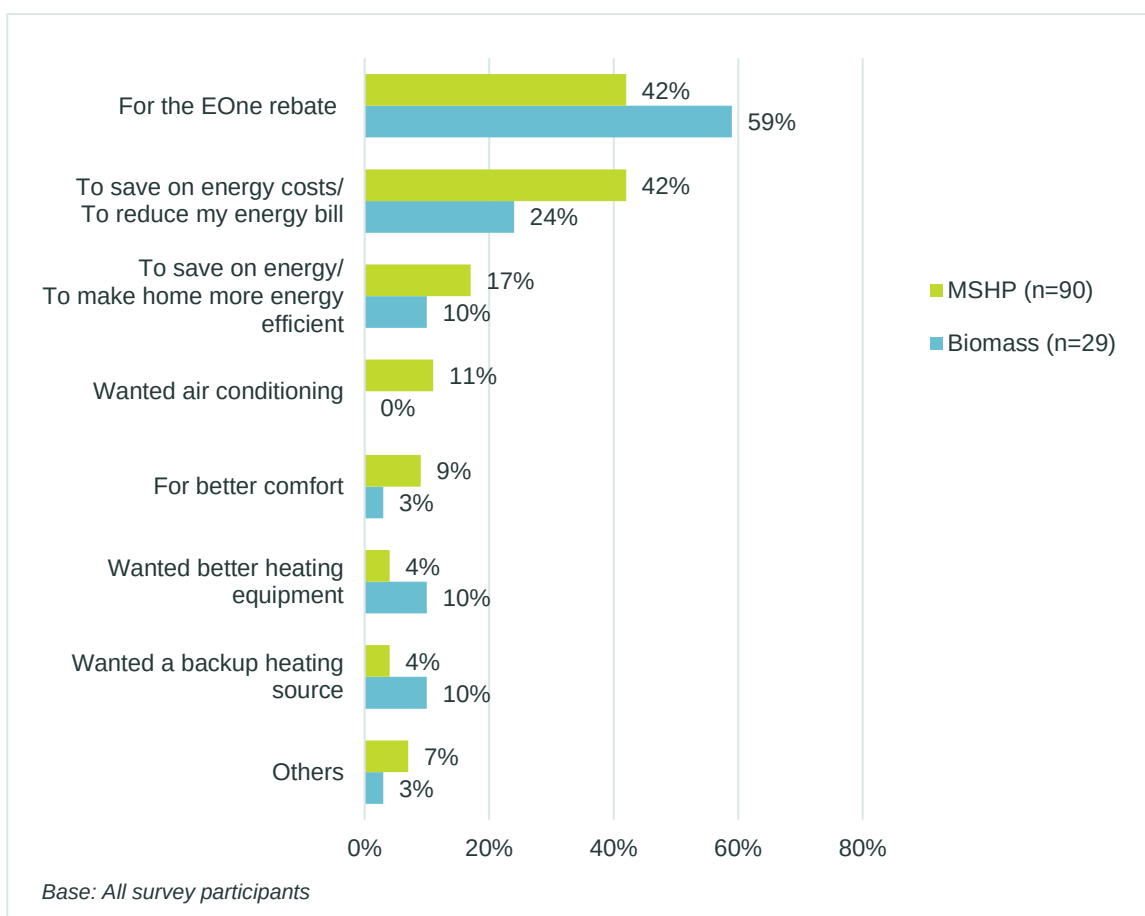
As the results illustrate in Figure 10 below, MSHP and biomass participants cite different sources of awareness about Green Heat. MSHP participants mentioned contractors/installers and word of mouth the most (28% and 23% respectively), whereas biomass participants indicated online sources most frequently (31%), followed by a retailer or distributor (17%), word of mouth (14%), or social media (10%) to a lesser extent. These results reflect EOne's marketing strategies targeting contractors, retailers, and distributors and using newer online and social media advertisements.

Figure 10: Source of Green Heat Awareness



The main reason participants were keen to participate in Green Heat revolves around **saving money**, either upfront through the rebate offered by EOne – particularly motivating for biomass participants (59%) – or in the near future by saving on energy costs – particularly among MSHP participants (42%). While reported much less often, alternative reasons for Green Heat participation included saving energy, having air conditioning, and increasing home comfort (see Figure 11).

Figure 11: Drivers to Green Heat Participation
– MSHP and Biomass Participants (Multiple Unaided Mentions)



8.2 Satisfaction

8.2.1 Participants

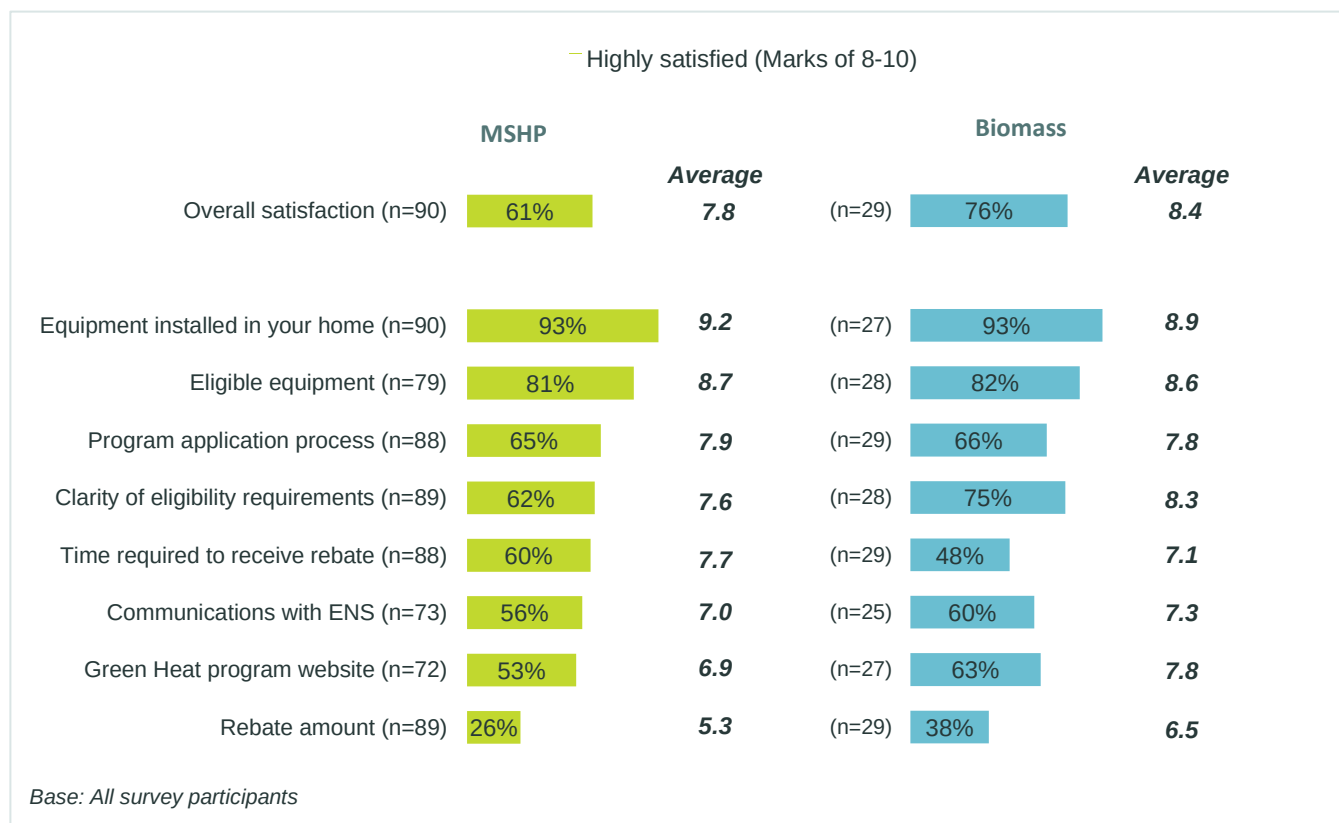
As the results in Figure 12 below indicate, biomass and MSHP participants are **highly satisfied** with the **equipment installed** in the home and the **selection of equipment** eligible for rebate. That said, **biomass participants have a higher level of satisfaction with the program overall than MSHP participants** (76% vs. 61% respectively are highly satisfied). This seems to be mainly due to lower satisfaction among MSHP participants with the **clarity of eligibility requirements** (62% for MSHP vs. 75% for biomass participants) and with the **Green Heat website** (53% for MSHP vs. 63% for biomass participants).

Satisfaction begins to slip when it comes to the **program application process** – two in three MSHP and biomass participants (65% and 66% respectively) are highly satisfied – but falls further for **communications with EOne** (56% and 60% respectively) and the **time required to receive the rebate**, particularly among biomass participants (48% vs. 60% for MSHP).

Moreover, the **rebate amount garners the lowest satisfaction** score of all the elements evaluated, especially among MSHP participants (26% for MSHP vs. 38% for biomass participants).

For the few interviewed ETS participants, four out of five are completely satisfied with the program component overall (score of 10/10) while one participant is much less so (score of 5/10).

Figure 12: Satisfaction¹¹ With Green Heat



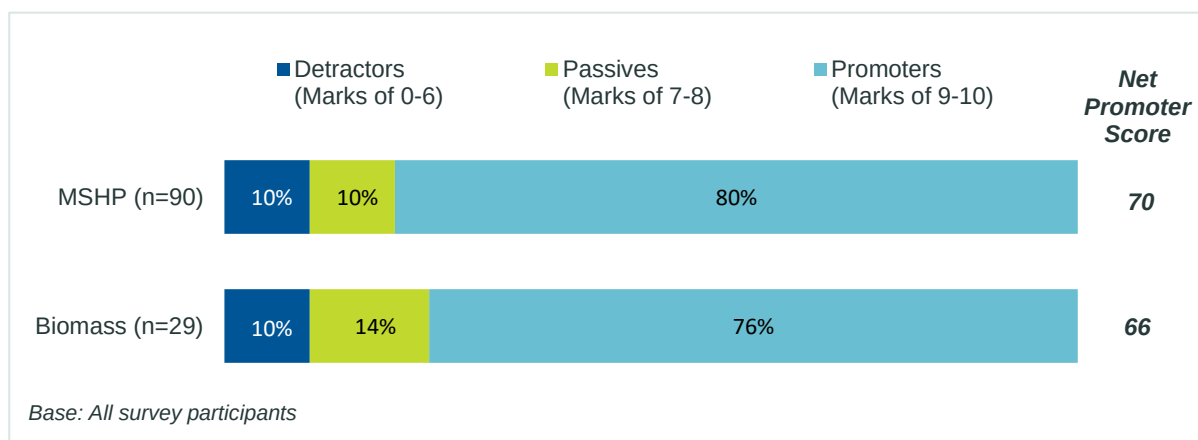
Net Promoter Score

As illustrated in Figure 13 below, the Net Promoter Score (NPS) is a tool that measures customer experience with and overall perceptions about a brand or program. It is calculated by subtracting the “Promoters” (i.e. those who provide a score of nine or ten and who will refer others and fuel growth) from the “Detractors” (i.e. those who provide a score of zero to six and who can impede growth through negative word of mouth). The NPS can range from a maximum score of 100 (if everyone is a “Promoter”) to a minimum score of -100 (if everyone is a “Detractor”). The higher the NPS, the better. The overall NPSs for Green Heat among MSHP participants (70) and biomass participants (66) are relatively high and indicate that there are far more Promoters of the program component than Detractors, although one in 10 say they would definitely not be likely to recommend Green Heat.¹²

¹¹ Satisfaction was measured using a scale of 0 to 10 where 0 means “Not at all satisfied” and 10 means “Completely satisfied”.

¹² The sample size (n=5) was too low to calculate a score for ETS participants.

Figure 13: Likelihood to Recommend Green Heat



8.2.2 Contractors

The average **rating of 6.6 for overall program satisfaction** among contractors – with nine out of 20 being highly satisfied and eight providing a more neutral score – reveals that the program component does not perform optimally for everyone (Table 27). **Low incentives, communication issues with EOne, and overly restrictive eligibility criteria** (switching from oil to ETS, replacing an old heat pump, not being able to participate in both Green Heat and the CGH Grant) are the most commonly cited reasons for overall dissatisfaction with the program component (see Figure 14).

With respect to the various evaluated aspects of Green Heat, contractors are most likely to be satisfied with the program eligibility criteria (average score of 7.8), the program application form (7.6), and the Green Heat website (7.3).

Contractors are **less satisfied with:**

- › The **effectiveness of the program marketing materials** (average score of 5.4) mainly because they say that there is not enough marketing and only limited amounts of program materials
- › The **incentives** (6.4), which are said to be **too low** compared to other programs, other provinces, and relative to current costs
- › The list of **eligible equipment** (6.5), with dissatisfaction revolving around:
 - › The perception that newer, highly efficient units do not qualify for a rebate while older less efficient units do
 - › The list not being updated regularly
- › The **ENS portal** in general (6.7), mainly because it is **difficult to navigate** or search for eligible equipment

Figure 14: Satisfaction with Green Heat Elements

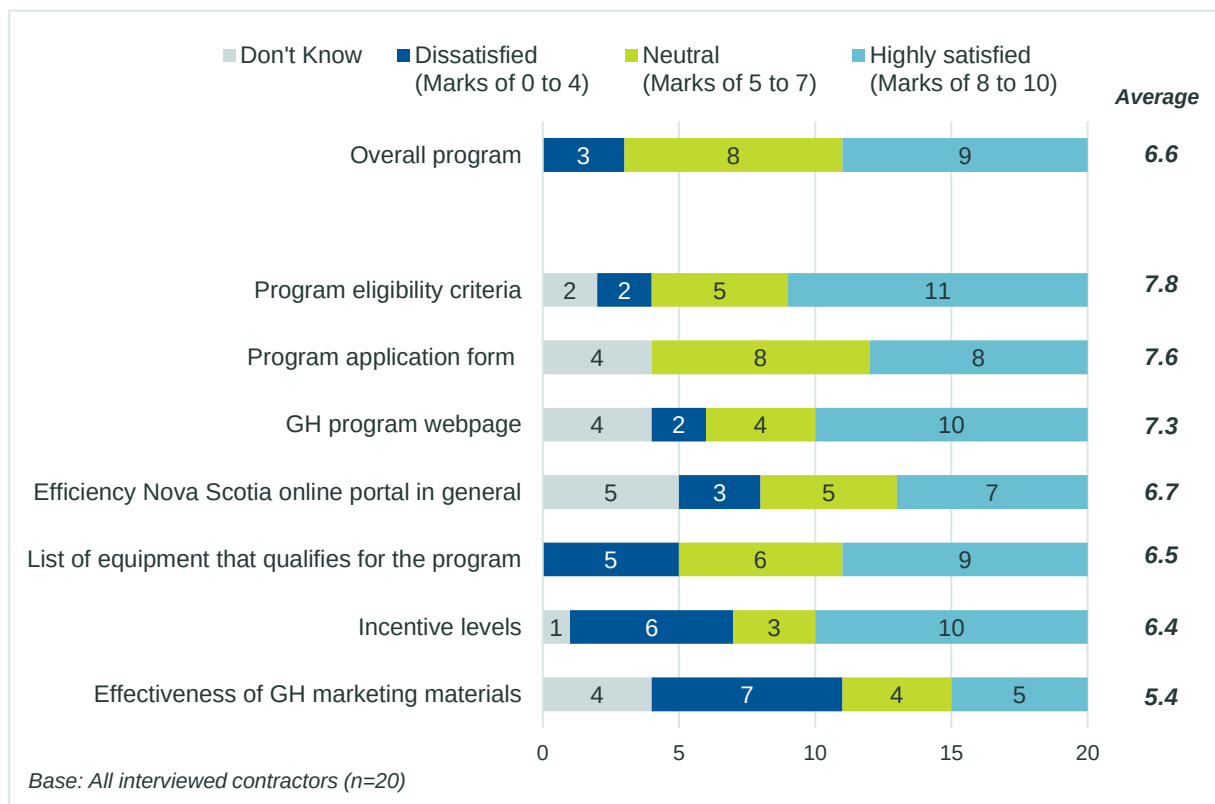


Table 27: Elements of Dissatisfaction and Justifications

Element of Dissatisfaction (Score of <8)		Reasons for Dissatisfaction/What Could Be Improved (#)	
n=11	Overall program	›	Communication issues/lack of information from EOne (4) › Eligibility criteria too restrictive (3) › Low incentives make program component irrelevant (2) › Too complicated for customers (1) › Don't know (1)
n=11	Effectiveness of Green Heat marketing materials	›	Limited materials/need more marketing (5) › Haven't seen any program marketing (2) › Misleading program component marketing from third parties (1) › No concerns (2)
n=11	List of equipment that qualifies for the program	›	Some newer, more efficient units do not qualify while older, less efficient units do (4) › List not updated regularly/my list is out of date (3) › List of eligible units for Green Heat does not match list of eligible units for the CGH Grant ¹³ (3) › Wood stoves should not be eligible (1) › Don't know (1)
n=9	Incentive levels	›	Too low compared to the CGH Grant (4) › Too low compared to other provinces (2) › Rebates have not increased to keep up with rising cost of equipment (2) › Too low (general) (1)
n=8	Efficiency Nova Scotia's online portal in general	›	Difficult to navigate across various programs/pages (4) › Search tool for eligible equipment ineffective (2) › Contractors need a dedicated ENS customer service representative (1) › No comment (1)
n=8	Program application form	›	Online form too difficult for some customers (2) › Too much detail required (2) › Need more clarity for customers (1) › No concerns (1) › Don't know (2)
n=7	Program eligibility criteria	›	Customers switching from oil to ETS should qualify (2) › Customers replacing an old heat pump should qualify (1) › Customers cannot participate in both Green Heat and the CGH Grant (1) › No one verifies if all contractors are being as efficient as they claim (1) › Don't know (2)
n=6	Green Heat webpage	›	Webpage difficult to navigate/find relevant information (3) › Information confusing for customers to read (2) › No concerns (1)

8.2.3 Application Form

Participants were asked about the ease of filling out the Green Heat application form. Overall, participants report that the application form was **easy to complete** and that the **instructions on how to fill out the form were simple to understand** (average mean scores of 8.2).¹⁴

¹³ The list of eligible units is, in fact, the same for Green Heat and the CGH Grant.

¹⁴ Participants were asked to provide their level of agreement with the statements: "The Heating System Rebates application form was easy to complete" and "The instructions on how to fill out the Heating System Rebates application form were simple to understand", using a scale of 0 to 10 where 0 means "Completely disagree" and 10 means "Completely agree." The average mean score was 8.2 for each statement.



More specifically:

- › 11% of Green Heat participants identified a **lack of website user-friendliness** and related difficulties completing the online application form.
- › 9% considered the application form **confusing**.
- › 6% said that there was **too much paperwork** or that it took too long to fill everything out.
- › 5% said that it was **difficult to find all the information** required.

Contractors indicate that filling out the form is fairly straightforward for those who are computer literate but can be challenging in general for those who are not.

Nearly all contractors (18 out of 20) say that they **direct participants to a Green Heat application form** in one format or another; only two indicate that they do not. The majority (16 out of 20) point participants to where they can apply online, although some contractors also provide a paper application form or PDF application form, particularly to assist older participants.

About half (nine out of 20) of contractors **help participants complete** the Green Heat application form. Among those who assist with the form, **many partially fill out** the application with their vendor information, but a few walk customers through the whole application or even submit it on their behalf.

The most frequently cited difficulty with the application form provided by contractors is participants **not collecting or including all the information they need**. This is a problem of interest to EOne staff as the Green Heat administration team deals with many incomplete applications. In particular, contractors mention that the **requirement to include the contractor's certification number is sometimes problematic** because they do not always like to give it out. Participants also seem to have **some difficulty taking photos** of the correct equipment information and/or **attaching** the resulting photos to their application.

Other potential reasons provided by contractors as to why some customers submit incomplete application forms include:

- › Making mistakes due to **lack of careful reading** or attention to detail
- › **Very limited knowledge** about MSHPs or ETS, which might cause required details to be missed (with some suggesting contractors should be responsible for clearly communicating such information).
- › A **lack of computer literacy** particularly among the aging population, leading to incomplete applications.

Another common issue with the application form is **finding and accessing the application form online**.

Additional difficulties include confusion about the application requirements versus other rebate applications, difficulty getting in touch with EOne about any questions, and finding the time to complete the application.

8.3 Familiarity with and Differences Between Green Heat and Home Energy Assessment/CGH Grant

8.3.1 Participant Familiarity

Nearly **nine in ten** (87%) Green Heat participants¹⁵ report knowing that Home Energy Assessment (**HEA**) enables access to the **CGH Grant**. Over one quarter of those who have heard of HEA/CGH **Grant** mention that they found out about HEA/CGH Grant via word of mouth (28%) or online (26%); one in seven (15%) report they saw an advertisement; and one in ten (11%) cite print ads (magazine or newspaper).

¹⁵ Questions about HEA/CGH **Grant** were not asked of ETS participants.



One quarter (27%) of participants aware of HEA claim that they **considered participating in CGH Grant instead of Green Heat** for their equipment purchase. This is more than twice as likely to be the case among biomass than MSHP participants (48% vs. 21% respectively).

Contractors state that on average **fewer than two in every ten customers** who know about both Green Heat and CGH Grant **choose to take part in Green Heat**. This finding supports the lower Green Heat participation rates in 2022 and 2023 since the launch of the CGH Grant.

Interestingly, **contractors or installers played a key role** in helping 17 out of 28 (61%) participants who had considered the CGH Grant to choose Green Heat instead. Furthermore, EOne Energy Solutions Advisors (ESAs) were said to have helped five out of 28 (18%) participants make the same decision. Other factors that played a part in customer decisions to participate in Green Heat instead of HEA/CGH Grant were the **cost of the home energy assessment** (21%), the **shorter wait times with Green Heat** (21%), and living in a home that is **new or already efficient** (18%). In addition to these justifications, contractors reported that customers who typically choose Green Heat do **not need multiple MSHP units** and therefore do not qualify for the CGH Grant.

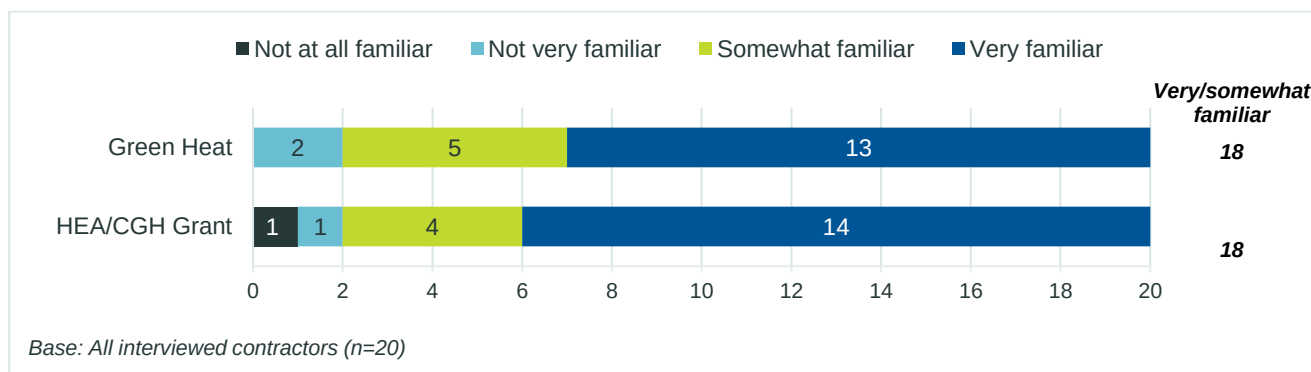


According to contractors, most customers experience at least some level of confusion about the differences between the two incentive schemes, with the majority of contractors indicating that the level of customer confusion is quite high.¹⁶

8.3.2 Contractor Familiarity

When interviewed contractors were asked about their familiarity with Green Heat, 13 out of 20 indicated they **knew the component well**. Familiarity with HEA/CGH Grant is equally robust – 14 out of 20 are very familiar with the component (Figure 15).

Figure 15: Contractor Familiarity with Green Heat and HEA/CGH Grant



However, responses outlining contractors' understanding of the differences between Green Heat and HEA/CGH Grant reveal that, although there is good knowledge, some uncertainty remains.

¹⁶ Contractors provided an average score of 7.6 on a scale of 0 to 10 where 0 means "The customer is very clear about the differences" and 10 means "The customer is very confused about the differences".



Incentives

Most contractors (14 of 20) understand that there is a **difference in the incentive structure** between the two incentive pathways. Those aware of the differences correctly note that the incentive is far larger under the CGH Grant than Green Heat. A few correctly state that, while Green Heat has a per-tonne rebate structure, the CGH Grant offers a flat rebate structure. A limited number of contractors also correctly notes that the CGH Grant offers interest free financing for efficiency measures while Green Heat does not.¹⁷

While just under half of contractors (eight of 20) indicate that they know customers cannot receive incentives from both Green Heat and CGH Grant, more than half **are not aware of this condition**, with some noting they believed the opposite to be true.

Home Energy Assessment

Less than half (eight out of 20) of contractors correctly identify a key difference is that CGH Grant requires a home energy assessment while Green Heat does not. Some contractors note that there is a difference between the two regarding the energy assessment requirement but do not specify what that difference is; others (three out of 20) incorrectly indicate that the energy assessment is required under both incentive pathways.

Equipment

Five contractors spontaneously mentioned that some of the equipment eligible for HEA/ CGH Grant is not covered under Green Heat or that, generally, the eligible equipment lists of the two do not match. Contractors understand that at least two heads (i.e. heat pump units) are required to qualify for HEA/CGH Grant¹⁸ while customers can qualify for Green Heat with only one head. A few contractors mention that Green Heat covers only heating equipment like MSHPs, while HEA/CGH Grant are more for whole home upgrades.

Funding Source and Responsiveness

Other differences mentioned, each by a limited number of contractors, include that Green Heat is provincially funded while the CGH Grant is federally funded, that it is easier to obtain responses to inquiries from EOne than it is from the federal government, and that the Green Heat application process is shorter and less complicated.

8.3.3 Distributors

All MSHP **distributors report some level of familiarity with Green Heat**, with three being very familiar and two stating they are somewhat familiar. Familiarity is similar with CGH Grant, with four distributors stating they are very familiar with the program and one stating they are somewhat familiar.

The CGH Grant is seen by MSHP distributors as offering higher incentives and wider product eligibility than Green Heat. That said, they report that it involves more steps, requires a longer process, and has longer wait times before incentives are issued.

¹⁷ Green Heat no longer offers a financing option since the launch of the mail-in rebate structure.

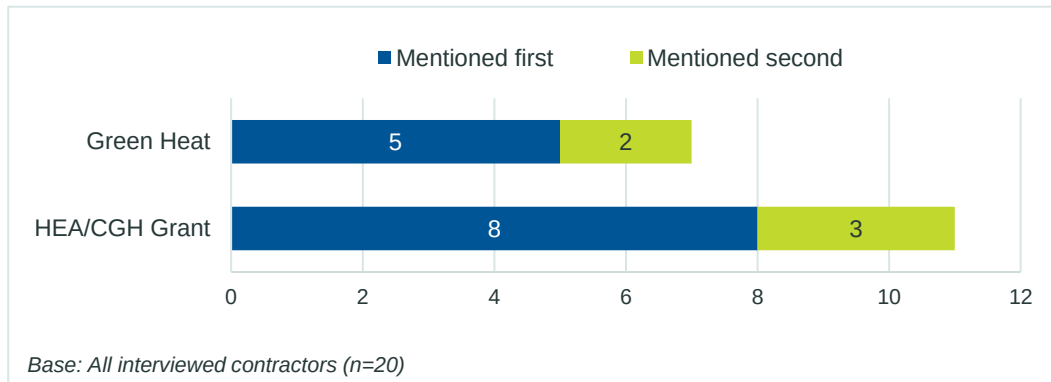
¹⁸ For the CGH Grant, there should be a minimum of one indoor head per floor.



8.4 Promotion and Recommendation

Contractors were asked to spontaneously name the programs they mention to customers who contact them to learn more about available incentives for MSHPs. As Figure 16 illustrates, **CGH Grant tends to be referenced more often** than Green Heat and is more likely to be the first program mentioned.

Figure 16: Mentions of Green Heat and the CGH Grant When Advising Customers About MSHP Incentives



Other incentive programs mentioned, albeit to a far lesser extent, include Affordable Single-family Homes and Oil to Heat Pump Affordability.

Before recommending a program to customers, contractors typically ask them one or more questions. Contractors commonly ask customers:

- › If they are aware of any rebate programs.
- › If they have participated in any rebate programs.
- › If they are aware of EOne.
- › What their goals are for their home in terms of heating.
- › How many MSHP units they want to install.
- › What their budget is for this project.

Occasionally, contractors also ask their customers about their household income bracket to determine if they qualify for other support.

All but one of the heat pump contractors that are aware of both programs note that they **generally ask their customers if they have already applied to have a home energy assessment done** and/or applied for HEA/CGH Grant. Contractors who say they ask their customers this question indicate that between three to eight out of ten of them have **already applied** for a home energy assessment and/or to HEA/CGH Grant. EOne staff mentioned that finding out that participants had already applied to HEA was a problem that occurred on a regular basis when processing Green Heat applications. The results indicate that, when participants find out that they do not qualify for HEA/CGH Grant, they apply to Green Heat instead. This speaks to confusion among customers over the differences between Green Heat and HEA/CGH Grant eligibility criteria (see Subsection 8.3.1).

Contractors are most likely to say that the **only instance in which they recommend Green Heat to a MSHP customer over the CGH Grant is if the customer does not qualify for the CGH Grant**, for example, when they only wish to install one heat pump or do not want to install a unit on every level of their home. One contractor mentioned they recommend Green Heat if the customer is **under time constraints** given the



longer wait times to receive funding through the CGH Grant. Meanwhile, contractors indicate almost exclusively that they **always recommend the CGH Grant over Green Heat if their customer wants to install whole home heating** (i.e. expected to qualify) because there is better financial incentive for the customer.

Contractors provide a variety of responses on how, if at all, they promote Green Heat to their customers. Just **under half (9/20) use various types of marketing materials** to promote the program component, including most commonly information on their company website, Google Ads, radio ads, and mentions on estimates and sales agreements. To a lesser extent, contractors report using social media ads, print ads in local newspapers, brochures containing rebate information, and mail campaigns to promote Green Heat. Moreover, roughly **half (8/20) indicate that they tell** all their customers about Green Heat during sales calls, home visits, or at point of sale, but they do not use any promotional materials to educate or inform customers about the program. Of the 20 contractors interviewed, only three indicate that they do not promote Green Heat at all.

8.5 Strengths and Challenges

According to contractors, the main strength of Green Heat is by far that the rebate incentivizes homeowners to install MSHPs and/or time of use systems (i.e. ETS). Contractors note that the money saved is a key driver for homeowners and that it **benefits contractors in the efficient home heating sector** because it encourages homeowners **to switch to more efficient heating and from fossil fuels**. Contractors further mention that it offers the push homeowners need to consider heat pumps or ETS and **helps educate the latter** on the other benefits of such systems, including improved home heating, long-term affordability and comfort, and that efficient technology can be a stepping stone toward a more environmentally conscious lifestyle. Other less frequent mentions about the main strengths of Green Heat include that the program is **simple** to apply for and offers **clear eligibility criteria**.

MSHP contractor quotes:

"To promote more efficient heating equipment into the marketplace. ... by far, HP industry is a money saver for homeowners. Great to be stressing how advantageous heat pumps are in terms of efficiency and cost."

"People are looking to update their system from the old fossil fuel industry. The rebates are very beneficial in winning customers over."

"Simple, clearly defined as to eligibility and expected rebate."

It should be highlighted that five of the 20 interviewed contractors do not believe Green Heat has a main strength. Those contractors provided commentary about how the **program lacks relevance since the introduction of the CGH Grant** that provides a much higher incentive, noting that revisions are required to ensure Green Heat establishes a niche.

While the cited challenges are diverse, the most commonly mentioned difficulty noted by six contractors dovetails with the concern that Green Heat is being dwarfed by other programs offering higher rebates. Those contractors note that the **CGH Grant offers far better monetary value** to homeowners than Green Heat.

MSHP contractor quotes:

"Historically, it provided an opportunity for people to get a rebate for a single type of measure who didn't want a home energy assessment, and that made sense. Now that's not the same thing with other programs in the marketplace."

"The amount of the incentives just pales in the comparison to the federal program and other provinces."



Another common challenge faced is that of contractors **having to support participants** who have little knowledge about rebate programs or heating systems to enable them to understand the eligibility criteria and application process. In this vein, some contractors say they would like for the onus to be on them to complete the necessary paperwork so that they can better support their participating customers rather than having to guide them through the process. Contractors note that it is especially challenging when it comes to elderly participants who have difficulty navigating the digital forms.

Some contractors mention **challenges related to communications with EOne**, particularly when trying to reach someone via phone with a question. Contractors explain that they routinely have participants who have tried calling multiple times to check on the status of their application or clarify information about Green Heat and cannot get through to speak to a staff member. Contractors say that this is frustrating not only for their customers who end up looking to them for answers, but also for themselves since they do not always have answers; they feel that EOne often delays in keeping them up to date on changes. Contractors feel responsible for informing customers of whether or not they are eligible for the rebate based on what equipment is to be installed, which puts them in an awkward position if the customer ends up assuming they are eligible but are not.

Finally, although very few interviewed contractors sell and install ETS, most that do cite the issue that customers wanting to **switch from oil heat to ETS are not eligible** to receive the Green Heat rebate; only those switching from electric heat to ETS are eligible. Contractors believe that a switch from oil to ETS should qualify to encourage homeowners to get off oil. They also note that it is unfair to ETS contractors that this switch is not covered because they lose business to heat pump contractors given that those switching from oil to heat pumps are eligible for the rebate.

Green Heat Strengths:

- › MSHP/ETS incentives
- › Encourages switch from fossil fuels
- › Benefits contractors
- › Educates participants
- › Simple application
- › Clear eligibility criteria

Green Heat Challenges:

- › Lacks relevance since the CGH Grant
- › Low rebates vs. the CGH Grant
- › Contractors having to provide customer support
- › Communications with EOne
- › Switch from oil to ETS not eligible

8.6 Suggestions for Improvements

Among the participants who have suggestions on how to improve Green Heat:

- › 17% suggest increasing the amount of the rebate.
- › 11% mention simplifying the application form and associated paperwork.
- › 6% suggest advertising more.

Contractors provided a range of suggestions for improving Green Heat, most of which echo challenges or reasons for dissatisfaction raised in Subsection 3.2 as well as the participant suggestions above. In particular, they mention:

- › Increasing the rebate amount
- › Amending rebate eligibility criteria, which include:
 - › Covering the switch from oil to ETS
 - › Allowing customers to receive rebates from Green Heat and the CGH Grant
- › Improving communication between customers or contractors and EOne
- › Improving the application form, specifically forgoing the requirement for photos.
- › Increasing marketing materials and program awareness



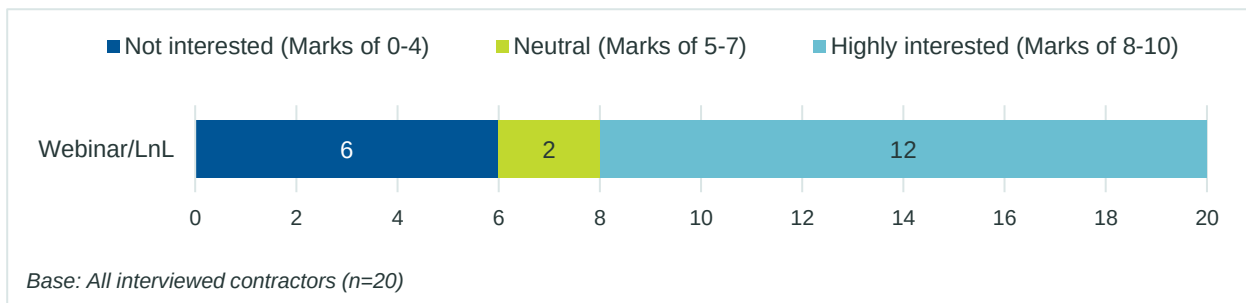
8.6.1 Additional Support

A variety of contractor suggestions are outlined below on additional support that could be provided by EOne to help contractors promote, educate about, or deliver Green Heat as efficiently as possible. These include:

- › Educating energy auditors in ETS
- › Educating contractors on the suite of EOne programs and their benefits
- › Providing one-on-one meetings with contractors to discuss program delivery and answer questions
- › Providing contractors with simple promotional material that clearly outlines program eligibility and rebate amounts
- › Establishing a list of preferred contractors experienced in HVAC technology
- › Creating consumer how-to videos to enhance their familiarity with HVAC technology and its benefits
- › Responding to contractor enquiries in a more timely manner
- › Providing more timely program updates
- › Setting clear explanations on rebate calculations (specifically how rebate amounts per tonne are calculated) and additional flowcharts and forms to assist contractors and homeowners in selecting which program to apply

Most contractors appear engaged with EOne programs. When asked how interested they are in attending a webinar or lunch-and-learn hosted by EOne to discuss the differences between Green Heat and HEA/CGH Grant, over half of contractors (12 of 20) express a high level of interest.

Figure 17: Contractor Interest in Attending an EOne Hosted Webinar or Lunch-and-learn



8.7 Awareness About, Motivations for, and Barriers to Purchasing ETS

MSHP participants and MSHP contractors were asked whether they had heard of electric thermal storage (ETS). A total of six in ten (61%) MSHP participants and 19 out of 20 contractors said they had heard of the technology. In addition, eight in 10 (78%) MSHP participants said they had heard of Nova Scotia Power's (NS Power's) time-of-rate day plan that requires customers to have an ETS unit that releases heat in the home at times of the day when grid demand is higher and energy is more expensive.

A minority (7/20) of interviewed MSHP contractors report selling ETS units; two sell heat pumps as well as ETS, while five sell only ETS. Most contractors who sell ETS say that the top factor motivating their customers to purchase ETS is the **time-of-day rates**. The **opportunities to save on energy/energy costs** and the **EOne rebate** are also drivers to purchase. These contractor results were corroborated by the five interviewed ETS participants; two of the five state that the most important reason for installing ETS in homes was to benefit from the time-of-day rates, another two for **better comfort**, and one for the energy savings/energy cost savings.



Reasons preventing customers from purchasing ETS all **centre around money**. Some contractors explicitly note that ETS costs are too high for some customers, while others explain that rebates are higher for heat pumps than ETS units, so customers choose that option instead. Some contractors cite other issues and complications with ETS when working with solar or heat pumps,¹⁹ while one contractor notes that customers may not opt for ETS if it is not a requirement for time-of-day heating.

¹⁹ Information regarding the specific issues/complications were not given.





9 Green Heat Impact Evaluation

The objectives of the 2023 Green Heat 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.

9.1 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 XIII. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

9.2 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.²⁰ For the 2023 evaluation, the Evaluator relied on the values presented in the 2020-2023 Measure Assessment; those values were drawn from the 2022 evaluation since a billing analysis for MSHPs could not be performed in 2023. Moreover, while the Evaluator typically performs an annual review of the central air-source heat pump (CASHP) unitary peak demand savings value to represent the characteristics of CASHPs installed through Green Heat for a given year, this was not performed in 2023 due to the very small number of CASHPs.

9.2.1 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.

9.2.2 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 2020-2023 Measure Assessment provides a detailed description of inputs, references, and unitary savings calculations for all measure categories. In 2023, no changes were made to the savings algorithms; therefore, the evaluated and tracked savings were identical.

Table 28 further below summarizes the tracked and evaluated energy savings values for each measure installed through Green Heat in 2023.

- › 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.

²⁰ Definition adapted from National Renewable Energy Laboratory, The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices, September 2014, p. 3.

- › Since solar measures are rarely installed, the energy savings thereof 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 28: 2023 Green Heat Tracked and Evaluated Unitary Energy Savings

Measure	Tracked Savings per Capacity [kWh/Btu/h]	Evaluated Savings [kWh/year]
Heat Pumps		
MSHPs – Fully Electrically Heated	0.179	3,045*
MSHPs – Mainly Electrically Heated	0.060	1,027*
CASHPs	0.101	4,141*
Air-to-water Heat Pumps	0.101	6,570*
Ground-source Heat Pumps (GSHPs)	N/A	N/A
Biomass		
Wood Stoves or Fireplace Inserts with Electric Resistance Baseline	N/A	10,443
Wood Stoves or Fireplace Inserts with Heat Pump Baseline	N/A	4,747
Pellet Stoves or Fireplace Inserts with Electric Resistance Baseline	N/A	8,959
Pellet Stoves or Fireplace Inserts with Heat Pump Baseline	N/A	4,072
Wood Furnaces/Boilers with Electric Resistance Baseline	N/A	N/A
Wood Furnaces/Boilers with Heat Pump Baseline	N/A	N/A
Pellet Furnaces/Boilers with Electric Resistance Baseline	N/A	N/A
Pellet Furnaces/Boilers with Heat Pump Baseline	N/A	N/A
Solar		
Solar DHW	N/A	N/A
Solar Thermal Air Heating	N/A	N/A
*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.		

9.2.3 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 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 2020-2023 Measure Assessment. No changes were made to the peak demand savings algorithms as part of the 2023 evaluation; therefore, only evaluated unitary savings are presented below.

- › For MSHPs and ETS 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 installed system 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 2022. Due to the small number of CASHPs installed in 2023, this number was not reviewed.

Table 29 below summarizes the evaluated unitary peak demand savings values for each measure.

Table 29: 2023 Green Heat Unitary Peak Demand Savings

Measure	Evaluated Peak Demand Savings [W]
Heat Pumps	
MSHPs – Fully Electrically Heated	2,470*
MSHPs – Mainly Electrically Heated	2,540*
Air-to-water Heat Pumps	3,989*
CASHPs	3,989*
GSHPs	N/A
Biomass	
Wood Stoves or Fireplace Inserts with Electric Resistance Baseline	4,000
Wood Stoves or Fireplace Inserts with Heat Pump Baseline	4,000
Pellet Stoves or Fireplace Inserts with Electric Resistance Baseline	4,000
Pellet Stoves or Fireplace Inserts with Heat Pump Baseline	4,000
Wood Furnaces/Boilers with Electric Resistance Baseline	7,660
Wood Furnaces/Boilers with Heat Pump Baseline	7,660
Pellet Furnaces/Boilers with Electric Resistance Baseline	7,775
Pellet Furnaces/Boilers with Heat Pump Baseline	7,775
Solar	
Solar DHW	N/A
Solar Thermal Air Heating	N/A
Demand Reduction	
ETS	1,141*
Three-element Water Heaters	200
DHW Heater Timers	491*
*Presented for information purposes only. The average unitary peak demand savings were calculated based on the sum of the peak demand savings for each installed system divided by the number of systems installed. Peak demand savings were obtained based on specification data for each installed system (see 2020-2023 Measure Assessment for more details).	

9.2.4 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 directly target heating and cooling loads, 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.



9.2.5 Effective Useful Life

As part of the 2020-2023 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 2022 evaluation remained valid for the 2023 evaluation. 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 9.2.6 and 9.3 below). The gross weighted average EUL value is equal to 18.0 years.

9.2.6 Evaluated Gross Savings

The annual gross savings for each category of measure installed through Green Heat in 2023 are listed in Table 30 below.

The gross savings at the generator were estimated by using a line loss factors associated to the rate code of each participant. The line loss factors correspond to the values submitted to the NSUARB as part of the 2014 Cost of Service Study Progress Update.²¹

²¹ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1. For municipal utility participants, the line loss factor of the most similar NS Power rate code was assumed. If a municipal utility participant did not have any specific rate code, the average of participants for which the line loss was known was used.

Table 30: Evaluated 2023 Green Heat Energy and Peak Demand Savings

Measure	MSHPs		CASHPs	Air-to-Water Heat Pumps
	Fully Electrical	Mainly Electrical		
Number of Units	937	239	4	2
Energy Savings				
Unitary Energy Savings (kWh)	3,045	1,027	4,141	6,570
Gross Energy Savings – at the Meter (GWh)	2.853	0.245	0.017	0.013
Line Loss Factor	1.094	1.095	1.095	1.095
Gross Energy Savings – at the Generator (GWh)	3.122	0.269	0.018	0.014
Effective Useful Life (years)	18.0	18.0	18.0	18.0
Gross Lifetime Energy Savings – at the Generator (GWh)	56.199	4.835	0.326	0.259
Peak Demand Savings				
Unitary Peak Demand Savings (W)	2,470	2,540	3,989	3,989
Gross Peak Demand Savings – at the Meter (MW)	2.315	0.607	0.016	0.008
Line Loss Factor	1.146	1.147	1.147	1.147
Gross Peak Demand Savings – at the Generator (MW)	2.652	0.696	0.018	0.009

Evaluated 2023 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	149	38	21	7	-	-	-	-
Energy Savings								
Unitary Energy Savings (kWh)	10,443	4,747	8,959	4,072	-	-	-	-
Gross Energy Savings – at the Meter (GWh)	1.556	0.180	0.188	0.029	-	-	-	-
Line Loss Factor	1.095	1.095	1.095	1.095	-	-	-	-
Gross Energy Savings – at the Generator (GWh)	1.703	0.197	0.206	0.031	-	-	-	-
Effective Useful Life (years)	18.0	18.0	18.0	18.0	-	-	-	-
Gross Lifetime Energy Savings – at the Generator (GWh)	30.660	3.554	3.707	0.562	-	-	-	-
Peak Demand Savings								
Unitary Peak Demand Savings (W)	4,000	4,000	4,000	4,000	-	-	-	-
Gross Peak Demand Savings – at the Meter (MW)	0.596	0.152	0.084	0.028	-	-	-	-
Line Loss Factor	1.147	1.147	1.147	1.147	-	-	-	-
Gross Peak Demand Savings – at the Generator (MW)	0.683	0.174	0.096	0.032	-	-	-	-

Evaluated 2023 Green Heat Gross Energy and Peak Demand Savings (Continued)

Measure	Solar DHW	Solar Thermal Air Heating	ETS	Three-element Water Heaters	DHW Heater Timers	Total
Number of Units	-	-	186	146	54	1,783
Energy Savings						
Unitary Energy Savings (kWh)	-	-	N/A	N/A	N/A	N/A
Gross Energy Savings – at the Meter (GWh)	-	-	-	-	-	5.081
Line Loss Factor	-	-	-	-	-	
Gross Energy Savings – at the Generator (GWh)	-	-	N/A	N/A	N/A	5.561
Effective Useful Life (years)	-	-	18.0	12.0	15.0	N/A
Gross Lifetime Energy Savings – at the Generator (GWh)	-	-	N/A	N/A	N/A	100.103
Peak Demand Savings						
Unitary Peak Demand Savings (W)	-	-	1,141	200	491	N/A
Gross Peak Demand Savings – at the Meter (MW)	-	-	0.212	0.029	0.027	4.074
Line Loss Factor	-	-	1.147	1.147	1.147	1.146
Gross Peak Demand Savings – at the Generator (MW)	-	-	0.243	0.033	0.030	4.668



Figure 18 compares tracked gross energy savings to evaluated gross energy savings at the generator. As outlined in the figure, tracked and evaluated energy savings are the same for all measures.

Figure 18: 2023 Green Heat Tracked and Evaluated Gross Energy Savings at the Generator

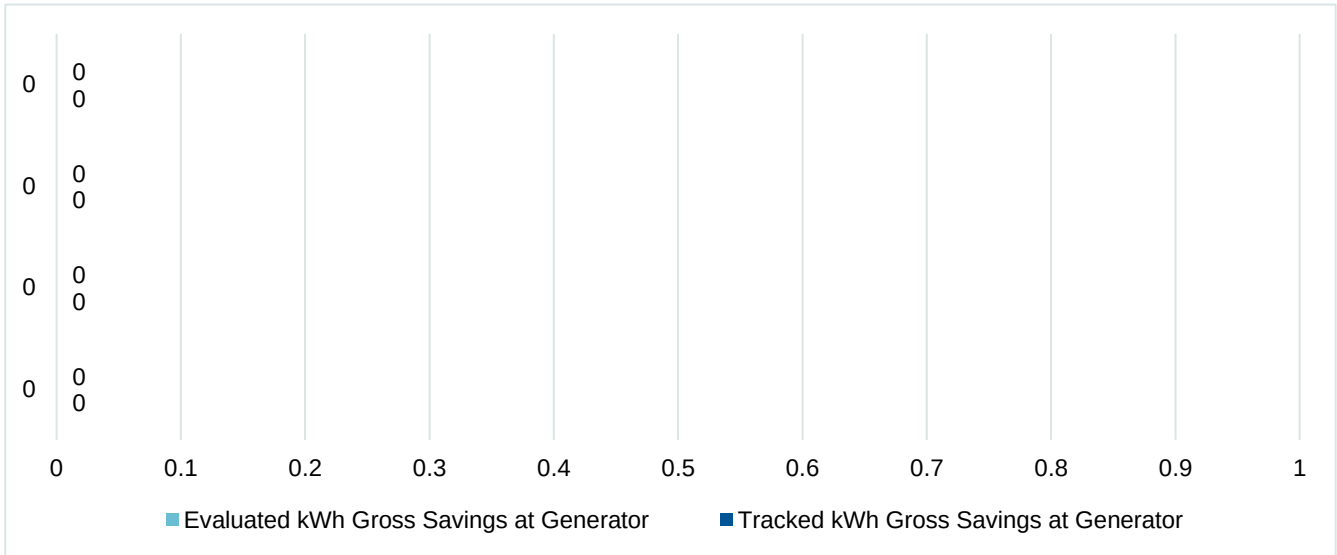
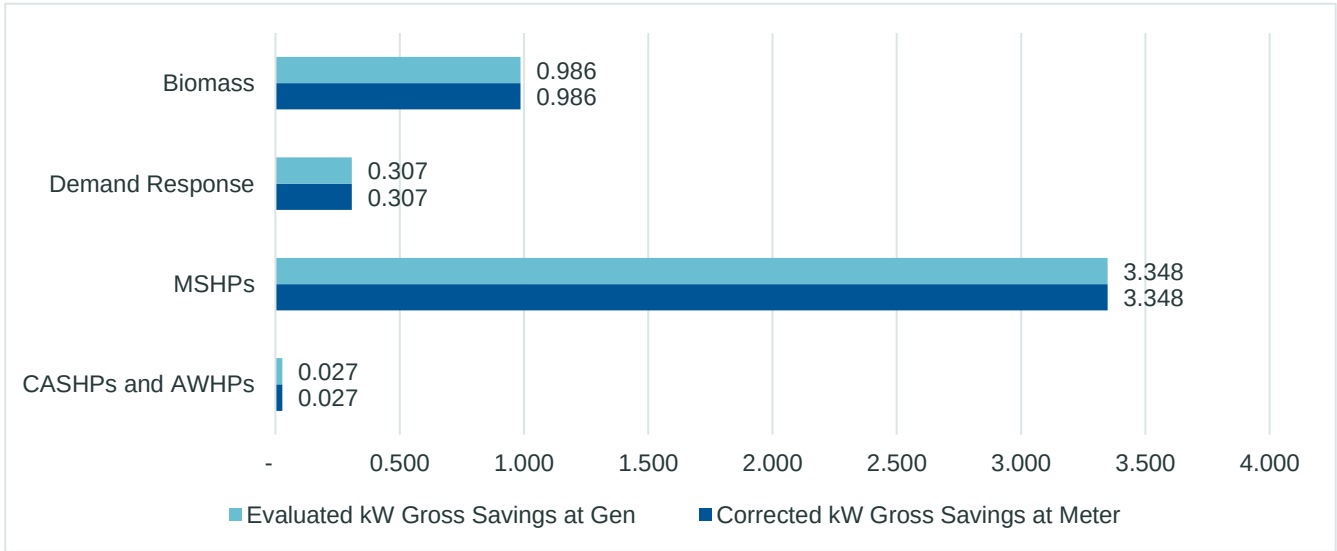


Figure 19 below compares tracked gross peak demand savings to evaluated gross peak demand savings at the generator. As outlined in the figure, tracked and evaluated demand savings are the same for all measures.

Figure 19: 2023 Green Heat Tracked and Evaluated Gross Peak Demand Savings at the Generator



As presented in Table 31, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor²² for GHG emissions generated by electricity production to Green Heat gross savings.

Table 31: Evaluated 2023 Green Heat GHG Gross Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	5,561
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO ₂ eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	3,069

9.3 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.

9.3.1 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. Free-ridership was assessed during the 2023 evaluation using a self-reporting approach that involved asking sampled participants to respond to a set of questions related to three types of measures during a telephone survey: MSHPs, biomass (wood stoves, pellet stoves, and wood fireplace inserts) and demand reduction measures (electric thermal storage).

When analyzing the MSHP survey results, the Evaluator found that 77% of participants had already made the decision to install a MSHP before hearing about Green Heat (compared to 73% in 2021). The Evaluator noted a general upward trend for free-ridership in all variables for MSHPs. The increase in percentages of individuals who had already decided on high-efficiency models, general MSHP installations, and awareness about specific features (such as heat pumps operating below -15 °C) implies evolving consumer awareness and interest in these technologies. The free-ridership level was established at 48%, which represents an increase compared to the previous free-ridership result (39%) from 2022.

The free-ridership level for biomass heating systems was established at 47%, which is an increase compared to the latest result obtained in 2021 (41%).

A lower free-ridership of 9% was established for demand reduction measures since they are new technologies with relatively low adoption levels. This number should be interpreted with care due to the small sample size and the higher margin of error.

Table 32 below outlines the free-ridership level obtained for each measure category.

²² At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO₂ eq tonnes) and total electricity generation (10,456 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 December 1st, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22'23.pdf (Last accessed December 1st, 2023).

Table 32: 2023 Green Heat Average Free-ridership Levels

Measure	Average Free-ridership Level	Sample Size	Population Size	Margin of Error
MSHPs	48%	90	1,132	5.5%
Biomass	47%	29	213	8.2%
Demand Reduction	9%	5	314	13.4%
CASHPs and GSHPs*	33%	30	54	7.6%

*CASHP and GSHP free-ridership levels were not measured in 2023 due to the very low number of participants that installed this measure. The free-ridership results presented above were established as part of the 2021 evaluation.

9.3.2 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 33.

Table 33: 2023 Green Heat NTGRs

Measure	Free-ridership	NTGR
MSHPs	48%	0.52
Biomass and Solar	47%	0.53
Demand Reduction	9%	0.91
CASHPs and GSHPs	33%	0.67

9.3.3 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 detailed results are presented in Table 34 below. The net energy savings resulted in 1,611 tonnes of CO₂ eq in net annual GHG emission reductions.

Table 34: Evaluated 2023 Green Heat Net Energy and Peak Demand Savings

Measure	MSHPs		CASHPs	Air-to-Water Heat Pumps
	Fully Electrical	Mainly Electrical		
Energy Savings				
Gross Energy Savings – at the Meter (GWh)	2.853	0.245	0.017	0.013
NTGR	0.52	0.52	0.67	0.67
Net Energy Savings – at the Meter (GWh)	1.484	0.128	0.011	0.009
Line Loss Factor	1.094	1.095	1.095	1.095
Net Energy Savings – at the Generator (GWh)	1.624	0.140	0.012	0.010
Effective Useful Life (years)	18.0	18.0	18.0	18.0
Net Lifetime Energy Savings – at the Generator (GWh)	29.224	2.514	0.219	0.173
Peak Demand Savings				
Gross Peak Demand Savings – at the Meter (MW)	2.315	0.607	0.016	0.008
NTGR	0.52	0.52	0.67	0.67
Net Peak Demand Savings – at the Meter (MW)	1.204	0.316	0.011	0.005
Line Loss Factor	1.146	1.147	1.147	1.147
Net Peak Demand Savings – at the Generator (MW)	1.379	0.362	0.012	0.006

Evaluated 2023 Green Heat Net Energy and Peak Demand Savings (Continued)

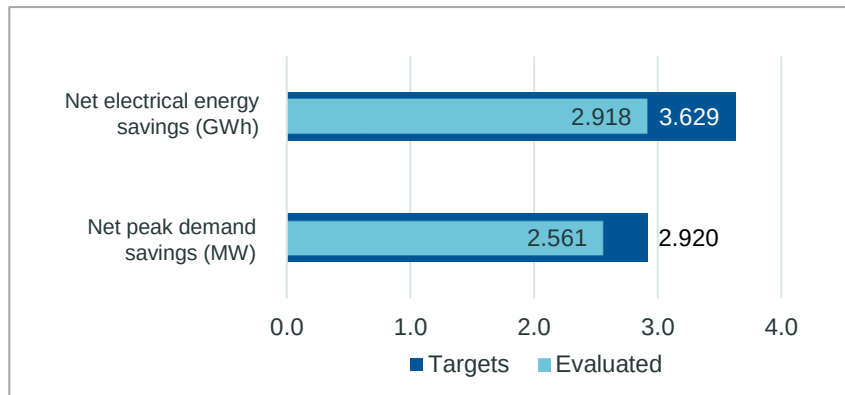
Measure	Wood Stoves or Fireplace Inserts		Pellet Stoves or Fireplace Inserts		Wood Furnaces or Boilers		Pellet Furnaces or Boilers	
	Electric Resistance Baseline	Heat Pump Baseline	Electric Resistance Baseline	Heat Pump Baseline	Electric Resistance Baseline	Heat Pump Baseline	Electric Resistance Baseline	Heat Pump Baseline
Energy Savings								
Gross Energy Savings – at the Meter (GWh)	1.556	0.180	0.188	0.029	-	-	-	-
NTGR	0.53	0.53	0.53	0.53	-	-	-	-
Net Energy Savings – at the Meter (GWh)	0.825	0.096	0.100	0.015	-	-	-	-
Line Loss Factor	1.095	1.095	1.095	1.095	-	-	-	-
Net Energy Savings – at the Generator (GWh)	0.903	0.105	0.109	0.017	-	-	-	-
Effective Useful Life (years)	18.0	18.0	18.0	18.0	-	-	-	-
Net Lifetime Energy Savings – at the Generator (GWh)	16.250	1.884	1.965	0.298	-	-	-	-
Peak Demand Savings								
Gross Peak Demand Savings – at the Meter (MW)	0.596	0.152	0.084	0.028	-	-	-	-
NTGR	0.53	0.53	0.53	0.53	-	-	-	-
Net Peak Demand Savings – at the Meter (MW)	0.316	0.081	0.045	0.015	-	-	-	-
Line Loss Factor	1.147	1.147	1.147	1.147	-	-	-	-
Net Peak Demand Savings – at the Generator (MW)	0.362	0.092	0.051	0.017	-	-	-	-

Evaluated 2023 Green Heat Net 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)	-	-	-	-	-	5.081
NTGR	-	-	0.91	0.91	0.91	N/A
Net Energy Savings – at the Meter (GWh)	-	-	-	-	-	5.561
Line Loss Factor	-	-	N/A	N/A	N/A	N/A
Net Energy Savings – at the Generator (GWh)	-	-	N/A	N/A	N/A	2.918
Effective Useful Life (years)	-	-	18.0	12.0	15.0	N/A
Net Lifetime Energy Savings – at the Generator (GWh)	-	-	N/A	N/A	N/A	52.526
Peak Demand Savings						
Gross Peak Demand Savings –at the Meter (MW)	-	-	0.212	0.029	0.027	4.074
NTGR	-	-	0.91	0.91	0.91	N/A
Net Peak Demand Savings – at the Meter (MW)	-	-	0.193	0.027	0.024	2.235
Line Loss Factor	-	-	1.147	1.147	1.147	N/A
Net Peak Demand Savings – at the Generator (MW)	-	-	0.221	0.030	0.028	2.561

As outlined in Figure 20, Green Heat fell short of both its electrical energy and peak demand savings targets by 19.6% and 12.3% respectively.

Figure 20: 2023 Green Heat Targets and Evaluated Savings



9.4 Realization Rate

Table 35 below compares the energy and peak demand savings established through this evaluation to those calculated in the 2023 tracking sheet. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 35: Comparison of 2023 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	5.561	GWh	0.60	3.352	GWh	87%
Evaluation Results	5.561	GWh	0.52	2.918	GWh	
Peak Demand Savings						
Tracked Savings by EOne	4.668	MW	0.63	2.949	MW	87%
Evaluation Results	4.668	MW	0.55	2.561	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 and peak savings determined by the Evaluator were identical to the initial gross savings tracked by EOne. Net energy and peak demand savings decreases are due to the update of NTGRs for biomass, MSHP, and demand reduction as part of the 2023 evaluation.



10 Green Heat Market Evolution

EOne has been active in the MSHP market through Green Heat since October 2015.²³ A market evolution assessment was completed as part of the 2017, 2018, 2019, and 2021 evaluations, the results of which served to analyze key market indicators and develop 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 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.

10.1 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 2023 NS Power load forecast and associated regulatory filings.^{24,25,26} NS Power uses a range of information including NS Power program component data, Natural Resources Canada (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 2022 and forecasts for 2023 and 2024.

10.2 Market Share of Heat Pumps

The data presented in this subsection are for all heat pumps, not just MSHPs. NS Power data indicate that, since 2013, over 90% of heat pumps installed through the NS Power on-bill financing program component have been MSHPs.²⁷ Similarly, EOne program component data indicate that, in 2023, 83% of heat pumps installed through EOne programs were MSHPs. This high representation is echoed further in Green Heat wherein 99% of incented heat pumps were MSHPs in 2023. Therefore, while this subsection presents general information on heat pumps, the Evaluator concludes that the information is representative of the MSHP market in Nova Scotia.

Figure 21 below depicts the number of incremental homes with new heat pump systems installed annually in Nova Scotia since 2015, including new constructions. It was estimated that almost 24,000 homes had new heat pump systems installed in 2022, a marked increase from approximately 17,000 in 2021 and more than 30% higher than the original NS Power forecast for 2022 of just over 16,500.^{28,29} This increase could be a result of the launch of the federal government's CGH Grant in May 2021. As noted above, the CGH Grant offers generous rebates for efficient heat pumps for existing homes. The bulk of heat pump installations are in existing homes, with installations in new homes remaining stable. The 2023 NS Power load forecast indicates a slight increase in non-electric and secondary systems for 2022 and predicts a similar increase in 2023 and a small decline in 2024 for secondary system installations.

²³ 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 was provided under the federal government's Low Carbon Economy Fund (LCEF) through the Province of Nova Scotia from July 2018 to March 2023.

²⁴ 20230620 NSPI to NSUARB 2023 Load Forecast Report + Appendices RED.

²⁵ 20230620 NSPI to NSUARB 2023 Load Forecast Synapse IRs 1-46 RED.

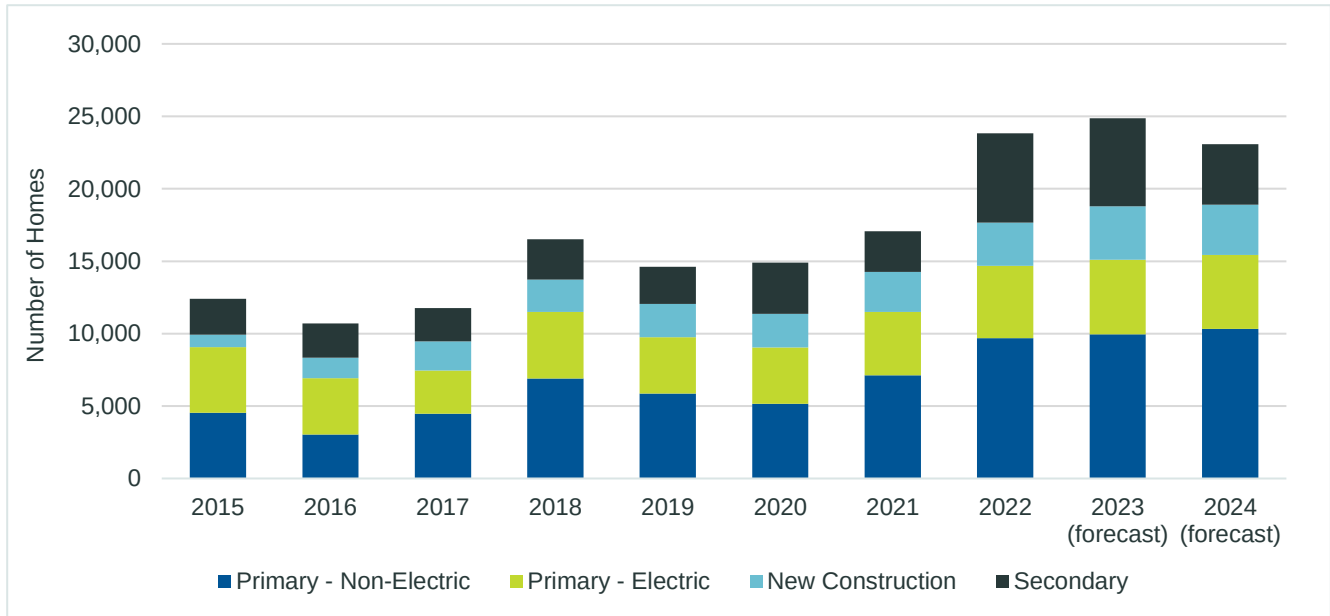
²⁶ 2023 LFR Attachment 01 Residential Intensities.

²⁷ Nova Scotia Utility and Review Board, Matter M08087. NSP Response to E1 IR-4 Att 1.

²⁸ 2022 LFR Attachment 01 Residential Intensities.

²⁹ 20230620 NSPI to NSUARB 2023 Load Forecast Report + Appendices RED (Section 4.4, p.33).

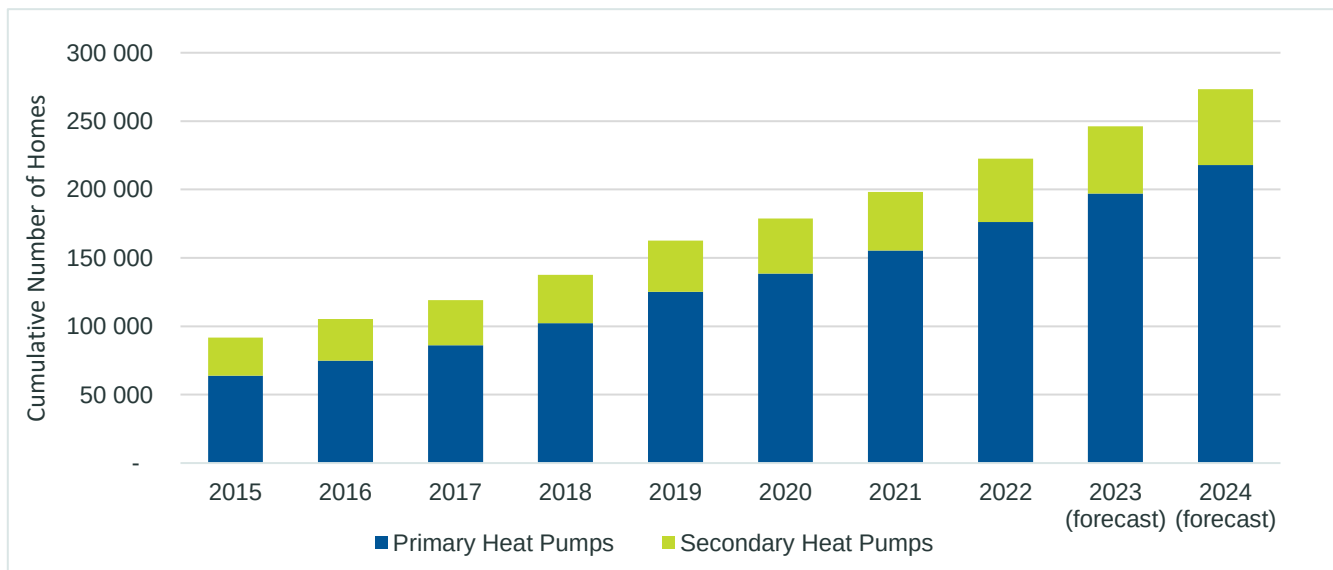
Figure 21: Incremental Homes with Heat Pump Systems Installed in Nova Scotia, 2015-2024



Sources: 2023 LFR Attachment 01 Residential Intensities; 2023 Load Forecast Report

While Figure 21 above presents new annual heat pump installations, Figure 22 below outlines the cumulative total number of homes with heat pumps in Nova Scotia. Just over 220,000 homes were estimated to have either a primary or secondary heat pump system in 2022. The **number of homes with heat pumps has grown steadily since 2015**. NS Power reports an average increase of about 18,500 homes with heat pumps per year between 2015 and 2022 and forecasts higher growth of on average around 25,500 homes in both 2023 and 2024. NS Power estimates that **40% of households³⁰** used a heat pump for some or all their heating requirements in 2023, up from an estimated 35% in 2021.

Figure 22: Homes with Heat Pump Systems (Cumulative), 2015-2024



Sources: 2023 LFR Attachment 01 Residential Intensities; 2023 Load Forecast Report

³⁰ 20230620 NSPI to NSUARB 2023 Load Forecast Report + Appendices RED (Section 4.4, p.33).

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.³¹ Since January 2021, systems eligible for a Green Heat rebate must appear on the NEEP Cold Climate Air Source Heat Pump list, and HSPF, seasonal energy efficiency ratio (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 SEER of 17 or more and a COP greater than or equal to 1.75 at -15°C are eligible for Green Heat.³² By narrowing the eligibility criteria, the program component targets a subset of high-efficiency MSHPs that provide the highest energy savings.

Table 36 below provides the number of Green Heat incented systems since 2019, 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 remained relatively steady over the 2019-2021 period (between roughly 5,500-5,900 per year). In 2022, the **number of Green Heat incented systems markedly declined** (by -39% to roughly 3,600) and the decrease continued in 2023 (by -16% to roughly 3,000).

Table 36: Green Heat Incented High-efficiency Mini-split Heat Pump Systems, 2019-2023

	2019		2020		2021		2022		2023	
	Electrical	Non-electrical	Electrical	Non-electrical	Electrical	Non-electrical	Electrical	Non-electrical	Electrical	Non-electrical
Number of MSHP Systems*	2,712	3,006	2,842	2,686	2,901	3,018	1,421	2,193	1,126	1,925
	5,718		5,528		5,919		3,614		3,051	
Average HSPF of Units	10.32		10.41		10.46		10.38		10.40	
*In almost all cases, one MSHP system incented by Green Heat equates to one home.										

The efficiency of MSHP units sold through Green Heat increased slowly between 2019 and 2021 from an average HSPF of 10.32 to 10.46 and has remained stable since 2022 at 10.41.

HEA Mini-split Heat Pumps

HEA also provides incentives for participants who install high-performing cold-climate MSHPs as part of a retrofit. Homeowners in Nova Scotia must register under HEA to receive the CGH Grant. EOne staff manage and administer the initiative that offers grants of up to \$5,000 to help homeowners implement energy efficiency retrofits in their primary residence, including the installation of MSHPs. It should be noted that participants cannot receive financial aid from both Green Heat and HEA/CGH Grant.

³¹ Systems with an HSPF below 9.565 were still admitted to the program component if equipped with a drain pan heater.

³² Heating Systems Rebate (Green Heat) Manual, revised April 29, 2021, p.14.

As indicated in Table 37 below, HEA counted more homes with MSHP system installations in 2022 and 2023 than in previous years (increases of 348% in 2022 and 116% in 2023),³³ which is a direct result of the availability of the CGH Grant.

Table 37: Homes with HEA Incented High-efficiency Mini-split Heat Pump Systems, 2019-2023*

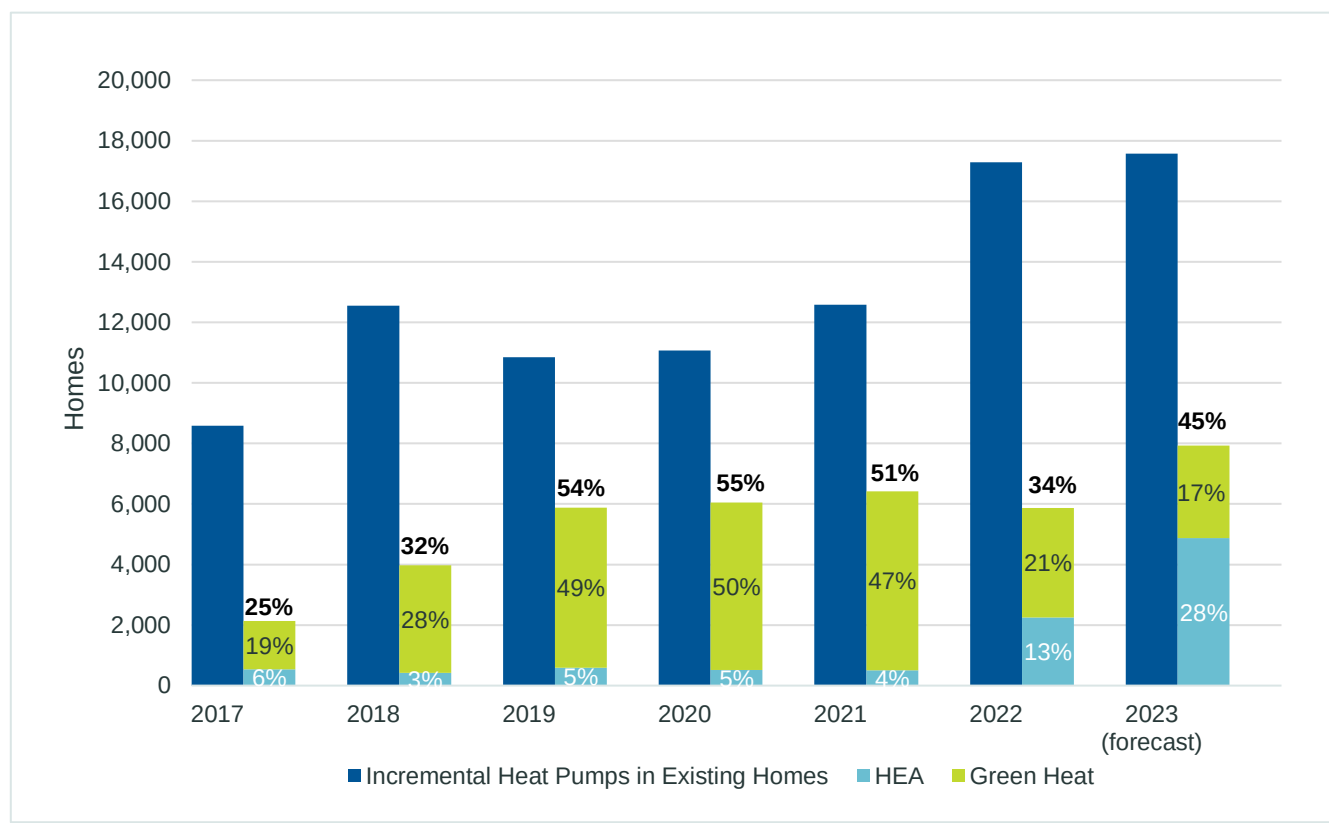
	2019	2020	2021	2022	2023
Number of Homes with MSHP Systems	585*	514*	503*	2,253	4,876
* For 2019-2021, the table indicates the number of MSHPs incented through HEA. In 2022 and 2023, the table indicates the number of homes in which MSHPs were installed.					

Figure 23 below presents the evolution of the number of MSHP systems incented through Green Heat and HEA³⁴ compared to an estimate of the incremental MSHP systems installed in existing homes in Nova Scotia assuming that 83% of heat pump systems are MSHPs as per EOne program component data. The NS Power numbers for 2022 and the forecast for 2023 indicate an increase in incremental heat pumps in the province and a **decrease in the percentage of MSHPs incented by EOne** (34% in 2022 and 45% in 2023 vs. 51% in 2021). The results reveal not only a decline between 2021 and 2023 in the percentage of MSHPs incented through Green Heat (from 47% in 2021 to 17% in 2023), but also a rise over the same period in the percentage of MSHPs incented through HEA (from 4% in 2021 to 28% in 2023). The **appeal of Green Heat therefore appears to be waning probably due to the relatively low incentive levels** in comparison to HEA through which access to the CGH Grant is accorded.

³³ For 2019-2021, the table indicates the number of incented MSHPs in HEA. In 2022 and 2023, this information was not available, only the number of homes was available.

³⁴ For 2022 and 2023, the number of homes in which MSHPs were installed is used to estimate the number of MSHPs incented through HEA.

Figure 23: Comparison of Incremental Mini-split Heat Pump Systems in Existing Homes with EOne Incented Systems, 2017-2023³⁵



10.2.1 Green Heat Eligible Mini-split Heat Pumps

The Evaluator interviewed five MSHP distributors 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 2021 evaluation. All interviewed distributors sell MSHPs wholesale to contractors and do not sell directly to homeowners. All interviewed distributors also sell high-performing cold-climate MSHPs. Four of the five distributors mentioned that all contractors to whom they sell MSHPs carry Green Heat-eligible units; the other distributor said that 80% of their contractors carry eligible MSHPs.

MSHP distributors were asked to report their Green Heat-eligible MSHP sales as a proportion of their total MSHP sales. Four out of the five interviewed distributors stated that between 75% and 98% of their MSHP sales in 2023 were high-performing cold climate units eligible for Green Heat.³⁶

Four of the five distributors are under the impression that a clear majority of the high-performing MSHPs they sell to contractors are incented by EOne. However, general confusion about all available offerings, the low incentives offered by Green Heat compared to the CGH **Grant**, and long rebate wait times were cited by distributors as explaining why not all purchasers of high-performing MSHP apply for an EOne incentive.

³⁵ For 2023, 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. For 2022 and 2023, the number of homes in which MSHPs were installed is used to estimate the number of MSHPs incented through HEA.

³⁶ One distributor estimated their Green Heat-eligible proportional breakdown at 60% based on a large proportion of their sales to apartment buildings that do not use high-efficiency units.

10.2.2 Mini-split Heat Pump Prices

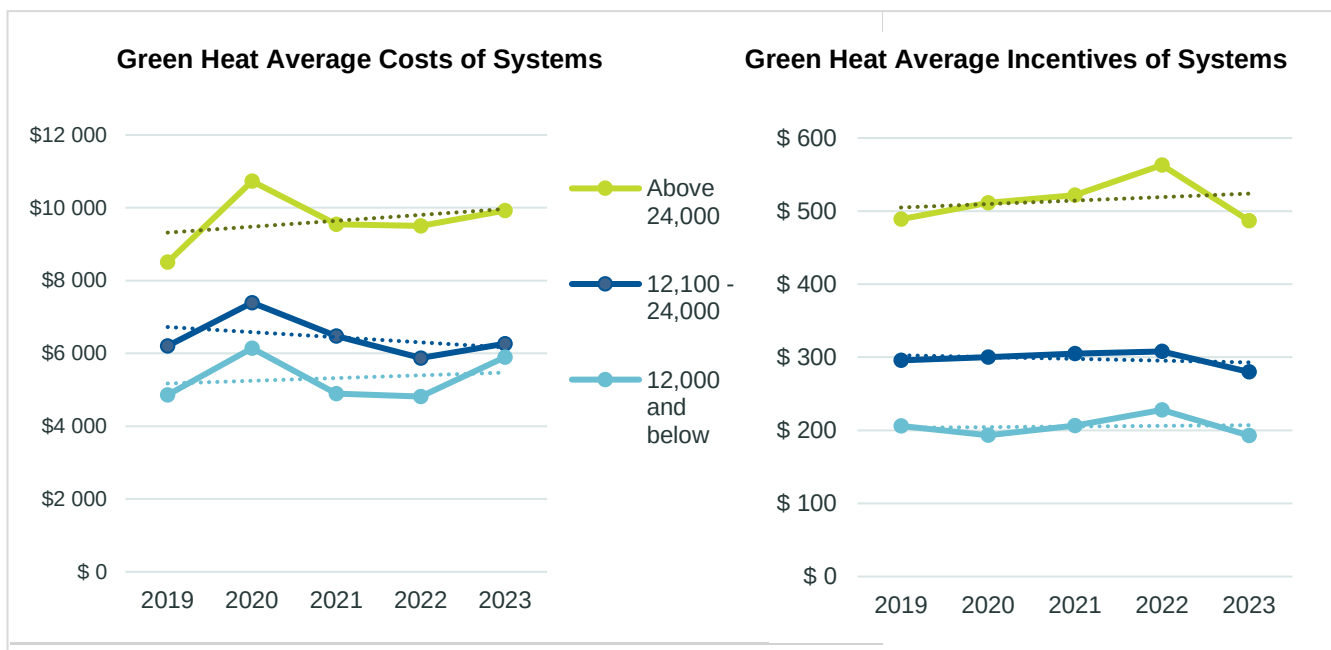
Figure 24 below provides the average cost of incented systems (excluding incentives) as well as the average incentive across nominal capacities based on the Green Heat tracking sheets from 2019 to 2023. This information indicates the general trend over time; the average cost values should be used with caution since large variations in system costs were observed in the tracking sheets and the cost data include systems with multiple units.

Although the tracking sheet results illustrate fluctuations during some years (particularly in 2020 for all nominal capacities), the **average cost of MSHPs has generally demonstrated a slow upward trend since 2021**. The average cost of capacities above 24,000 Btu/hr rose by 17% between 2019 and 2023 and the average cost of capacities of 12,000 Btu/hr and below rose by 21%.

Average incentive levels were relatively stable between 2019 and 2021 for all capacities, rose slightly in 2022 due to a higher average system size, but appeared to have fallen back in 2023 to at or slightly below 2019 levels.

All five distributors of Green Heat eligible MSHPs are of the opinion that average prices have increased since 2019, before the COVID-19 pandemic; one distributor said that they have seen an increase while two saw slight increases. Distributors say that inflation has caused prices to continue to rise in the past year, although not markedly so. Interviewed contractors are also of the opinion that the prices of heat pumps are climbing. Price increases are explained by the higher cost of raw materials, labour, and the effects of the pandemic.

Figure 24: Evolution of Green Heat Average Costs and Average Incentives – 2019-2023*



*The average costs and incentives from 2020 to 2023 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 standard 12,000 Btu/hr and a Green Heat-eligible 12,000 Btu/hr MSHP in 2023. The differential provided ranges from \$350 to \$800, with an average of approximately \$530, similar to the 2021 finding. The range varies due to the different costs, brands, and models carried by a given distributor.

10.2.3 Mini-split Heat Pump Market Outlook and Trends

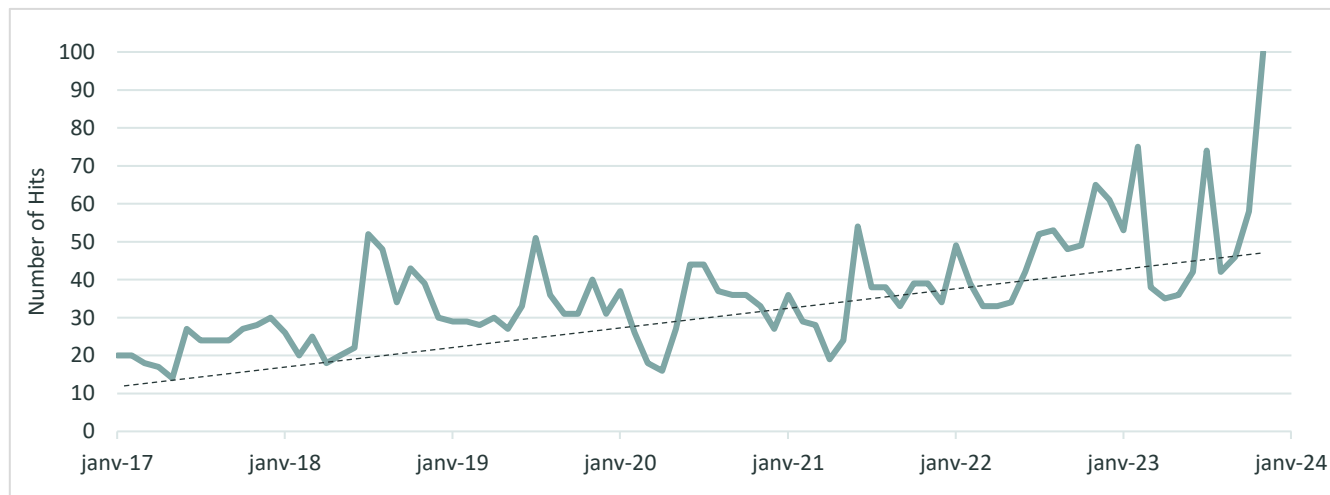
The Evaluator asked distributors and contractors to provide inputs to evaluate the evolution of MSHP sales over the past two years and for the near future.

Four of the five interviewed distributors report MSHP **sales increases from 2021 to 2023**. One distributor reports a 50% increase, while the other three report more modest increases ranging from 13% to 20%. Nearly all interviewed heat pump contractors note that demand for heat pumps has grown notably in the last two years. The increases are primarily explained by the availability of **incentive programs/rebates/grants**; the **CGH Grant** is cited as a major driver of demand, an increase in homeowners investing more in their homes during the COVID-19 pandemic, and general population growth within the province. Both distributors and contractors state that the **decreasing popularity of oil** (which is becoming more expensive) as a home heating fuel also explains higher sales. Two distributors note that demand has nearly surpassed contractor supply, leading to labour shortages. Other trends in MSHP sales include advancing technology for entry-level heat pumps as well as rising associated costs (with manufacturers adapting their offerings to incentive program requirements), greater competition within the industry (more sellers/suppliers), and an **increase in the number of off-brand, less expensive heat pumps** being purchased and installed.



Figure 25 presents the results of a “heat pump” keyword search using Google Trends and indicates an increasing interest over time from the Nova Scotia population to find out more about heat pumps.

Figure 25: Evolution of “Heat Pump” Keyword Search in Nova Scotia: Jan 2017 to Nov 2023



<https://trends.google.com/trends/explore?date=2017-01-01%202023-12-31&q=heat%20pump&hl=eng>

Distributors and contractors anticipate the **sales of MSHPs to continue increasing in 2024** and through 2025. Reasons for the expected increase include the **declining popularity of oil** furnaces and the continued popularity of MSHPs as a more financially attractive replacement to oil heat, **expectations that incentive programs will continue** in current or modified formats, and overall market momentum.

One distributor anticipates a **strong replacement business** with many installed MSHPs eventually needing to be replaced. Similarly, some distributors and contractors believe that the market is nearing saturation, particularly in urban areas, and expect to see a **shift from heat pump sales to heat pump maintenance or heat pump recycling** within the next two years. One distributor remains positive about the near future but questions how a possible recession might affect the market into 2025.

Four out of five distributors are aware that since January 1, 2023, heat pumps must meet new HSPF2 and SEER2 testing standards for heating and cooling. Those distributors note that the changes have affected the market in a variety of ways. Specifically, one distributor has seen an impact on the heat pump market whereby supply chain issues with North American manufacturers have led to an increase in Asian products on the market to meet demand. One distributor notices more confusion among contractors in determining which MSHP is eligible for a rebate. One distributor expects MSHPs to become even more efficient.

Two distributors believe there may be a **momentary lull** in the market when the expected change in US regulations regarding the type of refrigerants used in HVAC equipment takes effect in 2025.³⁷ One distributor notes that this change will require additional preparedness from manufacturers, which may temporarily affect the MSHP supply chain until they get up to speed.

10.2.4 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. The upcoming building Nova Scotia code (based on the NECB 2020), does not specifically require heat pump heating systems, although it will require buildings to be 50% more energy efficient than they are now by 2028, which is likely to require high-efficiency heating systems such as heat pumps. The Government of Canada has included more stringent minimum energy performance standards for heat pumps as part of Amendment 17 to the Energy Efficiency Regulations, which was published in late 2022. This regulation increases the performance requirements (in HSPF) and requires that performance ratings at -15°C be included in the HSPF calculations to better represent Canadian climatic conditions.³⁸ This change is an indication that the market is shifting toward heat pumps that perform better, especially at low temperatures.

10.2.5 Measured Free-ridership

The Evaluator analyzed the free-ridership level, the results of which are presented in Table 38 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% mainly due to an update to how one variable was accounted for in the free-ridership algorithm. In 2023, free-ridership increased to 48%, compared to the previous free-ridership result (39%) from 2021 and highlights growing consumer awareness about and interest in MSHPs.

Table 38: Green Heat Free-ridership Levels for MSHPs, 2017-2023

Free-ridership	2017	2018	2019	2020	2021	2022	2023
MSHPs	51%	54%	53%	53%	39%	39%	48%

³⁷ As part of the American Innovation and Manufacturing Act of 2020, restrictions on the use of hydrofluorocarbons in refrigerants in HVAC equipment, including heat pumps, will come into effect in the United States on January 1, 2025.

³⁸ 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>.

10.3 Market Evolution Summary

In their recommendations on market transformation program planning, Rosenberg and Hoefgen (2009) identify a number of factors, presented in Table 39 below, to be analyzed to identify whether energy efficiency program support should be withdrawn or reduced in light of changes observed in the market.³⁹

Table 39: Analysis of 2023 Key Factors in Energy Efficiency Program Planning

Factor	Results
Market share of heat pumps and efficient MSHPs	NS Power data indicate a marked increase in new heat pump systems installed in 2022, an increase that they forecast to continue in 2023. An estimated 40% of households in Nova Scotia were forecast to have used a heat pump for some or all household heating requirements in 2023. Distributors also report increased MSHP sales for 2023 driven primarily by the federal CGH Grant and EOne incentive programs and, to a lesser extent, the decreasing popularity of oil as a heating fuel. Distributors believe that sales of highly efficient heat pumps will continue to increase in 2024. The Evaluator estimates that 45% of the incremental MSHPs installed in Nova Scotia received an incentive from EOne through either Green Heat (17%) or HEA (28%) in 2023. The share of MSHPs receiving Green Heat incentives has declined compared to those receiving incentives through HEA that provides access to the CGH Grant.
Recent trends in prices and availability	The average cost of MSHPs incented through Green Heat has been slowly rising since 2019 despite fluctuations over time. The average cost of systems with higher capacities of above 24,000 Btu/hr has risen 17% over 2019 levels. Most distributors of Green Heat eligible MSHPs say they saw sales increase in 2022 and 2023 and costs increased in part due to the higher cost of raw materials and labour. According to distributors, these price increases have not affected the average price differential between a standard 12,000 Btu/hr MSHP and an equivalent capacity Green Heat-eligible MSHP with distributors providing a similar differential to that estimated in 2021. High-efficiency MSHPs remain accessible to consumers. Interviewed distributors again report that almost all contractors with whom they work install Green Heat eligible MSHPs. It should be noted that distributors also mention the arrival of lower quality, less expensive heat pumps to meet the higher demand in the market.
New energy performance standard	Electric resistance heating remains the minimal efficiency level as per building codes for small residential buildings. Amendment 17, published in late 2022, includes new performance requirements for heat pumps that require testing at -15°C and an increase in minimal HSPF values. This indicates that the market is moving toward more efficient heat pumps, including in cold conditions.
Market readiness for 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 26 below provides a qualitative indication of the adoption stages of MSHPs in Nova Scotia. The figure is not aimed at representing the exact market share of MSHPs, for which a more detailed analysis would be required.

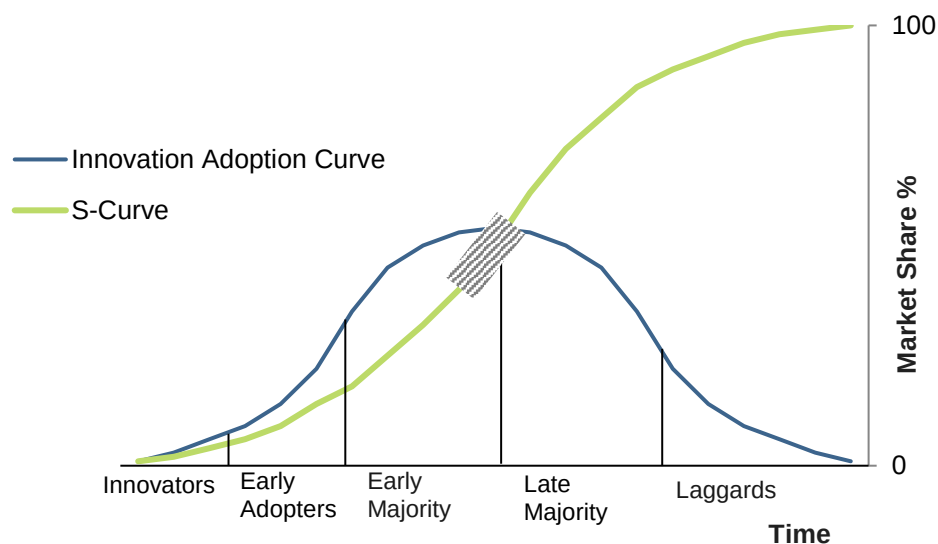
Figure 26 also illustrates how, with successive groups of consumers adopting a new technology (depicted by the innovation adoption curve in blue),⁴⁰ the MSHP market share (depicted by the S-curve in green) eventually reaches saturation. Sales then level off, taper, and eventually phase out. Due to its qualitative nature, the intersection between the market share and adoption rate depicted in the chart should be interpreted with caution.

³⁹ 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.

⁴⁰ Everett Rogers, Diffusion of Innovations, 1983.

The Evaluator maintains the conclusion from the 2021 evaluation that the MSHP market remains in a slowing growth phase that is nearing product maturity. This is supported by NS Power data estimating that 40% of households in Nova Scotia will use a heat pump for some or all their heating requirements in 2023. Distributors affirm continued consumer interest and sales. The hatched box in Figure 26 illustrates the MSHP placement on the product adoption curve.

Figure 26: 2023 Residential Market Evolution of Mini-split Heat Pumps



One noteworthy consideration is household funds to purchase energy efficient equipment. Despite the increased acceptance (demonstrated energy savings), benefits (higher energy costs), and existing rebates (e.g., the CGH Grant), there are many households that are simply unable to afford to purchase MSHPs; indeed, it is estimated that 43% of households in Nova Scotia were suffering from energy poverty at the end of 2023.⁴¹ This is an important consideration when reviewing Figure 26, as ongoing market adoption will likely be slowed over time as a greater percentage of homes without heat pumps may be low and modest-income households or homes that present additional challenges that must be overcome. This suggests that higher incentives may be needed in the future to maintain current adoption rates, otherwise, households in challenging positions may not have the means to purchase and install MSHPs.

⁴¹ Energy-Poverty-and-Equitable-Transition-Paper-December_2023_FINAL, EOne, December 2023.



11 Green Heat Key Findings and Recommendations

As mentioned previously, the main objectives of the 2023 Green Heat evaluation were as follows:

- › Collect information on participant and partner perspectives
- › Calculate gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions
- › Analyze the market evolution of mini-split heat pumps (MSHPs)

This section provides the Evaluator's key findings in relation the above objectives.

2023 Green Heat-Finding: Green Heat fell short of its net savings targets.

Green Heat achieved 2.918 GWh in net electrical energy savings and 2.561 MW in net peak demand savings at the generator in 2023, thus falling short of the planned net electrical energy savings of 3.629 GWh and net peak demand savings of 2.920 MW.

2023 Green Heat-Finding: Both the evaluated gross energy and peak demand savings were identical to the savings tracked by EOne.

Green Heat underwent a condensed impact evaluation in 2023. No changes were made by the Evaluator to gross energy and peak demand savings parameters and calculations, resulting in evaluated results that match tracked values.

2023 Green Heat-Finding: Green Heat participation levels decreased compared to 2021, particularly for MSHPs.

With 1,783 measures installed, the 2022 participation level was the lowest observed for Green Heat since 2016. The 2022 participation level dropped by 45% compared to 2021, and the 2023 participation level was 11% lower than in 2022.

The number of MSHPs incented through Green Heat decreased by 51% in 2022 (vs. 2021) and by 22% in 2023 (vs. 2022). Conversely, the number of homes with MSHPs installed and incented through HEA increased dramatically (by 348% in 2022 and by 116% in 2023).

The integration of the CGH Grant into HEA likely contributed to this situation. A portion of participants appears to have opted for that program rather than applying to Green Heat due to higher incentive levels.

2023 Green Heat-Finding: Most customers prefer HEA/CGH Grant over Green Heat, but Green Heat is a good option for a minority.

Contractors say that fewer than two in every 10 customers who know about both Green Heat and HEA/CGH Grant choose to take part in the former instead of the latter. That said, the findings reveal that there is still a place for Green Heat in the market: it interests those who do not need multiple MSHP units, is a simple program to apply to, does not involve a home energy assessment, and issues the rebate relatively quickly in comparison to other programs.



2023 Green Heat-Finding: Contractors/installers play an important role in recommending Green Heat.

Contractors/installers play a very important role not only in promoting and informing about incentive programs, but also in recommending Green Heat to customers. Contractors currently recommend HEA/ CGH Grant more often and before Green Heat mainly because of the higher incentives. Even so, contractors have a high level of engagement with EOne programs and are interested in participating in activities to further their education/understanding about Green Heat. It should be noted that contractors lack clarity about the differences between Green Heat and HEA/CGH Grant.

2023 Green Heat-Finding: There is confusion among customers about the differences between Green Heat and HEA/CGH Grant.

Contractors say that they generally ask customers if they have already applied for a home energy assessment or to HEA/CGH Grant, and many of customers already have. The results indicate that when participants find out that they do not qualify for HEA/CGH Grant, they apply to Green Heat instead. This speaks to confusion among customers over the differences between Green Heat and HEA/CGH Grant eligibility criteria.

2023 Green Heat-Finding: Overall satisfaction is lower among MSHP participants and contractors.

Most Green Heat participants are highly satisfied with the program overall although satisfaction is higher among biomass participants than MSHP participants (76% vs. 61% respectively). While participants are generally happy with the equipment installed in their home and the selection of equipment eligible for rebate, they are less satisfied with the rebate amount (38% for biomass vs. 26% for MSHP participants, see finding immediately below), the Green Heat website (63% for biomass vs. 53% for MSHP participants), and communications with EOne (60% and 56% respectively).

Overall satisfaction is not optimal among contractors (average score of 6.6 out of 10). Low incentives, communication issues with EOne, a perceived lack of marketing/marketing materials, the ENS portal being difficult to navigate (especially the eligible equipment list), and perceptions that the eligible equipment list is not regularly updated are the elements causing dissatisfaction.

Recommendation #1: It would be in EOne's best interests to ensure that Green Heat marketing materials are available to contractors and participants. It may be worthwhile to highlight the differences between Green Heat and HEA/CGH Grant in marketing materials.

Recommendation #2: Ensure that the Green Heat website is as user-friendly as possible by making sections, links, eligibility criteria, and eligible equipment lists clear, simple to understand, and easy to navigate. It may be worthwhile to highlight the differences between Green Heat and HEA/CGH Grant.

Recommendation #3: Investigate how communications between EOne and contractors and participants could be improved. Ensure that EOne provides timely responses or feedback to questions from contractors and participants.

2023 Green Heat-Finding: Participant and contractor satisfaction with the rebate amount is low, exacerbated by increases in average system costs (for MSHPs) as well as comparisons to CGH Grant incentives.

The Green Heat rebate amount garners the lowest satisfaction scores among participants for all Green Heat elements evaluated. Only 26% of MSHP and 38% of biomass participants declare that they are highly satisfied with the rebate amount. Dissatisfaction seems to be linked more to the comparison with the CGH Grant, although this might be aggravated by higher average system costs; contractors also consider the incentives to be too low compared with other programs. The lower Green Heat rebate is a key motivator to homeowners choosing to follow the HEA path toward the CGH Grant that offers significantly higher rebates.

2023 Green Heat-Finding: The application form is generally easy to complete, but some customers find it difficult to take photos correctly and attach/upload documents.

Participants were generally satisfied with the application process and found the application form easy to complete and the instructions simple to understand. About half of contractors say they help participants complete at least part of the form. Issues that partially explain why many participants do not include all the required information in the application form include difficulty taking photos of the correct equipment information and/or difficulty attaching/uploading the photos, not reading the form carefully, and some installers being reluctant to provide their certification numbers.

2023 Green Heat-Finding: MSHP participant awareness of time-of-day rates is relatively high, but there is still room to increase awareness about ETS and participation in Green Heat.

A total of 61% of MSHP participants said they had heard of ETS technology and 78% had heard of NS Power's time-of-rate day plan. Awareness has not yet translated into Green Heat participation, and the latter remains low (186 ETS measures in 2023).

2023 Green Heat-Finding: Free-ridership levels increased for Green Heat measures, particularly MSHPs.

The 2023 free-ridership level for MSHPs was established at 48%, a significant increase compared to the previous free-ridership result of 39% obtained in 2021. For biomass measures, the 2023 free-ridership level, evaluated at 47%, was a more modest increase compared to the result obtained in 2021 (41%). For demand reduction measures, free-ridership was low at 9% since those measures were still fairly new to Green Heat and had relatively low adoption levels.



2023 Green Heat-Finding: The MSHP market is in a sustained growth phase.

NS Power data indicate a marked increase in annual incremental heat pump installations in 2022 and forecasted that 40% of Nova Scotia households were using a heat pump in 2023. Heat pump distributors report sales increases over the 2022-2023 period driven by strong consumer interest in MSHPs and the rising cost of fossil fuels. The availability of financial assistance for MSHP installations, particularly under the CGH Grant, is also said by distributors and contractors to be a strong driver of market growth.

That being said, some distributors mention that, as the market matures, it may be moving toward more heat pump repairs and replacement systems than new installations, which would mean lower participation levels in Green Heat.

Furthermore, many of the remaining Nova Scotian households without heat pumps are managing with only a low or moderate-income or have homes with additional challenges that need to be addressed and will be unable to install an MSHP without additional means or higher incentives.

Recommendation #4: Consider offering increased incentives to low and moderate-income households and incentivizing heat pump replacements for those households. This recommendation is aimed at increasing Green Heat participation in two ways: (1) Through households that do not have a heat pump; and (2) through households that need to purchase a replacement heat pump but are not eligible under Green Heat.

As noted above, many Nova Scotian households have installed heat pumps, but 60% of households still do not have one. It is likely that a proportion of the remaining population that has yet to participate in Green Heat has less disposable income to purchase a heat pump. To continue the progression of heat pumps beyond the late majority stage of market evolution, an incentive covering a larger proportion of the measure cost might be required. Increasing the incentive specifically for low to moderate-income households might help reach that goal if EOne can do so while maintaining cost effectiveness.

The other factor that might reduce participation in the next few years is the increasing proportion of heat pumps purchased in Nova Scotia that will be used to replace heat pumps that are at the end of life; incentives are currently not available for heat pump replacements. To address this, EOne might allow heat pump replacements under Green Heat specifically for low to moderate-income households only. While it might not be necessary to incentivize higher-income households to replace their heat pumps at the end of life, it is possible that some lower income households will not replace their heat pump without an incentive.

12 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.

12.1 EPI Description

EPI provides participants with free-of-charge direct installations of energy efficient products. EOne contracts service providers to deliver EPI across the province. EPI is available to both homeowners and renters and encourages participants to also consider other EOne residential program components. Table 40 presents the products available for installation through EPI in 2023 and whether they were aimed at generating electrical savings, non-electrical savings, or both.

Table 40: 2023 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	X	X
Low-flow Showerheads	X	X
Thermostatic Shower Valves	X	X
Pipe Insulation	X	X
Hot Water Tank Wraps	X	-
Smart Thermostats (for non-electrically heated homes)	-	X
Smart Thermostats (for mini-split heat pumps [MSHPs]) ⁴²	X	X
Smart Thermostats (for electric baseboards)	X	-
Retractable Clotheslines	X	-
Foam Gaskets	X	X
Door Sweeps	X	X
Window Air Sealing	X	X
Door Weather Stripping	X	X
Window Film Kits ⁴³	X	X

Along with its main offering, EPI installed 97 smart thermostats for electric baseboards between April and June 2023 as a pilot measure. This pilot was directly correlated to the deployment of domestic hot water heater load controllers through the Residential Demand Response program component, which necessitated the expertise of electricians. When the installation of those controllers was paused, so was the installation of smart thermostats for electric baseboards.

⁴² Since May 2022, EPI has offered smart thermostats for MSHPs.

⁴³ Since October 2022, EPI has offered window film kits.

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 funds from the Green Fund for upgrades that reduce the use of other fuels. This report presents the evaluation results for the electricity ratepayer portion of EPI only.

EPI was aimed at achieving 8.268 GWh in net electrical energy savings and 0.760 MW in net peak demand savings at the generator in 2023.

12.2 Follow-up on Past Evaluation Report Recommendations

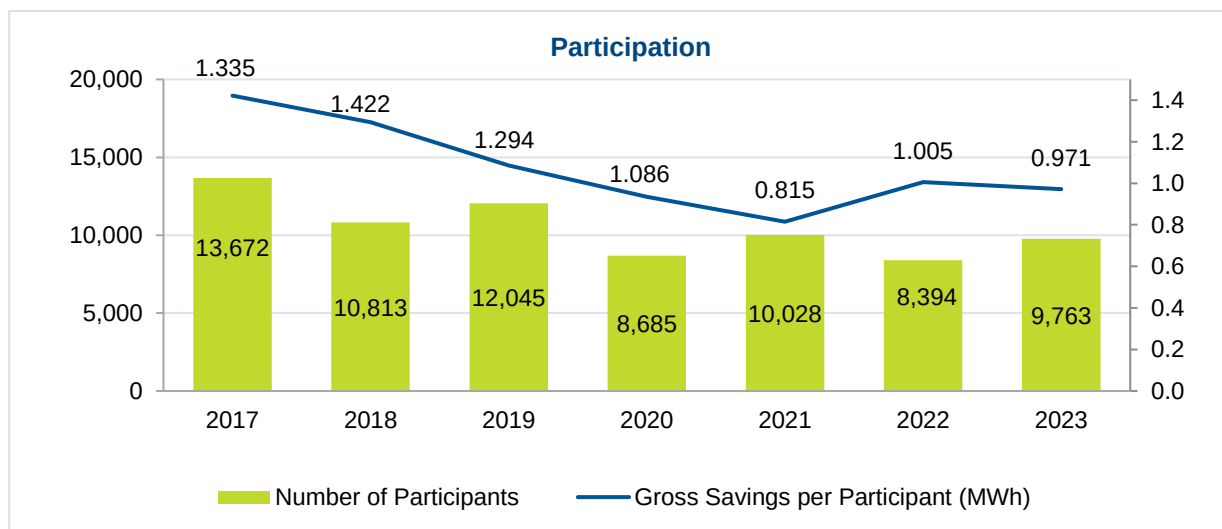
No major improvement recommendations were made for EPI in 2022.

12.3 Participation History

As presented in Figure 27 below, EPI had 9,763 DSM participants, which represents a 16% increase in participation compared to 2022.⁴⁴

In 2023, 153,775 efficient products were installed, which represents an 18% increase compared to 2022. On average, 15.8 products were installed per household, a similar result to the average of 15.5 products installed in 2022. The average savings per participant decreased by 3.4% in 2023 compared to 2022.

Figure 27: Overview of EPI Participation, 2017-2023

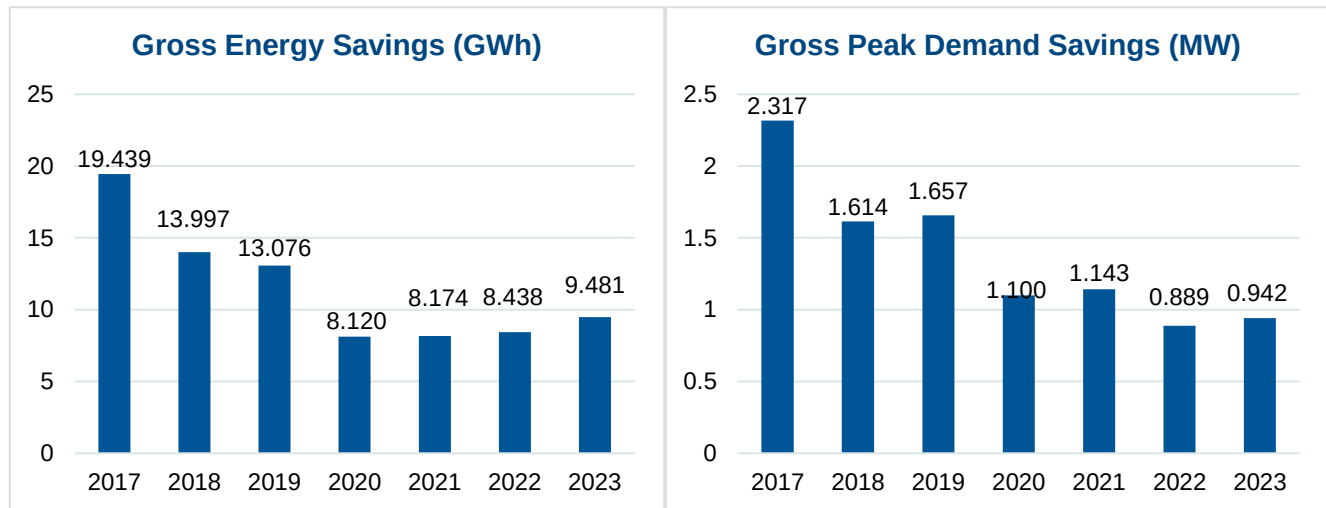


The average number of A-type lamps installed per single-family home increased from 7.0 in 2022 to 7.8 in 2023, while the average number of non-A-type lamp replacements per single-family home decreased from 2.9 in 2022 to 2.8 in 2023. With 118,018 LED lamps generating 4.400 GWh in gross savings, LED lamps remained the most popular product type representing 77% of products installed in EPI and accounting for 46% of EPI gross energy savings. Smart thermostats for MSHPs were also a significant contributor, accounting for 26% of EPI gross energy savings.

As illustrated in Figure 28 below, the 2023 gross energy and peak demand savings were slightly higher than those generated in 2022 due to the higher participation level.

⁴⁴ The number of participants is based on the number of unique reference numbers of participants that generated electricity savings.

Figure 28: Evolution of EPI Gross Savings, 2017-2023



13 EPI Evaluation Approach

The 2023 EPI evaluation comprised a condensed impact evaluation. The main objectives of the 2023 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 emissions⁴⁵

The Evaluator identified key research questions aimed at achieving these objectives. Table 41 outlines the EPI evaluation objectives and maps them to the research questions and methods established by the Evaluator. Each method is described further below.

Table 41: 2023 EPI 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 › Unitary Savings 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?	› Use of 2021 NTGR results › Calculations using evaluation results › Avoided GHG emission reduction calculations

Tracking Sheet Audit

Prior to performing the savings calculation review, the Evaluator audited the final 2023 tracking sheet to ensure it was complete and the entered data were consistent. The results obtained are presented in Appendix XVI.

Unitary Savings Review

The Evaluator established the unitary savings values for the new smart thermostat for electric baseboard measure. The 2020-2023 Measure Assessment⁴⁶ 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 smart thermostat measure. The 2020-2023 Measure Assessment was updated accordingly.

⁴⁵ First-year savings are based on typical energy consumption and do not consider changes in energy consumption resulting from the COVID-19 pandemic.

⁴⁶ The 2020-2023 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 and for the first year of the 2023-2025 DSM cycle, the Evaluator refers to the values presented in the 2020-2023 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 using the equations and parameters that were determined to be valid based on the current evaluation.

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 Nova Scotia Power (NSP) data.



14 EPI Impact Evaluation

The objectives of the 2023 EPI impact evaluation were to determine gross and net electrical energy and peak demand savings. Where appropriate, assumptions specific to the smart thermostat for electric baseboard pilot measure are outlined in the following subsections.

14.1 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 Appendix XVI. 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.⁴⁷ The Evaluator relied on information from the 2020-2023 Measure Assessment to calculate gross savings for EPI measures. The assumptions to calculate the gross savings of the smart thermostat for electric baseboard pilot measure were determined as part of the 2023 evaluation and added in the 2020-2023 Measure Assessment. 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 and referred to the 2020-2023 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. No data collection aimed at updating installation rates for measures of the EPI main offering was conducted in 2023. The product installation rates determined in the 2021 evaluation therefore remained unchanged, while an installation rate of 100% was assumed for the smart thermostat for electric baseboard pilot measure. Since no data were available to establish an installation rate for the window film kit measure, the Evaluator assumed that, due to both participants having to install the window films themselves and the complexity of the installation, it is assumed that not more than one-third of participants installed them.

Table 42 lists the installation rates that the Evaluator applied to gross savings.

⁴⁷ Definition adapted from: National Renewable Energy Laboratory, The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices, September 2014, p.3.

Table 42: 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
Smart Thermostats	100%	N/A	Assumption
Retractable Clotheslines	86%	8.1%	EPI 2018 DSM and 2018/19 PNS Surveys
Foam Gaskets	31%	N/A	2021 EPI evaluation
Door Sweeps	100%	0%	2021 EPI on-site visits
Window Air Sealing	84%	11.2%	2021 EPI on-site visits
Door Weather Stripping	84%	11.2%	2021 EPI on-site visits
Window Film Kits	33%	N/A	Assumption

14.2.2 Unitary Energy Savings

For EPI, EOne establishes separate unitary savings values for single-family homes and apartments. For the 2023 evaluation, the Evaluator used the unitary savings values from the 2020-2023 Measure Assessment. That document provides a detailed description of inputs, references, and unitary savings calculations for all product types offered through EPI.

Table 43 below summarizes the tracked and evaluated unitary energy savings for each product installed through EPI in 2023.

Table 43: 2023 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
PAR20 7 W Replacing 50 W	42.4	No change	42.4	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

2023 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				
Foam Gaskets (Electric resistance heating)	90.0	No change	90.0	No change
Foam Gaskets (Heat pump heating)	40.9	No change	40.9	No change
Door Sweeps (Electric resistance heating)	173	No change	173	No change
Door Sweeps (Heat pump heating)	78.6	No change	78.6	No change
Window Air Sealing (Electric resistance heating)	149	No change	149	No change
Window Air Sealing (Heat pump heating)	67.7	No change	67.7	No change
Door Weather Stripping (Electric resistance heating)	196	No change	196	No change
Door Weather Stripping (Heat pump heating)	89.1	No change	89.1	No change
Window Film Kits (Electric resistance heating)	333	No change	333	No change
Window Film Kits (Heat pump heating)	151	No change	151	No change
Other Products				
LED Nightlights	29.3	No change	29.3	No change
Faucet Aerators	110	No change	130	No change
Low-flow Showerheads (0.5 gpm)	187	No change	227	No change
Low-flow Showerheads (0.75 gpm)	281	No change	341	No change
Low-flow Showerheads (1.0 gpm)	374	No change	455	No change
Thermostatic Shower Valves (2.5 gpm)	118	No change	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
Smart thermostats (for MSHPs)	514	No change	514	No change
Smart thermostats (for electric baseboard)	348	No change	348	No change
Retractable Clotheslines	71.0	No change	71.0	No change

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 established unitary peak demand savings for each product based on the peak demand-to-energy ratios presented in the 2020-2023 Measure Assessment. Differences between tracked and evaluated peak demand savings reflect updates made to the unitary energy savings of certain products.

Table 44 summarizes the tracked and evaluated unitary peak demand savings for each product installed through EPI in 2023.

Table 44: 2023 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
PAR20 7 W Replacing 50 W	6.87	No change	6.87	No change
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

Product	EPI – Single-family Homes		EPI – Apartments	
	Tracked Savings [W/yr]	Evaluated Savings [W/yr]	Tracked Savings [W/yr]	Evaluated Savings [W/yr]
Air Sealing Products				
Foam Gaskets (Electric resistance heating)	25.5	No change	25.5	No change
Foam Gaskets (Heat pump heating)	11.6	No change	11.6	No change
Door Sweeps (Electric resistance heating)	49.0	No change	49.0	No change
Door Sweeps (Heat pump heating)	22.2	No change	22.2	No change
Window Air Sealing (Electric resistance heating)	42.2	No change	42.2	No change
Window Air Sealing (Heat pump heating)	19.2	No change	19.2	No change
Door Weather Stripping (Electric resistance heating)	55.5	No change	55.5	No change
Door Weather Stripping (Heat pump heating)	25.2	No change	25.2	No change
Window Film Kits (Electric resistance heating)	94.2	No change	94.2	No change
Window Film Kits (Heat pump heating)	42.7	No change	42.7	No change
Other Products				
LED Nightlights	4.75	No change	4.75	No change
Faucet Aerators	17.8	No change	21.1	No change
Low-flow Showerheads (0.5 gpm)	30.3	No change	36.8	No change
Low-flow Showerheads (0.75 gpm)	45.5	No change	55.2	No change
Low-flow Showerheads (1.0 gpm)	60.6	No change	73.7	No change
Thermostatic Shower Valves (2.5 gpm)	19.1	No change	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
Smart Thermostats (MSHP and electric baseboard)	0.00	No change	0.00	No change
Retractable Clotheslines	0.00	No change	0.00	No change

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 2023 evaluation, the Evaluator relied on the interactive effects factors presented in the 2020-2023 Measure Assessment. For each entry in the EPI tracking sheet, energy and peak demand interactive effects factors were determined based on product type, location, and home type and were applied to the unitary energy and peak demand savings values.

Table 45 and Table 46 below list the interactive effects factors for LED products and hot water insulation products respectively.

Table 45: 2023 EPI Interactive Effects Calculation Results for LED Products

Product	Location	Type of Home	Energy Interactive Effects Factors	Peak Demand Interactive Effects Factors
LED A-type Lamps	Indoor	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	N/A	0%	0%

Table 46: 2023 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%	-90.0%
	Electrical Heating	-28.5%	-90.0%
	No Electrical Heating	0%	0%
Apartments	Heat Pump Heating and Cooling	-23.0%	-90.0%
	Electrical Heating with Air Conditioning	-54.8%	-90.0%
	Electrical Heating Without Air Conditioning	-60.0%	-90.0%
	No Electrical Heating with Air Conditioning	5.2%	0%
	With Neither Electrical Heating nor Air Conditioning	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 properly tracked. The on-site visit results indicated that there were certain discrepancies in tracked savings.

Comparing the revised savings to 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 2023, 931 LED lamps were tracked under those new categories, which represent 1% of LED A-type lamps installed under EPI.

No data collection aimed at updating the adjustment ratio was conducted in 2023. Therefore, given the low number of LED lamps tracked under the new categories, as was the case 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 2020-2023 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, the EUL values established in 2022 evaluation remained valid for the 2023 evaluation. For lighting products, EUL values were updated since baseline changes are anticipated during the measure lifetimes due to the rapid evolution of the LED market driven in part by government regulations. Appendix II of the 2020-2023 Measure Assessment details the baseline changes and the rationale for the calculation of equivalent EUL values.

Table 47 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 47: 2023 EPI Equivalent EUL and Gross Lifetime Unitary Savings 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	3.0	2.0	31.6	
9 W Replacing 29 W	3.0	2.0	39.4	
9 W Replacing 40 W	2.3	1.6	49.0	
9 W Replacing 43 W	3.0	2.0	67.0	
9 W Replacing 60 W	2.3	1.7	85.5	
9 W Replacing 72 W	3.0	2.0	124	
9 W Replacing 100 W	2.4	1.7	152	
9 W Replacing 150 W	1.9	1.4	195	
9.5 W Replacing 29 W	3.0	2.0	38.4	
9.5 W Replacing 40 W	2.3	1.6	48.2	
9.5 W Replacing 43 W	3.0	2.0	66.0	
9.5 W Replacing 60 W	2.3	1.7	84.7	
9.5 W Replacing 72 W	3.0	2.0	123	
9.5 W Replacing 100 W	2.4	1.7	152	
9.5 W Replacing 150 W	1.9	1.4	193	
18 W Replacing 100 W	2.4	1.9	154	

Product	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]	Evaluated Gross Lifetime Unitary Savings [kWh]	
			Single-family	Apartments
LED Reflector Lamps				
PAR20 7 W Replacing 50 W	3.0	2.0	84.8	
PAR38 15 W Replacing 90 W	3.0	2.0	148	
PAR38 15 W Replacing 120 W	3.0	2.0	206	
PAR38 15 W Replacing 150 W	3.0	2.0	266	
GU10 7 W Replacing 35 W	3.0	2.0	55.2	
GU10 7 W Replacing 50 W	3.0	2.0	84.8	
LED Decorative Lamps				
7 W G25 Replacing 40 W	3.0	2.0	65.0	
5 W Chandelier E12 Replacing 40 W	3.0	2.0	69.0	
Air Sealing Products				
Foam Gaskets (Electric resistance heating)	15.0	No change	1,350	
Foam Gaskets (Heat pump heating)	15.0	No change	614	
Door Sweeps (Electric resistance heating)	15.0	No change	2,595	
Door Sweeps (Heat pump heating)	15.0	No change	1,179	
Window Air Sealing (Electric resistance heating)	15.0	No change	2,235	
Window Air Sealing (Heat pump heating)	15.0	No change	1,016	
Door Weather Stripping (Electric resistance heating)	15.0	No change	2940	
Door Weather Stripping (Heat pump heating)	15.0	No change	1,337	
Window Film Kits (Electric resistance heating)	1.0	No change	333	
Window Film Kits (Heat pump heating)	1.0	No change	151	
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 (2.5 gpm)	10.0	No change	1,180	1,430
Pipe Insulation (per ft)	13.0	No change	165	
Hot Water Tank Wraps	7.0	No change	1,113	826
Smart thermostats (for MSHPs)	10.0	No change	5,140	
Smart thermostats (for electric baseboard)	10.0	No change	3,480	
Retractable Clotheslines	10.0	No change	1,040	

14.2.7 Evaluated Gross Savings

Table 48 and Table 49 below present the annual gross savings results per product category and dwelling for the main EPI offering, including the smart thermostat for electric baseboard pilot measure. Table 50 presents the breakdown of savings results for apartments, single-family homes and for EPI as a whole.

Overall, total gross energy and peak demand savings amounted to 9.481 GWh and 0.942 MW at the generator respectively, which represent 65.685 GWh in lifetime electrical energy savings. As a result, the weighted average EUL value for gross electrical energy savings was established at 6.9 years. The smart thermostat for electric baseboard pilot measure contributed to total savings, accounting for 0.037 GWh in gross energy savings at the generator and representing 0.370 GWh in lifetime electrical energy savings as well as 0 MW in peak demand savings at the generator.

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 NSUARB as part of the 2014 Cost of Service Study Progress Update.⁴⁸

⁴⁸ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1. For municipal utility participants, the line loss factor of the most similar NS Power rate code was assumed. If a municipal utility participant did not have any specific rate code, the average of participants for which the line loss was known was used.

Table 48: Evaluated 2023 EPI Gross Energy and Peak Demand Savings per Measure - 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	476	382	16,036	304	50,079	209	4,431	6
Installation Rate (%)	94%	94%	94%	94%	94%	94%	94%	94%
Number of Units Installed	447	359	15,074	286	47,074	196	4,165	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*	-10.8%	-12.3%	-16.9%	-12.5%	-16.5%	-13.4%	-15.4%	2.0%
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)	0.006	0.006	0.368	0.008	1.899	0.010	0.303	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)	0.007	0.007	0.403	0.009	2.079	0.011	0.332	0.001
Effective Useful Life (years)	2.0	2.0	1.6	2.0	1.7	2.0	1.7	1.4
Gross Lifetime Energy Savings – at the Generator (GWh)	0.013	0.013	0.644	0.018	3.534	0.022	0.565	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*	-37.6%	-38.4%	-47.8%	-42.5%	-48.5%	-45.1%	-38.6%	0.0%
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	0.037	0.001	0.190	0.001	0.036	0.000
Line Loss Factor*	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.001	0.001	0.043	0.001	0.218	0.001	0.041	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. 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 2023 EPI Gross Energy and Peak Demand Savings per Measure - Single-family Homes (Continued)

Product Category	LED Lamps				
	18 W Replacing 100 W	PAR20 7 W Replacing 50 W	PAR38 15 W Replacing 90 W	PAR38 15 W Replacing 120 W	PAR38 15 W Replacing 150 W
Number of Units					
Number of Units	1,169	5,380	303	72	1,458
Installation Rate (%)	94%	94%	94%	94%	94%
Number of Units Installed	1,099	5,057	285	68	1,371
Energy Savings					
Unitary Savings Value (kWh)	80.8	42.4	73.9	103	133
Interactive Effects Factor*	-16.0%	-21.1%	0.0%	0.0%	0.0%
Adjustment Ratio	0.96	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.072	0.169	0.021	0.007	0.182
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.078	0.185	0.023	0.008	0.200
Effective Useful Life (years)	1.9	2.0	2.0	2.0	2.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.149	0.370	0.046	0.015	0.399
Peak Demand Savings					
Unitary Peak Demand Savings (W)	13.1	6.87	12.00	16.7	21.5
Peak Demand Interactive Effects Factor*	-49.2%	-63.7%	0.0%	0.0%	0.0%
Adjustment Ratio	0.96	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.007	0.013	0.003	0.001	0.029
Line Loss Factor*	1.1464	1.1466	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.008	0.014	0.004	0.001	0.034
* 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. 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 2023 EPI Gross Energy and Peak Demand Savings per Measure - Single-family Homes (Continued)

Product Category	LED Lamps				
	Nightlights	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	13,906	530	3,938	3,470	11,972
Installation Rate (%)	94%	94%	94%	94%	94%
Number of Units Installed	13,072	498	3,702	3,262	11,254
Energy Savings					
Unitary Savings Value (kWh)	29.3	27.6	42.4	32.5	34.5
Interactive Effects Factor*	-18.1%	-22.4%	-18.6%	-19.5%	-17.0%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.314	0.011	0.128	0.085	0.322
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.344	0.012	0.140	0.093	0.353
Effective Useful Life (years)	23.0	2.0	2.0	2.0	2.0
Gross Lifetime Energy Savings – at the Generator (GWh)	7.901	0.023	0.280	0.187	0.706
Peak Demand Savings					
Unitary Peak Demand Savings (W)	4.75	4.47	6.87	5.27	5.59
Peak Demand Interactive Effects Factor*	-57.1%	-65.4%	-58.6%	-57.6%	-50.5%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.027	0.001	0.011	0.007	0.031
Line Loss Factor*	1.1466	1.1466	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.031	0.001	0.012	0.008	0.036
* 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. 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 2023 EPI Gross Energy and Peak Demand Savings per Measure - Single-family Homes (Continued)

Product Category	Faucet Aerators	Thermostatic Shower Valves 2.5 gpm	Low-flow Showerheads		
			0.5 gpm Reduction	0.75 gpm Reduction	1.0 gpm Reduction
Number of Units					
Number of Units	4,165	599	252	108	2,633
Installation Rate (%)	85%	88%	96%	96%	96%
Number of Units Installed	3,540	527	242	104	2,528
Energy Savings					
Unitary Savings Value (kWh)	110	118	187	281	374
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)	0.389	0.062	0.045	0.029	0.945
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.426	0.068	0.050	0.032	1.035
Effective Useful Life (years)	10.0	10.0	10.0	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	4.263	0.681	0.495	0.319	10.349
Peak Demand Savings					
Unitary Peak Demand Savings (W)	17.8	19.1	30.3	45.5	60.6
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)	0.063	0.010	0.007	0.005	0.153
Line Loss Factor*	1.1465	1.1466	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.072	0.012	0.008	0.005	0.176
* 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. 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 2023 EPI Gross Energy and Peak Demand Savings per Measure - Single-family Homes (Continued)

Product Category	Pipe Insulation (per foot)	Hot Water Tank Wraps	Retractable Clotheslines	Smart Thermostats for Electric Baseboards	Smart Thermostats for MSHPs
Number of Units					
Number of Units	12,127	1,842	87	97	4,434
Installation Rate (%)	100%	100%	86%	100%	100%
Number of Units Installed	12,127	1,842	75	97	4,434
Energy Savings					
Unitary Savings Value (kWh)	12.7	159	71	348	514
Interactive Effects Factor*	-10.7%	-12.2%	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)	0.138	0.257	0.005	0.034	2.279
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.151	0.282	0.006	0.037	2.495
Effective Useful Life (years)	13.0	7.0	10.0	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	1.958	1.971	0.058	0.370	24.949
Peak Demand Savings					
Unitary Peak Demand Savings (W)	2.06	25.8	0	0	0
Peak Demand Interactive Effects Factor*	-10.7%	-12.2%	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)	0.022	0.042	0.000	0.000	0.000
Line Loss Factor*	1.1464	1.1465	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.026	0.048	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. 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 2023 EPI Gross Energy and Peak Demand Savings per Measure - Single-family Homes (Continued)

Product Category	Air Sealing Products– Electric Resistance Heating				
	Foam Gaskets	Door Sweeps	Window Air Sealing	Window Film Kits	Door Weather Stripping
Number of Units					
Number of Units	1,212	43	120	458	189
Installation Rate (%)	31%	100%	84%	33%	84%
Number of Units Installed	376	43	101	151	159
Energy Savings					
Unitary Savings Value (kWh)	90	173	149	333	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)	0.034	0.007	0.015	0.050	0.031
Line Loss Factor*	1.0946	1.0947	1.0947	1.0947	1.0939
Gross Energy Savings – at the Generator (GWh)	0.037	0.008	0.016	0.055	0.034
Effective Useful Life (years)	15.0	15.0	15.0	1.0	15.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.555	0.122	0.247	0.055	0.511
Peak Demand Savings					
Unitary Peak Demand Savings (W)	25.5	49.0	42.2	94.2	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)	0.010	0.002	0.004	0.014	0.009
Line Loss Factor*	1.1464	1.1466	1.1466	1.1464	1.1448
Gross Peak Demand Savings – at the Generator (MW)	0.011	0.002	0.005	0.016	0.010
* 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. 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 2023 EPI Gross Energy and Peak Demand Savings per Measure - Single-family Homes (Continued)

Product Category	Air Sealing Products – Heat Pump Heating					Total for Single-family Homes
	Foam Gaskets	Door Sweeps	Window Air Sealing	Window Film Kits	Door Weather Stripping	
Number of Units						
Number of Units	4,031	131	172	1,404	473	148,698
Installation Rate (%)	31%	100%	84%	33%	84%	91%
Number of Units Installed	1,250	131	144	463	397	136,006
Energy Savings						
Unitary Savings Value (kWh)	40.9	78.6	67.7	151	89.1	-
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)	0.051	0.010	0.010	0.070	0.035	8.411
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.056	0.011	0.011	0.077	0.039	9.207
Effective Useful Life (years)	15.0	15.0	15.0	1.0	15.0	6.9
Gross Lifetime Energy Savings – at the Generator (GWh)	0.839	0.169	0.161	0.077	0.581	63.616
Peak Demand Savings						
Unitary Peak Demand Savings (W)	11.6	22.2	19.2	42.7	25.2	-
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)	0.014	0.003	0.003	0.020	0.010	0.788
Line Loss Factor*	1.1465	1.1466	1.1466	1.1465	1.1466	1.1465
Gross Peak Demand Savings – at the Generator (MW)	0.017	0.003	0.003	0.023	0.011	0.903
* 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. 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 49: Evaluated 2023 EPI Gross Energy and Peak Demand Savings per Measure – 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	17	22	363	8	1,672	6	630	0
Installation Rate (%)	94%	94%	94%	94%	94%	94%	94%	94%
Number of Units Installed	16	21	341	8	1,572	6	592	0
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*	-25.3%	-9.4%	-31.8%	-13.3%	-33.0%	-8.9%	-53.2%	0.0%
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	0.007	0.000	0.051	0.000	0.024	0.000
Line Loss Factor*	1.0947	1.0947	1.0933	1.0947	1.0920	1.0947	1.0946	1.0947
Gross Energy Savings – at the Generator (GWh)	0.000	0.000	0.007	0.000	0.056	0.000	0.026	0.000
Effective Useful Life (years)	2.0	2.0	1.6	2.0	1.7	2.0	1.7	1.4
Gross Lifetime Energy Savings – at the Generator (GWh)	0.000	0.001	0.012	0.000	0.094	0.001	0.044	0.000
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*	-41.1%	-15.9%	-60.4%	-21.8%	-57.6%	-14.6%	-83.8%	0.0%
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	0.001	0.000	0.005	0.000	0.001	0.000
Line Loss Factor*	1.1466	1.1466	1.1457	1.1466	1.1295	1.1466	1.1459	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.001	0.000	0.006	0.000	0.002	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. 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 2023 EPI Gross Energy and Peak Demand Savings per Measure – Apartments (Continued)

Product Category	LED Lamps				
	18 W Replacing 100 W	PAR20 7 W Replacing 50 W	PAR38 15 W Replacing 90 W	PAR38 15 W Replacing 120 W	PAR38 15 W Replacing 150 W
Number of Units					
Number of Units	21	68	0	0	3
Installation Rate (%)	94%	94%	94%	94%	94%
Number of Units Installed	20	64	0	0	3
Energy Savings					
Unitary Savings Value (kWh)	80.8	42.4	73.9	103	133
Interactive Effects Factor*	-29.5%	-36.7%	0.0%	0.0%	0.0%
Adjustment Ratio	0.96	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.001	0.002	0.000	0.000	0.000
Line Loss Factor*	1.0947	1.0897	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.001	0.002	0.000	0.000	0.000
Effective Useful Life (years)	1.9	2.0	2.0	2.0	2.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.002	0.004	0.000	0.000	0.001
Peak Demand Savings					
Unitary Peak Demand Savings (W)	13.1	6.87	12.0	16.7	21.5
Peak Demand Interactive Effects Factor*	-45.7%	-68.8%	0.0%	0.0%	0.0%
Adjustment Ratio	0.96	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.000
Line Loss Factor*	1.1466	1.1430	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	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. 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 2023 EPI Gross Energy and Peak Demand Savings per Measure – Apartments (Continued)

Product Category	LED Lamps				
	Nightlights	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	780	10	66	94	137
Installation Rate (%)	94%	94%	94%	94%	94%
Number of Units Installed	733	9	62	88	129
Energy Savings					
Unitary Savings Value (kWh)	29.3	27.6	42.4	32.5	34.5
Interactive Effects Factor*	-27.8%	-40.6%	-33.5%	-39.9%	-38.7%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Energy Savings – at the Meter (GWh)	0.016	0.000	0.002	0.002	0.003
Line Loss Factor*	1.0860	1.0947	1.0947	1.0940	1.0875
Gross Energy Savings – at the Generator (GWh)	0.017	0.000	0.002	0.002	0.003
Effective Useful Life (years)	23.0	2.0	2.0	2.0	2.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.387	0.000	0.004	0.004	0.006
Peak Demand Savings					
Unitary Peak Demand Savings (W)	4.75	4.47	6.87	5.27	5.59
Peak Demand Interactive Effects Factor*	-54.7%	-63.0%	-62.7%	-70.9%	-64.4%
Adjustment Ratio	1.00	1.00	1.00	1.00	1.00
Gross Peak Demand Savings – at the Meter (MW)	0.002	0.000	0.000	0.000	0.000
Line Loss Factor*	1.1086	1.1466	1.1466	1.1458	1.1155
Gross Peak Demand Savings – at the Generator (MW)	0.002	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. 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 2023 EPI Gross Energy and Peak Demand Savings per Measure – Apartments (Continued)

	Faucet Aerators	Thermostatic Shower Valves 2.5 gpm	Low-flow Showerheads		
			0.5 gpm Reduction	0.75 gpm Reduction	1.0 gpm Reduction
Number of Units					
Number of Units	291	19	9	4	150
Installation Rate (%)	85%	88%	96%	96%	96%
Number of Units Installed	247	17	9	4	144
Energy Savings					
Unitary Savings Value (kWh)	130	143	227	341	455
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)	0.032	0.002	0.002	0.001	0.066
Line Loss Factor*	1.0897	1.0937	1.0947	1.0947	1.0901
Gross Energy Savings – at the Generator (GWh)	0.035	0.003	0.002	0.001	0.071
Effective Useful Life (years)	10.0	10.0	10.0	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.350	0.026	0.021	0.014	0.714
Peak Demand Savings					
Unitary Peak Demand Savings (W)	21.1	23.2	36.8	55.2	73.7
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)	0.005	0.000	0.000	0.000	0.011
Line Loss Factor*	1.1333	1.1369	1.1466	1.1466	1.1343
Gross Peak Demand Savings – at the Generator (MW)	0.006	0.000	0.000	0.000	0.012
* 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. 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 2023 EPI Gross Energy and Peak Demand Savings per Measure – Apartments (Continued)

Product Category	Pipe Insulation (per foot)	Hot Water Tank Wraps	Retractable Clotheslines	Smart Thermostats for Electric Baseboards	Smart Thermostats for MSHPs
Number of Units					
Number of Units	206	48	1	0	18
Installation Rate (%)	100%	100%	86%	100%	100%
Number of Units Installed	206	48	1	0	18
Energy Savings					
Unitary Savings Value (kWh)	12.7	118	71	348	514
Interactive Effects Factor*	-29.8%	-42.2%	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)	0.002	0.003	0.000	0.000	0.009
Line Loss Factor*	1.0947	1.0944	1.0947	1.0947	1.0947
Gross Energy Savings – at the Generator (GWh)	0.002	0.004	0.000	0.000	0.010
Effective Useful Life (years)	13.0	7.0	10.0	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.026	0.025	0.001	0.000	0.101
Peak Demand Savings					
Unitary Peak Demand Savings (W)	2.06	19.1	0	0	0
Peak Demand Interactive Effects Factor*	-29.8%	-42.2%	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	0.001	0.000	0.000	0.000
Line Loss Factor*	1.1462	1.1439	1.1466	1.1466	1.1466
Gross Peak Demand Savings – at the Generator (MW)	0.000	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. 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 2023 EPI Gross Energy and Peak Demand Savings per Measure – Apartments (Continued)

Product Category	Air Sealing Products – Electric Resistance Heating				
	Foam Gaskets	Door Sweeps	Window Air Sealing	Window Film Kits	Door Weather Stripping
Number of Units					
Number of Units	178	2	22	111	21
Installation Rate (%)	31%	100%	84%	33%	84%
Number of Units Installed	55	2	18	37	18
Energy Savings					
Unitary Savings Value (kWh)	90.0	173	149	333	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)	0.005	0.000	0.003	0.012	0.003
Line Loss Factor*	1.0888	1.0947	1.0947	1.0805	1.0945
Gross Energy Savings – at the Generator (GWh)	0.005	0.000	0.003	0.013	0.004
Effective Useful Life (years)	15.0	15.0	15.0	1.0	15.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.081	0.006	0.045	0.013	0.057
Peak Demand Savings					
Unitary Peak Demand Savings (W)	25.5	49.0	42.2	94.2	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)	0.001	0.000	0.001	0.003	0.001
Line Loss Factor*	1.1310	1.1466	1.1466	1.1085	1.1444
Gross Peak Demand Savings – at the Generator (MW)	0.002	0.000	0.001	0.004	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. 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 2023 EPI Gross Energy and Peak Demand Savings per Measure – Apartments (Continued)

Product Category	Air Sealing Products – Heat Pump Heating					Total for Apartments
	Foam Gaskets	Door Sweeps	Window Air Sealing	Window Film Kits	Door Weather Stripping	
Number of Units						
Number of Units	86	0	8	6	0	5,077
Installation Rate (%)	31%	100%	84%	33%	84%	89%
Number of Units Installed	27	0	7	2	0	4,524
Energy Savings						
Unitary Savings Value (kWh)	40.9	78.6	67.7	151	89.1	-
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)	0.001	0.000	0.000	0.000	0.000	0.251
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947	1.0908
Gross Energy Savings – at the Generator (GWh)	0.001	0.000	0.000	0.000	0.000	0.274
Effective Useful Life (years)	15.0	15.0	15.0	1.0	15.0	7.6
Gross Lifetime Energy Savings – at the Generator (GWh)	0.018	0.000	0.007	0.000	0.000	2.069
Peak Demand Savings						
Unitary Peak Demand Savings (W)	11.6	22.2	19.2	42.7	25.2	-
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	0.000	0.000	0.000	0.000	0.035
Line Loss Factor*	1.1466	1.1466	1.1466	1.1466	1.1466	1.1316
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.000	0.000	0.039

* 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. 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 50 combines total EPI results for single-family homes and apartments.

Table 50: Evaluated 2023 EPI Gross Energy and Peak Demand Savings

	Total for Single-family Homes	Total for Apartments	Grand Total
Number of Units			
Number of Units	148,698	5,077	153,775
Installation Rate (%)	91%	89%	91%
Number of Units Installed	136,006	4,524	140,530
Energy Savings			
Gross Energy Savings – at the Meter (GWh)	8.411	0.251	8.662
Line Loss Factor*	1.0947	1.0908	1.0946
Gross Energy Savings – at the Generator (GWh)	9.207	0.274	9.481
Effective Useful Life (years)*	6.909	7.555	6.928
Gross Lifetime Energy Savings – at the Generator (GWh)	63.616	2.069	65.685
Peak Demand Savings			
Gross Peak Demand Savings – at the Meter (MW)	0.788	0.035	0.822
Line Loss Factor*	1.1465	1.1316	1.1459
Gross Peak Demand Savings – at the Generator (MW)	0.903	0.039	0.942
* The installation rates, EUL values, and line loss factors correspond to the average for each offering weighted according to the proportion of each type of product and rate code. The installation rate is obtained by dividing the installed number of units by the total number of units. The EUL value is obtained by dividing lifetime gross energy savings at the generator by gross energy savings at the generator. 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 and evaluated gross energy savings at the generator, while Figure 30 further below compares the tracked and evaluated gross peak demand savings at the generator. As outlined in both figures, tracked and evaluated savings were the same for all measures.

Figure 29: 2023 EPI Tracked and Evaluated Gross Savings at the Generator

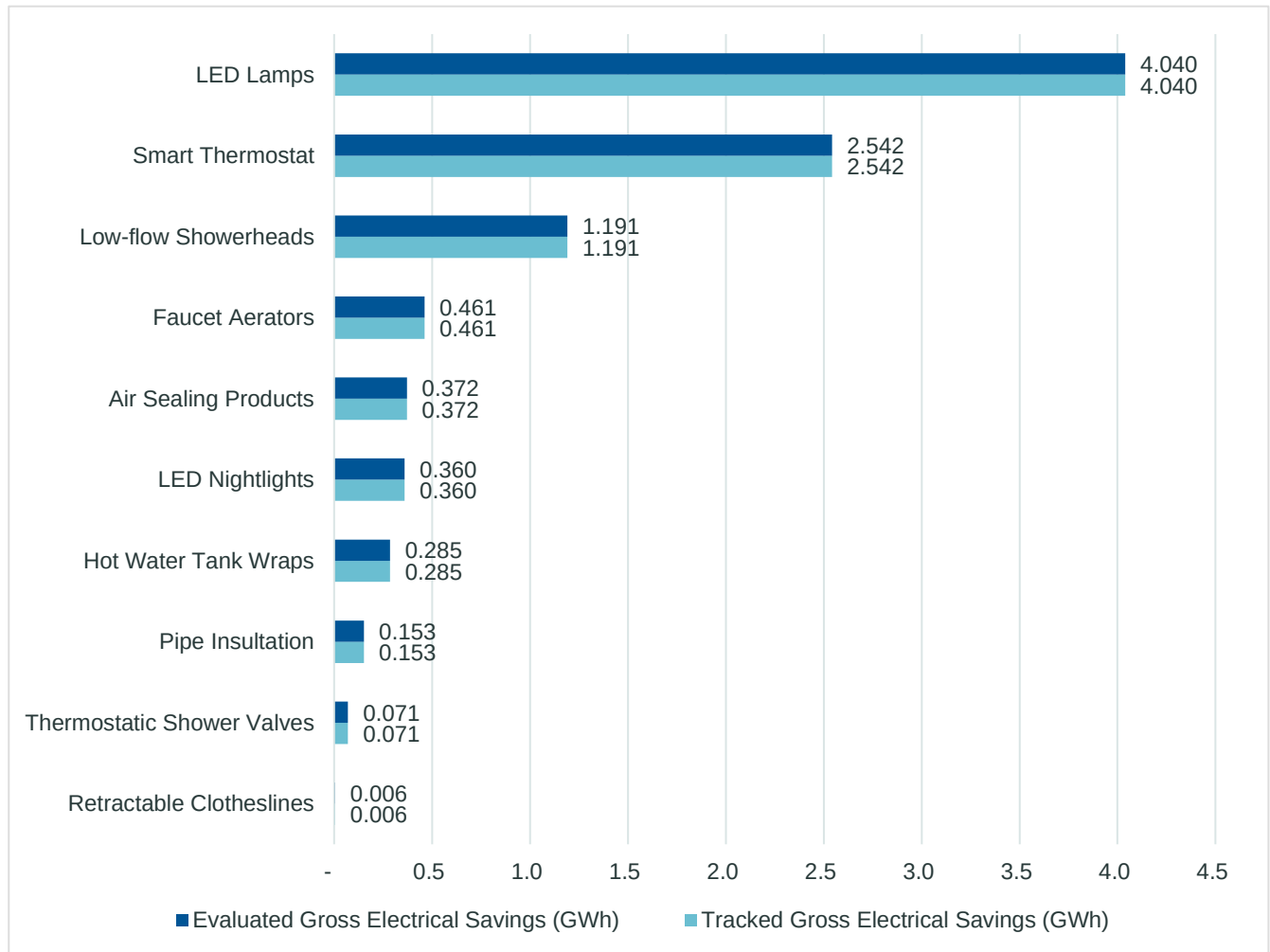
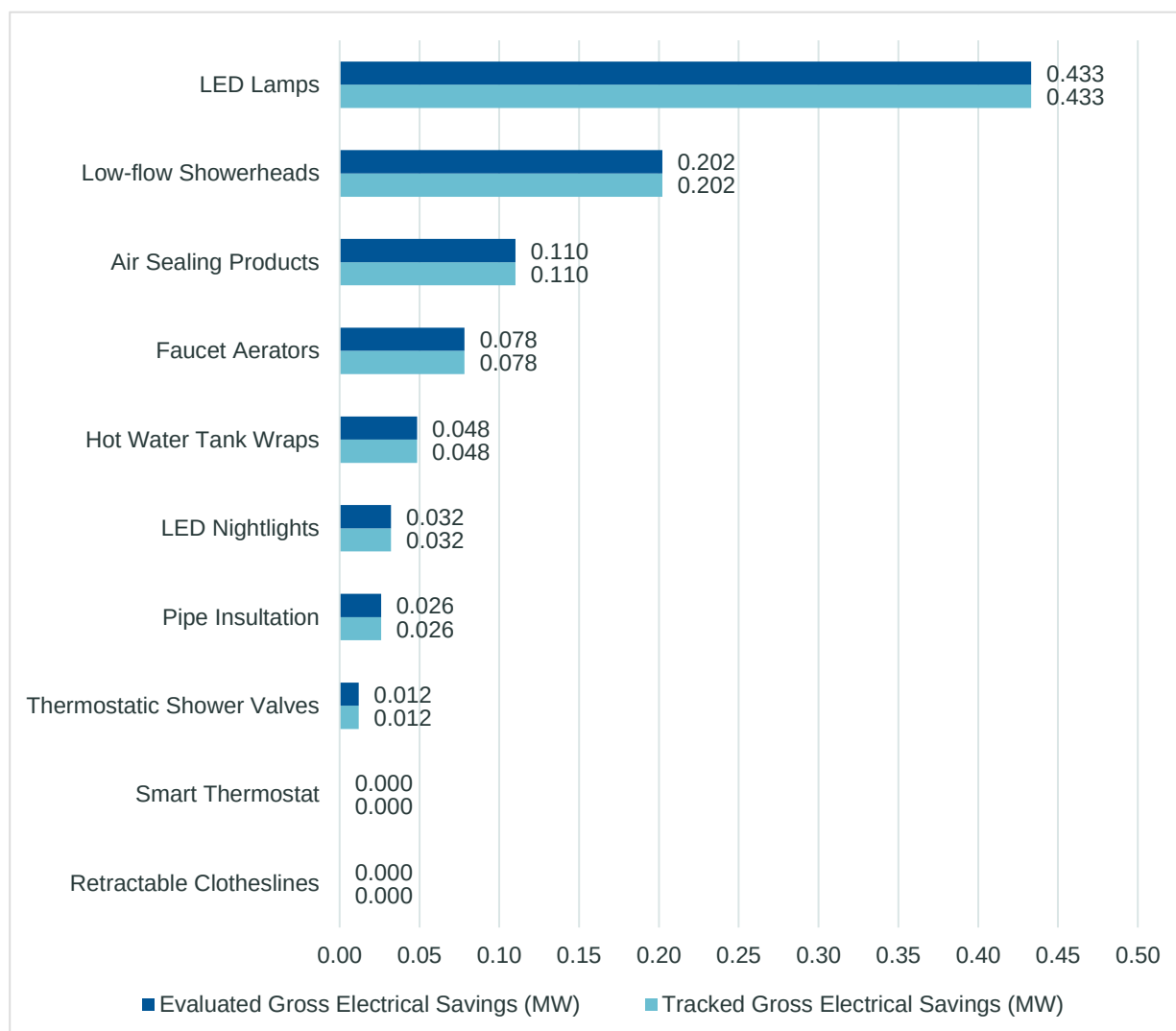


Figure 30: 2023 EPI Tracked and Evaluated Gross Peak Demand Savings at the Generator



As presented in Table 51, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor⁴⁹ for GHG emissions generated by electricity production to EPI gross savings results.

Table 51: Evaluated 2023 EPI Gross GHG Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	9.481
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO2 eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO2 eq)	5,233

⁴⁹ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO2 eq tonnes) and total electricity generation (10,456 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 December 1st, 2023), Emera inc., anagement's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22'23.pdf (Last accessed December 1st, 2023).

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. For low-income participants, the free-ridership level is assumed to be nil, while for non-low-income participants, free-ridership was assessed during the 2021 evaluation using a self-report approach that involved asking a set of questions during a telephone survey to 100 non-low-income participants that received at least LED lamps or a low-flow showerhead. No data collection aimed at updating these free-ridership levels was conducted in 2023.

Since no data collection aimed at establishing specific free-ridership levels for the smart thermostat for electric baseboard pilot measure was conducted in 2023, the free-ridership levels established for the main EPI offering for non-low-income participants were applied to this measure savings.

Table 52 outlines the free-ridership levels from the 2023 evaluation.

Table 52: 2023 EPI Participant Free-ridership Levels

Average Free-ridership Level		Margin of Error
Low-income Participants		
All Products	0%	N/A
Non-low-income Participants		
LED Lighting	25%	3.6%
Low-flow Showerheads	10%	3.0%
Other Products	0%	N/A

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. Similarly to free-ridership, no data collection aimed at updating the 2021 spillover level was conducted in 2023. Therefore, the 2021 survey results were used.

Table 53 below outlines the participant spillover level for the 2023 evaluation.

Table 53: 2023 EPI Participant Spillover Levels

Average Participant Spillover Level		Margin of Error
Low-income Participants		
All Products	0%	N/A
Non-low-income Participants		
All Products	10%	7.5%

14.3.3 Net-to-gross Ratio Calculation

The NTGR values were calculated using the following equation:

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

Overall NTGR values were calculated using the free-ridership and spillover levels established per participant type and product category and the proportions of savings associated with each participant type in each product category.

Table 54 below outlines the overall NTGR values for the 2023 evaluation.

Table 54: 2023 EPI Net-to-gross Ratios by Product Category

	EPI					
	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	0.85	1.00	1.00	1.00	1.10	1.00
Proportion of Product Category Gross Savings by Participant Type	61%	39%	62%	38%	73%	27%
Overall NTGR Values	0.91		1.00		1.07	

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:

$$Net\ Savings = Gross\ Savings \times NTGR$$

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

The detailed results per measure, including pilot results, are presented in Table 55. The net energy savings resulted in 5,164 tonnes of CO₂ eq in net annual GHG emission reductions.

Table 55: Evaluated 2023 EPI Net Energy and Peak Demand Savings per Measure

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)	0.006	0.006	0.375	0.008	1.950	0.010	0.327	0.001
NTGR	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Net Energy Savings – at the Meter (GWh)	0.006	0.006	0.341	0.008	1.775	0.010	0.298	0.001
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0946	1.0947	1.0947	1.0947
Net Energy Savings – at the Generator (GWh)	0.006	0.006	0.373	0.008	1.942	0.010	0.326	0.001
Effective Useful Life (years)	2.0	2.0	1.6	2.0	1.7	2.0	1.7	1.4
Net Lifetime Energy Savings – at the Generator (GWh)	0.012	0.013	0.597	0.016	3.302	0.021	0.554	0.001
Peak Demand Savings								
Gross Peak Demand Savings – at the Meter (MW)	0.001	0.001	0.038	0.001	0.195	0.001	0.037	0.000
NTGR	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Net Peak Demand Savings – at the Meter (MW)	0.001	0.001	0.035	0.001	0.178	0.001	0.034	0.000
Line Loss Factor*	1.1466	1.1466	1.1466	1.1466	1.1461	1.1466	1.1466	1.1466
Net Peak Demand Savings – at the Generator (MW)	0.001	0.001	0.040	0.001	0.203	0.001	0.039	0.000
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. These factors are obtained by dividing net savings at the generator by net savings at the meter.								

Evaluated 2023 EPI Net Energy and Peak Demand Savings per Measure (Continued)

Product Category	LED Lamps				
	18 W Replacing 100 W	PAR20 7 W Replacing 50 W	PAR38 15 W Replacing 90 W	PAR38 15 W Replacing 120 W	PAR38 15 W Replacing 150 W
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.073	0.171	0.021	0.007	0.183
NTGR	0.91	0.91	0.91	0.91	0.91
Net Energy Savings – at the Meter (GWh)	0.066	0.156	0.019	0.006	0.166
Line Loss Factor*	1.0947	1.0946	1.0947	1.0947	1.0947
Net Energy Savings – at the Generator (GWh)	0.072	0.170	0.021	0.007	0.182
Effective Useful Life (years)	1.9	2.0	2.0	2.0	2.0
Net Lifetime Energy Savings – at the Generator (GWh)	0.137	0.340	0.042	0.014	0.364
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.007	0.013	0.003	0.001	0.030
NTGR	0.91	0.91	0.91	0.91	0.91
Net Peak Demand Savings – at the Meter (MW)	0.007	0.012	0.003	0.001	0.027
Line Loss Factor*	1.1464	1.1465	1.1466	1.1466	1.1466
Net Peak Demand Savings – at the Generator (MW)	0.007	0.013	0.004	0.001	0.031
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. These factors are obtained by dividing net savings at the generator by net savings at the meter.					

Evaluated 2023 EPI Net Energy and Peak Demand Savings per Measure (Continued)

Product Category	LED Lamps				
	Nightlights	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)	0.329	0.011	0.130	0.087	0.325
NTGR	0.91	0.91	0.91	0.91	0.91
Net Energy Savings – at the Meter (GWh)	0.300	0.010	0.118	0.079	0.296
Line Loss Factor*	1.0943	1.0947	1.0947	1.0947	1.0946
Net Energy Savings – at the Generator (GWh)	0.328	0.011	0.129	0.087	0.324
Effective Useful Life (years)	23.0	2.0	2.0	2.0	2.0
Net Lifetime Energy Savings – at the Generator (GWh)	7.543	0.022	0.258	0.174	0.647
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.028	0.001	0.011	0.007	0.031
NTGR	0.91	0.91	0.91	0.91	0.91
Net Peak Demand Savings – at the Meter (MW)	0.026	0.001	0.010	0.007	0.029
Line Loss Factor*	1.1444	1.1466	1.1466	1.1466	1.1463
Net Peak Demand Savings – at the Generator (MW)	0.029	0.001	0.011	0.008	0.033
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. These factors are obtained by dividing net savings at the generator by net savings at the meter.					



Evaluated 2023 EPI Net Energy and Peak Demand Savings per Measure (Continued)

Product Category	Faucet Aerators	Thermostatic Shower Valves 2.5 gpm	Low-flow Showerheads		
			0.5 gpm Reduction	0.75 gpm Reduction	1.0 gpm Reduction
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.422	0.065	0.047	0.030	1.011
NTGR	1.07	1.07	1.00	1.00	1.00
Net Energy Savings – at the Meter (GWh)	0.451	0.069	0.047	0.030	1.011
Line Loss Factor*	1.0943	1.0947	1.0947	1.0947	1.0944
Net Energy Savings – at the Generator (GWh)	0.494	0.076	0.052	0.033	1.106
Effective Useful Life (years)	10.0	10.0	10.0	10.0	10.0
Net Lifetime Energy Savings – at the Generator (GWh)	4.936	0.757	0.517	0.333	11.063
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.068	0.010	0.008	0.005	0.164
NTGR	1.07	1.07	1.00	1.00	1.00
Net Peak Demand Savings – at the Meter (MW)	0.073	0.011	0.008	0.005	0.164
Line Loss Factor*	1.1455	1.1462	1.1466	1.1466	1.1458
Net Peak Demand Savings – at the Generator (MW)	0.084	0.013	0.009	0.006	0.188
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. These factors are obtained by dividing net savings at the generator by net savings at the meter.					

Evaluated 2023 EPI Net Energy and Peak Demand Savings per Measure (Continued)

Product Category	Pipe Insulation	Hot Water Tank Wraps	Retractable Clotheslines	Smart Thermostats for Electric Baseboards	Smart Thermostats for MSHPs
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.139	0.261	0.005	0.034	2.288
NTGR	1.07	1.07	1.07	1.07	1.07
Net Energy Savings – at the Meter (GWh)	0.149	0.279	0.006	0.036	2.449
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947
Net Energy Savings – at the Generator (GWh)	0.163	0.305	0.006	0.040	2.680
Effective Useful Life (years)	13.0	7.0	10.0	10.0	10.0
Net Lifetime Energy Savings – at the Generator (GWh)	2.123	2.136	0.063	0.395	26.804
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.023	0.042	0.000	0.000	0.000
NTGR	1.07	1.07	1.07	1.07	1.07
Net Peak Demand Savings – at the Meter (MW)	0.024	0.045	0.000	0.000	0.000
Line Loss Factor*	1.1464	1.1465	1.1466	1.1466	1.1466
Net Peak Demand Savings – at the Generator (MW)	0.028	0.052	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. These factors are obtained by dividing net savings at the generator by net savings at the meter.					



Evaluated 2023 EPI Net Energy and Peak Demand Savings per Measure (Continued)

Product Category	Air Sealing Products – Electric Resistance Heating				
	Foam Gaskets	Door Sweeps	Window Air Sealing	Window Film Kits	Door Weather Stripping
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.039	0.008	0.018	0.063	0.035
NTGR	1.07	1.07	1.07	1.07	1.07
Net Energy Savings – at the Meter (GWh)	0.041	0.008	0.019	0.067	0.037
Line Loss Factor*	1.0939	1.0947	1.0947	1.0919	1.0940
Net Energy Savings – at the Generator (GWh)	0.045	0.009	0.021	0.073	0.040
Effective Useful Life (years)	15.0	15.0	15.0	1.0	15.0
Net Lifetime Energy Savings – at the Generator (GWh)	0.681	0.137	0.312	0.073	0.607
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.011	0.002	0.005	0.018	0.010
NTGR	1.07	1.07	1.07	1.07	1.07
Net Peak Demand Savings – at the Meter (MW)	0.012	0.002	0.005	0.019	0.010
Line Loss Factor*	1.1444	1.1466	1.1466	1.1390	1.1447
Net Peak Demand Savings – at the Generator (MW)	0.013	0.003	0.006	0.022	0.012
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. These factors are obtained by dividing net savings at the generator by net savings at the meter.					

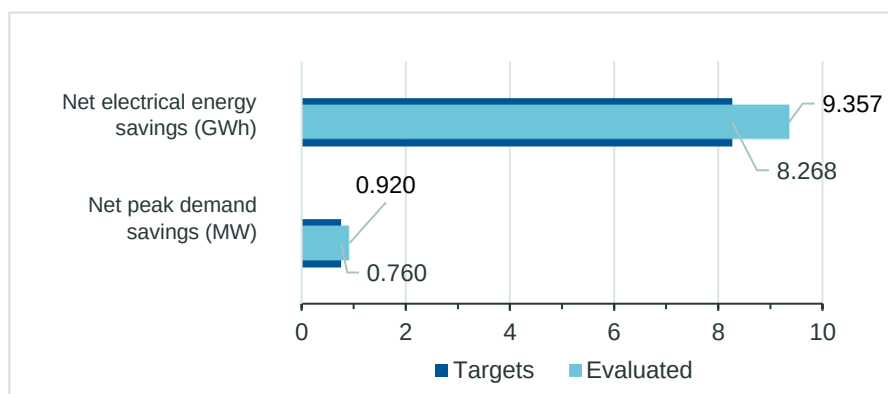
Evaluated 2023 EPI Net Energy and Peak Demand Savings per Measure (Continued)

Product Category	Air Sealing Products – Heat Pump Heating					Grand Total
	Foam Gaskets	Door Sweeps	Window Air Sealing	Window Film Kits	Door Weather Stripping	
Energy Savings						
Gross Energy Savings – at the Meter (GWh)	0.052	0.010	0.010	0.070	0.035	8.662
NTGR	1.07	1.07	1.07	1.07	1.07	0.99
Net Energy Savings – at the Meter (GWh)	0.056	0.011	0.011	0.075	0.038	8.549
Line Loss Factor*	1.0947	1.0947	1.0947	1.0947	1.0947	1.0946
Net Energy Savings – at the Generator (GWh)	0.061	0.012	0.012	0.082	0.041	9.357
Effective Useful Life (years)	15.0	15.0	15.0	1.0	15.0	7.2
Net Lifetime Energy Savings – at the Generator (GWh)	0.917	0.181	0.180	0.082	0.622	66.977
Peak Demand Savings						
Gross Peak Demand Savings – at the Meter (MW)	0.015	0.003	0.003	0.020	0.010	0.822
NTGR	1.07	1.07	1.07	1.07	1.07	0.98
Net Peak Demand Savings – at the Meter (MW)	0.016	0.003	0.003	0.021	0.011	0.803
Line Loss Factor*	1.1465	1.1466	1.1466	1.1465	1.1466	1.1459
Net Peak Demand Savings – at the Generator (MW)	0.018	0.004	0.004	0.024	0.012	0.920
* The line loss factors correspond to the average for each product weighted according to the proportion of each rate code. These factors are obtained by dividing net savings at the generator by net savings at the meter.						



As outlined in Figure 31, EPI exceeded its electrical energy and peak demand savings targets by 13% and 21% respectively.

Figure 31: 2023 EPI Targets and Net Evaluated Savings



14.4 Realization Rate

Table 56 below compares the energy and peak demand savings established through this evaluation to those tracked in the 2023 tracking sheet. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 56: Comparison of 2023 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	9.481	GWh	0.98	9.308	GWh	101%
Evaluation Results	9.481	GWh	0.99	9.357	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.942	MW	0.97	0.913	MW	101%
Evaluation Results	0.942	MW	0.98	0.920	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.						

Tracked and evaluated gross energy and peak demand savings were identical, yet evaluated net energy and peak demand savings were 1% higher than the values tracked by EOne because of the different proportions of low-income and non-low-income participants between 2022 and 2023.



15 EPI Key Findings and Recommendations

As mentioned previously, the main objectives of the 2023 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 the above objectives. The Evaluator has no specific recommendation for EPI.

2023 EPI Finding: EPI net electrical energy and peak demand savings exceeded targets.

EPI achieved 9.357 GWh in net electrical energy savings and 0.920 MW in net peak demand savings at the generator in 2023, thus exceeding the planned net electrical energy savings of 8.268 GWh and net peak demand savings of 0.760 MW. Energy savings were the highest since 2019, before the COVID-19 pandemic.

2023 EPI Finding: Participation increased in 2023, which contributed to greater savings compared to 2022.

With participation increasing by 16% in 2023, and similar savings per participant to 2022, EPI generated 12% more energy savings and 6% more peak demand savings. While LED lamps continued to be the most popular EPI measures with over 100,000 installs and representing over one third of EPI savings in 2023, the recently added smart thermostat for MSHP measure was also very popular with 4,452 installs, accounting for around one fourth of total EPI energy savings.

2023 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 were 1% higher than the values tracked by EOne. This small variation was due to the use of updated NTGRs based on the proportions of low-income and non-low-income participants in 2023.

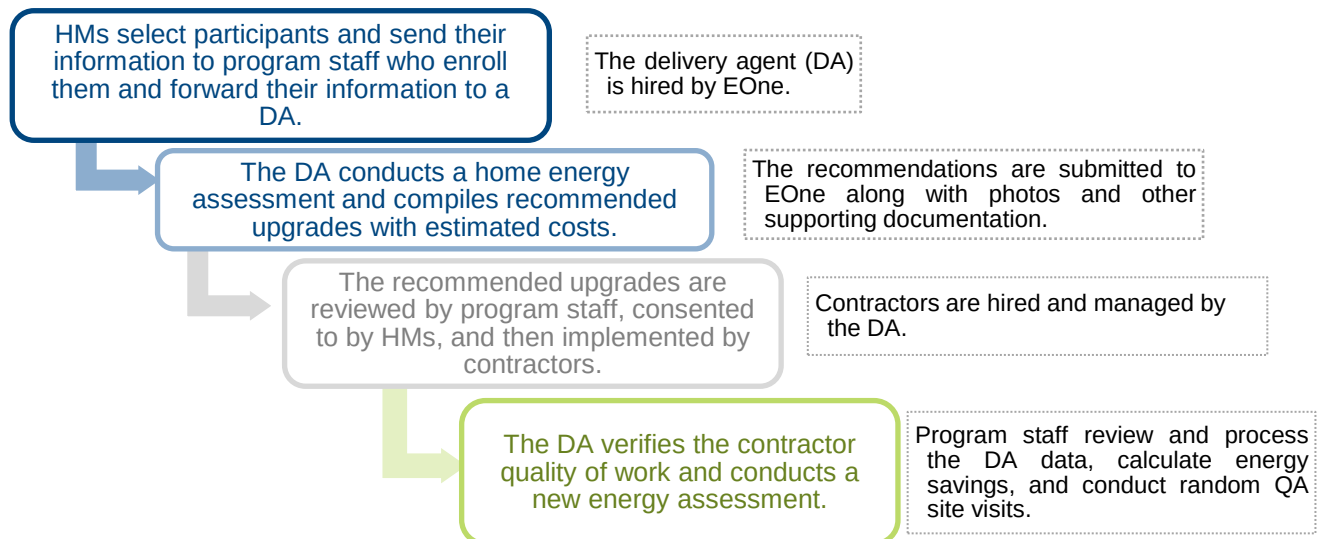
16 MHEEP Overview

This section describes the Mi'kmaw Home Energy Efficiency Project (MHEEP or the Project) 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 communities. EfficiencyOne (EOne) works with community housing managers (HMs), two delivery agents (DAs), and Mi'kmaw-preferred contractors to deliver the Project across all 13 Mi'kmaw communities in Nova Scotia. Figure 32 illustrates the participation process along with details about the program component.

Figure 32: 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 and heat recovery ventilation along with other measures such as carbon monoxide detectors may also be provided.

MHEEP also serves to identify opportunities to replace old appliances (dehumidifiers, refrigerators, and freezers) with energy efficient models and facilitates those replacements internally through the EOne Appliance Retirement program component. These measures are herein referred to as Appliance Replacement. Appliance Replacement was newly integrated into MHEEP reporting as of 2023, previously being included in Appliance Retirement reporting.

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 DSM funding is used for standard 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. In 2023, a third type of allocation called non-standard was introduced; it is considered non-standard because all savings (electric and non-electric) from this type of participant are attributed entirely to PNS funding. This report presents all electrical savings achieved by MHEEP and allocated to DSM funding.

MHEEP was aimed at achieving 0.608 GWh in net electrical energy savings and 0.300 MW in net peak demand savings at the generator in 2023.

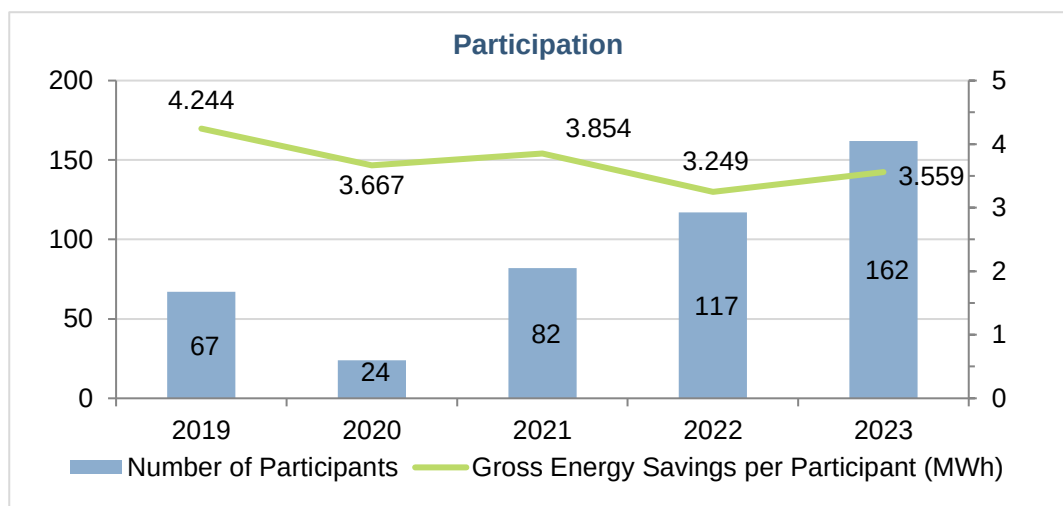
16.2 Follow-up on Past Evaluation Report Recommendations

No major improvement recommendations were made for MHEEP in 2022.

16.3 Participation History

As presented in Figure 33 below, 162 participants completed projects and achieved electrical energy savings under MHEEP in 2023, representing a 38% increase in participation compared to 2022 and resulting in the highest participation since MHEEP inception. The figure also illustrates a 10% increase in average savings per participant compared to 2022.

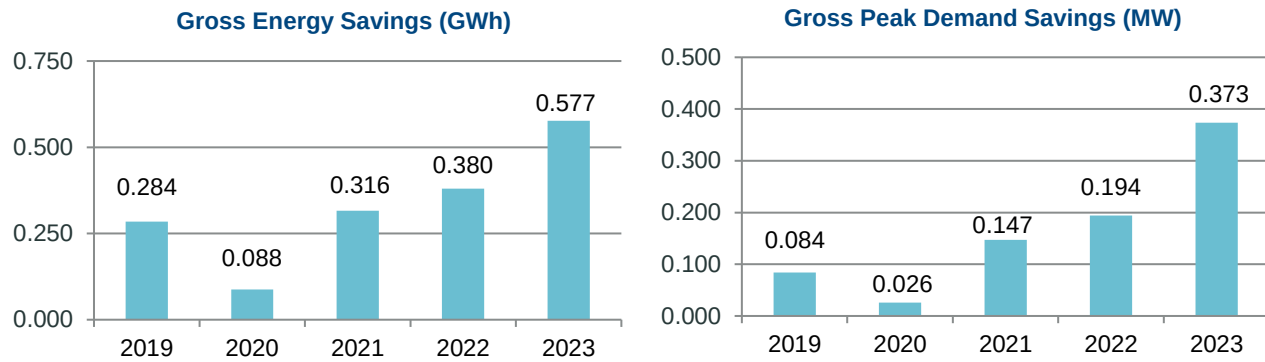
Figure 33: Overview of MHEEP Participation, 2019-2023



In addition to home retrofit projects completed through MHEEP, five old freezers were replaced in 2023 through the program component.

Figure 34 below provides an overview of the evolution of MHEEP gross energy and peak demand savings from 2019 to 2023. MHEEP total 2023 gross energy and peak demand savings were higher than in 2022 mainly due to higher participation levels.

Figure 34: Evolution of MHEEP Gross Savings, 2019-2023



17 MHEEP Evaluation Approach

The 2023 MHEEP evaluation comprised a condensed impact evaluation. The main objectives of the 2023 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

Table 57 outlines the evaluation objectives and maps them to the research questions and methods established by the Evaluator. Each method is described further below.

Table 57: 2023 MHEEP Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › What are the heating and building envelope measure savings calculated in HOT2000, and what are the adjustment ratios from HEA? › What are the unitary savings of non-modelled measures? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Unitary savings 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 NTGR of 1 › Avoided GHG emission reduction calculations

Tracking Sheet Audit

Prior to performing the savings review, the Evaluator performed an audit of the final 2023 tracking sheet to ensure it was complete and the entered data were consistent. The results obtained are presented in Appendix XVIII.

Unitary Savings Review

The Evaluator updated the gross savings values for freezer and refrigerator replacements using the proportion of units per manufacture year class and average unit size found in the 2023 tracking sheet. The 2020-2023 Measure Assessment⁵⁰ was then updated accordingly.

Calculations Using Evaluation Results

The Evaluator calculated the first-year and lifetime energy and peak demand savings using the equations and parameters that were determined to be valid based on the latest evaluation.

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 Nova Scotia Power (NS Power) data.

⁵⁰ The 2020-2023 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 and for the first year of the 2023-2025 DSM cycle, the Evaluator refers to the values presented in the 2020-2023 Measure Assessment.

18 MHEEP Impact Evaluation

The objectives of the 2023 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 standard electrical portion is covered in this report.

18.1 Tracking Sheet Audit

To ensure project 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 results obtained from the tracking sheet audit are presented in Appendix XVIII. 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.⁵¹ In 2023, MHEEP participants received building envelope upgrades, space heating upgrades, and/or appliance replacements that generated electrical savings.

MHEEP gross savings are obtained through HOT2000 modelling with the exception of the following non-modelled measures for which gross savings are calculated using unitary savings values:

- › Replaced old appliances through Appliance Replacement (dehumidifiers, refrigerators, and freezers)
- › Programmable and smart thermostats
- › Drain water heat recovery systems
- › Heat pump water heaters

The methodologies used for evaluating the gross savings are described in the following subsections.

18.2.1 Energy Savings

Modelled Measures

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.

$$\frac{\text{Gross Space Heating Savings (kWh)} = \% \text{ Electrical Heating}_D \times \left[\left(\text{SHC}_D(\text{MJ}) \times (1 - \text{OR}_D) \right) - \left(\text{SHC}_E(\text{MJ}) \times (1 - \text{OR}_E) \right) \right]}{3.6}$$

⁵¹ 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 ORs. The ORs were drawn from billing analyses conducted in 2015 and 2018 as part of HEA evaluations, and the results are presented in Table 58.

Table 58: Evaluated 2023 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 installed	19%	19%
A participant who registered without a heat pump and then had one installed	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.

Non-modelled Measures

Replaced appliances, 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 established as part of the 2020-2023 Measure Assessment activities. The Evaluator reviewed the unitary savings values of replaced refrigerators and freezers to account for the evolving mix of manufacture year-class and average unit size. Heat pump water heater unitary savings were also revised to align with the new value established as part of the development of a new heat pump water heater program.

Table 59 summarizes the tracked and evaluated unitary energy savings values for these measures.

Table 59: Tracked and Evaluated 2023 MHEEP Unitary Energy Savings

Measure	Tracked Savings [kWh/year]	Evaluated Savings [kWh/year]
Programmable Thermostats	221	No change
Smart Thermostats with Electric Resistance Baseline	348	No change
Smart Thermostats with Heat Pump Baseline	514	No change
Drain Water Heat Recovery Systems	599	No change
Heat Pump Water Heaters with Electric Resistance Baseline	865	1,179
Heat Pump Water Heaters with Heat Pump Baseline	1,360	1,280
Appliance Replacement		
Refrigerators	641	735
Freezers	1,686	2,006
Dehumidifiers	603	No change

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.

Replaced appliances, programmable and smart thermostats, drain water heat recovery systems, and heat pump water heaters are not modelled in HOT2000. Instead, peak demand savings are calculated based on unitary peak demand savings values. The detailed calculations for the unitary peak demand savings of each measure installed through MHEEP are presented in the 2020-2023 Measure Assessment.

Table 60 summarizes the tracked and evaluated unitary peak demand savings values for these measures.

Table 60: Tracked and Evaluated 2023 MHEEP Unitary Peak Demand Savings

Measure	Tracked Savings [W/year]	Evaluated Savings [W/year]
Programmable Thermostats	0	No change
Smart Thermostats with Electric Resistance Baseline	0	No change
Smart Thermostats with Heat Pump Baseline	0	No change
Drain Water Heat Recovery Systems	97	No change
Heat Pump Water Heaters with Electric Resistance Baseline	140	191
Heat Pump Water Heaters with Heat Pump Baseline	220	207
Appliance Replacement		
Refrigerators	88.5	101
Freezers	233	277
Dehumidifiers	202	No change

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.

For the 2023 evaluation, programmable and smart thermostats as well as drain water heat recovery systems and replaced old appliances were measures that are not modelled in HOT2000. As presented in the 2020-2023 Measure Assessment, they do not have an impact on the energy consumption of other elements to be considered.

18.2.4 Effective Useful Life

As part of the 2020-2023 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 for building envelope upgrades and space heating equipment are based on the measures installed by HEA participants since HEA and MHEEP participants install similar measures. The gross weighted average EUL value is 20.2 years.

Table 61: Tracked and Evaluated 2023 MHEEP Equivalent EUL Values

Measure	Tracked Equivalent EUL [years]	Evaluated Equivalent EUL [years]
Building Envelopes	20.8	No change
Space Heating Equipment		
Programmable Thermostats	10	No change
Smart Thermostats	10	No change
Drain Water Heat Recovery Systems	20	No change
Heat Pump Water Heaters	10	No change
Appliance Replacement		
Refrigerators	5	No change
Freezers	4	No change
Dehumidifiers	5	No change
Clothes Dryers	5	No change

18.2.5 Evaluated Gross Savings

The modelled and non-modelled measures annual gross savings at the meter are presented in Table 62 and Table 63 below respectively. Table 64 further below combines the savings of all MHEEP measures to present MHEEP total annual gross savings.

Table 62: Evaluated 2023 MHEEP Modelled Measure Gross Energy and Peak Demand Savings

	Total
Number of Participants	162
Energy Savings	
Gross Energy Savings Without Overestimation Ratio (OR) – at the Meter (GWh)	0.721
Gross Energy Savings with OR – at the Meter (GWh)	0.502
Effective Useful Life (years)	20.8
Gross Lifetime Energy Savings – at the Meter (GWh)	10.444
Peak Demand Savings	
Peak Demand-to-energy Ratio (MW/GWh)*	0.645
Gross Peak Demand Savings – at the Meter (MW)	0.324
* 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 formerly used (0.283 MW/GWh) because of the new calculation methodology applied for heat pumps and the addition of unmodelled prescriptive measures.	

Table 63: Evaluated 2023 MHEEP Non-modelled Measure* Gross Energy and Peak Demand Savings

Measure Category	Programmable Thermostats	Drain Water Heat Recovery Systems	Appliance Replacement - Freezers	Total
Number of Units Replaced	54	4	5	63
Energy Savings				
Unitary Energy Savings (kWh)	221	599	2,006	-
Gross Energy Savings – at the Meter (GWh)	0.012	0.002	0.010	0.024
Effective Useful Life (years)	10	20	4	-
Gross Lifetime Energy Savings – at the Meter (GWh)	0.119	0.048	0.040	0.207
Peak Demand Savings				
Unitary Peak Demand Savings (W)	0	97	277	-
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.001	0.002
* Only measures with at least one unit installed were included in this table.				

As presented in Table 63 above, appliances replaced through Appliance Replacement (freezer replacements) resulted in gross energy savings of 0.010 GWh and gross peak demand savings of 0.001 MW.

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 NSUARB as part of the 2014 Cost of Service Study Progress Update.⁵²

Table 64: Evaluated 2023 MHEEP Gross Energy and Peak Demand Savings

Measure Category	Modelled	Non-modelled	Total
Energy Savings			
Gross Energy Savings – at the Meter (GWh)	0.502	0.024	0.526
Line Loss Factor	1.095	1.095	-
Gross Energy Savings – at the Generator (GWh)	0.550	0.027	0.577
Effective Useful Life (years)	20.8	8.5*	-
Gross Lifetime Energy Savings – at the Generator (GWh)	11.436	0.227	11.663
Peak Demand Savings			
Gross Peak Demand Savings – at the Meter (MW)	0.324	0.002	0.325
Line Loss Factor	1.147	1.147	-
Gross Peak Demand Savings – at the Generator (MW)	0.371	0.002	0.373
* Corresponds to the equivalent EUL obtained from dividing the non-modelled measure lifetime energy savings at the meter by the energy savings at the meter (Table 63).			

⁵² Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

As presented in Table 65, GHG emission reductions were calculated by applying the Nova Scotia-specific factor⁵³ for GHG emissions generated by electricity production to MHEEP gross savings results.

Table 65: Evaluated 2023 MHEEP Gross GHG Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	0.577
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO2 eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO2 eq)	318

18.3 Net Savings

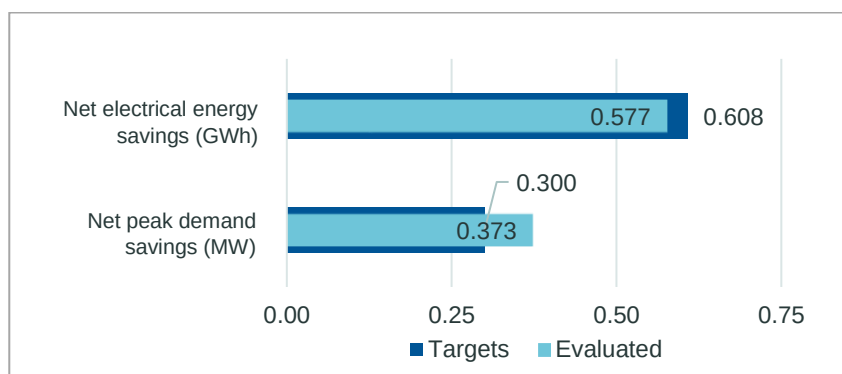
The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the NTGR. More precisely, the NTGR represents the positive or negative impacts of spillover and free-ridership effects 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 0.577 GWh and 0.373 MW at the generator respectively. Likewise, the net annual GHG emission reductions are equal to the gross annual GHG emission reduction.

As outlined in Figure 35, MHEEP fell short of its electrical energy savings target by 5% and exceeded its peak demand savings target by 24%.

Figure 35: 2023 MHEEP Targets and Evaluated Savings



⁵³ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO2 eq tonnes) and total electricity generation (10,456 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 December 1st, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22'23.pdf (Last accessed December 1st, 2023).

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 below. The table also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 66: Comparison of Tracked and Evaluated 2023 MHEEP Savings at the Generator

	Gross Savings		NTGR	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	0.575	GWh	1.00	0.575	GWh	100%
Evaluation Results	0.577	GWh	1.00	0.577	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.373	MW	1.00	0.373	MW	100%
Evaluation Results	0.373	MW	1.00	0.373	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 energy and peak demand savings determined by the Evaluator were nearly the same as the initial savings tracked by EOne. The differences, which were below 1%, were due to a revision to the prescriptive unitary savings values for appliance replacement measures.



19 MHEEP Key Findings and Recommendations

As mentioned previously, the main objectives of the 2023 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 the above objectives. The Evaluator has no specific recommendation for MHEEP.

2023 MHEEP Finding: MHEEP net electrical energy savings fell short of targets while peak demand savings exceeded targets.

MHEEP achieved 0.577 GWh in net electrical energy savings and 0.373 MW in net peak demand savings at the generator in 2023, thus not attaining the planned net electrical energy savings of 0.608 GWh while exceeding the planned net peak demand savings of 0.300 MW. MHEEP achieved 95% of the energy savings target in 2023 compared to 60% in 2022. Although the participation level was higher, it was not sufficient to reach the energy savings target.

2023 MHEEP Finding: With increases in average savings per participant and the number of participants, MHEEP achieved higher savings in 2023 compared to 2022 levels.

Compared to 2022, participation increased by 38% and the average savings per participant increased by 10%. Overall, these changes resulted in increases in total energy and peak demand savings of 52% and 92% respectively.

2023 MHEEP Finding: The evaluated net energy and peak demand savings determined by the Evaluator were nearly the same as the initial net savings tracked by EOne.

The differences between the energy and peak demand savings determined by the Evaluator and the initial savings tracked by EOne were below 1% and due to a revision of the prescriptive unitary savings values for appliance replacement measures.

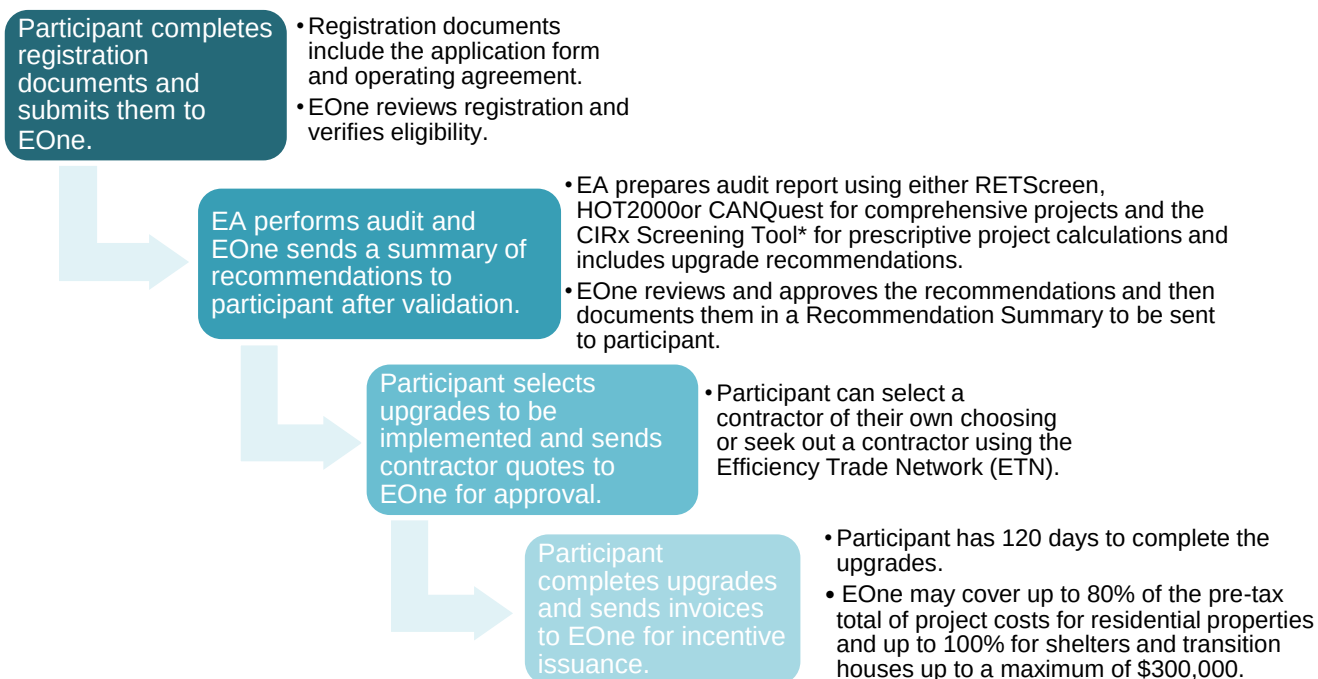
20 AMH Overview

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 energy 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 36.

Figure 36: 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.

In July 2023, the maximum incentive amounts were changed from \$15,000 to \$17,254 per affordable unit (multi-unit residential buildings [MURBs] and cooperatives) and from \$5,000 to \$5,751 per affordable room (rooming houses). The maximum rebate was amended in December 2022 to \$300,000 for all building types.



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 Province of Nova Scotia through the Green Fund allowed for an increase in the incentive amount of up to 80% of costs for electrical projects in residential properties and up to 100% in shelters and transition houses. This report presents all electrical savings achieved by AMH and allocated to DSM funding.

AMH was aimed at achieving 1.247 GWh in net electrical energy savings and 0.340 MW in net peak demand savings at the generator in 2023.

20.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated AMH in previous years and issued no formal improvement recommendations.

20.3 Participation History

Since 2021, AMH savings are generated by two types of projects, namely comprehensive and prescriptive projects. In 2023, 79 projects generating electrical savings were completed under AMH, including 11 comprehensive and 68 prescriptive projects, which resulted in 1.460 GWh in gross energy savings and 0.741 MW in gross peak demand savings.

As illustrated in Figure 37 below, the number of projects continued to increase with 61% more projects in 2023 compared to 2022. The number of prescriptive projects considerably increased, going from 37 projects in 2022 to 68 in 2023, while the number of comprehensive projects decreased from 12 to 11.

As observed in Figure 37 below, energy savings per project considerably vary from year to year mostly due to the various building sizes included in AMH. In 2023, energy savings per prescriptive project more than doubled compared to 2022 while they decreased for comprehensive projects.

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 37: Overview of AMH Participation, 2018-2023

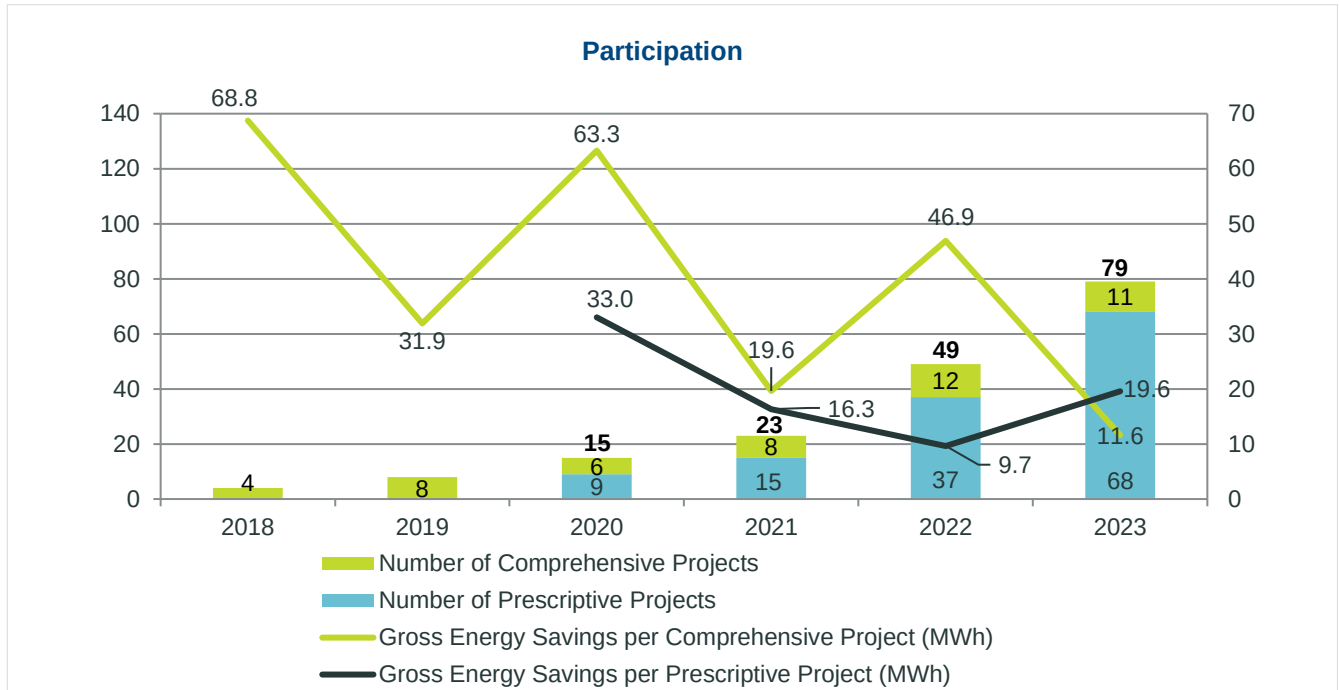
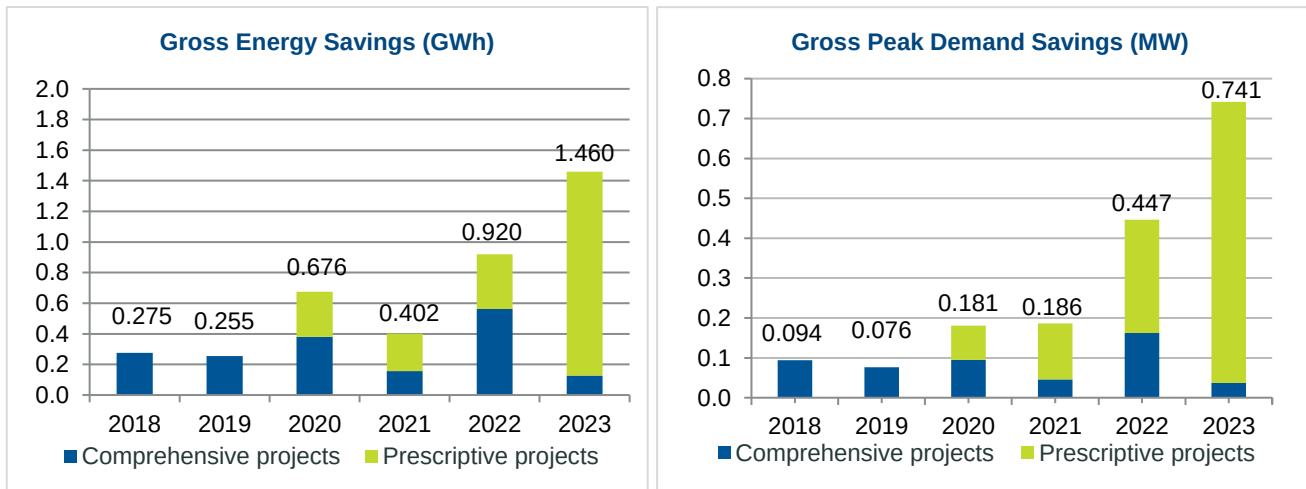


Figure 38 below presents the evolution of AMH gross savings since 2018. In 2023, prescriptive projects generated the most energy savings (91%) and the most peak demand savings (95%).

With over two times more prescriptive projects that generated higher average savings compared to 2022, the gross energy and peak demand savings increased by 59% and 66% respectively.

Figure 38: Evolution of AMH Gross Savings, 2018-2023



21 AMH Evaluation Approach

The 2023 evaluation consisted of a condensed impact evaluation. The main objectives of the 2023 AMH evaluation were as follows:

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

The Evaluator identified key research questions aimed at achieving the above objectives. Table 67 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 67: 2023 AMH Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › Using the adjustment ratio from the 2022 evaluation, 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 AMH?	› Calculations using a NTGR of 1 › Avoided GHG emission reduction calculations

Tracking Sheet Audit

Prior to performing the unitary savings review, the Evaluator performed an audit of the final 2023 tracking sheet to ensure it was complete and the entered data were consistent. The results obtained are presented in Appendix XX.

EUL Update

Using the effective useful life (EUL) values for common measures presented in the 2020-2023 Measure Assessment⁵⁴ and the proportion of measures implemented through AMH in 2023, the Evaluator calculated an average EUL for comprehensive projects. EUL values for each measure were used for prescriptive projects based on EUL values from the 2020-2023 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 using the equations and parameters that were determined to be valid based on the 2022 evaluation.

⁵⁴ The 2020-2023 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 values for all measures offered in EOne's program portfolio. For the evaluations conducted during the 2020-2023 DSM cycle, the Evaluator refers to the values presented in the 2020-2023 Measure Assessment.

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 Nova Scotia Power (NS Power) data.



22 AMH Impact Evaluation

The objectives of the 2023 AMH impact evaluation were to determine gross and net electrical energy and peak demand savings, annually avoided GHG emissions, as well as the EUL and associated lifetime energy savings.

22.1 Tracking Sheet Audit

To ensure program 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 as well as correcting the tracked savings as needed. The results are provided in Appendix XX. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

22.2 Gross Savings

Gross savings correspond to the change in energy consumption resulting from various electrical energy saving upgrades such as building envelope measures, space heating measures, and domestic hot water (DHW) measures implemented by AMH participants.

Since 2021, AMH savings have been generated by two types of projects: Comprehensive and prescriptive projects.

- › Comprehensive projects serve to implement measures that are modelled in HOT2000, RETScreen, or CANQuest. Energy savings for comprehensive projects are calculated by comparing the energy models of the base case and the proposed case. Calculations are performed with project specific parameters.
- › Prescriptive projects are not modelled and their energy savings are 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.

The following subsections describe the methodology used to review AMH gross savings in 2023. Interactive effects and EUL values were also assessed.

22.2.1 Energy Savings

In recent AMH evaluations, only minor adjustments were made to comprehensive project savings as a result of site visits and desk reviews. Therefore, the Evaluator elected to use the tracked savings as the evaluated savings for the 2023 evaluation for those projects.

Energy savings for AMH prescriptive projects are calculated through the CIRx Screening Tool equations. In 2023, EOne conducted a billing analysis to try to establish a full-load hours value for MSHPs specific to AMH. EOne modelled 65 units after ensuring each unit met minimum criteria (e.g. minimum 12 months of consumption data, minimum R square of 65%) for pre and post-consumption, after which only 34 units were left in the analysis. The results of the analysis performed by EOne were very similar to the full-load heating hours value from the 2017 Green Heat billing analysis. Since the Green Heat billing analysis had a much larger sample (170 participants), the Evaluator determined that the full-load hours for MSHPs should remain unchanged for AMH. Therefore, the adjustment ratios established through desk reviews in the 2022 evaluation remained applicable. Since no desk reviews aimed at updating the adjustment ratios of AMH prescriptive projects were conducted in 2023, the 2022 adjustment ratios were used again for the 2023 evaluation.



With heat pump projects representing the large majority of AMH prescriptive projects in 2022, the Evaluator established an adjustment ratio specific to heat pump projects. No adjustment ratio was established for other measures since only one-time adjustments were applied to other projects in 2022. The 2022 adjustment ratio of 0.998 ± 0.002 for energy savings was used in the 2023 evaluation.

22.2.2 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 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.

As for energy savings, peak demand savings for AMH comprehensive projects are obtained from energy models in HOT2000, RETScreen, or CANQuest. The Evaluator used the tracked savings as the evaluated savings for the 2023 evaluation for those projects.

Peak demand savings for AMH prescriptive projects are calculated through the CIRx Screening Tool equations. As for energy savings, the Evaluator established an adjustment ratio in the 2022 evaluation for prescriptive heat pump project peak demand savings based on desk review findings, while no adjustment ratio was established for other measures. Hence, an adjustment ratio of 1.054 ± 0.074 for peak demand savings was used in the 2023 evaluation.

22.2.3 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 space heating and DHW measures were already considered in the savings calculations of comprehensive projects since the engineering calculations or the simulation models encompass those effects. For prescriptive projects, the CIRx Tool includes interactive effects when applicable.

22.2.4 Effective Useful Life

Using the EUL values presented in the 2020-2023 Measure Assessment and the proportion of measures implemented through AMH in 2023, the Evaluator revised the EUL values for comprehensive projects. For prescriptive projects, EUL values for each measure were drawn from the 2020-2023 Measure Assessment. Table 68 below presents the EUL values used for prescriptive measures while Table 69 further below outlines the shares of savings and the equivalent EUL values for the three most implemented measure categories used to calculate the weighted average EUL for comprehensive projects. Once combining prescriptive and comprehensive savings, AMH average EUL value was established at 17.4 years.

Table 68: 2023 AMH Equivalent EUL Values for Prescriptive Measures

Measure Category	Evaluated Equivalent EUL [years]	Source
Heating Systems	18	GDS, 2007 ⁵⁵ – Heat Pumps
Lighting	5.7	Lifetime of 50,000 hours based on model specifications. Assumption that lamps are in common zones and turned on 24/7.
Appliance Upgrades	11	Values for appliance upgrades typically vary between 10 and 12 years, so a value of 11 years was assumed.

Table 69: 2023 AMH Equivalent EUL Values for Comprehensive Projects

Measure Category	Share of Savings [%]	Evaluated Equivalent EUL [years]	Source
Heating Systems	96.7%	18	GDS, 2007 – Heat Pumps
Water Heating	3.3%	10	DEER, 2014 – Heat Pump Water Heaters
Building Envelope	0%	25	GDS, 2007 – Insulation
Lighting	0%	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

22.2.5 Evaluated Gross Savings

The annual gross savings at the generator are presented in Table 70 below.

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 1.093 for energy savings and 1.143 for peak demand savings⁵⁶. 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.⁵⁷

⁵⁵ GDS Associates. *Measure Life Report Residential and Commercial/Industrial Lighting and HVAC Measures*, June 2007.

⁵⁶ For municipal utility participants, the line loss factor of the most similar NS Power rate code was assumed. If a municipal utility participant did not have any specific rate code, the average of participants for which the line loss was known was used.

⁵⁷ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix 1.

Table 70: Evaluated 2023 AMH Gross Energy and Peak Demand Savings

	Comprehensive	Prescriptive			Total
		Heat Pumps	Lighting	Other	
Number of Projects	11	63	5	0	79
Energy Savings					
Tracked Gross Energy Savings – at the Meter (GWh)	0.118	1.162	0.057	0.000	1.338
Adjustment Ratio for Energy Savings	-	0.998	-	-	-
Gross Energy Savings – at the Meter (GWh)	0.118	1.160	0.057	0.000	1.335
Line Loss Factor	1.093	1.093	1.093	1.093	1.093
Gross Energy Savings – at the Generator (GWh)	0.128	1.269	0.063	0.000	1.460
Equivalent Effective Useful Life (years)	17.7	18.0	5.7	11.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	2.264	22.843	0.357	0.000	25.465
Peak Demand Savings					
Tracked Gross Peak Demand Savings – at the Meter (MW)	0.033	0.573	0.011	0.000	0.618
Adjustment Ratio for Peak Demand Savings	-	1.054	-	-	-
Gross Peak Demand Savings – at the Meter (MW)	0.033	0.604	0.011	0.000	0.649
Line Loss Factor	1.143	1.143	1.143	1.143	1.143
Gross Peak Demand Savings – at the Generator (MW)	0.037	0.692	0.013	0.000	0.741

As presented in Table 71, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor⁵⁸ for GHG emissions generated by electricity production to AMH gross savings results.

Table 71: Evaluated 2023 AMH Gross GHG Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	1.460
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO2 eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO2 eq)	806

⁵⁸ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO2 eq tonnes) and total electricity generation (10,456 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 December 1st, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22'23.pdf (Last accessed December 1st, 2023).

22.3 Net Savings

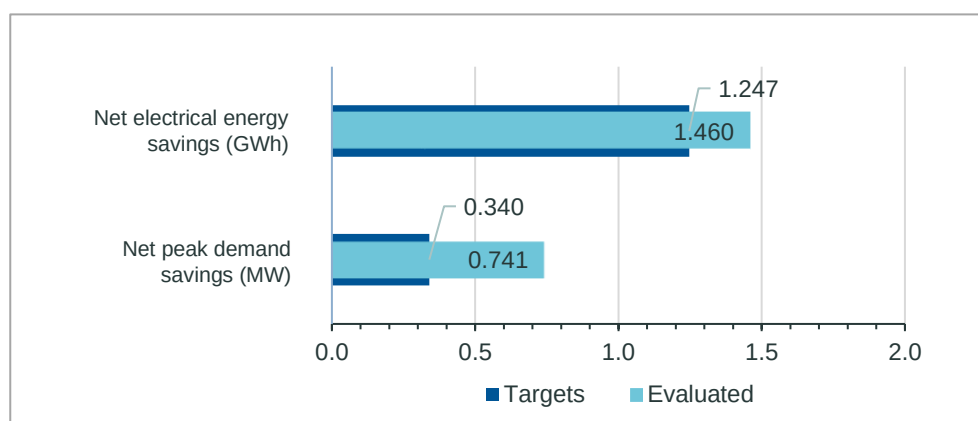
The Evaluator determined the net energy and peak demand savings, i.e. the electrical energy and peak demand savings that can be reliably attributed to a program component, by estimating the net-to-gross ratio (NTGR). More precisely, the NTGR represents the positive or negative impacts of spillover and 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.

22.3.1 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. Likewise, the net annual GHG emission reductions are equal to the gross annual GHG emission reductions.

As outlined in Figure 39, AMH exceeded its electrical energy and peak demand savings targets by 17% and 118% respectively.

Figure 39: 2023 AMH Targets and Evaluated Results



22.4 Realization Rate

Table 72 below compares the energy and peak demand savings established through this evaluation to those calculated in the 2023 tracking sheet. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and at peak demand savings.

Table 72: Comparison of 2023 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	1.462	GWh	1.00	1.462	GWh	100%
Evaluation Results	1.460	GWh	1.00	1.460	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.706	MW	1.00	0.706	MW	105%
Evaluation Results	0.741	MW	1.00	0.741	MW	
* The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by gross savings.						

The net evaluated energy savings were nearly the same as the value tracked by EOne, while net evaluated peak demand savings were 5% higher than the value tracked by EOne. The differences are due to the application of the adjustment ratios.



23 AMH Key Findings and Recommendations

As mentioned previously, the main objectives of the 2023 AMH evaluation were as follows:

- › 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 in relation to the above objectives. The Evaluator has no specific recommendation for AMH.

2023 AMH-Finding: In 2023, AMH exceeded its net electrical energy savings targets by 17% and net peak demand savings targets by 118%.

AMH achieved 1.460 GWh in net electrical energy savings and 0.741 MW in net peak demand savings at the generator in 2023, thus exceeding the planned net electrical energy savings of 1.247 GWh and the net peak demand savings of 0.340 MW.

2023 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 since its inception with 79 completed projects generating electrical savings in 2023. Among those 79 projects, 68 projects were prescriptive projects, which represent a significant increase compared to the 37 prescriptive projects in 2022. Conversely, the number of comprehensive projects slightly decreased compared to 2022. With more projects and higher savings per project, energy and peak demand savings respectively increased by 59% and 66% compared to 2022 results.

2023 AMH-Finding: The evaluated net energy savings determined by the Evaluator were nearly the same as 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 nearly the same as the value tracked by EOne, while net evaluated peak demand savings were 5% higher than the value tracked by EOne. The differences are due to the adjustment ratios applied by the Evaluator.



24 ASFH Overview

This section describes the Affordable Single-family Homes (ASFH) program component, follows up on past evaluation recommendations, and provides an overview of participation history.

24.1 ASFH Description

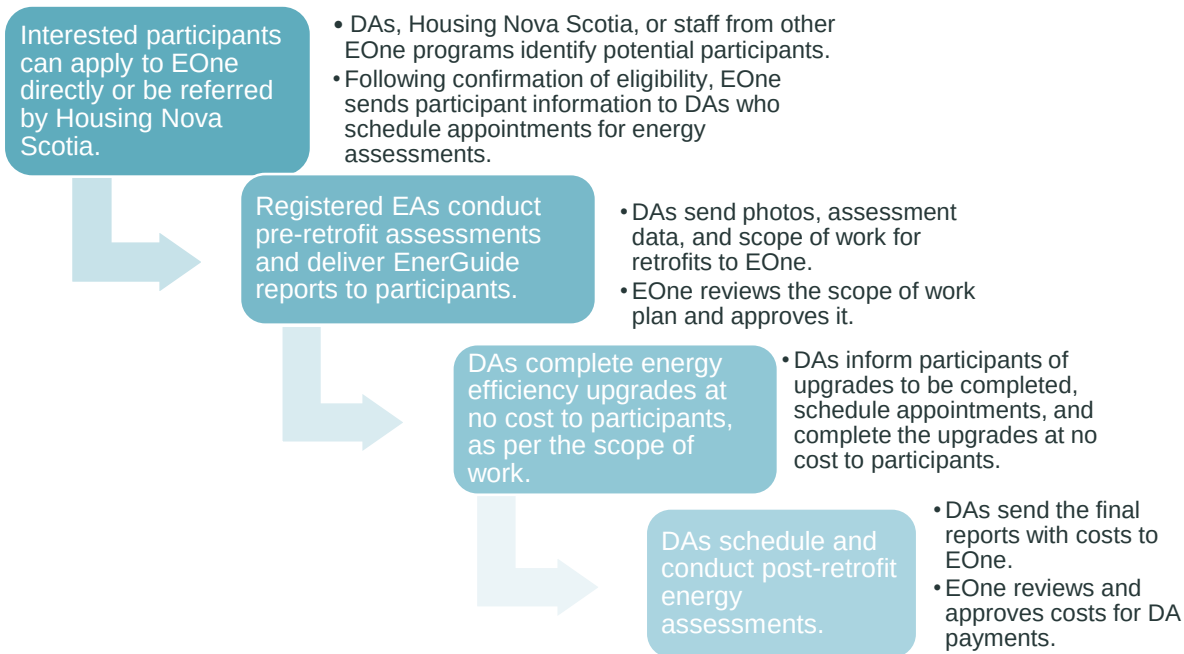
ASFH provides energy efficiency retrofits to income-qualified Nova Scotian homeowners at no cost to participants. The program component is marketed to all Nova Scotian's (both electric and non-electric homes) under the "HomeWarming" brand. The program component mainly provides building envelope measures such as draft-proofing and insulation for basements, crawl spaces, exposed floors, main walls, and attics. Heat pumps were also included in the ASFH offering. Moisture management measures such as bathroom fans, dehumidifiers, and dirt floor coverings may also be provided. Retrofits are selected and implemented on a case-by-case basis.

ASFH also serves to identify opportunities to replace old appliances (dehumidifiers, refrigerators, and freezers) with energy efficient models and facilitates these replacements internally through the EOne Appliance Retirement program component. These are herein referred to as Appliance Replacement measures. Appliance Replacement results were newly integrated into ASFH reporting as of 2023, which were previously being included in Appliance Retirement reporting.

While ASFH was launched in 2023 and is available to homes heated primarily with electricity, "HomeWarming" has provided the same services to homes heated primarily with sources other than electricity since 2012 through government funding. While electrical savings can be generated by non-electric participants, only the electrical savings of ASFH participants are included in this evaluation.

ASFH is supported by six delivery agents (DAs) across Nova Scotia, who conduct most of the field work. DAs use energy advisors (EAs) to perform pre-retrofit and post-retrofit energy assessments. Pre-retrofit assessments (D assessments) serve to examine the house, provide homeowners with a better understanding of how their house functions in relation to space heating, and identify applicable energy efficiency upgrades to be implemented. EAs generate home energy assessment reports that provide a high-level overview of energy usage and send them to homeowners. DAs then recommend retrofits to EOne and complete those approved by the latter. Lastly, EAs conduct post-retrofit assessments (E assessments) to verify implemented measures and provide a final EnerGuide rating calculated using HOT2000, a simulation tool developed by Natural Resources Canada (NRCan). Figure 40 below illustrates the participation process.

Figure 40: ASFH Participation Process Summary



ASFH participants are also eligible for the Efficient Product Installation (EPI) program component through which energy efficient products are installed at no cost to participants. ASFH participants are internally referred to EPI, and they generally participate in EPI before they receive a pre-retrofit assessment under ASFH.

ASFH was aimed at achieving 3.496 GWh in net electrical energy savings and 0.890 MW in net peak demand savings at the generator in 2023.

24.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator did not evaluate ASFH in previous years; therefore, there are no formal improvement recommendations.

24.3 Participation History

Participation in ASFH is defined as “homes with upgrades that generated electrical savings”. In 2023, 242 homes received upgrades. Among those homes, 224 implemented building envelope measures with 119 of them installing a heat pump. In addition, 18 participants only installed a heat pump. Furthermore, 53 appliances were replaced.⁵⁹

Although this report is focused on projects that generated electrical savings, it should be noted that, when considering ASFH (electrically heated) and government-funded (non-electrically heated) homes, most participants are non-electrically heated.

⁵⁹ Appliance replacements are not added to the participation numbers since these replacements occur after the ASFH participation is completed, so those participants were already included as participants.

25 ASFH Evaluation Approach

The 2023 evaluation consisted of a condensed impact evaluation. The main objectives of the 2023 ASFH evaluation were as follows:

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

The Evaluator identified key research questions aimed at achieving the above objectives. Table 73 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 73: 2023 ASFH Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › What are the savings for heating and building envelope measures calculated with HOT2000, and what are the adjustment ratios from HEA? › What are the unitary savings by measure category for non-modelled measures? › What are the evaluated first-year and lifetime gross electrical energy and peak demand savings?	› Tracking sheet audit › Savings calculation review › Unitary savings 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?	› Calculations using a NTGR of 1 › Avoided GHG emission reduction calculations

Tracking Sheet Audit

Prior to performing the savings calculation review, the Evaluator performed an audit of the final 2023 tracking sheet to ensure it was complete and the entered data were consistent. The results obtained are presented in Appendix XXII.

Unitary Savings Review

The Evaluator determined the unitary savings values to be used for ASFH non-modelled measures based on other measures found in EOne's portfolio. The 2020-2023 Measure Assessment (MA) was updated accordingly.⁶⁰

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 equations and parameters that were determined to be valid based on the current evaluation.

⁶⁰ The 2020-2023 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 and for the first year of the 2023-2025 DSM cycle, the Evaluator refers to the values presented in the 2020-2023 Measure Assessment.



GHG Emission Reduction Calculations

To obtain net avoided GHG emissions in CO₂ eq for ASFH, 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.

26 ASFH Impact Evaluation

The objectives of the 2023 ASFH impact evaluation were to determine gross and net electrical energy and peak demand savings, annually avoided GHG emissions, as well as the effective useful life (EUL) values and associated lifetime energy savings.

26.1 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 as well as correcting the tracked savings as needed. The results are provided in Appendix XXII. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

26.2 Gross Savings

For ASFH, gross savings are associated with building envelope measures and are calculated based on pre-retrofit and post-retrofit HOT2000 simulations, while the gross savings of replaced old appliances through the EOne Appliance Retirement program component (dehumidifiers, refrigerators and freezers) are calculated using unitary savings values. This subsection describes the methodology used to review ASFH gross savings for 2023.

26.2.1 Energy Savings

The energy savings methodology for modelled and non-modelled measures are presented in this subsection.

Modelled Energy Savings

The 2023 ASFH tracking sheet contained a total of 232 participants for whom building envelope measures were installed. Of these participants, 224 had positive modelled energy savings, while eight had zero or negative modelled energy savings that were capped at zero. These zero and negative savings related to the level of accuracy of the measurement tools used during the pre- and post-assessments as well as environmental factors that impacted blower door tests.

The gross savings associated with ASFH building envelope measures were calculated by comparing the pre-retrofit (D Assessment) and post-retrofit (E Assessment) modelled space heating energy consumption values, both of which were adjusted with overestimation ratios (ORs) using the equations below.

Only primarily electrically heated homes are eligible for demand-side management (DSM) funds, although other energy sources may be used as a secondary heating system. In those cases, the pre-retrofit percentages of space heating associated with electricity and non-electrical fuel are used to determine electrical savings, as expressed in the following equation.

$$\text{Gross Electrical Savings (kWh)} = \frac{\% \text{ Electrical Heating}_D \times [(SHC_D(MJ) \times (1 - OR_D)) - (SHC_E(MJ) \times (1 - OR_E))]}{3.6 \text{ MJ/kWh}}$$

Where:

- › SHC corresponds to total space heating consumption (all fuel types combined)
- › OR corresponds to the overestimation ratio used to adjust the modelled energy consumption (according to the space heating system in place during the D and E assessments)

Overestimation Ratios

As indicated in the gross savings equations, ORs are used to adjust modelled space heating consumption values because the HOT2000 software tends to slightly overestimate savings.

For the 2023 evaluation, the Evaluator considered the OR values established as part of the 2018 DSM Existing Residential evaluation⁶¹ still valid to adjust the modelled energy consumption of ASFH participants. These OR values were established through a billing analysis that compared electrical space heating energy consumption with actual participant billing data. Table 74 presents the ORs established for each scenario.

Table 74: 2022/23 Overestimation Ratio Values

Measure Category	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 installed	19%	19%
A participant who registered without a heat pump and had one installed	19%	0%

By applying these ORs to the results obtained from the HOT2000 simulations, both the errors associated with the software and input errors made by EAs were taken into account.

Non-modelled Energy Savings

Replaced appliances are not modelled in HOT2000. Instead, energy savings are calculated based on unitary energy savings values established as part of the 2020-2023 Measure Assessment activities. In addition, the Evaluator reviewed the unitary savings values of replaced refrigerators and freezers to account for the evolving mix of manufacture year-class and average unit size. For participants that installed a heat pump and had no modelled energy savings, energy savings were calculated using the Green Heat calculation approach (see Subsection 9.2). The specifications of each heat pump were used to obtain energy savings.

Table 75 summarizes the tracked and evaluated unitary energy savings values for those measures.

Table 75: 2023 Appliance Replacement Tracked and Evaluated Unitary Energy Savings

Measure	Tracked Savings [kWh/year]	Evaluated Savings [kWh/year]
Refrigerators	641	735
Freezers	1,686	2,006
Dehumidifiers	603	No change

⁶¹ M09096, E-5, 2018 DSM Evaluation Reports, Existing Residential Program 2018 DSM Evaluation, 15 March 2019.

26.2.2 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 ASFH, peak demand savings were calculated based on electrical savings using a peak demand-to-energy ratio of 0.283 MW/GWh (RES-Elect Space Heat & Cool) for space heating savings, as 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 ratio. The Evaluator considered that the approach used by Navigant to establish the peak demand-to-energy ratio was still valid and therefore used it to estimate peak demand savings.

An exception was made for heat pump measures. Peak demand savings were calculated separately for heat pump measures to ensure they were calculated correctly. Hence, the specifications of each heat pump were used to obtain peak demand savings. When heat pumps were included in the model, peak demand savings from the modelled savings were adjusted to accurately account for the peak demand savings attributable to heat pumps.

Replaced appliances are not modelled in HOT2000. Instead, peak demand savings are calculated based on unitary peak demand savings values. The detailed calculations for the unitary peak demand savings of each measure installed through ASFH are presented in the 2020-2023 Measure Assessment.

Table 76 summarizes the tracked and evaluated peak demand unitary energy savings values for those measures.

Table 76: 2023 Appliance Replacement Tracked and Evaluated Unitary Peak Demand Savings

	Tracked Savings [W/year]	Evaluated Savings [W/year]
Refrigerators	88.5	101
Freezers	233	277
Dehumidifiers	202	No change

26.2.3 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. Since ASFH 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 those measures.

For the 2023 evaluation, replaced old appliances were installed measures that are not modelled in HOT2000. As indicated in the 2020-2023 Measure Assessment, they do not have an impact on the energy consumption of other elements.



26.2.4 Effective Useful Life

As part of the 2020-2023 Measure Assessment activities, the Evaluator reviewed the EUL values used in the calculation of energy savings that are expected to persist over time. The EUL values for building envelope upgrades and space heating equipment are based on the measures installed by HEA participants since HEA and ASFH participants install similar measures. The EUL value presented in the in 2022 evaluation report remained valid for all measure categories. The gross weighted average EUL value is 20.1 years.

26.2.5 Evaluated Gross Savings

The modelled and non-modelled measure annual gross savings at the meter are presented in Table 77 and Table 78 below respectively. As presented in Table 63 above, appliances replaced through Appliance Replacement (freezer replacements) resulted in gross energy savings of 0.010 GWh and gross peak demand savings of 0.001 MW.

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 NSUARB as part of the 2014 Cost of Service Study Progress Update.

Table 79 further below combines the savings of all ASFH measures to present ASFH total annual gross savings.

Table 77: Evaluated 2023 ASFH Modelled Measure Gross Energy and Peak Demand Savings

Total	
Energy Savings	
Gross Energy Savings Without Overestimation Ratio (OR) – at the Meter (GWh)	1.512
Gross Energy Savings with OR – at the Meter (GWh)	1.230
Effective Useful Life (years)	20.8
Gross Lifetime Energy Savings – at the Meter (GWh)	25.589
Peak Demand Savings	
Peak Demand-to-energy Ratio (MW/GWh)*	0.412
Gross Peak Demand Savings – at the Meter (MW)	0.507
* 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 and the addition of unmodelled prescriptive measures.	

Table 78: Evaluated 2023 ASFH Non-modelled Measure Gross Energy and Peak Demand Savings

Measure Category	Non-modelled Heat Pumps	Appliance Replacement			Total
		Refrigerators	Freezers	Dehumidifiers	
Number of Units Replaced	18	6	14	33	71
Energy Savings					
Unitary Energy Savings (kWh)	-	735	2,006	603	-
Gross Energy Savings – at the Meter (GWh)	0.037	0.004	0.028	0.020	0.089
Effective Useful Life (years)	18	5	4	5	-
Gross Lifetime Energy Savings – at the Meter (GWh)	0.661	0.022	0.112	0.099	0.895
Peak Demand Savings					
Unitary Peak Demand Savings (W)	-	101	277	202	-
Gross Peak Demand Savings – at the Meter (MW)	0.029	0.001	0.004	0.007	0.040
* Only measures with at least one installed unit were included in this table.					



Table 79: Evaluated 2023 ASFH Gross Energy and Peak Demand Savings

Measure Category	Modelled	Non-modelled Heat Pump	Appliance Replacement	Total
Number of Participants with Savings	224	18	53	242**
Energy Savings				
Gross Energy Savings – at the Meter (GWh)	1.230	0.037	0.052	1.319
Line Loss Factor	1.0947	1.0947	1.0947	-
Gross Energy Savings – at the Generator (GWh)	1.347	0.040	0.057	1.444
Effective Useful Life (years)*	20.8	18.0	4.5	-
Gross Lifetime Energy Savings – at the Generator (GWh)	28.012	0.724	0.256	28.992
Peak Demand Savings				
Gross Peak Demand Savings – at the Meter (MW)	0.507	0.029	0.011	0.547
Line Loss Factor	1.1466	1.1466	1.1466	-
Gross Peak Demand Savings – at the Generator (MW)	0.581	0.033	0.013	0.627
* Corresponds to the equivalent EUL obtained from dividing the non-modelled measure lifetime energy savings at the meter by the energy savings at the meter (Table 78).				
**The total number of participants does not correspond to the sum of all measure categories since participants who benefited from appliance replacements also implemented additional measures.				

As presented in Table 80, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor⁶² for GHG emissions generated by electricity production to ASFH gross savings results.

Table 80: Evaluated 2023 ASFH Gross GHG Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	1.444
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO2 eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO2 eq)	797

26.3 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 ASFH, free-ridership and spillover effects were considered to be nil since participants are non-profits or low-income housing owners that traditionally have small housing budgets spread across many competing housing priorities. Therefore, a NTGR of 1.00 was applied.

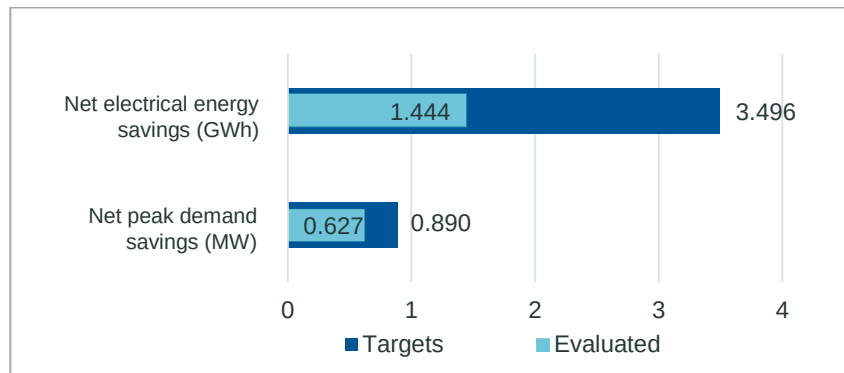
⁶² At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO2 eq tonnes) and total electricity generation (10,456 GWh) was drawn from the following two sources: Nova Scotia Power, Total System Emissions, <https://www.nspower.ca/clean-energy/air-emissions-reporting> (Last accessed December 1st, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22'23.pdf (Last accessed December 1st, 2023).

26.3.1 Evaluated Net Savings

Net savings are defined as the changes in energy use that are specifically attributable to ASFH. Since spillover and free-ridership effects were considered nil, the net energy savings are equal to the gross savings generated by the program component. Likewise, the net annual GHG emission reductions are equal to the gross annual GHG emission reductions.

As outlined in Figure 41, ASFH fell short of its electrical energy and peak demand savings targets by 59% and 30% respectively.

Figure 41: 2023 ASFH Targets and Evaluated Results



26.4 Realization Rate

Table 81 below compares the energy and peak demand savings established through this evaluation to those calculated in the 2023 tracking sheet. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 81: Comparison of 2023 ASFH 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	1.439	GWh	1.00	1.439	GWh	100%
Evaluation Results	1.444	GWh	1.00	1.444	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.624	MW	1.00	0.624	MW	100%
Evaluation Results	0.627	MW	1.00	0.627	MW	
* EThe NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by gross savings.						

The energy and peak demand savings determined by the Evaluator were slightly higher than the initial savings tracked by EOne. The differences, which were less than 1%, were due to a revision to the prescriptive unitary savings values for appliance replacement measures.



27 ASFH Key Findings and Recommendations

As mentioned previously, the main objectives of the 2023 ASFH evaluation were as follows:

- › Calculate gross and net ASFH 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 the above objectives. The Evaluator has no specific recommendation for ASFH.

2023 ASFH-Finding: In 2023, ASFH fell short of its electrical energy and peak demand savings targets by 59% and 30% respectively.

ASFH achieved 1.444 GWh in net electrical energy savings and 0.627 MW in net peak demand savings at the generator in 2023, thus not attaining the planned net electrical energy and peak demand savings of 3.496 GWh and 0.890 MW.

2023 ASFH-Finding: In 2023, 242 participants generated electrical savings through ASFH.

Among the 242 ASFH participants, 224 implemented building envelope measures with 119 of them installing a heat pump. In addition, 18 participants only installed a heat pump, and 53 appliances were replaced.

2023 ASFH-Finding: The energy and peak demand savings determined by the Evaluator were slightly higher than the initial savings tracked by EOne.

The energy and peak demand savings determined by the Evaluator were slightly higher than the initial savings tracked by EOne. The differences, which were less than 1%, were due to a revision to the prescriptive unitary savings values for appliance replacement measures.

CONCLUSION

Table 82 presents the participation levels, net-to-gross ratios (NTGRs), evaluated gross and net savings at the generator, annual GHG emission reductions, as well effective useful life (EUL) values for each program component and for Existing Residential as a whole.

Table 82: Overall 2023 Existing Residential Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value*	Value	Unit
HEA							
Energy Savings	4,085	Participants	30.581	GWh	0.85	25.966	GWh
Lifetime Energy Savings			717.412	GWh	0.84	600.938	GWh
Peak Demand Savings			8.446	MW	0.93	7.820	MW
Annual GHG Emission Reductions			16,877	Tonnes of CO2 eq	0.85	14,330	Tonnes of CO2 eq
EUL			23.5	Years		23.1	Years
Green Heat							
Energy Savings	1,783	Measures installed	5.561	GWh	0.52	2.918	GWh
Lifetime Energy Savings			100.103	GWh	0.52	52.526	GWh
Peak Demand Savings			4.668	MW	0.55	2.561	MW
Annual GHG Emission Reductions			3,069	Tonnes of CO2 eq	0.52	1,611	Tonnes of CO2 eq
EUL			18.0	Years		18.0	Years
EPI							
Energy Savings	9,763	Participants	9.481	GWh	0.99	9.357	GWh
Lifetime Energy Savings			65.685	GWh	1.02	66.977	GWh
Peak Demand Savings			0.942	MW	0.98	0.920	MW
Annual GHG Emission Reductions			5,233	Tonnes of CO2 eq	0.99	5,164	Tonnes of CO2 eq
EUL			6.9	Years		7.2	Years
MHEEP							
Energy Savings	162	Participants	0.577	GWh	1.00	0.577	GWh
Lifetime Energy Savings			11.663	GWh	1.00	11.663	GWh
Peak Demand Savings			0.373	MW	1.00	0.373	MW
Annual GHG Emission Reductions			318	Tonnes of CO2 eq	1.00	318	Tonnes of CO2 eq
EUL			20.2	Years		20.2	Years





	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value*	Value	Unit
AMH							
Energy Savings	79	Projects	1.460	GWh	1.00	1.460	GWh
Lifetime Energy Savings			25.465	GWh	1.00	25.465	GWh
Peak Demand Savings			0.741	MW	1.00	0.741	MW
Annual GHG Emission Reductions			806	Tonnes of CO2 eq	1.00	806	Tonnes of CO2 eq
EUL			17.4	Years		17.4	Years
ASFH							
Energy Savings	242	Participants	1.444	GWh	1.00	1.444	GWh
Lifetime Energy Savings			28.992	GWh	1.00	28.992	GWh
Peak Demand Savings			0.627	MW	1.00	0.627	MW
Annual GHG Emission Reductions			797	Tonnes of CO2 eq	1.00	797	Tonnes of CO2 eq
EUL			20.1	Years		20.1	Years
Total							
Energy Savings			49.104	GWh		41.722	GWh
Lifetime Energy Savings			949.321	GWh		786.562	GWh
Peak Demand Savings			15.798	MW		13.042	MW
Annual GHG Emission Reductions			27,100	Tonnes of CO2 eq		23,026	Tonnes of CO2 eq
EUL			19.3	Years		18.9	Years
* The average NTGR values presented in this table correspond to the ratios of net savings to gross savings by program component and then for the entire program.							

Existing Residential was aimed at achieving 38.526 GWh in net electrical energy savings and 11.550 MW in net peak demand savings at the generator for 2023. The program was able to achieve planned energy and peak demand savings. Green Heat, MHEEP, and ASFH fell below their energy target, while HEA, EPI and AMH exceeded theirs. All program components except Green Heat and ASFH exceeded their peak demand savings targets. HEA, MHEEP, and AMH participation levels reached their highest point in 2023, while ASFH was launched in 2023. HEA was the largest contributor to total program net energy (62%) and peak demand savings (60%).

Figure 42: 2023 Existing Residential Program Targeted and Evaluated Net Energy Savings

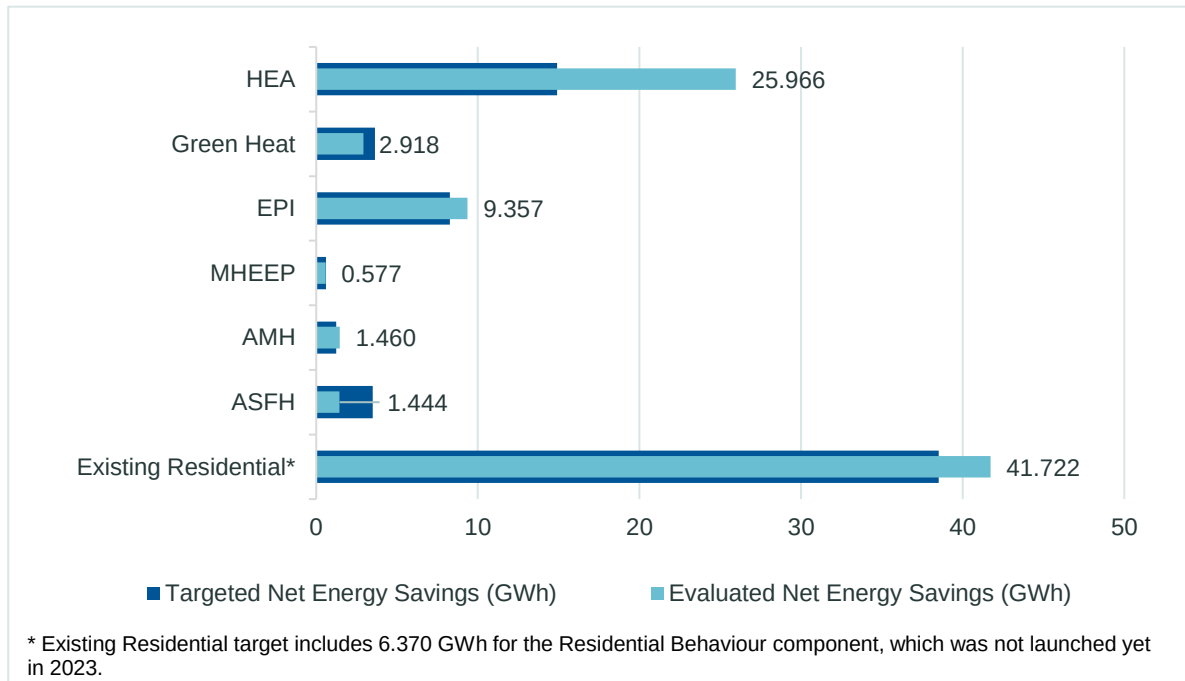
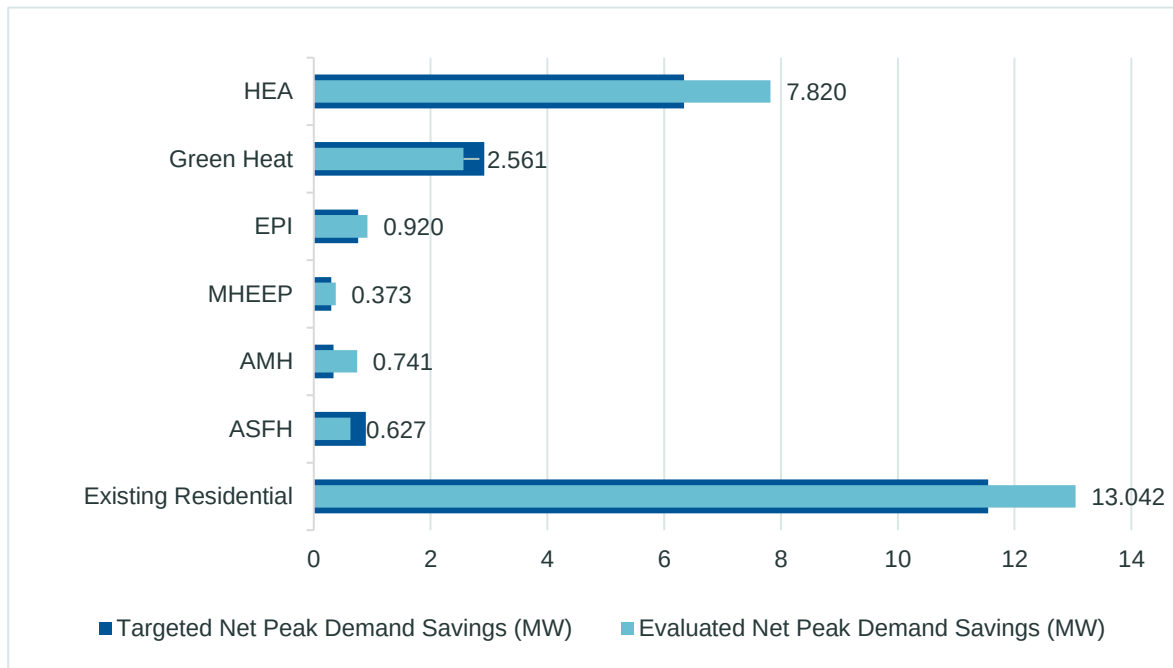


Figure 43: 2023 Existing Residential Program – Targeted and Evaluated Net Peak Demand Savings





LIST OF APPENDICES

The following are presented in the Existing Residential Program – Appendices document.

Home Energy Assessment

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Appendix II HEA Participant Survey Results

Appendix III HEA Tracking Sheet Audit

Appendix IV HEA Detailed Methodology and Billing Analysis Results

Appendix V HEA Algorithm for Free-ridership Calculations

Appendix VI HEA Spillover

Appendix VII HEA Reporting Requirements

Appendix VIII HEA 2023 Recommendations

Green Heat

Appendix IX Green Heat Participant Survey Questionnaire

Appendix X Green Heat Participant Survey Results

Appendix XI Green Heat Contractor Interview Guide

Appendix XII Green Heat Distributor Interview Guide

Appendix XIII Green Heat Tracking Sheet Audit

Appendix XIV Green Heat Algorithm for Free-ridership Calculation

Appendix XV Green Heat 2023 Recommendations

Efficient Product Installation

Appendix XVI EPI Tracking Sheet Audit

Appendix XVII EPI 2023 Recommendations

Mi'kmaw Home Energy Efficiency Project

Appendix XVIII MHEEP Tracking Sheet Audit

Appendix XIX MHEEP 2023 Recommendations

Affordable Multifamily Housing

Appendix XX AMH Tracking Sheet Audit

Appendix XXI AMH 2023 Recommendations



Affordable Single-family Homes

Appendix XXII ASFH Tracking Sheet Audit

Appendix XXIII ASFH 2023 Recommendations



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com





EfficiencyOne

EXISTING RESIDENTIAL PROGRAM

Appendix Report

2023 DSM EVALUATION

March 11, 2024



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APPENDIX I

HEA Participant Survey Questionnaire

HOME ENERGY ASSESSMENT PARTICIPANT SURVEY

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Telephone survey
Estimated Time to Complete	15 min
Target Audience	Participants whose projects generated electrical savings in 2023
Expected Number of Completions	100
Contact List Source	2023 HEA tracking sheet
Fielding Firm	Narrative Research
Estimated Timeline for fielding	November - December

Table 2: Research Objectives and Associated Sections

Research Objectives	Section
Verification and recall	A
Verification of action taken	B
Free-ridership	C-D-E
Cross-influence	F
Spillover	G
Satisfaction	H
Demographics	I

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 please speak with <INSERT NAME>?

1. Yes **[GO TO INTRODUCTION]**
2. No **[SAY “PERHAPS YOU CAN HELP ME ANYWAY.” GO TO INTRODUCTION]**

Hello, my name is _____ calling on behalf of 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 Home Energy Assessment 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: This program involves having an energy advisor conduct an assessment of the home, including a blower door test, and provide participants with energy efficiency upgrade recommendations.]

[IF NEEDED: In Nova Scotia, the federal Canada Greener Homes Grant initiative is co-delivered with Efficiency Nova Scotia through the Home Energy Assessment (HEA) program. You may recall participating in the Greener Homes program.]

[IF NEEDED: You may have recently been contacted by MQO 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 fifteen minutes.]

A. Verification and Recall

A1. We understand you participated in the Home Energy Assessment program. Is that correct?

1. Yes **[CONTINUE]**
 2. No, does not recall participating **[PROMPT:** “Are you sure? You may recall participating in the Greener Homes program which is co-delivered with Efficiency Nova Scotia’s Home Energy Assessment program. Someone would have come to your house to evaluate your energy efficiency and conducted a blower door test to verify the air tightness of your home. Then, you would have received a Renovation Upgrade Report about upgrades you could make to improve energy efficiency. They might have talked about you getting rebates to cover some of the cost of upgrades.”] **[IF PERSIST AS NO, THANK, TERMINATE AND RECORD]**
FIELD MANAGER TO PROVIDE PETER MACINTOSH WITH UPDATES IF THE PERCENTAGE OF TERMINATES IS HIGH
98. Don’t know/Refused **[PROBE:** “Is there someone else in the household who would know about having participated in the Home Energy Assessment program?”] **[IF YES, ASK TO SPEAK TO THE APROPRIATE PERSON AND RE-START AT INTRODUCTION. IF PERSISTS AS NO, THANK, TERMINATE AND RECORD.]**

[IF REFUSED, ASK “CAN WE SCHEDULE A MORE CONVENIENT TIME FOR YOU TO CONDUCT THIS SURVEY?”] [SCHEDULED, IF NECESSARY, FOR: _____]



B. Verification of Actions Taken

B1. Can you please tell me if any of the following upgrades were recommended for your home by the energy advisor? **[DO NOT ROTATE - CODE ONE ONLY PER STATEMENT]**

[1 = YES, RECOMMENDED, 2 = NO, NOT RECOMMENDED, 98 = DON'T KNOW / DON'T REMEMBER, 99 = REFUSED] [READ]

- a. Any type of heat pump, including mini-split, central or geothermal
- b. Insulation including attic, ceiling, exterior wall, exposed floor, basement, crawlspace, or foundation insulation
- c. Windows, doors or skylights
- d. Efficient ventilation system (heat recovery ventilation system)
- e. Air sealing or draft proofing
- f. Heat pump water heater
- g. Wood or pellet stove or furnace
- h. Smart thermostat
- i. Solar PV system

[ASK B2-B3 IF ANY ITEM IN B1 A THRU I=1 (“YES, RECOMMENDED”)]

B2. **IF MORE THAN ONE ITEM IN B1A-I=YES, READ:** Through the Home Energy Assessment program, have you installed any recommended energy efficiency upgrades, meaning that you received a rebate for installing one or more of the upgrades? Have you... **[READ IN ORDER. ACCEPT ONE RESPONSE]**

- 1. Installed at least one upgrade
- 2. Installed all the upgrades
- 3. Or did not install any upgrades
- 98. **[DON'T READ]** Don't know
- 99. **[DON'T READ]** Refused

B3. **IF ONLY ONE ITEM IN B1A-I=YES, READ:** Through the Home Energy Assessment program, have you installed this recommended energy efficiency upgrade, meaning that you received a rebate for installing the upgrade? **[DO NOT READ. ACCEPT ONE RESPONSE]**

- 1. Yes, installed the upgrade
- 2. No, did not install the upgrade
- 98. **[DON'T READ]** Don't know
- 99. **[DON'T READ]** Refused

[ASK B4 IF B2=1 (“YES, INSTALLED AT LEAST ONE UPGRADE”)]

B4. Which of the following recommended upgrades have you installed under the Home Energy Assessment program? **[ASK FOR EACH ITEM IN B1A THRU I = 1]**

[1 = YES, INSTALLED, 2 = NO, NOT INSTALLED, 98 = DON'T KNOW / DON'T REMEMBER, 99 = REFUSED] [READ]

- a. Any type of heat pump, including mini-split, central or geothermal
- b. Insulation including attic, ceiling, exterior wall, exposed floor, basement, crawlspace, or foundation insulation
- c. Windows, doors or skylights
- d. Efficient ventilation system (heat recovery ventilation system)
- e. Air sealing or draft proofing
- f. Heat pump water heater
- g. Wood or pellet stove or furnace
- h. Smart thermostat
- i. Solar PV system

B5. **[POSE B5 ONLY IF 'YES, INSTALLED' TO AT LEAST ONE ITEM IN B4a-i OR B2=2 "INSTALLED ALL UPGRADES OR B3=1 "INSTALLED THE UPGRADE"]** Were your energy efficiency upgrades installed as an extension of your house or installed as major renovations? **ACCEPT MULTIPLE RESPONSE, BUT ONLY IF CODE 1 AND CODE 2**

- 1. Yes, an extension of my house
- 2. Yes, a major renovation
- 3. No
- 98. Don't Know
- 99. Refused

B6. Did you have a fireplace or wood stove in place before having your home evaluated by an energy advisor? **ACCEPT MULTIPLE RESPONSE, BUT ONLY IF CODE 1 AND CODE 2**

- 1. Yes, a fireplace
- 2. Yes, a wood stove
- 3. No
- 98. Don't know
- 99. Refused

B7. **[IF B6 = YES 1 AND/OR 2]** How, if at all, did usage of your [a. 'fireplace' / b. 'wood stove'] change after you installed your energy efficiency upgrades? Did it ...: **[READ – POSE SEPARATELY FOR 'A' AND 'B', IF 1 AND 2 SELECTED IN B6]**

1. Significantly increase
2. Somewhat increase
3. Somewhat decrease
4. Significantly decrease
5. Did it not change?

VOLUNTEERED

98. Don't know
99. Refused

[ASK B8 IF A HEAT PUMP IS INSTALLED – IF B4A=1, OR IF B1A=1 AND (B2=2 OR B3=1)]

B8. Prior to installing your heat pump, did you already have a working air conditioner in your home? **[DO NOT READ RESPONSES]**

1. Yes
2. No
98. Don't Know
99. Refused

B9. **[ASK IF B8= 2]** If you had not installed a heat pump through your participation in the program, what is the likelihood that would you have purchased an air conditioner? Please answer on a scale of 0 to 10, where 0 is "Definitely not" and 10 is "Definitely." **[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

FREE-RIDERSHIP SERIES PROGRAMMING

Upgrades Installed	Programming
Solar PV installed	IF B4i=1 "Yes, installed", OR IF B1i=1 "Yes, recommended AND (B2=2 "Installed all upgrades" OR B3=1 "Yes, installed the upgrade") FOR SOLAR PV)
Heat Pump installed	IF B4a=1 "Yes, installed", OR IF B1a=1 "Yes, recommended AND (B2=2 "Installed all upgrades" OR B3=1 "Yes, installed the upgrade") FOR HEAT PUMP)
Other EE Upgrades installed	IF ANY "Yes, installed" at B4b-h, OR IF B1b-h=1 "Yes, recommended AND (B2=2 "installed all upgrades" OR B3=1 "Yes, installed the upgrade") FOR ANY UPGRADE B1b-h]

C. Free-ridership – Solar PV

[ASK SERIES IF SOLAR PV INSTALLED = IF B4I=1, OR IF B1I=1 AND (B2=2 OR B3=1)]

Now I would like to ask you a series of questions regarding your decision to install a solar PV system for which you received a Canada Greener Homes rebate issued by Efficiency Nova Scotia through the Home Energy Assessment program. To simplify my series of questions, I'll simply talk about the rebate.

C1. Had you already decided to install a solar PV system BEFORE you heard about the rebate available? **[CODE ONLY ONE]**

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

C2. **[IF C1=1]** Just to confirm: Before you learned about the solar PV rebate, you had already made the decision to install a solar PV system? **[CODE ONE ONLY – DO NOT READ RESPONSES]**

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

C3. Efficiency Nova Scotia gave you a rebate for the solar PV system you installed. If you had not received the rebate, would you have paid for the full cost of the solar PV system you installed? Please answer using 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]**

0-10 SCALE WITH END POINT LABELS – RECORD NUMBER

- 98. Don't Know
- 99. Refused

[READ FIRST TIME THROUGH ONLY] I would like you to consider what actions you would have taken if there was no solar PV rebate. For the next questions, answer on a scale of 0 to 10, where 0 is "Very Unlikely," and a 10 is "Very Likely."

[DO NOT ACCEPT A RANGE – ASK C4 TO C6 SEQUENCE IN ORDER/DO NOT RANDOMIZE]

C4. If there were no solar PV rebate, what is the likelihood that you would have installed a solar PV system?

0-10 SCALE WITH END POINT LABELS – RECORD NUMBER

- 98. Don't Know
- 99. Refused

C5. **[ASK IF C3 >=5]** If there were no solar PV rebate, what is the likelihood that you would have installed the same number of panels or the same capacity of solar PV system?

0-10 SCALE WITH END POINT LABELS – RECORD NUMBER

- 98. Don't Know
- 99. Refused

C6. If there were no solar PV rebate, what is the likelihood that you would have postponed your solar PV installation by at least one year?

___ Response ___98 Don't Know ___99 Refused

C7. I would like you to rate the importance of the following three factors in your decision to install your solar PV system. Use a scale from 0 to 10 where 0 is "No influence" and 10 is "Great influence". The first factor is... **[DO NOT ACCEPT A RANGE]**

Factor [READ AND RANDOMIZE]	Responses
a. The solar PV rebate	___ Response ___98 Don't Know ___Refused
b. Information or recommendations provided in the Renovation Upgrade Report	___ Response ___98 Don't Know ___Refused
c. Expert information or advice from the energy advisor who came to your home to conduct the energy assessment	___ Response ___98 Don't Know ___Refused

D. Free-ridership – HP and No Other EE Upgrades

[ASK SERIES IF HEAT PUMP INSTALLED – IF B4A=1, OR IF B1A=1 AND (B2=2 OR B3=1)] AND OTHER EE UPGRADES INSTALLED = NO]

Now, I would like to ask you a series of questions regarding your decision to install a high efficiency heat pump through the Home Energy Assessment program.

Series A: Questions on the decision to install a heat pump

- D1. Had you already decided to install a heat pump before you had your home evaluated by an energy advisor?
- 1. Yes
 - 2. No
 - 98. Don't know
 - 99. Refused



- D2. **[IF D1=1]** Just to confirm: before you had your home evaluated by an energy advisor, you had already made the decision to install a heat pump to heat your home?
1. Yes
 2. No
 98. Don't know
 99. Refused
- D3. **[IF B8=2, 98,99 AND D1=2, 98, 99 OR D2=2, 98, 99]** If there were no program, which of the following actions would you have taken? **[READ IN ORDER, CODE ONE ONLY]**
1. Kept your existing heating system **[GO TO F SECTION]**
 2. Kept your existing heating system and purchased an air conditioner **[GO TO F SECTION]**
 3. Purchased a new non-electric heating system (for example, oil or gas system) **[GO TO F SECTION]**
 4. Purchased a new non-electric heating system and an air conditioner **[GO TO F SECTION]**
 5. Purchased a heat pump
- [VOLUNTEERED]**
98. Don't know **[GO TO F SECTION]**
 99. Refused **[GO TO F SECTION]**
- D4. **[IF B8=1 AND D1=2, 98, 99 OR D2=2, 98, 99]** If there were no program, which of the following actions would you have taken? **[READ IN ORDER, CODE ONE ONLY]**
1. Kept your existing heating system **[GO TO F SECTION]**
 2. Purchased a new non-electric heating system (for example, oil or gas system) **[GO TO F SECTION]**
 3. Purchased a heat pump
- [VOLUNTEERED]**
98. Don't know **[GO TO F SECTION]**
 99. Refused **[GO TO F SECTION]**
- D5. **[IF D2=1 OR D3=5 OR D4=3]** If there were no 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 "Definitely not" and 10 is "Definitely." **[PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]0-10 SCALE WITH END POINT LABELS – RECORD NUMBER**
- [VOLUNTEERED]**
98. Don't know **[GO TO F SECTION]**
 99. Refused **[GO TO F SECTION]**



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 program, so the heat pump you 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.

D6. Were you aware that high efficiency heat pumps that operate at temperatures below -15°C were available, before you had your home evaluated by an energy advisor?

- 1. Yes
- 2. No
- 98. Don't know
- 99. Refused

D7. **[IF D6=1]** Before you had your home evaluated by an energy advisor, had you already made the decision to install a high-efficiency heat pump model?

- 1. Yes
- 2. No
- 98. Don't know
- 99. Refused

D8. Efficiency Nova Scotia gave you a rebate for your new high efficiency heat pump. If you had not received the rebate, 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 **[GO TO F SECTION]**
- 99. Refused **[GO TO F SECTION]**

- D9. 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 RANDOMIZE FACTORS; DO NOT ACCEPT A RANGE]**

Factor [READ AND RANDOMIZE]	Responses
a. The program rebate	__ Response __98 Don't Know __Refused
b. Information provided by Efficiency Nova Scotia on the benefits of high efficiency heat pumps	__ Response __98 Don't Know __Refused
c. Information provided by the retailers or contractors on the benefits of high efficiency heat pumps	__ Response __98 Don't Know __Refused

E. Free-ridership – Other/Multiple EE Upgrades

[ASK IF OTHER EE UPGRADES INSTALLED = YES]

Now I'm going to ask you to think of energy efficient upgrades **[IF SOLAR PV INSTALLED – B1I=1 OR B4I=1 AND (B2=2 OR B3=1) SHOW:** except Solar PV] that were made to your home under the Home Energy Assessment program.

- E1. Did you already have plans to install the energy efficient upgrades that were installed through the program, BEFORE having your home evaluated by an energy advisor? Did you ... **[CODE ONLY ONE – READ RESPONSES IN ORDER]**
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
 98. (Don't know)
 99. (Refused)
- E2. **[IF E1=1 OR 2]** Just to confirm: Before you had your home evaluated by an energy advisor, you had already made the decision to install **[all/some of]** the energy efficiency upgrades that were installed through the program? **[CODE ONE ONLY – DO NOT READ RESPONSES]**
1. Yes
 2. No
 98. Don't know
 99. Refused

- E3. Efficiency Nova Scotia gave you a rebate for the energy efficiency upgrades you installed in your home. If you had not received the rebate, would you have paid for the full cost of the energy efficiency upgrades you installed? Please answer using 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]

0-10 SCALE WITH END POINT LABELS – RECORD NUMBER

98. Don't Know
99. Refused

I would like you to consider what actions you would have taken if there was no Home Energy Assessment program. For the next questions, answer on a scale of 0 to 10, where 0 is “Very Unlikely,” and a 10 is “Very Likely.”

[DO NOT ACCEPT A RANGE – ASK E4 TO E6 SEQUENCE IN ORDER/DO NOT RANDOMIZE]

- E4. If there were no program, what is the likelihood that you would have installed exactly the same quantity of energy efficiency upgrades that were installed through the program?

0-10 SCALE WITH END POINT LABELS – RECORD NUMBER

98. Don't Know
99. Refused

- E5. **[IF B8=2, 98,99 AND D1=3, 98, 99 OR D2=2, 98, 99]** If there were no program, which of the following actions would you have taken? **[READ IN ORDER, CODE ONE ONLY]**

1. Kept your existing heating system
2. Kept your existing heating system and purchased an air conditioner
3. Purchased a new non-electric heating system (for example, oil or gas system)
4. Purchased a new non-electric heating system and an air conditioner
5. Purchased a heat pump

[VOLUNTEERED]

98. Don't know
99. Refused

E6. [IF B8=1 AND D1=3, 98, 99 OR D2=2, 98, 99] If there were no program, which of the following actions would you have taken? [READ IN ORDER, CODE ONE ONLY]

1. Kept your existing heating system
2. Purchased a new non-electric heating system (for example, oil or gas system)
3. Purchased a heat pump

[VOLUNTEERED]

98. Don't know
99. Refused

E7. If there were no program, what is the likelihood that you would have postponed the installation of the energy efficient upgrades by at least one year?

___ Response ___ 98 Don't Know ___ 99 Refused

E8. I would like you to rate the importance of the following three factors in your decision to install the energy efficiency upgrades. Use a scale from 0 to 10 where 0 is "No influence" and 10 is "Great influence". The first factor is... [DO NOT ACCEPT A RANGE]

Factor [READ AND RANDOMIZE]	Responses
a. The rebates offered for the energy efficiency upgrades	___ Response ___ 98 Don't Know ___ Refused
b. Information or recommendations provided in the Renovation Upgrade Report	___ Response ___ 98 Don't Know ___ Refused
c. Expert information or advice from the energy advisor who came to your home to conduct the energy assessment	___ Response ___ 98 Don't Know ___ Refused

F. Cross-Influence

[READ AND ROTATE (F1 + F2-F4) AND (F5 + F6-F8) SEQUENCES]

F1. Before participating in the Home Energy Assessment program in 2023, had you at any time in the past participated in any Efficiency Nova Scotia program?

1. Yes
2. No
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 energy efficient upgrades in your home.
- 1. Agree
 - 2. Disagree
 - 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 the program, you asked for an energy assessment of your home.
- 1. Agree
 - 2. Disagree
 - 98. (Don't know)
 - 99. (Refused)
- F4. **[IF F1=1]** Because of your previous participation in an Efficiency Nova Scotia program and what you learned by participating in the program, you took into account the savings on your energy bill when evaluating different upgrades for your home.
- 1. Agree
 - 2. Disagree
 - 98. (Don't know)
 - 99. (Refused)
- F5. Before participating in the Home Energy Assessment program in 2023, 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
 - 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 by Efficiency Nova Scotia was a major factor in your decision to install energy efficiency upgrades in your home.
- 1. Agree
 - 2. Disagree
 - 98. (Don't know)
 - 99. (Refused)
- F7. **[IF F5=1]** The promotion of energy efficiency by Efficiency Nova Scotia prompted you to ask for an energy assessment of your home.
- 1. Agree
 - 2. Disagree
 - 98. (Don't know)
 - 99. (Refused)
- F8. **[IF F5=1]** The promotion of energy efficiency by Efficiency Nova Scotia prompted you to take into account the savings on your energy bill when evaluating different upgrades for your home.
- 1. Agree
 - 2. Disagree
 - 98. (Don't know)
 - 99. (Refused)

G. Spillover

[ASK SECTION IF B2 = 1 OR 3, OR IF B3 = 2, OR IF ANY OF B4 = 2.]

You mentioned in a previous answer that there were some recommended upgrades that you decided not to install through the Home Energy Assessment program.

- G1. **Since the time that you participated** in the Home Energy Assessment program, have you installed one or more of the recommended upgrades on your own? **[CODE ONE ONLY – DO NOT READ RESPONSES]**
- 1. Yes
 - 2. No
 - 98. (Don't know)
 - 99. (Refused)

G2. **[IF G1=1]** Which upgrades have you installed on your own after participating in the Home Energy Assessment program? **[READ, ACCEPT MULTIPLE]**

[IF B2=1 (YES, INSTALLED AT LEAST ONE UPGRADE): LIST OF EACH ITEM IN B1A THRU I=1 (“YES, RECOMMENDED”) AND B4A THRU I=2 (“NO, NOT INSTALLED”)]

OR

[IF B2=3 (NO, DID NOT INSTALL ANY UPGRADES): LIST OF EACH ITEM IN B1A THRU I=1 (“YES, RECOMMENDED”)]

OR

[IF B3=2 (NO, DID NOT INSTALL THE UPGRADE): LIST OF THE ITEM IN B1A THRU I=1 (“YES, RECOMMENDED”)]

96. Other energy-efficient measures? **[PLEASE SPECIFY_____]**

G3. **[IF G1=1]** Have you received rebates from other Efficiency Nova Scotia programs for the energy efficiency upgrades you installed on your own after participating in the Home Energy Assessment program?

1. Yes **[GO TO NEXT SECTION]**

2. No

98. (Don't know) **[GO TO NEXT SECTION]**

99. (Refused) **[GO TO NEXT SECTION]**

G4. **[IF G3 = 2]** How influential was your experience with the Home Energy Assessment program on your decision to install some or all of the measures that you installed after participating in the program? Please give your answer on a scale of 0 to 10, where 0 indicates that the Home Energy Assessment program “had no influence at all on your decision to implement additional energy efficiency upgrades” and 10 indicates that the program was “extremely influential in your decision to implement additional energy efficiency upgrades.” **[DO NOT ACCEPT A RANGE]**

[0-10 SCALE WITH END POINT LABELS – RECORD NUMBER]

98. Don't Know/Don't recall

99. Refused

H. Satisfaction

- H1. **[NET PROMOTER SCORE]** Using a 0 to 10 scale, where 0 means “Definitely would not” and 10 means “Definitely would”, what is the likelihood that you would recommend the Home Energy Assessment program to a friend or colleague?

[0-10 SCALE WITH END POINT LABELS – RECORD NUMBER]

- 98. Don't Know/Don't recall
- 99. Refused

- H2. Using a scale from 0 to 10 where 0 is “Not at all satisfied” and 10 is “Completely satisfied”, how would you rate your satisfaction with the Home Energy Assessment program overall? **[DO NOT ACCEPT A RANGE]**.

[0-10 SCALE WITH END POINT LABELS – RECORD NUMBER]

- 98. Don't Know
- 99. Refused

- H3. **[IF H2<8]** What was the main reason you were not more satisfied with the program overall? **[PROBE FOR SPECIFIC REASON. RECORD FIRST MENTION AND THEN ACCEPT MULTIPLE RESPONSES KEEPING CODE 98 EXCLUSIVE]**

- 96. **RECORD VERBATIM:** _____
- 98. Don't know
- 99. Refused

- H4. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Home Energy Assessment program? Please indicate if any are not applicable to you. **[DO NOT RANDOMIZE] [DO NOT ACCEPT A RANGE]**

- a. The clarity of program requirements, that is, the eligibility requirements
- b. The initial home energy assessment overall
- c. Your EnerGuide label and Renovation Upgrade Report received for your home
- d. The final home energy assessment overall
- e. The expertise of your energy advisor
- f. Any communications you had with your energy advisor
- g. The amount of the rebate
- h. The website of the Home Energy Assessment program

[0-10 SCALE WITH END POINT LABELS– RECORD NUMBER]

- 97. Not applicable
- 98. Don't Know/Don't recall
- 99. Refused

H5. Do you have any recommendations for improving the Home Energy Assessment program? **[PROBE] Anything else? [DO NOT READ. ACCEPT MULTIPLE RESPONSES, KEEPING CODE 97, 98 AND 99 EXCLUSIVE]**

1. Increase the rebate
2. Offer additional products/measures eligible for rebates
3. Offer more information on the products/measures recommended
4. Simplify program application, forms, and associated paperwork
5. Speed up the process
6. Advertise the program more or in a better way
7. Improve the content of the Renovation Upgrade Report
8. Increase the time given to complete the upgrades
97. No recommendations
96. Other [SPECIFY: _____]
98. Don't know
99. Refused

I. Demographics

These final questions are asked for statistical purposes only. The information collected is strictly confidential.

I1. What type of residence do you live in? **[READ RESPONSES 1-7, SELECT ONE RESPONSE]**

1. Detached single-family home
2. Semi-detached house
3. Mobile home or house trailer
4. Townhouse or duplex with shared adjacent walls
5. Row house (Single story apartment building)
6. Apartment building that has fewer than five stories
7. Apartment building that has five or more stories
96. Other [SPECIFY: _____]
98. (Don't know)
99. (Refused)

I2. How many bedrooms are in your home? **[[RECORD NUMBER, DO NOT ACCEPT RANGE; ENTER ZERO FOR A STUDIO APARTMENT WITH NO BEDROOMS]**

96. RECORD NUMBER: ____
98. Don't know
99. Refused

13. Is your home occupied year round, or is it a seasonal home?
- 1. Year round residence
 - 2. Seasonal / vacation home
 - 96. Other [SPECIFY: _____]
 - 98. (Don't Know)
 - 99. (Refused)
14. **[DO NOT ASK IF 'SEASONAL/VACTION HOME' IN I3]** Including yourself, how many people live in this residence on a full-time basis?
96. Number of people: _____
15. In what age category do you fall? 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
 - 99. (Refused)
16. What is the highest level of education you have completed? **[READ IF NECESSARY]**
- 1. Less than high school graduation certificate
 - 2. High school graduation certificate and/or some post-secondary
 - 3. Trades certificate or diploma
 - 4. College certificate or diploma
 - 5. University certificate or diploma
 - 98. (Don't know)
 - 99. (Refused)



17. Which of the following income categories best describes your total annual household income before taxes in 2022? Stop me when I reach the right category. **[READ LIST; SELECT ONE RESPONSE]**

1. \$32,400 or less
2. Between \$32,401 and \$67,000
3. Between \$67,001 and \$86,000
4. Between \$86,001 and \$105,000
5. Between \$105,001 and \$110,000
6. More than \$110,000
98. (Don't know)
99. (Refused)

18. **[DO NOT READ]** Gender:

1. Male
2. Female
3. Other

END: Those are all the questions I have for you. Thank and terminate.

APPENDIX II

HEA Participant Survey Results

B. Verification of Actions Taken

B1A-B1I. [Recommended upgrades for home - % YES] Can you please tell me if any of the following upgrades were recommended for your home by the energy advisor?

	2023	
	Recommended	Implemented
Sample Size	100	100
Any type of heat pump, including mini-split, central or geothermal	57%	41%
Insulation including attic, ceiling, exterior wall, exposed floor, basement, crawlspace, or foundation insulation	63%	43%
Windows, doors or skylights	37%	18%
Efficient ventilation system (heat recovery ventilation system)	6%	3%
Air sealing or draft proofing	50%	30%
Heat pump water heater	20%	4%
Wood or pellet stove or furnace	5%	4%
Smart thermostat	27%	15%
Solar PV system	38%	29%

B2/B3. Through the Home Energy Assessment program, have you installed any recommended energy efficiency upgrades, meaning that you received a rebate for installing one or more of the upgrades? Have you...

	2023	2020
Sample Size	96	69
Installed at least one upgrade	67%	71%
Installed all the upgrades	32%	28%
Did not install any upgrades	1%	1%

B5. Were your energy efficiency upgrades installed as an extension of your house or installed as major renovations?

	2023
Sample Size	94
Yes, an extension of my house	40%
Yes, a major renovation	26%
No	26%
Don't Know	9%
Refused	1%

B6. Did you have a fireplace or wood stove in place before having your home evaluated by an energy advisor?

	2023
Sample Size	100
Yes, a fireplace	30%
Yes, a wood stove	30%
No	45%
Don't Know	2%

B7A. How, if at all, did usage of your [fireplace] change after you installed your energy efficiency upgrades? Did it ...:

	2023
Sample Size	30
Significantly increase	10%
Somewhat increase	0%
Somewhat decrease	7%
Significantly decrease	7%
It did it not change	73%
Don't know	3%
% INCREASE	10%
% DECREASE	13%

Base: Respondents who have a fireplace in place before having their home evaluated by an energy advisor

B7B. How, if at all, did usage of your [wood stove] change after you installed your energy efficiency upgrades? Did it ...:

	2023
Sample Size	30
Significantly increase	10%
Somewhat increase	10%
Somewhat decrease	20%
Significantly decrease	13%
It did it not change	37%
Don't know	10%
% INCREASE	20%
% DECREASE	33%

Base: Respondents who have a woodstove in place before having their home evaluated by an energy advisor

B8. Prior to installing your heat pump, did you already have a working air conditioner in your home?

2023	
Sample Size	41
Yes	24%
No	76%

Base: if a heat pump is installed

B9. If you had not installed a heat pump through your participation in the program, what is the likelihood that would you have purchased an air conditioner? Please answer on a scale of 0 to 10, where 0 is "Definitely not" and 10 is "Definitely."

2023	
Sample Size	31
MEAN	5.6

Base: Did not already have a working air conditioner prior to installing a heat pump

'Don't know' and 'Refused' are excluded from the mean calculation

UPGRADES INSTALLED.
[AMONG FULL-BASE]

2023	
Sample Size	100
Solar PV	29%
Heat Pump	41%
Other EE Upgrades	63%
No Upgrades	6%

C. Free-ridership – Solar PV

C1/C2. Had you already decided to install a solar PV system BEFORE you heard about the rebate available?

Just to confirm: Before you learned about the solar PV rebate, you had already made the decision to install a solar PV system?

2023	
Sample Size	29
Yes	34%
No	66%

Base: Respondents who installed Solar PV.

C3. Efficiency Nova Scotia gave you a rebate for the solar PV system you installed. If you had not received the rebate, would you have paid for the full cost of the solar PV system you installed? Please answer using 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.”

	2023
Sample Size	29
MEAN	6.6

Base: Respondents who installed Solar PV

'Don't know' and 'Refused' are excluded from the mean calculation

C4. If there were no solar PV rebate, what is the likelihood that you would have installed a solar PV system?

	2023
Sample Size	29
MEAN	6.2

Base: Respondents who installed Solar PV

'Don't know' and 'Refused' are excluded from the mean calculation

C5. If there were no solar PV rebate, what is the likelihood that you would have installed the same number of panels or the same capacity of solar PV system?

	2023
Sample Size	23
MEAN	7.7

Base: Respondents who definitely have pay the full cost C3 >5

'Don't know' and 'Refused' are excluded from the mean calculation

C6. If there were no solar PV rebate, what is the likelihood that you would have postponed your solar PV installation by at least one year?

	2023
Sample Size	29
MEAN	4.4

Base: Respondents who installed Solar PV

Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

C7A, B,C. I would like you to rate the importance of the following three factors in your decision to install your solar PV system. Use a scale from 0 to 10 where 0 is “No influence” and 10 is “Great influence”. The first factor is...

2023		
	Sample Size	Mean
The solar PV Rebate	29	6.9
Information or recommendations provided in the Renovation Upgrade Report	29	5.2
Expert information or advice from the energy advisor who came to your home to conduct the energy assessment	29	4.8

Base: Respondents who installed Solar PV

Table excludes responses of 'Don't know' and 'Refused'

D. Free-ridership – HP and No Other EE Upgrades

D1/D2. Had you already decided to install a heat pump before you had your home evaluated by an energy advisor?

Just to confirm: before you had your home evaluated by an energy advisor, you had already made the decision to install a heat pump to heat your home?

2023	
Sample Size	14
Yes	71%
No	29%

Base: Respondents who installed a heat pump but no other EE upgrades

D3. If there were no program, which of the following actions would you have taken?

2023	
Sample Size	4 (#)
Kept your existing heating system	2
Kept your existing heating system and purchased an air conditioner	1
Purchased a new non-electric heating system and an air conditioner	1

Base: Did not already have a working air conditioner prior to installing a heat pump and had no plan to install a heat pump

D5. If there were no 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 “Definitely not” and 10 is “Definitely.”

2023	
Sample Size	10
MEAN	4.7

Base: Respondents who decided to install and purchase a heat pump before home evaluation

'Don't know' and 'Refused' are excluded from the mean calculation

D6. Were you aware that high efficiency heat pumps that operate at temperatures below -15°C were available, before you had your home evaluated by an energy advisor?

2023	
Sample Size	9 (#)
Yes	5
No	4

D7. Before you had your home evaluated by an energy advisor, had you already made the decision to install a high-efficiency heat pump model?

2023	
Sample Size	5 (#)
Yes	5

Base : Respondents who were aware high efficiency heat pumps operate at temperatures below -15°C

D8. Efficiency Nova Scotia gave you a rebate for your new high efficiency heat pump. If you had not received the rebate, 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.”

2023	
Sample Size	9
MEAN	8.0

Base: Respondents who decided to install and purchase a heat pump before home evaluation

'Don't know' and 'Refused' are excluded from the mean calculation

D9A. 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...

2023		
	Sample Size	Mean
The program rebate	9	9.0.
Information provided by the retailers or contractors on the benefits of high efficiency heat pumps	9	7.3
Information provided by Efficiency Nova Scotia on the benefits of high efficiency heat pumps	9	5.1

Base : Respondents who decided to install and purchase a heat pump before home evaluation.

'Don't know' and 'Refused' are excluded from the mean calculation

E. Free-ridership – Other/Multiple EE Upgrades

E1/E2. Did you already have plans to install the energy efficient upgrades that were installed through the program, BEFORE having your home evaluated by an energy advisor? Did you ...

Just to confirm: Before you had your home evaluated by an energy advisor, you had already made the decision to install [all/some of] the energy efficiency upgrades that were installed through the program?

	2023	2020
Sample Size	63	68
Have plans to install all of the upgrades	57%	56%
Have plans to install some of the upgrades	5%	6%
Have no plans to install any of the upgrades	35%	38%
Don't know	3%	0%

E3. Efficiency Nova Scotia gave you a rebate for the energy efficiency upgrades you installed in your home. If you had not received the rebate, would you have paid for the full cost of the energy efficiency upgrades you installed? Please answer using 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."

	2023
Sample Size	63
MEAN	5.5

Base : Respondents who installed other EE upgrades

'Don't know' and 'Refused' are excluded from the mean calculation

E4. If there were no program, what is the likelihood that you would have installed exactly the same quantity of energy efficiency upgrades that were installed through the program?

	2023
Sample Size	63
MEAN	4.1

Base: Respondents who installed other EE upgrades

'Don't know' and 'Refused' are excluded from the mean calculation

E5. If there were no program, which of the following actions would you have taken?

	2023
Sample Size	3 (#)
Kept your existing heating system	1
Kept your existing heating system and purchased an air conditioner	1
Purchased a heat pump	1

Base : Respondents who prior to installing their heat pump did not have a working air conditioner and have no plans to install any upgrades

E6. If there were no program, which of the following actions would you have taken?

2023	
Sample Size	3 (#)
Kept your existing heating system	1
Purchased a heat pump	2

Base :Respondents who prior to installing their heat pump had a working air conditioner and have no plans to install any upgrades

E7. If there were no program, what is the likelihood that you would have postponed the installation of the energy efficient upgrades by at least one year?

2023	
Sample Size	63
MEAN	5.8

Base: Respondents who installed other EE upgrades

'Don't know' and 'Refused' are excluded from the mean calculation

E8A, B, C. I would like you to rate the importance of the following three factors in your decision to install the energy efficiency upgrades. Use a scale from 0 to 10 where 0 is "No influence" and 10 is "Great influence". The first factor is...

2023		
Sample Size	Sample Size	Mean
The rebates offered for the energy efficiency upgrades	63	7.7
Expert information or advice from the energy advisor who came to your home to conduct the energy assessment	63	7.3
Information or recommendations provided in the Renovation Upgrade Report	63	6.6

Base: Respondents who installed other EE upgrades

'Don't know' and 'Refused' are excluded from the mean calculation

F. Cross-Influence

F1. Before participating in the Home Energy Assessment program in 2023, had you at any time in the past participated in any Efficiency Nova Scotia program?

2023	
Sample Size	100
Yes	35%
No	64%
Don't know	1%

F2. Your previous participation in an Efficiency Nova Scotia program was a major factor in your decision to install energy efficient upgrades in your home.

	2023
Sample Size	35
Agree	66%
Disagree	31%
Don't know	3%

Base : Respondents who previously participated in ENS programs

F3. Because of your previous participation in an Efficiency Nova Scotia program and what you learned by participating in the program, you asked for an energy assessment of your home.

	2023
Sample Size	35
Agree	80%
Disagree	20%

Base : Respondents who previously participated in ENS programs

F4. Because of your previous participation in an Efficiency Nova Scotia program and what you learned by participating in the program, you took into account the savings on your energy bill when evaluating different upgrades for your home.

	2023
Sample Size	35
Agree	89%
Disagree	11%

Base : Respondents who previously participated in ENS programs

F5. Before participating in the Home Energy Assessment program in 2023, had you at any time in the past seen Efficiency Nova Scotia advertisements or information discussing the benefits of energy efficiency?

	2023
Sample Size	100
Yes	83%
No	17%

F6. The promotion of energy efficiency by Efficiency Nova Scotia was a major factor in your decision to install energy efficiency upgrades in your home.

	2023
Sample Size	83
Agree	82%
Disagree	18%

Base : Respondents who previously have seen ENS advertisements or information discussing the benefits of energy efficiency

F7. The promotion of energy efficiency by Efficiency Nova Scotia prompted you to ask for an energy assessment of your home.

	2023
Sample Size	83
Agree	87%
Disagree	13%

Base : Respondents who previously have seen ENS advertisements or information discussing the benefits of energy efficiency

F8. The promotion of energy efficiency by Efficiency Nova Scotia prompted you to take into account the savings on your energy bill when evaluating different upgrades for your home.

	2023
Sample Size	83
Agree	88%
Disagree	12%

Base : Respondents who previously have seen ENS advertisements or information discussing the benefits of energy efficiency

G. Spillover

G1. Since the time that you participated in the Home Energy Assessment program, have you installed one or more of the recommended upgrades on your own?

	2023	2020
Sample Size	65	50
Yes	29%	16%
No	71%	84%

Base : Respondents who did not install all upgrades recommended

Slight wording change from 2020

G2. Which upgrades have you installed on your own after participating in the Home Energy Assessment program?

	2023	2020
Sample Size	19	8 (#)
Insulation including attic, ceiling, exterior wall, exposed floor, basement, crawlspace, or foundation insulation	42%	1
Air sealing or draft proofing	26%	-
Windows, doors or skylights	16%	3
Solar PV system	11%	-
Heat pump water heater	11%	-
Any type of heat pump, including mini-split, central or geothermal	11%	2
Smart thermostat	5%	-
Other energy-efficient measures	11%	2

Base: Respondents who installed upgrades after participating in HEA

G3. Have you received rebates from other Efficiency Nova Scotia programs for the energy efficiency upgrades you installed on your own after participating in the Home Energy Assessment program?

	2023	2020
Sample Size	19	8 (#)
Yes	11%	-
No	89%	8

Base: Respondents who installed upgrades after participating in HEA

G4. How influential was your experience with the Home Energy Assessment program on your decision to install some or all of the measures that you installed after participating in the program? Please give your answer on a scale of 0 to 10, where 0 indicates that the Home Energy Assessment program “had no influence at all on your decision to implement additional energy efficiency upgrades” and 10 indicates that the program was “extremely influential in your decision to implement additional energy efficiency upgrades.”

	2023	2020
Sample Size	17	8
MEAN	7.5	6.1

Base: Respondents who installed upgrades after participating in HEA and did not receive rebates from other ENS program

Don't know/Don't recall and Refused are excluded from the mean calculation

H. Satisfaction

H1. [NET PROMOTER SCORE] Using a 0 to 10 scale, where 0 means “Definitely would not” and 10 means “Definitely would”, what is the likelihood that you would recommend the Home Energy Assessment program to a friend or colleague?

	2023
Sample Size	100
% Promoters (9-10)	73
% Passives (7-8)	16
% Detractors (0-6)	11
MEAN	8.9
Net Promoter Score	62

'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation.

'Net Promoter Score' calculated as percentage who gave a score of 9-10 (i.e., Promoters) minus the percentage who gave a score of 0-6 (i.e., Detractors), excluding the 'Don't know/Don't recall' and 'Refused' responses.

H2. Using a scale from 0 to 10 where 0 is “Not at all satisfied” and 10 is “Completely satisfied”, how would you rate your satisfaction with the Home Energy Assessment program overall?

	2023
Sample Size	100
10 - Completely satisfied	40%
9	9%
8	23%
7	10%
6	6%
5	7%
4	1%
3	2%
2	1%
1	0%
0 - Not at all satisfied	0%
Don't know	1%
Refused	0%
SATISFIED % (ratings of 8,9,10)	72
MEAN	8.3

'Don't know' and 'Refused' are excluded from the mean calculation

H3. What was the main reason you were not more satisfied with the program overall?

	2023
Sample Size	27
Too long to get the money/rebate	44%
Difficulty getting information/Trying to get information from the website	22%
Program requirement/Eligibility criteria are unclear	15%
The first or final energy audit took too long	15%
Problem receiving rebate	11%
I did not agree with the recommendations that were made	11%
The rebate received was too small	11%
Upfront costs/Having to put the money in before getting the rebate	7%
Assessment/Information was too generic/not specific to house	4%
Scope of the program is too narrow or limited	4%
Too much paperwork	4%
Problems with the pre- or post-retrofit report	4%

Base: Respondents who are not more satisfied with the Home Energy Assessment program

H4A. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Home Energy Assessment program? Please indicate if any are not applicable to you.

The clarity of program requirements, that is, the eligibility requirements	2023
Sample Size	100
10 - Completely satisfied	30%
9	6%
8	28%
7	14%
6	5%
5	7%
4	3%
3	1%
2	2%
1	1%
0 - Not at all satisfied	2%
Not applicable	0%
Don't know/Don't recall	1%
Refused	0%
SATISFIED % (ratings of 8,9,10)	64
MEAN	7.7

'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation.

H4B. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Home Energy Assessment program? Please indicate if any are not applicable to you.

The initial home energy assessment overall	2023
Sample Size	100
10 - Completely satisfied	42%
9	17%
8	21%
7	12%
6	2%
5	3%
4	1%
3	1%
2	0%
1	0%
0 - Not at all satisfied	1%
Not applicable	0%
Don't know/Don't recall	0%
Refused	0%
SATISFIED % (ratings of 8,9,10)	80
MEAN	8.6

'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation.

H4C. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Home Energy Assessment program? Please indicate if any are not applicable to you.

Your EnerGuide label and Renovation Upgrade Report received for your home	2023
Sample Size	100
10 - Completely satisfied	42%
9	14%
8	21%
7	11%
6	1%
5	3%
4	2%
3	2%
2	0%
1	1%
0 - Not at all satisfied	1%
Not applicable	1%
Don't know/Don't recall	1%
Refused	0%
SATISFIED % (ratings of 8,9,10)	77
MEAN	8.4

'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation.

H4D. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Home Energy Assessment program? Please indicate if any are not applicable to you.

The final home energy assessment overall	2023
Sample Size	100
10 - Completely satisfied	43%
9	17%
8	20%
7	10%
6	1%
5	6%
4	1%
3	0%
2	0%
1	0%
0 - Not at all satisfied	1%
Not applicable	0%
Don't know/Don't recall	1%
Refused	0%
SATISFIED % (ratings of 8,9,10)	80
MEAN	8.6

'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation.

H4E. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Home Energy Assessment program? Please indicate if any are not applicable to you.

The expertise of your energy advisor	2023
Sample Size	100
10 - Completely satisfied	56%
9	10%
8	15%
7	11%
6	0%
5	4%
4	1%
3	1%
2	0%
1	0%
0 - Not at all satisfied	1%
Not applicable	0%
Don't know/Don't recall	1%
Refused	0%
SATISFIED % (ratings of 8,9,10)	81
MEAN	8.8

'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation.

H4F. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Home Energy Assessment program? Please indicate if any are not applicable to you.

Any communications you had with your energy advisor	2023
Sample Size	100
10 - Completely satisfied	49%
9	16%
8	11%
7	7%
6	3%
5	6%
4	0%
3	4%
2	0%
1	0%
0 - Not at all satisfied	1%
Not applicable	2%
Don't know/Don't recall	1%
Refused	0%
SATISFIED % (ratings of 8,9,10)	76
MEAN	8.6

'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation.

H4G. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Home Energy Assessment program? Please indicate if any are not applicable to you.

The amount of the rebate	2023
Sample Size	100
10 - Completely satisfied	34%
9	12%
8	16%
7	15%
6	8%
5	3%
4	4%
3	5%
2	1%
1	0%
0 - Not at all satisfied	1%
Not applicable	1%
Don't know/Don't recall	0%
Refused	0%
SATISFIED % (ratings of 8,9,10)	62
MEAN	7.8

'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation.

H4H. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Home Energy Assessment program? Please indicate if any are not applicable to you.

The website of the Home Energy Assessment program	2023
Sample Size	100
10 - Completely satisfied	21%
9	4%
8	16%
7	19%
6	8%
5	8%
4	5%
3	2%
2	2%
1	1%
0 - Not at all satisfied	2%
Not applicable	8%
Don't know/Don't recall	4%
Refused	0%
SATISFIED % (ratings of 8,9,10)	41
MEAN	7.1

'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation.

H5. Do you have any recommendations for improving the Home Energy Assessment program? Anything else?

	2023
Sample Size	100
Speed up the process	17%
Simplify program application, forms, and associated paperwork	12%
Improve communication/follow-up	8%
Improve the website	7%
Offer more information on the products/measures recommended	7%
Increase the rebate	6%
Increase the time given to complete the upgrades	5%
Advertise the program more or in a better way	4%
Offer additional products/measures eligible for rebates	3%
Improve the content of the Renovation Upgrade Report	1%
Other	11%
No recommendations	46%
Don't know	1%

I. Demographics

11. What type of residence do you live in?

	2023	2020
Sample Size	100	70
Detached single-family home	87%	90%
Semi-detached house	6%	6%
Townhouse or duplex which share adjacent walls	4%	0%
Mobile home or house trailer	2%	0%
Row house (Single story apartment building)	1%	0%
Other	0%	4%

12. How many bedrooms are in your home?

	2023	2020
Sample Size	100	70
1	2%	3%
2	10%	13%
3	45%	53%
4	28%	26%
5+	15%	6%

13. Is your home occupied year round, or is it a seasonal home?

	2023	2020
Sample Size	100	70
Year round residence	100%	96%
Seasonal/vacation home	0%	4%

14. Including yourself, how many people live in this residence on a full-time basis?

	2023	2020
Sample Size	100	67
1	11%	19%
2	39%	42%
3	14%	13%
4	22%	19%
5+	12%	6%
Refused	2%	0%
MEAN	2.9	2.5

Base: Not asked if home is seasonal

Don't know/refused are excluded from the mean calculation

15. In what age category do you fall? Are you...

	2023	2020
Sample Size	100	70
18 to 24	1%	0%
25 to 34	10%	9%
35 to 44	25%	26%
45 to 54	17%	17%
55 to 64	20%	30%
65 or older	25%	19%
Refused	2%	0%

16. What is the highest level of education you have completed?

	2023	2020
Sample Size	100	70
Less than high school graduation certificate	1%	3%
High school graduation certificate and/or some post-secondary	11%	11%
Trades certificate or diploma	3%	3%
College certificate or diploma	16%	17%
University certificate or diploma	63%	64%
Refused	6%	1%

17. Which of the following income categories best describes your total annual household income before taxes in 2022? Stop me when I reach the right category.

	2023
Sample Size	100
Between \$32,401 and \$67,000	18%
Between \$67,001 and \$86,000	15%
Between \$86,001 and \$105,000	12%
Between \$105,001 and \$110,000	7%
More than \$110,000	32%
Don't know	1%
Refused	15%

New wording in 2023

18. [DO NOT READ] Gender:

	2023	2020
Sample Size	100	70
Male	64%	63%
Female	36%	37%

APPENDIX III

HEA Tracking Sheet Audit

This appendix presents the main 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

Table 1 presents the corrected tracked savings resulting from all changes made by the Evaluator.

Table 1: 2023 HEA Corrected Tracked Savings

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
HEA					
Gross Energy Savings at the Generator	32.606	GWh	30.584	GWh	-6.2%
Gross Peak Demand Savings at the Generator	27.879	MW	8.446	MW	-69.7%
Net Energy Savings at the Generator	23.600	GWh	24.018	GWh	1.8%
Net Peak Demand Savings at the Generator	19.786*	MW	6.893	MW	-65.2%
*The minor difference between the tracked net peak demand savings presented in this table (19.786 MW) and the value presented in the summary tab of the tracking sheet (19.789 MW) is due to rounding.					

The differences between the tracked and corrected values are mainly explained by the following corrections made by the Evaluator.

- › For the differences in gross energy savings:
 - › An adjustment to the 2022 estimated savings at the gross savings level (instead of only applying the adjustment at the net savings level)
 - › A few corrections made to hardcoded unitary energy savings values that were not consistent with the formula that should have been used.
- › For the difference in net energy savings:
 - › A correction made to the deduction in the estimated 2022 savings (they were missing NTGRs and line loss factors)
 - › A deduction of 10 additional participants for unconverted D assessment spillover
 - › The EPI savings deduction (added to those already identified for Green Heat).

- 
- › For the difference in demand savings:
 - › The correction made in the peak demand savings calculation for MSHP so that the formula considers if the previous system was electric or not
 - › Adjustments to the nominal heating capacity as well as the heating capacity at -15° and COP at -15°C for a few MSHPs based on values found in the NEEP Cold Climate Heat Pump List
 - › The same explanations as for the energy savings.



APPENDIX IV

HEA Detailed Methodology and Billing Analysis Results

Background

A billing analysis was conducted for HEA as part of the 2023 DSM evaluation to obtain measured electrical energy savings generated through the installation of energy efficiency upgrades. **Instead of calculating overestimation ratios (ORs) to be applied to pre and post-space heating consumption obtained from HOT2000**, as is the case in the current savings calculation approach, **the Evaluator planned to use the savings values obtained through the billing data to develop adjustment ratios that can be directly applied to the savings estimates obtained from HOT2000** using the whole home consumption (not only space heating).

The main reasons for recommending a change in the current savings calculation approach are as follows:

- › A higher proportion of participants use a heat pump for heating compared with the levels in the last billing analysis. The use of a heat pump instead of electrical baseboards makes it more difficult to isolate space heating consumption as the linear correlation with heating degree days is less significant. With the current savings calculation methodology, space heating consumption needs to be isolated because the ORs are calculated specifically for space heating.
- › The COVID-19 pandemic increased the credibility of arguments in favour of using a control group when conducting the billing analysis to avoid capturing pandemic effects in the analysis.
- › The complexity of the HEA savings calculation approach is increasing, and the approach includes unitary savings values for non-modelled space heating measures and domestic hot water (DHW) measures.

Methodology

To assess the electrical energy savings obtained from HEA energy efficiency upgrades, the billing analysis consisted of calculating the change in electrical energy consumption before (pre) and after (post) participation in HEA for a group of recent participants (treatment group). To account for variations in electrical energy consumption due to factors other than HEA participation, the Evaluator selected a control group and deducted the change in electrical energy consumption observed for that group over the same period. Subtracting the change in control group electrical energy consumption (i.e. a change that is not linked to the program component) from that of the treatment group ensures that **only savings attributable to HEA changes are captured and avoids capturing other effects that can have an impact on energy consumption** (e.g. the pandemic) because both the treatment and control groups are impacted by those effects.

Once the electrical energy savings are obtained from the billing data, they are compared with the savings values obtained from HOT2000 to establish average adjustment ratios.

The following subsections detail how the billing data were used to calculate the electrical energy savings and ultimately the adjustment ratios.



Selection of the Treatment and Control Groups

The initial treatment group included 886 HEA participants who were selected based on the following criteria:

- › Be 100% electrically heated according to HOT2000 (meaning that the primary heating system is electrical and there is no secondary heating system using other fuels and whose consumption is modelled in HOT2000, although the house can still have a supplementary heating system in place such as a fireplace or wood stove whose consumption is not modelled in HOT2000)
- › Have an E assessment date before June 2022 to ensure a full year of post data
- › Have a D assessment date no earlier than January 2019 to avoid overlap with control group participation
- › Use HOT2000 version 11.10 or 11.11

The Evaluator requested billing data for 1,123 participants based on these criteria and received billing data for 886 participants because NS Power account numbers were not available for all participants; hence, the Evaluator had to match the names and addresses.

The initial control group included a total of 2,315 customers who participated in HEA before those in the treatment group, who had an E assessment date between January 2017 and December 2018, and who were 100% electrically heated according to HOT2000. By selecting the control group among a sample of past HEA participants, the Evaluator ensures that control group participants have similar characteristics to treatment group participants, as recommended for matched control group approaches in Chapter 8 of the Uniform Methods Project (UMP). The process to match control and treatment participants is further described below. It should be noted that only the post-program participation period is looked at for control group customers and only the consumption listed in their electrical bills is used (not the modelled consumption). This means that the version of HOT2000 used to model control group household consumption has no impact on the analysis. The control group is only used to deduct any change in consumption that is not attributable to HEA from the change observed in the treatment group consumption data.

Billing Data Preparation

Billing data for all treatment group and control group participants were retrieved by EOne from the Nova Scotia Power (NS Power) system. The data consisted of bimonthly bills from 2017 to 2023. Before performing the billing analysis, the Evaluator validated the consumption load shapes for each treatment and control group participant to exclude those participants with inconsistent billing data. Data that matched the following criteria were excluded:

- › Nil consumption or missing data in the study period
- › Very high or very low peaks in the study period
- › Numerous abnormal variations in the consumption pattern (extremely high consumption months followed by close to zero consumption for instance)
- › Two bills covering the same billing period and indicating an end-year adjustment

For cases with three bills covering the same billing period, as these cases were usually recurrent for every billing period, it was assumed as being part of a time-of-use tariff, so the three entries were added up for each billing period.

After excluding the data that matched the above criteria, 542 treatment participants were retained for the next calculation steps. This means that about 40% of the sample was excluded, including 20% of participants who were omitted for having two bills over the same period. The customers kept in the billing analysis are from rate codes 02B and 03B, which represent the main rate codes in HEA.

Similar criteria were applied to the control group customers, and the sample remained largely sufficient for having a different match for each treatment group participant.

Control-Treatment Participant Matching

To determine the best suited control group participant for each treatment group participant, the Evaluator first applied a set of minimum conditions to comply:

- › The E assessment date of the control participant must be at least one year before the D assessment date of the treatment participant.
- › The weather station must be the same.
- › The heating type (with or without a heat pump) after the E assessment must be the same.

These conditions left treatment participants with more than one potential control participant. The following point system was then used to provide a score for each potential control participant. The control participant with the highest score was then considered the ideal match and was assigned to the given treatment participant. The point system is detailed in Table 1.

Table 1: Details on the Point System Used for the Selection of Control Participants

Parameters	Points
Average annual consumption of treatment and control candidates	Add a maximum of 2 points based on a function of the relative difference between the average annual consumption of treatment and control candidates using a sigmoid function that yields approximately the following points: › 2 points if difference is 10% › 1 point if difference is 25% › 0 points if difference is 50% or more
Residence size	› Add 1 point if the difference in residence size is ≤ 250 ft² › Add 0.5 points if the difference in residence size is ≤ 500 ft² › Otherwise, add 0 points
Construction year	› Add 1 point if the difference in construction year is ≤ 5 years › Add 0.5 points if the difference in construction year is ≤ 10 years › Otherwise, add 0 points

It should be noted that, each participant has different pre and post-program periods based on when participation in HEA occurred. Given this, each treatment group participant was assigned one control group participant, and the dates of the pre and post-periods of treatment participants were applied to the control participants for this match.

Weather Normalization

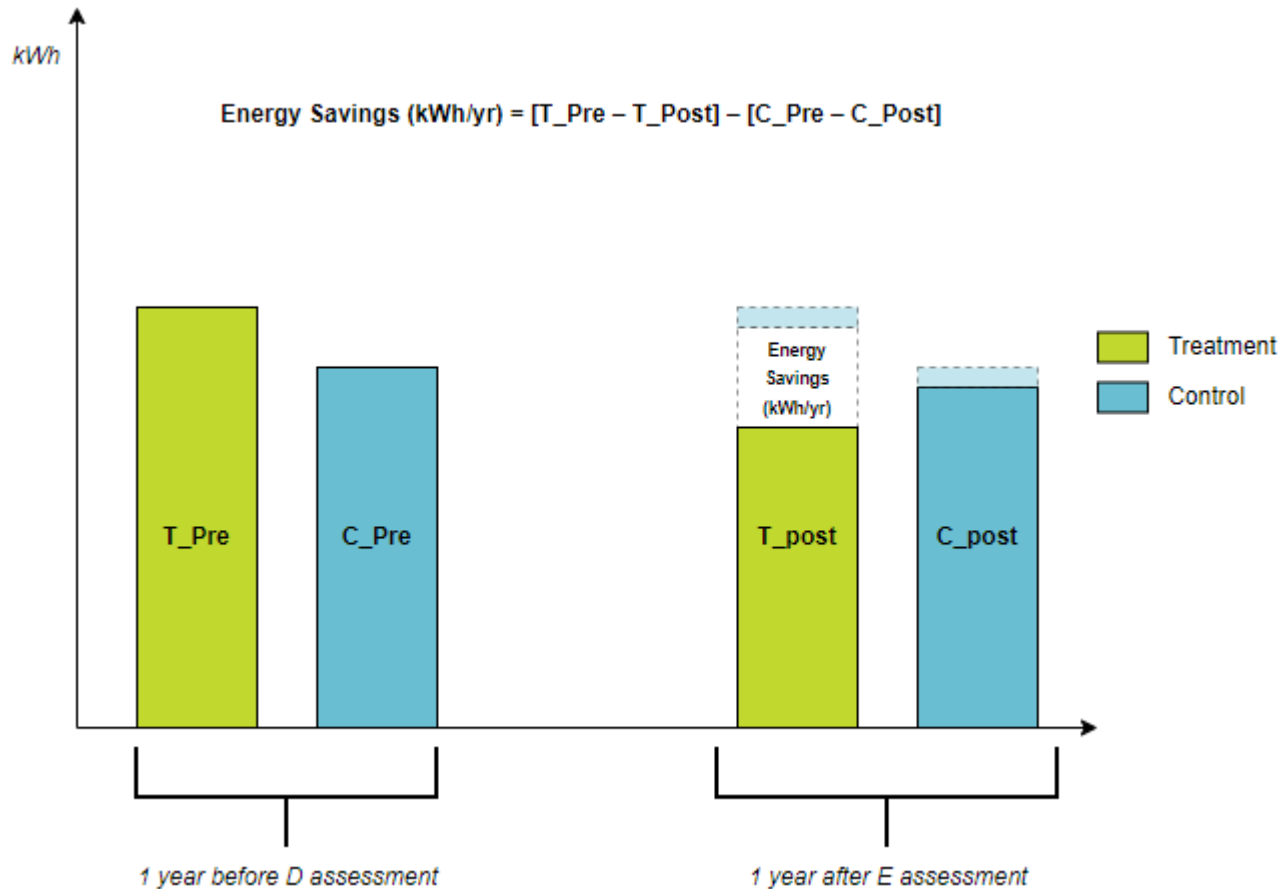
The Evaluator normalized the consumption values obtained from the electrical bills using normal weather data to obtain annual consumption values that are aligned with a typical meteorological year. A regression was used to determine how consumption related to heating and cooling degree days was associated with the weather station and billing dates of each control and treatment participant. Multiple iterations were made to select the most appropriate balance temperature to calculate the heating and cooling degree days.

Then, the normal heating and cooling degree days were included in each regression to obtain energy consumption during a typical weather year. The Evaluator calculated the normal heating and cooling degree days based on the previous 15 years (2008-2023) for the five weather stations selected for the analysis.

Energy Savings Calculation

Figure 1 below illustrates how energy savings were obtained by calculating the difference in the treatment group normalized annual consumption of each participant for the year before and after program participation and deducting the difference observed in the control group normalized annual consumption for the same period as the treatment participant to which the control participant was assigned.

Figure 1: Energy Savings Calculation Using Billing Data



- › Pre_T: Normalized annual consumption of the treatment participant for the year before the D assessment
- › Post_T: Normalized annual consumption of the treatment participant for the year after the E assessment
- › Pre_C: Normalized annual consumption of the assigned control participant for the year before the D assessment of the assigned treatment participant
- › Post_C: Normalized annual consumption of the assigned control participant for the year after the E assessment of the assigned treatment participant

Then, the energy savings were divided by the savings values obtained from HOT2000 to establish adjustment ratios.

$$\text{Adjustment Ratio} = \frac{\text{Energy Savings}}{\text{Modelled HOT2000 Savings}}$$

Results

Once the main steps of the billing analysis were completed, the Evaluator conducted several analyses to interpret the data but determined that the results were not conclusive.

Overall, the savings are very low, even negative for some of the scenarios analyzed. However, the Evaluator is not able to explain all the results that were obtained, thereby confirming savings with an acceptable level of certitude. For example, participants with lower electricity consumption in the pre-program period almost systematically see an increase in their post-program consumption. The following table presents the results analyzed for each heat pump scenario.

Table 2: Results Analyzed by Heat Pump Scenario

Scenario	Sample Size*	Pre-consumption (kWh/year)	Post-consumption (kWh/year)	Difference (kWh/year)
A participant who registered with a heat pump				
Treatment Group	163	16,854	17,498	(644)
Control Group	163	17,840	17,648	192
A participant who registered without a heat pump and then had one installed				
Treatment Group	309	16,898	16,184	715
Control Group	309	16,213	16,229	(16)
A participant who registered without a heat pump and who did not have one installed				
Treatment Group	41	16,185	16,096	89
Control Group	41	16,834	15,880	954

*29 pairs of treatment/control customers were removed from the analysis because they were missing either pre or post-normalized annual consumption data.

The Evaluator believes that part of the billing analysis results is likely due to savings not being as significant as expected. HOT2000 was already known for overestimating household consumption and, even if the results are not conclusive, they clearly point in that direction. If consumption values are overestimated, so can the savings, especially in the scenario wherein participants have a heat pump installed. As was the case with the ORs evaluated in previous evaluations, the results still tend to demonstrate that the overestimation is more significant when no heat pump is installed.

Other factors are potentially responsible for the inconclusive results, one being related to the interpretation of the billing data used for the analysis and another related to participants' behaviour potentially driven by the program (which means not offset by the control group). Without knowing the potential impact of the billing data interpretation on the results obtained, it is difficult to make conclusions about the impact of participant behaviour change.

The following subsection explains the different analyses conducted by the Evaluator to better understand the results and the effect of the billing data interpretation versus participant behaviour.



Billing Data Interpretation

EOne sent the Evaluator NS Power billing data to which it has access, and EOne answered the Evaluator's questions on data interpretation as best as they could, although several questions remained unanswered, and various elements lead the Evaluator to believe that the billing data could be misinterpreted or misused.

- › The billing data received for the study period (between 2018 and 2023 depending on participant participation dates) were bimonthly. EOne only has access to advanced metering infrastructure (AMI) data for the preceding six months. The transition to smart meters began in 2019 and continued through 2023, and the Evaluator questions if the reliability of the bimonthly billing data could have been negatively impacted during this transition period.
- › During the billing data preparation process, the Evaluator managed different scenarios that had to be interpreted and/or for which a decision had to be made on whether to keep or remove them from the billing data before conducting the billing analysis. These scenarios are as follows:
 - › Two bills covering the same billing period: Approximately half of the cases occurred at the end of a calendar year and were therefore interpreted by the Evaluator as end-year adjustments and removed from the sample. The other half were negative bills mostly associated with net metering rate codes (09 and 16). As mentioned in the Billing Data Preparation section above, the Evaluator decided to remove participants in this scenario from the sample. Combined, they represented approximately 20% of the initial sample.
 - › Three bills covering the same billing period: These cases usually occurred for every period so were assumed to be part of a time-of-use tariff with a bill for each rate (on-peak, off-peak, and standard rates). For each billing period, the three entries were added together.
 - › Two consecutive bills for two subsequent periods with the same average daily consumption value: The Evaluator was not able to understand this phenomenon that was observed for nine out of 10 participants and typically occurred at the end of a year. The bills were identified as actuals (not estimates) in most cases. This situation is one example of what the Evaluator believes might be related to the transition to AMI data.
 - › Approximately 20% of sampled participants presented a change in billing address although they had the same premise number (there are cases with three different addresses for the same premise number) during the study period (2018-2023).

It should also be noted that the Evaluator verified the impact of the weather normalization on results to ensure it was not a possible cause for the aforementioned inconclusive results. Globally, the normalization did not have a significant impact on the annual consumption results (under 5%).



Participant Behaviour

The other factors that add to the complexity of the data analysis are related to participant behaviour potentially driven by HEA. Indeed, HEA can generate effects other than the simple implementation of energy efficiency upgrades, such as behavioural changes. If these effects are generated by HEA, they will not be detected in the control group and will therefore not be deducted. The Evaluator knew that these effects were possible and added questions in the HEA survey to better understand their importance. However, the Evaluator did not expect that they would have a significant enough impact to result in negative or very low savings.

The main potential behaviour change is related to the use of supplemental heating. For the billing analysis, the Evaluator selected participants who were 100% electrically heated according to HOT2000. The Evaluator knows that this criterion does not consider supplemental heating such as wood stoves and fireplaces. The presence of such systems is tracked in HOT2000 but not considered in the modelled energy consumption as it is very dependent on homeowner behaviour. Therefore, there is no information available on the usage of supplemental heating systems before and after participation in HEA. Approximately half of sampled participants were identified as having a supplemental heating system in their house, mainly wood stoves. The installation of a heat pump through HEA can lead to reducing the use of supplemental heating systems like wood stoves and increasing electricity consumption. The savings resulting from the installation of a heat pump would therefore not be visible when only analyzing electricity bills since the replacement of wood heating with electrical heating would overshadow the increase in electrical efficiency. In such cases, an electricity billing analysis cannot accurately estimate savings since the baseline is not the previous electricity consumption.

The Evaluator also identified other behaviour changes that could have an impact on results, such as major renovations conducted at the same time as implementing energy efficiency upgrades as part of HEA or the addition of a cooling load resulting from the installation of a heat pump. The 2023 participant survey conducted as part of this evaluation revealed that:

- › A majority (72%) of participants implemented their energy efficiency upgrades in the context of an extension to their house (45%) or a major renovation (27%)
- › Three quarters (76%) of participants did not have a working air conditioner in their home prior to their participation in HEA

The survey also confirmed that about half of participants had a supplemental heating system in their house (23% wood stoves, 23% fireplaces, and 7% both). Among those participants, survey answers vary as if the usage of their supplemental heating system changed after the installation of their energy efficiency upgrades, but about one third declared changing their behaviour by using it less.

It should be noted that these survey results were obtained from 2023 HEA participants who were not included in the billing analysis, but this still indicates a trend in behaviour changes when customers participate in HEA.

2023 Savings Calculation Approach

Given the inconclusive results obtained through the billing analysis performed as part of this evaluation, the Evaluator considers it appropriate to keep using the current savings calculation methodology and ORs. The ORs already take into account the fact that HOT2000 overestimates consumption values and therefore savings. However, the billing analysis conducted as part of this evaluation seems to demonstrate that savings could be even lower than the savings obtained after applying the ORs. Moreover, without a clear understanding of how to interpret the billing data and the impact of HEA on behaviour changes, it is not possible to establish more accurate savings calculation parameters.

The Evaluator considered using parameters from other jurisdictions that have recently conducted a billing analysis for similar programs. This is the case for NB Power whose 2022/2023 Total Home evaluation resulted in energy savings based on participant billing data to be significantly lower than those modelled in HOT2000. While adjustment ratios were established as part of the NB Power 2022/2023 Total Home evaluation, the evaluation report still recommends further investigations to explain the results.

Going forward, the Evaluator recommends continuing the investigation on the inconclusive billing analysis results to determine if billing data are partly responsible for the inconclusive results and to what extent behaviour changes impact these results. Once this step is completed, the Evaluator should work with EOne to establish the most appropriate impact evaluation approach for the 2024 evaluation. Given the findings from this evaluation, it would not be acceptable to use the current ORs beyond 2023.

APPENDIX V

HEA Algorithm for Free-ridership Calculations

Table 1: Free-Ridership Algorithm for Solar PV

C3. If you had not received the rebate from Efficiency Nova Scotia, would you have paid the full cost of your solar PV system? (Scale 0 to 10)	C3 = Answer x 10% IF DK OR REF: C3 = EMPTY
C4. If there was no solar PV rebate, what is the likelihood that you would have installed a solar PV system? (Scale 0 to 10)	C4 = Answer x 10% IF DK OR REF: C4 = EMPTY
C5. If there was no solar PV rebate, what is the likelihood that you would installed the same number of panels or the same capacity of solar PV system? (Scale 0 to 10)	C5 = Answer x 10% IF DK OR REF: C5 = EMPTY
PA1 Score	MEAN VALUE OF: (C3; MIN(C4; C5))
C1. Had you already decided to install a solar PV system before you heard about the rebate available?	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 solar PV rebate, you had already made the decision to install a solar PV system?	IF 1. Yes: C2 = 100% IF 2. No OR DK OR REF: C2 = 0%
PA2 Score	C2
C7. Level of influence (Scale 0 to 10)	C7 = MAX(C7a; C7b; C7c)
PA3 Score	(10 – C7) x 10%
C6. If there was no solar PV rebate, what is the likelihood that you would have postponed your solar PV installation by at least one year?	C6 = (10 – Answer) x 10% IF DK OR REF: C6 = EMPTY
PA4 Score	C6
Inconsistency Test PA1	IF ABS (C3 – MIN (C4; C5)) ≥ 50% PA1 = MIN (C3; C4; C5)
Inconsistency Test PA2	IF C2 = 100% and C3 < 70% PA2 = EMPTY
Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)
F1. Before participating in the Home Energy Assessment program in 2023, had you at any time in the past participated in any Efficiency Nova Scotia program? F2. [IF F1=1] Your previous participation in an Efficiency Nova Scotia program was a major factor in your decision to install energy efficient upgrades in your home. 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. 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. F5. Before participating in the Home Energy Assessment program in 2023, had you at any time in the past seen Efficiency Nova Scotia advertisements or information discussing the benefits of energy efficiency?	Cross-influence (CI) = IF(F2 OR F6=Agree; 1) + IF(F3 OR F7=Agree; 1) + IF(F4 OR F8=Agree; 1)

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] Solar PV in your home. 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. 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.	
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 Heat Pump and No Other Energy-efficient Upgrades

Series A: Questions on the decision to install a heat pump	
D1. Had you already decided to install a heat pump before you had your home evaluated by an energy advisor?	IF 1. Yes: Use D2 IF 2. No OR DK OR REF: D2 = 0%
D2. [IF D1=1] Just to confirm: before you had your home evaluated by an energy advisor, you had already made the decision to install a heat pump to heat your home?	IF 1. Yes: D2 = 100% IF 2. No OR DK OR REF: D2 = 0%
D3/D4. If there were no program, which of the following actions would you have taken? 1. Kept your existing heating system 2. Kept your existing heating system and purchased an air conditioner 3. Purchased a new non-electric heating system (for example, oil or gas system) 4. Purchased a new non-electric heating system and an air conditioner 5. Purchased a heat pump	IF 1, 2, 3 or 4: D5 = 0% AND END IF 5: ASK D5
D5. If there were no program, what is the likelihood that you would have postponed the purchase of a heat pump by at least one year?	D5 = (10 – Answer) x 10% IF DK OR REF: D5 = EMPTY
PA1 Score (Series A)	MEAN VALUE OF: (D2; D5)
Series B: Questions on the decision to install a high-efficiency heat pump	
D6. Were you aware that high efficiency heat pumps that operate at temperatures below -15°C were available before you had your home evaluated by an energy advisor?	If 1. Yes: Use D7 IF 2. No, DK OR REF: D7 = 0% and END
D7. [IF D6=1] Before you had your home evaluated by an energy advisor, had you already made the decision to install a high-efficiency heat pump model?	IF 1. Yes: D7 = 100% IF 2. No, DK OR REF: D7 = 0%
D8. If you had not received the rebate from Efficiency Nova Scotia, would you have paid the total cost of your high-efficiency heat pump?	D8 = Answer x 10% IF DK OR REF: D8 = EMPTY
D9. Level of influence (Scale 0 to 10)	D9 = (10- MAX(D9a; D9b;D9c)) x 10%
PA2 Score (Series B)	IF PA1<=50% OR D6<>1: PA2 = 0%, OTHERWISE, MEAN VALUE OF: (D7; D8; D9)
Inconsistency Test PA2	IF D7 = 100% and D8 < 70% D7 = EMPTY

Free-Ridership	0.75xPA1+0.25xPA2
F1. Before participating in the Home Energy Assessment program in 2023, had you at any time in the past participated in any Efficiency Nova Scotia program? F2. [IF F1=1] Your previous participation in an Efficiency Nova Scotia program was a major factor in your decision to install energy efficient upgrades in your home. 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. 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. F5. Before participating in the Home Energy Assessment program in 2023, had you at any time in the past seen Efficiency Nova Scotia advertisements or information discussing the benefits of energy efficiency? 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] heat pump in your home. 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. 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.	Cross-influence (CI) = IF(F2 OR F6=Agree; 1) + IF(F3 OR F7=Agree; 1) + IF(E4 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 Other/Multiple EE Upgrades

E3. If you had not received the rebate from Efficiency Nova Scotia, would you have paid the entire cost of your EE upgrade (Scale 0 to 10)	E3 = Answer x 10% IF DK OR REF: E3 = EMPTY
E4. If there were no program, what is the likelihood that you would have installed exactly the same quantity of energy efficiency upgrades that were installed through the program?	E4 = Answer x 10% IF DK OR REF: E4 = EMPTY
PA1 Score	MEAN VALUE OF: (E3; E4)
E1. Did you already have plans to install the energy efficient upgrades that were installed through the program, BEFORE having your home evaluated by an energy advisor?	IF 1 Or 2 Yes: Use E2 IF 3. No OR DK OR REF: E2 = 0%
E2. Just to confirm: Before you had your home evaluated by an energy advisor, you had already made the decision to install [all/some of] the energy efficiency upgrades that were installed through the program?	IF 1. Yes: E2 = 100% IF 2. No OR DK OR REF: E2 = 0%
PA2 Score	E2
E8. Level of influence (Scale 0 to 10)	E8 = MAX(E8a; E8b, E8c)

PA3 Score	(10 – E8) x 10%
E5/E6. If there were no program, which of the following actions would you have taken? 1. Kept your existing heating system 2. Kept your existing heating system and purchased an air conditioner 3. Purchased a new non-electric heating system (for example, oil or gas system) 4. Purchased a new non-electric heating system and an air conditioner 5. Purchased a heat pump	IF 1, 2, 3 or 4: E7 = 0% AND END IF 5: ASK E7
E7. If there was no Green Heat program, what is the likelihood that you would have postponed installing the EE upgrades by at least one year?	E7 = (10 – Answer) x 10% IF DK OR REF: E7 = EMPTY
PA4 Score:	E7
Inconsistency Test PA1	IF ABS (E3 – E4) ≥ 50% PA1 = MIN (E3; E4)
Inconsistency Test PA2	IF 2E = 100% and E3 < 70% PA2 = EMPTY
Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)
F1. Before participating in the Home Energy Assessment program in 2023, had you at any time in the past participated in any Efficiency Nova Scotia program? F2. [IF F1=1] Your previous participation in an Efficiency Nova Scotia program was a major factor in your decision to install energy efficient upgrades in your home. 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. 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. F5. Before participating in the Home Energy Assessment program in 2023, had you at any time in the past seen Efficiency Nova Scotia advertisements or information discussing the benefits of energy efficiency? 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] EE upgrades in your home. 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. 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.	Cross-influence (CI) = IF(F2 OR F6=Agree; 1) + IF(F3 OR F7=Agree; 1) + IF(F4 OR F8=Agree; 1)

APPENDIX VI

HEA Spillover

Table 1: Spillover

INTRO. G Section asked to participants who have not implemented all the energy efficiency upgrades recommended in their assessment report through HEA.	IF Upgrades left: CONTINUE IF All upgrades were implemented through HEA :END
G1. Since the time that you participated in HEA, have you installed one or more of the recommended upgrades on your own ?	IF Yes: CONTINUE IF No OR DK OR REF : END
G3. Have you received financing or rebates from other Efficiency Nova Scotia programs for the energy efficiency upgrades you installed on your own after participating in HEA?	IF No: CONTINUE IF Yes OR DK OR REF : END
G2. Which upgrades have you installed on your own after participating in HEA?	G2 = SUM (kWh associated with each upgrade)
Additional Upgrade Savings:	G2
G4. How influential was your experience with HEA on your decision to install some or all of the measures that you installed on your own after participating in HEA? (Scale 0 to 10)	G4 = Answer x 10%
Attribution Level:	G4
Spillover Savings:	G2 x G4
Final Spillover Level = $\frac{\text{SUM of (G2 x G4) for All Respondents}}{\text{SUM of Program Savings for All Respondents}}$	



APPENDIX VII

HEA Reporting Requirements

HEA incentives originate from two sources of funding and are thus reported to two different parties via the 2022 DSM Evaluation and 2021/22 Province of Nova Scotia (PNS) Evaluation Reports. The DSM evaluation is focused on reporting electrical savings funded by electrical DSM funds, while the PNS evaluation is focused on participation and GHG emission reductions generated from 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 incorporation of the Canada Greener Homes Initiative, as a co-funder of energy assessments and measures for both DSM and PNS funding, has not changed anything in the reporting structure.

The equations presented in Table 1 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 pumps, 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_HeatingD and Elec_HeatingE) obtained from HOT2000 during the D and E assessments
- › Total space heating energy consumption (Total_HeatingD and Total_HeatingE) obtained from HOT2000 during the D and E assessments
- › Savings from space heating equipment and that are not modelled in HOT2000 (Non-modelled Heating Savings). These savings are reported in either the HEA DSM Evaluation Report or PNS Evaluation Report depending on the baseline heating system.

It should be noted that solar photovoltaic (PV) measures are excluded from these equations. All solar PV measures are claimed in the DSM Report as they offset electricity use.

Table 1: Reporting Requirements for Different Energy Savings 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 Report
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 funded by PNS funding, not DSM funding.	The savings are included in 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 with no PNS funding.

¹ To simplify the equations in Table 1, overestimation ratios are omitted.



APPENDIX VIII

HEA 2023 Recommendations

This appendix summarizes all the recommendations made by the Evaluator as part of the 2023 HEA evaluation.

Section	Recommendations
Executive Summary	Recommendation #1: Continue exploring the factors potentially responsible for the inconclusive billing analysis results, one being related to billing data interpretation, and work with the Evaluator to define the impact evaluation approach to be taken in 2024. Depending on the answers obtained through the exploration process, options other than a billing analysis may need to be considered for the 2024 evaluation. Given the change in the characteristics of participants entering the program component since 2018, the Evaluator does not consider it acceptable to use the current OR beyond 2023.

APPENDIX IX

Green Heat Participant Survey Questionnaire

HEATING SYSTEM REBATES (GREEN HEAT)

PARTICIPANT SURVEY

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Telephone participant survey
Estimated Time to Complete	20 min
Target Audience	Participant who purchased home heating equipment
Expected Number of Completions	130 (70 MSHP, 30 biomass (pellet stove, wood fireplace insert, wood stove) and 30 demand-response (electric thermal storage unit))
Contact List Source	2023 Green Heat tracking sheet
Fielding Firm	Narrative Research
Estimated Timeline for fielding	End September-October

Table 2: Research Objectives and Associated Sections

Research Objectives	Section
Verification	A
Awareness and Motivations for Participating	B
Free-ridership – Mini-split Heat Pumps	C
Free-ridership – Biomass	D
Free-ridership – Demand Measures	E
Cross-influence	F
Satisfaction	G
HEA/Greener Homes	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 Heating System Rebates program, previously called the Green Heat 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 HOME HEATING EQUIPMENT, SUCH AS HEAT PUMPS, FURNACES, AND BOILERS.]

[IF NEEDED: THE SURVEY WILL TAKE ABOUT 20 MINUTES.]

[IF NEEDED: You may have recently been contacted by MQO 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.]

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 Heating System Rebates program. Is this correct?

1. Yes [CONTINUE TO A4]
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]**
98. Don't know/Refused [**PROBE:** “Is there someone else in your household who would know about having participated in the Heating System Rebates 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 Heating System Rebates 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 A4]**
 4. No, I only installed a **<EQUIPMENT 2>** **[CONTINUE TO A4]**
 98. Don't know/Refused **[PROBE: "Is there someone else in your household who would know about having participated in the Heating System Rebates 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 YES AT A2 = 1 OR 2 AFTER PROMPT]** 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.**
- A4. **[ASK IF EQUIPMENT = ELECTRIC THERMAL STORAGE]** Can you please confirm that your electricity rate with Nova Scotia Power is a time-of-day rate? **[DO NOT READ. SINGLE RESPONSE]**
- [IF NECESSARY: THE TIME-OF-DAY RATE INVOLVES A LOWER PRICE PER KILOWATT HOUR BETWEEN 11 PM AND 7 AM THAN DURING THE REST OF THE DAY]**
1. Yes
 2. No
 98. Don't know
- A5. **[IF A4 = 2]** What rate are you on?
96. Specify: _____

B. Awareness and Motivations for Participating

B1. How did you first become aware of the Heating System Rebates program? **[DO NOT READ. SINGLE RESPONSE]**

1. In-store signage
2. Retailer flyer
3. Email
4. Through a contractor or installer
5. Through a retailer or distributor
6. Efficiency Nova Scotia website
7. Nova Scotia Power
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 the Heating System Rebates program? **[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
 12. Simpler than the Home Energy Assessment Program / Greener Homes Grant
 13. I wasn't making enough energy efficiency changes to make it worth my while to choose the Home Energy Assessment Program / Greener Homes Grant
 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 RESPONSES. PIPE BACK CODES FROM B2 BUT DO NOT SHOW RESPONSE FROM B2]**
97. **[EXCLUSIVE]** None/no other reasons
 98. **[EXCLUSIVE]** Don't know
 99. **[EXCLUSIVE]** Refused
- B4. **[ASK IF EQUIPMENT = ELECTRIC THERMAL STORAGE]** What was the SINGLE most important reason you were interested in installing an **ELECTRIC THERMAL STORAGE** in your home? **[SINGLE RESPONSE] [DO NOT READ]**
1. To benefit from time-of-day rates
 2. To save on energy/to save on energy costs
 3. To have a backup heating source
 4. For better comfort
 5. To make home more energy efficient
 6. To get the rebate offered by Efficiency Nova Scotia
 7. The environmental aspect
 96. Other [SPECIFY: _____]
 98. Don't know
 99. Refused

B5. **[ASK IF EQUIPMENT IS A MINI-SPLIT HEAT PUMP]** Have you ever heard of Electric thermal storage, or ETS?

[IF NECESSARY: ETS IS AN ELECTRIC HOME HEATING DEVICE CONTAINING CERAMIC BRICKS THAT CAN HELP LOWER YOUR HEATING COSTS BY STORING HEAT WHEN ELECTRICITY COSTS LESS, AND THEN RELEASING THE HEAT THROUGHOUT THE DAY.]

- 1. Yes, have heard of ETS
- 2. No, have not heard of ETS
- 98. Don't know
- 99. Refused

B6. **[ASK IF EQUIPMENT IS A MINI-SPLIT HEAT PUMP]** And have you ever heard of Nova Scotia Power's time-of-day rate?

[IF NECESSARY: THE TIME-OF-DAY RATE INVOLVES A LOWER PRICE PER KILOWATT HOUR BETWEEN 11 PM AND 7 AM THAN DURING THE REST OF THE DAY]

- 1. Yes, have heard of Nova Scotia Power's time-of-day rate
- 2. No, have not heard of Nova Scotia Power's time-of-day rate
- 98. Don't know
- 99. Refused

C. Free-Ridership – Mini-split Heat Pumps

[ASK C1 TO C10 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. Prior to installing your heat pump, did you already have a working air conditioner in your home?

- 1. Yes
- 2. No
- 98. Don't Know
- 99. Refused

- C2. Had you already decided to install a heat pump before you heard about the Heating System Rebates program?
1. Yes
 2. No
 98. Don't know
 99. Refused
- C3. **[IF C2=1]** Just to confirm: before you learned about the Heating System Rebates program, you had already made the decision to install a heat pump to heat your home?
1. Yes
 2. No
 98. Don't know
 99. Refused
- C4. **[IF C1= 2, 98,99 AND C2=2, 98, 99 OR C3=2, 98, 99]** If there were no Heating System Rebates 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. Kept your existing heating system and purchased an air conditioner **[GO TO G SECTION]**
 3. Purchased a new non-electric heating system (for example, oil or gas system) **[GO TO G SECTION]**
 4. Purchased a new non-electric heating system and an air conditioner **[GO TO G SECTION]**
 5. Purchased a heat pump
- [VOLUNTEERED]**
98. Don't know **[GO TO G SECTION]**
 99. Refused **[GO TO G SECTION]**
- C5. **[IF C1= 1 AND C2=2, 98, 99 OR C3=2, 98, 99]** If there were no Heating System Rebates 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 non-electric heating system (for example, oil or gas system) **[GO TO G SECTION]**
 3. Purchased a heat pump
- [VOLUNTEERED]**
98. Don't know **[GO TO G SECTION]**
 99. Refused **[GO TO G SECTION]**

- C6. **[IF C3=1 OR C4=5 OR C5=3]** If there were no Heating System Rebates 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 “Definitely not” and 10 is “Definitely.” **[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 Heating System Rebates 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.

- C7. Were you aware that high efficiency heat pumps that operate at temperatures below -15°C were available before you heard about the Heating System Rebates program?

- 1. Yes
- 2. No
- 98. Don't know
- 99. Refused

- C8. **[IF C7=1]** Before you heard about the Heating System Rebates program, had you already made the decision to install a high-efficiency heat pump model?

- 1. Yes
- 2. No
- 98. Don't know
- 99. Refused

- C9. 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

- C10. 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 __Refused
b. Information on the benefits of high efficiency heat pumps provided by Efficiency Nova Scotia	__ Response __98 Don't Know __Refused
c. Information on the benefits of high efficiency heat pumps provided by the retailers or contractors	__ Response __98 Don't Know __Refused

D. Free-Ridership – Biomass

[ASK D1 TO D7 IF EQUIPMENT = WOOD STOVE, PELLET STOVE, WOOD FURNACE OR WOOD FIREPLACE IN SAMPLE]

- D1. Moving along to another topic... Had you already decided to install a **<EQUIPMENT>** before you heard about the Heating System Rebates program?

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

- D2. **[IF D1=1]** Just to confirm: before you decided to participate in the Heating System Rebates program, you had already made the decision to install a **<EQUIPMENT>**?

1. Yes
2. No
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 Heating System Rebates 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 were no Heating System Rebates 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

- D5. If there were no Heating System Rebates 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 were no Heating System Rebates 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 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 __Refused
b. Information provided by Efficiency Nova Scotia	__ Response __98 Don't Know __Refused

E. Free-ridership – Demand Measures

[ASK E1 TO E7 IF EQUIPMENT = ELECTRIC THERMAL STORAGE]

- E1. **[ASK IF A4=1]** You mentioned earlier that your electricity rate with Nova Scotia Power is a time-of-day rate. Among the following three choices, which one best describes your decision-making process with regards to taking-part in the time-of-day rate with Nova Scotia Power: [READ]
1. You had already decided to apply to the time-of-day rate and only after that did you hear about the Heating System Rebates Rebate on **<EQUIPMENT>**
 2. You learned of the time-of-day rate through Heating System Rebates and because of that you decided to apply for the rate
 3. You had considered applying for the time-of-day rate, and the Heating System Rebates rebate on **<EQUIPMENT>** confirmed your decision
- [VOLUNTEERED]**
98. Don't know
99. Refused
- E2. Had you already decided to install a **<EQUIPMENT>** before you heard about the Heating System Rebates program?
1. Yes
 2. No
98. Don't know
99. Refused
- E3. **[IF E2=1]** Just to confirm: before you decided to participate in the Heating System Rebates program, you had already made the decision to install a **<EQUIPMENT>**?
1. Yes
 2. No
98. Don't know
99. Refused
- E4. 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 Heating System Rebates 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 E5 TO E7 SEQUENCE IN ORDER/DO NOT RANDOMIZE]

- E5. **[ASK IF A4=1]** If there were no Heating System Rebates program, what is the likelihood that you would still have applied for NS Power’s Time-of-Day Rate and installed a <EQUIPMENT>?

0-10 SCALE WITH END POINT LABELS – RECORD NUMBER

[VOLUNTEERED]

98. Don’t Know
99. Refused

- E6. If there were no Heating System Rebates 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 three 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 __ Refused
b. Information provided by Efficiency Nova Scotia	__ Response __ 98 Don’t Know __ Refused
c. The bill savings available through Nova Scotia Power’s time-of-day rate	__ Response __ 98 Don’t Know __ Refused

F. Cross-Influence

[READ AND ROTATE (F1 + F2 TO F4) AND (F5 + F6 TO F8) SEQUENCES]

- F1. Before participating in the Heating System Rebates program in 2023, had you at any time in the past participated in any Efficiency Nova Scotia program or service?
1. Yes
2. No
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 Heating System Rebates program in 2023, 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
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. **[NET PROMOTER SCORE]** Using a 0 to 10 scale, where 0 means "Definitely would not" and 10 means "Definitely would", what is the likelihood that you recommend the Heating System Rebates program to a friend or colleague?

[0-10 SCALE WITH END POINT LABELS– RECORD NUMBER]

98. Don't Know/Don't recall
99. Refused

- G2. Using a scale from 0 to 10 where 0 is “Not at all satisfied” and 10 is “Completely satisfied”, how would you rate your satisfaction with the Heating System Rebates program overall? **[RECORD NUMBER. DO NOT ACCEPT A RANGE]**.

[0-10 SCALE WITH END POINT LABELS– RECORD NUMBER]

- 98. Don't Know
- 99. Refused

- G3. **[IF H2<8]** What was the main reason you were not more satisfied with the program overall? **[PROBE FOR SPECIFIC REASON. RECORD FIRST MENTION AND THEN ACCEPT MULTIPLE RESPONSES KEEPING CODE 98 EXCLUSIVE]**

- 96. **RECORD VERBATIM:** _____
- 98. Don't know
- 99. Refused

- G4. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Heating System Rebates program? Please indicate if any are not applicable to you. **[DO NOT RANDOMIZE] [RECORD NUMBER. DO NOT ACCEPT A RANGE]**

- a. The clarity of program requirements, that is, the eligibility requirements
- b. The program application process
- c. The amount of the rebate
- d. The time required to receive rebate
- e. The equipment installed in your home
- f. The selection of equipment eligible for the rebate
- g. Any communications you had with Efficiency Nova Scotia
- h. The website of the Heating System Rebates program

[0-10 SCALE WITH END POINT LABELS– RECORD NUMBER]

- 97. Not applicable
- 98. Don't Know/Don't recall
- 99. Refused

G5. Using a scale of 0 to 10, where 0 is “Completely disagree” and 10 is “Completely agree”, how strongly do you agree or disagree with the following two statements about the Heating System Rebates application form? **[RECORD NUMBER. DO NOT ACCEPT A RANGE]**

- a. The Heating System Rebates application form was easy to complete.
- b. The instructions on how to fill out the Heating System Rebates application form were simple to understand.

[0-10 SCALE WITH END POINT LABELS– RECORD NUMBER]

- 97. Not applicable
- 98. Don't Know/Don't recall
- 99. Refused

G6. What, if any, difficulties did you have with your Heating System Rebates application?

- 96. ____ (specify)
- 97. None
- 98. Don't Know/Don't recall
- 99. Refused

H. HEA/Greener Homes

[DO NOT ASK SECTION H IF <EQUIPMENT> = ELECTRIC THERMAL STORAGE]

H1. Moving along ... Before today, did you know of, or had you ever heard of Efficiency Nova Scotia's Home Energy Assessment Program? The program provides rebates on heat pumps, insulation, draft-proofing, windows and doors, etc. to make your home more energy efficient. An advisor will first assess your home to see where it is losing heat and provide recommendations for improvements that can help you save energy. Through this program, you may also be eligible to receive federal funding from the Canada Greener Homes Grant.

- 1. Yes, had previously heard of this program
- 2. No, had not previously heard of this program **[GO TO SECTION I]**
- 98. (Don't know) **[GO TO SECTION I]**
- 99. (Refused) **[GO TO SECTION I]**

H2. **[ASK IF H1= YES]** How did you find out about the Home Energy Assessment Program? Any other ways? **[DO NOT READ. MULTIPLE RESPONSES. NOTE THE FIRST MENTION SEPARATELY AND THEN ALL OTHERS]**

1. Radio ads
2. Print ads (magazine or newspaper)
3. In-store signage
4. Retailer flyer
5. Email
6. Through a contractor or installer
7. Through a retailer or distributor
8. Efficiency Nova Scotia website
9. Word of mouth
10. Online advertisement on smart phone, computer or tablet
11. Saw an advertisement – general
12. Online
13. Social Media (e.g., Facebook, Twitter, Instagram, Snapchat, TikTok, YouTube, etc.)
14. Through another Efficiency Nova Scotia program
96. Other [SPECIFY: _____]
98. (Don't know)
99. (Refused)

H3. **[ASK IF H1=YES]** Did you ever consider participating in the Home Energy Assessment Program instead of Heating System Rebates to get a rebate for your **[INSERT EQUIPMENT]** purchase?

1. Yes, had considered this
2. No, had not considered this **[GO TO SECTION I]**
98. (Don't know) **[GO TO SECTION I]**
99. (Refused) **[GO TO SECTION I]**

H4. **[ASK IF H3=YES]** What factors helped you decide to take part in the Heating System Rebates Program instead of the Home Energy Assessment Program? Anything else? **[PROBE FOR MULTIPLE RESPONSES]**

[DO NOT READ]

1. My contractor or installer
2. An Efficiency Nova Scotia Energy Solutions advisor
3. Shorter wait times with Heating System Rebates
4. Heating System Rebates is simpler to understand than the Home Energy Assessment Program
5. I discussed options with friends/family/entourage
6. I knew someone who'd participated in Heating System Rebates
7. I knew someone who'd participated in the Home Energy Assessment Program and they did not have a good experience
96. Other [SPECIFY: _____]
98. (Don't know)
99. (Refused)

H5. **[ASK IF H3=YES]** Did you use any of the following to help you decide which program to participate in? Please answer yes or no to each. **[READ] [RANDOMIZE IF NO AUTOFILLS]**

- a. **[IF CODE 1 SELECTED AT H4, AUTOFILL AS YES]** Your contractor or installer
 - b. **[IF CODE 2 SELECTED AT H4, AUTOFILL AS YES]** An Efficiency Nova Scotia Energy Solutions advisor
-
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)



I. Recommendations for Program Improvements

- I1. Now thinking exclusively about the Heating System Rebates program, do you have any recommendations for improving the program? **[PROBE]** Anything else? **[DO NOT READ. ACCEPT MULTIPLE KEEPING CODE 97, 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. Advertise the program more or in a better way
 7. Improve the online portal
 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: _____]
 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]**
96. RECORD NUMBER: ____
 98. Don't know
 99. Refused

J3. How many individuals, including yourself, are part of your immediate household?

DO NOT ACCEPT RANGE – NUMBER MUST BE AT LEAST 1

96. Record Number: _____

97. Prefer not to say

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 last year? Stop me when I reach the right category. **[READ LIST; PERMIT ONE RESPONSE]**

1. Less than \$28,000
2. At least \$28,000 but less than \$39,000
3. At least \$39,000 but less than \$47,000
4. At least \$47,000 but less than \$54,000
5. At least \$54,000 but less than \$61,000
6. At least \$61,000 but less than \$100,000
7. \$100,000 or more

VOLUNTEERED

98. Don't know
97. Refusal/Prefer not to answer

J7. What is the language you speak most often at home? **[READ LIST ONLY IF NECESSARY ONE ANSWER ONLY]**

1. English
2. French
96. Other (Please specify: _____)

[VOLUNTEERED]

99. Refused

J8. **[DO NOT READ; BY OBSERVATION]** Gender:

1. Male
2. Female
96. Other

END: Those are all the questions I have for you. I thank you very much for your time and cooperation.
Have a nice day!

APPENDIX X

Green Heat Participant Survey Results

B1. Aware of the Heating System Rebates program

	2023	MSHP	Biomass	ETS (#)
Sample Size	124	90	29	5
Through a contractor or installer	23%	28%	7%	1
Word of mouth	22%	23%	14%	2
Online	15%	9%	31%	2
Through a retailer or distributor	13%	12%	17%	0
Through news media (e.g., TV news, newspaper, etc.	10%	13%	3%	0
Social Media (e.g., Facebook, X (formerly Twitter), Instagram, Snapchat, TikTok, YouTube, etc.)	4%	2%	10%	0
Saw an advertisement - general	3%	3%	3%	0
Online advertisement on smart phone, computer, or tablet	2%	0%	7%	0
Efficiency Nova Scotia website	2%	1%	3%	0
Retailer flyer	2%	2%	0%	0
I had a heat pump before	1%	1%	0%	0
In-store signage	1%	0%	3%	0
Other	2%	2%	0%	0
Don't know	2%	2%	0%	0

B2. What was the SINGLE most important reason you were interested in participating in the Heating System Rebates program?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
To get the rebate offered by Efficiency Nova Scotia	41%	39%	55%	0
To save on energy costs/To reduce my energy bill	32%	33%	21%	4
To save on energy/To make home more energy efficient	5%	3%	7%	1
To have a backup heating source	3%	3%	3%	0
For better comfort	3%	3%	3%	0
Wanted a better solar systems or home heating equipment	2%	2%	3%	0
Wanted air conditioning	2%	3%	0%	0
To replace another heat source	2%	2%	0%	0
Convenience/Ease of use/maintain	2%	2%	0%	0
Old system wasn't working properly	2%	2%	0%	0
The environmental aspect	1%	0%	3%	0
Other	4%	4%	3%	0
Don't know	1%	1%	0%	0

B3. Were there any other reasons?

	2023	MSHP	Biomass	ETS
Sample Size	123	89	29	5
To save on energy costs/To reduce my energy bill	12%	12%	7%	2
To save on energy/To make home more energy efficient	11%	13%	3%	1
Wanted air conditioning	7%	9%	0%	0
To get the rebate offered by Efficiency Nova Scotia	5%	3%	7%	1
Wanted a better solar systems or home heating equipment	4%	2%	7%	1
The environmental aspect	4%	2%	7%	1
For better comfort	4%	6%	0%	0
Convenience/Ease of use/maintain	2%	1%	3%	1
To have a backup heating source	2%	1%	7%	0
Old system wasn't working properly	2%	2%	0%	0
To heat the basement	1%	1%	0%	0
To replace another heat source	1%	1%	0%	0
Wanted wood stove/Like wood heat	1%	0%	3%	0
Other	2%	3%	0%	0
No other reasons	50%	52%	48%	1
Don't know	5%	3%	10%	0

Base: Respondents who indicated a single most important reason for participating in the heating systems rebates program.

B2/B3.What was the SINGLE most important reason you were interested in participating in Green Heat? Were there any other reasons?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
To get the rebate offered by Efficiency Nova Scotia	45%	42%	59%	1
To save on energy costs/To reduce my energy bill	40%	42%	24%	5
To save on energy/To make home more energy efficient	15%	17%	10%	1
Wanted air conditioning	8%	11%	0%	0
For better comfort	7%	9%	3%	0
Wanted a better solar systems or home heating equipment	6%	4%	10%	1
To have a backup heating source	6%	4%	10%	0
Convenience/Ease of use/maintain	4%	3%	3%	1
The environmental aspect	4%	2%	7%	1
Old system wasn't working properly	3%	4%	0%	0
To replace another heat source	2%	3%	0%	0
To heat the basement	1%	1%	0%	0
Wanted wood stove/Like wood heat	1%	0%	3%	0
Other	6%	7%	3%	0
Don't know	6%	4%	10%	0

B4. What was the SINGLE most important reason you were interested in installing an ELECTRIC THERMAL STORAGE in your home?

	2023	MSHP	Biomass	ETS
Sample Size	5	-	-	5
For better comfort	2	-	-	2
To benefit from time-of-day rates	2	-	-	2
To save on energy/to save on energy costs	1	-	-	1

Base: Respondents who installed electric thermal storage (ETS)

B5. Have you ever heard of Electric thermal storage, or ETS?

	2023	MSHP	Biomass	ETS
Sample Size	90	90	-	5
Yes, have ETS	61%	61%	-	5
No, have not ETS	39%	39%	-	0

Base: Respondents who installed a mini-split heat pump

B6. And have you ever heard of Nova Scotia Power's time-of-day rate?

	2023	MSHP	Biomass	ETS
Sample Size	90	90	-	-
Yes, have heard of Nova Scotia Power's time-of-day rate	78%	78%	-	-
No, have not heard of Nova Scotia Power's time-of-day rate	20%	20%	-	-
Don't know	2%	2%	-	-

Base: Respondents who installed a mini-split heat pump

C1. Prior to installing your heat pump, did you already have a working air conditioner in your home?

	2023	MSHP	Biomass	ETS
Sample Size	90	90	-	-
Yes	31%	31%	-	-
No	69%	69%	-	-

Base: Respondents who installed a mini-split heat pump

C2. Had you already decided to install a heat pump before you heard about the Heating System Rebates program?

	2023	MSHP	Biomass	ETS
Sample Size	90	90	-	-
Yes	79%	79%	-	-
No	20%	20%	-	-
Refused	1%	1%	-	-

Base: Respondents who installed a mini-split heat pump

C3. Just to confirm: before you learned about the Heating System Rebates program, you had already made the decision to install a heat pump to heat your home?

	2023	MSHP	Biomass	ETS
Sample Size	71	71	-	-
Yes	97%	97%	-	-
No	1%	1%	-	-
Refused	1%	1%	-	-

Base: Respondents who had decided to install a mini-split heat pump before learning about the Heating System Rebates Program

C2/C3 COMBINED. Had you already decided to install a heat pump before you heard about the Heating System Rebates program? Just to confirm: before you learned about the Heating System Rebates program, you had already made the decision to install a heat pump to heat your home?

	2023	MSHP	Biomass	ETS
Sample Size	90	90	-	-
Yes	78%	78%	-	-
No	21%	21%	-	-
Refused	1%	1%	-	-

Base: Respondents who installed a mini-split heat pump

C4. If there were no Heating System Rebates program, which of the following actions would you have taken?

	2023	MSHP	Biomass	ETS
Sample Size	14	14	-	-
Kept your existing heating system	36%	36%	-	-
Kept your existing heating system and purchased an air conditioner	21%	21%	-	-
Purchased a heat pump	36%	36%	-	-
Don't know	7%	7%	-	-

Base: Respondents who installed heat pumps but did not already have a working air-conditioner AND had not already decided to install a heat pump before learning about the Heating System Rebates Program

C5. If there were no Heating System Rebates program, which of the following actions would you have taken?

	2023	MSHP	Biomass	ETS
Sample Size	7	7	-	-
Kept your existing heating system	29%	29%	-	-
Purchased a heat pump	71%	71%	-	-

Base: Respondents who installed heat pumps but already had a working air-conditioner AND had not already decided to install a heat pump before learning about the Heating System Rebates Program

C6. If there were no Heating System Rebates 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 "Definitely not" and 10 is "Definitely."

	2023	MSHP	Biomass	ETS
Sample Size	79	79	-	-
10 - Definitely	15%	15%	-	-
9	3%	3%	-	-
8	4%	4%	-	-
7	8%	8%	-	-
6	1%	1%	-	-
5	9%	9%	-	-
4	0%	0%	-	-
3	3%	3%	-	-
2	3%	3%	-	-
1	3%	3%	-	-
0 - Definitely not	51%	51%	-	-
Don't know	1%	1%	-	-
Refused	1%	1%	-	-
LIKELY % (ratings of 8,9,10)	22	22	-	-
MEAN	3.3	3.3	-	-

Base: Respondents who already decided to install a heat pump before learning about the Heating System Rebates Program, OR those who would have still purchased a heat pump in the absence of the Heating Systems Rebates Program. Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

C6. If there were no Heating System Rebates 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 “Definitely not” and 10 is “Definitely.”

	2023	MSHP	Biomass	ETS
Sample Size	77	77	-	-
10 - Definitely	16%	16%	-	-
9	3%	3%	-	-
8	4%	4%	-	-
7	8%	8%	-	-
6	1%	1%	-	-
5	9%	9%	-	-
4	0%	0%	-	-
3	3%	3%	-	-
2	3%	3%	-	-
1	3%	3%	-	-
0 - Definitely not	52%	52%	-	-
LIKELY % (ratings of 8,9,10)	22	22	-	-
MEAN	3.3	3.3	-	-

Base: Respondents who already decided to install a heat pump before learning about the Heating System Rebates Program, OR those who would have still purchased a heat pump in the absence of the Heating Systems Rebates Program.

Responses of 'Don't know' and 'Refused' are excluded from the table

C7. Were you aware that high efficiency heat pumps that operate at temperatures below -15°C were available before you heard about the Heating System Rebates program?

	2023	MSHP	Biomass	ETS
Sample Size	79	79	-	-
Yes	70%	70%	-	-
No	27%	27%	-	-
Don't know	4%	4%	-	-

Base: Respondents who already decided to install a heat pump before learning about the Heating System Rebates Program, OR those who would have still purchased a heat pump in the absence of the Heating Systems Rebates Program.

C8. Before you heard about the Heating System Rebates program, had you already made the decision to install a high-efficiency heat pump model?

	2023	MSHP	Biomass	ETS
Sample Size	55	55	-	-
Yes	84%	84%	-	-
No	16%	16%	-	-

Base: Respondents who already decided to install a heat pump before learning about the Heating System Rebates Program, OR those who would have still purchased a heat pump in the absence of the Heating Systems Rebates Program AND who were aware that high-efficiency heat pumps operate to a temperature below -15°C.

C9. 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.”

	2023	MSHP	Biomass	ETS
Sample Size	79	79	-	-
10 - Definitely Would Have Paid	73%	73%	-	-
9	5%	5%	-	-
8	9%	9%	-	-
7	3%	3%	-	-
6	1%	1%	-	-
5	8%	8%	-	-
4	1%	1%	-	-
3	0%	0%	-	-
2	0%	0%	-	-
1	0%	0%	-	-
0 - Definitely Would Not Have Paid	0%	0%	-	-
WOULD PAY % (ratings of 8,9,10)	87	87	-	-
MEAN	9.2	9.2	-	-

Base: Respondents who installed mini-split heat pumps

Responses of 'Don't know' and 'Refused' are excluded from the table

C10A. 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...

The program rebate

	2023	MSHP	Biomass	ETS
Sample Size	79	79	-	-
10 - Great influence	16%	16%	-	-
9	3%	3%	-	-
8	11%	11%	-	-
7	6%	6%	-	-
6	3%	3%	-	-
5	14%	14%	-	-
4	6%	6%	-	-
3	5%	5%	-	-
2	5%	5%	-	-
1	1%	1%	-	-
0 - No influence	29%	29%	-	-
Don't know	0%	0%	-	-
Refused	0%	0%	-	-
IS INFLUENCE % (ratings of 8,9,10)	30	30	-	-
MEAN	4.6	4.6	-	-

Base: Respondents who installed mini-split heat pumps

Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

C10B. 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...

Information on the benefits of high efficiency heat pumps provided by Efficiency Nova Scotia

	2023	MSHP	Biomass	ETS
Sample Size	79	79	-	-
10 - Great influence	20%	20%	-	-
9	1%	1%	-	-
8	14%	14%	-	-
7	6%	6%	-	-
6	6%	6%	-	-
5	16%	16%	-	-
4	6%	6%	-	-
3	4%	4%	-	-
2	1%	1%	-	-
1	3%	3%	-	-
0 - No influence	22%	22%	-	-
Don't know	0%	0%	-	-
Refused	0%	0%	-	-
IS INFLUENCE % (ratings of 8,9,10)	35	35	-	-
MEAN	5.3	5.3	-	-

Base: Respondents who installed mini-split heat pumps

Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

C10C. 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...

Information on the benefits of high efficiency heat pumps provided by the retailers or contractors

	2023	MSHP	Biomass	ETS
Sample Size	79	79	-	-
10 - Great influence	42%	42%	-	-
9	8%	8%	-	-
8	18%	18%	-	-
7	5%	5%	-	-
6	4%	4%	-	-
5	8%	8%	-	-
4	3%	3%	-	-
3	3%	3%	-	-
2	4%	4%	-	-
1	1%	1%	-	-
0 - No influence	6%	6%	-	-
Don't know	0%	0%	-	-
Refused	0%	0%	-	-
IS INFLUENCE % (ratings of 8,9,10)	67	67	-	-
MEAN	7.5	7.5	-	-

Base: Respondents who installed mini-split heat pumps

Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

D1. Had you already decided to install a high efficiency <EQUIPMENT> before you heard about the Heating System Rebates program?

	2023	MSHP	Biomass	ETS
Sample Size	29	-	29	-
Yes	76%	-	76%	-
No	21%	-	21%	-
Don't know	3%	-	3%	-

Based: Respondents installed a wood stove, pellet stove, wood furnace or wood fireplace

D2. Just to confirm: before you decided to participate in the Heating System Rebates program, you had already made the decision to install a <EQUIPMENT>?

	2023	MSHP	Biomass	ETS
Sample Size	22	-	22	-
Yes	95%	-	95%	-
No	5%	-	5%	-

Based: Respondents installed a wood stove, pellet stove, wood furnace or wood fireplace AND already decided to install this equipment before hearing about the Heating System Rebates Program

D1/D2 COMBINED. Had you already decided to install a high efficiency <EQUIPMENT> before you heard about the Heating System Rebates program? Just to confirm: before you decided to participate in the Heating System Rebates program, you had already made the decision to install a <EQUIPMENT>?

	2023	MSHP	Biomass	ETS
Sample Size	29	-	29	-
Yes	72%	-	72%	-
No	24%	-	24%	-
Don't know	3%	-	3%	-

Based: Respondents installed a wood stove, pellet stove, wood furnace or wood fireplace

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."

	2023	MSHP	Biomass	ETS
Sample Size	29	-	29	-
MEAN	8.4	-	8.4	-

Based: Respondents installed a wood stove, pellet stove, wood furnace or wood fireplace
Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

D4. If there were no Heating System Rebates program, what is the likelihood that you would have installed an electrical heating system instead of the <EQUIPMENT> you installed through the program?

	2023	MSHP	Biomass	ETS
Sample Size	29	-	29	-
MEAN	3.6	-	3.6	-

Based: Respondents installed a wood stove, pellet stove, wood furnace or wood fireplace
Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

D5. If there were no Heating System Rebates program, what is the likelihood that you would have kept your old heating system instead of installing a new one?

	2023	MSHP	Biomass	ETS
Sample Size	29	-	29	-
MEAN	5.8	-	5.8	-

Based: Respondents installed a wood stove, pellet stove, wood furnace or wood fireplace
Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

D6. If there were no Heating System Rebates program, what is the likelihood that you would have postponed installing the <EQUIPMENT> by at least one year?

	2023	MSHP	Biomass	ETS
Sample Size	29	-	29	-
MEAN	4.1	-	4.1	-

Based: Respondents installed a wood stove, pellet stove, wood furnace or wood fireplace
Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

D7A. 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 program rebate

	2023	MSHP	Biomass	ETS
Sample Size	29	-	29	-
10 - Great influence	14%	-	14%	-
9	0%	-	0%	-
8	7%	-	7%	-
7	14%	-	14%	-
6	7%	-	7%	-
5	24%	-	24%	-
4	0%	-	0%	-
3	0%	-	0%	-
2	10%	-	10%	-
1	3%	-	3%	-
0 - No influence	21%	-	21%	-
Don't know	0%	-	0%	-
Refused	0%	-	0%	-
IS INFLUENCE % (ratings of 8,9,10)	21	-	21	-
MEAN	4.8	-	4.8	-

Based: Respondents installed a wood stove, pellet stove, wood furnace or wood fireplace
Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

D7B. 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”.

Information provided by Efficiency Nova Scotia

	2023	MSHP	Biomass	ETS
Sample Size	29	-	29	-
10 - Great influence	10%	-	10%	-
9	7%	-	7%	-
8	10%	-	10%	-
7	7%	-	7%	-
6	3%	-	3%	-
5	7%	-	7%	-
4	3%	-	3%	-
3	10%	-	10%	-
2	10%	-	10%	-
1	0%	-	0%	-
0 - No influence	31%	-	31%	-
Don't know	0%	-	0%	-
Refused	0%	-	0%	-
IS INFLUENCE % (ratings of 8,9,10)	28	-	28	-
MEAN	4.2	-	4.2	-

Based: Respondents installed a wood stove, pellet stove, wood furnace or wood fireplace
Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

E1. You mentioned earlier that your electricity rate with Nova Scotia Power is a time-of-day rate. Among the following three choices, which one best describes your decision-making process with regards to taking-part in the time-of-day rate with Nova Scotia Power:

	2023	MSHP	Biomass	ETS
Sample Size	5	-	-	5
You had already decided to apply to the time-of-day rate and only after that did you hear about the Heating System Rebates	1	-	-	1
You learned of the time-of-day rate through Heating System Rebates and because of that you decided to apply for the rate	1	-	-	1
You had considered applying for the time-of-day rate, and the Heating System Rebates rebate on confirmed your decision	3	-	-	3

Base: Respondents who installed ETS and who have a time-of-day rate with NSP

E2. Had you already decided to install a <EQUIPMENT> before you heard about the Heating System Rebates program?

	2023	MSHP	Biomass	ETS
Sample Size	5	-	-	5
Yes	3	-	-	3
No	2	-	-	2

Base: Respondents who installed ETS

E3. Just to confirm: before you decided to participate in the Heating System Rebates program, you had already made the decision to install a <EQUIPMENT>?

	2023	MSHP	Biomass	ETS
Sample Size	3	-	-	3
Yes	2	-	-	2
No	1	-	-	1

Base: Respondents who installed ETS AND who already decided to install ETS before hearing about the Heating System Rebates Program

E2/E3 COMBINED. Had you already decided to install a <EQUIPMENT> before you heard about the Heating System Rebates program? Just to confirm: before you decided to participate in the Heating System Rebates program, you had already made the decision to install a <EQUIPMENT>?

	2023	MSHP	Biomass	ETS
Sample Size	5	-	-	5
Yes	2	-	-	2
No	3	-	-	3

Base: Respondents who installed ETS

E4. 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."

	2023	MSHP	Biomass	ETS
Sample Size	5	-	-	5
MEAN	3.0	-	-	3.0

Base: Respondents who installed ETS

Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

E5. If there were no Heating System Rebates program, what is the likelihood that you would still have applied for NS Power's Time-of-Day Rate and installed a <EQUIPMENT>?

	2023	MSHP	Biomass	ETS
Sample Size	5	-	-	5
MEAN	2.6	-	-	2.6

Base: Respondents who installed ETS

Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

E6. If there were no Heating System Rebates program, what is the likelihood that you would have postponed installing the <EQUIPMENT> by at least one year?

	2023	MSHP	Biomass	ETS
Sample Size	5	-	-	5
MEAN	4.0	-	-	4.0

Base: Respondents who installed ETS

Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

E7A. I would like you to rate the influence of the following three 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 program rebate

	2023	MSHP	Biomass	ETS
Sample Size	5	-	-	5
10 - Great influence	4	-	-	4
9	0%	-	-	0
8	0%	-	-	0
7	1	-	-	1
6	0%	-	-	0
5	0%	-	-	0
4	0%	-	-	0
3	0%	-	-	0
2	0%	-	-	0
1	0%	-	-	0
0 - No influence	0%	-	-	0
IS INFLUENCE % (ratings of 8,9,10)	80	-	-	80
MEAN	9.4	-	-	9.4

Base: Respondents who installed ETS

Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

E7B. I would like you to rate the influence of the following three 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”.

Information provided by Efficiency Nova Scotia

	2023	MSHP	Biomass	ETS
Sample Size	5	-	-	5
10 - Great influence	2	-	-	2
9	0	-	-	0
8	0	-	-	0
7	0	-	-	0
6	0	-	-	0
5	2	-	-	2
4	0	-	-	0
3	0	-	-	0
2	0	-	-	0
1	0	-	-	0
0 - No influence	1	-	-	1
IS INFLUENCE % (ratings of 8,9,10)	40	-	-	40
MEAN	6.0	-	-	6.0

Base: Respondents who installed ETS

Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

E7C. I would like you to rate the influence of the following three 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 bill savings available through Nova Scotia Power’s time-of-day rate

	2023	MSHP	Biomass	ETS
Sample Size	5	-	-	5
10 - Great influence	4	-	-	4
9	1	-	-	1
8	0	-	-	0
7	0	-	-	0
6	0	-	-	0
5	0	-	-	0
4	0	-	-	0
3	0	-	-	0
2	0	-	-	0
1	0	-	-	0
0 - No influence	0	-	-	0
IS INFLUENCE % (ratings of 8,9,10)	100	-	-	100
MEAN	9.8	-	-	9.8

Base: Respondents who installed ETS

Responses of 'Don't know' and 'Refused' are excluded from the mean calculation

F1. Before participating in the Heating System Rebates program in 2023, had you at any time in the past participated in any Efficiency Nova Scotia program or service?

	2023	MSHP	Biomass	ETS
Sample Size	113	79	29	5
Yes	47%	47%	48%	2
No	51%	52%	48%	3
Don't know	2%	1%	3%	0

F2. Your previous participation in an Efficiency Nova Scotia program was a major factor in your decision to install [a/an] <EQUIPMENT> in your home.

	2023	MSHP	Biomass	ETS
Sample Size	53	37	14	2
Agree	26%	22%	43%	0
Disagree	72%	76%	57%	2
Don't know	2%	3%	0%	0

Base: Respondents have participated in an ENS program or service in the past

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.

	2023	MSHP	Biomass	ETS
Sample Size	53	37	14	2
Agree	49%	46%	57%	1
Disagree	51%	54%	43%	1

Base: Respondents have participated in an ENS program or service in the past

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.

	2023	MSHP	Biomass	ETS
Sample Size	53	37	14	2
Agree	57%	54%	57%	2
Disagree	43%	46%	43%	0

Base: Respondents have participated in an ENS program or service in the past

F5. Before participating in the Heating System Rebates program in 2023, had you at any time in the past seen Efficiency Nova Scotia advertisements or information discussing the benefits of energy efficiency?

	2023	MSHP	Biomass	ETS
Sample Size	113	79	29	5
Yes	84%	85%	86%	3
No	16%	15%	14%	2

F6. 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.

	2023	MSHP	Biomass	ETS
Sample Size	95	67	25	3
Agree	43%	45%	36%	2
Disagree	57%	55%	64%	1

Base: Respondents have seen advertisements or information from ENS in the past

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.

	2023	MSHP	Biomass	ETS
Sample Size	95	67	25	3
Agree	52%	55%	44%	1
Disagree	47%	45%	52%	2
Don't know	1%	0%	4%	0

Base: Respondents have seen advertisements or information from ENS in the past

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.

	2023	MSHP	Biomass	ETS
Sample Size	95	67	25	3
Agree	69%	73%	60%	2
Disagree	31%	27%	40%	1

Base: Respondents have seen advertisements or information from ENS in the past

G1. Using a 0 to 10 scale, where 0 means “Definitely would not” and 10 means “Definitely would”, what is the likelihood that you recommend the Heating System Rebates program to a friend or colleague?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
10 - Definitely would	75%	76%	72%	4
9	4%	4%	3%	0
8	9%	8%	14%	0
7	2%	2%	0%	0
6	2%	2%	0%	0
5	5%	4%	3%	1
4	1%	1%	0%	0
3	1%	0%	3%	0
2	0%	0%	0%	0
1	2%	2%	0%	0
0 - Definitely would not	1%	0%	3%	0
Don't know/Don't recall	0%	0%	0%	0
Refused	0%	0%	0%	0
LIKELY % (ratings of 8,9,10)	88	88	90	80
MEAN	9.1	9.2	8.9	9.0

Responses of 'Don't Know/Don't recall' and 'Refused' are excluded from the mean calculation

G1. Using a 0 to 10 scale, where 0 means “Definitely would not” and 10 means “Definitely would”, what is the likelihood that you recommend the Heating System Rebates program to a friend or colleague?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
10 - Definitely would	75%	76%	72%	4
9	4%	4%	3%	0
8	9%	8%	14%	0
7	2%	2%	0%	0
6	2%	2%	0%	0
5	5%	4%	3%	1
4	1%	1%	0%	0
3	1%	0%	3%	0
2	0%	0%	0%	0
1	2%	2%	0%	0
0 - Definitely would not	1%	0%	3%	0
LIKELY % (ratings of 8,9,10)	88	88	90	80
MEAN	9.1	9.2	8.9	9.0

Responses of 'Don't Know/Don't recall' and 'Refused' are excluded from the table

G2. Using a scale from 0 to 10 where 0 is “Not at all satisfied” and 10 is “Completely satisfied”, how would you rate your satisfaction with the Heating System Rebates program overall?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
10 - Completely satisfied	48%	44%	52%	4
9	6%	4%	10%	0
8	12%	12%	14%	0
7	12%	14%	7%	0
6	3%	3%	3%	0
5	10%	10%	10%	1
4	1%	1%	0%	0
3	1%	1%	0%	0
2	3%	4%	0%	0
1	3%	3%	3%	0
0 - Not at all satisfied	1%	1%	0%	0
Don't know	0%	0%	0%	0
Refused	0%	0%	0%	0
SATISFIED % (ratings of 8,9,10)	65	61	76	80
MEAN	8.0	7.7	8.4	9.0

Responses of 'Don't Know/Don't recall' and 'Refused' are excluded from the mean calculation

G3. What was the main reason you were not more satisfied with the program overall?

	2023	MSHP	Biomass	ETS
Sample Size	43	35	7	1
The rebate amount is too small	47%	51%	29%	0
Requirements to be eligible for rebate	12%	14%	0%	0
The rebate application form is too long or complicated to complete	9%	9%	14%	0
Information is too vague/Didn't receive any/enough information	7%	6%	14%	0
Poor communication	5%	3%	14%	0
It is too long to receive the rebate amount	5%	3%	14%	0
Other	9%	6%	14%	1
Don't know	7%	9%	0%	0

Base: Respondents who are less than satisfied with the program overall

G4A. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Heating System Rebates program? Please indicate if any are not applicable to you.

The clarity of program requirements, that is, the eligibility requirements

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
10 - Completely satisfied	40%	40%	34%	4
9	13%	13%	14%	0
8	11%	8%	24%	0
7	8%	8%	10%	0
6	2%	2%	3%	0
5	12%	16%	3%	0
4	2%	1%	3%	0
3	2%	2%	3%	0
2	2%	2%	0%	0
1	6%	7%	0%	1
0 - Not at all satisfied	0%	0%	0%	0
Not applicable	2%	1%	3%	0
Don't know/Don't recall	0%	0%	0%	0
Refused	0%	0%	0%	0
SATISFIED % (ratings of 8,9,10)	65	61	72	80
MEAN	7.8	7.6	8.2	8.2

Responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation

G4B. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Heating System Rebates program? Please indicate if any are not applicable to you.

The program application process

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
10 - Completely satisfied	43%	41%	41%	4
9	7%	8%	7%	0
8	15%	14%	17%	1
7	10%	10%	10%	0
6	6%	6%	7%	0
5	7%	9%	3%	0
4	2%	2%	3%	0
3	3%	3%	3%	0
2	2%	1%	7%	0
1	2%	3%	0%	0
0 - Not at all satisfied	0%	0%	0%	0
Not applicable	2%	2%	0%	0
Don't know/Don't recall	0%	0%	0%	0
Refused	0%	0%	0%	0
SATISFIED % (ratings of 8,9,10)	65	63	66	100
MEAN	7.9	7.9	7.8	9.6

Responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from mean calculation

G4C. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Heating System Rebates program? Please indicate if any are not applicable to you.

The amount of the rebate

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
10 - Completely satisfied	15%	12%	14%	3
9	2%	2%	3%	0
8	14%	11%	21%	1
7	11%	8%	24%	0
6	7%	8%	7%	0
5	23%	27%	14%	1
4	4%	4%	3%	0
3	3%	3%	3%	0
2	6%	8%	3%	0
1	13%	16%	7%	0
0 - Not at all satisfied	0%	0%	0%	0
Not applicable	1%	1%	0%	0
Don't know/Don't recall	0%	0%	0%	0
Refused	0%	0%	0%	0
SATISFIED % (ratings of 8,9,10)	31	26	38	80
MEAN	5.7	5.3	6.5	8.6

Responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation

G4D. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Heating System Rebates program? Please indicate if any are not applicable to you.

Time required to receive rebate

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
10 - Completely satisfied	35%	38%	31%	0
9	6%	7%	0%	1
8	15%	14%	17%	1
7	14%	11%	17%	2
6	4%	3%	7%	0
5	13%	13%	10%	1
4	5%	4%	7%	0
3	3%	3%	3%	0
2	2%	1%	7%	0
1	2%	2%	0%	0
0 - Not at all satisfied	0%	0%	0%	0
Not applicable	2%	2%	0%	0
Don't know/Don't recall	0%	0%	0%	0
Refused	0%	0%	0%	0
SATISFIED % (ratings of 8,9,10)	56	59	48	40
MEAN	7.5	7.7	7.1	7.2

Responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation

G4E. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Heating System Rebates program? Please indicate if any are not applicable to you.

The equipment installed in your home

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
10 - Completely satisfied	62%	67%	41%	5
9	15%	14%	17%	0
8	15%	12%	28%	0
7	1%	1%	0%	0
6	2%	1%	7%	0
5	1%	1%	0%	0
4	0%	0%	0%	0
3	1%	1%	0%	0
2	1%	1%	0%	0
1	1%	1%	0%	0
0 - Not at all satisfied	0%	0%	0%	0
Not applicable	1%	0%	3%	0
Don't know/Don't recall	0%	0%	0%	0
Refused	1%	0%	3%	0
SATISFIED % (ratings of 8,9,10)	92	93	86	100
MEAN	9.2	9.2	8.9	10.0

Responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation

G4F. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Heating System Rebates program? Please indicate if any are not applicable to you.

The selection of equipment eligible for the rebate

	2023	MSHP	Biomass	ETS
Sample Size	112	79	28	5
10 - Completely satisfied	53%	53%	43%	5
9	13%	18%	4%	0
8	16%	10%	36%	0
7	5%	4%	11%	0
6	3%	3%	4%	0
5	6%	8%	4%	0
4	2%	3%	0%	0
3	0%	0%	0%	0
2	1%	1%	0%	0
1	1%	1%	0%	0
0 - Not at all satisfied	0%	0%	0%	0
SATISFIED % (ratings of 8,9,10)	82	81	82	100
MEAN	8.7	8.7	8.6	10.0

Responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the table

G4G. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Heating System Rebates program? Please indicate if any are not applicable to you.

Any communications you had with Efficiency Nova Scotia

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
10 - Completely satisfied	28%	29%	24%	2
9	5%	4%	7%	0
8	14%	12%	21%	0
7	4%	3%	7%	0
6	6%	7%	3%	0
5	12%	10%	17%	1
4	1%	1%	0%	0
3	3%	4%	0%	0
2	2%	3%	0%	0
1	7%	7%	7%	1
0 - Not at all satisfied	0%	0%	0%	0
Not applicable	16%	17%	14%	1
Don't know/Don't recall	2%	2%	0%	0
Refused	0%	0%	0%	0
SATISFIED % (ratings of 8,9,10)	47	46	52	40
MEAN	7.1	7.0	7.3	6.5

Responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation

G4H. On a scale of 0 to 10, where 0 is “Not at all satisfied” and 10 is “Completely satisfied,” how satisfied were you with each of the following aspects of the Heating System Rebates program? Please indicate if any are not applicable to you.

The website of the Heating System Rebates program

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
10 - Completely satisfied	23%	21%	28%	2
9	3%	3%	3%	0
8	21%	18%	28%	2
7	8%	9%	7%	0
6	9%	8%	14%	0
5	8%	7%	10%	1
4	2%	2%	3%	0
3	2%	2%	0%	0
2	2%	3%	0%	0
1	5%	7%	0%	0
0 - Not at all satisfied	0%	0%	0%	0
Not applicable	14%	18%	3%	0
Don't know/Don't recall	2%	2%	3%	0
Refused	0%	0%	0%	0
SATISFIED % (ratings of 8,9,10)	48	42	59	80
MEAN	7.2	6.9	7.8	8.2

Responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation

G5A. Using a scale of 0 to 10, where 0 is “Completely disagree” and 10 is “Completely agree”, how strongly do you agree or disagree with the following two statements about the Heating System Rebates application form?

The Heating System Rebates application form was easy to complete

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
10 - Completely agree	45%	48%	38%	2
9	6%	6%	10%	0
8	19%	17%	21%	2
7	8%	11%	0%	0
6	2%	1%	7%	0
5	7%	8%	7%	0
4	2%	1%	7%	0
3	2%	2%	3%	0
2	1%	0%	3%	0
1	0%	0%	0%	0
0 - Completely disagree	2%	2%	0%	0
Not applicable	3%	3%	0%	1
Don't know/Don't recall	1%	1%	0%	0
Refused	1%	0%	3%	0
AGREE % (ratings of 8,9,10)	70	70	69	80
MEAN	8.2	8.3	7.9	9.0

Responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation

G5B. Using a scale of 0 to 10, where 0 is “Completely disagree” and 10 is “Completely agree”, how strongly do you agree or disagree with the following two statements about the Heating System Rebates application form?

The instructions on how to fill out the Heating System Rebates application form were simple to understand

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
10 - Completely agree	44%	49%	31%	2
9	6%	3%	14%	1
8	16%	16%	17%	1
7	11%	11%	14%	0
6	2%	2%	3%	0
5	6%	8%	3%	0
4	6%	3%	14%	0
3	0%	0%	0%	0
2	1%	1%	0%	0
1	1%	1%	0%	0
0 - Completely disagree	1%	1%	0%	0
Not applicable	3%	3%	0%	1
Don't know/Don't recall	1%	1%	0%	0
Refused	1%	0%	3%	0
AGREE % (ratings of 8,9,10)	67	68	62	80
MEAN	8.2	8.3	7.9	9.3

Responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused' are excluded from the mean calculation

G6. What, if any, difficulties did you have with your Heating System Rebates application?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
None	67%	64%	72%	4
Website user-friendliness/functionality issues	11%	13%	7%	0
Confusing application/Hard to understand the process	9%	10%	7%	0
Too much paperwork/Time taken to fill everything out	6%	6%	10%	0
Other	5%	4%	3%	1
Hard to find all information required for application	5%	6%	3%	0
Slow process/Delays in processing the application	3%	3%	3%	0
Don't know/Don't recall	2%	2%	0%	0

H1. Before today, did you know of, or had you ever heard of Efficiency Nova Scotia's Home Energy Assessment Program? The program provides rebates on heat pumps, insulation, draft-proofing, windows and doors, etc. to make your home more energy efficient. An advisor will first assess your home to see where it is losing heat and provide recommendations for improvements that can help you save energy. Through this program, you may also be eligible to receive federal funding from the Canada Greener Homes Grant.

	2023	MSHP	Biomass	ETS
Sample Size	119	90	29	-
Yes, had previously heard of this program	87%	90%	79%	-
No, had not previously heard of this program	13%	10%	21%	-

Base: Respondents who did not install ETS

H2: FIRST MENTION How did you find out about the Home Energy Assessment Program?

	2023	MSHP	Biomass	ETS
Sample Size	104	81	23	-
Online	21%	20%	26%	-
Word of mouth	21%	19%	30%	-
Saw an advertisement – general	11%	12%	4%	-
Through a contractor or installer	7%	6%	9%	-
Through another Efficiency Nova Scotia program	6%	5%	9%	-
Through the mail (e.g., flyers, brochures)	5%	6%	0%	-
Social Media (e.g., Facebook, Twitter, Instagram, Snapchat, TikTok, YouTube, etc.)	5%	4%	9%	-
Efficiency Nova Scotia website	5%	6%	0%	-
Through news media (e.g., News, TV news, etc.)	4%	2%	9%	-
Print ads (magazine or newspaper)	4%	5%	0%	-
Through Nova Scotia Power (e.g., with bill, website, etc.)	2%	1%	4%	-
Through a retailer or distributor	2%	2%	0%	-
Email	2%	2%	0%	-
Retailer flyer	2%	2%	0%	-
Radio ads	1%	1%	0%	-
Other	2%	2%	0%	-
Don't know	2%	2%	0%	-

Base: Respondents who did not install ETS AND who have previously heard about ENS' Home Energy Assessment Program

H2: TOTAL MENTIONS How did you find out about the Home Energy Assessment Program? Any other ways?

	2023	MSHP	Biomass	ETS
Sample Size	104	81	23	-
Word of mouth	28%	26%	35%	-
Online	26%	26%	26%	-
Saw an advertisement – general	15%	17%	9%	-
Print ads (magazine or newspaper)	11%	14%	0%	-
Through the mail (e.g., flyers, brochures)	9%	11%	0%	-
Through news media (e.g., News, TV news, etc.)	9%	9%	9%	-
Through a contractor or installer	8%	7%	9%	-
Through another Efficiency Nova Scotia program	6%	5%	9%	-
Social Media (e.g., Facebook, Twitter, Instagram, Snapchat, TikTok, YouTube, etc.)	6%	5%	9%	-
Efficiency Nova Scotia website	5%	6%	0%	-
Retailer flyer	5%	6%	0%	-
Email	4%	5%	0%	-
Through Nova Scotia Power (e.g., with bill, website, etc.)	3%	2%	4%	-
Through a retailer or distributor	3%	4%	0%	-
Radio ads	3%	4%	0%	-
Online advertisement on smart phone, computer or tablet	2%	2%	0%	-
Other	4%	5%	0%	-
Don't know	2%	2%	0%	-

Base: Respondents who did not install ETS AND who have previously heard about ENS' Home Energy Assessment Program

H3. Did you ever consider participating in the Home Energy Assessment Program instead of Heating System Rebates to get a rebate for your [INSERT EQUIPMENT] purchase?

	2023	MSHP	Biomass	ETS
Sample Size	104	81	23	-
Yes, had considered this	27%	21%	48%	-
No, had not considered this	68%	75%	43%	-
Don't know	5%	4%	9%	-

Base: Respondents who did not install ETS AND who have previously heard about ENS' Home Energy Assessment Program

H4. What factors helped you decide to take part in the Heating System Rebates Program instead of the Home Energy Assessment Program? Anything else?

	2023	MSHP	Biomass	ETS
Sample Size	28	17	11	-
Costs/Cost of assessment	21%	6%	45%	-
Shorter wait times with Heating System Rebates	21%	29%	9%	-
New/quality home/Home already efficient	18%	18%	18%	-
Already did an assessment	7%	0%	18%	-
Heating System Rebates is simpler to understand than the Home Energy Assessment Program	7%	12%	0%	-
I discussed options with friends/family/entourage	4%	6%	0%	-
My contractor or installer	4%	6%	0%	-
Other	29%	35%	18%	-
Don't know	4%	6%	0%	-

Base: Respondents who considered going through the HEA program instead of the Heating System Rebates Program

H5A. Did you use any of the following to help you decide which program to participate in? Please answer yes or no to each.

Your contractor or installer

	2023	MSHP	Biomass	ETS
Sample Size	28	17	11	-
Yes	61%	71%	45%	-
No	39%	29%	55%	-

Base: Respondents who considered going through the HEA program instead of the Heating System Rebates Program

H5B. Did you use any of the following to help you decide which program to participate in? Please answer yes or no to each.

An Efficiency Nova Scotia Energy Solutions advisor

	2023	MSHP	Biomass	ETS
Sample Size	28	17	11	-
Yes	18%	24%	9%	-
No	82%	76%	91%	-

Base: Respondents who considered going through the HEA program instead of the Heating System Rebates Program

I1. Now thinking exclusively about the Heating System Rebates program, do you have any recommendations for improving the program? Anything else?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
Increase the rebate	17%	22%	3%	0
Simplify program application, forms and associated paperwork	11%	12%	10%	0
Advertise the program more or in a better way	6%	4%	7%	1
Lower the criteria for eligibility/More people should be eligible	5%	3%	3%	2
Improve communication/Better support	4%	3%	7%	0
Speed up the process	4%	2%	7%	1
Offer additional equipment eligible for rebates	3%	1%	3%	2
Improve the online portal	2%	1%	7%	0
Offer more information the equipment recommended	2%	1%	3%	0
Offer more information on the requirements of the program	1%	1%	0%	0
Other	6%	7%	3%	0
No recommendation	51%	52%	52%	1
Don't know	2%	0%	10%	0

J1. What type of residence do you live in?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
Detached single-family home	81%	79%	90%	4
Mobile home or house trailer	8%	10%	3%	0
Townhouse or duplex which share adjacent walls	5%	4%	3%	1
Apartment/Condominium	4%	6%	0%	0
Row house	1%	1%	0%	0
Don't know	1%	0%	3%	0

J2. How many bedrooms are in your home?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
1	1%	1%	0%	0
2	25%	24%	31%	0
3	45%	43%	41%	5
4	23%	23%	28%	0
5	3%	4%	0%	0
6	2%	2%	0%	0
Don't know	1%	1%	0%	0

J3. How many individuals, including yourself, are part of your immediate household?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
1	23%	26%	17%	0
2	52%	51%	55%	3
3	10%	9%	14%	1
4	7%	7%	10%	0
5	4%	3%	3%	1
6	3%	4%	0%	0

J4. Please stop me when I reach your age group. Are you...

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
25 to 34	5%	2%	10%	1
35 to 44	8%	7%	7%	2
45 to 54	15%	13%	21%	0
55 to 64	23%	23%	17%	2
65 or over	48%	54%	38%	0
Refused	2%	0%	7%	0

J5. What is the highest level of education you have completed?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	6
Less than high school graduation diploma	6%	4%	10%	0
High school graduation diploma and/or some post-secondary	21%	20%	24%	1
Trades certificate or diploma	6%	7%	3%	1
College certificate or diploma	18%	14%	28%	1
University degree, certificate or diploma	40%	43%	28%	2
Other	8%	10%	3%	0
Refused	2%	1%	3%	0

J6. Which of the following income categories best describes your total annual household income before taxes last year?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
Less than \$28,000	6%	7%	7%	0
At least \$28,000 but less than \$39,000	6%	4%	14%	0
At least \$39,000 but less than \$47,000	10%	9%	14%	1
At least \$47,000 but less than \$54,000	10%	12%	3%	0
At least \$54,000 but less than \$61,000	7%	7%	3%	2
At least \$61,000 but less than \$100,000	20%	22%	17%	0
\$100,000 or more	27%	27%	28%	2
Don't know	1%	0%	3%	0
Refusal/Prefer not to answer	11%	12%	10%	0

J7. What is the language you speak most often at home?

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
English	90%	94%	86%	2
French	4%	3%	7%	0
Other	5%	2%	3%	3
Refused	1%	0%	3%	0

J8. [DO NOT READ; BY OBSERVATION] Gender:

	2023	MSHP	Biomass	ETS
Sample Size	124	90	29	5
Male	59%	54%	66%	5
Female	41%	46%	34%	0

APPENDIX XI

Green Heat Contractor Interview Guide

HEATING SYSTEM REBATES (GREEN HEAT) PROGRAM EVALUATION

GUIDE FOR INTERVIEWS WITH CONTRACTORS

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Semi-directed in-depth interview
Estimated Time to Complete	20-25 minutes
Target Audience	Contractors: › HP alone › HP + ETS or ETS alone [minimum of 5 ETS contractors]
Expected Number of Completions	20
Contact List Source	Efficiency One
Fielding Firm	Narrative Research
Estimated Timeline for fielding	October 2023

Table 2: Research Objectives and Associated Questions

Research Questions	Question #
How familiar are contractors with Green Heat? How do contractors promote the program?	B1-B2
How well do contractors understand the differences between GH and HEA?	B1, C2-C4
Under what conditions would a contractor recommend either GH or HEA?	C5-C6
Why do participants choose GH over HEA?	C7-C11
What is the level of satisfaction with the program among contractors?	D1
Why are participants providing incomplete applications?	E1-E4
What works well and what are the key challenges for this program?	F1-F2
How could the GH program be improved?	G1-G2
What has changed since the announcement of Greener Homes? How has the market evolved over the past two years and how is the market expected to evolve in the future?	H1-H2

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

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



INTRODUCTION

Hello, may I speak with **[Contact name]**?

My name is **[Interviewer name]** and I'm calling from Narrative Research, a market research firm. Efficiency One has mandated the evaluation of its Heating System Rebates Program, which provides financial incentives for the purchase of high-efficiency heating equipment, including mini-split heat pumps (MSHPs). Efficiency Nova Scotia has informed us that **[BUSINESS NAME]** has participated in the program, and we are interested in your opinion from your perspective as a contractor. Are you the person most familiar with **[BUSINESS NAME]**'s involvement in the program? Our discussion should last about 20-25 minutes.

A. Identification and Screening of Respondent

- › Person responsible available **[CONTINUE]**
- › Person responsible currently unavailable **[ARRANGE CALL BACK WITH THE RIGHT PERSON]**
- › Don't know **[ASK TO SPEAK TO ANOTHER PERSON WHO WOULD KNOW ABOUT THE PROGRAM]**
- › Refused **[THANK AND TERMINATE]**

Do you have any questions before we start?

Program Participation Process (For Reference)

- › Homeowners purchase an eligible measure and have it installed by a certified installer.
- › Homeowners have 180 days to complete the GH application form and attach the required documentation (receipts, pictures, copy of the power bill).
- › EOne reviews the application (if incomplete EOne contacts participant to send other required information).
- › If the application is approved, EOne completes internal payment and sends the incentive cheque to the homeowner.

B. Respondent Involvement in the Program

B1. To begin, what is your title, and could you briefly describe your role with the company?

C. Program Familiarity and Promotion

C1. How familiar are you with Efficiency Nova Scotia's Heating System Rebates Program? Are you **[READ RESPONSES IN ORDER]**?

1. Very familiar
2. Somewhat familiar
3. Not very familiar
4. Not at all familiar
98. **[DO NOT READ]** Don't know
99. **[DO NOT READ]** Refusal

C2. How, if at all, does your company promote the program? **[IF NOT MENTIONED]** What types of promotional materials does your company use?

C3. How familiar are you with Efficiency Nova Scotia's Home Efficiency Assessment (HEA) Program which gives access to funding from the federal government's Greener Homes Grant? Are you **[READ RESPONSES IN ORDER]**?

1. Very familiar
2. Somewhat familiar
3. Not very familiar
4. Not at all familiar / Do not know it **[GO TO NEXT SECTION]**
98. **[DO NOT READ]** Don't know **[GO TO NEXT SECTION]**
99. **[DO NOT READ]** Refusal **[GO TO NEXT SECTION]**

[READ] For the purposes of the rest of the interview, when we say "Greener Homes", we are referring to Efficiency Nova Scotia's Home Efficiency Assessment program, which gives access to funding from the federal government's Greener Homes Grant.

C4. Based on what you know, what are the main differences between the Heating System Rebates Program and Greener Homes?

[PROBE FOR:]

- a. Differences in eligibility (which ones?)
- b. Differences in incentive structure (which ones?)
- c. Requirement for a Home Energy Assessment
- d. Other differences (specify_____)
98. Don't know **[GO TO NEXT SECTION]**
99. Refusal **[GO TO NEXT SECTION]**

C5. Were you aware that customers cannot participate in BOTH the Heating System Rebates AND the Greener Homes programs?

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



D. HEA/Greener Homes

[DO NOT ASK SECTION D IF CONTRACTOR TYPE = ETS ALONE]

- D1. If a homeowner is interested in installing a mini-split heat pump (MSHP) and is contacting you to find out about available incentives for their purchase, which programs would you mention to them?
[DO NOT READ]
1. Heating System Rebates / Green Heat
 2. Home Energy Assessment / Canada Greener Homes
 96. Other (specify: _____)
 97. None
 98. Don't know
 99. Refusal
- D2. **[ASK IF CODES 1, 2, 96 AT D1]** What, if any, questions would you typically ask the homeowner before recommending a specific program?
- D3. **[ASK IF CODES 1 TO 3 AT C3]** If the MSHP a customer wants to install is eligible for both the Green Heat and the Greener Homes programs, in what situations or under what circumstances would you recommend they apply to the Heating System Rebates program rather than Greener Homes? Why? Any other reasons?
- D4. **[ASK IF CODES 1 TO 3 AT C3]** And in what situations or under what circumstances would you recommend the customer applies to Greener Homes rather than Heating System Rebates? Why? Any other reasons?
- D5. **[ASK IF CODES 1 TO 3 AT C3]** Using a 0-to-10 scale, where 0 is “the customer is very clear about the differences between both incentive programs” and 10 is “the customer is very confused about the differences”, how would you rate customers’ level of understanding of the differences between Heating System Rebates and Greener Homes?
- [RANGE: 0-10] ____/10**
98. Don't know
 99. Refusal
- D6. **[ASK IF CODES 1 TO 3 AT C3]** Out of a typical ten customers who know of both programs, how many would you say choose Heating System Rebates over Greener Homes?
- [RANGE: 0-10] ____/10**
98. Don't know
 99. Refusal
- D7. **[IF 1 OR MORE AT D6]** What is the main reason customers choose Heating System Rebates over Greener Homes?

D8. **[ASK IF CODES 1 TO 3 AT C3]** In your conversations with customers who are interested in Heating System Rebates, do you generally ask if they have already applied to the Greener Homes program?

- 1. Yes
- 2. No
- 98. Don't know
- 99. Refusal

D9. **[ASK IF YES AT D8]** For every 10 customers interested in the Heating System Rebates program, how many have already applied to Greener Homes once they contact you?

[RANGE: 0-10] ____/10

- 98. Don't know
- 99. Refusal

E. Satisfaction

I would now like to discuss your satisfaction with the Heating System Rebates program.

E1. On a scale of 0 to 10, where 0 is “not at all satisfied” and 10 is “completely satisfied”, how satisfied are you with each of the following eight aspects of the Heating System Rebates Program.
[ASK FOR REASON IF 7 OR LOWER]

Aspects of the Program	Score 0 = Not at all satisfied 10 = Completely Satisfied	Reason If 7 or less, please share the reason(s) for your score.
a. The overall program	--/10	What could be improved?
b. The list of equipment that qualifies for the program	--/10	Which upgrades should be added or removed?
c. The program eligibility criteria	--/10	Which eligibility criteria are problematic and why?
d. The incentive levels	--/10	Which incentive levels should be revised and why?
e. The program application form	--/10	What could be improved?
f. The Heating System Rebates program webpage	--/10	What could be improved?
g. The Efficiency Nova Scotia online portal in general	--/10	What could be improved?
h. The effectiveness of Heating System Rebates marketing materials	--/10	What could be improved?

F. Application Form

- F1. With respect to the Heating System Rebates application process, do you typically give customers a paper application form, a PDF application form, or do you tell them where to apply online?
1. Yes, give them a paper application form
 2. Yes, give them a PDF application form
 3. Yes, give them the online reference
 4. Both
 5. No
 6. Other (specify: _____)
 98. Don't know
 99. Refusal
- F2. Do you typically help homeowners complete the Heating System Rebates application form or process?
1. Yes
 2. No
- F3. In your experience, where do homeowners have the most difficulties when completing the application?
- F4. Do you have any insights into why participants are providing incomplete applications or documentation?

G. Strengths and Challenges

- G1. Overall, what is the main strength of the Heating System Rebates program? What are the other strong points of the Heating System Rebates program?
- G2. What is the main challenge you have faced with this program? Are there other challenges that either you or your customers have faced with Heating System Rebates?

H. Suggestions for Improvements

- H1. Do you have any recommendations to improve the Heating System Rebates Program?
- H2. What additional support, if any, could Efficiency Nova Scotia provide to help you promote, educate about or deliver the program as efficiently as possible?
- H3. On a 1-to-10 scale, where 1 is not at all interested and 10 is highly interested, how interested would you be in attending a webinar or lunch-and-learn session given by Efficiency Nova Scotia to find out more about the differences between the two programs?

[RANGE: 0-10] ____/10

- 98. Don't know
- 99. Refusal

I. Market Evaluation

[DO NOT ASK SECTION D IF CONTRACTOR TYPE = ETS ALONE]

- I1. What changes in the MSHP market, if any, have you seen over the last two years in Nova Scotia?
- I2. How do you expect the MSHP market to evolve in the next two years? What makes you say that?

J. ETS

- J1. [ASK IF CONTRACTOR TYPE = HP ALONE] Have you ever heard of Electric thermal storage, or ETS? [IF NECESSARY: ETS is an electric home heating device containing ceramic bricks that can help lower heating costs by storing heat when electricity costs less, and then releasing the heat throughout the day.]
 - 1. Yes
 - 2. No
 - 98. Don't know
 - 99. Refused
- J2. [ASK IF J1 = YES] Do you sell Electric thermal storage (ETS)?
 - 1. Yes
 - 2. No
 - 98. Don't know
 - 99. Refused

J3. **[ASK IF J2 = YES OR CONTRACTOR TYPE = ETS ALONE OR HP + ETS]** What motivates your customers to purchase an ETS? **[MULTIPLE RESPONSES] [DO NOT READ]**

1. To benefit from time-of-day rates
2. To save on energy/to save on energy costs
3. To reduce my energy bill
4. To have a backup heating source
5. For better comfort
6. To make home more energy efficient
7. Old system wasn't working properly
8. To get the rebate offered by Efficiency Nova Scotia
9. The environmental aspect
10. Wanted better home heating equipment
96. Other (specify:_____)
98. Don't know
99. Refused

J4. **[ASK IF J2 = YES OR CONTRACTOR TYPE = ETS ALONE OR HP + ETS]** What prevents your customers from purchasing an ETS? **[MULTIPLE RESPONSES] [DO NOT READ]**

1. Cost
2. Not interested in time-of-day rate
3. Don't understand the benefits of the equipment
4. Current heating system isn't ready to be replaced
5. Have an alternative heating heating system
6. Rebates are higher for heat pumps
7. Not a measure supported by Greener Homes
96. Other (specify:_____)
98. Don't know
99. Refused

END

Those are all the questions I have. Thank you for your time.

APPENDIX XII

Green Heat Distributor Interview Guide

GREEN HEAT

INTERVIEW GUIDE WITH DISTRIBUTORS

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
Heating Systems Rebates vs. Greener Homes	D
Product Adoption Curve	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. As part of the 2023 evaluation of their Heating System Rebates 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 responses.

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, 2020 OR 2021)]

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? **[TERMINATE IF NO, OTHERWISE 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? **[TERMINATE IF NO, OTHERWISE 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, 2020 OR 2021)]

- 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 2022 and 2023? **[IF NO, RECORD THE CHANGE. TERMINATE IF THEY NO LONGER SELL TO MSHPs]**



B. Efficiency and Price of MSHPs

Efficiency Nova Scotia's Heating System Rebates program provides incentives to high-performance cold climate MSHPs; that is multi-zone MSHPs that have a HSPF (high seasonal performance factor) of over 10 or higher in Region V as well as a seasonal energy efficiency ratio (SEER) of 17 more and a COP (coefficient of performance) at -15 degrees Celsius that is greater than or equal to 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 Heating System Rebates eligible MSHPs as high-performing cold climate MSHPs. Please keep in mind that Heating System Rebates eligible MSHPs are higher performing and more energy-efficient than most ENERGY STAR certified MSHPs.

I would like to discuss the characteristics of the MSHPs that you sell.

B1. Do you (still) sell high-performing cold climate MSHPs?

- a. Yes **GO TO B3**
- b. No

B2. **[ASK IF NO AT B1]** Just to confirm, you do not currently sell high-performing cold climate MSHPs?

- a. I **do not** sell high-performing cold climate MSHPs **[ASK B2_1, THEN TERMINATE]**
- b. I do sell high-performing cold climate MSHPs **[CONTINUE]**

B2_1. **[ASK IF DO NOT SELL MSHPs AT B2 (CODE a)]** Why don't you currently sell high-performing cold climate MSHPs? **[THANK AND TERMINATE]**

B3. What percentage of the contractors that you sell MSHPs to carry high-performing cold climate MSHPs?

- a. **[IF LOWER THAN 90% ASK]** In 2021, we estimated that on average 90% of contractors carries high-performing cold climate MSHPs. Why do you think fewer of the contractors you do business with today 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. And thinking more specifically of the last year, how have prices of MSHPs evolved? Why?

B6. 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?]

B7. 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?]

B8. To confirm, the average price difference between a standard efficiency MSHP and a high-performing cold climate MSHP with a 12,000 Btu/hour cooling capacity would be about **[\$B7-\$B6]**. Is that correct?

B9. **[ASK IF B8<\$525 OR >\$625]** In 2021, the average price difference was \$570 meaning that the price of a high-performing cold climate MHSP was about 10% higher than a standard efficiency MSHP. You estimated today's price difference to be **[\$B7-\$B6B4]**. Can you help us understand why there might be a difference between what was reported in 2021 and your differential estimate today? **[PROBE:** Has the price evolved? Was our 2021 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 MSHPs increase, decrease or stay the same from 2021 to 2023? By what percentage an [increase/decrease]? Why do you think they have [increased/decreased/stayed the same]? **[PROBE FOR EACH:** Federal Government incentives from the Canada Greener Homes program, impact of COVID, supply chain, demand for renovations, inflation]

Increase	No change	Decrease
☐ %	☐	☐ %

Explanation: _____

C2. To the best of your knowledge, have your overall sales of MSHPs increased, decreased or stayed the same from 2022 to 2023? By what percentage an [increase/decrease]? Why do you think they have [increased/decreased/stayed the same]? **[PROBE:** Federal Government incentives from the Canada Greener Homes program, impact of COVID, supply chain, demand for renovations, inflation]

Increase	No change	Decrease
☐ %	☐	☐ %

Explanation: _____

- 
- C3. Do you expect your sales of MSHPs to increase, decrease or stay the same in 2024?
- 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 2023 were high-performing cold climate MSHPs?
- RECORD (%):**
- C4A. **[IF LOWER THAN 70% ASK]** In 2021 we estimated that between 70% and 90% of MSHP sales were high-performing cold climate MSHPs. Why do you think fewer of the contractors you do business with today are selling fewer high-performing MSHPs?
- 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 fewer than one quarter of total MSHP sales in Nova Scotia, including standard and high-performing MSHPs, go through an Efficiency Nova Scotia program, a drop from half in 2021. Does this 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. [ASK SECTION IF TIME] Heating Systems Rebates vs. Greener Homes

- D1. How familiar are you with Efficiency Nova Scotia's Heating Systems Rebates Program?
1. VERY FAMILIAR
 2. SOMEWHAT FAMILIAR
 3. NOT FAMILIAR
- D2. How familiar are you with the federal government's Canada Greener Homes Grant program?
1. VERY FAMILIAR
 2. SOMEWHAT FAMILIAR
 3. NOT FAMILIAR
- D3. **[ASK IF VERY OR SOMEWHAT FAMILIAR AT BOTH D AND D2]** Based on what you know, what are the main differences between the Heating System Rebates Program and the Canada Greener Homes Grant program?

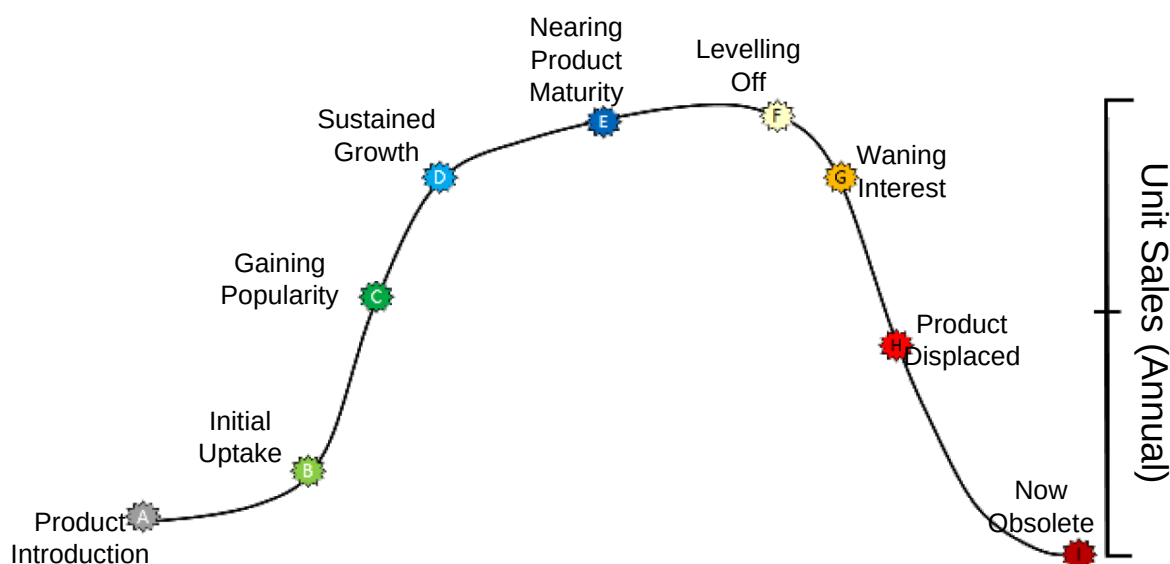
E. Product Adoption Curve

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]**

E1. Apart from price which we have already discussed, what changes in the MSHP market, if any, have you seen over the last two years in Nova Scotia? **[PROBE FOR: changes related to COVID, efficiency, materials, incentive programs (especially Canada Greener Homes Grant), 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.



E2. **[IF 2021 CURVE IS NOT AVAILABLE]** Where on the product adoption curve would you place MSHPs?

[IF 2021 CURVE IS AVAILABLE] Where on the product adoption curve would you place MSHPs this year? In 2021, your response was... **[NOTE: USE 2021 LETTER CURVE TO REMIND RESPONDENTS WHAT THEY ANSWERED IN 2021.]**

2021 Response (if available)	2023 Letter on the Curve	Why do you think that?
Mini Split Heat Pumps		

E3. How do you expect the MSHP market to evolve in the next two years (2024 – 2025)? What makes you say that?

- 
- E4. Were you aware that since January 1, 2023, heat pumps must meet new HSPF2 and SEER2 testing standards for heating and cooling? **[IF YES]** How have these new testing requirements affected the market?

F. Closing

- F1. 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 XIII

Green Heat Tracking Sheet Audit

This appendix presents the main 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

Table 1 presents the corrected tracked savings resulting from all changes made by the Evaluator.

Table 1: 2023 Green Heat Corrected Tracked Savings

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
Green Heat					
Gross Energy Savings at the Generator	5.281	GWh	5.561	GWh	5.30%
Gross Peak Demand Savings at the Generator	4.651	MW	4.668	MW	0.38%
Net Energy Savings at the Generator	3.186	GWh	3.352	GWh	5.18%
Net Peak Demand Savings at the Generator	2.938	MW	2.949	MW	0.40%

The differences in energy savings are due to an adjustment of the baseline for several wood fireplace inserts as well as wood and pellet stoves from a heat pump baseline to an electrical resistance baseline according to the primary and secondary heating sources. This adjustment explains most of the change in energy savings. Another reason is the adjustment of the nominal heating capacity as well as the heating capacity at 15° and COP at -15°C used for mini-split heat pumps for a few projects based on values found in the NEEP Cold Climate Heat Pump list.

The differences in demand savings are due to the adjustment to the nominal heating capacity used for mini-split heat pumps for a few projects based on values found in the NEEP Cold Climate Heat Pump list and an adjustment to the calculation for electric thermal storage by excluding blower parasitic losses.

APPENDIX XIV

Green Heat Algorithm for Free-ridership Calculation

Table 1: Free-Ridership Algorithm for Biomass

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 an electrical heating system instead of the <EQUIPMENT> you installed through the program? (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 already decided to install a <EQUIPMENT> before you heard about the Green Heat program?	IF 1. Yes: Use D2 IF 2. No OR DK OR REF: D1 = 0%
D2. [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: D2 = 100% IF 2. No OR DK OR REF: E2 = 0%
PA2 Score:	D1
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?	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)
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. 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. / 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.	Cross-influence (CI) = IF(F2 OR F6=Agree; 1) + IF(F3 OR F7=Agree; 1) + IF(F4 OR F8=Agree; 1)

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. 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. 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.	
Revised Free-Ridership	IF C1=0 OR 1, Revised FR = FR IF C1=2, Revised FR = FR*.75 IF C1=3, Revised FR = FR*.50

Table 2: Free-Ridership Algorithm for MSHPs

Series A: Decision to install a HP	
C1. Prior to installing your heat pump, did you already have a working air conditioner in your home?	Used for C5 question
C2. Had you already decided to install a heat pump before you heard about the Green Heat program?	IF 1. Yes: Use C3 IF 2. No OR DK OR REF: C2 = 0%
C3. [IF C2=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: C3 = 100% IF 2. No OR DK OR REF: C3 = 0%
C4. [IF C1= 2, 98,99 AND C2=2, 98, 99 OR C3=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. Kept your existing heating system and purchased an air conditioner 3. Purchased a new electric heating system other than a heat pump 4. Purchased a new non-electric heating system (e.g. oil or gas system) 5. Purchased a heat pump	IF 1, 2, 3 or 4: 0% and END IF 5: ASK C6
C5. [IF C1= 1 AND C2=2, 98, 99 OR C3=2, 98, 99] If there were no Heating System Rebates program, which of the following actions would you have taken?] 1. Kept your existing heating system 2. Purchased a new non-electric heating system (for example, oil or gas system) 3. Purchased a heat pump	IF 1, 2 or 3: 0% and END IF 5: ASK C6
C6. [IF C3=1 OR C4=5 OR C5=3] 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)	C6 = (10 – Answer) x 10% IF DK OR REF: C6 = EMPTY
PA1 Score (Series A)	MEAN VALUE OF: (C2; C4; C5; C6)

Series B: Decision to install a high-efficiency HP	
C7. 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 C8 IF 2. No, DK OR REF: C7 = 0% and END
C8. [IF C7=1] Before you heard about the Green Heat program, had you already made the decision to install a <u>high-efficiency</u> heat pump model?	IF 1. Yes: C8 = 100% IF 2. No, DK OR REF: C8 = 0%
C9. 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)	C9 = Answer x 10% IF DK OR REF: C9 = EMPTY
C10. Level of influence (Scale 0 to 10)	$C10 = (10 - \text{MAX}(C10a; C10b; C10c)) * 10\%$
PA2 Score (Series B)	IF PA1 ≤ 50% OR C7 > 1 PA2 = 0%, OTHERWISE MEAN VALUE OF: (C8; C9; C10)
Inconsistency Test #1	IF C8 = 100% and C7 < 70% C8 = EMPTY
Free-Ridership	0.75xPA1+0.25xPA2
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. 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. / 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. 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. 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. 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.	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 Demand-response Measures

E4. 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)	E4 = Answer x 10% IF DK OR REF: E4 = EMPTY
PA1 Score:	MEAN VALUE OF: (E4)
E2. Had you already decided to install a <EQUIPMENT> before you heard about the Green Heat program?	IF 1. Yes: Use E3 IF 2. No OR DK OR REF: E2 = 0%
E3. [IF E2=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: E3 = 100% IF 2. No OR DK OR REF: E3 = 0%
PA2 Score:	E2
E7. Level of influence (Scale 0 to 10)	E7 = MAX(E7a; E7b;E7c)
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 PA2	IF E3 = 100% and E4 < 70% PA2 = EMPTY
Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)
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. 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. / 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. 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. 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. 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.	Cross-influence (CI) = IF(F2 OR F6=Agree; 1) + IF(F3 OR F7=Agree; 1) + IF(F4 OR F8=Agree; 1)



APPENDIX XV

Green Heat 2023 Recommendations

This appendix summarizes all the recommendations made by the Evaluator as part of the 2023 Green Heat evaluation.

Section	Recommendations
Executive Summary	Recommendation #1: Ensure that Green Heat program marketing materials are available to contractors and participants.
Executive Summary	Recommendation #2: Ensure that the Green Heat website is as user-friendly as possible by making sections, links, eligibility criteria, and eligible equipment lists clear, simple to understand, and easy to navigate.
Executive Summary	Recommendation #3: Investigate how communications between EOne and contractors and participants could be improved. Ensure that EOne provides timely responses or feedback to questions from contractors and participants.
Executive Summary	Recommendation #4: Consider offering increased incentives to low and moderate-income households that do not yet have a heat pump and incentivizing heat pump replacements for such households if it is cost-effective to do so.

APPENDIX XVI

EPI Tracking Sheet Audit

This appendix presents the results of the EPI 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 the following:
 - › 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

Table 1 presents the corrected tracked savings resulting from all changes made by the Evaluator. More details are described further below.

Table 2: 2023 EPI Corrected Tracked Savings

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
EPI					
Gross Energy Savings at the Generator	9.455	GWh	9.481	GWh	0.3%
Gross Peak Demand Savings at the Generator	0.895	MW	0.942	MW	5.3%
Net Energy Savings at the Generator	9.439	GWh	9.308	GWh	-1.4%
Net Peak Demand Savings at the Generator	0.880	MW	0.913	MW	3.7%

The differences between the tracked and corrected savings are explained by the Evaluator correcting unitary savings values, interactive effects factors, installation rates, net-to-gross ratio (NTGR) values, and coefficient of performance (COP) values, establishing values for measures with nil tracked savings, and adjusting how primary and secondary heating system types informed savings calculations. The changes made by the Evaluator were a mix of upward and downward adjustments, resulting in small differences in overall savings results.



APPENDIX XVII

EPI 2023 Recommendations

The Evaluator has no specific recommendation for EPI. No major improvement recommendations were made for EPI in previous years.

APPENDIX XVIII

MHEEP Tracking Sheet Audit

This appendix presents the main 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

Table 1 presents the corrected tracked savings resulting from all changes made by the Evaluator.

Table 1: 2023 MHEEP Corrected Tracked Savings

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
MHEEP (Excluding Appliance Replacements)					
Gross Energy Savings at the Generator	0.566	GWh	0.566	GWh	0.0%
Gross Peak Demand Savings at the Generator	0.372	MW	0.372	MW	-0.01%
Net Energy Savings at the Generator	0.566	GWh	0.566	GWh	0.0%
Net Peak Demand Savings at the Generator	0.372	MW	0.372	MW	-0.01%
Appliance Replacements					
Gross Energy Savings at the Generator	0.009	GWh	0.009	GWh	0%
Gross Peak Demand Savings at the Generator	0.001	MW	0.001	MW	0%
Net Energy Savings at the Generator	0.009	GWh	0.009	GWh	0%
Net Peak Demand Savings at the Generator	0.001	MW	0.001	MW	0%
MHEEP Total					
Gross Energy Savings at the Generator	0.575	GWh	0.575	GWh	0%
Gross Peak Demand Savings at the Generator	0.373	MW	0.373	MW	-0.01%
Net Energy Savings at the Generator	0.575	GWh	0.575	GWh	0%
Net Peak Demand Savings at the Generator	0.373	MW	0.373	MW	-0.01%

The small downward adjustments to gross and net peak demand savings were due to the unitary peak demand savings adjustment for drain water heat recovery measures.



APPENDIX XIX

MHEEP 2023 Recommendations

The Evaluator has no specific recommendation for MHEEP. No major improvement recommendations were made for MHEEP in previous years.

APPENDIX XX

AMH Tracking Sheet Audit

This appendix presents the main 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

Table 1 presents the corrected tracked savings resulting from tracking sheet audit conducted by the Evaluator.

Table 1: 2023 AMH Corrected Tracked Savings

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
AMH					
Gross Energy Savings at the Generator	1.462	GWh	1.462	GWh	0%
Gross Peak Demand Savings at the Generator	0.706	MW	0.706	MW	0%
Net Energy Savings at the Generator	1.462	GWh	1.462	GWh	0%
Net Peak Demand Savings at the Generator	0.706	MW	0.706	MW	0%

As outlined in the table above, the Evaluator made no changes to the values tracked by EOne.

APPENDIX XXI

AMH 2023 Recommendations

The Evaluator has no specific recommendation for AMH. No major improvement recommendations were made for AMH in previous years.

APPENDIX XXII

ASFH Tracking Sheet Audit

This appendix presents the main 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

Table 3 presents the corrected tracked savings resulting from all changes made by the Evaluator.

Table 3: 2023 ASFH Corrected Tracked Savings

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
ASFH					
Gross Energy Savings at the Generator	1.385	GWh	1.439	GWh	4%
Gross Peak Demand Savings at the Generator	0.590	MW	0.624	MW	6%
Net Energy Savings at the Generator	1.385	GWh	1.439	GWh	4%
Net Peak Demand Savings at the Generator	0.590	MW	0.624	MW	6%

The corrected energy savings were higher than the tracked savings because some projects had no savings while they should have as well as because of certain corrections to line loss factors and overestimation ratios.

While the corrections made to energy savings also impacted peak demand savings, the corrected peak demand savings were further increased due to multiple heat pump projects not having tracked peak demand savings although they should have, so the Evaluator calculated peak demand savings for these projects.

APPENDIX XXIII

ASFH 2023 Recommendations

The Evaluator has no specific recommendation for ASFH. No major improvement recommendations were made for ASFH in previous years.



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com



ECONOLÉR



EfficiencyOne

NEW RESIDENTIAL PROGRAM

Final Report

2023 DSM EVALUATION

March 11, 2024



ECONOLUX

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
HEA	Home Energy Assessment
NBC	National Building Code
NHC	New Home Construction
NS Power	Nova Scotia Power
NSUARB	Nova Scotia Utility and Review Board
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.
Available Demand Response Capacity	The capacity which is available to NSP to reduce system peak demand. This capacity is calculated based on the first two hours of all events called between December and February, excluding weekends and holidays. If an event is shorter than two hours, only the first hour is used to measure the available DR capacity. Available DR capacity is evaluated on a per-participant basis, based on the average demand reduction observed for each event that the participant was scheduled to participate in. E1's total available DR capacity is the sum of each participant's available DR capacity.
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 base consumption.
Bias	Systematic deviations of measurements from the true value.
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.
Confidence interval	The estimated range of values that is likely to include unknown population parameters.
Demand response	Demand response measures generate savings in the form of available capacity or load reduction in response to events called by the electric utility (Nova Scotia Power) to reduce the load at strategic moments. These events can be called at any time and for any duration, although they are usually called for one to three hours during peak periods.
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 home 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 a home is through modelled home 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 equipment life and 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 CO2	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, gas 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 ratios, etc.) validated or measured during the evaluation process. Unless otherwise specified, evaluated savings are 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 a building (such as heating and cooling) due to the installation of an energy efficiency measure.
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 and 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 a program on the market (such as increased product availability, practices, and prices) that extends beyond changing program participant behaviours. 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. For industrial participants on an interruptible rate, peak demand savings may include savings on non-firm loads, i.e. loads that may be interrupted when Nova Scotia Power's 10-minute reserve is low.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	An 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.
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.
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 net-to-gross ratios. 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. A 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).



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EXECUTIVE SUMMARY

This report presents the 2023 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 2023 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: Summary of 2023 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 › Avoided GHG emission reduction calculations

Program Performance

Table 2 presents the participation levels, Net-to-gross ratios (NTGRs), evaluated gross and net savings at the generator, annual GHG emission reductions, as well as effective useful life (EUL) values for New Residential.

Table 2: Overall 2023 New Residential Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
NHC							
Energy Savings	816	Participants	5.868	GWh	0.90	5.281	GWh
Lifetime Energy Savings			180.731	GWh	0.90	162.658	GWh
Peak Demand Savings			2.121	MW	0.90	1.909	MW
Annual GHG Emission Reductions			3,238	Tonnes of CO2 eq	0.90	2,915	Tonnes of CO2 eq
EUL			30.8	Years		30.8 ¹	Years

¹ 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 30.8 years

New Residential was aimed at achieving 3.146 GWh in net electrical energy savings and 1.060 MW in net peak demand savings at the generator for 2023. The program exceeded both planned net electrical energy savings and peak demand savings.

The following subsection presents the findings and recommendations resulting from the 2023 evaluation.

NHC Findings and Recommendations

This subsection presents the key findings from the NHC evaluation. There are no recommendations for 2023.

2023 NHC-Finding: NHC exceeded its electrical energy and peak demand savings targets by 68% and 80% respectively.

2023 NHC-Finding: With 816 completed houses, NHC participation decreased by 11% in 2023 compared to 2022 as remaining participants completed their projects ahead of program closure.

2023 NHC-Finding: Evaluated gross savings were identical to the savings tracked by EOne, while evaluated net savings were slightly lower.

Program Tracked and Evaluated Savings

Table 3 below presents a comparison of EOne tracked energy and peak demand savings compared to evaluated savings at the generator. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings. Furthermore, the NTGRs correspond to the rounded averages obtained by dividing net savings by gross savings.

Table 3: Comparison of 2023 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	5.868	GWh	0.91	5.340	GWh	99%
Evaluation Results	5.868	GWh	0.90	5.281	GWh	
Peak Demand Savings						
Tracked Savings by EOne	2.121	MW	0.91	1.930	MW	99%
Evaluation Results	2.121	MW	0.90	1.909	MW	
* The NTGRs listed in this table match 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 demand-side management (DSM) for Nova Scotians. EOne provides energy efficiency, demand response, and carbon mitigation services through the Efficiency Nova Scotia (ENS) franchise. Regulatory oversight is provided by the Nova Scotia Utility and Review Board (NSUARB). EOne receives funding for its electricity 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 ENS franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2023 DSM program portfolio.

This evaluation report relates to the New Residential program comprised of one component: New Home Construction (NHC). Table 4 below lists the New Residential program component and the type of evaluation conducted for 2023. 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 4: Types of Evaluations Conducted for Each Program Component, 2023

Program	Program Component	2023		
		Process	Market	Impact
New Residential	New Home Construction			Condensed

Key findings, electrical first-year and lifetime energy savings, peak demand savings, and avoided 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 demand-side management (DSM) funds, and only electrically heated households are eligible.² Figure 1 illustrates the participation process along with details about the program component.

Figure 1: NHC Participation Process Summary

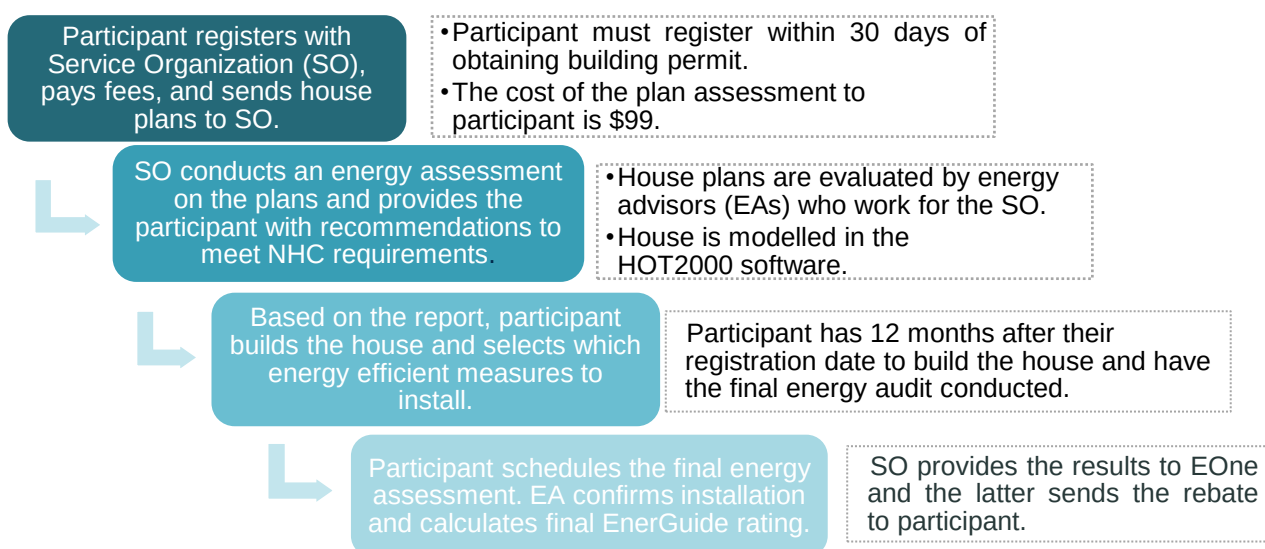


Table 5 presents the incentives available to 2023 NHC participants.

Table 5: 2023 NHC Incentive Structure

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

* Tier 3 homes were eligible for an additional \$2,000 from the Province of Nova Scotia as part of its Advanced New Homes pilot under NHC. Funds were available on a first come first served basis until that fund was exhausted.

² 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.

In 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 was closed to new registrations on June 24, 2022 and ceased operations on December 31, 2023. In this period, all open registrations were closed out or completed.

For 2023, NHC was aimed at achieving 3.146 GWh in net electricity savings and 1.060 MW in net peak demand savings at the generator.

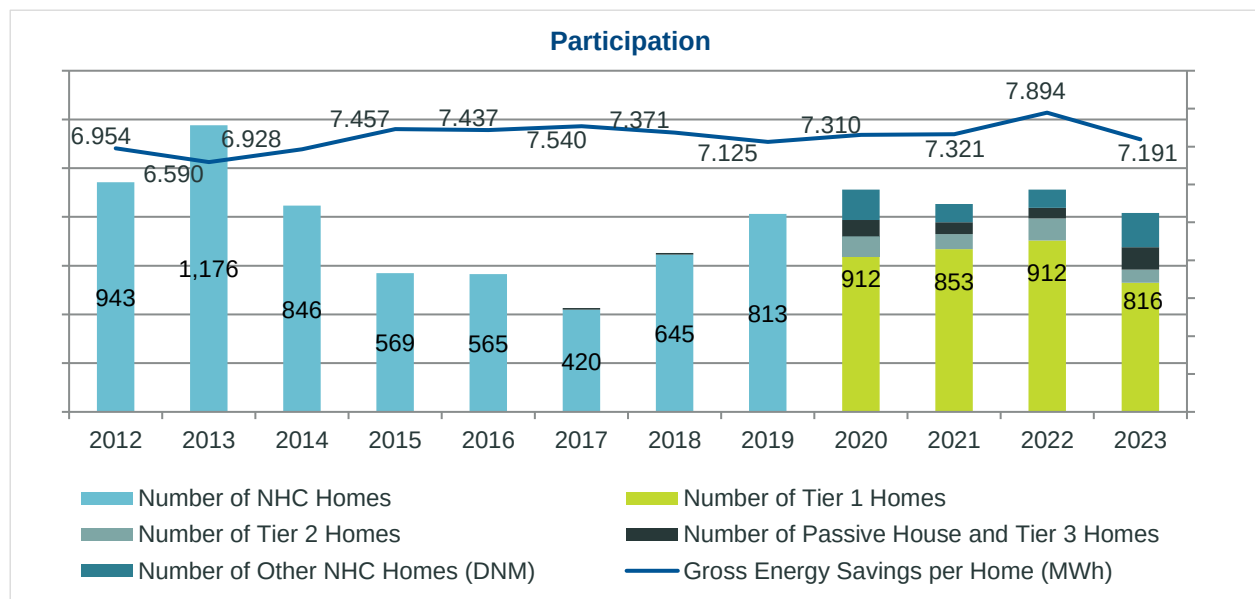
1.2 Follow-up on Past Evaluation Report Recommendations

Given the program ceased operation in 2023, the past recommendations are no longer relevant.

1.3 Participation History

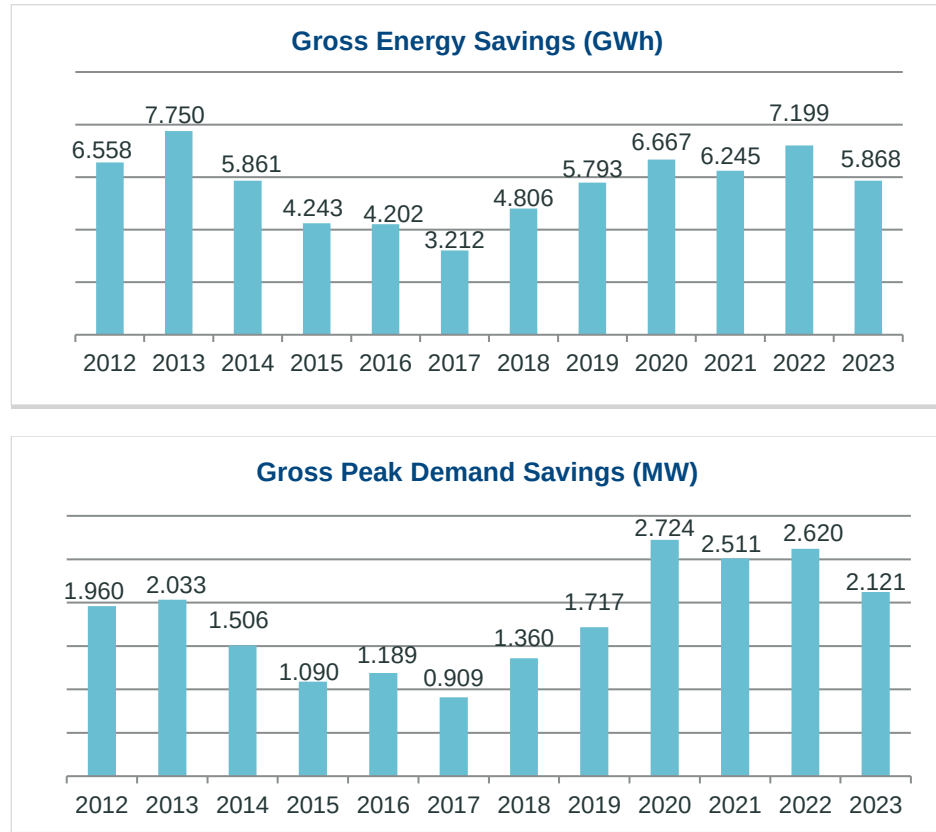
The evolution of NHC participation levels as well as that of gross energy and peak demand savings from 2012 to 2023 is presented in Figure 2 and Figure 3 below, respectively. A total of 816 houses were completed in 2023, which represents a reduction of 11% compared to the 2022 level. Of those homes 530 qualified under Tier 1, 54 under Tier 2, and 92 under Tier 3. A total of 140 houses did not meet (DNM) the minimum requirement to qualify for a rebate, which is higher than the 75 homes that did not meet the minimum requirement in 2022. Each year, savings are claimed for such houses because they received an assessment of their house plans and were influenced by NHC to improve home energy performance even if they did not reach the minimum standard required to receive a rebate.

Figure 2: Overview of NHC Participation, 2012-2023³



³ 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.

Figure 3: Evolution of NHC Gross Savings at the Generator, 2012-2023



2 NHC Evaluation Approach

The scope of this evaluation was a condensed impact evaluation. Given the program was wound down in 2023, savings calculations are based on the parameters (e.g. overestimation ratios (ORs)) of the Home Energy Assessment (HEA) evaluation results.

The main objectives of the 2023 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 emissions

The Evaluator identified key research questions aimed at achieving these objectives. Table 6 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 6: 2023 NHC Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Calculate gross results	› Are the data in the tracking sheet complete, accurate, and consistent? › Were the savings 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 net-to-gross ratio (NTGR) results from 2020 › Calculations using evaluation results › Avoided GHG emission reduction calculations

Tracking Sheet Audit

Prior to performing the savings calculation review, the Evaluator performed an audit of the final 2023 tracking sheet to ensure it was complete and the entered data were consistent. 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 Nova Scotia Power (NS Power) data.

3 NHC Impact Evaluation

The objectives of the 2023 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 results obtained from the tracking sheet audit are presented 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 (EUL) 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 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 Ratios

ORs are used to adjust the modelled energy consumption values generated in HOT2000 because the software tends to 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 7 presents the OR established for each scenario.

Table 7: 2023 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% electrical 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 2% of 2023 participant homes had a non-electrical backup heating system installed.

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.

$$CCHP \text{ Peak Demand Savings}_W = \frac{1,000}{3.412} \times HC_{min} \times \left(\frac{1}{COP_{base\_min}} - \frac{1}{COP_{ee\_min}} \right)$$

Table 8: Unitary Peak Demand Savings Values for CCHPs

Variable	Symbol	Value
Rated heating capacity of the new CCHP at outdoor air temperature of – 5 °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:

$$Non - CCHP \text{ Peak Demand Savings}_W = (Gross \text{ Energy Savings} - CCHP \text{ Energy Savings}) \times 0.283 \frac{W}{kWh}$$

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 2020-2023 Measure Assessment.⁴ 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 accounted for in the HOT2000 simulations.

3.2.4 Effective Useful Life

As part of the 2020-2023 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 2023 evaluation.

Table 9 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. The weighted average EUL value is 30.8 years.

Table 9: Summary of 2023 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 10 below presents the annual gross savings for NHC. The gross savings at the generator were calculated using line loss factors between the meter and the generator of 1.095 for energy savings and 1.147 for peak demand savings⁵. 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.⁶

⁴ The 2020-2023 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 and for the first year of the 2023-2025 DSM cycle, the Evaluator refers to the values presented in the 2020-2023 Measure Assessment

⁵ For municipal utility participants, the line loss factor of the most similar NS Power rate code was assumed.

⁶ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 10: Evaluated 2023 NHC Gross Energy and Peak Demand Savings

	Total
Number of Participants	816
Energy Savings	
Gross Energy Savings Without Overestimation Ratio (OR) – at the Meter (GWh)	6.449
Gross Energy Savings with OR – at the Meter (GWh)	5.360
Line Loss Factor	1.095
Gross Energy Savings with OR – at the Generator (GWh)	5.868
Effective Useful Life (years)*	30.8
Gross Lifetime Energy Savings – at the Generator (GWh)	180.731
Peak Demand Savings	
Peak Demand-to-energy Ratio (MW/GWh)**	0.345
Gross Peak Demand Savings – at the Meter (MW)	1.850
Line Loss Factor	1.147
Gross Peak Demand Savings – at the Generator (MW)	2.121
* 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 30.8 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.	

As presented in Table 11, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor⁷ for GHG emissions generated by electricity production to NHC gross savings.

Table 11: Evaluated 2023 NHC GHG Gross Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	5.868
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO ₂ eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	3,238

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.

⁷ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO₂ eq tonnes) and total electricity generation (10,456 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 December 1st, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22'23.pdf (Last accessed December 1st, 2023).

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 2023 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 NHC homeowner and builder applicants in 2023, as outlined in Table 12.

Table 12: 2023 NHC Overall Free-ridership Level

	Free-ridership Level from 2019	Margin of Error	Participation Proportion in 2023	2023 Overall Free-ridership Level (Homeowners and Builders Combined)
Participant Homeowners	28%	7.6%	21%	24%
Participant Builders	23%	5.3%	79%	

3.3.2 Spillover (Market Effects)

Spillover occurs when participants decide to implement energy efficiency measures in new construction projects without participating in a 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.

$$\text{Spillover Level} = \frac{\text{Total \# of } N - P \text{ Houses} \times \%N - P \text{ Houses}_{EE} \times \%Attrib \times \%Elect}{\text{Total \# of Participating Houses}}$$

Since the number of houses built in Nova Scotia in 2023 was not available at the time of the evaluation, the 14% spillover level established in 2022 was applied for the 2023 evaluation.

3.3.3 Net-to-gross Ratio Calculation

The NHC NTGR is calculated using the following equation.

$$NTGR = (1 - \%Free - ridership + \%Spillover [Market Effects])$$

By applying the free-ridership and spillover levels discussed in the previous subsections, the NHC NTGR value was estimated at 0.90 as presented in Table 13.

Table 13: 2023 NHC NTGR

Free-ridership	Participant Spillover	NTGR
24%	14%	0.90

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 calculation above to the evaluated gross savings as exemplified in the following equation.

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

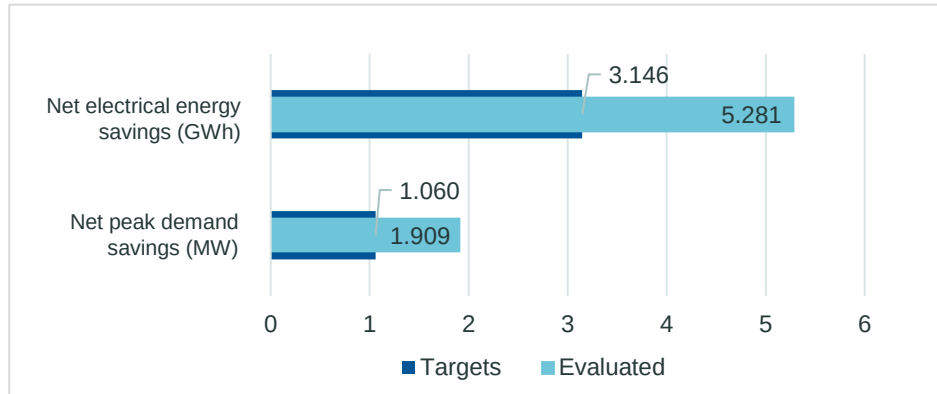
This equation was used to calculate both energy and peak demand savings. Detailed results are presented in Table 14. The net energy savings resulted in 2,915 tonnes of CO₂ eq in net annual GHG emission reductions.

Table 14: Evaluated 2023 NHC Net Energy and Peak Demand Savings

Total	
Energy Savings	
Gross Energy Savings – at the Meter (GWh)	5.360
NTGR	0.90
Net Energy Savings – at the Meter (GWh)	4.824
Line Loss Factor	1.095
Net Energy Savings – at the Generator (GWh)	5.281
Effective Useful Life (years)*	30.8
Net Lifetime Energy Savings – at the Generator (GWh)	162.658
Peak Demand Savings	
Gross Peak Demand Savings – at the Meter (MW)	1.850
NTGR	0.90
Net Peak Demand Savings – at the Meter (MW)	1.665
Line Loss Factor	1.147
Net Peak Demand Savings – at the Generator (MW)	1.909
* 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 30.8 years.	

As outlined in Figure 4, NHC exceeded its electrical energy and peak demand savings targets by 68% and 80% respectively.

Figure 4: 2023 NHC Targets and Evaluated Results



3.4 Realization Rate

A comparison of the energy and peak demand savings values established through the 2023 evaluation to those tracked by EOne is presented in Table 15. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy and peak demand savings.

Table 15: Comparison of 2023 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	5.868	GWh	0.91	5.340	GWh	99%
Evaluation Results	5.868	GWh	0.90	5.281	GWh	
Peak Demand Savings						
Tracked Savings by EOne	2.121	MW	0.91	1.930	MW	99%
Evaluation Results	2.121	MW	0.90	1.909	MW	
* The NTGRs listed in this table match the rounded averages obtained by dividing net savings by gross savings.						

Both the evaluated gross energy and peak demand savings determined by the Evaluator were identical to the initial gross savings tracked by EOne. The evaluated net energy and peak demand savings determined by the Evaluator were 1% below the net results tracked by EOne due to the slight decrease to the NTGR value resulting from the different mix of participant homeowners and builders.



4 NHC Key Findings and Recommendations

As mentioned previously, the main objectives of the 2023 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 emissions

This section provides the Evaluator's key findings in relation to the above objectives. The Evaluator had no recommendation as part of the 2023 NHC evaluation.

2023 NHC-Finding: NHC net electrical energy and peak demand savings exceeded targets.

NHC achieved 5.281 GWh in net electrical energy savings and 1.909 MW in net peak demand savings at the generator in 2023, thus exceeding the planned net electrical energy savings of 3.146 GWh and net peak demand savings of 1.060 MW.

2023 NHC-Finding: NHC participation decreased by 11% in 2023.

With a total of 816 completed houses, the 2023 participation level decreased by 11% compared to 2022. 530 of those homes qualified under Tier 1, 54 under Tier 2, and 92 under Tier 3. A total of 140 houses did not meet the minimum requirement to qualify for a rebate, which is higher than the 75 homes that did not meet the minimum requirement in 2022.

2023 NHC-Finding: Evaluated gross savings were identical to the savings tracked by EOne, while evaluated net savings were slightly lower.

The net evaluated energy and peak demand savings determined by the Evaluator were both 1% lower than the net results tracked by EOne due to the slight decrease to the NTGR value due to the different mix of participant homeowners and builders (in 2022 the proportion of participants who were homeowners was 25% while in 2023 was 21%).

CONCLUSION

Table 16 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 16: Overall 2023 New Residential Participation and Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
NHC							
Energy Savings	816	Participants	5.868	GWh	0.90	5.281	GWh
Lifetime Energy Savings			180.731	GWh	0.90	162.658	GWh
Peak Demand Savings			2.121	MW	0.90	1.909	MW
Annual GHG Emission Reductions			3,238	Tonnes of CO2 eq	0.90	2,915	Tonnes of CO2 eq
EUL			30.8	Years		30.8 ⁸	Years

Figure 5 and Figure 6 below illustrate the net energy and peak demand savings targets and results for the New Residential program in 2023. New Residential was aimed at achieving 3.146 GWh in net electrical energy savings and 1.060 MW in net peak demand savings at the generator for 2023. The program exceeded its net energy and peak demand savings targets by 68% and 80% respectively.

Figure 5: 2023 New Residential Targeted and Evaluated Net Energy Savings

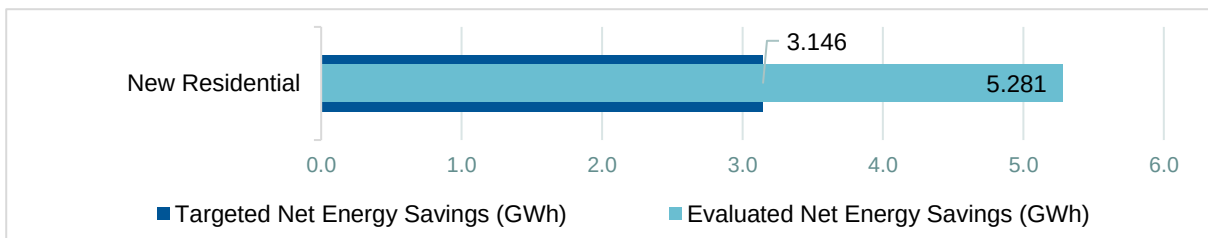
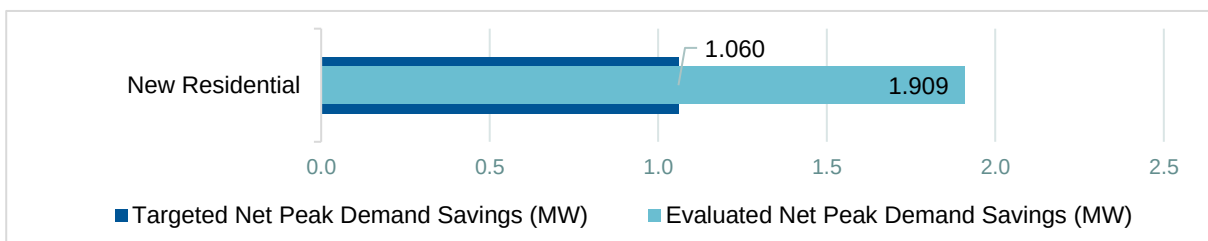


Figure 6: 2023 New Residential Targeted and Evaluated Net Peak Demand Savings



⁸ 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 30.8 years



LIST OF APPENDICES

The following are presented in the New Residential Program – Appendices document.

New Home Construction

Appendix I: Tracking Sheet Audit

Appendix II: 2023 Recommendations



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com



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NEW RESIDENTIAL PROGRAM

Appendix Report

2023 DSM EVALUATION

March 11, 2024



ECONOLUX



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APPENDIX I

Tracking Sheet Audit

This appendix presents the main 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

Table 1 presents the corrected tracked savings resulting from all changes made by the Evaluator.

Table 1: 2023 NHC Corrected Tracked Savings

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
NHC					
Gross Energy Savings – at the Generator	5.847	GWh	5.868	GWh	0.36%
Gross Peak Demand Savings – at the Generator	1.733	MW	2.121	MW	22.38%
Net Energy Savings – at the Generator	5.340	GWh	5.340	GWh	0.00%
Net Peak Demand Savings – at the Generator	1.937	MW	1.930	MW	-0.35%

The tracked net energy savings values were slightly increased because the corrected savings include the gross savings of three supplemental files and exclude the negative savings of one participant. The tracked value for gross peak demand savings was increased by 22% mainly because the more recent calculation methodology for peak demand savings established in 2020 had not been used. However, the net tracked energy savings were correctly calculated and were only negligibly increased because of a participant with negative savings. The net peak demand savings were slightly reduced since the removed participant with negative energy savings had positive peak demand savings.



APPENDIX II

2023 Recommendations

The Evaluator has no specific recommendation for NHC. No major improvement recommendations were made for NHC in previous years.



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com





EfficiencyOne

EFFICIENT PRODUCT REBATES PROGRAM

Final Report

2023 DSM EVALUATION

March 12, 2024



ECONOLUX



ABBREVIATIONS

BER	Business Energy Rebates
BNI	Business, non-profit and institutional
CEE	Consortium for Energy Efficiency
DLC	DesignLights Consortium
DSM	Demand-side management
EER	Energy efficiency ratio
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
EUL	Effective useful life
GHG	Greenhouse gas
HOU	Hours of use
HSPF	Heating seasonal performance factor
HVAC	Heating, ventilation and air conditioning
ISR	In-service rate
LED	Light-emitting diode
MA	Measure Assessment
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
SEER	Seasonal energy efficiency ratio
VFD	Variable frequency drive

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.
Available Demand Response Capacity	The capacity which is available to NSP to reduce system peak demand. This capacity is calculated based on the first two hours of all events called between December and February, excluding weekends and holidays. If an event is shorter than two hours, only the first hour is used to measure the available DR capacity. Available DR capacity is evaluated on a per-participant basis, based on the average demand reduction observed for each event that the participant was scheduled to participate in. E1's total available DR capacity is the sum of each participant's available DR capacity.
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 base consumption.
Bias	Systematic deviations of measurements from the true value.
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.
Confidence interval	The estimated range of values that is likely to include unknown population parameters.
Demand response	Demand response measures generate savings in the form of available capacity or load reduction in response to events called by the electric utility (Nova Scotia Power) to reduce the load at strategic moments. These events can be called at any time and for any duration, although they are usually called for one to three hours during peak periods.
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 home 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 a home is through modelled home 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 equipment life and 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 CO2	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, gas 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 ratios, etc.) validated or measured during the evaluation process. Unless otherwise specified, evaluated savings are 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 a building (such as heating and cooling) due to the installation of an energy efficiency measure.
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 and 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 a program on the market (such as increased product availability, practices, and prices) that extends beyond changing program participant behaviours. 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 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. For industrial participants on an interruptible rate, peak demand savings may include savings on non-firm loads, i.e. loads that may be interrupted when Nova Scotia Power's 10-minute reserve is low.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	An error in measurement because 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.
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.
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 net-to-gross ratios. Those parameters, except 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. A 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).



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EXECUTIVE SUMMARY

This report presents the 2023 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 Application Rebates and Instant Rebates 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 types of evaluation conducted for the program component and the corresponding methodology.

Table 1: Summary of 2023 Efficient Product Rebates Program Evaluation

Program Component	Evaluation Type			Methodology
	Impact	Process	Market	
BER	Condensed			› Tracking sheet audit › Effective useful life (EUL) update › Calculations using evaluation results › Avoided GHG emission reduction calculations › Use of the 2021 Application Rebates net-to-gross ratio (NTGR) results and the 2022 Instant Rebates NTGR results

Program Performance

Table 2 presents the participation levels, NTGRs, evaluated gross and net savings at the generator, annual GHG emission reductions, as well EUL values for each service and Efficient Product Rebates as a whole.

Table 2: Overall 2023 Efficient Product Rebates Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
Application Rebates							
Energy Savings	227	Projects	11.406	GWh	0.74	8.440	GWh
Lifetime Energy Savings			193.870	GWh	0.74	143.464	GWh
Peak Demand Savings			1.854	MW	0.74	1.372	MW
Annual GHG Emission Reductions			6,295	Tonnes of CO2 eq	0.74	4,658	Tonnes of CO2 eq
EUL			17.0	Years		17.0	Years
Instant Rebates							
Energy Savings	240,886	Products sold	36.639	GWh	0.83	30.373	GWh
Lifetime Energy Savings			498.827	GWh	0.83	412.834	GWh
Peak Demand Savings			5.609	MW	0.83	4.642	MW
Annual GHG Emission Reductions			20,221	Tonnes of CO2 eq	0.83	16,763	Tonnes of CO2 eq
EUL			13.6	Years		13.6	Years
Total							
Energy Savings			48.045	GWh	0.81	38.814	GWh
Lifetime Energy Savings			692.697	GWh	0.80	556.298	GWh
Peak Demand Savings			7.463	MW	0.81	6.014	MW
Annual GHG Emission Reductions			26,516	Tonnes of CO2 eq	0.81	21,421	Tonnes of CO2 eq
EUL			14.4	Years		14.3	Years
* The average NTGR values presented in the total correspond to the ratios of net savings to gross savings for both Application Rebates and Instant Rebates.							

Efficient Product Rebates was aimed at achieving 30.007 GWh in net electrical energy savings and 5.340 MW in net peak demand savings at the generator for 2023. The program exceeded both planned net electrical energy savings 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 from the BER evaluation. The Evaluator has no recommendations for BER.

2023 BER-Finding: BER net electrical energy savings and peak demand savings both exceeded targets by 29% and 13% respectively.

2023 BER-Finding: Instant Rebates participation increased by 19% in 2023. While Application Rebates participation decreased by 21% in 2023, its gross energy savings per participant increased by 11% compared to 2022. Overall, BER gross energy savings and peak demand savings increased respectively by 5% and 4% between 2022 and 2023 mainly due to the increase of Instant Rebates savings generated by light-emitting diode (LED) linear lamps and LED linear fixtures.

2023 BER-Finding: Evaluated net energy savings were less than 1% lower than the values tracked by EOne for Application Rebates, while peak demand savings were identical. Both evaluated net energy and peak demand savings were less than 1% higher than tracked results for Instant Rebates.

Program Tracked and Evaluated Savings

Table 3 compares EOne tracked energy and peak demand savings to evaluated savings at the generator. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings. Furthermore, the NTGRs are also presented and 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 other sections.

Table 3: Comparison of 2023 Tracked and Evaluated Savings at the Generator

		Gross Savings		NTGR	Net Savings		Realization Rate
		Value	Unit		Value	Unit	
BER	Energy Savings						
	Tracked Savings by EOne	48.166	GWh	0.81	38.907	GWh	100%
	Evaluation Results	48.045	GWh	0.81	38.814	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	7.476	MW	0.81	6.025	MW	100%
	Evaluation Results	7.463	MW	0.81	6.014	MW	
*Different NTGRs were established for Application Rebates 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 established through this evaluation were almost identical to those calculated in the 2023 tracking sheet.

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 demand-side management (DSM) for Nova Scotians. EOne provides energy efficiency, demand response and carbon mitigation services through the Efficiency Nova Scotia (ENS) franchise. Regulatory oversight is provided by the Nova Scotia Utility and Review Board (NSUARB). EOne receives funding for its electricity 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 ENS franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2023 DSM program portfolio.

This evaluation report relates to the Efficient Product Rebates program, which is comprised of Business Energy Rebates (BER) program component. Table 4 below lists the Efficient Product Rebates program component and the type of evaluations conducted for 2023. 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, 2023

Program	Program Component	2023		
		Process	Market	Impact
Efficient Product Rebates	BER			Condensed

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

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

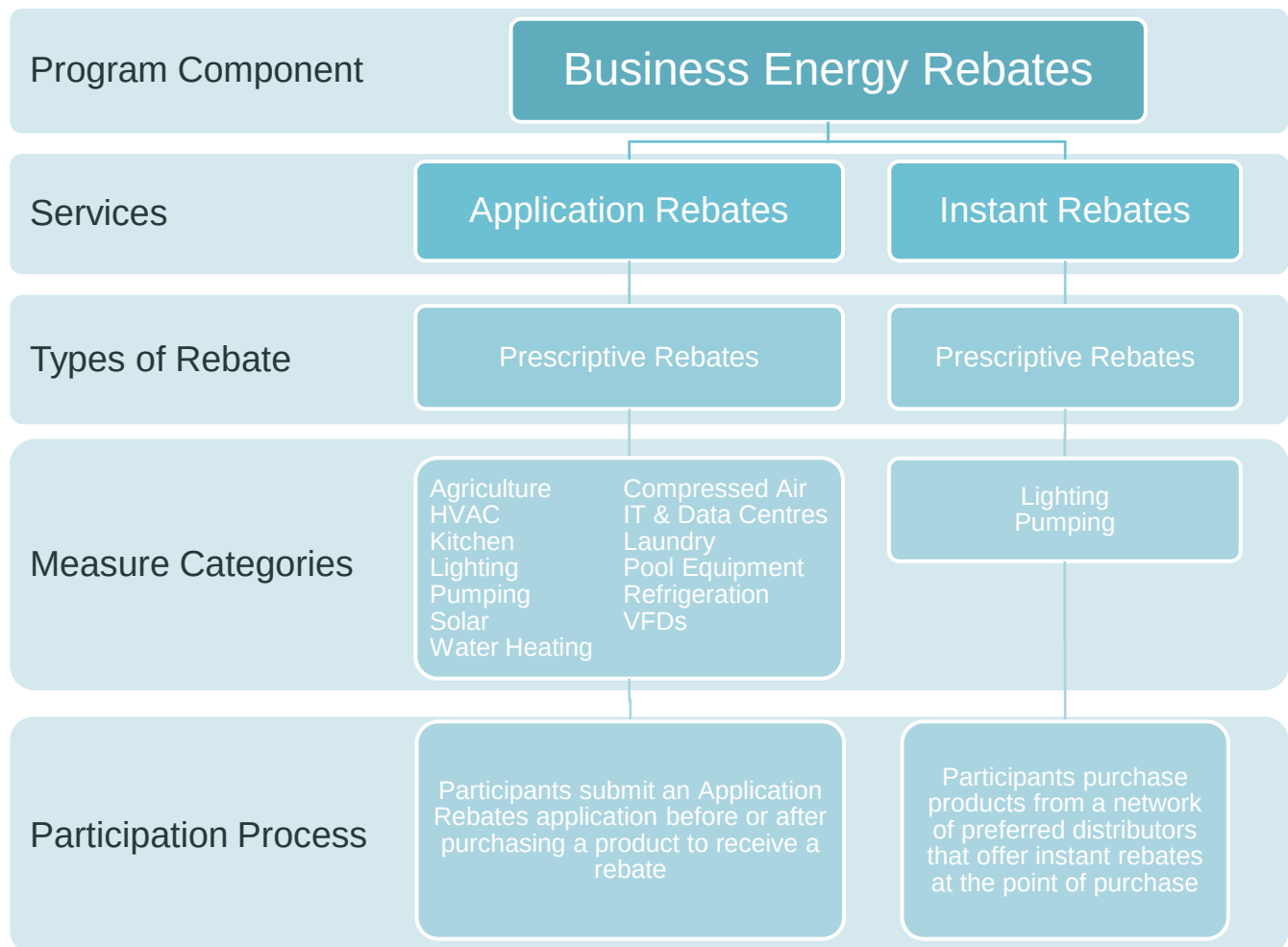
1 BER Overview

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 1 presents an overview of the program component.

Figure 1: BER Program Component 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 DesignLights Consortium (DLC) and the National Electrical Manufacturers Association.

Rebates offered through BER are delivered through two services, namely through the Application Rebates service formerly known as the Mail-in service and through the Instant Rebates service. Instant Rebates reaches a greater number of participants and offers quick and convenient access to BER but limited participant details tracking. Conversely, Application Rebates allows for better project-level control since more participant details are provided to EOne. All the BER technologies are available through Application Rebates, 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. Distributors also provide customer service for measures that are only eligible through Application Rebates by sharing their expertise and assisting with completing applications.

In an effort to increase participation, EOne increased the rebate amounts on select lighting measures during the second half of 2022 and the first quarter of 2023.

BER was aimed at achieving 30.007 GWh in net electrical energy savings and 5.340 MW in net peak demand savings at the generator in 2023.

1.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated BER in previous years and issued improvement recommendations. Table 5 below provides a summary of the implementation status of past recommendations that have been completed or are in progress.

The Evaluator notes that only one recommendation from 2022 is still in progress.

Table 5: Implementation Status of Past Recommendations for BER

#	Past Recommendations	Status	Comments
2018 BER-R3	Investigate ways to liaise more clients with non-lighting contractors.	Complete	In the second quarter of 2022, EOne conducted a survey with Instant Rebates participating organizations. Questions ranged from how EOne can improve their marketing efforts to what they feel is the next biggest non-lighting product category. Results are being reviewed by program staff and common themes will inform future program changes. EOne Instant Rebates staff have also been participating in regular BNI-focused Preferred Partners Network training sessions to answer questions and provide information about how contractors and their customers can participate in Instant Rebates. The Evaluator considers that EOne has taken various steps to address this recommendation.
2022-BER-R1	Develop a process for Application Rebates to ensure that, prior to offering a new quasi-prescriptive measure, savings algorithms are established and that key information is collected and tracked.	Complete	BER has adopted EOne's standardized approach to adding new measures, which includes discussing new measures ahead of time with EOne's Engineering and Planning team and following the TRC and PAC testing protocols established by EOne. When adding new measures, EOne will also discuss these measures with the third-party evaluator to determine the key information required for data collection and tracking.

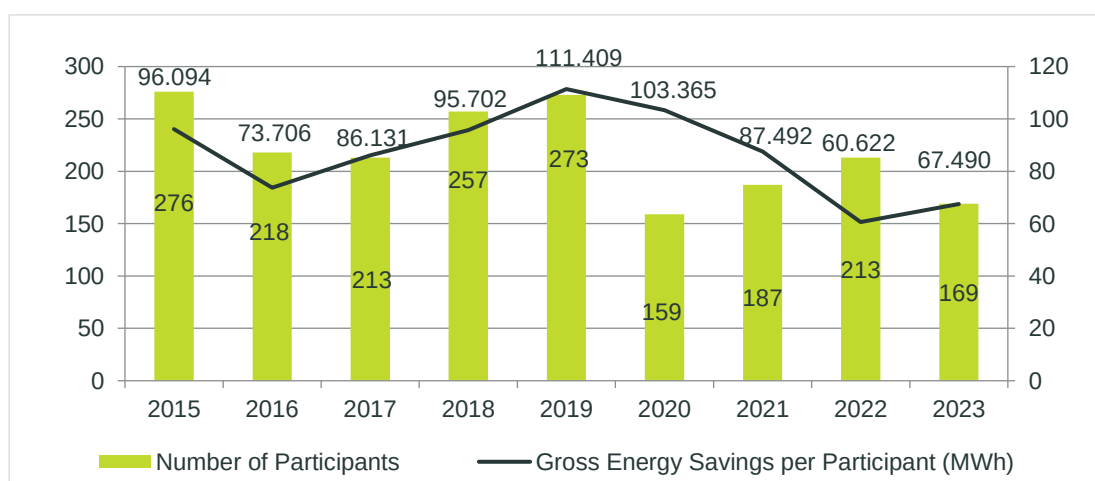
#	Past Recommendations	Status	Comments
2022-BER-R2	Explore ways to increase BER decision-makers' awareness about the DLC Premium certification, for example through the promotion of DLC Premium lighting rebates, conferences, training sessions, and webinars.	Complete	In Q1 2023, the EOne program team delivered a webinar with distributor partners and members of the public to discuss the evolution of BER and the potential for higher rebates for DLC premium products. The EOne marketing team will include DLC Premium products only in all promotional materials related to lighting. In addition, BER was the focus of an Efficiency Preferred Partners (EPP) pilot that incentivizes contractors and distributor partners to participate in BER Application Rebates in 2023. In an effort to highlight the benefits of DLC Premium products, only projects that serve to install DLC Premium lighting were eligible for the EPP bonus incentive. The Evaluator considers that EOne has taken various steps to address this recommendation.
2022-BER-R3	Consider increasing DLC Premium rebates to counterbalance the higher prices of DLC Premium products compared to DLC Standard products.	Complete	EOne agrees with this recommendation, and DLC premium products currently offer a higher rebate in select measure categories compared to DLC standard products.

1.3 Participation History

BER Application Rebates

In 2023, 12,912 units were rebated with the vast majority of those being in the lighting category (94%). A total of 227 projects were implemented by 169 unique participants² under Application Rebates. Figure 2 below illustrates how Application Rebates participation has evolved since 2015. The number of participating businesses decreased in 2023 with 21% fewer participating businesses compared to 2022. This decrease in participants correlated to a 19% decrease in the number of completed Application Rebates projects, although the gross savings achieved per participant increased by 11%.

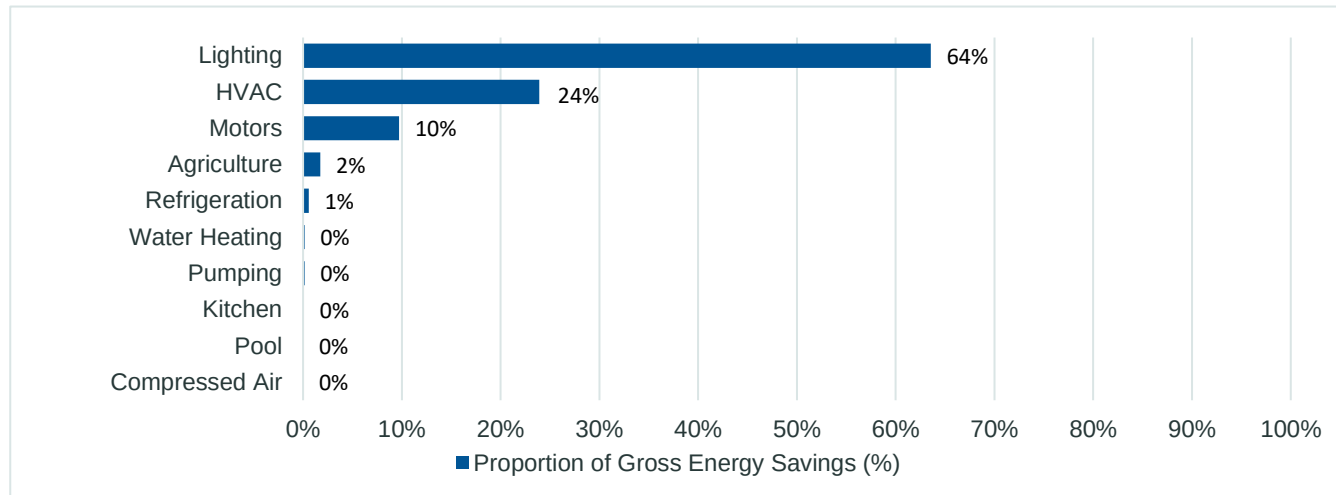
Figure 2: Overview of Participation in Application Rebates, 2015-2023



² The number of unique participants in Application Rebates corresponds to the number of businesses that participated in the service.

Figure 3 below illustrates the distribution of gross savings among Application Rebates measure categories. With 64% and 24% in gross savings being respectively generated by the lighting and heating, ventilation and air conditioning (HVAC) measure categories, these two categories account for most Application Rebates savings (88% in total). For 2023, the Evaluator observed a return to 2021 levels in the proportion of Application Rebates savings generated by lighting measures following a dip in 2022. In 2021 and 2022 respectively, 64% and 57% in gross energy savings were attributed to lighting. The water heating, motor, pumping, pool, and compressed air measure categories each represented less than 1% of total savings. The IT & data centre and laundry measure categories were not included in Figure 3 since no projects in those measure categories were submitted in 2023.

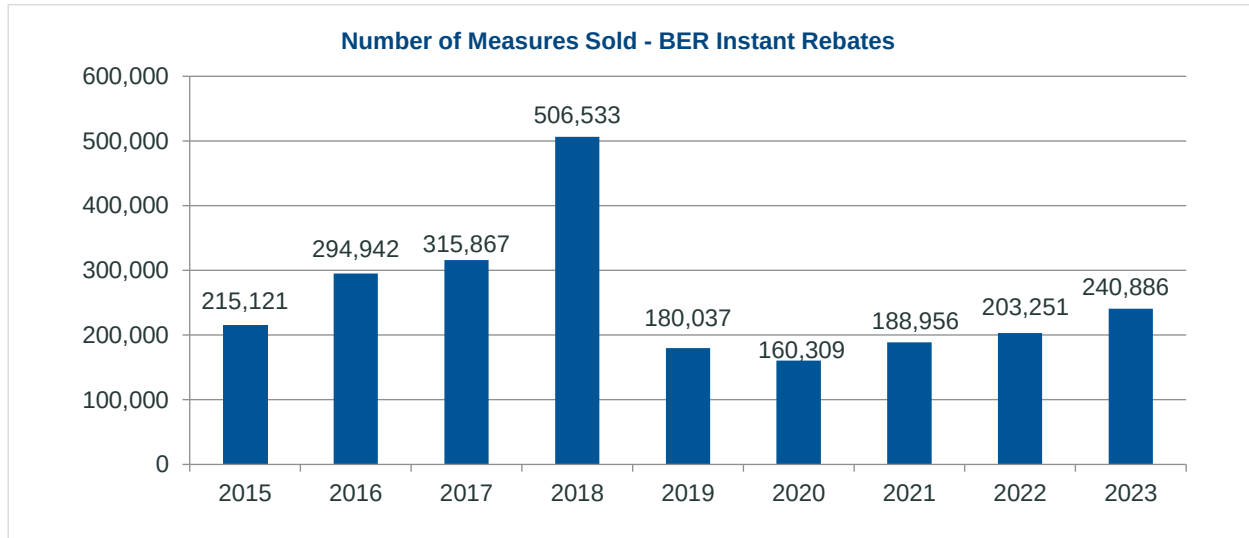
Figure 3: Distribution of 2023 Application Rebates Gross Energy Savings by Measure Category



BER Instant Rebates

Participant information tracking has improved over the past few years. Although the tracking sheet does indicate the total number of measures rebated through the program, the available data collected by distributors does not directly correlate to Instant Rebate participant numbers. Figure 4 indicates that 240,886 measures were rebated through Instant Rebates in 2023, a 19% increase compared to 2022 levels.

Figure 4: Instant Rebates Measures Rebated, 2015-2023



As outlined in Figure 5 below, participation levels increased for the four main lighting measures in 2023, with LED linear lamps and LED linear fixtures having the largest increases (25% and 14% respectively) compared to 2022. LED directional and architectural fixtures and circulator pumps were the only two measures that had lower participation levels than in 2022 (58% and 35% respectively).

Figure 5: Instant Rebates Measures Rebated, 2022-2023

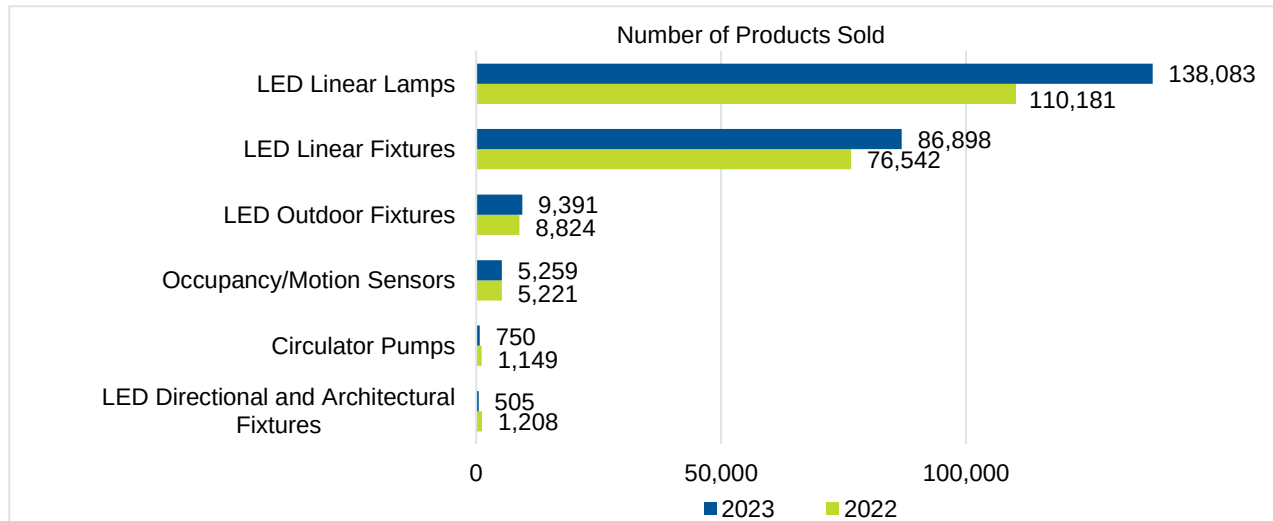
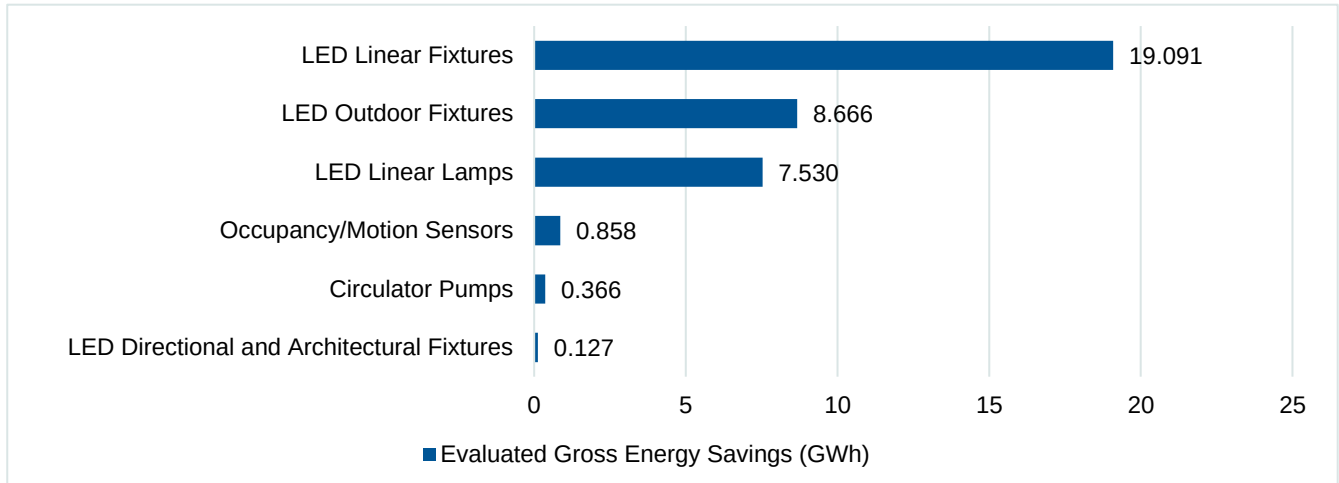


Figure 6 provides an overview of the distribution of Instant Rebates gross savings among the various pumping and lighting measures. In 2023, LED linear fixtures generated the largest share of gross savings (52%) followed by LED outdoor fixtures (24%) and LED linear lamps (21%).

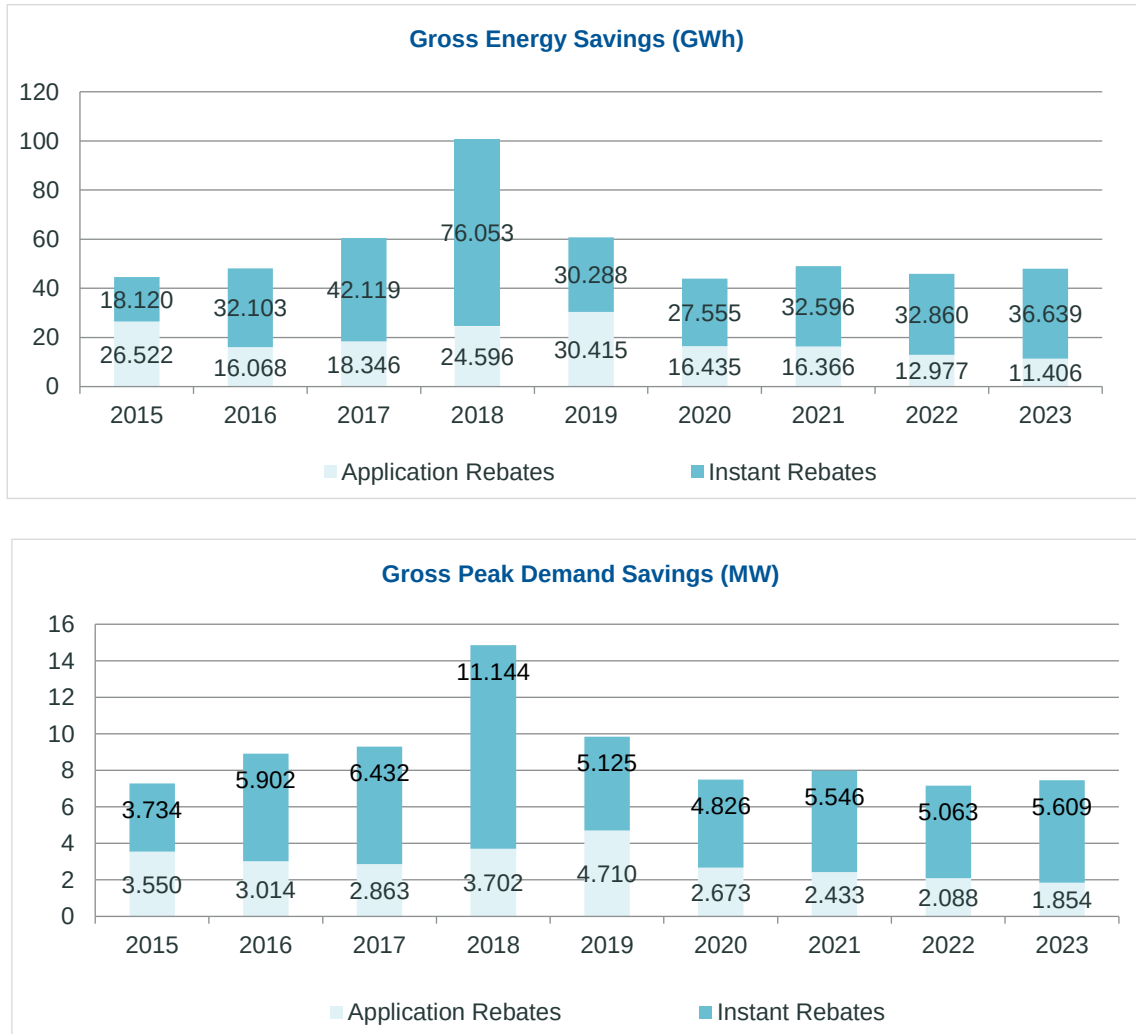
Figure 6: Distribution of 2023 Instant Rebates Gross Savings by Measure



BER Overall

As presented in Figure 7 below, BER generated a total of 48.045 GWh in gross energy savings at the generator in 2023, which represents a 5% increase compared to 2022 results and a return to 2021 levels. In 2023, gross peak demand savings totalled 7.463 MW for both Application Rebates and Instant Rebates, representing a 4% increase from 2022. This was due mainly to the increase in Instant Rebates savings generated by LED linear lamps and LED linear fixtures.

Figure 7: Evolution of BER Gross Savings, 2015-2023



2 BER Evaluation Approach

The 2023 BER evaluation comprised a condensed impact evaluation. The main objectives of the 2023 BER evaluation were as follows:

- › Calculate gross and net BER results (for both Application Rebates and Instant Rebates), namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions.

The Evaluator identified key research questions aimed at achieving these objectives. Table 6 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.

Table 6: 2023 BER 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 › EUL 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 for BER?	› Use of the 2021 Application Rebates NTGR results and the 2022 Instant Rebates NTGR results › 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 2023 tracking sheets to ensure they were complete and the entered data were consistent. The detailed protocols used for the Application Rebates and Instant Rebates tracking sheet audits and the results obtained are presented in Appendix I and Appendix II respectively.

EUL Update

The Evaluator 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 3 and Section 4 below.

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 precision³ of a measurement, while its associated confidence level indicates the probability of a measurement falling within the margin of error.⁴

As part of the condensed BER evaluation, no data-collection activities warranted the calculation of margins of error.

³ 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.

⁴ As part of this evaluation, the confidence levels and 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 Impact Evaluation for Application Rebates

The objectives of the 2023 Application Rebates impact evaluation were to determine 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 results obtained from the tracking sheet audit are presented 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 refer to changes in energy consumption resulting from actions taken by participants regardless of their reasons for participating.⁵ For each Application Rebates project, EOne tracks annual gross savings using the equations defined in the most up-to-date BER CIRx Screening Tool (version 1.6), an EOne tool presenting the savings calculation methodologies, assumptions, and equipment parameters specific to each project.

3.2.1 Adjustment Ratios

Table 7 outlines the adjustment ratios applied in the 2023 evaluation. These ratios were all established using 2022 project review results with the exception of the lighting measure category whose ratio was not updated in 2022 and uses the values established in the 2021 evaluation.

Table 7: 2023 Application Rebates 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	1.002	0.3%	1.000	2.1%
Variable Frequency Drives (VFDs)	1.000	-	1.000	-
Pumping	1.000	-	1.000	-
Refrigeration	1.000	-	1.000	-
Agriculture	1.002	0.2%	1.039	4.0%
Kitchen	1.000	-	1.000	-
IT & Data Centres	1.000	-	1.000	-
Water Heating	1.000	-	1.000	-
Compressed Air	1.000	-	1.000	-
Pools	1.000	-	1.000	-
Laundry	1.000	-	1.000	-
Solar	1.000	-	1.000	-

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

In addition to the adjustment ratio listed above for HVAC measures, the Evaluator corrected the heating seasonal performance factor (HSPF) and seasonal energy efficiency ratio (SEER) of heat pumps to correspond to the new metrics, namely HSPF2 and SEER2, which are required by Amendment 17 to the Energy Efficiency Regulations. To convert HSPF and SEER values, the Evaluator used the crosswalk factors developed by the CEE,⁶ which are outlined below.

Table 8: Factors for Converting SEER, EER and HSPF to SEER2, EER2 AND HSPF2

Heat Pump Type	SEER2	EER2	HSPF2
Ducted	0.95	0.95	0.85
Non-ducted	1.00	1.00	0.90
Packaged	0.95	0.95	0.84

This change only impacted small heat pumps since SEER and HSPF values are not used to estimate the savings of large heat pumps (>65,000 Btu/hr). The adjustments made to SEER and HSPF values corresponded to an adjustment ratio of 0.974 for HVAC measure category energy savings. Peak demand savings were not impacted by this change because their estimation does not rely on any of these metrics.

3.2.2 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 BER CIRx Screening Tool. For BER, interactive effects only apply to indoor lighting projects. A recalculation of adjustments to lighting savings was not included in the scope of the 2023 evaluation. Based on site visit observations during a previous evaluation, 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 BER CIRx Screening Tool value that most accurately corresponded to the situation observed on site. Lighting interactive effects adjustments are included in the adjustment ratio applied to the 2023 evaluation and are presented in Subsection 3.2.1 above.

3.2.3 Effective Useful Life

As part of the 2020-2023 Measure Assessment (MA)⁷ 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 previous evaluations remained valid for the 2023 evaluation.

The evaluated equivalent EUL values are applied to each measure 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 and is equal to 17.0 years. (see Subsections 3.2.4 and 3.3.4 below).

⁶ Consortium for Energy Efficiency, *Converting Between Appendices M and M1*, 2023.

<https://cee1.my.site.com/s/resources?id=a0V2R00000sUQbyUAG> (Last accessed February 14th, 2024).

⁷ The 2020-2023 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 and for the first year of the 2023-2025 DSM cycle, the Evaluator refers to the values presented in the 2020-2023 Measure Assessment.

3.2.4 Evaluated Gross Savings

The savings achieved for each Application Rebates measure category are presented in Table 9 below. Both energy and peak demand savings were revised by applying the adjustment ratios discussed in Subsection 3.2.1 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 2023 tracking sheet⁸. The line loss factors correspond to the values submitted to the NSUARB as part of the 2014 Cost of Service Study Progress Update.⁹

⁸ For municipal utility participants, the line loss factor of the most similar NS Power rate code was assumed.

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 2023 Application Rebates Gross Energy and Peak Demand Savings

Measure Category	Agriculture	Kitchen	Compressed Air	Water Heating	HVAC	Lighting
Energy Savings						
Tracked Gross Energy Savings Without Adjustment Ratio – at the Meter (GWh)	0.185	0.011	0.001	0.017	2.612	6.869
Tracked Adjustment Ratio on Energy Savings	1.002	1.000	1.000	1.000	1.002	0.993
Updated Adjustment Ratio on Energy Savings with HSPF2 Adjustment	1.002	1.000	1.000	1.000	0.974	0.993
Gross Energy Savings – at the Meter (GWh)	0.185	0.011	0.001	0.017	2.545	6.821
Line Loss Factor	1.082	1.094	1.095	1.063	1.072	1.063
Gross Energy Savings – at the Generator (GWh)	0.200	0.012	0.002	0.018	2.727	7.249
Effective Useful Life (years)	15.0	11.6	10.0	10.0	16.2	17.7
Gross Lifetime Energy Savings – at the Generator (GWh)	3.003	0.143	0.016	0.184	44.170	128.454
Peak Demand Savings						
Tracked Gross Peak Demand Savings – at the Meter (MW)	0.041	0.001	0.000	0.004	0.561	1.157
Overall Adjustment Ratio on Peak Demand Savings	1.039	1.000	1.000	1.000	1.000	0.841
Gross Peak Demand Savings – at the Meter (MW)	0.042	0.001	0.000	0.004	0.561	0.973
Line Loss Factor	1.099	1.137	1.147	1.070	1.093	1.069
Gross Peak Demand Savings – at the Generator (MW)	0.047	0.002	0.000	0.005	0.613	1.040

Evaluated 2023 Application Rebates Gross Energy and Peak Demand Savings (Continued)

Measure Category	Motors	Pool	Pumping	Refrigeration	Total for All Categories
Energy Savings					
Tracked Gross Energy Savings Without Adjustment Ratio – at the Meter (GWh)	1.043	0.002	0.016	0.062	10.818
Tracked Adjustment Ratio on Energy Savings	1.000	1.000	1.000	1.000	-
Updated Adjustment Ratio on Energy Savings with HSPF2 Adjustment	1.000	1.000	1.000	1.000	-
Gross Energy Savings – at the Meter (GWh)	1.043	0.002	0.016	0.062	10.704
Line Loss Factor	1.064	1.090	1.063	1.090	-
Gross Energy Savings – at the Generator (GWh)	1.110	0.002	0.017	0.067	11.406
Effective Useful Life (years)	15.0	10.0	15.0	14.5	-
Gross Lifetime Energy Savings – at the Generator (GWh)	16.651	0.024	0.252	0.973	193.870
Peak Demand Savings					
Tracked Gross Peak Demand Savings – at the Meter (MW)	0.125	0.000	0.001	0.011	1.902
Adjustment Ratio on Peak Demand Savings	1.000	N/A	1.000	1.000	-
Gross Peak Demand Savings – at the Meter (MW)	0.125	0.000	0.001	0.011	1.719
Line Loss Factor	1.068	N/A	1.070	1.146	-
Gross Peak Demand Savings – at the Generator (MW)	0.133	0.000	0.001	0.013	1.854

Figure 8 below compares the tracked and evaluated gross energy savings, while Figure 9 further below compares the tracked and evaluated gross peak demand energy savings.

The only differences between tracked and evaluated savings outlined in the figures are due to updating the HSPF and SEER values used in heat pump savings calculations to HSPF2 and SEER2.

Figure 8: 2023 Application Rebates Tracked and Evaluated Gross Energy Savings at the Generator

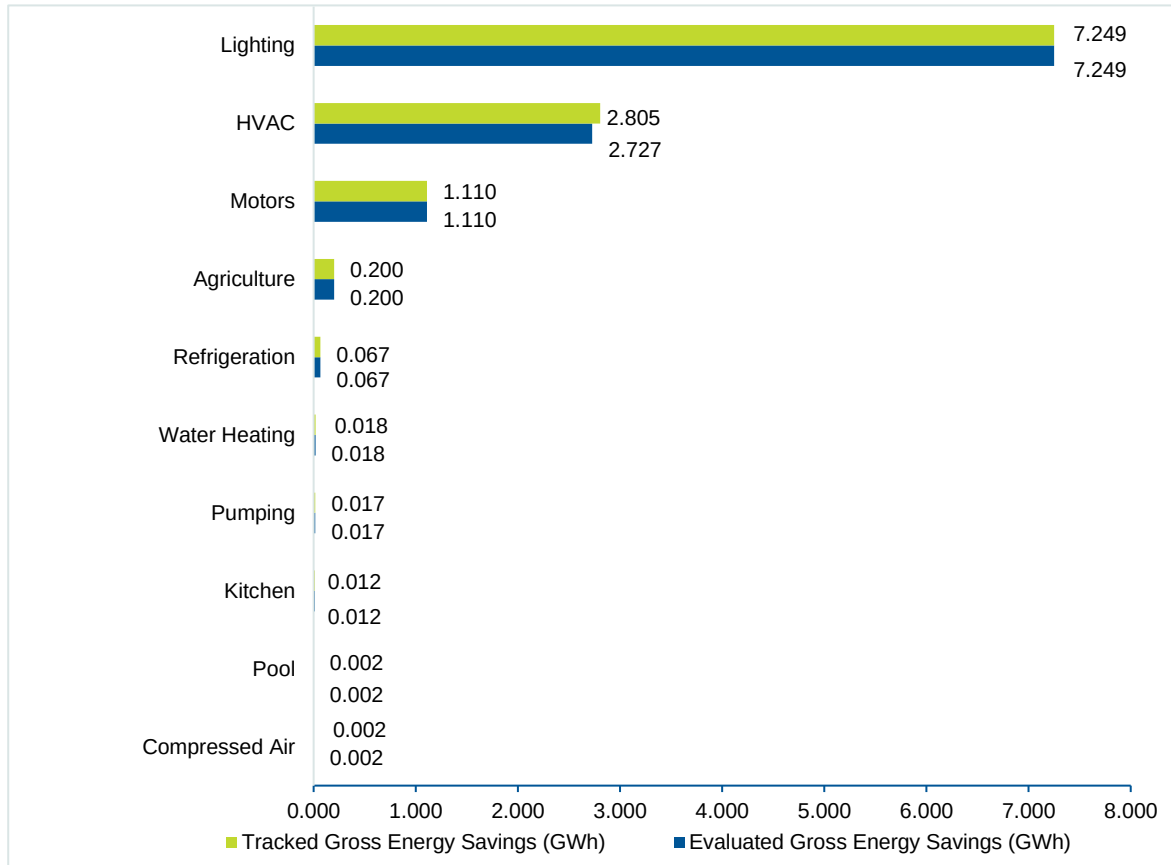
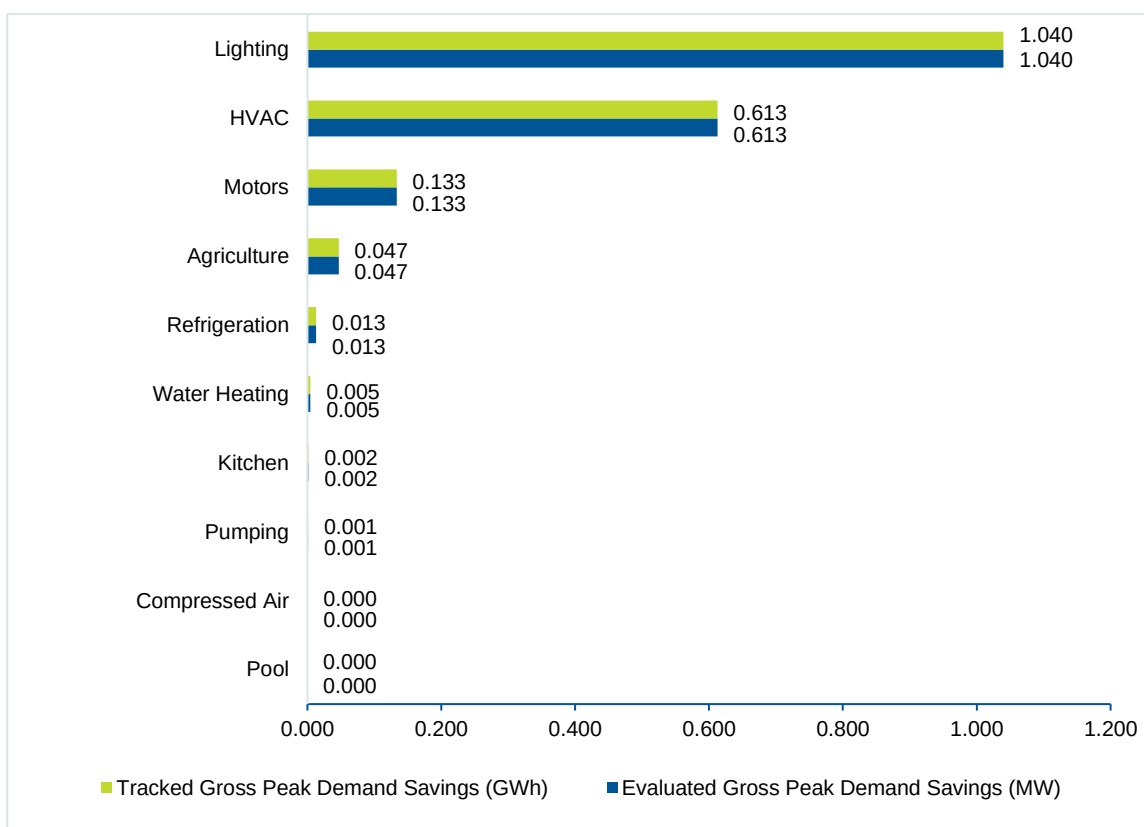


Figure 9: 2023 Application Rebates Tracked and Evaluated Gross Peak Demand Savings at the Generator



As presented in Table 10 below, GHG emissions reductions were calculated applying the Nova Scotia-specific factor¹⁰ for GHG emissions generated by electricity production to Application Rebates gross savings.

Table 10: Evaluated 2023 Application Rebates Gross GHG Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	11.406
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO2 eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO2 eq)	6,295

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 service, by estimating the NTGR. More precisely, the NTGR is established by considering the effects that positively or negatively affect energy savings, namely free-ridership and spillover.

¹⁰ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO2 eq tonnes) and total electricity generation (10,456 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 December 1, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22%2723.pdf (Last accessed December 1, 2023).

3.3.1 Free-ridership

In the case of Application Rebates, free-ridership occurs when participants would have still implemented energy efficiency measures in the absence of the service. The free-ridership level was assessed during the 2021 evaluation using a self-report approach that involved asking participants a set of questions during a telephone survey. Since no data collection aimed at updating the free-ridership level was conducted in 2023, the Evaluator used the 2021 free-ridership level.

Table 11 outlines the free-ridership level used for the 2023 evaluation.

Table 11: 2023 Application Rebates Free-ridership

Measure Category	Average Free-ridership Level	Margin of Error
All	26%	6.6%

3.3.2 Spillover

For Application Rebates, spillover occurs when participants implement eligible energy efficiency measures due to influence from previously participating in the service without having received any kind of additional support.

The 2022 evaluation found that the spillover level was nil; a spillover level of 0% was therefore used in 2023.

3.3.3 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 Application Rebates, the Evaluator calculated the NTGR value, the result of which is presented in Table 12.

Table 12: 2023 Application Rebates NTGR

Measure Category	Free-ridership	Spillover	NTGR
All	26%	0%	0.74

3.3.4 Evaluated Net Savings

Net savings are defined as the changes in energy use attributable specifically to Application Rebates. Net savings were estimated by applying the above NTGR to the evaluated gross savings, as illustrated in the following equation.

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

Detailed results are presented in Table 13 below. The net energy savings resulted in 4,658 tonnes of CO₂ eq in net annual GHG emission reductions.

Table 13: Evaluated 2023 Application Rebates Net Energy and Peak Demand Savings

Measure Category	Agriculture	Commercial Kitchen	Compressed Air	DHW	HVAC	Lighting
Energy Savings						
Gross Energy Savings – at the Meter (GWh)	0.185	0.011	0.001	0.017	2.545	6.821
NTGR	0.74	0.74	0.74	0.74	0.74	0.74
Net Energy Savings – at the Meter (GWh)	0.137	0.008	0.001	0.013	1.883	5.048
Line Loss Factor	1.082	1.094	1.095	1.063	1.072	1.063
Net Energy Savings – at the Generator (GWh)	0.148	0.009	0.001	0.014	2.018	5.365
Effective Useful Life (years)	15.0	11.6	10.0	10.0	16.2	17.7
Net Lifetime Energy Savings – at the Generator (GWh)	2.222	0.106	0.012	0.136	32.686	95.056
Peak Demand Savings						
Gross Peak Demand Savings – at the Meter (MW)	0.042	0.001	0.000	0.004	0.561	0.973
NTGR	0.74	0.74	0.74	0.74	0.74	0.74
Net Peak Demand Savings – at the Meter (MW)	0.031	0.001	0.000	0.003	0.415	0.720
Line Loss Factor	1.099	1.137	1.147	1.070	1.093	1.069
Net Peak Demand Savings – at the Generator (MW)	0.035	0.001	0.000	0.003	0.454	0.770

Evaluated 2023 Application Rebates Net Energy and Peak Demand Savings (Continued)

Measure Category	Motors	Pool	Pumping	Refrigeration	Total for All Categories
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	1.043	0.002	0.016	0.062	10.704
NTGR	0.74	0.74	0.74	0.74	0.74
Net Energy Savings – at the Meter (GWh)	0.772	0.002	0.012	0.046	7.921
Line Loss Factor	1.064	1.090	1.063	1.090	1.066
Net Energy Savings – at the Generator (GWh)	0.821	0.002	0.012	0.050	8.440
Effective Useful Life (years)	15.0	10.0	15.0	14.5	17.0
Net Lifetime Energy Savings – at the Generator (GWh)	12.322	0.018	0.186	0.720	143.464
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.125	0.000	0.001	0.011	1.719
NTGR	0.74	0.74	0.74	0.74	0.74
Net Peak Demand Savings – at the Meter (MW)	0.092	0.000	0.001	0.008	1.272
Line Loss Factor	1.068	N/A	1.070	1.146	1.078
Net Peak Demand Savings – at the Generator (MW)	0.099	0.000	0.001	0.010	1.372

3.4 Realization Rate

Table 14 below compares the energy and peak demand savings established through the 2023 Application Rebates evaluation to those outlined in the 2023 tracking sheet. It also includes the realization rates, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 14: Comparison of 2023 Application 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	11.483	GWh	0.74	8.498	GWh	99%
Evaluation Results	11.406	GWh	0.74	8.440	GWh	
Peak Demand Savings						
Tracked Savings by EOne	1.854	MW	0.74	1.372	MW	100%
Evaluation Results	1.854	MW	0.74	1.372	MW	
* The average NTGR values presented in this table correspond to the ratios of net savings to gross savings for Application Rebates.						

The slight difference in tracked and evaluated energy savings is due to the Evaluator recalculating heat pump savings using HSPF2 and SEER2 values.



4 Impact Evaluation for Instant Rebates

The objectives of the 2023 Instant Rebates impact evaluation were to determine gross and net electrical energy and peak demand savings.

4.1 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 results obtained from the tracking sheet audit are presented in Appendix II. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

4.2 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 the identification of eligible measures for participants is performed at the point of sale (as opposed to on site), information on participants as well as individual project operating conditions and old measure parameters are not fully detailed in the tracking sheet. Hence, EOne estimates savings based on a set of assumptions specific to each measure type. Energy and peak demand savings are calculated for each data entry; the equations used for lighting measures 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), while unitary savings values are used for occupancy and motion sensors as well as circulator pump measures.

The equations, their parameters, as well as the EUL values from the 2022 evaluation were used for Instant Rebates measures in 2023.

Detailed descriptions on the savings calculations are presented in the 2020-2023 Measure Assessment.

4.2.1 Summary of Adjustments to Gross Energy Savings

As part of the 2020-2023 Measure Assessment activities, the Evaluator reviewed the equation parameters such as the hours of use (HOU) and baseline wattages used to determine the energy savings of measures eligible under Instant Rebates. In 2023, no changes were made to Instant Rebates energy savings in the 2020-2023 Measure Assessment.

4.2.2 In-service Rates

Research indicates that a percentage of measures purchased through rebate programs might be stored for later use. As part of the 2020-2023 Measure Assessment activities, the Evaluator established the ISR for Instant Rebates measures. In 2023, the Evaluator maintained the ISR of 85% for LED linear lamps and the ISR of 100% for fixtures, occupancy and motion sensors, as well as circulator pumps.

¹¹ Definition adapted from National Renewable Energy Laboratory, *The Uniform Methods Project, Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

4.2.3 Peak Demand Savings

As part of the 2020-2023 Measure Assessment activities, the Evaluator established a PCF of 60% for indoor lighting measures. This percentage constitutes the weighted average PCF of all indoor lighting measures installed in 2022 through Application Rebates and Small Business Energy Solutions (SBES) – another BNI program component of EOne – since no participant-specific information was available for Instant Rebates. In 2023, this value was maintained for indoor lighting measures, as well as a PCF of 100% for outdoor measures and circulator pumps since they are assumed to be in operation during the peak demand period.

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; this is taken into account in the gross unitary savings equation presented in the 2023 tracking sheet.

As part of the 2020-2023 Measure Assessment activities, the Evaluator established the interactive effects factors for each measure eligible under Instant Rebates based on the average values of indoor lighting measures installed through Application Rebates and SBES in 2022 since no participant-specific information was available for Instant Rebates. Additionally, for categories that include recessed fixtures, namely LED linear fixtures and LED linear lamps, the interactive effects factor calculations considered the limited interaction of recessed fixtures with heating and cooling systems as well as the proportions of recessed fixtures in the 2023 Instant Rebates tracking sheet. The 2023 interactive effects factor calculation results, comprised of interactive effect factors from the 2022 evaluation and adjusted by the proportions of recessed fixtures in the 2023 tracking sheet, are outlined in Table 15.

Table 15: 2023 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	-4.9%	-9.2%
	Non-recessed	-8.7%	-16.1%
	Weighted Average	-7.9%	-14.7%
LED Linear Lamps	Recessed	-1.6%	-7.1%
	Non-recessed	-2.9%	-12.5%
	Weighted Average	-2.6%	-11.4%
LED Outdoor Fixtures		0.0%	0.0%
Directional and Architectural LED Fixtures		4.0%	0.0%
Indoor Occupancy/Motion Sensors		-4.1%	-13.2%
Outdoor Motion Sensors		0.0%	0.0%
Circulator Pumps		0.0%	0.0%



4.2.5 Effective Useful Life

As part of the 2020-2023 Measure Assessment activities, the Evaluator reviewed the EUL values used in the calculation of electrical energy savings that are expected to persist over time. For all Instant Rebates measures, the EUL values established in the 2021 evaluation remained valid for the 2023 evaluation.

The evaluated 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, and is equal to 13.6 years (see Subsections 4.2.6 and 4.3.3 below).

4.2.6 Evaluation Gross Savings

The energy and peak demand savings associated with Instant Rebates were calculated using the unitary savings values (including baseline wattages, the actual wattages of efficient measures, ballast factors where applicable, as well as interactive effects factors, PCFs, and ISRs for lighting measures) from the 2020-2023 Measure Assessment. The savings at the generator were calculated using weighted average line loss factors determined based on the distribution of the rate code spending of other BNI programs in 2023. Those line loss factors were maintained in 2023. 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.¹²

The total savings established for each measure type are presented in Table 16 below.

¹² Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 16: Evaluated 2023 Instant Rebates Gross Energy and Peak Demand Savings

Measure Category	LED Linear Fixtures	LED Linear Lamps	LED Outdoor Fixtures	LED Directional and Architectural Fixtures	Outdoor Motion Sensors	Indoor Occupancy/ Motion Sensors	Circulator Pumps	Total for All Measures
Number of Units	86,898	138,083	9,391	505	299	4,960	750	240,886
Energy Savings								
Tracked Gross Energy Savings – at the Meter (GWh)	19.471	8.543	8.137	0.115	0.035	0.803	0.344	37.448
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	0.921	0.974	1.000	1.040	1.000	0.959	1.000	-
Gross Energy Savings – at the Meter (GWh)	17.926	7.071	8.137	0.119	0.035	0.770	0.344	34.403
Line Loss Factor	1.065	1.065	1.065	1.065	1.065	1.065	1.065	-
Gross Energy Savings – at the Generator (GWh)	19.091	7.530	8.666	0.127	0.038	0.820	0.366	36.639
Effective Useful Life (years)	11.6	11.6	20.1	11.6	10.0	10.0	15.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	221.455	87.350	174.472	1.475	0.376	8.203	5.497	498.827
Peak Demand Savings								
Tracked Gross Demand Savings – at the Meter (MW)	4.528	1.987	1.858	0.027	0.009	0.150	0.052	8.611
Adjustment Ratio on Demand 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	-
Peak Coincidence Factor	0.60	0.60	1.00	0.60	1.00	0.60	1.00	-
Interactive Effects Factor	0.853	0.886	1.000	1.000	1.000	0.868	1.000	-
Total Peak Demand Savings – at the Meter (MW)	2.317	0.897	1.858	0.016	0.009	0.078	0.052	5.228
Line Loss Factor	1.073	1.073	1.073	1.073	1.073	1.073	1.073	-
Total Peak Demand Savings – at the Generator (MW)	2.486	0.963	1.993	0.017	0.010	0.084	0.056	5.609

Figure 10 below compares the tracked and evaluated gross energy savings, while Figure 11 further below compares the tracked and evaluated gross peak demand energy savings.

Evaluated gross energy savings were close to tracked savings. The slight differences between tracked and evaluated peak demand savings for LED linear fixtures and LED linear lamps were due to the revision of interactive effects.

Figure 10: 2023 Instant Rebates Tracked and Evaluated Gross Energy Savings at the Generator

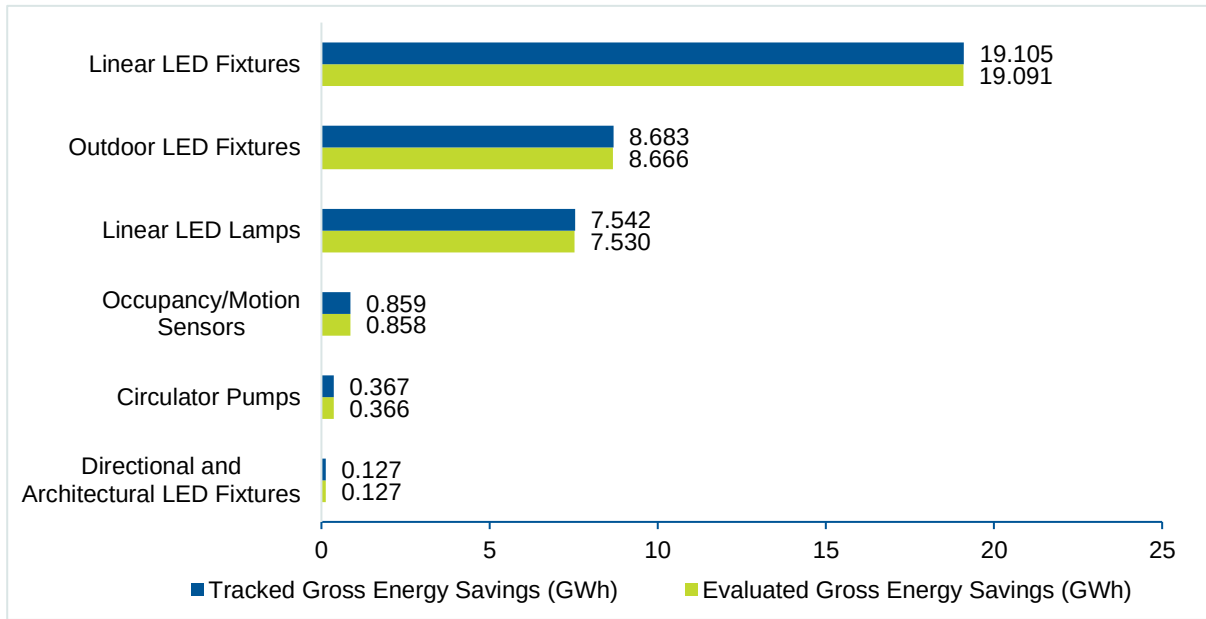
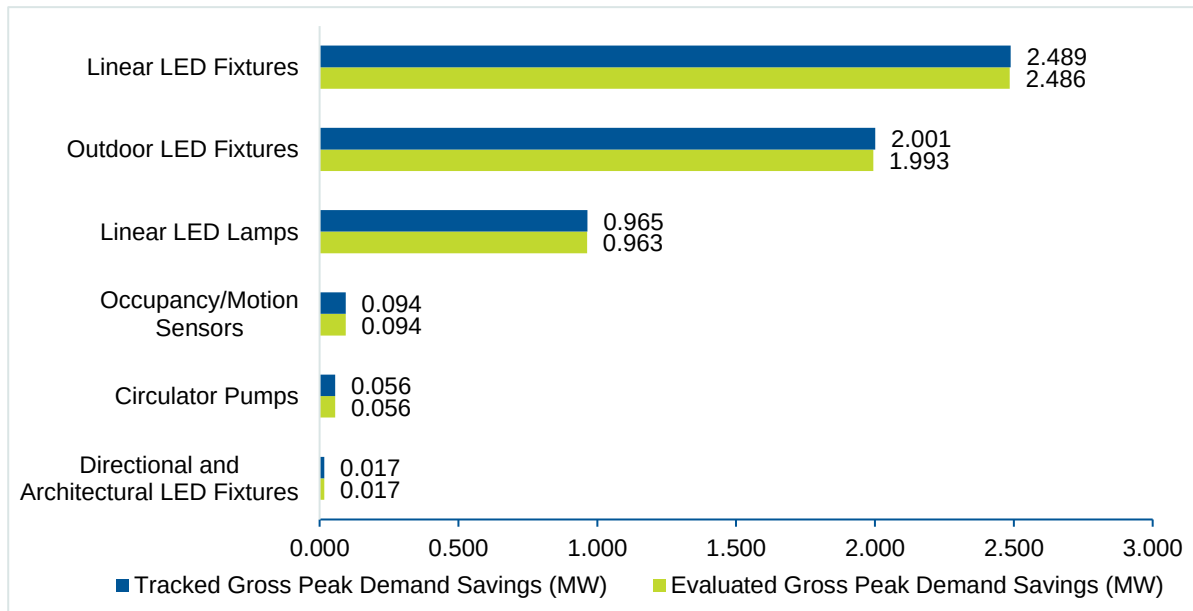


Figure 11: 2023 Instant Rebates Tracked and Evaluated Gross Peak Demand Savings at the Generator



As presented in Table 17, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor¹³ for GHG emissions generated by electricity production to Instant Rebates gross savings.

Table 17: Evaluated 2023 Instant Rebates Gross GHG Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	36.639
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO2 eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO2 eq)	20,221

4.3 Net Savings

The Evaluator determined the net energy savings, i.e. the electrical energy savings that can be reliably attributed to a service, by estimating the NTGR. In the case of Instant Rebates, the NTGR is established by considering free-ridership.

4.3.1 Free-ridership

For Instant Rebates, free-ridership corresponds to the proportion of savings attributed 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.

Free-ridership was assessed for the three main lighting measures during the 2022 evaluation using a self-report approach that involved both asking participants and distributors a set of questions during a telephone survey for participants and a telephone interview for distributors. Since no data collection aimed at updating the free-ridership level was conducted in 2023, the Evaluator used the 2022 free-ridership levels.

Table 18: 2023 Instant Rebates Free-ridership

Measure Category	Average Distributor Influence Level (from distributor interviews)	Free-ridership Level (from participant survey)	Overall Free-ridership Level	Margin of Error
LED Linear Fixtures	64%	24%	14%	5.1%
LED Linear Lamps	62%	43%	27%	12.8%
LED Outdoor Fixtures	57%	31%	18%	10.4%

4.3.2 Net-to-gross Ratio

The NTGR is calculated using the following equation:

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

¹³ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO2 eq tonnes) and total electricity generation (10,456 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 December 1, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22%2723.pdf (Last accessed December 1, 2023).

As presented in Table 19, the NTGRs for the main measure categories were established using the free-ridership levels outlined in Subsection 4.3.1 above. For the other measures sold through Instant Rebates, a NTGR of 1.00 was used.

Table 19: 2023 Instant Rebates NTGRs

Measure	Free-ridership	NTGR
LED Linear Fixtures	14%	0.86
LED Linear Lamps	27%	0.73
LED Outdoor Fixtures	18%	0.82
Other Measures	0%	1.00

4.3.3 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 NTGRs differed from one measure category to another.

Table 20 below presents the details of the calculations. The net energy savings resulted in 16,763 tonnes of CO₂ eq in net annual GHG emission reductions.

Table 20: Evaluated 2023 Instant Rebates Net Energy and Peak Demand Savings

Measure Category	LED Linear Fixtures	LED Linear Lamps	LED Outdoor Fixtures	LED Directional and Architectural Fixtures	Outdoor Motion Sensors	Indoor Occupancy /Motion Sensors	Circulator Pumps	Total for All Measures
Energy Savings								
Gross Energy Savings – at the Meter (GWh)	17.926	7.071	8.137	0.119	0.035	0.770	0.344	34.403
NTGR	0.86	0.73	0.82	1.00	1.00	1.00	1.00	-
Net Energy Savings – at the Meter (GWh)	15.416	5.162	6.673	0.119	0.035	0.770	0.344	28.519
Line Loss Factor	1.065	1.065	1.065	1.065	1.065	1.065	1.065	-
Net Energy Savings – at the Generator (GWh)	16.418	5.497	7.106	0.127	0.038	0.820	0.366	30.373
Effective Useful Life (years)	11.6	11.6	20.1	11.6	10.0	10.0	15.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	190.452	63.766	143.067	1.475	0.376	8.203	5.497	412.834
Peak Demand Savings								
Gross Peak Demand Savings – at the Meter (MW)	2.317	0.897	1.858	0.016	0.009	0.078	0.052	5.228
NTGR	0.86	0.73	0.82	1.00	1.00	1.00	1.00	-
Net Peak Demand Savings – at the Meter (MW)	1.992	0.655	1.523	0.016	0.009	0.078	0.052	4.327
Line Loss Factor	1.073	1.073	1.073	1.073	1.073	1.073	1.073	-
Net Peak Demand Savings – at the Generator (MW)	2.138	0.703	1.635	0.017	0.010	0.084	0.056	4.642

4.4 Realization Rate

Table 21 compares the total tracked and evaluated savings for Instant Rebates. It also includes the realization rates representing the ratio of evaluated net savings to tracked net savings for both energy savings and peak demand savings.

Table 21: Comparison of 2023 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	36.683	GWh	0.83	30.409	GWh	100%
Evaluation Results	36.639	GWh	0.83	30.373	GWh	
Peak Demand Savings						
Tracked Savings by EOne	5.623	MW	0.83	4.653	MW	100%
Evaluation Results	5.609	MW	0.83	4.642	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 peak demand savings were close to the values tracked by EOne. The only differences are attributed to the slight increase in interactive effects.

5 Overall BER Results

As outlined in Figure 12, BER exceeded its electrical energy and peak demand savings targets by 29% and 13% respectively.

Figure 12: 2023 BER Targets and Evaluated Savings

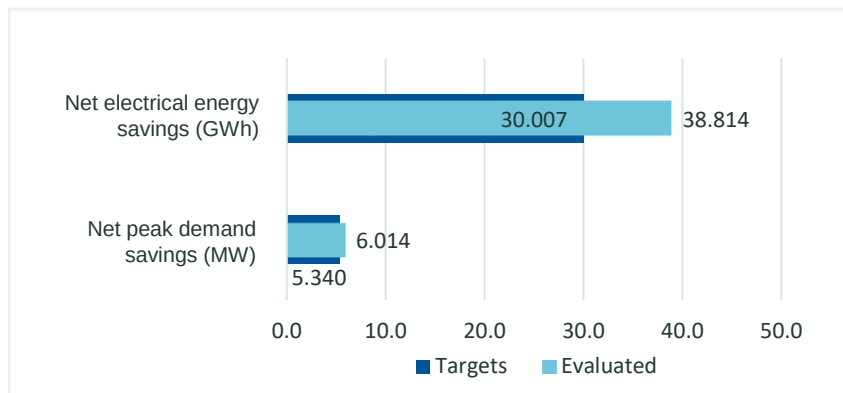


Table 22 compares the savings tracked by EOne to the 2023 evaluated savings for BER along with the corresponding realization rates.

Table 22: Comparison of 2023 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	48.166	GWh	0.81	38.907	GWh	100%
Evaluation Results	48.045	GWh	0.81	38.814	GWh	
Peak Demand Savings						
Tracked Savings by EOne	7.476	MW	0.81	6.025	MW	100%
Evaluation Results	7.463	MW	0.81	6.014	MW	
*Different NTGRs were established for Application Rebates 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 established through this evaluation were almost identical to those calculated in the 2023 tracking sheet.



6 BER Key Findings and Recommendations

The main objectives of the 2023 BER evaluation were as follows:

- › Calculate gross and net BER energy savings, 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 recommendations for BER.

2023 BER-Finding: BER net electrical energy savings and peak demand savings both exceeded targets by 29% and 13% respectively.

BER achieved 38.814 GWh in net electrical energy savings and 6.014 MW in net peak demand savings at the generator in 2023, thus exceeding both the planned net electrical energy savings of 30.007 GWh by 29% and the planned net peak demand savings of 5.340 MW by 13%.

2023 BER-Finding: Instant Rebates participation increased by 19% in 2023. While Application Rebates participation decreased by 21% in 2023, its gross energy savings per participant increased by 11% compared to 2022.

In 2023, Instant Rebates participation increased with 19% more measures rebated. In 2023, Application Rebates participation decreased with 21% fewer participating businesses although net savings per participant increased by 11% compared to 2022 after several years of decline. Overall, BER gross energy savings and peak demand savings increased respectively by 5% and 4% between 2022 and 2023. This was mainly due to the increase in Instant Rebates savings generated by LED linear lamps and LED linear fixtures.

2023 BER-Finding: Evaluated net energy savings were less than 1% lower than the values tracked by EOne for Application Rebates, while peak demand savings were identical. Both evaluated net energy and peak demand savings were less than 1% higher than tracked results for Instant Rebates.

Overall, evaluated BER savings were almost identical to the values tracked by EOne.

CONCLUSION

Table 23 presents the participation levels, net-to-gross ratios (NTGRs), evaluated gross and net savings at the generator, annual GHG emission reductions, as well effective useful life (EUL) values for each service and Efficient Product Rebates as a whole.

Table 23: Overall 2023 Efficient Product Rebates Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
Application Rebates							
Energy Savings	227	Projects	11.406	GWh	0.74	8.440	GWh
Lifetime Energy Savings			193.870	GWh	0.74	143.464	GWh
Peak Demand Savings			1.854	MW	0.74	1.372	MW
Annual GHG Emission Reductions			6,295	Tonnes of CO2 eq	0.74	4,658	Tonnes of CO2 eq
EUL			17.0	Years		17.0	Years
Instant Rebates							
Energy Savings	240,886	Products sold	36.639	GWh	0.83	30.373	GWh
Lifetime Energy Savings			498.827	GWh	0.83	412.834	GWh
Peak Demand Savings			5.609	MW	0.83	4.642	MW
Annual GHG Emission Reductions			20,221	Tonnes of CO2 eq	0.83	16,763	Tonnes of CO2 eq
EUL			13.6	Years		13.6	Years
Total							
Energy Savings			48.045	GWh	0.81	38.814	GWh
Lifetime Energy Savings			692.697	GWh	0.80	556.298	GWh
Peak Demand Savings			7.463	MW	0.81	6.014	MW
Annual GHG Emission Reductions			26,516	Tonnes of CO2 eq	0.81	21,421	Tonnes of CO2 eq
EUL			14.4	Years		14.4	Years
* The average NTGR values presented in the total correspond to the ratios of net savings to gross savings for both Application Rebates and Instant Rebates.							

Figure 13 and Figure 14 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 2023. Efficient Product Rebates was aimed at achieving 30.007 GWh in net electrical energy savings and 5.340 MW in net peak demand savings at the generator for 2023. The program exceeded planned energy and peak demand savings. Instant Rebates was the largest contributor to total program net energy and peak demand savings.

Figure 13: 2023 Efficient Product Rebates Targeted and Evaluated Net Energy Savings

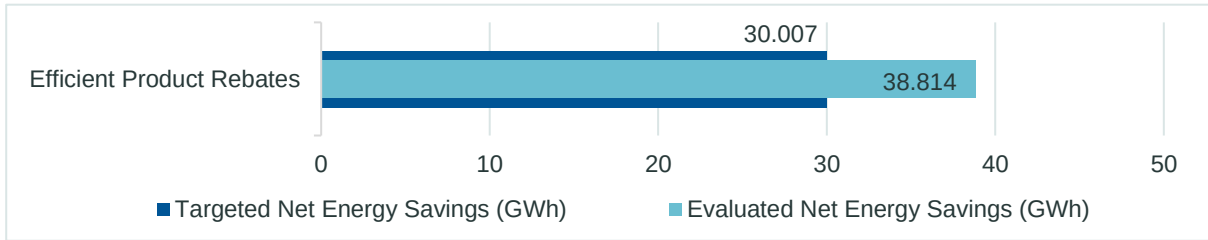
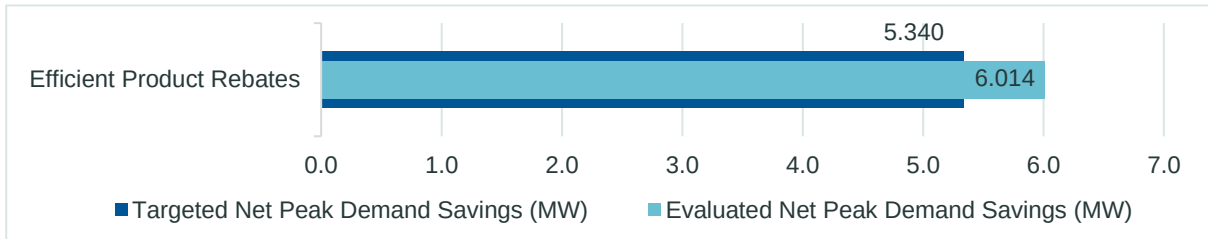


Figure 14: 2023 Efficient Product Rebates Targeted and Evaluated Net Peak Demand Savings





LIST OF APPENDICES

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

Business Energy Rebates

Appendix I BER: Application Rebates Tracking Sheet Audit

Appendix II BER: Instant Rebates Tracking Sheet Audit

Appendix III BER: 2023 Recommendations



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com





EfficiencyOne

EFFICIENT PRODUCT REBATES PROGRAM

Appendix Report

2023 DSM EVALUATION

March 12, 2024



ECONOLUX



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APPENDIX I

BER Application Rebates Tracking Sheet Audit

This appendix presents the main 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

Table 1 presents the corrected tracked savings resulting from all changes made by the Evaluator.

Table 1: 2023 Application Rebates Corrected Tracked Savings

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
Application Rebates					
Gross Energy Savings – at the Generator	11.483	GWh	11.483	GWh	0.00%
Gross Peak Demand Savings – at the Generator	1.854	MW	1.854	MW	0.00%
Net Energy Savings – at the Generator	8.497	GWh	8.498	GWh	0.00%
Net Peak Demand Savings – at the Generator	1.371	MW	1.372	MW	0.10%

The small difference in net energy and demand energy savings was due to the Evaluator correcting the net-to-gross ratio (NTGR) for six individual measures.

APPENDIX II

BER Instant Rebates Tracking Sheet Audit

This appendix presents the main 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

Table 2 and Table 3 below present the corrected tracked savings resulting from all changes made by the Evaluator.

Table 2: 2023 Instant Rebates Corrected Tracked Savings - Lighting

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
Instant Rebates - Lighting					
Gross Energy Savings – at the Generator	36.286	GWh	36.316	GWh	0.08%
Gross Peak Demand Savings – at the Generator	7.348	MW	5.567	MW	-24.25%
Net Energy Savings – at the Generator	30.006	GWh	30.042	GWh	0.12%
Net Peak Demand Savings – at the Generator	5.970	MW	4.597	MW	-23.00%

Tracked gross and net energy savings at the generator were less than 1% lower than the corrected values. This was due to a few entries having inconsistent interactive effects factors for energy savings.

The differences between tracked and corrected peak demand savings at the generator were larger for both the gross and net values with differences of 24% and 23% respectively. These were due to many entries having inconsistent interactive effects factors for energy and peak demand savings, peak coincidence factors, unitary demand savings values, or NTGRs, which were partially caused by input errors in the 2020-2022 Measure Assessment (MA) and led to confusion.

Table 3: 2023 Instant Rebates Corrected Tracked Savings - Pumping

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
Instant Rebates - Pumping					
Gross Energy Savings – at the Generator	0.367	GWh	0.367	GWh	0.09%
Gross Peak Demand Savings – at the Generator	0.056	MW	0.056	MW	0.00%
Net Energy Savings – at the Generator	0.367	GWh	0.367	GWh	0.09%
Net Peak Demand Savings – at the Generator	0.056	MW	0.056	MW	0.00%

Tracked and corrected energy and peak demand savings at the generator were almost identical for both gross and net results.

Inconsistent line loss factors had a negligible impact on the difference between tracked and corrected savings.

The inconsistent peak coincidence factors and unitary demand savings for the two booster pump entries had no impact on the difference between tracked and corrected savings since the quantities sold cancelled themselves.



APPENDIX III

BER 2023 Recommendations

The Evaluator made no specific recommendation as part of the 2023 evaluation of BER.



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com



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EfficiencyOne

CUSTOM INCENTIVES PROGRAM

Final Report

2023 DSM EVALUATION

March 20, 2024

In collaboration with:





ABBREVIATIONS

BDM	Business development manager
BER	Business Energy Rebates
BNI	Business, non-profit, and institutional
BOpt	Building Optimization
BPA	Bouthillette Parizeau
CEE	Consortium for Energy Efficiency
CPA	Custom Project Agreement
DSM	Demand-side management
EMIS	Energy Management Information Systems
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
EPS	Energy Performance Services
EUL	Effective useful life
GHG	Greenhouse gas
IEM	Industrial energy manager
IPMVP	International Performance Measurement and Verification Protocol
KPIs	Key performance indicators
LED	Light-emitting diode
M&V	Measurement and verification
MOU	Memorandum of Understanding
MURB	Multi-unit residential building
NECB	National Energy Code of Canada for Buildings
NS Power	Nova Scotia Power
NSUARB	Nova Scotia Utility and Review Board
NTGR	Net-to-gross ratio
ODR	Operational Demand Reduction
OEM	On-site energy manager
P4P	Pay-for-Performance
SEM	Strategic Energy Management
UARB	Utility and Review Board

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.
Available Demand Response Capacity	The capacity which is available to NSP to reduce system peak demand. This capacity is calculated based on the first two hours of all events called between December and February, excluding weekends and holidays. If an event is shorter than two hours, only the first hour is used to measure the available DR capacity. Available DR capacity is evaluated on a per-participant basis, based on the average demand reduction observed for each event that the participant was scheduled to participate in. E1's total available DR capacity is the sum of each participant's available DR capacity.
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 base consumption.
Bias	Systematic deviations of measurements from the true value.
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.
Confidence interval	The estimated range of values that is likely to include unknown population parameters.
Demand response	Demand response measures generate savings in the form of available capacity or load reduction in response to events called by the electric utility (Nova Scotia Power) to reduce the load at strategic moments. These events can be called at any time and for any duration, although they are usually called for one to three hours during peak periods.
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 home 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 a home is through modelled home 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 equipment life and 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 CO2	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, gas 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 ratios, etc.) validated or measured during the evaluation process. Unless otherwise specified, evaluated savings are 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 a building (such as heating and cooling) due to the installation of an energy efficiency measure.
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 and 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 a program on the market (such as increased product availability, practices, and prices) that extends beyond changing program participant behaviours. 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. For industrial participants on an interruptible rate, peak demand savings may include savings on non-firm loads, i.e. loads that may be interrupted when Nova Scotia Power's 10-minute reserve is low.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	An 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.
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.
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 net-to-gross ratios. 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. A 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).



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EXECUTIVE SUMMARY

This report presents the 2023 demand-side management (DSM) results of the Custom Incentives program administered by EfficiencyOne (EOne). This program is comprised of two components: (1) Custom and (2) Strategic Energy Management (SEM).¹ The Custom program component is further comprised of the Retrofit, Pay-for-Performance, New Construction and Building Optimization services. Combined, the two 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 2023 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 Retrofit, this evaluation also included a process evaluation. Table 1 summarizes the types of evaluation conducted for each program component and the corresponding methodology.

Table 1: Summary of 2023 Custom Incentives Program Evaluation

Program Component	Evaluation Type			Methodology
	Impact	Process	Market	
Custom	Comprehensive	X - Retrofit		› Participant phone interviews (New Construction) › Consultant and Business Development Manager (BDM) interviews (Retrofit) › Participant and Service Provider Interviews (Retrofit) › Interviews with participants who recently signed Custom Project Agreements (CPAs) (New Construction) › Project file reviews and participant follow-up interviews or site visits (regular Retrofit, and Building Optimization [BOpt]) › Project desk reviews (Solar PV) › Project review and energy model reviews (New Construction) › Logic model update (Retrofit) › Tracking sheet audit › Effective useful life (EUL) update (Retrofit, New Construction) › Calculations using evaluation results › Avoided GHG emission reduction calculations
SEM	Comprehensive	X - SEM		› Business Development Manager interview › Service Provider interview › Participant interviews › Logic model review › Tracking sheet audit › Project reviews supported by site visits or phone interviews › Effective useful life (EUL) update › Calculations using evaluation results › Greenhouse gas (GHG) emission reduction calculations

¹ In 2023, SEM and Energy Management Information Systems (EMIS) were merged into one program component. Previously, SEM and EMIS were offered as separate program components.

Program Performance

Table 2 below presents the participation levels, average net-to-gross ratios (NTGRs), evaluated gross and net savings at the generator, annual GHG emission reductions, as well as average EUL values for each program component and for Custom Incentives as a whole.

Table 2: Overall 2023 Custom Incentives Participation and Savings

	Participation Level		Gross Savings		NTGR*	Net Savings	
	Value	Unit	Value	Unit	Value	Unit	Value
Custom							
Energy Savings	114	Projects Completed	28.377	GWh	0.77	21.746	GWh
Lifetime Energy Savings			262.312	GWh	0.72	189.031	GWh
Peak Demand Savings ²			4.108	MW	0.74	3.053	MW
Annual GHG Emission Reductions			15,661	Tonnes of CO2 eq	0.77	12,002	Tonnes of CO2 eq
EUL			9.2	Years		8.7	Years
SEM							
Energy Savings	6	Projects Completed ³	3.381	GWh	1.00	3.381	GWh
Lifetime Energy Savings			18.443	GWh	1.00	18.443	GWh
Peak Demand Savings			0.366	MW	1.00	0.366	MW
Annual GHG Emission Reductions			1,866	Tonnes of CO2 eq	1.00	1,866	Tonnes of CO2 eq
EUL			5.5	Years		5.5	Years
Total							
Energy Savings			31.758	GWh		25.127	GWh
Lifetime Energy Savings			280.755	GWh		207.474	GWh
Peak Demand Savings			4.474	MW		3.419	MW
Annual GHG Emission Reductions			17,527	Tonnes of CO2 eq		13,868	Tonnes of CO2 eq
EUL			8.8	Years		8.3	Years
*The NTGRs listed in this table match the rounded averages obtained by dividing net savings by gross savings.							

Custom Incentives was aimed at achieving 25.732 GWh in net electrical energy savings and 5.623 MW in net peak demand savings at the generator for 2023. The program nearly attained its planned energy savings target but fell short of achieving its peak demand savings target. 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.

² Peak demand savings include both firm and non-firm loads (the latter being loads that may be interrupted by Nova Scotia Power). For Custom and SEM, 27% and 18% respectively of peak demand savings in 2023 were generated by participants that are on an interruptible rate.

³ Completed SEM projects reference participants that generated savings in a given year.



Custom Findings and Recommendations

This section provides the key findings and recommendations from the Custom evaluation. The first key findings and recommendations apply to Custom in general, while the others are specific to certain Custom services. The recommendations are also outlined in Appendix XIII.

Custom General Key Findings and Recommendations

2023 Custom Finding: Custom achieved 21.746 GWh in net electrical energy savings and 3.053 MW in net peak demand savings at the generator in 2023, thus falling short of the planned electrical energy savings of 22.730 GWh by 4% and the planned peak demand savings of 5.280 MW by 42%.

2023 Custom Finding: Compared to 2022, Custom participation decreased in 2023 due in part to the lack of participation in the Pay-for-Performance (P4P) service and the removal of the Retrofit Operational Demand Reduction offer.

2023 Custom Finding: Following the project reviews, the Evaluator adjusted the energy and peak demand savings for Retrofit, New Construction, and Building Optimization.

2023 Custom Finding: Retrofit free-ridership levels increased for regular Retrofit and solar PV projects, and were established at 25% and 38% respectively. New Construction free-ridership decreased compared to the 2022 level, although it remained relatively high at 31%. Retrofit spillover was established at 2% for regular Retrofit projects and 1% for solar PV projects. Free-ridership and spillover were not measured for Building Optimization and were therefore maintained at 9% and 0% respectively (values from 2021).

2023 Custom Finding: Evaluated net energy and peak demand savings determined by the Evaluator were respectively 3% and 9% lower than the savings tracked by EOne. This result was mainly due to adjustments made by the Evaluator during project reviews.

Retrofit Key Findings and Recommendations

2023 Retrofit Finding: Participants are very satisfied with Custom Retrofit while consultants are somewhat satisfied.

2023 Retrofit Finding: Participants place a high value on savings measurement and verification and find the process generally easy to follow.

2023 Retrofit Finding: The primary barriers to implementing energy efficiency projects are the costs and insufficient returns on investment of energy efficiency projects.

Retrofit Recommendation #1: EOne should update the Custom Retrofit logic model to address current barriers and document links to other program offers such as SEM and On-site Energy Managers (OEMs).

2023 Retrofit Finding: Custom Incentives program offers are coherent despite minor overlaps and, where savings assumptions are not consistent between offers, these are appropriate and justified.

2023 Retrofit Finding: The opportunity to achieve emission reductions or electrify operations is a minor added value for most Retrofit participants.

2023 Retrofit Finding: Custom-specific adjustment ratios for solar PV projects were established at 1.101 for projects modelled with PV Watts and 0.942 for those modelled with RETScreen Expert.



New Construction Key Findings and Recommendations

2023 New Construction Finding: Project reviews revealed continued room for improvement in the model review process.

2023 New Construction Finding: Free-ridership continued to remain relatively high in 2023 at 31%, and several participants reported factors outside of New Construction being significant motivators for constructing energy efficient buildings.

SEM Findings and Recommendations

This section provides the key findings and recommendations from the SEM evaluation. The recommendations are also outlined in Appendix XIX.

2023 SEM-Finding: SEM achieved 3.381 GWh in net electrical energy savings and 0.366 MW in net peak demand savings at the generator in 2023, thus surpassing the planned electrical energy savings of 3.002 GWh by 13% and the planned peak demand savings of 0.343 MW by 7%.

2023 SEM-Finding: The SEM participation level has remained stable over the past five years. Energy savings per participant were similar to those in 2022.

2023 SEM-Finding: With an average overall satisfaction rating of 8.0, participant satisfaction with SEM was high.

2023 SEM-Finding: The bottom-up measurement and verification (M&V) approach adopted in 2022 has not prevented SEM from meeting its energy management objectives.

SEM Recommendation #1: Consider including plant-level KPIs and their progression since program inception in participant reporting. This addition could benefit participants and be used to better advertise the success of SEM.

2023 SEM-Finding: While the second main objective of SEM is to “support capital energy efficiency projects identified by SEM”, no metrics attest to the realization of that objective.

SEM Recommendation #2: Track the number of projects implemented by SEM participants and the resulting savings from capital projects incented in BER or Custom.

2023 SEM-Finding: The main barriers to strategic energy management are the large time commitment, the availability of skilled staff, and the lower priority level of energy management compared to other business imperatives.

2023 SEM-Finding: SEM is effective at addressing the knowledge barrier, although the lack of available staff and lower priority level for energy management remain significant barriers for participants.

SEM Recommendation #3: Better communicate the value of energy management to both participants and non-participants, including its potential for decarbonization.

2023 SEM-Finding: The M&V methodologies applied to quantify savings were generally appropriate and accurate, and the Evaluator made no major adjustments to energy savings. Peak demand savings were increased by 34% due to projects whose peak demand savings had not been calculated.

2023 SEM-Finding: The assumption that the NTGR is equal to 1 remained valid despite the evolution of the program component.

Program Tracked and Evaluated Savings

Table 3 below compares EOne tracked energy and peak demand savings to evaluated savings at the generator. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings. Furthermore, the NTGRs are also presented and 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 other sections.

Table 3: Comparison of 2023 Tracked and Evaluated Savings at the Generator

		Gross Savings		NTGR*	Net Savings		Realization Rate
		Value	Unit		Value	Unit	
Custom	Energy Savings						
	Tracked Savings by EOne	29.112	GWh	0.77	22.400	GWh	97%
	Evaluation Results	28.377	GWh	0.77	21.746	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	4.744	MW	0.71	3.366	MW	91%
	Evaluation Results	4.108	MW	0.74	3.053	MW	
SEM	Energy Savings						
	Tracked Savings by EOne	3.391	GWh	1.00	3.391	GWh	100%
	Evaluation Results	3.381	GWh	1.00	3.381	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	0.272	MW	1.00	0.272	MW	134%
	Evaluation Results	0.366	MW	1.00	0.366	MW	
*The NTGRs listed in this table match 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 demand-side management (DSM) for Nova Scotians. EOne provides energy efficiency, demand response and carbon mitigation services through the Efficiency Nova Scotia (ENS) franchise. Regulatory oversight is provided by the Nova Scotia Utility and Review Board (NSUARB). EOne receives funding for its electricity 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 ENS franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2023 DSM program portfolio.

This report presents the evaluation results of the Custom Incentives program comprised of two components: 1) Custom and 2) Strategic Energy Management (SEM).⁴ Table 4 below lists the Custom Incentives program components and the types of evaluations conducted for 2023. 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 4: Types of Evaluations Conducted for Each Program Component, 2023

Program	Program Component	2023		
		Process	Market	Impact
Custom Incentives	Custom	X - Retrofit		Comprehensive
	SEM	X - SEM		Comprehensive

For each program, the Evaluator prepared a DSM evaluation report presenting key findings, electrical first-year and lifetime energy savings, peak demand savings, and avoided greenhouse gas (GHG) emissions.⁵

⁴ In 2023, SEM and Energy Management Information Systems (EMIS) were merged into one program component. Previously, SEM and EMIS were offered as separate program components.

⁵ Unless specified otherwise, energy savings refer to first-year energy savings rather than lifetime energy savings throughout 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 peak demand. Business development managers (BDM) also work with participants to assist them in moving their projects forward and identifying consultants. As illustrated in Figure 1, Custom includes four different services.

Figure 1: Custom Services

Retrofit	• Technical and financial support to help organizations conduct scoping and feasibility studies • Technical and financial support for the implementation of energy efficiency projects using a customized and flexible approach* • Organizations with annual consumption of 350,000 kWh or higher are eligible provided projects have not yet started
New Construction	• Technical and financial support to achieve electrical energy savings in new buildings and for major renovations in existing buildings, excluding savings from lighting systems • Participation begins at the preliminary design stage to ensure the effective implementation of energy efficiency measures and achievement of maximum savings • Eligible facilities must be 15,000 sq. ft. or larger • Projects must achieve reductions in total building energy consumption of at least 25% and must save at least 100,000 kWh in electricity
Building Optimization	• Technical and financial support to help organizations conduct an investigation study with the objective of improving building operational efficiency • Technical and financial support for the implementation of no-cost or low-cost energy efficiency measures (e.g. operating schedule changes) identified through a recommissioning process • Eligible facilities must not have been commissioned in the previous two years, must have a building automation system, and annually consume 350,000 kWh or more
Pay-for-Performance (P4P)	• Financial support for reductions in electricity consumption achieved through a variety of capital and behavioural energy efficiency upgrades • Incentives are based on verified facility energy performance • Organizations with annual consumption of 1,000,000 kWh or higher are eligible if projects generate reductions in electricity consumption of at least 10%

* The Retrofit service also includes compressed air leak audits and solar PV projects for which a semi-prescriptive approach has been developed to establish evaluated savings. The approach for compressed air leak audits has already been implemented, while the approach for solar PV projects was developed in 2023 and applied to determine gross savings for solar PV projects completed in 2023 (see Subsection 4.2.2).



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 three types of projects for which savings were tracked in 2023 were:

- › Projects not completed in 2023. For those projects, the portion of savings corresponding to the savings claims submitted in 2023 were claimed as partial savings.
- › 2023 single-year projects. Projects started and completed in 2023. For these projects, all project savings were claimed in 2023 as final savings.
- › Multiyear projects. Projects that had partial savings claimed in previous years and were fully completed in 2023. For these projects, the remaining portion of savings corresponding to the savings claims submitted in 2023 were claimed as final savings. The 2023 adjustment ratios and net-to-gross ratios (NTGRs) were applied to the savings for those projects since they were completed in 2023.

Retrofit, P4P, New Construction, and Building Optimization combined were aimed at generating net electrical energy savings of 22.730 GWh and net peak demand savings of 5.280 MW at the generator in 2023.

1.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated Custom in previous years and issued improvement recommendations. Table 5 below provides a summary of the implementation status of each recommendation presented in the Executive Summary section of the 2022 Evaluation Report as well as recommendations issued in the 2021 Evaluation Report and that are still being implemented.

Table 5: Implementation Status of Past Recommendations for Custom

#	Recommendations	Status	Comments
2021 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 Custom. This should include developing appropriate protocols, documentation, and allowances for reviews of underlying savings determination methodologies as part of the annual evaluation plan.	Complete	In 2022 and 2023, EOne worked with the Evaluator to develop processes specific to project types that are better suited to a quasi-prescriptive approach. Since 2022, domestic water booster pumps have had a rebate available through BER and efforts were made to simplify compressed air leak audit projects. In 2023, EOne worked with the Evaluator to establish criteria for solar project eligibility. Solar projects must provide production data after implementation to verify the system is operating as expected. A savings verification approach relying on standardized savings assumptions has been implemented for compressed air leak audit projects since 2022, and a semi-prescriptive approach was developed for solar PV projects as part of the 2023 evaluation.
2022 Retrofit R1	Collect the required data and undertake a study to quantify, with reasonable confidence, a Nova Scotia relevant adjustment ratio between ex-ante simulation software performance estimates and ex-post installed field performance for solar PV projects.	Complete	As part of the 2023 DSM evaluation process, EOne provided to the Evaluator full-year energy production data with modelled energy production for 18 solar PV projects completed between 2021 and 2023. Eight of those projects were modelled with RETScreen and ten with PV Watts. The Evaluator determined distinct adjustment ratios for each modelling tool, which were applied in 2023 and will be applied in future years to calculate energy savings for Custom solar PV projects.
2022 Retrofit R2	Require measurement and verification (M&V) efforts based on the International Performance Measurement and Verification Protocol (IPMVP) Option C approach for any Retrofit indoor horticultural lighting projects.	In progress	Program staff are currently exploring different methods for accurately representing the interactive effects associated with horticultural lighting projects, including the International Performance Measurement and Verification Protocol (IPMVP) Option C approach. This review will also provide a better understanding of the scale of interactive effects that will be fed into program design. EOne intends on providing findings to the Evaluator in 2024.
2022 New Construction R1	Revisit the model review process to ensure that as-built documents are used.	In progress	Program staff reviewed EOne's Custom New Construction model review process in 2023. However, the Evaluator found that this was still an issue for a number of projects in the 2023 evaluation, resulting in savings adjustments. EOne will make revisions to improve the standardization and accuracy of model reviews.
2022 New Construction R2	Update the Program Guide to include the approach proposed in the 2022 evaluation for fan power baselines in multi-unit residential buildings (MURBs).	Complete	EOne has revised Subsection 7.4.1. of the New Construction Program Guide to include the new approach to the fan power baseline for MURBs.
2022 New Construction R3	Monitor free-ridership for this service and undertake a process evaluation in 2023 or 2024 to provide recommendations on the service given the potentially shifting market and regulatory context.	In progress	The Evaluator conducted a comprehensive impact evaluation of Custom New Construction in 2023, which included a review of the free-ridership algorithm to ensure different aspects of the decision-making process were captured. The free-ridership level in 2023 was established at 31%, and participant interview responses indicated changes in the market. A process evaluation focused on the changing market and regulatory context for the program component will be conducted in 2024.

1.3 Participation History

This subsection provides a participation overview for the four Custom services.

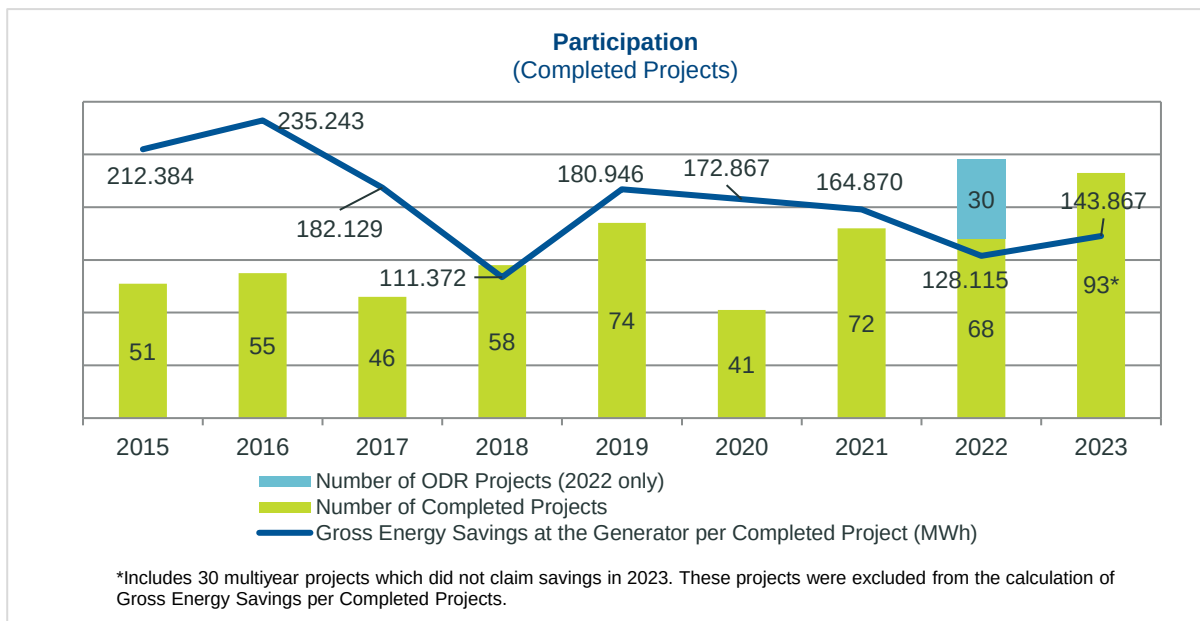
Retrofit

In 2023, energy and/or demand savings were generated by a total of 107 Retrofit projects, including:

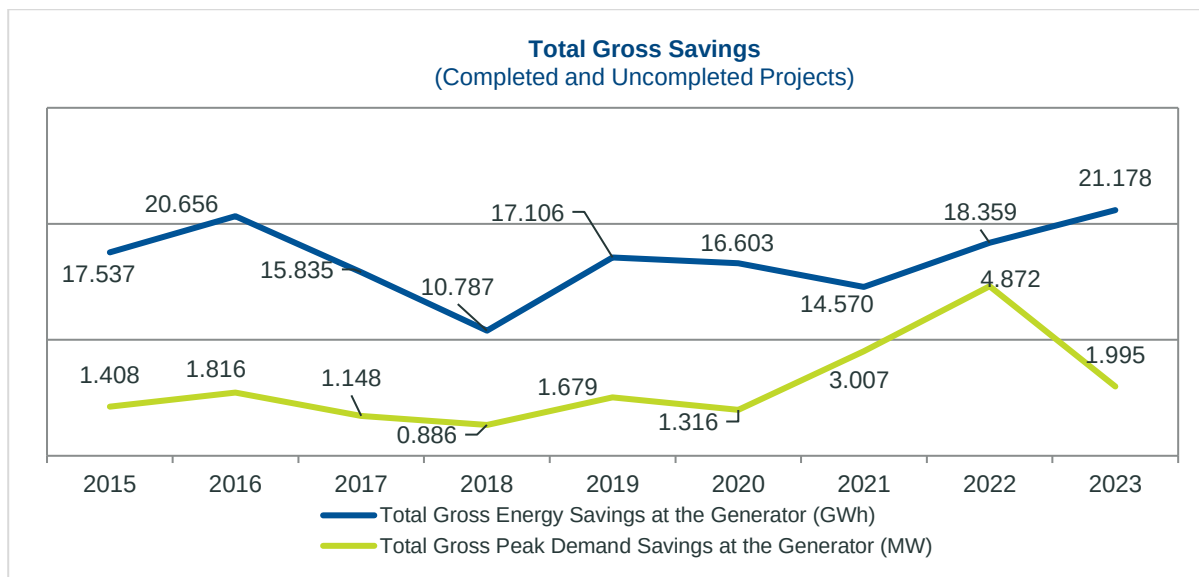
- › 93 projects completed in 2023
 - › 62 single-year projects started and completed in 2023
 - › 31 multiyear projects completed in 2023⁶
- › 14 projects that claimed partial savings in 2023 but were not completed
 - › Nine projects that were started in 2023 but that were not completed and for which partial savings were claimed for 2023
 - › Five multiyear projects that were started prior to 2023 but that were not completed and for which partial savings were claimed for 2023

As presented in Figure 2 below, 93 completed projects generated energy savings in 2023, which is 37% higher than the 68 projects completed in 2022 (excluding the Operational Demand Reduction (ODR) projects completed in 2022). Average energy savings in 2023 per completed project increased by 12% compared to 2022. Altogether, Retrofit achieved 15% more gross energy savings in 2023 compared with 2022, while gross demand savings decreased by 41% over the same period due in large part to the inclusion of the Operational Demand Reduction projects in 2022, which significantly increased gross demand savings in that year.

Figure 2: Overview of Retrofit Participation, 2015-2023

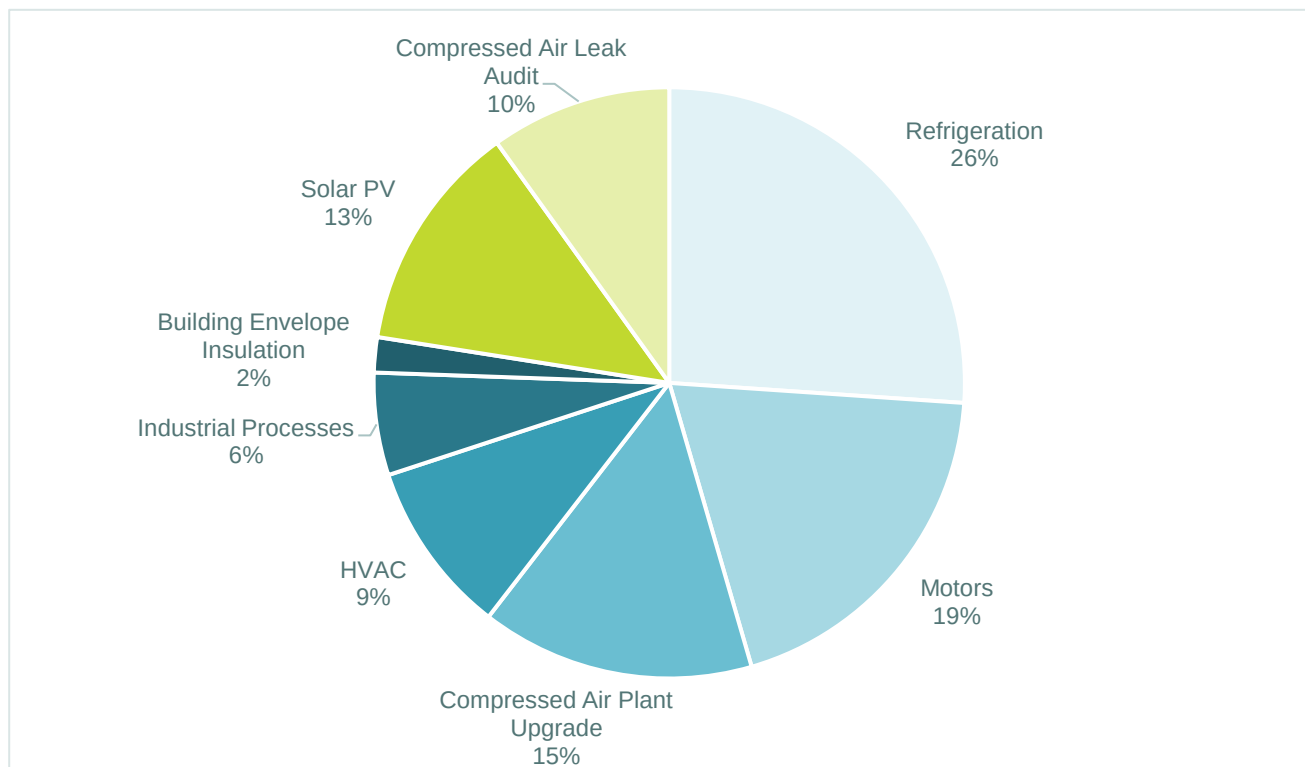


⁶ Multiyear projects include 30 projects that were started in 2022 and completed in November or December 2022. These projects could not be included as single-year completed projects in 2022 due to sampling constraints associated with the evaluation timeline. These projects were therefore reported as partial claims for the 2022 evaluation and as multiyear completions for 2023.



As illustrated in Figure 3 below, the three measure types that contributed the most to Retrofit tracked energy savings at the meter were: Refrigeration, motors and compressed air plant upgrades. The figure also indicates that semi-prescriptive compressed air leak audits and solar PV projects contributed 10% and 13% respectively to overall Retrofit savings, while regular Retrofit projects contributed 77%.

Figure 3: Retrofit Energy Savings by Measure Type - Projects Completed in 2023



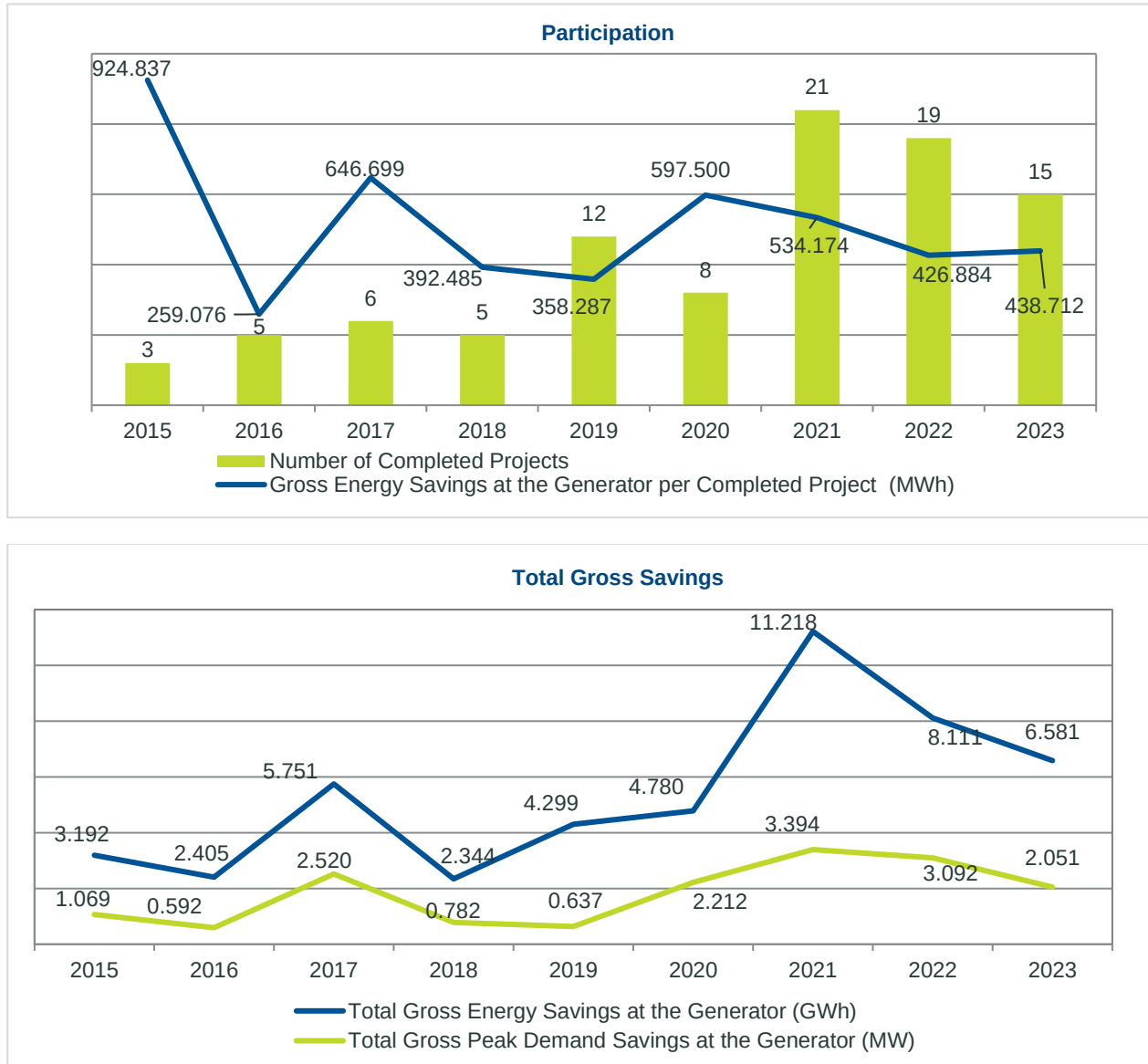
Pay-for-Performance

No projects generated savings under the Pay-for-Performance (P4P) service in 2023.

New Construction

In 2023, 15 projects were completed under New Construction. 12 of the 15 completed projects were multi-unit residential buildings. As highlighted in Figure 4 below, the number of completed projects reached a new high in 2021 but trended downward in 2022 and 2023. The energy savings per project remained relatively unchanged in 2023 compared to 2022, although the number of projects decreased and resulted in lower overall program savings. New Construction projects generated 6.581 GWh and 2.051 MW in gross energy and peak demand savings respectively.

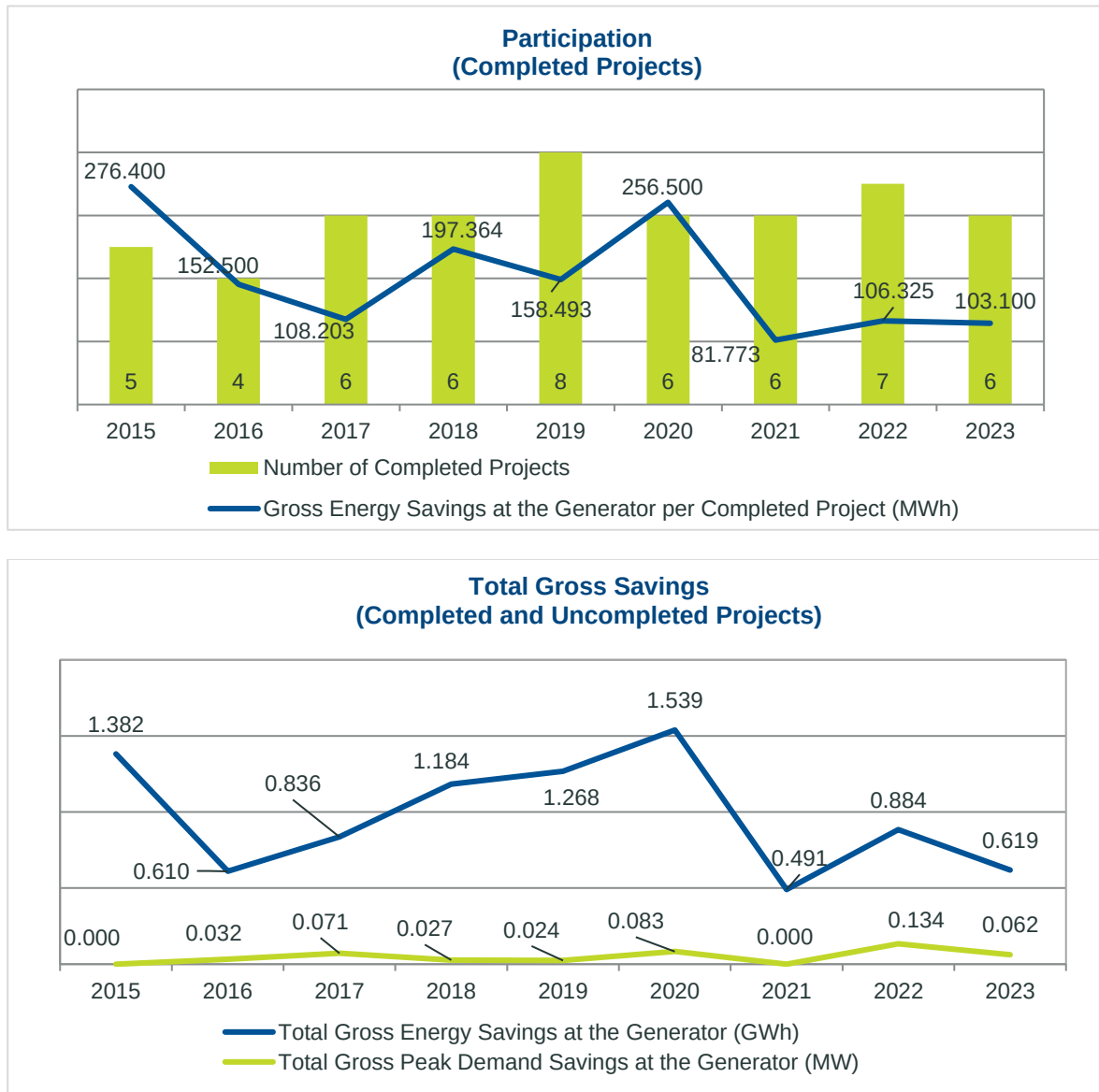
Figure 4: Overview of Participation in New Construction, 2015-2023



Building Optimization

A total of six Building Optimization projects reported savings in 2023. Five of them were single-year projects (started and completed in 2023), while the other project claimed partial savings, having been started in 2023 but not completed. Although the number of projects completed in 2023 remained modest, it is comparable to the participation levels of previous years. As depicted in Figure 5 below, the average energy savings per project were slightly lower (3%) in 2023 compared with 2022, with total gross energy and peak demand savings decreasing by 30% and 53% respectively.

Figure 5: Overview of Participation in Building Optimization, 2015-2023



2 Custom Evaluation Approach

The 2023 Custom evaluation comprised a comprehensive impact evaluation for Retrofit, Building Optimization, and New Construction. For Building Optimization, given its smaller contribution to Custom savings, NTGR results from 2021 were applied. The main objectives of the 2023 Custom evaluation were as follows:

- › Calculate gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions
- › For Retrofit solar PV projects, develop a semi-prescriptive approach to be used to calculate savings for future projects, notably by determining an adjustment ratio and identifying key parameters
- › Collect information on participant perspectives for Retrofit
- › Collect information on participation motivations, barriers, and the decision-making process for Retrofit

The Evaluator identified key research questions aimed at achieving the above objectives. Table 6 outlines the evaluation objectives and maps them to the research questions, methods, and sample sizes (n) established by the Evaluator. Each method is described further below.

Table 6: 2022 Custom Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Collect information on participant and partner perspectives on Retrofit	› What is the level of satisfaction with the different elements of Custom among participants and partners? › How are participants' decarbonization and electrification objectives impacting Custom? › What works well and what are the key challenges for Custom and by project type? › How can EOne improve Custom?	› Business Development Manager interviews (n=2) › Participant interviews (n=13) › Consultant interviews (n=8)
Update program service logic for Retrofit	› How is participation (type, size) in various offers evolving over time? › Are the offers in place (compressed air, regular projects, solar PV, on-site energy manager [OEM]) addressing market barriers and appropriate to attain program objectives? › Are the offers in place coherent with other program component offers (e.g. BER, SEM/EMIS)? › Is there overlap in measures and services offered under multiple EOne components? › Where appropriate, are impact assumptions and methodologies consistent with measures and services offered under multiple EOne components?	› Logic model update › Participation history using tracking sheets
Determine an adjustment ratio to be used for future solar PV projects	› How do predicted energy production values compare to measured energy production for solar PV installations in Nova Scotia?	› Study comparing modelled and measured energy production data, environmental factors, and software bias.
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 implemented? › Have the correct EUL values been applied to sampled Custom project measures, and which values require a 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 with site visits or participant follow-up interviews › Regular Retrofit (n= 20) › Building Optimization (n=6) › Project file desk reviews: Retrofit solar PV (n=18) › Energy Model reviews: New Construction (n=12) › Savings verification: Compressed air leak audits (n=8) › Calculations using evaluation results
Calculate net results	› What are the free-ridership and spillover levels for regular Retrofit, solar PV, and New Construction projects? › 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 Custom?	› Participant phone interviews › Regular Retrofit (n= 20) › Solar PV Retrofit (n=15⁷) › New Construction (n=9) › Building Optimization (2021 NTGR used) › Calculations using evaluation results › Avoided GHG emission reduction calculations

Business Development Manager Interview

In October 2023, the Evaluator interviewed the two Business Development Managers (BDMs) respectively in charge of industrial and commercial customers to discuss program challenges and successes, barriers to implementing energy efficiency projects and differentiating points between the various Custom Incentives offerings. The guide used for the BDM interview is presented in Appendix I.



Participant Phone Interviews

To collect information on participant free-ridership and perspectives, the Evaluator conducted participant phone interviews with 13 regular Retrofit participants, six solar PV participants,⁷ and eight New Construction participants in December 2023 and January 2024. One additional New Construction participant was interviewed earlier in the process, after they had completed their Customer Purchase Agreement (CPA). The interview guides are presented in Appendices II, VIII and IX for Retrofit and New Construction participants respectively.

Consultant Phone Interviews

To better understand barriers to participation and opportunities to improve the program, the Evaluator conducted phone interviews with eight consultants that supported Retrofit projects in 2023. Interviews were conducted in December 2023 and January 2024. The interview guide is presented in Appendix III.

Adjustment Ratio for Solar PV Projects

In the fall of 2023, the Evaluator compared full-year energy production data provided by participants with modelled production for 18 solar PV projects with the objective of determining an average actual-to-modelled ratio. This average ratio will be used as an adjustment ratio to reliably estimate actual energy savings based on modelled savings for future Custom solar PV projects in Nova Scotia. The modelling parameters were also validated for each project.

Tracking Sheet Audit

Prior to performing any savings calculations, the Evaluator conducted an audit of the final 2023 tracking sheets to ensure they were complete and data entry was consistent. The detailed protocol used for the tracking sheet audit and the results thereof are presented in Appendix IV.

Project File Reviews and Participant Site Visits or Follow-up Phone Interviews

In the fall of 2023 and January 2024, Econoler and its subcontractor CDM Energy Solutions carried out a full technical review of project documentation for 20 regular Retrofit projects and six Building Optimization projects. Pursuant to the desk reviews, site visits or follow-up phone interviews with participants were conducted to finalize the project reviews. The phone interviews were also used to collect information on free-ridership and spillover for regular Retrofit participants.

The protocol presented in Appendix VII was used to review Retrofit and Building Optimization projects. The Retrofit participant interview guide is presented in Appendix II.

Savings Verification

In the fall of 2023 and January 2024, the Evaluator completed savings verifications of eight compressed air leak audit projects, by validating that the correct input parameters were used to estimate savings for all completed projects in this category.

⁷ To determine the evaluated free-ridership level for solar PV participants, the Evaluator included results from interviews conducted with six 2023 participants, seven 2022 participants, and two 2021 participants, resulting in a total sample size of 15 participants.



Energy Model Reviews

In the fall of 2023 and January 2024, Econoler and its subcontractor 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. Project file reviews were found to be sufficient for all 12 projects. The protocol for the energy model reviews is presented in Appendix X.

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 4, 5, and 6 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.

Note on Margins 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 precision⁸ of the measurement, while its associated confidence level indicates the probability of a measurement falling within the margin of error.⁹

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 2023 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 2023 DSM Programs Evaluation Executive Summary.

⁸ 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.

⁹ 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 Retrofit Process Evaluation

The results of the Retrofit process evaluation are separated into two main subsections. Subsection 3.1 summarizes participant and consultant perspectives, while Subsection 3.2 is focused on the logic model review.

3.1 Retrofit Participant and Consultant Perspectives

3.1.1 Consultant Involvement in Retrofit

Among the eight consultants interviewed, four occupy an ownership position within the company, and four are involved in sales either as an account manager (n=2), a vice president of sales (n=1), or a service manager (n=1). Consultants' primary focus areas include refrigeration (n=4), electrical systems (n=4), heating, ventilation, and air conditioning (HVAC) (n=3), automated controls (n=1), and solar (n=1). Three of the eight consultants have worked with Retrofit for at least ten years, while two others have been involved for between five and 10 years and the remaining three are less experienced with the service.

Consultants are often involved at each step of the service. With the exception of one consultant who did not comment on their specific role throughout the process, all are involved in confirming participant eligibility, notably by helping identify upgrades that may be eligible for Retrofit, partaking in discussions with EOne on possible upgrades, and liaising with EOne once opportunities have been identified. Only one consultant reported assisting with the application process, with one other providing the required application information to customers.

Six of the eight consultants are involved in conducting scoping studies and feasibility studies.

All consultants are involved in the implementation of upgrades by overseeing the entire project or, at times, acting as a project manager by coordinating the work of subcontractors. All consultants are involved in the measurement and verification aspects by collaborating with EOne to facilitate the installation of monitoring equipment and to collect and communicate the required information during the monitoring period.

3.1.2 Participant Recruiting

Interviewed consultants reported multiple avenues through which Retrofit projects are initiated. For the most part, consultants initiate the discussion with their clients about participating in Retrofit (n=7), although a good number report that, on occasion, their clients also bring up the topic with them (n=4), someone from EOne makes the suggestion (n=4), or that the idea arises as part of discussions between EOne and their own clients (n=3).

Half of interviewed consultants indicated that they help clients to determine whether a project should be submitted under Business Energy Rebates (BER) or Retrofit. The choice of program is usually made in consultation with EOne staff. One consultant mentioned that complex projects are often directed to Retrofit, while BER is preferred for simple upgrades. This feedback was also reflected by participants who indicated that they are sometimes unsure about which program is the best option for a given energy efficiency upgrade. Importantly, EOne staff are consistently available to provide direction and support in program selection.



Consultants reported mixed perspectives on the influence of Retrofit on their business. Four consultants said that Retrofit has helped them win projects they may not have secured otherwise due to the appeal of the incentive and its ability to reduce the payback period. One consultant suggested that Retrofit has had a limited influence on winning business given that the incentive amounts are disproportionately low relative to the costs of large upgrades. The three other interviewed consultants do not believe Retrofit has influenced their business.

3.1.3 Awareness and Motivations for Participating and Implementing Upgrades

Participant Perspectives

Most participants learned about Retrofit directly from EOne staff or marketing (n=5) or were already aware of the service before considering their project (n=4). Other sources of awareness are through an electrician (n=1), energy manager (n=1), retailer (n=1), or learning about the service themselves (n=1).

Participants were motivated to implement energy efficiency upgrades to improve the efficiency of their building or equipment (n=3) and to save on energy costs (n=3). Other motivations included the organization's energy mandate or strategy (n=2) and replacing old equipment (n=2).

Participation in Retrofit is primarily motivated by the program's financial incentive and the energy cost savings achieved (n=8). One participant indicated they were motivated to replace faulty equipment.

Consultant Perspectives

Consultants believe that incentives help reduce the cost of the upgrades and is most often the greatest motivation to participate in Retrofit (n=5). According to consultants, the energy cost savings resulting from the upgrades also foster interest in the service (n=3) in addition to reduced maintenance costs from installing higher efficiency equipment (n=1). An organization's desire to reduce GHG emissions (n=2) or enhance their reputation as a green organization (n=1) are other motivators identified by consultants to explain why customers take part in Retrofit.

3.1.4 Barriers to Implementing Other Energy Efficiency Projects

Participant Perspectives

Among Retrofit participants, the top barrier to implementing energy efficiency projects is cost or a poor return on investment (n=5). Project costs are addressed by Retrofit incentives, although participants and consultants indicated that, in some cases, incentives are not significant relative to the cost of certain energy efficient solutions (n=3). Participants and contractors also noted that materials and labour costs have increased significantly in the past several years (n=2).

Other barriers to implementing energy efficiency projects reported by participants include a lack of project management resources to develop and execute projects (n=3), availability of a trained workforce (n=3), equipment supply issues (n=2), and a lack of awareness about incentive programs (n=2). Other financial challenges include a lack of incentives for non-electrical upgrades (n=1), insufficient government funding (n=1), a debt cap maintained by businesses and that limits borrowing for projects (n=1), and uncertain returns on investment for energy efficiency upgrades (n=1). Finally, one operation requires ongoing power and the given business cannot afford to shut down power to complete retrofit projects.

Consultant Perspectives

Consistent with participant feedback, consultants indicated that project costs and insufficient returns on investment are the primary barriers to businesses carrying out energy efficiency projects (n=6). Two consultants specifically noted that returns on investment for many energy projects do not meet their clients' investment criteria – one mentioned that a four-year payback was too long for some clients. Another consultant mentioned that commercial real estate owners cannot always recoup the costs of energy projects, and that universities generally have less access to capital than in past years.

Another barrier cited by consultants is the timeline to develop energy efficiency projects through Retrofit. Two consultants said that energy efficiency projects take more time to develop than like-for-like replacements and, when the required time for conducting feasibility studies and program application processing is added, the resulting longer project timelines become a barrier for some businesses. This specific issue was mentioned by only one consultant. Another consultant said that the cost of conducting the measurement and verification (M&V) required by Retrofit was in some cases higher than the incentive payment and this might be a barrier to participation.

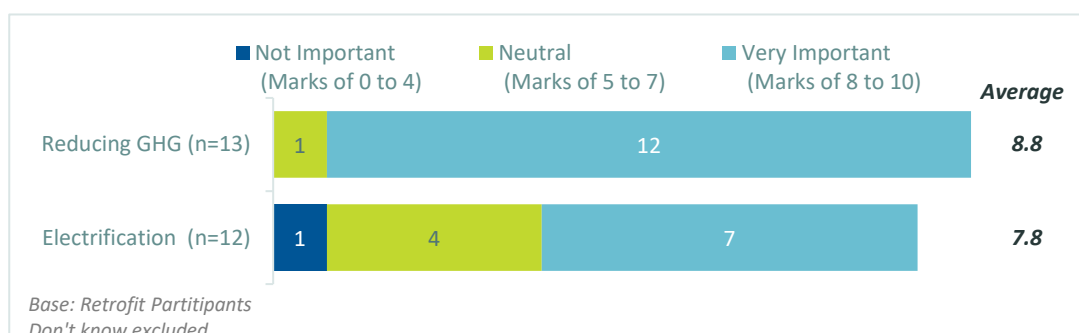
Consultants provided suggestions on how EOne could facilitate their work and reduce delays. One consultant appreciated EOne's assistance with the administrative functions involved in completing the feasibility study and M&V reports and suggested that, to further reduce administrative tasks, consideration should be given to standardizing the feasibility study and measurement and verification report forms based on the types of upgrades or projects completed. Similarly, another consultant would like to see additional training for EOne staff so they become familiar with common project scenarios to improve application processing times and reduce the need for back and forth with consultants. Other consultants also asked for assistance with M&V and for EOne to take on the responsibility of conducting feasibility studies to free up the time consultants invest in such activities.

3.1.5 Decarbonization and Electrification

Participant Perspectives

Retrofit participants place a high degree of importance on reducing GHG emissions. Participants provided an average score of 8.8 out of 10 on a scale where 0 means that reducing emissions is “Not important” and 10 means it is “Very important” for the organization. Using the same scale, participants provided an average score of 7.8 out of 10 regarding the importance of electrification to their organization.

Figure 6: Importance of Reducing GHG Emissions and Electrification



More than half of interviewed participants indicated that reducing GHG emissions had a small influence on their decision to participate – this was often seen as one minor benefit that stacked with other more significant benefits (energy and cost savings in most cases) and helped the business case to go forward. Four participants indicated that the opportunity to reduce GHG emissions had no influence on their decision to participate in Retrofit, although one of them said that it would have a significant impact in the near future when emission reductions will be an important goal for their organization. No participants indicated that reducing GHG emissions was the most important factor in their decision to participate in Retrofit.

Consultant Perspectives

Consultants reported that GHG reductions and electrification are areas of interest for some organizations, but achieving cost savings through energy efficiency is still the primary motivation among Nova Scotia businesses. Most consultants have discussions with at least some of their clients about GHG reduction opportunities and electrification, although two consultants indicated that their clients have not been interested in emission reductions and discussions are focused on achieving energy cost savings.

Regarding specific questions and concerns among clients when it comes to achieving emission reductions and electrification in their operations, three consultants said that a primary challenge is uncertainty or lack of knowledge about the best opportunities or technologies to reduce emissions or electrify their operations. Those consultants indicated that EOne plays an important role in educating and guiding businesses toward effective solutions, although a lot more knowledge building is needed to help more businesses decide to take action.

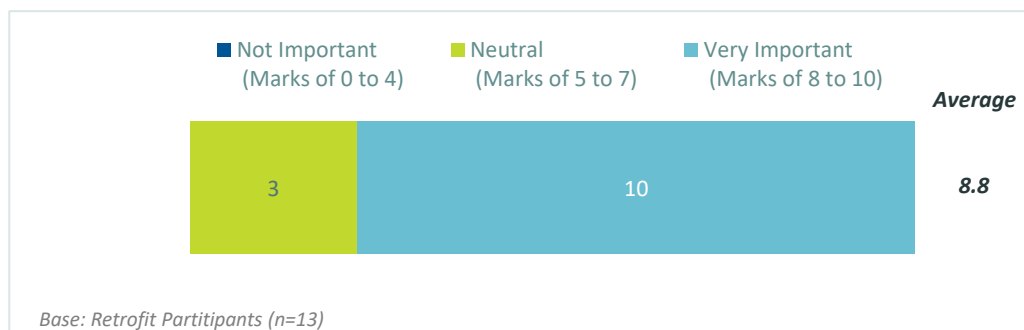
Three consultants also mentioned carbon credits as an area in which their customers are interested, but one indicated that it is too complicated to obtain such credits.

3.1.6 Measurement and Verification

Participant Perspectives

Participants place a high degree of importance on the M&V of energy efficiency projects, rating its importance an average of 8.8 out of 10 where 1 means measurement and verification is not important to their organizations and 10 means it is very important.

Figure 7: Importance of Measurement and Verification





Most participants did not experience significant challenges in planning and conducting energy savings M&V on their Retrofit projects. When asked to name challenges they faced, half of participants indicated that the process was “intuitive” or “a no-brainer” or that they received support from EOne and this made the process smooth. Two participants experienced challenges related to collecting and accessing energy performance data to support M&V; one participant indicated their systems have limited performance monitoring capabilities, and another had difficulty accessing pre-retrofit performance data to support baseline development. One of those businesses said that having now put measurement systems in place, they did not expect to have any future challenges with M&V.

Regarding opportunities to improve the experience of participants when conducting M&V, three participants suggested EOne could help participants to access or properly install performance monitoring equipment. One participant suggested EOne could provide an incentive to cover the cost of M&V.

Consultant Perspectives

Overall for Retrofit projects, consultants were more likely to point out challenges with M&V than participants. Two consultants said that cost is a challenge; in some cases, the M&V cost exceeded the Retrofit incentive, which devalued the service for those businesses. One consultant said that the M&V requirements are not adapted to facilities with energy usage that fluctuates throughout the year or from year to year, thus creating difficulty with savings calculations in such cases. Contrary to feedback from participants, two consultants indicated that their clients do not always see the value of M&V and are hesitant to invest in installations that support proper monitoring.

Several consultants provided suggestions on how EOne could support the implementation of comprehensive M&V for Retrofit projects. One consultant recommended that M&V be conducted independently from the consultants that work on upgrade projects to improve consistency and fairness across projects. Another recommended that Retrofit require participants to establish the M&V plan after the feasibility study is completed and before implementation/construction, thereby providing an opportunity to install the required monitoring systems at the same time as the upgrades. Two consultants also suggested that the cost of M&V be covered by the Retrofit incentive.

3.1.7 Satisfaction and Support from EOne

Participant Perspectives

Since solar PV projects are now distinguished from regular Retrofit projects within the Retrofit offer, participant satisfaction results are presented separately for each project category.

Participants are satisfied with Custom Retrofit overall, with an average score of 8.0 among regular Retrofit participants and 8.8 among solar PV participants on a scale where 1 means “Not at all satisfied” and 10 means “Completely satisfied”. Satisfaction results for each project category are provided in Figure 8 below.

Based on the same scale, the overall performance of EOne in supporting participant organizations also received positive ratings with an average score of 9.2 among regular Retrofit participants and 9.0 among solar PV participants.

Across both regular Retrofit and solar PV participants combined, satisfaction is highest with the timely responsiveness of EOne employees to requests and inquiries (total average score of 8.6), the technical expertise of EOne employees related to the service (8.4), the speed with which the application was approved (8.4), and the ability to provide estimates on the savings or return on investment associated with the service (8.0). Satisfaction is lowest overall with the value of the service relative to the time and cost involved (7.6).

Figure 8: Satisfaction with Custom Retrofit, 2023
Highly Satisfied (Marks of 8-10)



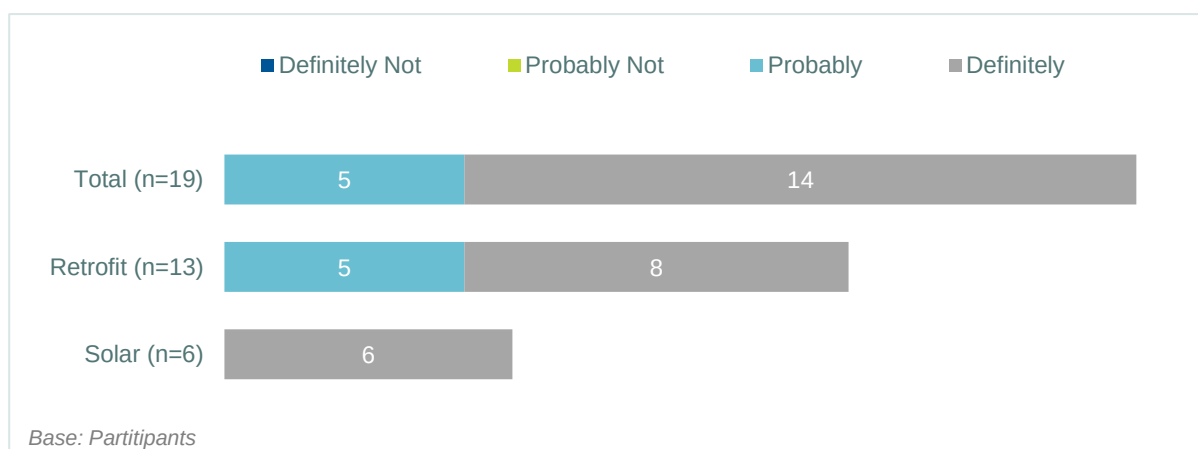
Reasons provided by a small group of Retrofit participants to explain why they were not highly satisfied primarily include the rebate amounts being too low, especially considering the time involved in completing the participation process. A lack of clarity in the calculation of energy savings and monitoring as well as On-site Energy Managers (OEMs) or EOne employees lacking expertise were also mentioned. Complete results are presented in Table 7.

Table 7: Reasons for Dissatisfaction – Regular Retrofit & Solar PV, 2023

	Factor Assessed	Reasons for Dissatisfaction/What Could Be Improved (#)
Regular Retrofit n=4 Solar PV n=3	The value of the service relative to the time and cost involved	› The rebate amounts are too low (Regular: 4) (Solar PV:3) › Non-electrical fuels ineligible (Regular : 1)
Regular Retrofit n=4 Solar PV n=1	The ability to provide estimates on the savings or return on investment associated with the service	› Feasibility study lacks accuracy (Regular:1) (Solar PV:1) › EOne staff/OEMs lack technical knowledge (Regular:1) (Solar PV:1) › Rebate calculated based on amount of KWh for the year/not considering year-to-year fluctuations in production (Regular: 1) › More time spent on calculating estimates due to lack of baseline data for expansion or new construction projects (Regular: 1) › Delays in completing projects (Regular: 1)
Regular Retrofit n=3 Solar PV n=1	Custom Retrofit overall	› Too much back and forth with EOne/time consuming (Regular:1) › Administrative burden (Regular:1) › The rebate amounts are too low (Regular:1) › Unspecified (Regular:1) › Rebates not available for non-electrical savings (Solar PV:1)
Regular Retrofit n=2 Solar PV n=1	The timely responsiveness of employees to your requests and enquiries	› No response/need to follow up with EOne (Regular:1) › Unspecified (Regular:1) (Solar PV:1)
Regular Retrofit n=1 Solar PV n=3	The technical expertise of EOne staff related to the service	› EOne staff/OEMs lack technical knowledge (Regular:1) (Solar PV:1) › Incentives change regularly (Solar PV:1) › Unspecified (Solar PV:1)
Solar PV n=1	EOne's overall performance in working with your organization	› General dissatisfaction (Solar PV: 1)

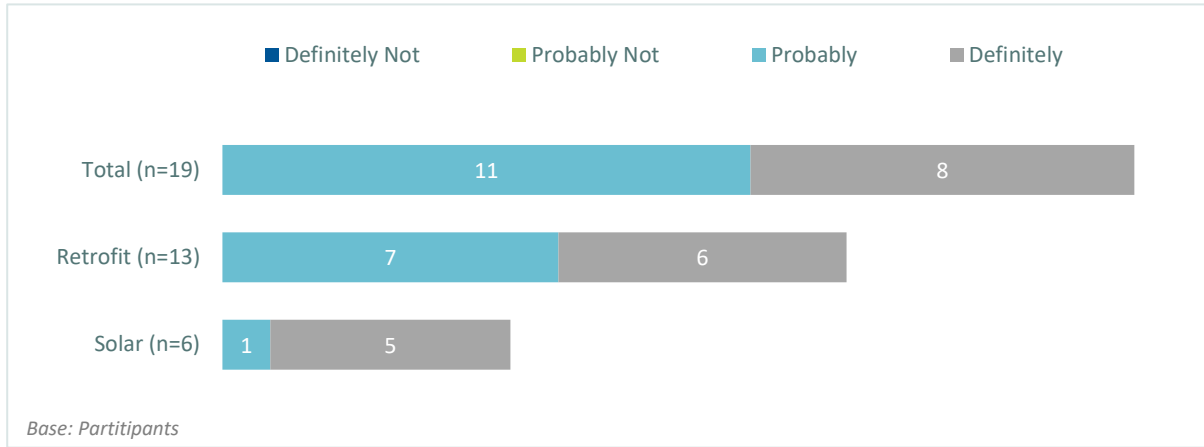
Most participants indicated that they would recommend EOne programs, with most regular Retrofit participants (n=8) and all solar PV participants (n=6) saying they would definitely recommend and all others saying they would probably recommend, as indicated in Figure 9.

Figure 9: Willingness to Recommend EOne Programs



Participants indicated they are highly likely to participate in other EOne programs. Nearly all solar PV participants (n=5) and about half of regular Retrofit participants (n=6) would definitely participate in other programs if the occasion was presented to them, while the remaining participants indicated they would probably do so, as indicated in Figure 10.

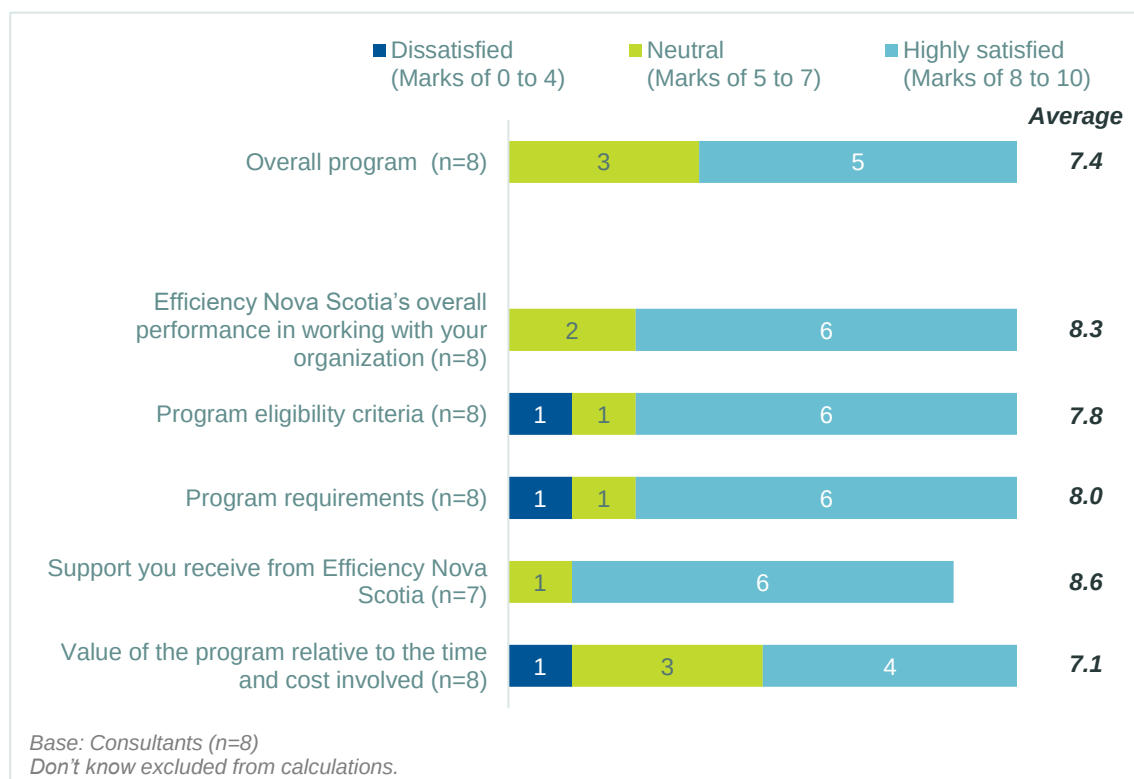
Figure 10: Likelihood of Participating in Other EOne Programs



Consultant Perspectives

Consultants are satisfied with Custom Retrofit overall with an average satisfaction score of 7.4 out of 10 where a score of 0 means “Not at all satisfied” and a score of 10 means “Completely satisfied”. Satisfaction is high with the support received from EOne (average score of 8.6), EOne’s overall performance in working with consultants (8.3), the program requirements (8.0), and the program eligibility criteria (7.8). Satisfaction is lowest with the value of the service relative to the time and cost involved (7.1). Complete results are presented in Figure 11 below.

Figure 11: Satisfaction with Custom Retrofit



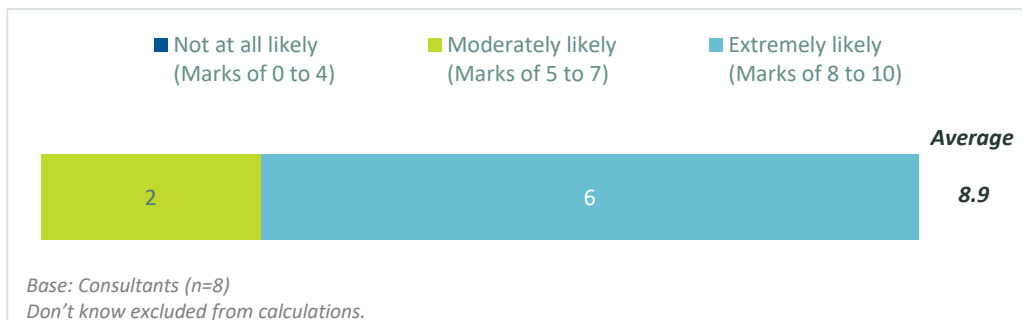
Consultants provided a range of justifications for lower satisfaction scores. Low incentive levels as well as the time and complexity involved in supporting Retrofit projects were the only two issues mentioned by more than one consultant. The detailed results are presented in Table 8.

Table 8: Reasons for Dissatisfaction

Factor Assessed		Reasons for Dissatisfaction/What Could Be Improved (#)	
n=4	Value of the service relative to the time and cost involved	›	Incentives too low/should be more value for the customer (1)
		›	Custom Retrofit does not generate sales/incentive not attractive (1)
		›	Time consuming for consultants – studies and M&V (1)
		›	General dissatisfaction (1)
n=3	Overall Retrofit service	›	Too complex/needs streamlining/make it easier to participate/ faster process (2)
		›	Incentives too low (2)
		›	Demanding/long M&V process (1)
		›	Should focus on GHG emission reductions and address non-electrical savings opportunities (1)
n=2	Retrofit eligibility criteria	›	Specific eligibility requirements make it difficult to participate (general mention) (1)
n=2	Retrofit requirements	›	Required equipment expensive compared to the incentive – e.g. motor fan (1)
		›	General dissatisfaction (1)
n=2	EOne's overall performance in working with your organization	›	Slow to respond to enquiries or provide feedback on projects (1)
		›	Inability to provide estimate on incentives before upgrades are completed (1)
		›	General dissatisfaction (1)
n=1	Support received from EOne	›	Would like them to provide more support with program activities – reports, M&V (1)

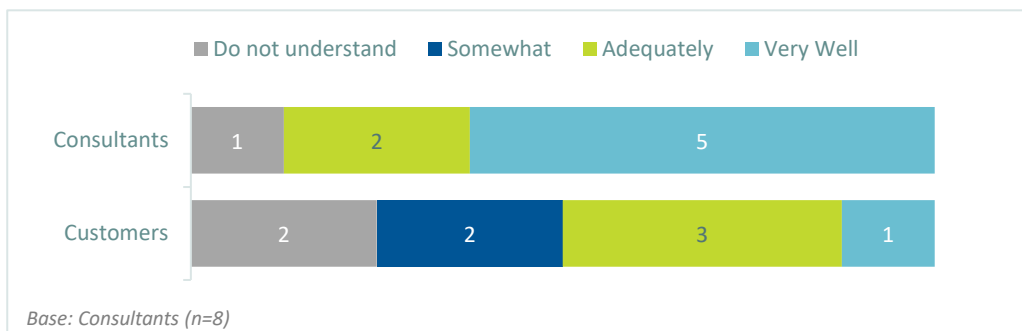
Consultants are highly likely to recommend Retrofit to a peer, colleague, or future client based on their experience, with an average score of 8.9 on a scale where 0 means “Not at all likely” and 10 means “Extremely likely”, as indicated in Figure 12.

Figure 12: Likelihood to Recommend Retrofit Among Consultants



Consultants generally believe that they and their peers greatly or adequately understand Custom Retrofit participation requirements. Only one consultant indicated that the requirements are not well understood among consultants. In contrast, consultants are divided in assessing how well customers understand the service, with half indicating that customers greatly or adequately understand the requirements and the other half indicating that the requirements are only somewhat understood or not understood by participants. The detailed results are presented in Figure 13.

Figure 13: Level of Understanding of Requirements for Program Participation



Suggestions provided by consultants to improve understanding of the program requirements among consultants and participants include providing timely information on program changes, maintaining consistency in program requirements, building awareness about Retrofit and energy efficiency overall, and educating businesses about the value of energy efficiency (one mention each).

Other suggestions for services or support that EOne could provide to help consultants complete more projects under Retrofit include reinstating the preferred supplier list, increasing the incentive amounts, and supporting consultants in completing the feasibility study and M&V plan by providing document templates for common measure types.



3.1.8 Suggestions for Improvements

Participant Perspectives

The primary suggestions from participants to improve Custom Retrofit were to increase the incentive amounts (n=6) and expand eligible measures to include non-electrical upgrades (n=3). Other suggestions, each mentioned by one participant, included incentivizing energy storage and renewable energy sources, providing assistance to identify potential energy savings, and providing the incentive up-front so it can be used to cover the cost of upgrades.

Consultant Perspectives

Consultants did not identify additional challenges or suggestions to improve Retrofit beyond those discussed above.

3.2 Logic Model Review

The logic model review served to assess the degree to which Retrofit is achieving its goals as anticipated at the time of design. To do so, the Evaluator compared the logic model assumptions to the findings of the multiple data-collection activities and reviewed the connections to relevant offers and Custom Incentives program components or services.

Overall, the offers of the various Custom Incentives program components and services are coherent – the types of measures and incentive levels available across the different offers are appropriate and justified. Some participants and consultants indicated that they had questions about which offer was the best option for a given project, although they consistently said that EOne staff were available and supportive in answering these questions and this did not pose a barrier to participation.

3.2.1 Logic Model

The main objective of the logic model is to link program objectives to the barriers thereto and identify actions or offers to address the barriers. The Evaluator examined the Retrofit logic model to assess alignment between logic model elements – barriers and program supports – and the barriers and program offers observed in the evaluation. The Evaluator also identified missing elements and opportunities to improve the Retrofit logic model.

Objectives

According to the program manual, Retrofit and Custom Incentives more broadly have the following objectives:

- › Influence electrical energy efficiency and system peak demand reduction projects in Nova Scotia
- › Build awareness around the benefits of energy efficiency among participants
- › Help BNI customers overcome barriers to implementing large and complex energy efficiency projects
- › Further diversify EOne program offerings by developing new programs based on technologies and methods successfully trialed through Custom Incentives



The first two objectives are properly reflected in the logic model, but the third and fourth objectives are treated insufficiently, or not at all. As discussed in more detail below, while Retrofit does help customers overcome the barriers to large and complex energy efficiency projects, those barriers – cost and access to project management resources – are not presented accurately or in sufficient detail in the logic model. The objective of diversifying EOne program offerings does not appear in the logic model.

Barriers and Actions

The logic model indicates the primary barrier to achieving program objectives is that projects are “not eligible for standard EOne programs”. While this is a legitimate barrier to the execution of large and complex energy efficiency projects, it is secondary to other barriers observed in the evaluation, including the cost of energy efficiency projects and a need for technical and project management support to identify and develop energy efficiency opportunities. These barriers are not currently captured in the Retrofit logic model.

The logic model indicates that energy savings measurement and verification will lead to an increase in the number of energy efficiency projects as well as enable BNI customers to implement more complex and expensive measures. There appears to be an assumption that successful participation in Retrofit will lead businesses to develop additional projects, some of which may not be implemented through EOne programs and instead be counted as participant spillover. This is a possible outcome, although the links between such actions and outcomes are poorly supported in the logic model. The Evaluator is skeptical that participation in Retrofit will result in greater participant spillover as Retrofit spillover has been consistently low over time and the Evaluator did not observe any program elements dedicated to enhancing spillover.

The Directory of Contractors and Consultants mentioned in the logic model appears to no longer be supported.

The Evaluator identified program actions and links that are not accounted for in the logic model, including:

- › The link between Retrofit and SEM. SEM has an objective to increase the number of capital projects completed through Retrofit, thus suggesting this is or may become an important source for Retrofit participation and savings.
- › OEMs are not accounted for among Retrofit offers.

SEM and OEMs provide project management resources in addition to other support to address one of the primary barriers noted by Retrofit participants, the lack of project management resources to develop energy efficiency projects.

4 Retrofit Impact Evaluation

The objectives of the 2023 Retrofit 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.

As described in Subsection 1.1 above, Retrofit includes three types of savings: (1) Partial savings (projects to be completed in future years); (2) final savings for single-year 2023 projects; and (3) final savings for multiyear projects. As presented in Table 9, 14 projects achieved partial savings in 2023, 62 single-year projects claimed final savings in 2023, and 31 multiyear projects claimed final savings in 2023.

Table 9: Evaluated 2023 Retrofit Projects

Type of Savings Claimed	Number of Projects
Single-year Projects with Final Savings in 2023	62
Multiyear Projects with Final Savings in 2023	31
Total Projects with Final Savings in 2023	93
Partial Savings in 2023	14
Total	107

Given the range of different project types completed in Retrofit, three distinct project categories were analyzed individually, namely: (1) Regular Retrofit projects; (2) solar PV projects; and (3) compressed air leak audit projects. For each project category, a distinct evaluation approach was used to determine gross and net savings. NTGRs were evaluated separately for regular Retrofit and solar PV projects. For compressed air leak audit projects, NTGR results from 2021 evaluation were applied.

Table 10 summarizes the impact evaluation approach for each project category under Retrofit. Results for the three project categories are presented below and are then combined as the aggregated results for Retrofit in Subsections 4.2.7 and 4.3.4. Partial savings projects are excluded from the totals presented in this table.

Table 10: Impact Evaluation Approach per Retrofit Project Category

Retrofit Project Category	Number of Projects Completed in 2023	Gross Savings Methodology	Net Savings Methodology
Regular Retrofit*	54	Adjustment ratio determined from a full review of a sample of projects (n=20)	NTGR evaluated in 2023 (n=20)
Solar PV	31	Adjustment ratio determined from a review of a sample of projects completed between 2021 and 2023 (n=18) **	NTGR evaluated in 2023 (n=15 ***)
Compressed Air Leak Audit	8	Savings verification, applying adjustment ratio from 2021	NTGR from 2021 applied

*The regular Retrofit category includes all projects that are not included in one of the other two categories.

**Two distinct adjustment ratios were developed for solar PV projects, one for projects modelled with PV Watts and one for those modelled with RETScreen Expert. These ratios will serve to calculate savings for future solar PV projects using a semi-prescriptive verification approach. See Subsection 4.2.2 below.

***The evaluated NTGR for solar PV projects relies on free-ridership and spillover interview results for 15 unique participants who completed a total of 21 projects between 2021 and 2023.



4.1 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 IV. 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 the changes in energy consumption resulting from actions taken by Retrofit participants regardless of why they participated.¹⁰ 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.

EOne calculates gross savings for each individual file in accordance with best measurement and verification practices for commercial and industrial energy efficiency projects. The Evaluator used the information and data made available by participants and EOne and supplemented these with engineering assumptions and professional judgments where necessary.

4.2.1 Savings Verification for Compressed Air Leak Audit Projects

For compressed air leak audit projects, the Evaluator verified savings by validating that the correct input parameters were used to estimate savings and applying a previously established adjustment ratio to tracked savings for each file to determine gross savings.

For compressed air leak audit projects, the Evaluator applied the 2021 evaluated Retrofit adjustment ratios for energy and demand savings.

4.2.2 Adjustment Ratio for Solar PV Projects

The Evaluator compared the full-year energy production data provided by participants with modelled production for 18 solar PV projects with the objective of determining an average actual-to-modelled ratio. This average ratio will be used as an adjustment ratio to reliably estimate actual energy savings based on modelled savings for future solar PV projects. The modelling parameters of each project were also validated.

To perform this analysis, EOne collected full-year energy production data for 18 solar PV projects that were completed between 2021 and 2023. Out of those 18 projects, eight used RETScreen Expert as the modelling tool to estimate savings, while the other ten projects used PV Watts. While any modelling tool comprises some inherent bias when estimating solar PV energy production, each tool models energy production in its own unique way and therefore has its own unique modelling bias. Consequently, the Evaluator established a distinct adjustment ratio for projects modelled with RETScreen Expert as well as a ratio for those modelled with PV Watts. Including projects completed in previous years was therefore crucial to allow for a large enough sample size to be used for each project group.

¹⁰ Definition adapted from 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).

For each project, the Evaluator made two adjustments to ensure a valid comparison between modelled and actual energy production data. The first adjustment involved applying a snow loss reduction factor to modelled energy production based on the solar PV panel angle; a 1% reduction was applied to projects with panel angles equal to or greater than 25°, and a 4% reduction was applied for panel angles lower than 25°. The second adjustment involved adjusting actual production data to determine what the production would have been for a normal year. Since the modelled production level relies on irradiance values for a normal year and the production data reflect actual irradiance for the data-collection year, the Evaluator calculated the ratio of normal irradiance values (daily average for the year in kWh/m²/day) to actual values and applied the resulting ratio to the collected production data to determine the adjusted actual energy production for each project.

The last step of the analysis involved dividing the adjusted actual energy production level by the adjusted modelled production for each project and then calculating the average adjustment ratio for each project group (RETScreen Expert projects and PV Watts projects). The results of this analysis are presented in Table 11.

Table 11: Solar PV Adjustment Ratios

Modeling Software	Adjustment Ratio	Margin of Error
RETScreen Expert	0.942	4%
PV Watts	1.101	2%

Given the low margins of error, the above adjustment ratios can be used to reliably establish final energy savings generated by future commercial solar PV projects using the following semi-prescriptive algorithm.

$$\text{Gross Energy Savings (kWh)} = \text{Modelled Energy Production (kWh)} * (1 - \text{Snow Loss Factor}) * \text{Adj. Ratio}$$

The Evaluator also applied the above adjustment ratios to determine evaluated gross energy savings for solar PV projects completed in 2023. Peak demand savings for solar PV projects were established as nil given that the energy generated by solar PV systems during the Nova Scotia peak period is negligible.

4.2.3 Project Review Sampling Methodology – Regular Retrofit Projects

For the regular Retrofit project category, the Evaluator used a stratified sampling approach to select 20 projects for review from a total of 54 projects completed in 2023. More specifically, the Evaluator ranked projects based on their energy savings and divided them into strata. In the last stratum (which contained the largest projects), all projects were sampled, while the strata of smaller projects were sampled at a lower rate. Within each stratum, projects were selected randomly. The selected sample of 20 projects represented 72% of total tracked energy savings for projects completed in 2023. Only completed projects were considered for sampling, and projects with partially claimed savings were excluded from the project reviews. Those projects will be eligible for review in a future evaluation when they are considered complete (in 2024 or later). The Evaluator obtained gross savings by extrapolating the results of the sampled project reviews to all regular Retrofit projects through a weighted average adjustment ratio.



4.2.4 Project Review Findings – Regular Retrofit Projects

The Evaluator reviewed the project sample to ensure the best measurement and verification practices were applied for commercial and industrial energy efficiency projects and adjusted the tracked savings accordingly.

As a result of the review process, the Evaluator made adjustments to the savings of nine of the 20 sampled files. These are broken down as three projects having a combination of energy and peak demand adjustments, two projects having only energy savings adjustments, and four projects having only peak demand savings adjustments.

Of the three projects for which both energy and peak demand savings were adjusted:

- › One of the projects consisted of installing a new refrigeration system with a high efficiency refrigerant (R717) instead of the standard refrigerant (R449), thereby allowing the chiller to supply the required cooling capacity while using less power. The installed measure allows for the reuse of waste heat generated by the refrigeration system to heat the ventilation system make-up air as well as to provide heat to the frost protection system of the refrigeration system. The resulting additional energy savings were not originally considered by the participant and were added to total project savings as part of the project review process. This resulted in an upward adjustment to the energy and peak demand savings of that project.
- › One of the projects involved a compressed air system upgrade for which the Evaluator made an adjustment to the M&V methodology. The post-project consumption was adjusted to ensure that it only reflected the change in air compressor efficiency and excluded any consumption changes arising from differences in compressed air demand between the reference and performance periods. This change resulted in an upward adjustment to energy savings and a downward adjustment to peak demand savings.
- › One project involved replacing an alternating current induction motor with an alternating current permanent magnet motor. While the participant properly calculated savings arising from decommissioning two ventilation fans needed to cool the induction motor, savings associated with the improved motor efficiency were not originally considered and were therefore added by the Evaluator as part of the project review process. This resulted in an upward adjustment to energy and peak demand savings.

Of the four projects for which only peak demand savings were adjusted:

- › Three projects received an upward savings adjustment to properly reflect average demand savings for the facility's operation hours coinciding with the heating season.
- › One project received a downward savings adjustment arising from a correction to the power factor used in the calculation of baseline peak demand.

Finally, of the two projects for which only energy savings were adjusted, one received an upward adjustment and one received a downward adjustment, both resulting from corrections to the savings calculations.

The Evaluator used the above adjustments to calculate average adjustment ratios for energy and peak demand savings for the project sample (results are provided in Subsection 4.2.7 below) with the following exceptions: Five adjustments made to peak demand savings and one adjustment made to energy savings were applied as one-time adjustments and excluded from the calculation of the adjustment ratios.

The Evaluator notes that, in 2022, EOne implemented M&V guidelines for Retrofit participants following recommendations on M&V made in previous evaluation reports. The Evaluator further notes a marked improvement in the quality of M&V based on the reviewed 2023 Retrofit projects.



4.2.5 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.

4.2.6 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 EUL values were selected based on the values outlined in the 2020-2023 Measure Assessment.¹¹

Following the review of the 20 sampled regular Retrofit projects, the Evaluator found that five of those projects required adjustments to their EUL values. Changes made by the Evaluator were a result of establishing a better understanding of the installed measures through the project reviews. For example, two projects implemented multiple energy saving measures, such as LED lighting, a central heat plant, and building automation system upgrades, each of which has a different EUL. For both of these projects, the EUL was tracked as the EUL for only one of the measures, and the Evaluator adjusted the project EUL to be a weighted average of each measure's EUL based on the savings attributed to each measure. The Evaluator also revised the EUL for one project that implemented compressed air system retrofits by adjusting the tracked 10-year EUL values to a 15-year EUL, which is the value that the Evaluator supports for such systems. Finally, the Evaluator made an upward adjustment to the EUL for a refrigeration upgrade project from the tracked 10-year EUL to a 15-year EUL as well as made a downward adjustment to the EUL for a boiler conversion project from a 20-year EUL to a 15-year EUL. Given that only minor adjustments were made to the EUL values of reviewed projects, the Evaluator did not apply any overall adjustment to the remaining regular Retrofit projects and maintained the tracked EUL values as the evaluated EUL values.

Following the savings verification performed on compressed air leak audit projects, the Evaluator adjusted the EUL of all projects from four years to two years in accordance with the 2020-2023 Measure Assessment.

For solar PV projects, the Evaluator adjusted the tracked 25-year EUL to 22.4 years, the latter being the equivalent EUL that accounts for the solar panel output degradation rate of 0.8% per year over the measure lifetime.¹²

4.2.7 Evaluated Gross Savings

Savings for Retrofit are claimed under three defined categories: (1) Partial savings; (2) final savings for single-year 2023 projects; and (3) final savings for multiyear projects. For projects that claimed partial savings in previous years and were completed in 2023, 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. The Evaluator applied a distinct current-year adjustment ratio to the savings of each project category under Retrofit based on the approaches described in Subsections 4.2.1, 4.2.2, and 4.2.3 above. These adjustment ratios are presented in Table 12 below. The Evaluator aggregated results from all project categories to determine overall evaluated gross savings for Retrofit.

¹¹ The 2020-2023 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 for all measures offered in EOne's program portfolio. For the evaluations conducted during the 2020-2022 DSM cycle and for the first year of the 2023-2025 DSM cycle, the Evaluator refers to the values presented in the 2020-2023 Measure Assessment

¹² National Renewable Energy Laboratory (NREL). (2012). Photovoltaic Degradation Rates — An Analytical Review.

Table 12: 2023 Retrofit Adjustment Ratios per Project Category

Retrofit Project Category	Adjustment Ratio on Energy Savings (Margin of Error)	Adjustment Ratio on Demand Savings (Margin of Error)
Regular Retrofit	1.017 ($\pm 0.9\%$) *	1.011 ($\pm 1.9\%$) *
Solar PV - PV Watts	1.101 ($\pm 2.3\%$)	N/A **
Solar PV - RETScreen	0.942 ($\pm 4.2\%$)	N/A **
Compressed Air Leak Audit	0.981 ($\pm 1.2\%$)***	1.007 ($\pm 4.8\%$)***
*Following project reviews, the Evaluator applied one-time adjustments to the energy savings of one project and to the peak demand savings of five projects. Those projects were therefore excluded from the calculation of the average adjustment ratio for this category. **The energy generated by solar PV systems coinciding with the Nova Scotia peak periods is considered nil, and none of the solar PV projects completed in 2023 had tracked peak demand savings. ***Adjustment ratios were not calculated for compressed air leak audit projects in 2023, instead the 2021 Retrofit adjustment ratios were used.		

Table 13 presents an example of how the true-up adjustment was applied to the gross energy savings of a multiyear project completed in 2023.

Table 13: Example of a 2023 True-up Adjustment

	2022	2023	Total
Tracked Savings (kWh)	838,744	1,032,154	1,870,898
Year-specific Adjustment Ratio	0.916	1.017	
Revised Savings Prior to True-up (kWh)	768,290	1,049,701	1,817,990
Total Project Revised Savings with 2023 Adjustment Ratio (kWh)			1,902,703
True-up (kWh)			84,713

Table 14 below presents the overall evaluated gross savings for Retrofit, which were obtained by applying the appropriate adjustment ratios from Table 12 above to the energy savings and peak demand savings of each project and by applying true-up adjustments to the final savings of multiyear projects completed in 2023. The adjustment ratios presented in Table 14 are the resulting adjustment ratios for each type of savings claimed in Retrofit and are obtained by dividing gross savings without true-up adjustments by tracked savings. 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 Update¹³ provided by NS Power¹⁴.

¹³ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

¹⁴ For municipal utility participants, the line loss factor of the most similar NS Power rate code was assumed.

Table 14: Evaluated 2023 Retrofit Gross Energy and Peak Demand Savings

	Partial Savings Claimed	Final Savings Claimed for Single-year Projects	Final Savings Claimed for Multiyear Projects	Total
Number of Projects	14	62	31	107
Energy Savings				
Tracked Gross Energy Savings – at the Meter (GWh)	11.636	7.760	0.019	19.415
Adjustment Ratio for Energy Savings*	0.993	1.032	1.017	-
Gross Energy Savings Without True-up Adjustment (GWh)	11.551	8.007	0.019	19.576
True-up Adjustment for Gross Energy Savings (GWh)	N/A	N/A	0.541	0.541
Gross Energy Savings – at the Meter (GWh)	11.551	8.007	0.560	20.117
Line Loss Factor**	1.049	1.058	1.059	-
Gross Energy Savings – at the Generator (GWh)	12.114	8.471	0.593	21.178
Effective Useful Life (years)***	4.2	9.5	12.9	-
Gross Lifetime Energy Savings – at the Generator (GWh)	50.617	80.657	7.644	138.918
Peak Demand Savings				
Tracked Gross Peak Demand Savings – at the Meter (MW)	1.132	0.871	0.000	2.003
Adjustment Ratio for Peak Demand Savings*	1.008	0.843	1.000	-
Gross Peak Demand Savings Without True-up Adjustment (MW)	1.141	0.734	0.000	1.875
True-up Adjustment for Gross Peak Demand Savings (MW)	N/A	N/A	0.027	0.027
Gross Peak Demand Savings – at the Meter (MW)	1.141	0.734	0.027	1.903
Line Loss Factor**	1.044	1.055	1.064	-
Gross Peak Demand Savings – at the Generator (MW)	1.191	0.774	0.029	1.995
* The adjustment ratios listed in this table are the averages obtained by dividing gross savings without true-up adjustments by tracked savings. They differ from the values presented in Table 12 because of the different adjustment ratios applied to each project category. ** The line loss factors are average values obtained by dividing gross savings at the generator by gross savings at the meter. Each retrofit project received its own specific line loss factor based on participant rate codes. *** These EULs are average EUL values obtained by dividing gross lifetime energy savings by gross energy savings. each retrofit project received its own specific EUL to obtain lifetime savings.				

As presented in Table 15 below, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor¹⁵ for GHG emissions generated by electricity production to Retrofit gross savings.

¹⁵ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO₂ eq tonnes) and total electricity generation (10,456 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 December 1st, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22'23.pdf (Last accessed December 1st, 2023).

Table 15: Evaluated 2023 Retrofit GHG Gross Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	21.178
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO2 eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO2 eq)	11,688

4.3 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 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.

For each of the three Retrofit project categories, the Evaluator determined a distinct NTGR. Table 16 describes the approach used to determine the NTGR for each project category.

Table 16: 2023 NTGR Approach per Retrofit Project Category

Retrofit Project Category	Number of Projects Completed in 2023	NTGR Methodology	Sample Size (Unique Participant Interviews) *
Regular Retrofit	54	Free-ridership and spillover were measured by conducting phone interviews with sampled participants for each category	13**
Solar PV	31		15
Compressed Air Leak Audit	8	NTGR from 2021 evaluation applied	N/A

*If a participant completed more than one project sampled for review, only one interview was conducted. The associated NTGR was applied to all projects completed by that participant unless they indicated that their decision-making process differed across projects, in which case a distinct NTGR was calculated for each project.

**Although the evaluation methodology included a sample size of n=20, only 13 of the sampled participants were reached despite multiple efforts to contact participants.

4.3.1 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. For compressed air leak audit projects, the NTGR was not measured in 2023 or 2022; therefore, the 2021 NTGR was applied since the 2021 project sample used to assess free-ridership included compressed air leak audit projects. For both the regular Retrofit and solar PV project categories, the corresponding 2023 free-ridership level was assessed using a self-report approach that involved asking participants a set of questions during phone interviews. The questionnaire 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 one of these two factors, the free-ridership level was adjusted downward to better capture the overall influence of EOne activities on participant decisions.

For each project category mentioned above, the feedback collected from the participant interviews was converted into a corresponding overall free-ridership level using the algorithm presented in Appendix V. For solar PV projects, the Evaluator relied on the interview results for 15 unique participants who completed a total of 21 projects between 2021 and 2023 (two interviews were completed in 2021, seven in 2022, and six in 2023). This approach is consistent with the sampling methodology used to establish solar PV adjustment ratios, as described in Subsection 4.2.2 above, which also considered projects completed between 2021 and 2023.

The free-ridership level calculated for each project category is presented in Table 17 along with the corresponding margin of error.

Table 17: 2023 Retrofit Free-ridership Level per Project Category

Retrofit Project Category	Free-ridership Level	Margin of Error
Regular Retrofit	25%	6.3%
Solar PV	38%	9.5%
Compressed Air Leak Audit	16%*	10.6%*
* Free-ridership for compressed air leak audit projects was not measured in 2023; the free-ridership level from the 2021 evaluation is presented here for reference only.		

For regular Retrofit projects, the free-ridership level was established at 25%, which represents an increase of 8% compared with 2022. Of the 13 unique regular Retrofit respondents, seven provided a score of 8 out of 10 or higher when asked about the likelihood that they would have paid the full amount for their energy efficiency project had the implementation incentive not been offered, where 0 means “Definitely would not have paid the full amount” and “10” means “Definitely would have paid the full amount”. Additionally, six of 13 respondents indicated that they would have implemented the exact same energy efficiency project without the incentive.

In the context of the study conducted to develop a semi-prescriptive approach to determine savings for solar PV projects (see details in Subsection 4.2.2 above), which relied on data from projects completed between 2021 and 2023, the Evaluator used interview results from 15 participants who completed projects within the same time period to establish the free-ridership level for the solar PV project category. With this methodology, the free-ridership level for solar PV projects was established at 38% and can be applied to future projects completed in this category. This higher free-ridership level relative to that of regular Retrofit projects is explained in large part by a combination of two factors. Overall, compared to regular Retrofit participants, solar PV participants were more likely to report that they would have implemented their project in the absence of the service. Additionally, those participants reported a somewhat lower influence of the service on their decision-making compared to regular Retrofit participants.

For regular Retrofit and solar PV projects, the project sampling methodology is based on energy savings because incentives for those projects have been historically paid based on energy savings. Therefore, consistent with past evaluations, free-ridership was calculated based on the energy savings for these project categories, and the resulting NTGR was applied to both energy and demand savings to establish net savings for both parameters.

As in previous evaluations, the Evaluator considered the free-ridership level for each project category to be representative of the balance of projects in the project tracking sheet given that the margins of error were below the 10% target for this parameter.

4.3.2 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 VI.

Similarly to free-ridership, spillover was assessed separately for regular Retrofit participants and solar PV participants.

Among the 13 unique respondents from regular Retrofit participants, one mentioned having implemented energy efficiency measures on their own and that their participation in Custom Retrofit had a direct influence on their decision to implement the measures. That participant implemented operational procedure changes that resulted in significant reported energy cost savings from which the Evaluator estimated annual energy savings. Among the 15 unique solar PV participants interviewed, one mentioned having implemented an additional energy efficiency measure on their own, and the Evaluator estimated the additional energy savings associated with that measure based on the information provided.

As a result of the above, a spillover level of 2% was established for regular Retrofit projects and 1% for solar PV projects.

4.3.3 Net-to-gross Ratio Calculation

The NTGR was calculated using the following equation:

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

Table 18 outlines the free-ridership and spillover levels established for Retrofit along with the NTGR values calculated for each project category.

Table 18: Evaluated 2023 Retrofit NTGRs

Project Category	Free-ridership Level	Spillover Level	NTGR
Regular Retrofit	25%	2%	0.77
Solar PV	38%	1%	0.63
Compressed Air Leak Audit*	16%	0%	0.84
*Free-ridership and spillover for compressed air leak audit projects were not measured in 2023; the values from the 2021 evaluation are presented here for reference.			

4.3.4 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:

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

The Evaluator applied the corresponding NTGR to the gross savings generated in each project category under Retrofit. The evaluated NTGRs are presented in Table 18 above. The Evaluator aggregated results from all project categories to determine overall evaluated net savings for Retrofit.

The Evaluator applied a true-up adjustment to the net energy savings of multiyear projects completed in 2023 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 appropriate NTGR for 2023. This approach is similar to the one described in Subsection 4.2.7 above.

The results are listed in Table 19 below. The average EUL was established to 7.0 years, and the net energy savings resulted in 9,239 tonnes of CO2 eq in net annual GHG emission reductions.

Table 19: Evaluated 2023 Retrofit Net Energy and Peak Demand Savings

	Partial Savings Claimed	Final Savings Claimed for Single-year Projects	Final Savings Claimed for Multiyear Projects	Total
Energy Savings				
Gross Energy Savings – at the Meter (GWh)	11.551	8.007	0.560	20.117
NTGR*	0.811	0.760	0.768	
Net Energy Savings Without True-up Adjustment (GWh)	9.370	6.084	0.430	15.884
True-up Adjustment for Net Energy Savings (GWh)			-0.055	-0.055
Net Energy Savings – at the Meter (GWh)	9.370	6.084	0.375	15.830
Line Loss Factor**	1.049	1.057	1.057	
Net Energy Savings – at the Generator (GWh)	9.825	6.432	0.397	16.654
Effective Useful Life***	4.0	9.2	12.0	
Net Lifetime Energy Savings – at the Generator (GWh)	39.307	58.942	4.780	103.028
Peak Demand Savings				
Gross Peak Demand Savings – at the Meter (MW)	1.141	0.734	0.027	1.903
NTGR*	0.822	0.779	0.770	
Net Peak Demand Savings Without True-up Adjustment (MW)	0.938	0.572	0.021	1.531
True-up Adjustment for Net Peak Demand Savings (MW)			-0.019	-0.019
Net Peak Demand Savings – at the Meter (MW)	0.938	0.572	0.002	1.513
Line Loss Factor**	1.044	1.055	1.060	
Net Peak Demand Savings – at the Generator (MW)	0.979	0.603	0.003	1.585
*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 4.3.3 above because of true-up adjustments and the different NTGRs applied to each project category. ** The line loss factors are average values obtained by dividing gross savings at the generator by gross savings at the meter. Each retrofit project received its own specific line loss factor depending on participant rate codes. *** These EULs are average EUL values obtained by dividing gross lifetime energy savings by gross energy savings. Each retrofit project received its own specific EUL to obtain lifetime savings.				

4.4 Realization Rate

Table 20 below compares the total tracked and evaluated savings for Retrofit. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 20: Comparison of 2023 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	20.467	GWh	0.83	16.915	GWh	98%
Evaluation Results	21.178	GWh	0.79	16.654	GWh	
Peak Demand Savings						
Tracked Savings by EOne	2.101	MW	0.83	1.753	MW	90%
Evaluation Results	1.995	MW	0.79	1.585	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 4.3.3 above because of true-up adjustments and the different NTGRs applied to each project category.						

Evaluated gross energy savings were higher than the tracked gross energy savings primarily due to the adjustment ratio being above one. This had a large impact on the true-up adjustments of the multiyear projects completed in 2023 since those savings had originally been claimed as partial claims in 2021 and/or 2022 and received adjustment ratios below one. Despite the evaluated adjustment ratio for peak demand savings being above one, evaluated gross peak demand savings were lower than the tracked value due to large downward one-time adjustments made to the demand savings of five projects. Those projects received their own project-specific adjustments and were not included in the adjustment ratio calculation. Evaluated net energy and peak demand savings were lower than tracked savings because the 2023 evaluated NTGR was lower than the NTGR tracked by EOne.



5 New Construction Impact Evaluation

The objective of the 2023 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.

5.1 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 IV. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

5.2 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 final building design that includes the energy efficiency measures that reduce electricity consumption.

The gross savings evaluation approach for New Construction is based on energy model reviews.

5.2.1 Sampling Methodology

For the energy model review, the Evaluator selected a sample of 12 projects from a total of 15 projects completed in 2023. The project sample represented 88% of total tracked energy savings for projects completed in 2023.

The Evaluator sampled projects based on project size and building type to capture the largest volume of savings and variety of modelling approaches in the project reviews. Given that 80% of completed projects were reviewed, a stratified sampling approach was not used to select the sampled projects. Adjustments to reviewed projects were extrapolated to all projects.

5.2.2 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 the review mainly on the project files provided by EOne. The pictures, mechanical plans, specification sheets, and other documents available in the project files included enough details to confirm energy efficiency measure installations and validate the input data of the energy models. It should be mentioned that the most common simulation software remains eQuest as 14 out of 15 projects completed in 2023 were modelled in eQuest; one project was modelled in HAP. All reviewed 2023 projects were modelled in eQuest. Of the 15 projects completed in 2023, 12 were multi-unit residential buildings.



The quality of the information available in the project files continues to be very good. The project files that were provided to the Evaluator were well documented with photos, EOne site visit results, explanatory notes, etc. Hence, no phone calls had to be made to complete the 2023 energy model review. It should be noted that there were several instances of incomplete project files being transferred to the Evaluator, and EOne provided the required additional information after the Evaluator had conducted the project review, thus requiring a revision to initial evaluation results. The Evaluator recommends that EOne refine its process (e.g. using a checklist) to ensure all information is provided to the Evaluator at the onset of the evaluation.

The following subsections summarize 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 all 12 projects reviewed by the Evaluator for 2023.

The energy model reviews resulted in an average adjustment ratio of 0.829 for gross energy savings with a margin of error of 3.9%. The adjustments made were as follows:

- › The most frequent adjustment made was matching the modelled specifications of building systems with the specifications of installed building systems. In many of those cases, the building modeller had followed the design specifications. However, upon inspection of the site visit photos, the Evaluator found discrepancies between the as-built and original designs. This type of adjustment was also made several times in the 2022 evaluation, and correcting discrepancies between as-built and designed building specifications should continue to be a focus of improvement in 2024. Corrections were also made to HVAC and building envelope characteristics.
- › One project had energy savings associated with a water loop heat pump serving as a central heat plant for the given building. To consider the energy savings associated with such a system, the Evaluator applied the methodology that had been developed and agreed to by the Evaluator and EOne in 2023, thus resulting in an alteration to the baseline modelled boiler system. To reduce confusion in the future, the Evaluator recommends that the agreed methodology for water loop heat pumps be added to program guidelines.
- › Several adjustments had to be made due to clerical errors in the model, which, upon adjustment by the Evaluator, resulted in significant savings reductions. This most specifically applied to building envelope characteristics and could be prevented with a more thorough internal model review.
- › Another reason for substantial adjustments was that some projects had minor although numerous adjustments.

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 were 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.

In addition, certain considerable discrepancies were identified between modelled and tracked demand savings prior to applying adjustments, with a majority of projects differing by over 20%.



As a result, the average adjustment ratio for gross peak demand savings was 0.776 with a margin of error of 12.6%. As mentioned above, this result is mainly explained by the changes made to the energy models for energy savings.

5.2.3 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.

5.2.4 Effective Useful Life

The Evaluator reviewed the EUL values of each sampled project by calculating a weighted average EUL value based on measure specific EUL values and their associated annual energy savings. The revised measure level EUL values were selected based on the values outlined in the 2020-2023 Measure Assessment and the measure category identified in the tracking sheet.

The primary reason for EUL adjustments was that EUL values did not correspond to the EUL values defined in the 2020-2023 Measure Assessment for the given measure categories, thus resulting primarily in EUL values being adjusted downward.

5.2.5 Evaluated Gross Savings

The 2023 gross energy and peak demand savings calculated for New Construction are presented in Table 21 below. They were obtained by applying the average adjustment ratios of 0.829 on energy savings and 0.776 on peak demand savings for all projects completed in 2023. 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 Power¹⁶.

¹⁶ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1. For municipal utility participants, the line loss factor of the most similar NS Power rate code was assumed.

Table 21: Evaluated 2023 New Construction Gross Energy and Peak Demand Savings

	Final Savings for Projects Fully Claimed in 2023
Number of Projects	15
Energy Savings	
Tracked Gross Energy Savings – at the Meter (GWh)	7.465
Adjustment Ratio for Energy Savings	0.829
Gross Energy Savings – at the Meter (GWh)	6.189
Line Loss Factor	1.063
Gross Energy Savings – at the Generator (GWh)	6.581
Effective Useful Life (years)	18.0
Gross Lifetime Energy Savings – at the Generator (GWh)	118.528
Peak Demand Savings	
Tracked Gross Peak Demand Savings – at the Meter (MW)	2.474
Adjustment Ratio for Peak Demand Savings	0.776
Gross Peak Demand Savings – at the Meter (MW)	1.920
Line Loss Factor	1.068
Gross Peak Demand Savings – at the Generator (MW)	2.051

As presented in Table 22 below, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor¹⁷ for GHG emissions generated by electricity production to New Construction gross savings.

Table 22: Evaluated 2023 New Construction Gross GHG Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	6.581
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO2 eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO2 eq)	3,632

5.3 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 as a building developer who participated in this program is unlikely to implement energy efficiency measures in other projects without being a repeat participant in the program and the 2022 evaluation revealed the potential for non-participant spillover to be low. Thus, spillover was not measured as part of this evaluation.

¹⁷ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO2 eq tonnes) and total electricity generation (10,456 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 December 1st, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023, https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22'23.pdf (Last accessed December 1st, 2023).

5.3.1 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 used comprised questions for all applicable variables in the decision-making process, including planning, efficiency, and cost.

For the 2023 evaluation, the Evaluator used the free-ridership questionnaire developed for the 2021 evaluation since it 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 served 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.

The algorithm used to calculate the overall free-ridership level is presented in Appendix XI. The Evaluator attempted to measure free-ridership for the 12 sampled projects in the project review. The Evaluator was able to contact decisions makers for nine of the 12 sampled projects. One of the interviews was completed earlier after the participant signed the Customer Project Agreement (CPA) and the remaining eight interviews were conducted at project completion.

The weighted average free-ridership level was measured at 31% with a margin of error of 6.2%, thus representing a decrease compared to the free-ridership level of 39% in 2022.

The questionnaire and algorithm used as part of the 2023 evaluation allowed the Evaluator to capture different levels of EOne influence such as the mandatory energy model, implementation incentive, as well as technical assistance. Similarly to 2022, participants continued to report lower influence from the program on their decision to design a better-than-code building and on the energy efficiency measures implemented, with other factors outside the program (e.g. other funding sources) playing a larger role in decision making. The 2023 free-ridership results further validate EOne's plan to undertake a 2024 process evaluation for New Construction.

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 31% free-ridership level was applied to both total gross energy and peak demand savings.

5.3.2 Net-to-gross Ratio Calculation

The NTGR is calculated using the following equation:

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

Table 23 outlines the free-ridership level established for New Construction along with the NTGR value calculated. Participant spillover is not included as it was assumed to be nil.

Table 23: Evaluated 2023 New Construction NTGR

Projects Fully Claimed in 2023	
Free-ridership Level	31%
NTGR	0.69

5.3.3 Evaluated Net Savings

Net savings represent the savings that can be reliably attributed to a service. For New Construction, net savings are calculated by applying the NTGR value in the following equation:

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

The results are listed in Table 24 below. The average EUL was established to 18.0 years, and the net energy savings resulted in 2,500 tonnes of CO₂ eq in net annual GHG emission reductions.

Table 24: Evaluated 2023 New Construction Net Energy and Peak Demand Savings

	Final Savings for Projects Fully Claimed in 2023
Energy Savings	
Gross Energy Savings – at the Meter (GWh)	6.189
NTGR	0.69
Net Energy Savings – at the Meter (GWh)	4.259
Line Loss Factor	1.063
Net Energy Savings – at the Generator (GWh)	4.529
Effective Useful Life (years)	18.0
Net Lifetime Energy Savings – at the Generator (GWh)	81.575
Peak Demand Savings	
Gross Peak Demand Savings – at the Meter (MW)	1.920
NTGR	0.69
Net Peak Demand Savings – at the Meter (MW)	1.321
Line Loss Factor	1.068
Net Peak Demand Savings – at the Generator (MW)	1.412

5.4 Realization Rate

Table 25 below compares the total tracked and evaluated savings for New Construction. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 25: Comparison of 2023 New Construction – 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	7.937	GWh	0.61	4.842	GWh	94%
Evaluation Results	6.581	GWh	0.69	4.529	GWh	
Peak Demand Savings						
Tracked Savings by EOne	2.643	MW	0.61	1.612	MW	88%
Evaluation Results	2.051	MW	0.69	1.412	MW	

Evaluated energy and peak demand savings were lower than those tracked by EOne because of adjustments made to the energy models, which resulted in an overall downward adjustment to gross savings. This was counterbalanced in part by a lower free-ridership level compared to the tracked value.



6 Building Optimization Impact Evaluation

The objectives of the 2023 Building Optimization impact evaluation were to determine gross and net electrical energy and peak demand savings, annually avoided GHG emissions, as well as EUL values and associated lifetime energy savings. Similarly to Retrofit, Building Optimization includes three types of savings: (1) Partial savings (projects to be completed in future years); (2) final savings for single-year projects completed in 2023; and (3) final savings for multiyear projects completed in 2023. In 2023, one multiyear and five single-year projects claimed final savings.

6.1 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 IV. 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 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 each individual Building Optimization project file in accordance with best measurement and verification practices for commercial and industrial energy efficiency projects using the information and data made available by participants and EOne as well as by supplementing the data with engineering assumptions and judgments where necessary.

6.2.1 Project Review Findings

All six completed Building Optimization projects were reviewed by the Evaluator. As a result of the review process, the Evaluator adjusted the energy savings of two projects and the demand savings of all six projects.

- › One project received a minor upward adjustment to energy savings resulting from a correction to a transcription error.
- › One project received a downward adjustment to energy savings due to a mistake in one of the key assumptions used to calculate savings. The project involved the installation of lighting controls in an office building and, while the fixtures affected by those controls are two-tube fixtures, the baseline consumption used to calculate savings was that of four-tube fixtures, thereby inflating overall baseline consumption by a factor of two. The Evaluator adjusted the baseline consumption, resulting in a 50% reduction to savings.
- › For all six projects reviewed, claimed demand savings were nil, and the Evaluator attributed demand savings to each project based on average demand savings over the annual hours of operation and their coincidence with the peak demand periods.

Since all completed projects were reviewed and adjusted on a case-by-case basis, no average adjustment ratio was established. As such, the Evaluator obtained the total Building Optimization gross energy and peak demand savings by summing the evaluated savings for each project.



6.2.2 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.

6.2.3 Effective Useful Life

The Evaluator validated the EUL values based on the 2020-2023 Measure Assessment.

The Evaluator adjusted the EUL value for one project from 8 to 5.9 years based on a weighted average of the measures of the project (variable frequency drive upgrades and control measure changes). The Evaluator also modified the EUL of two projects with lighting controls measures from 8 to 5 years as per the 2020-2023 Measure Assessment.

6.2.4 Evaluated Gross Savings

Table 26 below presents the overall evaluated gross savings for Building Optimization, which were obtained by applying project-specific adjustments to energy and peak demand savings as a result of project reviews. The adjustment ratios in Table 26 are the resulting adjustment ratios for each type of savings claim and are obtained by dividing gross savings without true-up adjustments by tracked savings. The resulting peak demand adjustment ratios were not calculated since peak demand savings were not tracked, however the Evaluator calculated peak demand savings for each Building Optimization project and added them to gross savings. 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 Update¹⁸ provided by NS Power¹⁹

¹⁸ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

¹⁹ For municipal utility participants, the line loss factor of the most similar NS Power rate code was assumed.

Table 26: Evaluated 2023 Building Optimization Gross Energy and Peak Demand Savings

	Finals Savings Claimed for Multiyear projects	Final Savings Claimed for Single- year Projects	Total
Number of Projects	1	5	6
Energy Savings			
Tracked Gross Energy Savings – at the Meter (GWh)	0.211	0.454	0.666
Adjustment Ratio for Energy Savings*	1.000	0.816	
Gross Energy Savings Without True-up Adjustment (GWh)	0.211	0.371	0.582
True-up Adjustment for Gross Energy Savings (GWh)	-		-
Gross Energy Savings – at the Meter (GWh)	0.211	0.371	0.582
Line Loss Factor**	1.063	1.064	
Gross Energy Savings – at the Generator (GWh)	0.224	0.394	0.619
Effective Useful Life (years)***	5.9	9.0	
Gross Lifetime Energy Savings – at the Generator (GWh)	1.324	3.541	4.866
Peak Demand Savings			
Tracked Gross Peak Demand Savings – at the Meter (MW)	-	-	-
Adjustment Ratio for Peak Demand Savings*	-	-	
Gross Peak Demand Savings Without True-up Adjustment (MW)	-	-	-
True-up Adjustment for Gross Peak Demand Savings (MW)	-		-
Gross Peak Demand Savings – at the Meter (MW)	0.016	0.042	0.058
Line Loss Factor**	1.070	1.067	
Gross Peak Demand Savings – at the Generator (MW)	0.017	0.045	0.062
* The adjustment ratios listed in this table are the averages obtained by dividing gross energy savings without true-up adjustments by tracked gross energy savings. ** The line loss factors are average values obtained by dividing gross savings at the generator by gross savings at the meter. Each Retrofit project received its own specific line loss factor depending on participant rate codes. *** These EULs are average EUL values obtained by dividing gross lifetime energy savings by gross energy savings. Each retrofit project received its own specific EUL to obtain lifetime savings.			

As presented in Table 27 below, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor²⁰ for GHG emissions generated by electricity production to Building Optimization gross savings.

²⁰ At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO₂ eq tonnes) and total electricity generation (10,456 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 December 1st, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22'23.pdf (Last accessed December 1st, 2023).

Table 27: Evaluated 2023 Building Optimization Gross GHG Emission Reductions

Total	
Gross Energy Savings – at the Generator (GWh)	0.619
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO2 eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO2 eq)	341

6.3 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 NTGR. For Building Optimization, free-ridership and spillover are considered in the NTGR calculation.

Given the smaller contribution of Building Optimization to Custom savings, free-ridership and spillover levels were not measured in 2023 or 2022. To obtain net energy and peak demand savings, the Evaluator applied the NTGR results from the 2021 Custom evaluation to gross savings.

6.3.1 Net-to-gross Ratio Calculation

The NTGR was calculated using the following equation:

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

Table 28 outlines the free-ridership and spillover levels established for Building Optimization along with the NTGR value.

Table 28: Evaluated 2023 Building Optimization NTGR

Value for Savings Claimed in 2023 *	
Free-ridership Level	9% ($\pm 7.2\%$)
Participant Spillover Level	0%
NTGR	0.91
*Free-ridership and spillover levels were not measured in 2022 or 2023, results from the 2021 Custom evaluation were applied.	

6.3.2 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:

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

The detailed net savings results are presented in Table 29. The average EUL was established to 7.9 years, and the net energy savings resulted in 311 tonnes of CO2 eq in net annual GHG emission reductions.

Table 29: Evaluated 2023 Building Optimization Net Energy and Peak Demand Savings

	Partial Savings Claimed	Final Savings Claimed for Single-year Projects	Total
Number of Projects	1	5	6
Energy Savings			
Gross Energy Savings – at the Meter (GWh)	0.211	0.371	0.582
NTGR	0.91	0.91	
Net Energy Savings – at the Meter (GWh)	0.192	0.337	0.529
Line Loss Factor*	1.063	1.064	
Net Energy Savings – at the Generator (GWh)	0.204	0.359	0.563
Effective Useful Life (years)**	5.9	9.0	
Net Lifetime Energy Savings – at the Generator (GWh)	1.205	3.223	4.428
Peak Demand Savings			
Gross Peak Demand Savings – at the Meter (MW)	0.016	0.042	0.058
NTGR	0.91	0.91	
Net Peak Demand Savings – at the Meter (MW)	0.015	0.038	0.053
Line Loss Factor*	1.070	1.067	
Net Peak Demand Savings – at the Generator (MW)	0.016	0.041	0.057
* The line loss factors are average values obtained by dividing gross savings at the generator by gross savings at the meter. Each Retrofit project received its own specific line loss factor depending on participant rate codes. ** These EULs are average EUL values obtained by dividing Gross Lifetime Energy Savings by Gross Energy Savings. Each Retrofit project received its own specific EUL to obtain lifetime savings.			

6.4 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 30 below. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 30: Comparison of 2023 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	0.708	GWh	0.91	0.644	GWh	87%
Evaluation Results	0.619	GWh	0.91	0.563	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.000	MW	-	0.000	MW	
Evaluation Results	0.062	MW	0.91	0.057	MW	

Evaluated energy savings were lower than those tracked by EOne due to downward adjustments made to the energy savings of two projects. Evaluated peak demand savings were higher than those tracked by EOne due to the addition of peak demand savings for all reviewed projects.

7 Overall Savings for Custom

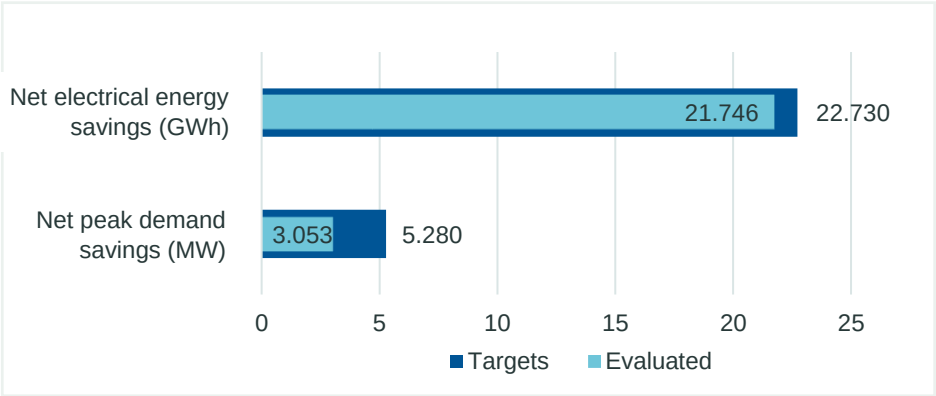
A comparison of the energy and peak demand savings values established through this evaluation and those tracked by EOne is presented in Table 31. The realization rate, representing the ratio of evaluated net savings to tracked net savings, was established at 97% energy savings and at 91% for peak demand savings.

Table 31: Comparison of 2023 Custom Tracked and Evaluated Savings at the Generator

		Gross Savings		NTGR*	Net Savings		Realization Rate
		Value	Unit	Value	Value	Value	Unit
Retrofit	Energy Savings						
	Tracked Savings by EOne	20.467	GWh	0.83	16.915	GWh	98%
	Evaluation Results	21.178	GWh	0.79	16.654	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	2.101	MW	0.83	1.753	MW	90%
	Evaluation Results	1.995	MW	0.79	1.585	MW	
New Construction	Energy Savings						
	Tracked Savings by EOne	7.937	GWh	0.61	4.842	GWh	94%
	Evaluation Results	6.581	GWh	0.69	4.539	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	2.643	MW	0.61	1.612	MW	88%
	Evaluation Results	2.051	MW	0.69	1.412	MW	
Building Optimization	Energy Savings						
	Tracked Savings by EOne	0.708	GWh	0.91	0.644	GWh	87%
	Evaluation Results	0.619	GWh	0.91	0.563	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	0.000	MW	-	0.000	MW	
	Evaluation Results	0.062	MW	0.91	0.057	MW	
Total Custom	Energy Savings						
	Tracked Savings by EOne	29.112	GWh	0.77	22.400	GWh	97%
	Evaluation Results	28.377	GWh	0.77	21.746	GWh	
	Peak Demand Savings						
	Tracked Savings by EOne	4.744	MW	0.71	3.366	MW	91%
	Evaluation Results	4.108	MW	0.74	3.053	MW	
* NTGRs differ for each service. The NTGRs listed in this table match the rounded averages obtained from dividing net savings by gross savings.							

As outlined in Figure 14 below, Custom fell short of its electrical energy savings target by 4% and its peak demand savings target by 42%. Custom achieved 262.312 GWh and 189.031 GWh in gross and net lifetime energy savings respectively, resulting in a weighted average EUL of 9.2 years for gross energy savings and 8.7 for net energy savings.

Figure 14: 2023 Custom Targets and Evaluated Results





8 Custom Key Findings and Recommendations

The main objectives of the 2023 Custom evaluation were as follows:

- › Calculate gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions
- › For Retrofit solar PV projects, develop a semi-prescriptive approach to be used to calculate savings for future projects, notably by determining an adjustment ratio and identifying key parameters
- › Collect information on participant perspectives for Retrofit.
- › Collect information on participation motivations, barriers, and the decision-making process for Retrofit.

This section provides the Evaluator's key findings and recommendations in relation to these objectives. The first key findings and recommendations apply to Custom in general, while the others are specific to certain Custom services. The recommendations are also outlined in Appendix XIII.

General Custom Key Findings and Recommendations

2023 Custom Finding: Custom net electrical energy and peak demand savings fell short of targets in 2023.

Custom achieved 21.746 GWh in net electrical energy savings and 3.053 MW in net peak demand savings at the generator in 2023, thus falling short of the planned electrical energy savings of 22.730 GWh by 4% and the planned peak demand savings of 5.280 MW by 42%.

2023 Custom Finding: Compared to 2022, Custom participation decreased in 2023 due in part to the lack of participation in the Pay-for-Performance (P4P) service and the removal of the Retrofit Operational Demand Reduction offer.

With 114 projects completed across the four Custom services,²¹ the 2023 participation level for Custom was lower compared with 2022 when 204 projects were completed. One element that explains this decrease is the fact that in 2023, no projects were completed under the P4P service, whereas one participant completed 80 projects through this service in 2022. In 2022, an Operational Demand Reduction (ODR) offer was trialed under the Retrofit service, which was not continued in 2023 and through which 30 projects were completed in 2022. Excluding ODR projects, the number of Retrofit projects completed in 2023 (93) increased compared to the number of projects completed in 2022 (68). Projects completed under New Construction and Building Optimization decreased slightly in 2023 with 15 and six projects respectively compared to 19 and seven projects completed in 2022 respectively.

²¹ Custom includes four services: Retrofit (107 projects completed), New Construction (15 projects completed), Pay-for-Performance (no projects completed), and Building Optimization (six projects completed).

2023 Custom Finding: Following the project reviews, the Evaluator adjusted the energy and peak demand savings for Retrofit, New Construction, and Building Optimization.

For Retrofit, the Evaluator made adjustments to energy or peak demand savings, which varied for each project category (regular Retrofit, solar PV, and compressed air leak audit projects). In 2022, EOne implemented M&V guidelines for Retrofit participants following recommendations on M&V made in previous evaluation reports. This led to an overall marked improvement in the quality of M&V provided for reviewed 2023 Retrofit projects.

For Building Optimization, the Evaluator adjusted the energy savings of two projects and the demand savings of all six projects. Demand savings were not tracked by EOne, although demand savings were added to each Building Optimization project.

For New Construction, resulting adjustments ratios for gross energy and peak demand savings were 0.829 and 0.776 respectively.

2023 Custom Finding: Retrofit free-ridership levels increased for regular Retrofit and solar PV projects. New Construction free-ridership decreased compared to the 2022 level, although it remained relatively high.

The overall free-ridership level for regular Retrofit projects was established at 25%, while it was established at 38% for solar PV projects and 16% for compressed air leak audit projects (value from 2021). In comparison, the free-ridership level in 2022 was 17% for regular Retrofit projects and 29% for solar PV projects (free-ridership for solar PV projects was measured for the first time in 2022). Free-ridership was not measured for Building Optimization and was therefore maintained at 9% (value from 2021).

The 2023 free-ridership level for New Construction was established at 31%, down from 39% in 2022.

Retrofit spillover was established at 2% for regular Retrofit projects and 1% for solar PV projects. Spillover was not measured for Building Optimization and therefore maintained as nil (value from 2021).

2023 Custom Finding: Both the evaluated net energy and peak demand savings determined by the Evaluator were lower than the savings tracked by EOne.

Evaluated net energy and peak demand savings were respectively 3% and 9% lower than the values tracked by EOne. This result was mainly due to adjustments made by the Evaluator during project reviews.

Retrofit Key Findings and Recommendations

2023 Retrofit Finding: Participants are very satisfied with Custom Retrofit while consultants are somewhat satisfied.

Participants are particularly satisfied with EOne's performance as well as the responsiveness and technical expertise of EOne staff, and they are highly likely to recommend EOne programs to their peers. Some consultants find the offer complex and time consuming, while others indicated that incentive levels are not sufficient to motivate action on deep retrofits. Despite these issues, consultants are also highly likely to recommend Custom Retrofit to their clients and peers.

2023 Retrofit Finding: Participants place a high value on savings measurement and verification and find the process generally easy to follow.

While participants found the measurement and verification process valuable, some consultants indicated that the process could be streamlined to reduce administration time and effort. Some consultants requested that EOne consider developing consistent templates for the feasibility study and measurement and verification (M&V) plan reports for certain common project types such as motor, refrigeration, and compressed air plant upgrades to streamline the process for consultants and program staff.

2023 Retrofit Finding: The primary barriers to implementing energy efficiency projects are the costs and insufficient returns on investment of energy efficiency projects.

This challenge impacts the majority of Retrofit participants. Other challenges include a lack of internal project management resources to identify and implement energy efficiency upgrades and access to a qualified workforce (internal and external) to support energy efficiency. Although program incentives and other supports such as SEM and On-site Energy Managers (OEMs) address these barriers, they are not presented well in the Retrofit program logic model.

Retrofit Recommendation #1: EOne should update the Custom Retrofit logic model to address current barriers and document links to other program offers such as SEM and OEMs.

2023 Retrofit Finding: Custom program offers are coherent despite minor overlaps and, where savings assumptions are not consistent between offers, these are appropriate and justified.

Participants and consultants regularly face uncertainty regarding which program or offer is the best fit for a given project, although they consistently indicated that EOne staff support them in program selection and this uncertainty does not pose a barrier to participation.

There is a gap in support for energy efficiency projects for other fuels, including natural gas, oil, and propane. Participants indicated a need for support for non-electrical energy efficiency.

Energy savings assumptions are generally consistent across EOne services. One case wherein assumptions are not consistent is the treatment of the NTGR for compressed air leak audit and repair projects in the Retrofit and SEM offers. The Evaluator believes it is appropriate to treat the NTGR differently for these two offers as SEM participants complete a larger share of projects generating spillover savings, thus justifying the assumed NTGR of 1 for SEM.

2023 Retrofit Finding: The opportunity to achieve emission reductions or electrify operations is a minor added value for most Retrofit participants.

Participants see the opportunity to reduce emissions or electrify their operations as an additional although relatively minor value that adds to the more significant value from reducing energy consumption and energy cost. Some participants see emission reductions as a significant future goal for their organizations.

2023 Retrofit Finding: Custom-specific adjustment ratios for solar PV projects were established at 1.101 for projects modelled with PV Watts and 0.942 for those modelled with RETScreen Expert.

These adjustment ratios along with the algorithm presented in Subsection 4.2.2 will allow gross energy savings to be established using a semi-prescriptive approach for future solar PV projects completed under Custom.

New Construction Key Findings and Recommendations

2023 New Construction Finding: Project reviews revealed continued room for improvement in the model review process.

The reviews of New Construction projects revealed that the building energy performance model of several projects followed design specifications, although site visits revealed that different and less efficient building system equipment was installed. This issue was identified in the 2022 evaluation and remained in the 2023 evaluation. In addition, there were several instances whereby clerical errors in the modelling resulted in adjustments, which also reinforces the need for a more rigorous model review process.

2023 New Construction Finding: Free-ridership continued to remain relatively high in 2023 at 31%, and several participants reported factors outside of New Construction being significant motivators for constructing energy efficient buildings.

The 2023 free-ridership results further validate EOne's plan to undertake a process evaluation for New Construction in 2024.



9 SEM Overview

This section describes the Strategic Energy Management (SEM) program component, follows up on past evaluation recommendations, and provides an overview of participation history.

9.1 SEM Description

In 2023, SEM and Energy Management Information Systems (EMIS) were merged into one program component. Previously, SEM and EMIS were offered as separate program components. 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.²² Activities are conducted through a third-party Service Provider that delivers the program component. Participants commit to participating for 12 months, although EOne offers additional years to participants who want to continue operating the energy management system. SEM participants can also obtain funding for an EMIS, which is an additional tool that assists participants in using energy consumption data from metered systems to inform decisions about their processes. This funding may be used to conduct an EMIS audit, develop and implement an EMIS plan that involves the configuration of metering and monitoring equipment, as well as procure training and organizational support.

SEM provides participants with energy Kaizens²³ and mapping, treasure hunts,²⁴ 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.

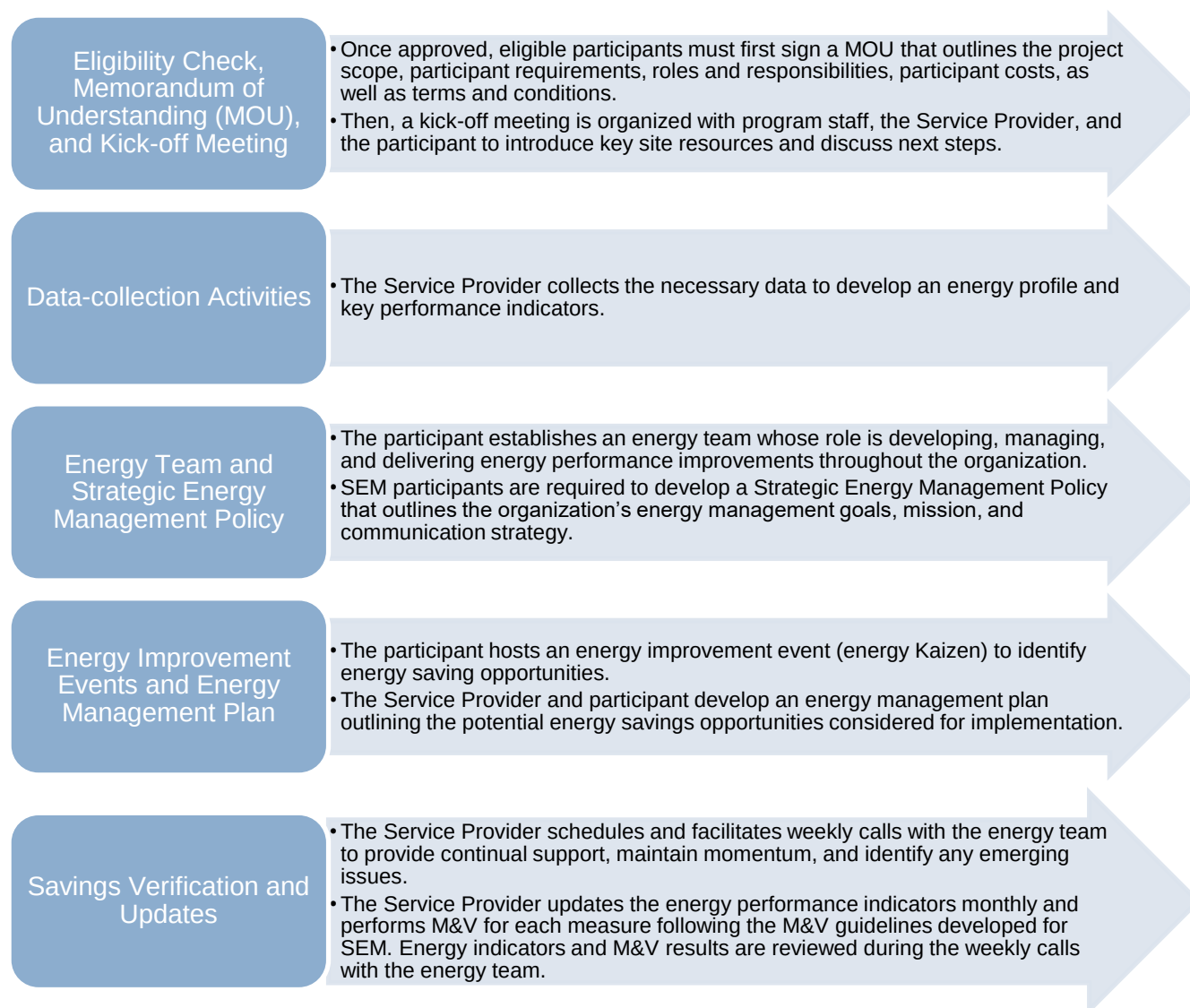
Figure 15 below illustrates the SEM participation process along with details about the program component.

²² An SEM project is defined as the implementation of a strategic energy management system in a facility.

²³ Energy Kaizens are activities aimed at continuously improving energy consumption by identifying waste and focusing on eliminating it.

²⁴ These consist of walkthroughs of plants aimed at identifying energy savings opportunities.

Figure 15: 2023 SEM Participation Process Summary



Starting in 2021, SEM participants were offered performance-based incentives for the savings achieved through the program component. The objective of this incentive is to facilitate recruitment and encourage the completion of energy efficiency projects. SEM participants may enroll in the Large Industrial initiative aimed at filling energy management capacity gaps for large industrial customers; 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. 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.

SEM was aimed at generating net electrical energy savings of 3.002 GWh and peak demand savings of 0.343 MW at the generator in 2023.

9.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated SEM in previous years and issued improvement recommendations. Table 32 provides a summary of the implementation status of the recommendations presented in the Executive Summary section of the 2022 Evaluation Report.

Table 32: Implementation Status of Past Recommendations for SEM

#	Recommendations	Status	Comments
2022 SEM – R1	Investigate the impact of interruptible load rates on peak demand savings and, if needed, implement changes to peak demand savings calculation methodologies for participants on interruptible loads	Complete	EOne worked with NS Power and the Evaluator to determine the best approach to calculating peak demand savings for customers on interruptible load rates. It was determined that peak demand savings should include both firm (non-interruptible) and non-firm loads, although this should be clarified in the peak demand savings definition.
2022 SEM – R2	Request that the Service Provider include the rationale for selecting a given measurement and verification (M&V) approach in M&V reports.	Complete	EOne agrees with this recommendation. EOne worked with the Service Provider to have them include the rationale for selecting an M&V approach and to ensure reports reflect the rationale for any changes to the planned M&V approach compared to the M&V approach that was actually implemented.
2022 SEM – R3	Conduct a process evaluation of SEM in tandem with a Custom Retrofit process evaluation.	Complete	This evaluation report includes the results of a process evaluation for both SEM and Custom Retrofit, which was aimed at better defining the differences between the various offers within the Custom Incentives program as well as ensuring that all aspects of SEM are aligned with SEM objectives.

9.3 Participation History

There were nine active participants in SEM in 2023: seven continuing participants and two new participants. Six of the nine active participants achieved savings in 2023. Moreover, the energy savings level was at its highest since the program inception in 2015, slightly above the 2022 results; this was primarily a result of one participant that generated 54% of all energy savings in 2023. Figure 16 and Figure 17 below illustrate the participation and savings trends since 2018 respectively.

Figure 16: Overview of SEM Participation, 2018-2023²⁵

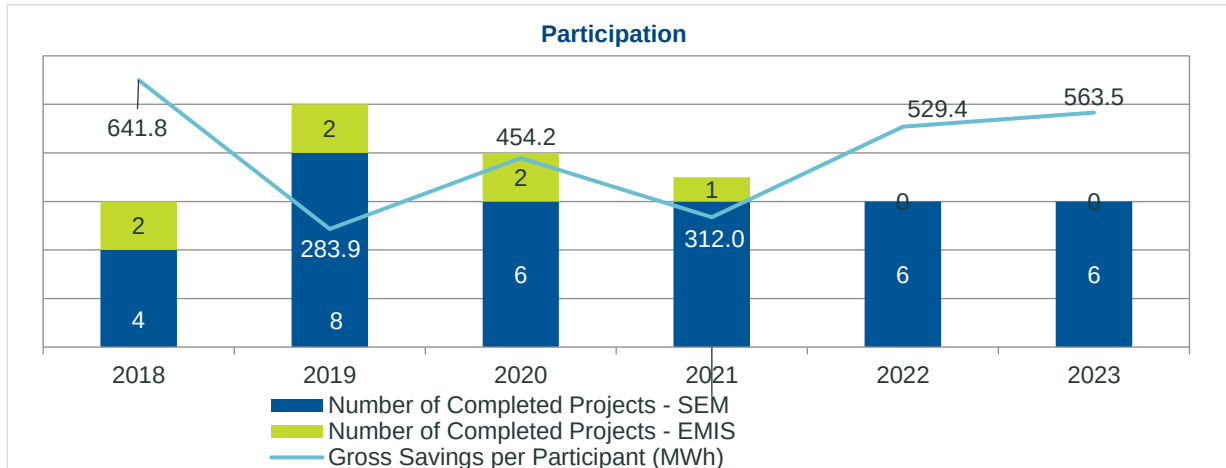
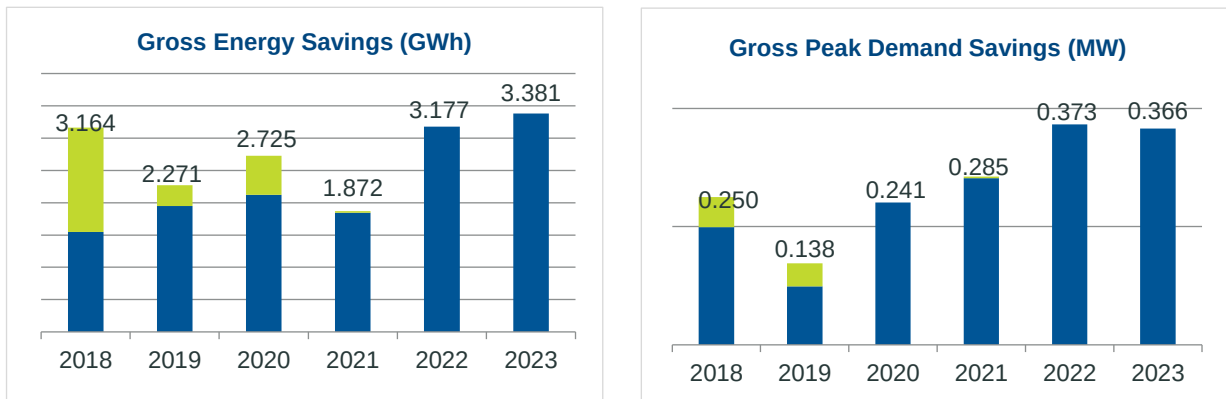


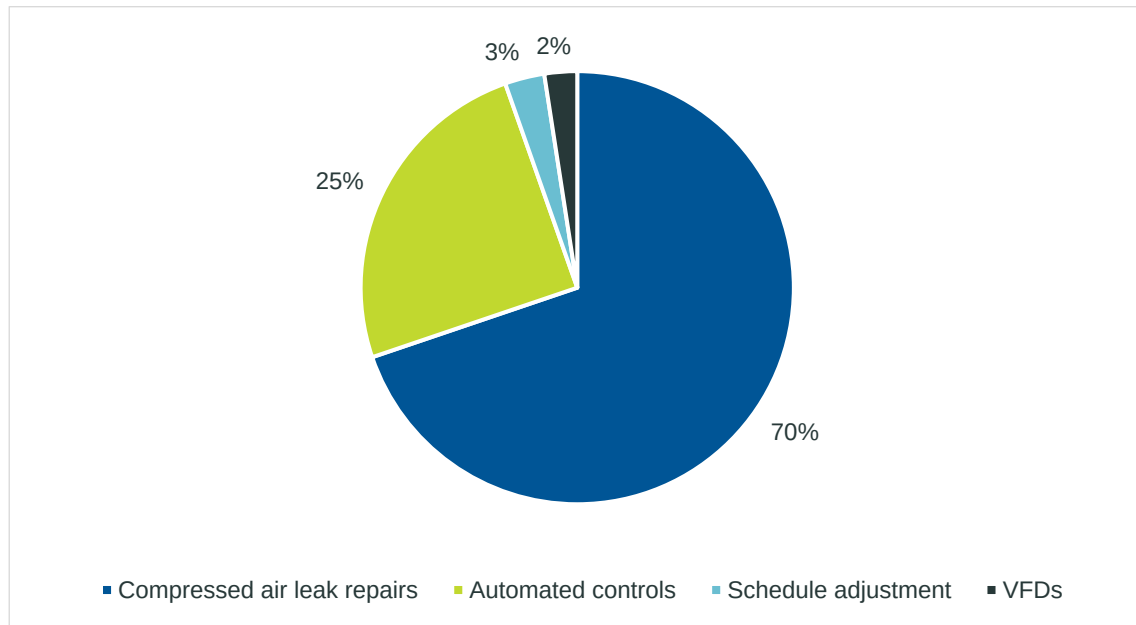
Figure 17: Evolution of SEM Gross Savings, 2018-2023



Similarly to 2022, most SEM energy savings are the result of compressed air leak repair measures as illustrated in Figure 18 below. Of the nine measures implemented by participants in 2023, four were compressed air leak repairs, and one of those projects generated 54% of 2023 energy savings. This is not surprising since compressed air leak repairs represent a large proportion of savings, primarily because participating facilities have very large compressed air systems.

²⁵ The 2019 savings values per participant are based only on the savings that occurred in 2019. In this graph and the following, EMIS savings were included in historical data – they are presented in green.

Figure 18: Distribution of SEM Energy Savings per Measure Category



10 SEM Evaluation Approach

The 2023 SEM evaluation comprised a comprehensive impact evaluation. The main objectives of the SEM evaluation were as follows:

- › Calculate SEM gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions.
- › Collect information on participant and partner perspectives
- › Update the SEM program logic

The Evaluator identified key research questions aimed at achieving these objectives. Table 33 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 33: 2023 SEM Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Collect information on participant and partner perspectives	› What is the level of satisfaction with SEM? › To what extent do SEM participants adopt SEM minimum elements? Why are those adopted? › What are the objectives and needs of SEM participants and potential participants? › How do participants' decarbonization and electrification objectives impact SEM? › Under what conditions, if any, would SEM participants be interested in the Energy Management Information Systems (EMIS) program component? › What works well and what are the key challenges for SEM and for each project type? › How could EOne improve SEM?	› Business Development Manager interview › Service Provider interview › Participant interviews
Update SEM program logic	› What are the barriers to SEM project implementation? › Does the offer in place address market barriers and is it appropriate to attain SEM objectives? › Is SEM coherent with other program component offers (e.g. Custom Retrofit, IEM)? Is there overlap? › Where appropriate, are the impact assumptions and methodologies consistent for measures and services offered under multiple components?	› Business Development Manager interview › Service Provider interview › Participant interviews › Logic model review
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 › Project reviews supported by site visits or phone interviews › EUL update › Calculations using evaluation results
Calculate net results	› In light of the SEM measure mix, what would be the most appropriate way to estimate NTGRs? › What are the free-ridership and spillover levels for SEM projects? › 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 › Calculations using evaluation results › GHG emission reduction calculations



Business Development Manager Interview

In October 2023, the Evaluator interviewed the Business Development Manager (BDM) in charge of industrial customers (only industrial customers are eligible for SEM, not commercial customers) to discuss program challenges and successes, barriers to implementing strategic energy management protocols and differentiating points between the various Custom Incentives offerings. The guide used for the BDM interview is presented in Appendix I.

Service Provider Interview

In November 2023, the Evaluator conducted a 1.5-hour phone interview with Energy Performance Services (EPS), the current Service Provider for all SEM participants. The interview covered subjects such as satisfaction with the program component, barriers to implementing strategic energy management protocols, and compliance of the SEM participation process with Consortium for Energy Efficiency (CEE) SEM Minimum Elements. The guide used for the Service Provider interview is presented in Appendix XIV.

Participant Interviews

Participant interviews were conducted for process related questions (such as satisfaction, barriers, interest in EMIS, etc.) between December and January. These interviews were sometimes conducted at the same time as the project review interviews in January or earlier in December depending on the participant's preference. The average length of the participant interviews was approximately 30 minutes. The Evaluator conducted nine participant interviews (including one interview with a new participant who had not yet achieved savings and two with continuing participants who did not generate savings in 2023). The guide used for the participant process interview is presented in Appendix XV.

Logic Model Review

The logic model review was aimed at determining whether SEM was achieving its goals in the way that it was anticipated at the time of design. The Evaluator reviewed the logic model presented in the program manual and compared the assumptions made to how the program is actually being implemented based on the findings of the BDM, Service Provider, and participant interviews.

Tracking Sheet Audit

Prior to performing the savings review, the Evaluator audited the final 2023 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 XVI.

Project Reviews

In January 2023, a total of six project reviews were conducted, one for each participant that generated savings. Four of these project reviews were supported by phone interviews, while site visits were conducted for the other two participants (one continuing participant that had not yet been visited and one new participant). The desk reviews and phone interviews were conducted by Econoler. Equilibrium Engineering conducted site visits for two new participants based on the results of the desk reviews that were performed by Econoler ahead of the visit. The Evaluator also contacted the Service Provider for clarifications where necessary.



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 2023. The EUL values were selected from the values presented in the 2020-2023 Measure Assessment.²⁶

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 13 below.

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 Nova Scotia Power (NS Power) data.

²⁶ The 2020-2023 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 for all measures offered in EOne's program portfolio. For the evaluations conducted during the 2020-2022 DSM cycle and for the first year of the 2023-2025 DSM cycle, the Evaluator refers to the values presented in the 2020-2023 Measure Assessment.



11 SEM Process Evaluation

The results of the SEM process evaluation are separated into two main sections. Subsection 11.1 summarizes participant perspectives and outlines some key elements brought forward during the BDM and the Service Provider interviews. Subsection 11.2 is focused on the logic model review.

11.1 Participant Perspectives

Interviews were conducted with all nine participants currently enrolled in SEM. In addition to the questions designed for impact evaluation purposes, survey participants were asked questions regarding their awareness about SEM, their motivations and barriers related to participation, as well as their satisfaction and recommendations for improvement.

11.1.1 SEM Awareness, Motivations for Participating, and Challenges

Before taking part in SEM, four of the nine interviewed participants indicated already being aware of what a strategic energy management program was, and three of those were already considering implementing a strategic energy management approach.

At the time of joining SEM, participants primarily expected the energy mapping and treasure hunts to be the most useful elements of SEM. While most participants said that SEM was helpful in the ways that they had anticipated, two specifically mentioned that the employee engagement aspect was more useful than expected.

Two main sources of motivation for participating stood out from the interviews. Five respondents mentioned the desire to reduce energy costs as a key participation driver, and four respondents mentioned the lack of internal resources to implement energy efficiency measures. With regard to the latter, respondents further specified that identifying energy saving opportunities was generally not an issue but that having the resources to implement the identified measures was the more flagrant need.

Competing priorities and the lack of available qualified staff were also identified as key barriers encountered by participants in implementing their strategic energy management approach. Three participants also mentioned difficulty in organizing the work between the Service Provider and their teams.

SEM participant quotes:

“It was difficult trying to figure out the right mix of who needs to be on the team to ensure good representation from the maintenance, facilities, equipment, and production teams so that we fully understood what could be done.”

“It was a trial-and-error process to understand how [the Service Provider] could be most useful – now they are very useful!”

“At first, it was difficult agreeing with [the Service Provider] and internal stakeholders on the project scope definition, timeline, budget, and plan.”

The Evaluator also sought to determine if participant needs were changing due to decarbonization or electrification targets. Two out of the nine participants mentioned having corporate decarbonization targets, and three expected targets to be set soon due to pressure from major clients; therefore, more than half of participants are looking to reduce their GHG emissions.



Three participants mentioned that SEM would be more valuable to them if it included incentives for non-electric fuels. This point of view was also shared by the Service Provider that indicated that SEM programs in North America are increasingly targeting GHG emission reductions and, as such, typically include non-electric fuels. Interestingly, two participants mentioned that electricity usage was not related to decarbonization; conversely, the Evaluator notes that this is not the case given the current carbon intensity of the grid in Nova Scotia. This seemed to indicate that some participants do not see the link between electricity energy efficiency and decarbonization and that better communicating this link could increase engagement in SEM given that many participants are looking to decarbonize their business.

Participant interviews also included some questions to understand why few participants take advantage of the EMIS incentives that are available through SEM. Interestingly, six of the nine participants have an EMIS or are in the process of implementing one, so there is no lack of interest in such systems. One participant indicated that the SEM process had allowed them to update their EMIS and better use it. The three participants who do not have an EMIS mentioned that they lacked the time and resources to implement and operate it but also expressed interest in having one in the future.

11.1.2 Satisfaction with SEM

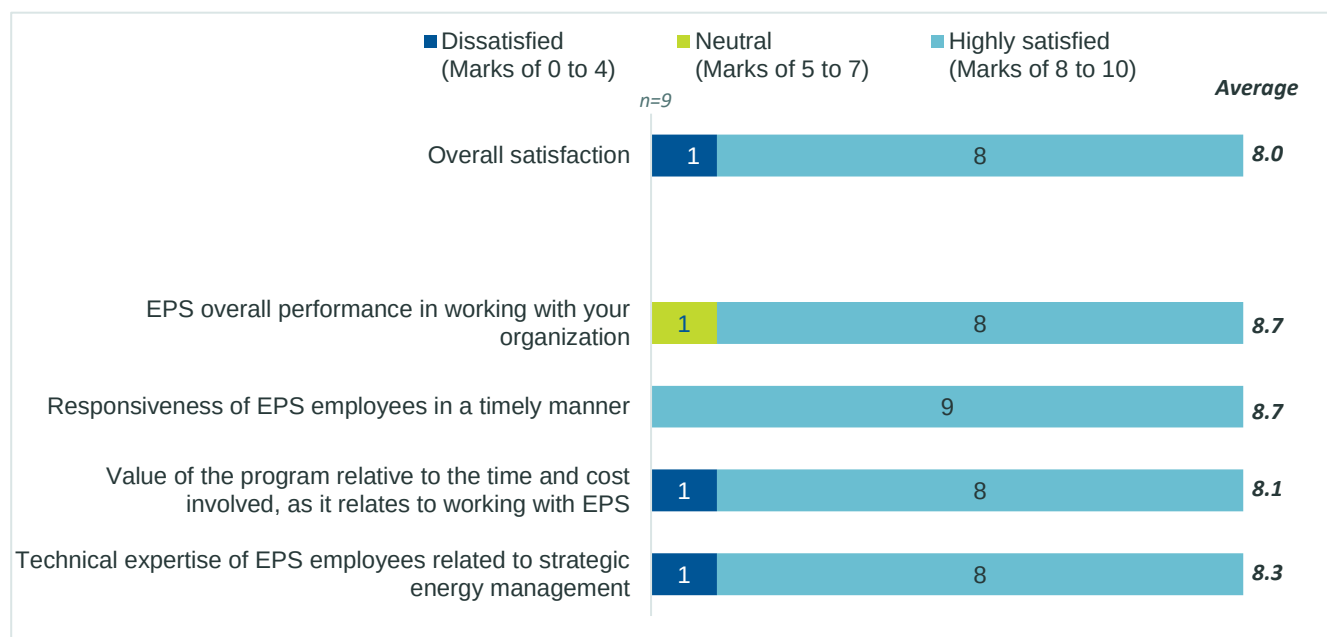
The Evaluator assessed two key aspects of participant satisfaction, overall satisfaction with SEM and satisfaction with the Service Provider.

There was a high level of satisfaction with SEM overall with an average rating of 8.0.²⁷ The main reason provided by respondents for being highly satisfied was the great support and expertise provided by SEM and Service Provider staff. One participant indicated not being satisfied, citing difficulty in identifying energy saving opportunities as the main reason.

Participant interviews also revealed a high level of satisfaction with the Service Provider. As illustrated in Figure 19 below, participants were highly satisfied with overall Service Provider performance as well as with their responsiveness, their technical expertise, and the value of SEM relative to the time and cost involved as it relates to working with the Service Provider.

²⁷ On a scale of 0 to 10, where 0 indicates “Not at all satisfied” and 10 indicates “Completely satisfied”.

Figure 19: Satisfaction With SEM



11.1.3 Suggestions for Improvement

While most participants were highly satisfied with SEM and the Service Provider, several still identified opportunities for improvement.

- › Three respondents indicated that they would see value in having more on-site support to help with driving and implementing projects either in the form of IEM whose time would be shared among a few participants (for participants who do not already have an IEM) or in the form of more frequent site visits by Service Provider staff.
- › Two respondents mentioned that they would like to see incentives for non-electrical measures added to SEM.
- › One respondent mentioned that they would like SEM to leverage the EOne network to put participants in touch with other local consultants who could provide expertise and support for some specific projects as well as with other companies in the same sector to promote constructive exchanges on strategic energy management practices.
- › One respondent indicated that, when relevant, SEM should put more emphasis on process improvements and deeper changes in operational practices to generate energy saving opportunities.

11.2 Logic Model Review

The logic model review was aimed at determining whether SEM was achieving its goal in the way that it was anticipated at the time of design. To do so, the Evaluator first assessed which elements of the CEE SEM Minimum Elements²⁸ were completed by SEM participants. Then, the program logic model assumptions were compared to the findings of the BDM, Service Provider, and participant interviews.

²⁸ Consortium for Energy Efficiency, *CEE Strategic Energy Management Minimum Elements*, 2014 (Available at: <https://cee1.my.site.com/s/resources?id=a0V2R00000sUQcE>).

11.2.1 Compliance with CEE SEM Minimum Elements

The CEE SEM Minimum Elements is a reference document that describes, “from the energy efficiency program perspective, the minimum conditions that an industrial company or facility should have in place in order to effectively and continuously improve their energy performance.” The Evaluator assessed to what extent SEM participants have adopted CEE SEM Minimum Elements using participants’ self-assessments. The results are summarized in Table 34 below. The Minimum Elements are indicated as “partial” when they are not fully implemented but are no longer being actively improved.

Table 34: Adoption of CEE SEM Minimum Elements Reported Among SEM Participants

SEM Minimum Element Completed or in Place	Participant Responses								
	P1	P2	P3	P4	P5	P6	P7	P8*	P9*
Energy policy and long-term energy reduction goals	In progress	Yes	Yes	Yes	In progress	No	In progress	No	No
Dedicated resources (energy champion and energy team)	Yes	Yes	Yes	Yes	Partial	Partial	Partial	No	Yes
Energy management assessment	Yes	Yes	Yes	Yes	Yes	Yes	Partial	No	Partial
Energy end-uses map	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial	Yes
Energy performance indicator tracking and established goals	Yes	Yes	Yes	Yes	Yes	Partial	Yes	Partial	Partial
Potential project register	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Employee engagement plan	Yes	Yes	Partial	Yes	Yes	Yes	Yes	No	In progress
Periodic reassessment of energy performance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

It should be noted that P8 and P9 are new participants who have been enrolled in SEM for less than one year, which explains why they have adopted fewer SEM Minimum Elements than other participants. Indeed, continuing participants have adopted almost all SEM Minimum Elements. The element that remains incomplete for most participants is the energy policy; participants indicated that this was less of a priority because it did not directly result in savings and because of the time and effort required to achieve this milestone. The Service Provider echoed those remarks. The Evaluator also noted that, although most participants indicated that they do track energy performance indicators, these are currently not reported by the Service Provider; reporting on these would provide improved visibility on the gains made throughout SEM participation for both participants and EOne.

11.2.2 Logic Model

The main objective of the logic model is to link program objectives to the barriers that prevent achieving the objectives and identify actions or means to reduce the barriers. The Evaluator therefore assessed each of those components as presented in the current SEM logic model and determined whether each component was aligned with previous evaluation findings as well as identified missing components and potential improvements.

Objectives

The objectives of SEM are to “offer a structured path to SEM and support capital energy efficiency projects identified through SEM”. The Evaluator considers that these objectives are attained because the evaluation served to determine that:

- › SEM participants complete a vast majority of the CEE SEM Minimum Elements and therefore follow a structured path to SEM.
- › Many participants indicated that they benefited from the SEM process and the Service Provider’s expertise to identify and build business cases for multiple capital energy efficiency projects that are generally incented through the Custom Retrofit or the Business Energy Rebates (BER) program.

The Evaluator notes that the evidence for capital energy efficiency projects being completed by SEM participants is incomplete/lacking; such projects came up in both participant and Service Provider interviews, but no metrics were readily available to assess the extent to which SEM generates capital energy efficiency projects. Such projects are not mentioned in SEM annual reports prepared for participants, and the project savings achieved by SEM participants through Retrofit or BER are not compiled annually. The Evaluator believes this SEM objective should be assessed through metrics to determine if it has been reached or not.

Barriers and Actions

The current logic model lists “savings not being guaranteed” and “large time commitment” as the main participant barriers to implementing a strategic energy management approach. While the large time commitment is a similar barrier to the lack of available staff that was mentioned by multiple participants, the risk of not achieving savings is not a barrier that was identified by neither participants, nor the Service Provider. As previously noted in Subsection 11.1.1, other major barriers are the presence of competing priorities and the lack qualified staff members; hence, these should be added to the logic model.

The fact that participants identify “competing priorities” as a major barrier denotes an underlying barrier in the Evaluator’s opinion, notably the low value attributed to energy efficiency and therefore energy costs compared to production imperatives. If organizations fully valued energy efficiency, they would be less likely to put energy efficiency projects at the bottom of the priority list. Seeing this barrier in this light leads to identifying other actions that EOne could undertake through SEM to increase the uptake of strategic energy management practices.

The BDM, Service Provider, and participant interviews allowed the Evaluator to compile a list of the pertinent barriers to the implementation of a strategic energy management approach and the ways in which SEM reduces the barriers. The barriers and corresponding actions taken by EOne through SEM are summarized in Table 35.

Table 35: SEM Barriers and Corresponding Actions

Barriers	Actions
Lack of available staff and large time commitment	Service Provider does a part of the data analysis.
Lack of skilled staff in energy management	Service Provider offers expertise on the SEM process, energy data analysis, savings estimations, business case buildings, and M&V.
Lower priority level of energy management compared to other business imperatives	Weekly and monthly meetings with the Service Provider provide accountability and maintain pressure for participants to complete tasks related to their energy efficiency projects.



SEM includes actions and means that directly address the three main barriers to strategic energy management. Based on participant feedback, the Service Provider is especially effective at addressing the lack of energy management skills since their expertise is highly valued. However, in the Evaluator's opinion, the other two abovementioned barriers are not currently fully addressed by the program component. Additional actions that could be taken to further reduce those two barriers include:

- › Adding IEM support. IEMs could contribute differently than the SEM Service Provider. They could devote time to gathering data on potential energy savings and managing energy efficiency projects. This was a request made by two participants who currently do not have access to IEMs (since they are not part of the Large Industrial initiative), as mentioned in Subsection 11.1.3 above. However, the Evaluator has reservations about this approach because the additional projects that may be completed due to IEM support might not generate sufficient savings to justify the additional investment by EOne.
- › Emphasizing education and marketing efforts for participants (and non-participants) to more appropriately value energy management. While many participants are interested in decarbonizing their facilities, the link between this goal and SEM is not obvious to many; marketing SEM as a tool for decarbonization could be an effective angle to increase the perceived relevance of the strategic energy management approach. This action might also address the “lack of available staff” barrier since more highly valuing energy management might result in attributing resources toward this goal. For that reason, improving the perceived value of energy management seems like a better investment than offering further IEM support.

The marketing efforts to non-participants could also build on one of the main strengths of SEM, namely high participant satisfaction. In addition to advertising how SEM provides great support to participants, case studies could showcase the results achieved through the program component; to do so, it would be important to track plant-level key performance indicators (KPIs) so that the cumulative impact of SEM can be communicated to potential participants.



12 SEM Impact Evaluation

The objectives of the 2023 SEM impact evaluation were to determine project gross and net electrical energy and peak demand savings as well as annually avoided GHG emissions, EUL values, and associated lifetime energy savings.

12.1 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 results obtained from the tracking sheet audit are presented in Appendix XVI. The tracked savings results presented in this report therefore refer to the corrected tracked savings obtained by the Evaluator.

12.2 Gross Savings

This subsection describes the methodology used to review the six SEM projects that generated savings in 2023 and summarizes the review findings. Interactive effects, EUL values, and revised gross savings were also assessed.

12.2.1 Project Review Findings

The Evaluator reviewed the calculation methodologies for the abovementioned six projects based on project documentation as well as the information obtained through interviews with participants and the Service Provider. All projects used a bottom-up approach to quantify savings, meaning that a distinct M&V methodology was applied for each measure in a manner that is generally consistent with how Custom Retrofit savings are measured. This has been the preferred approach since 2022, while most projects before that used a top-down approach (a whole-facility M&V approach that implied continuously measuring consumption).

The M&V reports provided for each measure were complete and allowed understanding the nature of the measures and the savings quantification approach. The Evaluator considered the M&V methodology to be generally thorough and aligned with best practices. While in 2022 there were some concerns on certain projects being measured during insufficient periods, the Evaluator had no major concerns with the periods for which M&V was conducted in 2023. As noted in Subsection 9.2, some improvements remain to be made on the documentation of the M&V approach selection, although the Evaluator considered that the selected approach was appropriate for all projects.

The Evaluator made adjustments to energy savings for only two measures that were part of two separate projects. For one project, a correction was made to the exponent parameter involved in the variable frequency drive measure, which reduced the savings for that project by less than 3%. Another measure was adjusted for two reasons: 1) There was a mistake in the M&V calculation (a formula did not point to the data at the right dates); and 2) the on-site visit revealed that the scheduling of this measure was being overridden more than anticipated due to more overtime shifts to meet increased production demand. These adjustments had an impact of about 1% on the energy savings of that project.

Three projects saw a significant upward adjustment to their peak demand savings. Two measures did not have any peak demand savings tracked when they in fact generated savings during the peak demand period. In another case, the peak demand savings calculation was based on the participant's monthly demand charge savings instead of the grid-level peak demand savings.

Overall, the adjustment ratios for energy and peak demand savings were 0.997 and 1.340 respectively.

12.2.2 Interactive Effects

For each project reviewed, 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.

12.2.3 Effective Useful Life

As part of the 2020-2023 Measure Assessment activities, the Evaluator reviewed the EUL values for all measure categories to ensure they were still valid and revised them where appropriate.

Since all savings were measured using a bottom-up approach, an EUL value was assigned based on the measure implemented in accordance with the EUL values found in the 2020-2023 Measure Assessment. This resulted in a weighted average EUL of 5.46 years.

12.2.4 Evaluated Gross Savings

The 2023 evaluated SEM gross energy and peak demand savings at the generator are listed in Table 36 below.

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.²⁹ 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.

Table 36: Evaluated 2023 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)	0.253	2.981	3.233
Adjustment Ratio for Energy Savings	0.991	0.998	0.997
Gross Energy Savings – at the Meter (GWh)	0.250	2.974	3.224
Line Loss Factor	1.063	1.047	1.049
Gross Energy Savings – at the Generator (GWh)	0.266	3.115	3.381
Equivalent Effective Useful Life (years)	10.4	5.0	5.46
Gross Lifetime Energy Savings – at the Generator (GWh)	2.777	15.666	18.443
Peak Demand Savings			
Tracked Gross Peak Demand Savings (MW)	0.000	0.261	0.261
Adjustment Ratio for Peak Demand Savings	-	1.272	1.340
Gross Peak Demand Savings – at the Meter (MW)	0.018	0.332	0.349
Line Loss Factor	1.063	1.046	1.047
Gross Peak Demand Savings – at the Generator (MW)	0.019	0.347	0.366

²⁹ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1. For municipal utility participants, the line loss factor of the most similar NS Power rate code was assumed.

As presented in Table 37, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor³⁰ for GHG emissions generated by electricity production to SEM gross savings.

Table 37: Evaluated 2023 SEM Gross GHG Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	3,381
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO ₂ eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO₂ eq)	1,866

12.3 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 the program component, by estimating the NTGR. More precisely, the NTGR represents the positive or negative impacts of spillover and free-rider effects on gross savings.

As recommended in the 2022 evaluation, the Evaluator reassessed the assumption that the SEM NTGR was equal to 1. As part of the 2022 evaluation, the Evaluator had observed that a majority of the savings achieved in SEM could be implemented through the Custom Retrofit service (in particular for compressed air leak repairs) for which the measured NTGR is below 1. This situation persisted in 2023, and the Evaluator is of the opinion that assuming a NTGR value of 1 was still valid based on the following information:

- Two questions were asked to participants for each measure that they completed in 2023 to determine whether they would have identified the measure and implemented it without Service Provider support and the incentive. While they indicated that a majority of measures (7/9) would have been identified without SEM, on average, participants indicated that there was only a 4 out of 10 likelihood that they would have completed the measure in the absence of the incentive.
- Three of the six participants that generated savings in 2023 implemented additional measures that were not quantified or included in the tracked gross savings. In total, 10 additional measures were implemented as part of their participation in SEM. Those measures included, for example, compressed air cutoff to idle zones as well as heating and ventilation system schedule automation to match production. While the magnitude of savings for those measures is unknown, this indicates a spillover level that is significantly higher than for Custom Retrofit (which was measured at 2% for regular Retrofit projects).

The Evaluator does not recommend reassessing this assumption in the next five years unless program component design or results change significantly.

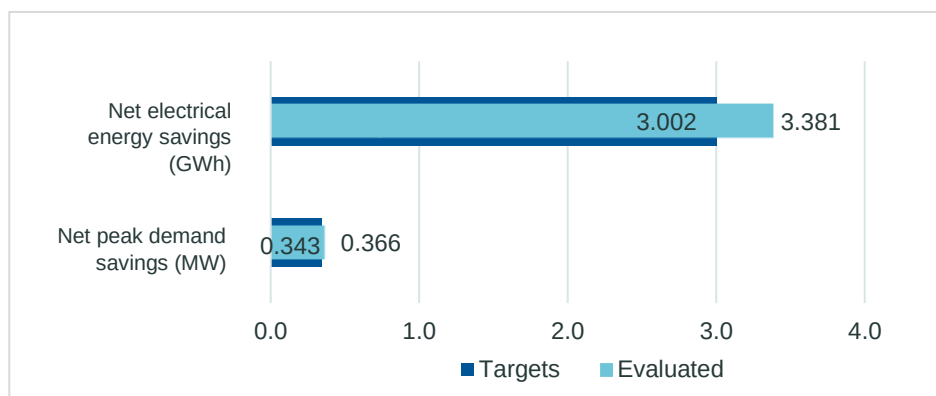
³⁰ At the time of writing, 2021 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2020 total system emissions data (6,283,894 CO₂ eq tonnes) and total electricity generation (10,759 GWh) was drawn from the following two sources: Nova Scotia Power, *Total 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).

12.3.1 Evaluated Net Savings

Net savings are defined as the changes in energy use that are specifically attributable to SEM. Since spillover and free-rider effects were considered nil, net SEM impacts are equal to the gross savings generated by the program component. The 2023 net energy and peak demand savings for SEM were estimated at 3.381 GWh and 0.366 MW at the generator respectively. The net energy savings resulted in 1,866 tonnes of CO₂ eq in net annual GHG emission reductions.

As outlined in Figure 20 below, SEM surpassed its energy and peak demand savings targets by 13% and 7% respectively.

Figure 20: 2023 SEM Targets and Evaluated Results



12.4 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 38 below. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 38: Comparison of 2023 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	3.391	GWh	1.00	3.391	GWh	100%
Evaluation Results	3.381	GWh	1.00	3.381	GWh	
Peak Demand Savings						
Tracked Savings by EOne	0.272	MW	1.00	0.272	MW	134%
Evaluation Results	0.366	MW	1.00	0.366	MW	
* The average NTGR values presented in this table correspond to the ratios of net savings to gross savings for SEM.						

The evaluated net energy savings were less than 1% below the tracked value due to two projects whose savings were slightly adjusted downward.

The evaluated peak demand savings were 34% above the tracked value because three projects saw their peak demand savings increased primarily because peak demand savings had not been considered for some measures.



13 SEM Key Findings and Recommendations

As mentioned previously, the main objectives of the 2023 SEM evaluation were as follows:

- › Calculate SEM gross and net results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions
- › Collect information on participant and partner perspectives
- › Update the SEM program logic

This section presents the Evaluator's key findings and recommendations related to the above objectives. The recommendations are also outlined in Appendix XIX.

2023 SEM-Finding: SEM exceeded its net energy and peak demand savings targets.

In 2023, SEM achieved 3.381 GWh and 0.366 MW in energy and peak demand savings respectively. Energy savings were 13% above the planned energy savings of 3.002 GWh and 7% above the planned peak demand savings of 0.343 MW.

2023 SEM-Finding: The SEM participation level has remained stable over the past five years. Energy savings per participant were similar to those in 2022.

There were nine active participants in SEM in 2023, seven continuing participants and two new participants. Six of the nine active participants completed projects with savings in 2023, which corresponds to the average for the previous five years.

2023 SEM-Finding: Participant satisfaction with SEM was high.

Participants provided an average overall satisfaction rating of 8.0 for SEM, an average that was reduced by one of the nine participants who provided a much lower rating than the others. The main reason for being highly satisfied was the quality of support and expertise provided by EOne staff and the Service Provider.

2023 SEM-Finding: The bottom-up M&V approach adopted in 2022 has not prevented SEM from meeting its energy management objectives.

In the 2022 evaluation report, the Evaluator had expressed concerns about the potential impacts of no longer tracking plant performance through a top-down model. Participants seemed to continue to implement all aspects of SEM, including those that do not generate savings that can be captured with a bottom-up approach. That being said, the plant-level performance metrics are no longer visible in the annual reports provided by the Service Provider. This makes the year-over-year improvement in energy performance less visible to both participants and EOne.

Recommendation #1: Consider including plant-level KPIs and their progression since program inception in participant reporting. This addition could benefit participants and be used to better advertise the success of SEM.

2023 SEM-Finding: While the second main objective of SEM is to “support capital energy efficiency projects identified by SEM”, no metrics attest to the realization of that objective.

Recommendation #2: Track the number of projects implemented by SEM participants and the resulting savings from capital projects incented in BER or Custom.



2023 SEM-Finding: The main barriers to strategic energy management are the large time commitment, the availability of skilled staff, and the lower priority level of energy management compared to other business imperatives. The last two are not clearly identified in the logic model, and another assumed barrier (savings not being guaranteed) was not identified as meaningful by participants.

2023 SEM-Finding: SEM is effective at addressing the knowledge barrier, although the lack of available staff and lower priority level for energy management remain significant barriers for participants.

Recommendation #3: Better communicate the value of energy management to both participants and non-participants, including its potential for decarbonization. Getting participants to value energy management might be an effective solution to the two barriers that are not fully addressed by SEM. An angle that could be used to promote strategic energy management is its usefulness in achieving decarbonization targets (even in facilities that are fully supplied by electricity); many participants indicated that this was an objective for their organization or that they expected it would become one soon due to market pressure. The value of energy management could also be communicated by sharing success stories about current participants to prospective participants. Current participants are likely to contribute to this communication effort since they are highly satisfied with the services offered by SEM. Compiling improvements through energy performance indicators over multiple years of SEM engagement would also enable making a compelling case for energy management as a way to increase competitiveness.

2023 SEM-Finding: The M&V methodologies applied to quantify savings were generally appropriate and accurate, and the Evaluator made no major adjustments to energy savings. Peak demand savings were increased by 34% due to projects whose peak demand savings had not been calculated.

While adjustments to energy savings were minor, three projects had peak demand savings that had not been considered, so evaluated peak demand savings were increased by a margin of 34% compared to tracked values. EOne has a written guideline for calculating peak demand savings, although its application by the Service Provider remains variable.

2023 SEM-Finding: The assumption that the NTGR is equal to 1 remained valid despite the evolution of the program component. Participants implemented a significant number of measures that are not included in reported gross savings, which is the main justification for maintaining a NTGR of 1. The Evaluator does not consider that this assumption creates disparities with some measures that are also implemented in Custom Retrofit and that have a NTGR of less than 1 since SEM generates significantly more spillover than Custom Retrofit.

CONCLUSION

Table 39 presents the participation levels, net-to-gross ratios (NTGRs), evaluated gross and net savings at the generator, annual GHG emission reductions, as well effective useful life (EUL) values for each Custom Incentives program component and for the program as a whole.

Table 39: Overall 2023 Custom Incentives Participation and Evaluated Savings

	Participation Level		Gross Savings		NTGR*	Net Savings	
	Value	Unit	Value	Unit	Value	Unit	Value
Custom							
Energy Savings	114	Projects Completed	28.377	GWh	0.77	21.746	GWh
Lifetime Energy Savings			262.312	GWh	0.72	189.031	GWh
Peak Demand Savings			4.108	MW	0.74	3.053	MW
Annual GHG Emission Reductions			15,661	Tonnes of CO2 eq	0.77	12,002	Tonnes of CO2 eq
EUL			9.2	Years		8.7	Years
SEM							
Energy Savings	6	Participants	3.381	GWh	1.00	3.381	GWh
Lifetime Energy Savings			18.443	GWh	1.00	18.443	GWh
Peak Demand Savings			0.366	MW	1.00	0.366	MW
Annual GHG Emission Reductions			1,866	Tonnes of CO2 eq	1.00	1,866	Tonnes of CO2 eq
EUL			5.5	Years		5.5	Years
Total							
Energy Savings			31.758	GWh		25.127	GWh
Lifetime Energy Savings			280.755	GWh		207.474	GWh
Peak Demand Savings			4.474	MW		3.419	MW
Annual GHG Emission Reductions			17,527	Tonnes of CO2 eq		13,868	Tonnes of CO2 eq
EUL			8.8	Years		8.3	Years
* The NTGRs listed in this table match the rounded averages obtained from dividing net savings by gross savings.							

Figure 21 and Figure 22 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 2023. Custom Incentives was aimed at achieving 25.732 GWh in net electrical energy savings and 5.623 MW in net peak demand savings at the generator for 2023. The program nearly attained its planned energy savings target but fell short of achieving its planned peak demand savings target. Custom was the largest contributor to total program net energy and peak demand savings.

Figure 21: 2023 Custom Incentives Program Targeted and Evaluated Net Energy Savings

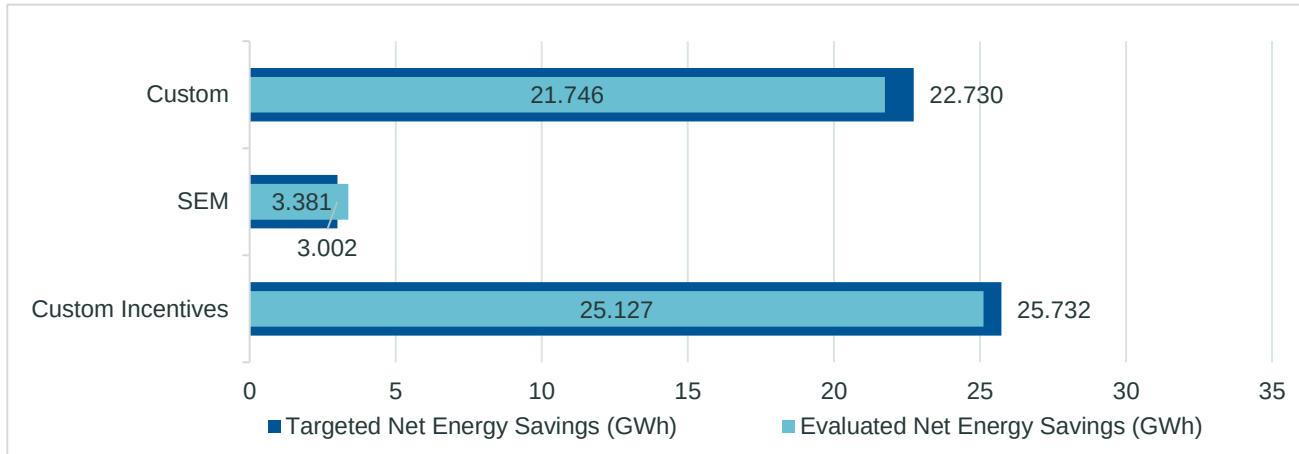
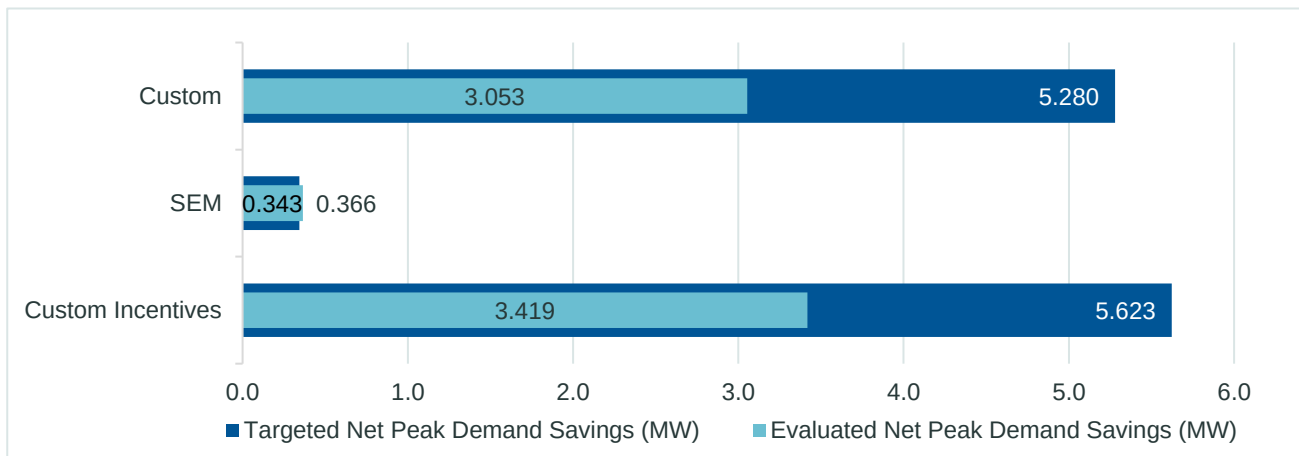


Figure 22: 2023 Custom Incentives Program Targeted and Evaluated Net Peak Demand Savings





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PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com





EfficiencyOne

CUSTOM INCENTIVES PROGRAM

Appendix Report

2023 DSM EVALUATION

March 20, 2024

In collaboration with:



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APPENDIX I

Retrofit and SEM Interview Guide with BDMS

RETROFIT-SEM PROGRAM EVALUATION

GUIDE FOR INTERVIEWS WITH BDMS

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Semi-directed in-depth interview
Estimated Time to Complete	60 minutes for Industrial, 45 – 60 min for Commercial interview
Target Audience	BDM: › Industrial BDM (Retrofit and SEM) › Commercial BDM (n = 2, Retrofit only)
Expected Number of Completions	3
Contact List Source	Efficiency One
Fielding Firm	Econoler
Estimated Timeline for fielding	October 2023

Table 2: Research Objectives and Associated Questions

Research Questions	Question #
What works well and what are the key challenges for the service and by project type?	E1 – E3, E5, E9, E11-E15
How could EOne improve on the service?	C5, C7, E4, E6, E10
Are the offers in place (compressed air, typical projects, solar, OEM) addressing barriers in market and appropriate to attain program objectives?	B series, C series, E7-E8,
Are the offers in place coherent with other program component offers (P4P, BER, SEM/EMIS)?	B7
How are participant's decarbonization and electrification objectives impacting the service?	D series

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A. Respondent Involvement in the Program

- A1. To begin, please tell me about your roles as a Business Development Manager as it relates to the Retrofit and SEM program services?

B. Participant Recruiting

- B1. How do you typically describe the value or benefits of Retrofit to potential participants?
- B2. I understand that you are involved in recommending participants that would benefit from an OEM. How are OEMs selected for a certain participant or site?
- B3. How do you describe the value or benefits of OEMs to potential participants?
- B4. Do you work with participants that have an OEM? If yes, how do you work with OEM's to increase opportunities?
- B5. **[Industrial only]** How do you typically describe the value or benefits of SEM to potential participants?
- B6. **[Industrial only]** Do you generally propose SEM to participants that have already expressed an interest in the topic? If so, do potential participants fully understand what SEM entails?
- B7. **[Industrial only]** In your opinion, how does the services offered by EPS, the SEM provider, differ from those of an OEM?
- B8. How do you determine whether a participant fits best in Retrofit, Retrofit with OEM, SEM or BER?

C. Motivations and Barriers

My next questions are specifically about Retrofit.

- C1. In your experience, what prevents customers from implementing their energy efficiency projects in the absence of support from EOne?
- C2. What are the most common motivations for participants to part in the Retrofit program?
- C3. What are the most common motivations for participants to participate in the OEM offer?
- C4. We have heard that availability of qualified consultants may be a challenge for Retrofit participants. To what extent has this been an issue for businesses that you work with?

[Industrial only] The following questions are specific to SEM.

- C5. In your experience, what are the most common barriers to the implementation of a strategic energy management process in industrial facilities?
- C6. What are the most common motivations for participants to take part in the SEM program?

- 
- C7. In recent years, the SEM program has changed its M&V approach to prioritize project-specific measurements rather than using a facility-wide model. Has that had any impact on the participant interest or involvement in SEM?

D. Decarbonization and Electrification

- D1. Have your customers discussed decarbonization or electrification with you? If yes, what are their concerns? [PROBE: carbon credits]
- D2. In your opinion, how do participant's decarbonization and electrification objectives impact their participation in Retrofit? [PROBE: less/more interest in EE, looking for projects that meet both objectives, different M&V needs]
- D3. **[Industrial only]** In your opinion, how do participant's decarbonization and electrification objectives impact their participation in SEM? [PROBE: are they more invested in the participation process, more interested in facility-wide performance, implementing learning on both energy sources]
- D4. **[Industrial only]** Would SEM become more attractive if it was marketed as an all-fuel program?

E. Challenges and Opportunities

- E1. Overall, what is the main strength of the Retrofit program?
- E2. What is the main challenge of the Retrofit program?
- E3. What feedback have you heard from participants about the Retrofit program? Anything specific to Compressed Air Leak Audit? Solar?
- E4. In your opinion, how well do customers and consultants understand what is required for program participation? Do you have suggestions on how this could be improved?
- E5. Are there any other challenges with the Retrofit program or its delivery that we haven't discussed?
- E6. How, if at all, could the participant experience and process be improved for the Retrofit program?
- E7. How, if at all, do you support participant in finding a consultant [PROBE: do you have a directory that you use]?
- E8. Do you have any suggestions on how the barrier of lack of available consultants could be improved?
- E9. How would you describe EOne's relationship with consultants and contractors?
- E10. Do you have any suggestions for improving relationships?
- E11. **[Industrial only]** Overall, what is the main strength of the SEM program?
- E12. **[Industrial only]** What is the main challenge of the SEM program?

- 
- E13. **[Industrial only]** What feedback have you heard from participants about the SEM program?
- E14. **[Industrial only]** Are there any other challenges with the SEM program or its delivery that we haven't discussed?
- E15. **[Industrial only]** How, if at all, could the participant experience and process be improved for the SEM program?

Those are all the questions I have for you today. Would you like to add anything else regarding the Retrofit program?

APPENDIX II

Retrofit and Solar Participant Interview Guide

CUSTOM RETROFIT

PARTICIPANT INTERVIEW GUIDE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview
Estimated Time to Complete	30 min. (for Retrofit) / 25 min. (for Solar)
Target Audience	Custom Retrofit and Solar PV participants
Expected Number of Completions	Retrofit up to 15, Solar 7
Contact List Source	EOne
Fielding Firm	Narrative
Estimated Timeline for fielding	October - November

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
Identifying Key Decision-makers [Retrofit / Solar]	A
Awareness and Participation [Only for Retrofit]	B
Free-ridership [Retrofit / Solar]	C
Cross-influence [Retrofit / Solar]	D
Spillover [Retrofit / Solar]	E
Measurement and Verification [Only for Retrofit]	F
Decarbonization and Electrification [Only for Retrofit]	G
Barriers [Only for Retrofit]	H
Satisfaction [Retrofit /Solar]	I

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I am with _____ and we are conducting an evaluation of the Custom Retrofit program offered by Efficiency Nova Scotia.

This interview should take up to 30 minutes. Is this still a good time for you?

[READ THIS INTRO IF CUSTOM RETROFIT]

We would like to better understand your organization's decision-making process regarding the energy efficiency project you completed as part of the Custom Retrofit program. More specifically, we are looking to understand how you decided how you made the decision implement your energy efficiency Retrofit* project for the building located at **[SPECIFY LOCATION*]**. We will refer to this as your decision "to implement your energy efficiency project" throughout this interview.

[READ THIS INTRO IF SOLAR PV]

We would like to better understand your organization's decision-making process regarding the Solar photovoltaics (PV) project you implemented at **[SPECIFY LOCATION*]**.

***[IF MORE THAN ONE COMPLETED PROJECT IS BEING REVIEWED]** This interview specifically refers to the following projects that you have implemented **[SPECIFY PROJECT NAMES AND LOCATIONS]**, so please think of both of/all these projects when answering the questions. Let me know during the interview when and how your responses differ by project.

Your responses will be kept confidential, and results from all interviews will be provided in aggregate format. Your responses will not affect the incentive amount you have or will receive for this project.

A. Identifying Key Decision-makers [Retrofit / Solar]

A1. We would like to speak with someone that played a key role in the financial decision to implement the **[solar PV / energy efficiency]** project for your organization. Are you that person?

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

A2. **[IF A1=YES OR DK/REFUSE]** Please describe your role in the decision-making process for this project.

96. Specify:

A3. **[IF A1=NO]** Could you provide the name, role, and contact information for someone who played a key role in the decision to implement the **[solar PV / energy efficiency]** project? **[RECORD INFORMATION; THANK & TERMINATE AND REACH OUT TO NEW CONTACT]**

96. Specify name:
Specify role:
Specify contact info (email and/or phone):

B. Awareness, and Participation [Retrofit]

- B1. How did you first hear about the Custom Retrofit program?
96. Specify:
- B2. Why did your organization decide to implement the **[solar PV / energy efficiency]** project? **[DO NOT READ]**
96. Specify:
- 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
98. Don't know
99. Refused
- B3. Why did your organization decide to participate in the Custom Retrofit program?
96. Specify:

C. Free-ridership [Retrofit / Solar]

- C1. Had your organization finalized the details of the **[solar PV / energy efficiency]** project BEFORE knowing that you would receive an incentive from Efficiency Nova Scotia?
1. Yes
 2. No
98. Don't know
99. Refused
- C2. **[IF C1=YES]** When you decided to implement the **[solar PV / energy efficiency]** project, 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
- C3. Efficiency Nova Scotia gave your organization a rebate of **[ASK IF RETROFIT: \$<STUDY INCENTIVE>** for the **[INVESTIGATION OR FEASIBILITY]** study] and **[ASK IF RETROFIT AND**



SOLAR: \$<IMPLEMENTATION INCENTIVE>] for the project implementation, totalling **<TOTAL>** in incentives for your energy efficiency project.

I would like to understand the impact of this incentive on the financial case for your project. To what extent did these financial incentives improve the payback period for this project?

1. The financial incentives improved the payback period by a very significant margin; or
2. The financial incentives improved the payback period by a somewhat significant margin; or
3. The financial incentives DID NOT improve the payback period by a significant margin
98. Don't know
99. Refused

C4. If the implementation incentive of **\$<IMPLEMENTATION INCENTIVE>** had not been offered, what is the likelihood that you would have paid the full amount for your energy efficiency project? Please answer on a scale of 0 to 10, where "0" means "Definitely Would Not Have Paid the full amount" and "10" means "Definitely Would Have". **[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

C5. **[ASK IF RETROFIT AND IF \$<STUDY INCENTIVE> >0]** As part of its Custom Retrofit 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". **[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

- C6. **[ASK IF RETROFIT AND IF C5 = 0-10]** Did you use the study as a decision-making tool during the planning stage, to compare and select the potential measures for the energy efficiency project?
1. Yes
 2. No
 98. Don't know
 99. Refused
- C7. You received an \$<IMPLEMENTATION INCENTIVE> incentive based on **[IF Solar: solar PV energy production]** energy savings when your **[IF Retrofit: 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. You would have implemented the exact same **[solar PV / energy efficiency]** project. OR
 2. **[IF SOLAR]** You would have implemented a project with a smaller or less performant Solar PV system? **[IF RETROFIT]** You would have implemented a project with fewer or less impactful energy efficiency measures. OR
 3. You would have implemented the exact same **[solar PV project / energy efficiency measures]** but delayed the project by at least a year. OR
 4. You would not have implemented the project at all.
 98. (Don't know)
 99. (Refused)
- C8. I would like you to rate the influence of the following factors on your decision to implement the **[solar PV / energy efficiency]** project. Using a scale of 0 to 10, where 0 means "Not at all important" and 10 means "Extremely important", how important are each of the following factors in your decision to implement the energy efficiency measures through the Custom Retrofit program.

Factor [READ AND RANDOMIZE]	Responses		
a. [ASK IF Retrofit] The program financial incentive for the [Investigation or Feasibility Study] .	__ Response	__98 Don't Know	__Refused
b. The program financial incentive for the implementation of the [solar PV project / energy efficiency measures] .	__ Response	__98 Don't Know	__Refused
c. [ASK IF Retrofit] The information from the [Investigation or Feasibility Study] regarding the energy savings associated with each potential measure.	__ Response	__98 Don't Know	__Refused
d. The recommendations and technical assistance provided by the Business Development Manager, or other Efficiency Nova Scotia staff about the [solar PV system / energy efficiency measures] .	__ Response	__98 Don't Know	__Refused
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.	__ Response	__98 Don't Know	__Refused

- C9. Did your organization use the services of an Onsite Energy Manager (OEM) before implementing the project?
1. Yes
 2. No
 98. Don't know
 99. Refused
- C10. **[IF C9 = YES]** How does having an On-site Energy Manager (OEM) add value to your organization?
- C11. **[IF C9=YES]** I would like you to rate the influence of the Onsite Energy Manager (OEM) on your decisions related to the energy efficiency project. Using a scale of 0 to 10, where 0 means "Not at all influential" and 10 means "Extremely influential", please rate the influence of the Onsite Energy Manager (OEM) on your decision to implement **[solar PV project / energy efficiency measures]** through the Custom Retrofit program.

Factor [READ AND RANDOMIZE]	Responses		
a. [ASK IF Custom Retrofit] Identification of the measure in the project.	__ Response	__98 Don't Know	__Refused
b. Development of the business case for the project.	__ Response	__98 Don't Know	__Refused
c. Communicating or explaining the project to relevant decision-making stakeholders and/or selling the business case	__ Response	__98 Don't Know	__Refused
d. Developing the technical specification of the [solar PV system / measures] and/or interfacing with third-party service providers such as consultants or contractors.	__ Response	__98 Don't Know	__Refused
e. Managing and advancing decision-making tasks and maintaining project momentum.	__ Response	__98 Don't Know	__Refused

D. Cross-Influence [Retrofit / Solar]

[READ AND ROTATE (D1 + D2 TO D3) AND (D4 + D5 TO D7) SEQUENCES]

- D1. Before participating in the Custom Retrofit program for this project, had your organization already participated in this program or in any other Efficiency Nova Scotia program?
1. Yes, Custom Retrofit.
 2. Yes, in another Efficiency Nova Scotia program
 3. Yes, both
 4. No **(GO TO D4)**
 98. Don't know **(GO TO D4)**
 99. Refused **(GO TO D4)**

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. **[IF D1 =YES (1 OR 2 OR 3)]** As a result of your past participation in an Efficiency Nova Scotia program and what you learned from it, you asked a technical staff member from your organization (or a supplier/contractor) to examine the **[solar PV / energy efficiency]** options for your project.

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't Know
- 99. Refused

- D3. **[IF D1 = YES (1 OR 2 OR 3)]** As a result of your past participation in an Efficiency Nova Scotia program and what you learned from it, you considered the cost effectiveness of the **[solar PV system / energy efficiency measures]** for your project by evaluating the different options for your organization.

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't Know
- 99. Refused

- D4. Before participating in the Custom Retrofit program had you seen energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, brochures, newsletters or presentations?

- 1. Yes
- 2. No **(GO TO SECTION E)**
- 98. Don't know/Refuse **(GO TO SECTION E)**

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".

- D5. **[IF D4 = YES]** The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in your decision to implement the **[solar PV / energy efficiency]** project.

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't Know
- 99. Refused

- 
- D6. **[IF D4 = YES]** The energy efficiency promotional materials distributed by Efficiency Nova Scotia led you to ask a technical staff member from your organization (or a supplier/contractor) to examine the **[solar PV / energy efficiency]** options for your project.

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know
99. Refused

- D7. **[IF D4 = YES]** The energy efficiency promotional materials distributed by Efficiency Nova Scotia led you to consider the cost effectiveness of the **[Solar PV system / energy efficiency measures]** by evaluating the different options for your organization.

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know
99. Refused

E. Spillover [Retrofit / Solar]

- E1. Since first taking part in the Custom Retrofit program, have you implemented any additional energy efficiency measures outside of the program?

1. Yes
2. No **[GO TO SECTION F]**
98. Don't know **[GO TO SECTION F]**
99. Refused **[GO TO SECTION F]**

- E2. **[IF E1 = 1]** For the energy efficiency upgrades that you implemented outside of the program, did you receive or plan on requesting financing or rebates from Efficiency Nova Scotia?

1. Yes **[GO TO SECTION F]**
2. No
98. Don't know
99. Refused

E3. **[IF E2 = NO OR DK/REFUSED]** Can you please describe these measures by providing the following information?

- a. Name of measure
- b. Type of energy source saved
- c. If all non-electric **(GO TO SECTION F)**
- d. Location of the facility
- e. If not in Nova Scotia **(GO TO SECTION F)**
- f. Quantity of measures (or physical area covered by the measure in sq meters or sq feet)
- g. Technical information, such as HOU, capacity, efficiency, etc.
- h. Estimated savings (in kWh or \$)
- i. If no quantitative information is available, but the measure is the same as the one implemented through Custom Retrofit, probe participant on its relative size with respect to the Custom Retrofit project evaluated (% of size, area covered by measure, price, etc.).
- j. **If respondent is unable to provide details on spillover project (GO TO SECTION F).**

E4. **[IF E2 = NO OR DK/REFUSED]** Using a scale from 0 to 10, where 0 is “No influence” and 10 is “Great influence”. To what extent did your experience with the energy efficiency project implemented through the Custom Retrofit program influence your decision to implement these additional energy efficiency measures that were conducted outside of the program?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't Know
- 99. Refused

E5. **[IF E2 = NO OR DK/REFUSED]** Why did you implement this project without the assistance of an Efficiency Nova Scotia program?

- 96. Specify
- 98. Don't know/ Refused

F. Measurement & Verification [Retrofit]

- F1. Using a scale from 0 to 10, where 0 is “Not important” and 10 is “Very important”. How important is the measurement and verification of energy efficiency projects to your company?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know
99. Refused

- F2. What challenges, if any, did you encounter developing and implementing the measurement and verification plans related to Custom Retrofit projects?

- F3. Do you have any suggestions on how EOne could support the implementation of comprehensive measurement and verification plans?

G. Decarbonization and Electrification [Retrofit]

- G1. Using a scale from 0 to 10, where 0 is “Not important” and 10 is “Very important”. How important is reducing GHG emissions to your company?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know
99. Refused

- G2. Using the same 0 to 10 scale, how important is electrification to your company?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know
99. Refused

- G3. How, if at all, has reducing GHG emissions and/or electrification influenced your participation in the Custom Retrofit program?

H. Barriers [Retrofit]

- H1. What is the main challenge or barrier that prevents your business from implementing other energy efficiency projects?
- a. Specify:
 - b. Are there any other challenges or barriers?

I. Satisfaction [Retrofit / Solar]

- I1. Using a scale from 1 to 10 where 0 is “Not at all satisfied” and 10 is “completely satisfied” how would you rate your satisfaction with the Custom Retrofit program overall? **[PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]**

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

- 98. Don't Know
- 99. Refused

- I2. **[IF J1<8]** What was the main reason you are not more satisfied with the program overall?

- 96. Specify:

- I3. Using the same 1 to 10 scale, how satisfied are you with Efficiency Nova Scotia's overall performance in working with your organization?

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

- 98. Don't Know/Don't recall
- 99. Refused

14. Thinking about your overall experience with Efficiency Nova Scotia staff... I will read you a list of factors, and I would like to know how satisfied you are with each. On a scale of 1 to 10, where “1” is not at all satisfied and “10” is completely satisfied, how satisfied are you with...

Factor [READ AND RANDOMIZE]	Responses	Reason If 7 or less, please share the reason(s) for your score.
a. The responsiveness of employees to your requests and enquiries in a timely manner	___ Response ___98 DK ___99 Ref ___97 N/A	What could be improved?
b. The speed with which the application was approved	___ Response ___98 DK ___99 Ref ___97 N/A	N/A
c. The value of the program or service relative to the time and cost involved	___ Response ___98 DK ___99 Ref ___97 N/A	What could be improved?
d. The ability to provide estimates of the savings or return on investment associated with the program	___ Response ___98 DK ___99 Ref ___97 N/A	What could be improved?
e. The technical expertise of Efficiency Nova Scotia employees related to the program	___ Response ___98 DK ___99 Ref ___97 N/A	What could be improved?

15. Based on your personal experience, would you definitely, probably, probably not, or definitely not recommend the programs offered by Efficiency Nova Scotia to others? **[CODE ONE ONLY]**

1. Definitely
2. Probably
3. Probably not
4. Definitely not

VOLUNTEERED

98. Don't know
99. Refused

16. Do you have any suggestions to improve the Custom Retrofit program?

96. Specify:



17. How likely would you be to participate in other programs offered by Efficiency Nova Scotia if your organization qualified? Would you definitely, probably, probably not, or definitely not participate in other programs? **[CODE ONE ONLY]**

1. Definitely
2. Probably
3. Probably not
4. Definitely not

VOLUNTEERED

97. Not eligible for any other programs
98. Don't know
99. 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 III

Retrofit Consultant Interview Guide

RETROFIT PROGRAM EVALUATION

GUIDE FOR INTERVIEWS WITH CONSULTANTS

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Semi-directed in-depth interview
Estimated Time to Complete	20-25 minutes
Target Audience	Consultants and Contractors
Expected Number of Completions	8
Contact List Source	Tracking sheet – see sample
Fielding Firm	Econoler
Estimated Timeline for fielding	October 2023

Table 2: Research Objectives and Associated Questions

Research Questions	Question #
Are the offers in place (compressed air, typical projects, solar, OEM) addressing barriers in market and appropriate to attain program objectives?	C1, C3, D series
Are the offers in place coherent with other program component offers (P4P, BER, SEM/EMIS)?	C2
How are participant's decarbonization and electrification objectives impacting the service?	E series
What works well and what are the key challenges for the service and by project type?	F series, G2
How could EOne improve on the service?	F4-F6, G series
What is the level of satisfaction with the different elements of the services among participants and partners?	F1-F2-F3

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]**



Hello, may I speak with **[Contact name]**?

My name is [Interviewer name] and I'm calling from Narrative Research, a market research firm. Efficiency Nova Scotia has mandated the evaluation of its Custom Retrofit Program, which provides financial incentives for the implementation of energy efficiency measures in commercial, industrial and institutional facilities. Efficiency Nova Scotia has informed us that **[BUSINESS NAME(S)]** has participated in the program, and we are interested in your opinion from your perspective as a consultant or contractor. Are you the person most familiar with **[BUSINESS NAME(S)]**'s involvement in the program? Our discussion should last about 25-30 minutes.

A. Identification and Screening of Respondent

- › Person responsible available **[CONTINUE]**
- › Person responsible currently unavailable **[ARRANGE CALL BACK WITH THE RIGHT PERSON]**
- › Don't know **[ASK TO SPEAK TO ANOTHER PERSON WHO WOULD KNOW ABOUT THE PROGRAM]**
- › Refused **[THANK AND TERMINATE]**

Do you have any questions before we start?

Role of Consultants or Contractors (For Reference)

Participants will hire technical experts (consultants or contractors) to fulfill various program requirements. Their role might include:

- › Identifying potential measures, quantify savings and discussing energy efficiency measures with customer
- › Building energy models
- › Completing scoping and feasibility studies
- › Designing and implementing (supplying and/or installing) energy efficiency measures
- › Conducting measurement and verification

Program Participation Process (For Reference)

- › A participant might ask for a scoping study, which is eligible to a Custom Retrofit incentive, to identify opportunities to save electricity. Otherwise, the participant might already be aware of an opportunity.
- › If a more detailed analysis is needed to determine the potential costs and savings of a measure, the participant can apply for a feasibility study incentive. ENS pays 100% up to \$15,000 of the feasibility study and can provide guidance to complete the study. Upon approval by ENS, a qualified consultant performs the feasibility study.
- › If the feasibility study is conclusive, or no feasibility study is needed, the participant submits a project application, based upon which ENS estimates the available incentive and draft a Custom Project Agreement which state the project requirements.
- › The participant and their consultant / contractors implement the energy efficiency measures and, as required, conduct measurement and verification of the project performance. Once the project is completed, ENS issue the incentive payment.

B. Respondent Involvement in the Program

- 
- B1. To begin, what is your title and your role with the company?
- B2. What is the main type of work your firm does? [PROBE: Lighting, motors, HVAC, Solar etc.]
- B3. In general, a Custom Retrofit project has five phases. Please describe how you are typically involved in each phase. Let's start with the first phase:
- a. Confirming eligibility
 - b. Scoping study [IF NECESSARY, ADD: a high-level assessment of a facility to identify potential measures]
 - c. Feasibility study [IF NECESSARY, ADD: a detailed analysis of energy efficiency measures costs and savings]
 - d. Implementation or installation of the measures
 - e. Measurement and Verification (M&V) [IF NECESSARY, ADD: the process of measuring the performance of energy efficiency measures after they have been installed]
- B4. How long have you worked with ENS's Custom Retrofit program?

C. Participant Recruiting

- C1. Who initiates the discussion about participating in the Custom Retrofit program? Would it be [READ]?
- a. You/Your business brings up the topic with your clients
 - b. Your client brings up the topic with you
 - c. The idea arises as part of a discussion between your business and your client
 - d. Someone from Efficiency Nova Scotia (BDM, OEM) suggests to you and your client
- C2. Do you sometimes have to determine whether a project should be submitted under Business Energy Rebates or Custom Retrofit program?
- a. If yes, how do you determine which program is the best fit?
- C3. Has the Custom Retrofit program helped you win projects that you may not have otherwise secured?
- a. How so?

D. Motivations and Barriers

- D1. In your experience, what prevents customers from implementing their energy efficiency projects?
- D2. What are the most common motivations for your customers to take part in the Custom Retrofit program?
- D3. We understand that consultants' and contractors' limited availability can be a barrier to projects. What assistance could Efficiency Nova Scotia provide to facilitate your work as a consultant, or otherwise reduce delays in program participants accessing qualified consultant or contractor?

E. Decarbonization and Electrification

- E1. Have you had discussions with your customers about reducing GHG emissions or electrification?
- a. If yes, what issues or concerns are top of mind? [PROBE: carbon credits]
- E2. In your opinion, how do these issues impact their choices your customers are making related to the Custom Retrofit program – in terms of what they are looking to accomplish; level of interest in certain measures; etc.? [PROBE: less/more interest in EE, looking for projects that meet both objectives, different M&V needs]

F. Consultant Satisfaction and Support from ENS

- F1. I am interested in your assessment of the Custom Retrofit program. On a scale of 0 to 10, where 0 is “not at all satisfied” and 10 is “completely satisfied”, how satisfied are you with each of the following six aspects of the Custom Retrofit Program. **[ASK FOR REASON IF 7 OR LOWER]**

Aspects of the Program	Score	Reason If 7 or less, please share the reason(s) for your score.
	0 = Not at all satisfied 10 = Completely Satisfied	
a. The overall program	--/10	What could be improved?
b. The program eligibility criteria	--/10	Which eligibility criteria are problematic and why?
c. The value of the program relative to the time and cost involved. Please comment from your perspective, not that of the program participant.	--/10	What could be improved?
d. The program requirements	--/10	What requirements are problematic to you and why?
e. The support you receive from Efficiency Nova Scotia	--/10	What could be improved?
f. Efficiency Nova Scotia's overall performance in working with your organization	--/10	What could be improved?

- F2. Using a scale from 0 to 10 where 0 is “not at all likely” and 10 is “extremely likely” how likely is it that you would recommend this program to a peer, colleague or future client?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't Know
- 99. Refused

- F3. **[IF F2<8]** What is the main reason you are not more likely to recommend the program? **[PROBE FOR SPECIFIC REASON. ACCEPT MULTIPLE RESPONSES BUT DO NOT PROBE]**

RECORD VERBATIM: _____

[VOLUNTEERED]

- 98. Don't know
- 99. Refused

- F4. In your opinion, how well do customers and consultants understand what is required for program participation? They ... **[ASK FOR EACH (customers / consultants)]**

- a) Customers
 - 1. Understand the requirements very well
 - 2. Adequately understand the requirements
 - 3. Understand the requirements somewhat
 - 4. Do not understand the requirements
- b) Consultants

- F5. **[IF F4A AND/OR F4B = 3 OR 4]** Do you have suggestions on how to improve understanding of the program requirements?

- F6. From your experience, what barriers, if any, exist for implementing measurement and verification plans related to Custom Retrofit projects?

- F7. Do you have any suggestions on how EOne could support the implementation of comprehensive measurement and verification plans?

- F8. What additional services or support, if any, should Efficiency Nova Scotia offer to help you complete more projects under the Custom Retrofit program?



G. Suggestions for Improvements

- G1. Are there any other challenges with the Custom Retrofit program or its delivery that we haven't discussed?
- G2. Other than increased incentives, do you have any recommendations to improve the Custom Retrofit program?
- G3. Is there anything else about the program that we have not discussed that you would like to mention?

APPENDIX IV

Custom Tracking Sheet Audit

This appendix presents the main 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

Table 1 presents the corrected tracked savings resulting from all changes made by the Evaluator.

Table 1: 2023 Custom Corrected Tracked Savings

Program Component Result	Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	
Gross Energy Savings – at the Generator	29.112	GWh	29.112	GWh	0.000%
Gross Demand Savings – at the Generator	4.744	MW	4.744	MW	-0.003%
Net Energy Savings – at the Generator	22.400	GWh	22.400	GWh	0.000%
Net Demand Savings – at the Generator	3.366	MW	3.366	MW	-0.003%

There were no substantial differences between the tracked and corrected tracked energy and demand savings. The minor changes in peak demand savings were due to adjustments made to line loss factors.

APPENDIX V

Retrofit Algorithm for Free-Ridership Calculation

Question	Response	Score
INTRODUCTION I am with _____ and we are conducting an evaluation of the Custom Retrofit program 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 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* project for the building located at [SPECIFY LOCATION*]. We will refer to this as your decision "to implement your energy efficiency project" throughout this interview. *[IF MORE THAN ONE COMPLETED PROJECT IS BEING REVIEWED] This interview pertains two the following projects that you have implemented [SPECIFY PROJECT NAMES AND LOCATIONS], so please think of both of/all these projects when answering the questions. Please let me know if the answers to some of the questions would be different for one of the implemented projects. 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.	N/A	EMPTY
Identifying Key Decision-makers		
A1a. We would like to speak with someone that played a key role in the financial decision to implement the energy efficiency project for your organization. Are you that person?	1) Yes	EMPTY
	2) No	
	98) DK/Refuse	
A1b. [IF A1a=YES OR DK/Refuse] Please describe your role in the decision-making process for this project.	Answer: _____	Contextual information to help identify if respondent is a key decision-maker.

A2. [IF A1a=NO] Who played a key role in the decision to implement the energy efficiency project? Can you provide their names, roles, contact information?	Answer: _____	Contextual information to help identify other key decision-makers to interview.
Participant Perspectives		
B1. How did you first hear about the Custom Retrofit program?	Answer: _____	To report on participant perspectives on the program.
B2. Why did your organization decide 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	
B3. Why did your organization decide to participate in the Custom Retrofit program?	Answer: _____	
B4. What challenges or barriers related to your participation in the Custom Retrofit program did you face during the implementation of your energy efficiency project, if any?	Answer: _____	
B5. [IF B4=CHALLENGE MENTIONED, then ask:] What was the most significant challenge or barrier?	Answer: _____	
B6. Do you have any suggestions to improve the Custom Retrofit program?	Answer: _____	
Planning		
C1. 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	USE D2
	2) No	0%
	98) DK/Refuse	0%
C2. [IF C1=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	0%
	2) Somewhat confident	25%
	3) Not very confident	75%
	4) Not at all confident	100%
	98) DK/Refuse	50%

Cost		
C3. Efficiency Nova Scotia gave your organization a rebate of \$<STUDY INCENTIVE> for the [Investigation or Feasibility] study and \$<IMPLEMENTATION INCENTIVE> for the project implementation, totalling <TOTAL> in incentives for your energy efficiency project. I would like to understand the impact of this incentive on the financial case for your project. To what extent did these financial incentives improve the payback period for this project?	1) The financial incentive improved the payback period by a very significant margin	NO SCORE (FOR CONTEXT ONLY)
	2) The financial incentive improved the payback period by a somewhat significant margin	ASK C5 TO ALL PARTICIPANTS
	3) The financial incentive DID NOT improve the payback period by a significant margin	
	98) DK/Refuse	
C4. If the implementation incentive had not been offered, what is the likelihood that you would have paid the full amount for your energy efficiency project? Please answer on a scale of 0 to 10, where “0” means “Definitely Would Not Have Paid” and “10” means “Definitely Would Have Paid.”	0 to 10 scale	10% x (ANSWER)
	98) DK/Refuse	EMPTY
[ASK IF \$<STUDY INCENTIVE> ≥0] C5. As part of its Custom Retrofit 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 C6
	98) DK/Refuse	EMPTY
C6. [IF C5 ≠ 98] Did you use the study as a decision-making tool during the planning stage, to compare and select the potential measures for the energy efficiency project?	1) Yes	C5 Score x 10%
	2) No	EMPTY
	98) DK/Refuse	EMPTY
Efficiency and Quantity		
C7. 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) You would have implemented the exact same energy efficiency project.	100%
	2) You would have implemented a project with fewer or less impactful energy efficiency measures.	50%
	3) You would have implemented the exact same energy efficiency measures but delayed the project by at least a year.	0%
	4) You would not have implemented the project at all.	0%
	98) DK/Refuse	EMPTY

Influence		
C8. I would like you to rate the importance of factors on your decision to implement the energy efficiency project based on your participation in the Custom Retrofit program. Using a scale of 0 to 10, where 0 means “Not at all important” and 10 means “Extremely important”, how important are each of the following five factors in your decision to implement the energy efficiency measures through the Custom Retrofit program. a. The program financial incentive for the [Investigation or Feasibility Study]. b. The program financial incentive for the implementation of the energy efficiency measures. c. The information from the [Investigation or Feasibility Study] regarding 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 about the 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
C9. Did your organization use the services of an Onsite Energy Manager while the project was being considered for implementation?	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
C10. [IF C9=YES] How does having an On-site Energy Manager (OEM) add value to your organization?	Answer : _____	To provide context
C11. [IF C9=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 Onsite Energy Manager (OEM) contribution with the following aspects of implementing the energy efficiency measures through the Custom Retrofit 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

Cross Influence		
D1. Before participating in the Custom Retrofit program for this project, had your organization already participated in this program or in another Efficiency Nova Scotia program?	1) Yes, Custom Retrofit.	To determine if participants should respond to questions D2 and D3.
	2) Yes, in another Efficiency Nova Scotia program	
	3) Yes, both	
	4) No (SKIP TO D4)	
	98) DK/Refuse (SKIP TO D4)	
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. [IF D1 = 1 OR 2 OR 3] As a result of your previous participation in an Efficiency Nova Scotia program and what you learned from it, you asked a technical staff member from your organization (or a supplier/contractor) to examine the energy efficiency options for your project.	Score: _____	Score
	98) DK/Refuse	EMPTY
D3. [IF D1 = 1 OR 2 OR 3] As a result of your previous participation in an Efficiency Nova Scotia program and what you learned from it, you considered the cost effectiveness of the energy efficiency measures for your project by evaluating the different options for your organization.	98) DK/Refuse	EMPTY
D4. Before participating in the Custom Retrofit program had you saw 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 D5, D6, and D7.
	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".		
D5. [IF D4 = 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
D6. [IF D4 = 1] The energy efficiency promotional materials distributed by Efficiency Nova Scotia led you to ask a technical staff member from your organization (or a supplier/contractor) to examine the energy efficiency options for your project.	Score: _____	Score
	98) DK/Refuse	EMPTY
D7. [IF D4 = 1] The energy efficiency promotional materials distributed by Efficiency Nova Scotia led 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 (C1',C4',C6,C7) - C1: Adjusted with C2 and with Inconsistency Test #1 - C4: Adjusted with Inconsistency Test #2 - C6: No adjustment - C7: No adjustment	

Influence	MAXIMUM (C8a, C8b, C8c, C81d, C8e, C11a, C11b, C11c, C11d, C11e,) Maximum score among influence factors in C8 and C11
Inconsistency Test #1 (Planning/Cost)	IF C1 = 100% AND C4<70% AND C4 not EMPTY, C1' = EMPTY
Inconsistency Test #2 (Influence/Cost)	IF $ABS(C4 - (1-C8b)) \geq 60\%$ AND C8b not EMPTY, $C4' = (C4 + (1-C8b)) \div 2$)
Free-ridership Calculation	FR = AVERAGE (Intention, (100-Influence))
Cross Influence	CI = IF (D5 $\geq$ 8: 1) + IF (MAX (D2, D6) $\geq$ 8: 1) + IF (MAX (D3, D7) $\geq$ 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%

APPENDIX VI

Retrofit Algorithm for Participant Spillover Calculation

Question	Response	Score
Spillover		
E1. Since first taking part in the Custom Retrofit program, have you implemented any additional energy efficiency measures outside of the program?	1) YES	Continue to E2
	2) NO 98) DK/Refuse	Thank and Terminate
E2. [IF E1 = 1] For the energy efficiency upgrades that you implemented outside of the program, 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 E3
E3. [IF E2 = 2 or 98] Can you please describe these measures by providing the following information?	1. Name of measure	To inform estimate of additional energy savings (in kWh).
	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.	If respondent is unable to provide details on spillover project, thank and terminate.
	4. Quantity of measures (or physical area covered by the measure in sq meters or sq feet)	
	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, probe participant on its relative size with respect to the Custom Retrofit project evaluated (% of size, area covered by measure, price, etc).	
E4. [IF E2 = 2 or 98] Did your experience with the energy efficiency project implemented through the Custom Retrofit program influence your decision to implement these additional energy efficiency measures that were conducted outside of the program? 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 those additional energy efficiency measures” and 10 indicates that the program was “extremely influential” in your decision these measures.	Score: _____	Score
	98) DK/Refuse	EMPTY
E5. [IF E2 = 2 or 98] Why did you implement this project without the assistance of an Efficiency Nova Scotia program?	Answer: _____	For contextual information on spillover.
Spillover	SO = SUM OF (E3 x E4) for All Respondents/SUM of Respondent Savings	



APPENDIX VII

Retrofit and Building Optimization Project Review Protocols

Project Review Protocol

The Evaluator used the same project review protocol in 2023 as the one used for the 2022 Custom Retrofit evaluation. The protocol includes questions and assessment fields for measurement and verification (M&V) plans and reports to ensure that the review is consistent with past evaluation recommendations. The protocol also includes dedicated worksheets containing measure specific data fields for individual project measures.

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 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 was conducted.

1. General Information

Virtual Visit Date: _____	Team: _____	Contact Name: _____				
Project ID: _____		Contact Title: _____				
Project Type (Regular Retrofit (project type) / Compressed Air/ Bopt) :		Role on the project: _____				
		Administer FR/SO? _____				
Company Name: _____	Alternate FR/SO contact: _____					
Facility Name: _____	Contact Phone: _____					
Address: _____	Email: _____					
Consultant: _____						
Other people met during the visit: _____	_____	_____				
Type of building:	<table border="1"> <tr> <td>Commercial/institutional</td> <td>Industrial/manufacturing</td> </tr> <tr> <td>Municipal</td> <td>Other (specify)</td> </tr> </table>	Commercial/institutional	Industrial/manufacturing	Municipal	Other (specify)	Specify: _____
Commercial/institutional	Industrial/manufacturing					
Municipal	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.

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

#####

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 Adjustment: PAR MESURE

Measure #1		*Name of the Measure*						
			Tracking sheet	Evaluator	% of Tracked savings	Project status	Finish month	
Electricity Savings		kWh/yr						
Peak Demand Savings		kW						
Peak Coincidence Factor		-						

Measure #2		*Name of the Measure*						
			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.

See Templates sheet, the idea is to have uniform language across all project reviews, since these summaries will be used to produce the Summary of Adjustment spreadsheet for EOne.

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 rational, 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

New Construction Participant Phone Interview Guide (CPA Stage)

CUSTOM – NEW CONSTRUCTION PARTICIPANT PHONE INTERVIEW GUIDE / WEB SURVEY

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview Guide / Web survey (back-up)
Estimated Time to Complete	15 minutes
Target Audience	New Construction participants have completed an agreement at the project agreement stage (CPA stage))
Expected Number of Completions	Census
Contact List Source	2022 New Construction tracking sheet
Fielding Firm	Econoler/Narrative
Estimated Timeline for fielding	June 2022 – in continue: Quarterly basis

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
What is the free-ridership level for New Construction?	C, C

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 – Telephone IDI

I am with Narrative, and we are conducting an evaluation of the Efficiency Nova Scotia Custom New Construction program. This interview should take about 15-20 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 will receive or you have received for this project.

Introduction – Online Survey

Narrative Research and Econoler are currently conducting a formal evaluation of the Efficiency Nova Scotia Custom New Construction program. Your organization recently entered into an agreement in **[CPA ACCEPTED DATE]** with Efficiency Nova Scotia to assist in the design of energy efficient measures for the **[INSERT PROJECT NAME]** project. As part of the evaluation process, we are interested in better understanding your organization's decision to build an energy efficient building (also referred to on the survey as a "better-than-code building"), including your choice of energy efficient materials or equipment that exceed building code requirements.

Please take a few minutes to complete the evaluation survey. This should only take you about 15 minutes of your time.

This survey is administered by Narrative Research and Econoler. 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 will receive or you have received for this project.

A. Identifying Key Decision-makers

A1. **[SINGLE RESPONSE]** Did you play a key role in your organization's decision to build an energy efficient, or better-than-code, building.

1. Yes
2. No
98. I am unsure

A2. **[IF A1=YES; CAPTURE VERBATIM]** Please briefly describe your role in the decision-making process.

A3. **[IF A1= YES; SINGLE RESPONSE]** Did others within your organization play a key role in the decision to build a better-than-code building?

1. Yes
2. No
98. I am unsure

A4. **[IF A1=YES]** Can you provide the name, role, and contact information (email and/or telephone) of one or two of the key decision-makers?

1. No, I cannot provide this information
2. Yes – Please provide the contact information below

Contact Person 1:

Name: **[RECORD]**

Role: **[CAPTURE VERBATIM]**

Email and/or phone number: **[RECORD IN FORMAT]**

Contact Person 2 [OPTIONAL]:

Name: **[RECORD]**

Role: **[CAPTURE VERBATIM]**

Email and/or phone number: **[RECORD IN FORMAT]**

[IF A1=YES OR A3=NO OR A4=NO: GO TO SECTION B]

A5. **[IF A1= NO OR DK; OPTIONAL RESPONSE FOR CONTACT INFO]** Can you provide the names, roles and contact information of one or two people who played a key role in your organization's decision to build a better-than-code building?

1. No
2. Yes – Please provide the contact information below

Contact Person 1:

Name: **[RECORD]**

Role: **[CAPTURE VERBATIM]**

Email: **[RECORD IN FORMAT]**

Phone number: **[RECORD NUMERALS ONLY]**

Contact Person 2 [OPTIONAL]:

Name: **[RECORD]**

Role: **[CAPTURE VERBATIM]**

Email: **[RECORD IN FORMAT]**

Phone number: **[RECORD NUMERALS ONLY]**

[IF A1= NO or DK: 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. Project Stage

B1. **[MULTIPLE RESPONSE KEEPING CODE 98 AND 99 EXCLUSIVE]** Now thinking of the **[INSERT PROJECT NAME]** project, at what stage is the project currently in? Please select all that apply.

- 1. Conceptual
- 2. Design
- 3. Construction
- 4. Building Occupancy
- 96. Other stage – Please specify: _____
- 98. I am unsure
- 99. I prefer not to say

C. Free-ridership

C1. **[CAPTURE VERBATIM; KEEP CODE 98 & 96 EXCLUSIVE]** Why did your organization decide to build a better-than-code building?

CAPTURE VERBATIM

- 98. I am unsure
- 96. I prefer not to say

C2. **[SINGLE RESPONSE]** Was the design of your better-than-code building finalized BEFORE knowing that your organization would receive an incentive from Efficiency Nova Scotia?

- 1. Yes
- 2. No
- 98. I am unsure
- 99. I prefer not to say

C3. **[IF C1=YES; SINGLE RESPONSE]** During the design stage, how confident were you that your organization would receive an incentive from Efficiency Nova Scotia?

- 1. Very confident
- 2. Somewhat confident
- 3. Not very confident
- 4. Not at all confident
- 98. I am unsure
- 99. I prefer not to say

- C4. **[SINGLE RESPONSE]** Which one of the following best represents the impact of the financial incentive offered by Efficiency Nova Scotia on the financing of the new building project?
1. The incentive from Efficiency Nova Scotia reduced the cost of the building's energy efficiency measures, allowing the project to be **within its approved budget**.
 2. The incentive from Efficiency Nova Scotia reduced the cost of the building's energy efficiency measures, significantly **strengthening the case for the overall project from a financial perspective**.
 3. The incentive from Efficiency Nova Scotia 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. The incentive from Efficiency Nova Scotia did not have a significant impact on the financing of the project.
98. I am unsure
99. I prefer not to say
- C5. **[SINGLE RESPONSE]** You received an incentive of **<INSERT MODELING INCENTIVE AMOUNT>** 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?
- INSERT 0-10 SCALE WITH END POINTS: 0=VERY UNLIKELY AND 10=VERY LIKELY
98. Don't know
99. I prefer not to say
- C6. **[SINGLE RESPONSE]** Did the energy modeling consultant help you assess different options available for building envelope and HVAC equipment?
1. Yes
 2. No
98. I am unsure
99. I prefer not to say
- C7. **[SINGLE RESPONSE]** Your organization 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. Your organization would have designed the exact same better-than-code building.
 2. Your organization would have designed a less efficient building but still exceeded the minimum energy efficiency requirements prescribed in the building code.
 3. Your organization would have designed a less efficient building that met the minimum energy efficiency requirements prescribed in the building code.
98. I am unsure
99. I prefer not to say

C8. **[IF C7=2; SINGLE RESPONSE PER STATEMENT; DO NOT RANDOMIZE]** Without the incentive provided by Efficiency Nova Scotia or the expertise provided by the energy modeler, what is the likelihood that your organization would have:

- a. designed a building with HVAC equipment as efficient as those you installed
- b. designed a building with **an envelope as efficient as the one you built, including insulation levels and glazing performance**
- c. designed a building with **as many efficiency measures as you included**

INSERT 0-10 SCALE WITH END POINTS: 0=VERY UNLIKELY AND 10=VERY LIKELY

98. I am unsure

99. I prefer not to say

C9. **[IF C7=2 AND IF AVERAGE (C8a, C8b and C8c) $\geq$ 8; CAPTURE VERBATIM; KEEP CODE 98 AND 99 EXCLUSIVE]** 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. Please explain how your building would have been different than what it is right now.

CAPTURE VERBATIM

98. I am unsure

99. I prefer not to say

C10. **[SINGLE RESPONSE PER STATEMENT; DO NOT RANDOMIZE]** Rate the influence of the following factors 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.

INSERT 0-10 SCALE WITH END POINTS: 0=NOT AT ALL IMPORTANT AND 10=EXTREMELY IMPORTANT

98. I am unsure

99. I prefer not to say



D. Cross-Influence

D1. **[SINGLE RESPONSE]** Before participating in the Custom New Construction program for the **[INSERT PROJECT NAME]** project, had your organization 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
98. I am unsure
99. I prefer not to say

[IF D1=4, 98 OR 99: SKIP TO D4]

[ASK D2 AND D3 IF D1= YES (CODE 1-3); SHOW INTRO ON SAME PAGE AS D2 AND D3] To what extent do you agree or disagree with the following two statements:

D2. **[ASK IF D1= YES (CODE 1-3); SINGLE RESPONSE]** Because of your organization's previous participation in an Efficiency Nova Scotia program and what you learned from it, you/your organization asked a technical staff member or energy modeler to examine the energy efficiency options for your current building project.

INSERT 0-10 SCALE WITH END POINTS: 0=COMPLETELY DISAGREE AND 10=COMPLETELY AGREE

98. I am unsure
99. I prefer not to say

D3. **[ASK IF D1= YES (CODE 1-3); SINGLE RESPONSE]** Because of your organization's previous participation in an Efficiency Nova Scotia program and what you learned from it, you/your organization looked at the cost effectiveness of the energy efficiency measures in your new building by evaluating the different options available.

INSERT 0-10 SCALE WITH END POINTS: 1=COMPLETELY DISAGREE AND 10=COMPLETELY AGREE

98. Don't know
99. I prefer not to say

D4. **[SINGLE RESPONSE]** 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
- 98. I am unsure
- 99. I prefer not to say

[IF D4=2, 98 OR 99: GO TO END]

[ASK D5 TO D7 IF D4=YES; SHOW INTRO AND D5-D7 ON SAME PAGE] To what extent do you agree or disagree with the following three statements:

D5. **[ASK IF D4=YES; SINGLE RESPONSE]** The energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, brochures, newsletters, or presentations were a major factor in your organization's decision to build a better-than-code building.

INSERT 0-10 SCALE WITH END POINTS: 0=COMPLETELY DISAGREE AND 10=COMPLETELY AGREE

- 98. I am unsure
- 99. I prefer not to say

D6. **[ASK IF D4=YES; SINGLE RESPONSE]** The energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, brochures, newsletters or presentations prompted you/your organization to ask a technical staff member or energy modeler to examine the energy efficiency options for your building project.

INSERT 0-10 SCALE WITH END POINTS: 0=COMPLETELY DISAGREE AND 10=COMPLETELY AGREE

- 98. I am unsure
- 99. I prefer not to say

D7. **[ASK IF D4=YES; SINGLE RESPONSE]** The energy efficiency promotional materials distributed by Efficiency Nova Scotia through its website, brochures, newsletters, or presentations prompted you/your organization to consider the cost effectiveness of the energy efficiency measures in your new building by evaluating the different options offered to your organization.

INSERT 0-10 SCALE WITH END POINTS: 0=COMPLETELY DISAGREE AND 10=COMPLETELY AGREE

- 98. I am unsure
- 99. I prefer not to say

END: [PHONE: These are all the questions I have for you.] [ONLINE SURVEY: That's all the questions we have for you.] Thank you very much for your time and cooperation!

APPENDIX IX

New Construction Participant Interview Guide (Completed Projects)

CUSTOM NEW CONSTRUCTION PARTICIPANT INTERVIEW GUIDE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview
Estimated Time to Complete	20 min.
Target Audience	Custom New Construction participants
Expected Number of Completions	12 with a project completed
Contact List Source	EOne
Fielding Firm	Narrative
Estimated Timeline for fielding	November-January

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
Identifying Key Decision-makers	A
Free-ridership	B
Cross-influence	C
Satisfaction	D

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 _____ and we are performing an evaluation of the Custom New Construction program service offered by Efficiency Nova Scotia.

This interview should take up to 20 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.

A. 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
- 2. No
- 98. Don't know
- 99. Refused

A2. **[IF A1=YES OR DK/REFUSE]** Please describe your role in the decision-making process for this project.

96. Specify:

A3. **[IF A1= 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?

96. Specify:

[IF A1= YES: GO TO SECTION B]

A4. **[IF A1=NO]** 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?

96. Specify:

[IF A1= 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. Free-ridership

B1. 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

B2. Had your organization finalized the design of the new building BEFORE knowing that you would receive an incentive from Efficiency Nova Scotia?

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

B3. **[IF B2=YES]** 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]**

1. Very confident
2. Somewhat confident
3. Not very confident
4. Not at all confident
98. Don't know
99. Refused

- B4. I would like to understand the impact of the financial incentives offered by Efficiency Nova Scotia on the financial case for your new building project. Which of the following best represents the role of the financial incentive? Did the financial incentives **[READ]**?
1. 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.** **OR**
 2. Reduced the cost of the energy efficiency measures, significantly **strengthening the case for the overall project from a financial perspective.** **OR**
 3. 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. **OR**
 4. Did not have a significant impact on the decision.
 98. (Don't know)
 99. (Refused)
- B5. You received an incentive of **<MODELING INCENTIVE \$\$\$>** 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".
1. Score: _____
 98. Don't Know
 99. Refused
- B6. **[IF C5 ≠ 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
- B7. 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)

B8. **[IF C7 = 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”.

96. Score: _____

98. Don't know

99. Refused

B9. **[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”.

96. Score: _____

98. Don't know

99. Refused

B10. **[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”.

96. Score: _____

98. Don't know

99. Refused

B11. **[IF C7 = 2 AND IF AVERAGE (B9,B10,B10) ≥ 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?

B12. 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:

96. Score: _____
98. Don't know
99. Refused

C. Cross-Influence

C1. 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 C4]**
98. Don't know **[SKIP TO C4]**
99. Refused **[SKIP TO C4]**

[ASK C2 AND C3 IF C1= YES (codes 1-3)] 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”.

C2. **[ASK IF C1= YES (codes 1-3)]** 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

C3. **[ASK IF C1= YES (codes 1-3)]** 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

C4. 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 D1]**

98. Don't know **[SKIP TO D1]**

99. Refused **[SKIP TO D1]**

[ASK C5 TO C7 IF C4=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".

C5. **[ASK IF C4= 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

C6. **[ASK IF C4= 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

- C7. **[ASK IF C4= 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

D. Satisfaction

- D1. Using a scale from 1 to 10, where "1" is Not at all satisfied and "10" is Completely satisfied, how satisfied are you with Efficiency Nova Scotia's overall performance in working with your organization?

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

98. Don't Know/Don't recall

99. Refused

- D2. **[IF D1<5]** Why are you dissatisfied with Efficiency Nova Scotia's overall performance in working with your organization?

96. Specify:

- D3. Thinking about your overall experience with Efficiency Nova Scotia staff... I will read you a list of factors, and I would like to know how satisfied you are with each. On a scale of 1 to 10, where "1" is not at all satisfied and "10" is completely satisfied, how satisfied are you with...

Factor [READ AND RANDOMIZE]	Responses			
a. The responsiveness of employees to your requests and enquiries in a timely manner	__ Response	__98 DK	__99 Ref	__97 N/A
b. The speed with which the application was approved	__ Response	__98 DK	__99 Ref	__97 N/A
c. The value of the program or service relative to the time and cost involved	__ Response	__98 DK	__99 Ref	__97 N/A
d. The ability to provide estimates of the savings or return on investment associated with the program	__ Response	__98 DK	__99 Ref	__97 N/A
e. The technical expertise of Efficiency Nova Scotia employees related to the program	__ Response	__98 DK	__99 Ref	__97 N/A

D4. Based on your personal experience, would you definitely, probably, probably not, or definitely not recommend the programs offered by Efficiency Nova Scotia to others? **[CODE ONE ONLY]**

1. Definitely
2. Probably
3. Probably not
4. Definitely not

VOLUNTEERED

98. Don't know
99. Refused

D5. How likely would you be to participate in other programs offered by Efficiency Nova Scotia if your organization qualified? Would you definitely, probably, probably not, or definitely not participate in other programs? **[CODE ONE ONLY]**

1. Definitely
2. Probably
3. Probably not
4. Definitely not

VOLUNTEERED

97. Not eligible for any other programs
98. Don't know
99. 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 X

New Construction Energy Model Review Protocol

Project Review Protocol



Custom New Construction
Efficiency Nova Scotia
Simulation Model Review Protocol

1. General Information

Review Date: _____ Contact Name: _____
Project ID: _____ Contact Title: _____
Project Type: _____ Contact Phone: _____
Project Status: _____ Email: _____
Project Name: _____
Address: _____

Project Energy Efficiency Measure(s)

Information Sent by E1 Sufficient to Review the Project? _____ (Y/N)

Call or Virtual Visit Needed _____ (Call/Visit)

List of people participating to the virtual visit/call: _____

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	

Description from project documentation	
Virtual visit	
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	

Description from project documentation	
Virtual visit	
As modeled by participant	
Changes to model by Econoler	

	EOne	Evaluator
Basecase		
Proposed		

[illegible]

6. Energy and Demand Savings Adjustments

Adjustments made to energy savings?		(Y/N)	Percent of Tracked Energy Savings	#DIV/0!
			Percent of Tracked Peak Demand Savings	#DIV/0!
Adjustments made to demand savings?		(Y/N)	Client Rate Code	
Adjustments made to PCF?		(Y/N)	Line Loss Factor Used	

7. Summarize Adjustments to Energy, Demand & Diversity Factor

Modelling 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.

Please refers to E1 White Paper - Baseline HVAC System in MURBs for MURBS

- 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 XI

New Construction Algorithm for Free-Ridership Calculation

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.
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.

Question (From the Custom New Construction Participant Interview Guide)		Response	Score
Planning			
B2. Had your organization finalized the design of the new building BEFORE knowing that you would receive an incentive from Efficiency Nova Scotia?	Yes	USE B3	
	No	0%	
	98) DK/Refuse	0%	
[ASK IF B2=1] B3. 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		
B4. I would like to understand the impact of the financial incentives offered by Efficiency Nova Scotia on the financial case for your new building project. Which of the following best represents the role of the financial incentive? [READ]	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.	IF B5 => 50% OR EMPTY= 100% IF B5 < 50% = 50%	
	Did not have a significant impact on the decision.	IF B5 => 50% OR EMPTY= 100% IF B5 < 50% = 50%	
	98) DK/Refuse	EMPTY	
B5. 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 B6	
	98) DK/Refuse	EMPTY	
[ASK IF B5 ≠ 98] B6. Did the energy modeling consultant help you assess different options available for building envelope and HVAC equipment?	1) Yes	B5 Score x 10%	
	2) No	EMPTY	
	98) DK/Refuse	EMPTY	

Question (From the Custom New Construction Participant Interview Guide)	Response	Score
Efficiency and Quantity		
B7. You [received/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 the exact same better-than-code building.	100%
	Would have designed a less efficient building but would have still exceeded the minimum energy efficiency requirements prescribed in the building code.	AVERAGE (B8, B9, B10)*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 B7=2] B8. 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”.	Score: _____	Score x 10%
	98) DK/Refuse	EMPTY
[ASK IF B7=2] B9. Without 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 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”.	Score: _____	Score x 10%
	98) DK/Refuse	EMPTY
[ASK IF B7=2] B10. Without 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”.	Score: _____	Score x 10%
	98) DK/Refuse	EMPTY
[ASK IF B7=2 AND IF AVERAGE (B8, B9, B10) ≥ 8] B11. 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 (B8, B9, B10)/2

Question (From the Custom New Construction Participant Interview Guide)	Response	Score
Influence		
B12. Finally, I'm going to ask 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”, 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. 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.	For each sub-question: Score : _____ 98) DK/Refuse	For each sub-question: Score x 10% EMPTY
B1. Can you explain why your organization decided to build a better-than-code building? [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.
Cross Influence		
C1. 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 C2 and C3.
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”.		
C2. 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 building project.	Score: _____ 98) DK/Refuse	Score EMPTY

Question (From the Custom New Construction Participant Interview Guide)	Response	Score
C3. 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.	Score: _____	Score
	98) DK/Refuse	EMPTY
C4. Before participating in the Custom New Construction program service, had you had 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 C5, C6, and C7.
	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”.		
C5. 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
	98) DK/Refuse	EMPTY
C6. 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.	Score: _____	Score
	98) DK/Refuse	EMPTY
C7. 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.	Score: _____	Score
	98) DK/Refuse	EMPTY
Inconsistency	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”.	
Intention	AVERAGE (B2, B4, B7) B2: Adjusted with B3 B4: Adjusted by B5-B6 B7: Adjusted with B8, B9, B10 and validated with B11	
Influence	MAXIMUM (B12a, B12b, B12c, B12d, B12e) Maximum score among influence factors in B12	
Free-ridership Calculation	FR = AVERAGE (Intention, 100-Influence)	
Cross Influence	BI = IF (C5 ≥ 8: 1) + IF (MAX (C2, C6) ≥ 8: 1) + IF (MAX (C3, C7) ≥ 8: 1)	
Revised Free-ridership (w/ cross-influence)	IF BI = 0 OR 1: Revised FR = FR IF BI = 2: Revised FR = FR x 75% IF BI = 3: Revised FR = FR x 50%	



APPENDIX XII

Custom Adjustment Ratio Calculation Example

This appendix provides an example of the project review process and calculations used to adjust the energy savings results for a regular Retrofit project. The calculation described below presents the adjustments made to a refrigeration retrofit project that took place at a lobster holding facility. The adjustments were 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 the rationale behind the adjustments.

Project Background

The participant operates four lobster holding tanks that are fed with seawater, one of which was previously unrefrigerated (Tank #1), while the other three (Tanks #2, #3, and #4) each had a refrigeration unit and a heat exchange system to maintain optimal water temperatures inside the tanks. The Retrofit project consisted of two measures: Replacing the existing R22 refrigerant with a more efficient R449A refrigerant; and adding refrigeration units on Tanks #2 and #4. The participant provided performance data sheets for all refrigeration units, including refrigeration capacity and overall consumption, for both the efficient and baseline cases (for the baseline case, performance data were provided for units using R404 refrigerant that was used as a proxy for the existing R22 refrigerant given their similar properties).

Tracked Savings Calculation

For this project, an EOne project engineer created an Excel spreadsheet to calculate electrical energy consumption for all four tanks for both the base cases and efficient cases, using the refrigeration unit performance data from the manufacturer, weather and seawater temperature data, as well as on-site measurements (to validate the efficiency of the heat exchange units). The spreadsheet also calculated peak demand savings that occur during the utility's winter peak demand period (December to February, from 5 pm to 7 pm).

Revised Savings Calculation

The Evaluator found that the assumptions and the analysis performed by EOne were generally sound. Moreover, after reviewing the savings calculations, the Evaluator found mistakes in some of the Excel formulas used to calculate the refrigeration load for each of the four tanks. These formulas did not use the correct target temperatures to calculate the temperature difference (ΔT), which in turn is used to calculate the refrigeration load. The Evaluator corrected this mistake, which caused a downward adjustment to the consumption levels and demand savings.

The Evaluator also adjusted the effective useful life (EUL) for this project. Since the refrigerant was changed in a mix of existing and new refrigeration units, the remaining useful life of the measure varies across units (the more efficient refrigerant will stop generating savings when each unit reaches the end of its useful life). Therefore, the Evaluator calculated an average EUL weighted by the first-year savings generated by each unit and applied it to total project savings. Consequently, the EUL was adjusted from 15 years to 11 years.



Adjustment Ratio Calculation

Adjustment ratios are determined by comparing revised savings values with tracked savings values. Due to the revisions made to this project, the calculated adjustment ratio for energy savings was 0.825.

$$\frac{\text{Revised ES}}{\text{Tracked ES}} = \frac{105,425 \text{ kWh}}{127,826 \text{ kWh}} = 0.825$$

APPENDIX XIII

Custom 2023 Recommendations

This appendix summarizes all the recommendations made by the Evaluator as part of the 2023 Custom evaluation.

Section	Recommendations
Executive Summary	Retrofit Recommendation #1: EOne should update the Custom Retrofit logic model to address current barriers and document links to other program offers such as SEM and On-site Energy Managers (OEMs).

APPENDIX XIV

SEM Service Provider Interview Guide

RETROFIT-SEM PROGRAM EVALUATION

GUIDE FOR INTERVIEWS WITH SEM SERVICE PROVIDER

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Semi-directed in-depth interview
Estimated Time to Complete	60 minutes
Target Audience	EPS, service provider for SEM
Expected Number of Completions	1
Contact List Source	Efficiency One
Fielding Firm	Econoler
Estimated Timeline for fielding	November 2023

Table 2: Research Objectives and Associated Questions

Research Questions	Question #
To what extent do SEM participants adopt SEM minimum elements? Why are those adopted?	A4-A5-A6-B6
What are the objectives and needs of SEM participants and potential participants?	B2
Under what conditions, if any, would SEM participants be interested in EMIS?	A9
How are participant's decarbonization and electrification objectives impacting the service?	B3-B4-B5
What works well and what are the key challenges for the service and by project type?	C1-C2-C3
How could EOne improve on the service?	C4-C5-C6
What are the barriers for SEM projects?	B1
Are the offers in place addressing barriers in market and appropriate to attain program objectives?	B1-B2-C4
Are the offers in place coherent with other program component offers (Retrofit, OEM)?	A3-A7-A8-A9-A10-B6
Is the support offered sufficient to conduct appropriate M&V?	B7

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. Participation Process

- A1. At what point in the participation process does EPS become involved?
- A2. When EPS first contacts participants, how well do they understand what “strategic energy management” implies? What are their expectations?
- A3. EOne’s internal documents indicate that the objectives of SEM are 1) to provide a structured path to strategic energy management and 2) to support capital EE projects identified by SEM. Do you believe those properly represent the value offered by SEM? Would you add anything?
- A4. The SEM delivery structure, taken from your Methodology document, involves the following steps:

Engagement	Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
First Engagement (15 months)	Conduct Program Kickoff Meeting	SSA #1														
	Assemble Energy Team															
	Conduct Initial Energy Management Assessment		WS #1													
	Develop an Energy Policy		WS #2													
	Saving Energy															
	Energy Map		SSA #2													
	Conduct Energy Kaizen Event			SSA #3												
	Develop an Energy Usage Model and Energy Savings Target	M&V #1														
	Tracking Energy Performance															
	Conduct Capital/EMIS Scoping Study				WS #3											
	Employee Engagement Planning					SSA #5										
	Employee Engagement Implementation Support								WS #4							
	Conduct Capital Planning								SSA #8							
	Report Monthly Energy Savings and Progress				SSA #4											
	Document Model Methodology and Non-Routine Adjustments				M&V #2											
	Provide Energy Model Support				M&V #1 & M&V #2											
	Develop and Maintain a List of Action Items				M&V #2											
	Conduct Current Energy Management Assessment							SSA #6							SSA #6	
	Management Review							SSA #7								SSA #9
	Perform Transition Planning/Program Close Out															SSA #9
	Report 12-month Energy Savings															M&V #3

Many steps are related to the development and maintenance of the energy model. How does that process change if the M&V approach for this participant is not a facility-wide model?

- A5. We have compared the participation process with CEE’s minimum elements for SEM. We would like to clarify a few elements.
- i) There is a workshop to develop an energy policy. Is it a requirement of the program that this policy be completed and signed? How is the policy then used in your activities?
 - ii) There is a workshop to develop EnPIs. Does EPS establish the EnPIs and the measurement process as part of the workshop or is this done by the participant after the fact?
 - iii) Same question for the employee engagement plan.
- A6. Are there elements of your SEM delivery process that are less appealing or with which participants are less engaged? Why is that?
- A7. Do you work with participants that have an on-site energy manager provided by Efficiency Nova Scotia? If so, how does that change the support that you provide participants?

- A8. How does the work you do differ from that of the OEM?
- A9. I understand you support SEM participants you submit applications to the Custom Retrofit program. In your opinion, does the Retrofit offer properly complement the SEM program?
- A10. The participation levels in Energy Management Information Systems (EMIS) have been quite low in previous years. Under what conditions would this program offering have value for SEM customers?

B. Motivations and Barriers

- B1. In your experience, what are the most common barriers to the implementation of a strategic energy management process in industrial facilities?
- B2. What are the most common motivations for participants to take part in the SEM program? What portion of your work do you believe has the most value to them?
- B3. Have you had participants state that their participation in SEM was motivated by decarbonization or electrification objectives for the company?
- B4. In your opinion, how do participants' decarbonization and electrification objectives impact their participation in SEM? [PROBE: are they more invested in the participation process, more interested in facility-wide performance, implementing learning on both energy sources]
- B5. Would SEM become more attractive if it was marketed as an all-fuel program?
- B6. In recent years, the SEM program has changed its M&V approach to prioritize project-specific measurements rather than using a facility-wide model. Has that had any impact on the participant interest or involvement in SEM?
- B7. Last year, we noted that M&V periods were sometimes a bit short, especially in cases where measure persistence was a potential issue, which would warrant longer M&V periods. What are the barriers that limit your ability to conduct M&V for a longer period of time?

C. Challenges and Opportunities



- C1. Overall, what is the main strength of the SEM program?
- C2. What is the main challenge of the SEM program?
- C3. What feedback have you heard from participants about the SEM program?
- C4. Is there something else the program should offer to better address barriers to the implementation of full strategic energy management in participating facilities?
- C5. Are there any other challenges with the SEM program or its delivery that we haven't discussed?
- C6. How, if at all, could the participant experience and process be improved for the SEM program?

Those are all the questions I have for you today. Would you like to add anything else regarding the SEM program?

APPENDIX XV

SEM Participant Interview Guide

STRATEGIC ENERGY MANAGEMENT

PARTICIPANT INTERVIEW GUIDE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview
Estimated Time to Complete	30 minutes
Target Audience	All SEM participants
Expected Number of Completions	9 (all participants)
Contact List Source	EOne
Fielding Firm	Econoler and Equilibrium (if done during site visits)
Estimated Timeline for fielding	November 2023 – January 2024

Table 2: Research Objectives and Associated Questions

Research Questions	Questions
What is the level of satisfaction with SEM?	F series
To what extent do SEM participants adopt SEM minimum elements? Why are those adopted?	D1-D2
What are the objectives and needs of SEM participants and potential participants?	C1-C2-C3-C4
How are participant's decarbonization and electrification objectives impacting the service?	E1-E2
Under what conditions, if any, would SEM participants be interested in EMIS?	D3-D4-D5
What works well and what are the key challenges for the service and by project type?	F2-F3
How could EOne improve the service?	F6
What are barriers for SEM projects?	A3
Is the offer in place addressing barriers in market and appropriate to attain program objectives?	C5-C6
Is SEM coherent with other program component offers (e.g. Custom Retrofit, OEM)? Is there overlap?	D6-D7
What are the free-ridership and spillover levels for SEM projects?	B series

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]**



Through this interview, we hope to better understand your organization's decision-making process regarding the implementation of strategic energy management, how the program benefited your organization and how it can be improved.

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.

A. Awareness

A1. Before being contacted by ENS to take part in the SEM program, were you aware of what a strategic energy management program was?

- 1. Yes
- 2. No
- 98. Don't know
- 99. Refused

A2. **[IF A1=YES]** Before taking part in the SEM program, were you considering implementing a strategic energy management approach in your company?

- 1. Yes
- 2. No
- 98. Don't know
- 99. Refused

A3. **[IF A1=YES]** What are the main reasons why you did not implement strategic management approach without the support of ENS?

A4. Did you already have tools or procedures that allowed you to measure and improve your energy consumption before participating in the SEM program?

- 1. Yes
- 2. No
- 98. Don't know
- 99. Refused



B. Free-ridership and Spillover

Series of questions to be asked for each measure.

- B1. Without the support from EPS, would you have identified this energy efficiency opportunity?
1. Yes
 2. No
 98. Don't know
 99. Refused
- B2. **[Ask if B1=1]** Please consider the technical support provided by EPS and by Efficiency Nova Scotia, as well as the \$[MEASURE INCENTIVE] incentive you received for this project. Without this support, what is the likelihood that you would have completed this energy efficiency project? Please answer on a scale of 0 to 10, where "0" means "Definitely Would Not Have Completed this Project" and "10" means "Definitely Would Have".
- B3. Your annual report lists the following projects that were completed through your strategic energy management approach this year [LIST PROJECTS]. Have you completed other electricity reduction projects this year?

C. Motivations and Barriers

- C1. When you first considered participating in SEM, what was the main source of motivation for your organization to implement a strategic energy management approach?
- C2. When you first considered participating in SEM, which elements of the program did you think were going to be most useful to your organization? [Probe: establishing an energy policy, modelling the energy consumption of your facility, conducting treasure hunts to identify efficiency opportunities]
- C3. Did these expectations turn out to be true, or were there other elements of the program that proved of greater value to you?
- C4. What is the main challenge or barrier that you faced during the implementation of strategic energy management approach?
- i) Any other challenge?
- C5. How has the SEM program helped you overcome these challenges?
- C6. Would you have needed additional help from the SEM program and EPS to overcome these challenges?

D. Participation Process

- D1. We would like to validate with you which elements of the SEM process your organization has completed so far. Do you have:
- i) An energy policy signed by the organization management?
 - ii) An assigned energy champion and energy team?
 - iii) An assessment of your organization energy management practices (using a performance scorecard or facilitated energy management assessment)?
 - iv) A map of your facility's energy end-uses?
 - v) A set of energy performance indicators and established goals for improvement?
 - vi) An employee engagement plan?
 - vii) A process to periodically review energy performance?
- D2. For elements that were not implemented in the organization: why has this not been a priority?
- D3. The SEM program can offer incentives to implement energy management information systems, which provide additional metering data and analysis of your energy consumption. Have you considered this option?
- D4. Why did you not pursue it?
- D5. Under what conditions would an energy management information system be useful and worthwhile to your organization?
- D6. Have there been occasions where you had to decide whether to submit a specific project through the SEM program, the Custom Retrofit or any other programs offered by ENS?
- D7. In those cases, which program did you choose and why?

E. Decarbonization and Electrification

- E1. Does your organization have a decarbonization or an electrification target?
- E2. **[SKIP IF E1=NO]** How, if at all, has reducing GHG emissions reductions and/or electrification influenced your participation in SEM? [Probe: increased the involvement of your energy team or the energy savings targets for SEM? Focussed their attention to non-electric fuels?]

F. Satisfaction

- 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 SEM program overall? **[PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]**

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

98. Don't Know
99. Refused

- F2. **[IF E1<8]** What was the main reason you were not more satisfied with the program overall?

96. Specify:

- F3. **[IF E1≥8]** What was the main reason you were satisfied with the program overall?

96. Specify:

- F4. Using the same 10-point scale, how satisfied are you with EPS' overall performance in working with your organization?

1-10 SCALE WITH END POINT LABELS– RECORD NUMBER

98. Don't Know/Don't recall
99. Refused

- F5. Thinking about your overall experience with EPS staff... I will read you a list of factors, and I would like to know how satisfied you are with each. On a scale of 1 to 10, where “1” is not at all satisfied and “10” is completely satisfied, how satisfied are you with...

Factor [READ AND RANDOMIZE]	Responses				Reason If 7 or less, please share the reason(s) for your score.
a. The responsiveness of EPS employees to your requests and inquiries in a timely manner	__ Response	__98 DK	__99 Ref	__97 N/A	What could be improved?
c. The value of the program or service relative to the time and cost involved	__ Response	__98 DK	__99 Ref	__97 N/A	What could be improved?
e. The technical expertise of EPS employees related to strategic energy management	__ Response	__98 DK	__99 Ref	__97 N/A	What could be improved?

- F6. Do you have any suggestions to improve the Strategic Energy Management program?

96. Specify:

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 XVI

SEM Tracking Sheet Audit

This appendix presents the main 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

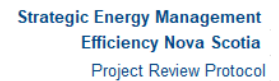
Table 1 presents the corrected tracked savings resulting from all changes made by the Evaluator.

Table 1: 2023 SEM & 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	3.386	GWh	3.391	GWh	0.15%
Gross Peak Demand Savings – at the Generator	0.272	MW	0.272	MW	-0.01%
Net Energy Savings – at the Generator	3.386	GWh	3.391	GWh	0.15%
Net Peak Demand Savings – at the Generator	0.272	MW	0.272	MW	-0.01%

The minor changes in energy and peak demand savings were due to adjustments made to the line loss factors.

Interviewed participants were asked free-ridership validation questions. These questions are listed at the end of the protocol.



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:	Commercial/institutional		Industrial/manufacturing		
	Municipal		Other (specify)		

Number of years in program (1st, 2nd, et.c)	
What was the savings quantification approach last year (bottom-up or top-down)	
Last year measure list	
Last year savings	

4. Impact Evaluation & Savings Adjustments

Reporting period	
Overall M&V approach and reasoning	

Which measures were implemented and do they generate incremental energy and demand savings?

Measure	Implementation date	Expected to generate incremental savings for this year?	Time period when generating savings	PCF

Bottom-up Approach

Measure 1	Notes
Measure Description	
Validation of the measure (is it installed and operational?)	
Savings calculation approach - What is it and is it appropriate?	
What is the baseline and is it appropriate?	
Are savings annualized for a standard year?	
Are IE considered?	
EUL	

		Tracked	Evaluated	% of Tracked savings			
Electricity Savings	kWh/yr						
Peak Demand Savings	kW						
Peak Coincidence Factor	-						

Top-down Approach		Short answer	NOTES
Periods and boundaries			
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?			
Do any adjustments need to be made for COVID impacts?			
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			
Does the ECM cause other impacts outside of the measurement			
Savings Adjustments			
Documented Savings Calculations	Tracking Sheet	Annual report	
Energy Savings (kWh)			
Peak Demand Savings (kW)			
PCF			
Evaluator's Savings Calculations	Value	Notes	
Energy Savings (kWh)			
Peak Demand Savings (kW)			
PCF			
Summary of Adjustments			
Energy Adjustment Ratio (%)	#DIV/0!		
Peak Demand Adjustment Ratio (%)	#DIV/0!		
Summary of Evaluator's Findings and Adjustment			
(TO BE COPIED IN THE SUMMARY FILE SHARED WITH EONE)			

Free-ridership Validation Questionnaire

SEM Free Ridership Survey

MEASURE 1

B1. Without the support from EPS, would you have identified this energy efficiency opportunity? (Yes / No)

B2. [Ask if B1=1] Please consider the technical support provided by EPS and by Efficiency Nova Scotia, as well as the \$[MEASURE INCENTIVE] incentive you received for this project. Without this support, what is the likelihood that you would have completed this energy efficiency project? Please answer on a scale of 0 to 10, where "0" means "Definitely Would Not Have Completed this Project" and "10" means "Definitely Would Have"

MEASURE 2

B1. Without the support from EPS, would you have identified this energy efficiency opportunity? (Yes / No)

B2. [Ask if B1=1] Please consider the technical support provided by EPS and by Efficiency Nova Scotia, as well as the \$[MEASURE INCENTIVE] incentive you received for this project. Without this support, what is the likelihood that you would have completed this energy efficiency project? Please answer on a scale of 0 to 10, where "0" means "Definitely Would Not Have Completed this Project" and "10" means "Definitely Would Have"

MEASURE 3

B1. Without the support from EPS, would you have identified this energy efficiency opportunity? (Yes / No)

B2. [Ask if B1=1] Please consider the technical support provided by EPS and by Efficiency Nova Scotia, as well as the \$[MEASURE INCENTIVE] incentive you received for this project. Without this support, what is the likelihood that you would have completed this energy efficiency project? Please answer on a scale of 0 to 10, where "0" means "Definitely Would Not Have Completed this Project" and "10" means "Definitely Would Have"

ALL MEASURES

B3. Your annual report lists the following projects that were completed through your strategic energy management approach this year [LIST PROJECTS]. Have you completed other electricity reduction projects this year?

(For analysis: Check if these tools came from EMIS, in which case they shouldn't count toward FR)

NOTES:

APPENDIX XVIII

SEM Detailed Project Review Adjustments

Table 1: 2023 SEM Energy Savings Adjustments

Project	Tracked Savings (kWh)	Evaluated Savings (kWh)	Adjustment Ratio	Explanation for Adjustment
1	36,798	36,798	1.000	None.
2	633,512	633,512	1.000	None.
3	287,808	287,808	1.000	None.
4	1,745,580	1,745,580	1.000	None.
5	277,003	269,869	0.974	For one measure (chilled water pumping control), the exponent used in the pump affinity laws to estimate power at average speed was 3, which is only valid if the VFD does not waste any energy. The Evaluator therefore adjusted the savings with a 2.7 exponent.
6	252,600	250,409	0.991	The Evaluator concluded the savings were slightly overestimated for one measure because there was a mistake in the M&V calculation whereby energy usage during shutdown was not properly taken into account and the schedule was not fully implemented due to more overtime than planned.
Total	3,233,301	3,223,976	99.7%	

Table 2: 2023 SEM Peak Demand Savings Adjustments

Project	Tracked Savings (MW)	Evaluated Savings (MW)	Adjustment Ratio	Explanation for Adjustment
1	0.0043	0.0043	1.000	None.
2	0	0.0654	N/A	A peak coincidence factor (PCF) of 0% was used for tracked savings, which seems to be too conservative; the participant confirmed that all lines would typically be in production until 6 pm, therefore a PCF of 50% would be appropriate.
3	0.0329	0.0329	1.000	None.
4	0.1926	0.1926	1.000	None.
5	0.0243	0.0298	1.226	The Evaluator increased peak demand savings for the VFD measure because the tracked peak demand savings calculation was based on monthly participant-specific demand, not grid-level average peak demand.
6	0	0.0177	N/A	Peak demand savings were increased to account for vacuum pump smart switches generating savings around the clock.
Total	0.26076	0.34936	134.0%	

APPENDIX XIX

SEM 2023 Recommendations

This appendix summarizes all the recommendations made by the Evaluator as part of the 2023 SEM evaluation.

Section	Recommendations
Executive Summary	Recommendation #1: Consider including plant-level KPIs and their progression since program inception in participant reporting. This addition could benefit participants and be used to better advertise the success of SEM.
Executive Summary	Recommendation #2: Track the number of projects implemented by SEM participants and the resulting savings from capital projects incented in BER or Custom.
Executive Summary	Recommendation #3: Better communicate the value of energy management to both participants and non-participants, including its potential for decarbonization. Getting participants to value energy management might be an effective solution to the two barriers that are not fully addressed by SEM. An angle that could be used to promote strategic energy management is its usefulness in achieving decarbonization targets (even in facilities that are fully supplied by electricity); many participants indicated that this was an objective for their organization or that they expected it would become one soon due to market pressure. The value of energy management could also be communicated by sharing success stories about current participants to prospective participants. Current participants are likely to contribute to this communication effort since they are highly satisfied with the services offered by SEM. Compiling improvements through energy performance indicators over multiple years of SEM engagement would also enable making a compelling case for energy management as a way to increase competitiveness.



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com





EfficiencyOne

DIRECT INSTALLATION PROGRAM

Final Report

2023 DSM EVALUATION

March 14, 2024

In collaboration with:



ABBREVIATIONS

BNI	Business, non-profit and institutional
CDI	Commercial Direct Install
CIS	Customer Information System
DIY	Do-it-yourself
DSM	Demand-side management
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
EUL	Effective useful life
GHG	Greenhouse gas
HSPF	Heating seasonal performance factor
HVAC	Heating, ventilation and air conditioning
LED	Light emitting diode
NPS	Net Promoter Score
NS Power	Nova Scotia Power
NSUARB	Nova Scotia Utility and Review Board
NTGR	Net-to-gross ratio
SBES	Small Business Energy Solutions
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.
Available Demand Response Capacity	The capacity which is available to NSP to reduce system peak demand. This capacity is calculated based on the first two hours of all events called between December and February, excluding weekends and holidays. If an event is shorter than two hours, only the first hour is used to measure the available DR capacity. Available DR capacity is evaluated on a per-participant basis, based on the average demand reduction observed for each event that the participant was scheduled to participate in. E1's total available DR capacity is the sum of each participant's available DR capacity.
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 base consumption.
Bias	Systematic deviations of measurements from the true value.
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.
Confidence interval	The estimated range of values that is likely to include unknown population parameters.
Demand response	Demand response measures generate savings in the form of available capacity or load reduction in response to events called by the electric utility (Nova Scotia Power) to reduce the load at strategic moments. These events can be called at any time and for any duration, although they are usually called for one to three hours during peak periods.
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 home 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 a home is through modelled home 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 equipment life and 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 CO2	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, gas 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 ratios, etc.) validated or measured during the evaluation process. Unless otherwise specified, evaluated savings are 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 a building (such as heating and cooling) due to the installation of an energy efficiency measure.
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 and 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 a program on the market (such as increased product availability, practices, and prices) that extends beyond changing program participant behaviours. 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. For industrial participants on an interruptible rate, peak demand savings may include savings on non-firm loads, i.e. loads that may be interrupted when Nova Scotia Power's 10-minute reserve is low.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	An 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.
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.
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 net-to-gross ratios. 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. A 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).



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EXECUTIVE SUMMARY

This report presents the 2023 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 2023 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 types of evaluation conducted and the corresponding methodology.

Table 1: Summary of 2023 Direct Installation Program Evaluation

Program Component	Evaluation Type			Methodology
	Impact	Process	Market	
Small Business Energy Solutions	Comprehensive ¹	X	-	› EOne staff interviews: Energy auditor, business development manager, on-site energy manager › Participant survey › Dropped out participant interviews › Contractor interviews › Tracking sheet audit › Site visits and desk reviews › Effective useful life (EUL) update › Calculations using evaluation results › Peak demand savings review for heat pumps › Avoided GHG emission reduction calculations

Program Performance

Table 2 presents the participation levels, net-to-gross ratios (NTGRs), evaluated gross and net savings at the generator, annual GHG emission reductions, as well effective useful life (EUL) values for the Direct Installation program.

¹ With the exception of the Commercial Direct Install (CDI) pilot because it underwent a condensed impact evaluation.

Table 2: Overall 2023 Direct Installation Participation and Evaluated Savings²

	Participation Level		Gross Savings		NTGR*	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
Energy Savings	467	Projects	9.180	GWh	0.81	7.451	GWh
Lifetime Energy Savings			140.929	GWh	0.81	113.821	GWh
Peak Demand Savings			1.840	MW	0.81	1.491	MW
Annual GHG Emission Reductions			5,066	tonnes of CO2 eq	0.81	4,112	Tonnes of CO2 eq
EUL			15.4	years		15.3	Years
* The average NTGR values presented in this table correspond to the ratios of net savings to gross savings for SBES.							

Direct Installation was aimed at achieving 11.897 GWh in net electrical energy savings and 2.070 MW in net peak demand savings at the generator for 2023. The program did not meet planned net energy and peak demand savings targets.

SBES Findings and Recommendations

This subsection presents the key findings from the SBES evaluation.

2023 SBES-Finding: Net electrical energy and peak demand savings did not meet targets for 2023.

2023 SBES-Finding: Participation in SBES decreased in 2023, while energy savings per project remained flat compared to 2022.

2023 SBES-Finding: Following the SBES desk reviews and site visits, the Evaluator made minor adjustments to the energy and peak demand savings for all measure categories.

2023 SBES Recommendation 1: Consider improvements to the Customer Information System (CIS), namely by reviewing how missing entries are treated and extracting more information from the CIS to allow validating automated calculations.

2023 SBES-Finding: The free-ridership level for DIY increased by 5% in 2023 mainly due to an increase in free-ridership among lighting projects.

2023 SBES-Finding: Overall participant satisfaction is high and in the same range as recent years.

2023 SBES-Finding: Overdue projects may still be in progress.

2023 SBES Recommendation 2: Consider implementing communication strategies for participants who are approaching their project expiration date.

2023 SBES-Finding: Stakeholders experience dissatisfaction with processing times.

2023 SBES-Finding: Overall competing projects or high demand for construction services were not significant barriers to completing energy efficiency projects under SBES.

² The results presented in this table include savings for SBES and the CDI pilot.

Program Tracked and Evaluated Savings

Table 3 below compares EOne tracked energy and peak demand savings compared to evaluated savings at the generator. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings. Furthermore, the NTGRs are also presented and 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 other sections.

Table 3: Comparison of 2023 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	8.915	GWh	0.86	7.629	GWh	98%
Evaluation Results	9.180	GWh	0.81	7.451	GWh	
Peak Demand Savings						
Tracked Savings by EOne	1.825	MW	0.85	1.559	MW	96%
Evaluation Results	1.840	MW	0.81	1.491	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 demand-side management (DSM) for Nova Scotians. EOne provides energy efficiency, demand response and carbon mitigation services through the Efficiency Nova Scotia (ENS) franchise. Regulatory oversight is provided by the Nova Scotia Utility and Review Board (NSUARB). EOne receives funding for its electricity 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 ENS franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2023 DSM program portfolio.

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 for 2023. 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 4: Type of Evaluation Conducted for SBES, 2023

Program	Program Component	2023		
		Process	Market	Impact
Direct Installation	SBES	X	-	Comprehensive

For each program, the Evaluator prepared a DSM evaluation report presenting key findings, electrical first-year and lifetime energy savings, peak demand savings, and avoided greenhouse gas (GHG) emissions.⁴

⁴ Unless specified otherwise, energy savings refer to first-year energy savings rather than lifetime energy savings throughout 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 in electricity annually. Businesses with electricity consumption higher than this limit are directed toward the EOne Custom or Business Energy Rebates program components. SBES offers on-bill financing for electric-only businesses.

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; since the spring of 2023, the auditor is an EOne staff rather than an external contractor. The Audit path is intended for participants who request assistance identifying potential energy savings measures for implementation. The DIY path does not include an energy audit and is intended for participants who have identified one or more energy saving measures that they wish to implement.

Since the last quarter of 2020, SBES incentive amounts have been increased. 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 for project completion was extended to 120 days.

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 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 1 and Figure 2 below illustrate the key steps of the participation process for the Audit and DIY paths respectively.

Figure 1: 2023 Audit Path Participation Process

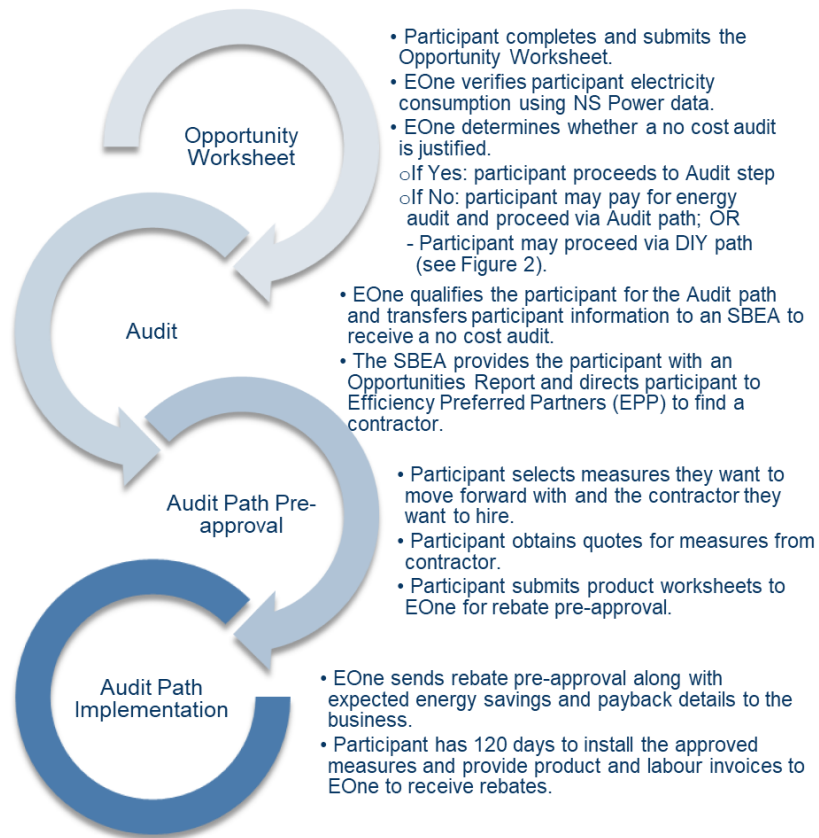
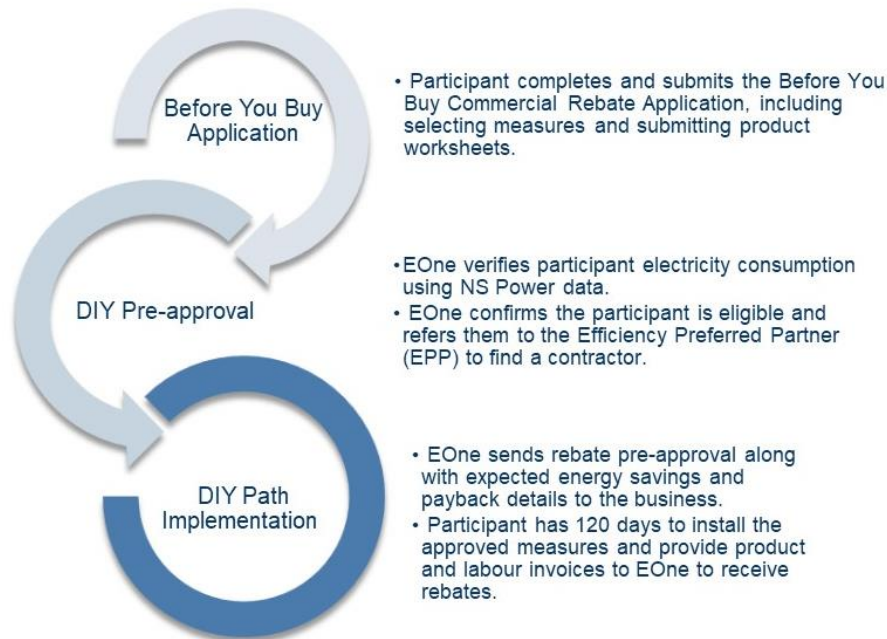


Figure 2: 2023 DIY Path Participation Process



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 launched the Commercial Direct Install (CDI) pilot. The pilot provides small businesses with free-of-charge direct installations of energy efficient products. EOne indicated that CDI was still in the pilot stage in 2023.

SBES was aimed at achieving net electrical energy savings of 11.897 GWh and net peak demand savings of 2.070 MW at the generator in 2023.

1.2 Follow-up on Past Evaluation Report Recommendations

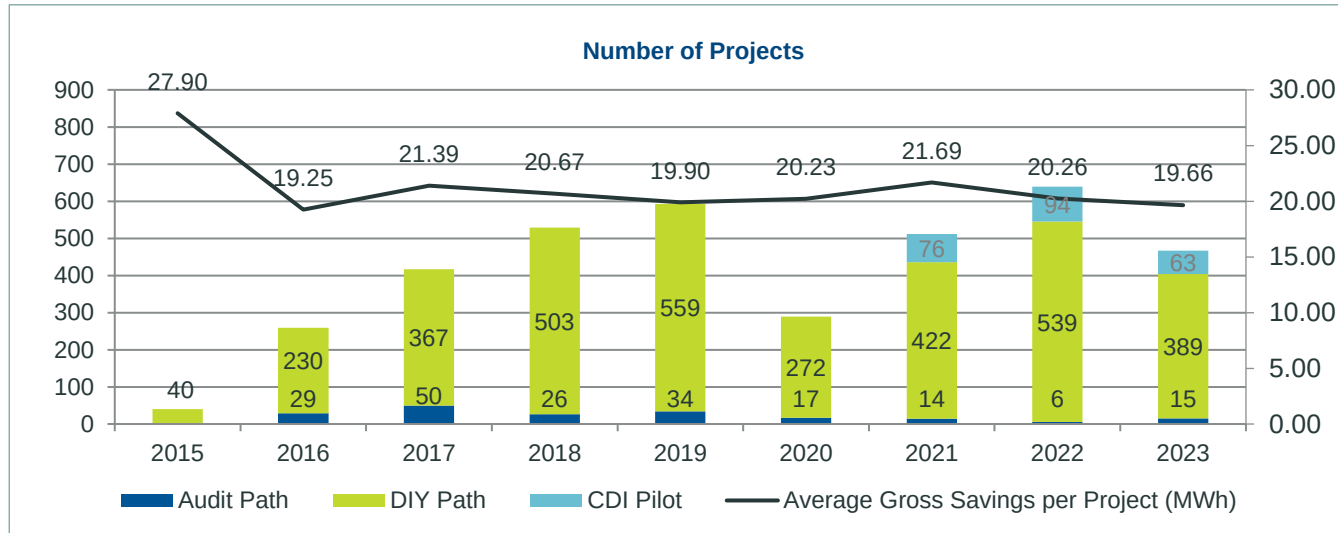
No major past recommendations remained unimplemented for SBES.

1.3 Participation History

In 2023, SBES rebated a total of 38,797 units: 477 through the Audit path and 38,320 through the DIY path.

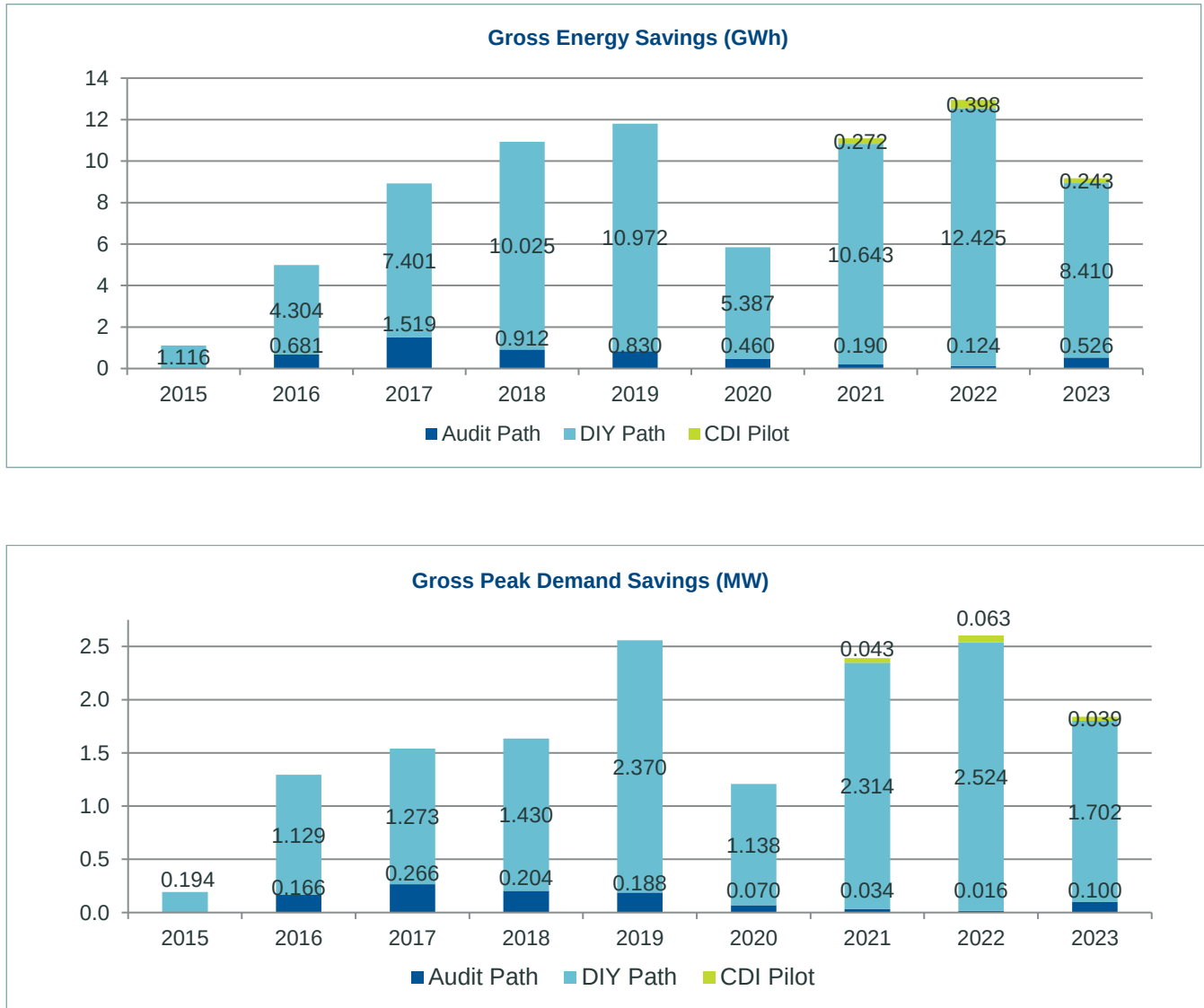
As presented in Figure 3 below, SBES participation included 467 projects in 2023, which represented a 27% decrease compared to 2022. A decrease was observed in DIY path participants (28%) as well as in Commercial Direct Install (CDI) pilot participation (33%). The number of Audit projects remained low with 15 projects in 2023, which was nine more than in 2022 (150% increase). DIY projects continued to be the most popular, representing 83% of all projects with 389 projects. Gross energy savings per project have remained relatively stable since 2016.

Figure 3: Overview of SBES Participation, 2015-2023



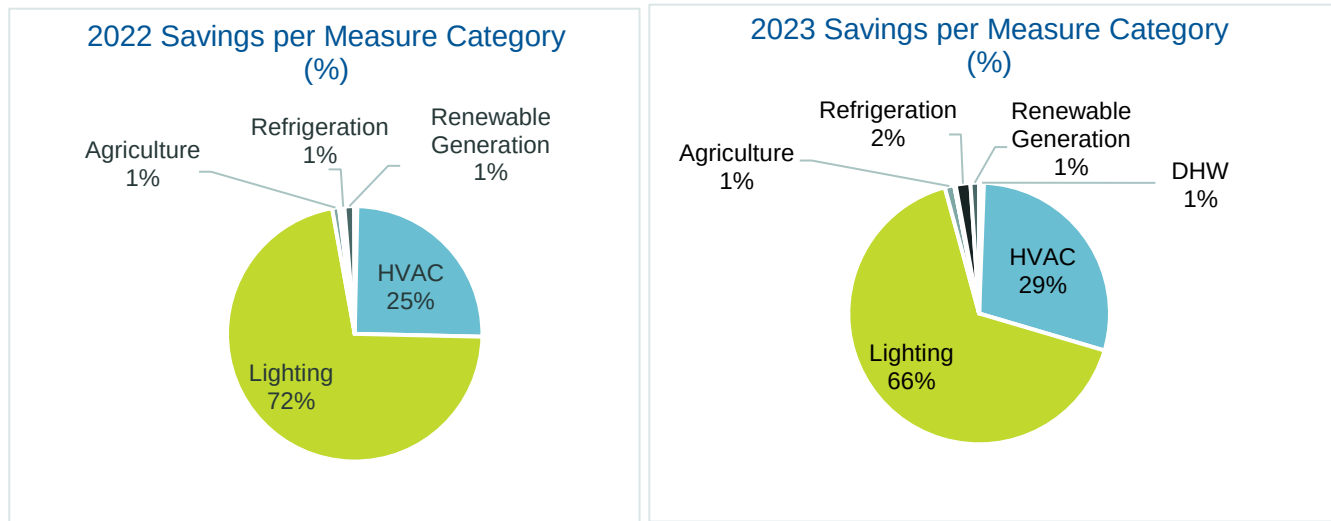
The decrease in participation is reflected in gross energy and peak demand savings as illustrated in Figure 4 below. Gross energy and peak demand savings were both 29% lower in 2023 compared to 2022.

Figure 4: Evolution of SBES Gross Savings, 2015-2023



As presented in Figure 5 below, lighting represented a slightly smaller proportion of total program energy savings in 2023 than in 2022, while HVAC represented a slightly larger share.

Figure 5: 2022-2023 Energy Savings per Measure Category



2 SBES Evaluation Approach

The 2023 SBES evaluation consisted of a comprehensive impact evaluation and a process evaluation. The evaluation for the Commercial Direct Install (CDI) pilot was a condensed evaluation as it was evaluated in a previous year. The main objectives of the 2023 SBES evaluation were as follows:

- › Collect information on participant, partner, and staff perspectives
- › Calculate gross and net SBES results, namely electrical first-year and lifetime energy savings, peak demand savings, as well as avoided GHG emissions

The Evaluator identified key research questions aimed at achieving the above objectives. Table 5 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 5: 2023 SBES Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Collect information on participant, partner, and staff perspectives	› What is the level of satisfaction with the service among participants and contractors? › What barriers or competing priorities do contractors face, and how do they impact participant success and project completion times? › How could EOne increase the value to contractors of promoting and executing projects with SBES support? › What works well and what are the key challenges for the service? › How could EOne improve the program component?	› EOne staff interviews: Energy auditor, business development manager, on-site energy manager › Participant survey › Dropped out participant interviews › Contractor interviews
Calculate gross results	› Are the gross savings calculated for a sample of projects consistent with both EOne savings calculation methods and the measures observed on site? › 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 › Desk reviews with site visits › Effective useful life (EUL) update › Peak demand savings review for heat pumps › Calculations using evaluation results
Calculate net results	› What is the free-ridership level for 2023? › What is the spillover level for 2023? › 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?	› Participant survey › Site visits › Calculations using evaluation results › Avoided GHG emission reduction calculations

EOne Staff Interviews

Econoler began the SBES process evaluation by interviewing EOne staff, namely the in-house energy auditor, a business development manager, and an on-site energy manager. The questionnaire used for these staff interviews is presented in Appendix I.



Participant Survey

In November 2023, Narrative Research conducted a telephone survey with a total of 46 SBES participants. The average length of the survey was 15.4 minutes. The questionnaire used is presented in Appendix II and complete survey results are outlined in Appendix III. Drawing a random sample of 46 from a population of 298 yields a margin of error of 11.4% at a 90% confidence level. The margin of error is slightly higher than the targeted $\pm 10\%$ due to the small population size; a sufficient sample size was not achieved given the limited response rate. It is therefore possible that quantitative results are slightly different than those that would be obtained from a full population, although the Evaluator found it acceptable for the purpose of this qualitative process evaluation.

Dropped Out or Overdue Participant Interviews

EOne provided the Evaluator with a list of participants who had been approved for SBES but had not completed any projects. The Evaluator prepared the interview sample by selecting participants who had received approval for their project at least eight months prior but had not completed it.

The Evaluator spoke with 10 participants whose projects had all been in progress for more than 150 days and were assumed to have dropped out of SBES. Of these 10, two participants had dropped out, while the other eight were in progress and had the intention of completing their energy efficiency project and submitting the completion paperwork to EOne. Of the two that chose not to complete SBES participation, one did not go through with the energy efficiency project, while the other completed the project but did not submit the SBES completion materials. The Evaluator conducted detailed interviews with five of these dropped-out or overdue participants, including the two that chose not to complete SBES processes, after screening out five other participants that had overdue projects still in progress (for a total of 10 dropped-out or overdue participants).

The interview guide is presented in Appendix IV.

Contractor Interviews

In November 2023, Narrative Research conducted nine interviews with SBES participating contractors. The guide used for these interviews is presented in Appendix V. Participating contractors were grouped by number of projects completed; accordingly, a sample was drawn by randomizing a selection of two contractors from each group.

Tracking Sheet Audit

Prior to performing the savings calculation review, the Evaluator performed an audit of the final 2023 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 VI.

Desk Reviews with Site Visits

In the fall of 2023, Equilibrium Engineering conducted 42 desk reviews of SBES projects complemented by on-site visits at participant facilities. The site visits also served to collect information on spillover levels. The sampling methodology and protocol for the desk reviews and site visits are presented in Appendix VII.



Peak Demand Savings Review for Heat Pumps

The Evaluator revised the peak demand savings for air-source heat pumps for which nil peak demand savings were tracked by EOne. The revised peak demand savings values were based on the specific characteristics of each model.

EUL Update

As part of the 2020-2023 Measure Assessment activities, the Evaluator updated 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 the first-year and lifetime gross energy and peak demand savings as per the calculation methodology presented in Section 3 below.

GHG Emission Reduction Calculation

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 Nova Scotia Power (NS Power) data.

Note on Margins 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 SBES evaluation, the Evaluator calculated the margins of error for savings adjustment ratios. 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 2023 DSM Program 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 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 SBES Process Evaluation

This section presents the results of surveys and interviews with SBES participants, dropped-out participants (businesses that applied to SBES but whose projects had not been completed after a minimum of 8 months), contractors, as well as program staff. The results are presented by topic and stakeholder group below.

3.1 Awareness and Motivation to Participate

3.1.1 Participants

The main source of participant awareness about SBES, as shown in Table 6, continues to be contractors, equipment vendors, or energy consultants (35%), while other key sources include prior experience with the program component (20%), the ENS website (20%), friends or colleagues (11%), the internet in general (11%), or through receipt of an email or electronic newsletter (9%). All other sources are mentioned by 4% or less.

Table 6: Source of Awareness About SBES

How Participants Learned about SBES	2019	2021	2023
Sample Size	50	50	46
From a contractor, equipment vendor, energy consultant	50%	24%	35%
Through experience with the program component	8%	14%	20%
From the Efficiency Nova Scotia (ENS) website	8%	4%	20%
Friends or colleagues	12%	20%	11%
Internet (general)	-	12%	11%
Received an email or electronic newsletter	4%	6%	9%
TV/radio ad	8%	4%	4%
From an ENS account representative	22%	10%	2%
Received an informational brochure	2%	-	4%
Others	10%	10%	15%
Don't know	4%	2%	2%

Table 7 summarizes who initiated the discussion about SBES. In most cases, participants initiated the conversation about SBES (57%) followed by contractors (24%).

Table 7: Who Initiated the Discussion About SBES?

Who Initiated Discussions About Participating in SBES	2017	2019	2021	2023
Sample Size	70	50	50	46
You/your business initiated it	47%	26%	44%	57%
Your contractor initiated it	29%	32%	28%	24%
The idea arose in discussion between your business and your contractor	17%	20%	16%	11%
Someone from ENS suggested the program component	6%	12%	6%	7%
Others	-	6%	4%	2%
Don't know	1%	4%	2%	-

Table 8 summarizes the motivation behind survey respondents' reason to participate. The primary reason participants provided for choosing to participate in SBES was to reduce energy costs (35%) followed by accessing rebates (24%) and becoming more energy efficient (20%). Certain participants indicated that they chose to participate in SBES after already planning to upgrade their equipment (17%).

Table 8: Motivation to Participate in SBES

Main Reason for Participating in SBES	2019	2021	2023
Sample Size	50	50	46
To reduce energy costs*	60%	32%	35%
To receive rebates	4%	10%	24%
To upgrade measures/be more efficient	-	22%	20%
Already planning to do upgrades	8%	-	17%
To learn more about energy efficiency opportunities by obtaining an energy audit	-	-	2%
To save energy	22%	26%	-
To be more environmentally friendly	-	6%	-
Others	4%	4%	2%
Don't know/refused	2%	-	-

*In 2023, this response option was changed from "To save money/reduce energy bill", which was used in 2021 and 2022.

Among DIY participants, three in 10 (31%) did not know that an audit option was available, while the remainder was aware the audit was available but did not choose this option for various reasons. One quarter of those participants (24%) knew the audit was an option but thought their project did not require it. One fifth (20%) had conducted an audit previously, separate from their participation in SBES, while just over one in 10 (13%) knew about the audit option but was not interested.

3.1.2 Dropped-out or Overdue Participants

It is important to note that, among ten participants considered by EOne as having dropped out of SBES because their projects were not complete after at least eight months, eight indicated they were still in the process of completing their project or preparing their completion documentation. For this reason, these participants are herein referred to as dropped-out or overdue participants.



Although 10 dropped-out or overdue participants were originally contacted for interviews, five of those were screened out in the initial stage of the interview when it was learned that their projects were in progress. Of the remaining five dropped-out or overdue participants, two chose not to complete the SBES process. In one of those cases, participation was ended before the work started because the proposed equipment did not meet the participant's expectations. In the other instance, the project was discontinued before construction began because the cost-benefit analysis did not meet the participant's investment criteria even with the incentives.

There are varied sources of SBES awareness among dropped-out or overdue participants, including previous experience with SBES or another ENS program (2), an ENS representative (1), word of mouth from friends or colleagues (1), and a local Member of the Legislative Assembly (1).

3.1.3 Contractor Perspectives

Contractors regard SBES as an important resource for helping small business clients save money on energy efficiency projects and a sales tool for engaging with small business clients.

All nine interviewed contractors mentioned being motivated to help their customers participate in SBES so the latter can save money through either incentives or energy cost savings. Some contractors also mentioned SBES to customers because it helps them generate business they otherwise might not have.

Regarding how they promote SBES to their clients, most contractors said they typically discuss EOne programs with their customers during initial sales interactions (six mentions). One contractor mentioned promoting SBES through occasional media buys and on their website. Two contractors indicated that they do not proactively promote EOne programs to their customers, but some customers approach them and are already aware of the program.

Most contractors indicate that clients rarely ask them about SBES before the contractor brings it up (six mentions). One contractor noted that all their customers seem to already know about SBES, while two were unsure given they were not the only person who handles sale interactions. This result contrasts with participant feedback indicating that more than half of participants initiated the discussion about SBES. These findings may point to generally high awareness on the part of both participants and contractors.

Although many customers were unaware of SBES until mentioned by the contractor, most eligible businesses found it to be a good fit and chose to participate.

3.2 Barriers to Participation

3.2.1 Participants

Participants were asked to rate the extent to which certain factors posed barriers to installing energy efficiency upgrades in their businesses. As outlined in Table 9 below, financial challenges and lack of funds were the most significant barriers for participants. These were followed by time constraints or competing priorities, which is linked to other feedback that long application processing times impacted their planning and financing processes (see Subsections 3.2.2 and 3.2.3). Participants also noted the need for information or technical support to get a project idea off the ground and the availability of qualified contractors to complete upgrade or renovation projects. Concerns that rebates are not available or that upgrades will not work as well as advertised were relatively low, suggesting these were minor barriers. Compared to previous years, financial challenges and time constraints were barriers that increased in importance in 2023.

Table 9 presents participant responses regarding barriers to implementing measures through SBES on a scale of 1 to 10, where 1 means "Not a barrier" and 10 means "A significant barrier".

Table 9: Barriers to Participation in SBES

Barriers to Measure Implementation	2017		2019		2021		2023	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Financial challenges, even after rebate, such as lack of funds, taking too long to recoup investments, etc.	68	5.3	50	5.1	49	4.4	46	6.0
Time constraints or competing priorities for your business**	68	3.4	49	4.4	49	3.9	45	5.3
Need for information or technical support to get a project idea off the ground***	-	-	-	-	-	-	46	5.1
Availability of qualified contractors to complete upgrade or renovation projects***	-	-	-	-	-	-	46	5.0
Concern that rebates are not available or that upgrades will not work as well as advertised***	-	-	-	-	-	-	31	3.2
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	-	-
Don't know/refused excluded from calculations *Wording change in 2021 **Wording change in 2023 ***New question added ~Question not asked in 2023								

3.2.2 Dropped-out or Overdue Participants

The barriers to participation outlined above were echoed by this group, the dropped-out or overdue participants identified costs, timelines, contractor availability, and supply chain issues as barriers to participation.

Three participants identified project costs as the most important barrier to completing energy efficiency projects. Among these, one participant identified the additional upgrade costs necessary to support energy efficiency upgrades while two others identified higher contractor costs as the issue.

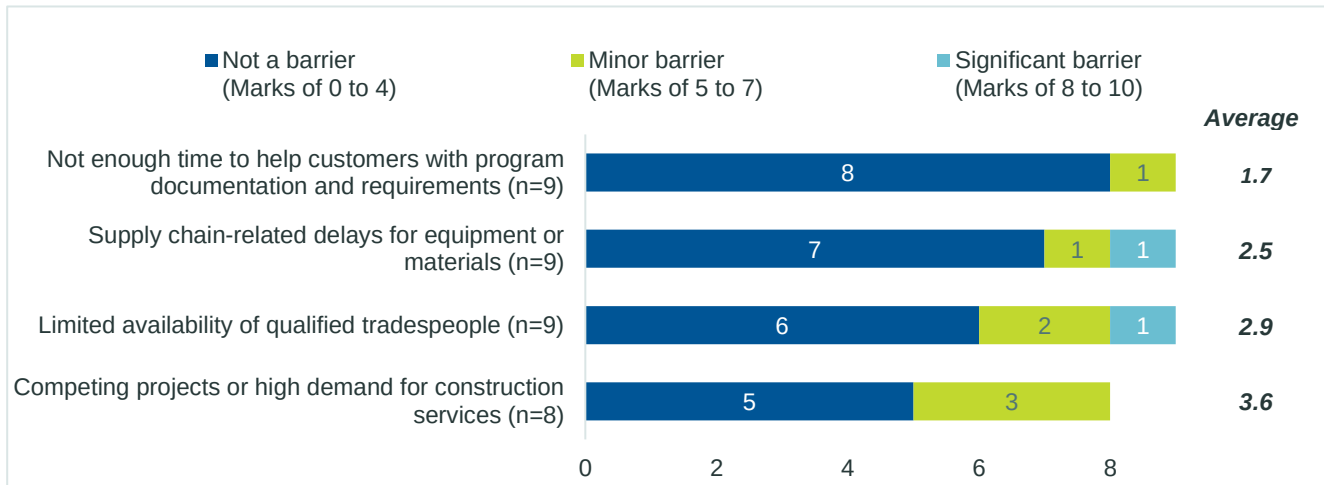
Four dropped-out or overdue participants identified program component timelines as a barrier to completing their project. Two of these said that longer-than-expected application processing times had impacted their project schedules by creating issues with securing financing and ordering materials. Two more dropped-out participants identified the time constraints of the program to implement their project as a barrier to completion.

Three out of five participants who had engaged contractors did not experience any issues regarding work quality. Two reported issues with contractor availability to complete their project, on one occasion because the contractor did not prioritize the work. One participant identified short and minor delays due to supply issues.

3.2.3 Contractor Perspectives

As presented in Figure 6 below, contractors did not consider competing projects or high demand for construction services to be a barrier preventing them from completing more energy efficiency projects under SBES. Similarly, contractors claimed that their ability to serve their SBES participant clients was not significantly impacted by issues such as the limited number of qualified tradespeople, supply chain-related delays for equipment or materials, and not having enough time to help customers with SBES documentation and requirements. None of these factors is considered as impacting client participation in SBES.

Figure 6: Barriers to Project Completion



The equipment supply chain-related delays were not considered to have a major impact on clients that participate in SBES other than slowing down upgrade completions. One contractor mentioned that one of the projects needed an extended timeline from SBES given that the pre-approved equipment was no longer in stock and that a new piece needed to be ordered. Similarly, the limited number of qualified tradespeople did slow down the completion of upgrades, albeit with no significant impact on finishing the SBES projects within time limits. Challenges related to competing projects or high demand for construction services were seen as impacting contractors more than SBES participants. Likewise, a lack of time to help customers with program component paperwork and requirements was not seen as causing clients issues in SBES participation.

In addition to the barriers presented Figure 6 above, contractors were asked what they feel are the largest barriers preventing small businesses from completing energy efficiency projects. Nearly half of interviewed contractors mentioned up-front costs. Other mentions included old buildings in need of repair and risks that energy cost savings would not be realized (one mention each). Contractors indicated that, in many cases, project costs are well above the incentive received and that the incentive is only received upon project completion, which means customers need to be able to pay for the upgrades up front. Likewise, contractors identified the SBES application timeframe as a source of dissatisfaction that can impact timelines and is therefore a barrier to participation. Other less commonly cited barriers include the current state or age of buildings and lack of knowledge about effective solutions.

3.3 Participant and Contractor Satisfaction

3.3.1 Participants

As in recent years, participants were very satisfied with SBES overall and with most aspects of the program component. Results, where comparable, were generally on par with the preceding year. The details are presented in Table 10 and Table 11 below.

Table 10: Satisfaction with SBES Overall

Overall Satisfaction with SBES	2017	2019	2021	2023
Sample Size	70	50	50	46
Mean	8.8	9.2	9.1	8.8
Don't know/refused excluded from calculations				

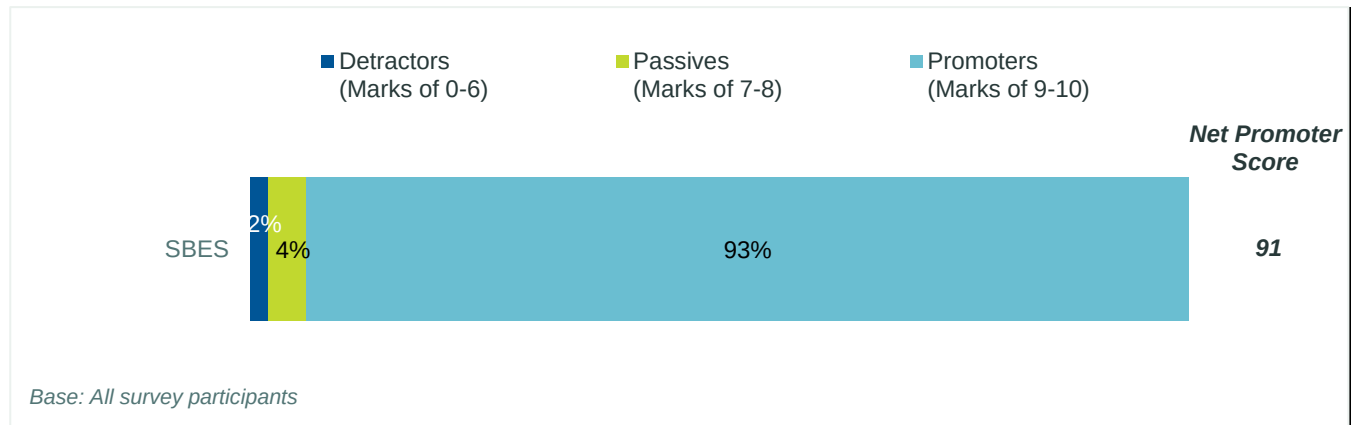
Table 11: Satisfaction with Aspects of SBES

Satisfaction with Aspects of SBES	2017		2019		2021		2023■	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Mean (0 = "Not at all satisfied", 10 = "Completely satisfied")								
AUDIT:* <i>The usefulness of the audit report</i>	20	8.4	7	8.0	1	10.0	1	10.0
FINANCING: <i>The program financing</i>	-	-	-	-	19	9.4	12	9.8
<i>The quality of the work performed by the contractor</i>	-	-	50	9.4	48	9.5	45	9.4
REBATE: <i>The program rebate</i>	-	-	-	-	47	9.1	40	9.3
<i>The quality and performance of the equipment that was installed**</i>	70	9.4	50	9.1	47	9.3	44	9.3
<i>The ease of finding a contractor~</i>	65	8.8	41	9.2	47	9.2	-	-
<i>The availability of the contractor you selected to complete the project</i>	-	-	-	-	-	-	44	9.2
<i>The ease of obtaining contractor bids</i>	-	-	-	-	-	-	36	8.1
<i>The program forms and documents</i>	-	-	42	9.1	40	8.8	38	8.7
<i>The time it took for the program to process the paperwork and pay your rebate</i>	-	-	-	-	-	-	41	8.2
Don't know/Not applicable/Refused excluded from calculations								
*Asked to participants who received audits only								
**Wording change in 2023								
~This statement in 2023 was divided into "The availability of the contractor you selected to complete the project" and "The ease of obtaining contractor bids".								
■In 2023, the scale changed from 1 = "Not at all satisfied", 10 = "Completely satisfied" to 0 = "Not at all satisfied", 10 = "Completely satisfied".								

Among the small number (n=5) of participants who expressed dissatisfaction with one or more aspects of SBES, reasons included the process/program taking too long (1 mention), expecting to receive a rebate for certain equipment installed but learning it did not qualify (one mention), and a desire for a higher incentive (one mention).

The Net Promoter Score (NPS) is a tool that measures customer experience and overall perceptions of a brand or program. It is calculated by subtracting the “Promoters” (who provide a score of 9 or 10 and who will refer others and fuel growth), from the “Detractors” (who provide a score of 0 to 6 and who can impede growth through negative word of mouth). The NPS can range from a maximum score of 100 (if everyone is a “Promoter”) to a minimum score of -100 (if everyone is a “Detractor”). The higher the NPS score, the better. Figure 7 below illustrates the distribution of the NPS. The overall NPS for SBES was 91 for 2023, a very strong result. This score indicates that most SBES participants are Promoters (93%), with very few Detractors (2%).

Figure 7: Likelihood to Recommend SBES



When asked for ideas to improve the program component, nearly two thirds of participants suggested EOne could improve SBES by offering project financing or helping with costs beyond current incentives. This feedback suggests there may be an opportunity for EOne to improve awareness about the on-bill financing option currently available to SBES participants. Another suggestion put forth by a smaller percentage is to offer more measures eligible for rebates (15%), up from 2% in 2021. Table 12 below summarizes participant suggestions to improve SBES.

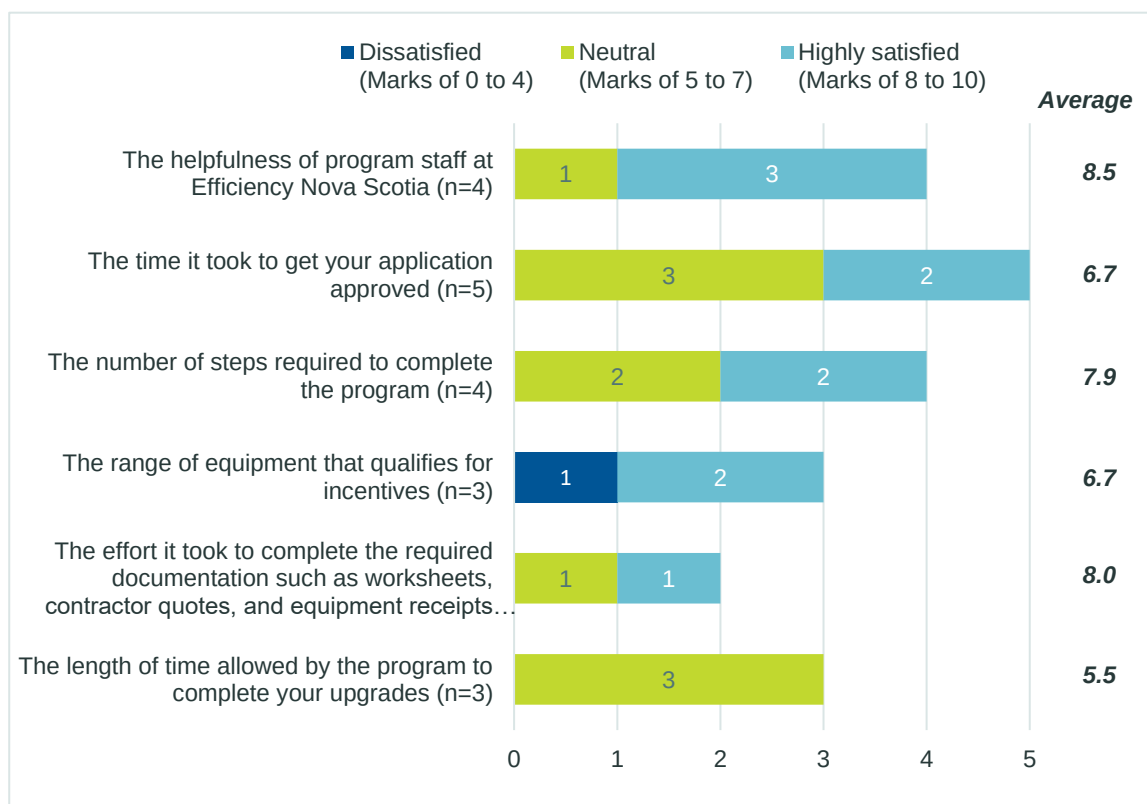
Table 12: Participant Suggestions to Improve SBES

Participant Recommendations to Improve SBES	2017	2019	2021	2023
Sample Size	70	50	50	46
Offer financing/help with cost	1%	-	4%	63%
Offer more measures eligible for rebates	4%	10%	2%	15%
Increase rebates	9%	8%	6%	9%
Better marketing/awareness	11%	4%	2%	7%
Simplify the program/less paperwork	6%	4%	2%	7%
Monitor the status of the applications/clarity on the delays to receive the rebates	-	-	-	7%
Speed up the process/receive rebate more quickly	6%	2%	4%	-
Improve communication	10%	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%	7%
No recommendations	64%	66%	62%	7%
Don't know*	-	-	-	2%
Multiple responses				
*Wording change in 2023				

3.3.2 Dropped-out or Overdue Participants

Although not all dropped-out or overdue participants were able to speak to every stage of the SBES process, satisfaction was highest with the helpfulness of EOne program staff. Satisfaction is more moderate with the range of equipment that qualifies for incentives and the time it took to get the application approved. Meanwhile, dropped-out participants were least satisfied with the length of time allowed by SBES to complete upgrades. These outcomes are detailed in Figure 8 below.

Figure 8: Satisfaction with SBES Processes



None of the five dropped-out or overdue participants had any questions that were not resolved by their contractor or EOne staff during the process.

All five dropped-out participants faced challenges with or barriers to completing SBES. Some faced supply chain issues and labour delays or shortages, with one dropped-out participant noting that this impacted participation given the limited timeline prescribed by SBES to complete upgrades. One dropped-out participant noted that cost hindered the completion of their upgrades, another one mentioned that upgrades were restricted to measures eligible under SBES, while another one was affected by contractor delays. Despite these challenges, none of the dropped-out participants expected to receive SBES support that they did not get.

When asked if SBES could have done anything differently to encourage them to install energy efficient upgrades, dropped-out participants provided a variety of comments. The two participants with projects still in progress noted there is nothing EOne could have done differently. The other three participants respectively mentioned that EOne could have been more forthcoming about the range of rebates that were offered, expanded the eligibility criteria, and helped small businesses secure funds to carry out their projects.

3.3.3 Contractors

Contractors were generally satisfied with SBES. Satisfaction was highest with project documentation requirements (8.4), while it was lower with the application and rebate amounts. In contrast, contractors were dissatisfied with the time for projects to be approved (4.3), which can take six weeks on average and up to 20 weeks in extreme instances. For those dissatisfied, rebate amounts being too low and not clearly understanding how rebates are calculated were reported as other common sources of dissatisfaction with SBES.

Figure 9: Satisfaction with SBES Program Elements

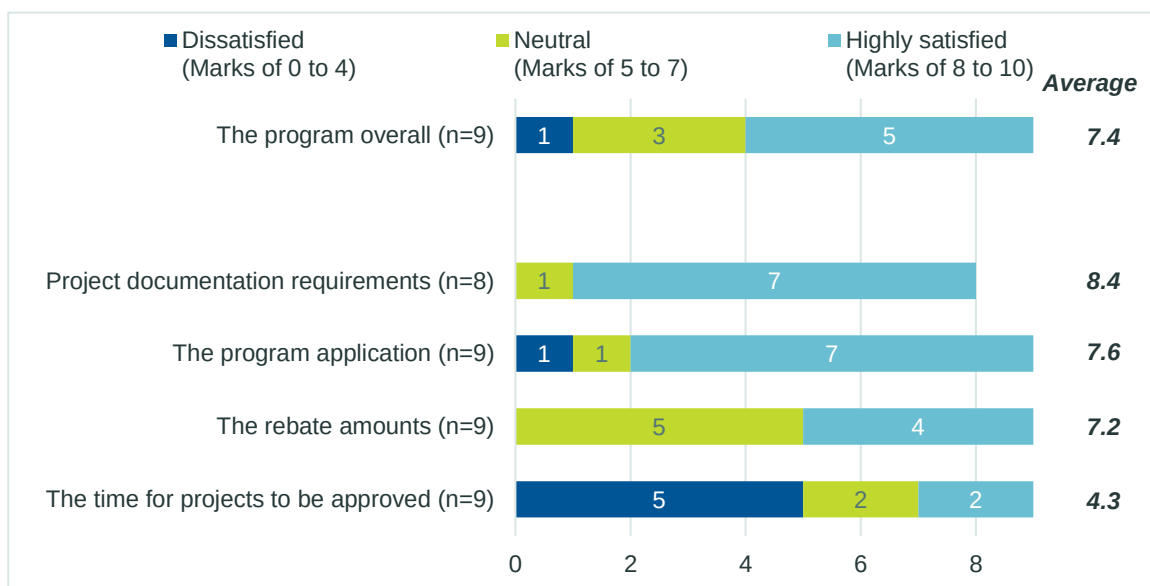


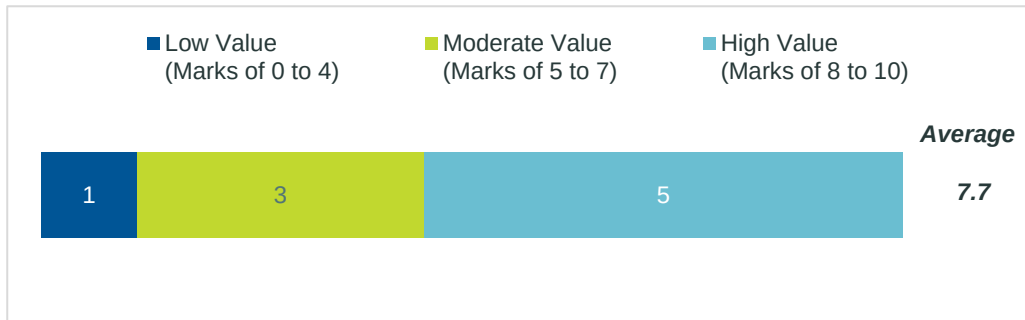
Table 13: Reasons for Dissatisfaction

Factor Assessed		Reasons for Dissatisfaction/What Could Be Improved (#)	
n=7	The time for projects to be approved	›	Time required for pre-approval is too long/pre-approval generally takes up to six weeks and as much as 20 weeks (7)
		›	Losing business because of long processing times (1)
n=5	The rebate amounts	›	Inability to provide participants with an estimate of the rebate they will receive before pre-approval or before the upgrades are completed/rebate amounts vary across participants without clear explanation (2)
		›	Low rebate amounts (general mention) (2)
		›	Some participants receive lower rebate than they had anticipated prior to the work being completed (1)
n=4	The program overall	›	Limited measures included in SBES (1)
		›	Long application processing/approval time (3)
		›	Low rebate amounts (1)
		›	Different programs confusing to navigate for clients (1)
n=2	The program application	›	The same equipment needs to be reported per room if each measure location room is heated by a different source (i.e. cumbersome layout of application) (1)
		›	Displeased with the process (general mention) (1)
n=1	Project documentation requirements	›	Too much documentation required/responsibility of the contractor to show the work was not incentivized through another program/EOne asks for invoices for upgrades with client copied on these communications (breach of confidentiality) (1)

Contractors indicated that SBES is valuable for their businesses, with a score of 7.7 out of 10 (where 0 means “Not valuable” and 10 means “Extremely valuable”) as presented in Figure 10 below. SBES increases business for contractors by promoting the completion of deep retrofit projects among their clients.

SBES brings value by contributing to increased business for contractors. Two contractors noted that SBES encourages small businesses to consider more holistic or deeper retrofit projects than they otherwise would. Suggestions to make SBES even more valuable include to ensure adequate staffing, facilitate opportunities for contractors to network with others in the trade, offer special promotions, increase program marketing, shorten pre-approval times, broaden program eligibility, explain how the rebate is calculated, and ensure SBES is aligned with the provincial plan for energy solutions (one mention each).

Figure 10: SBES Value for Participating Contractors





4 SBES Impact Evaluation

The objectives of the 2023 SBES impact evaluation were 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 results obtained from the tracking sheet audit are presented in Appendix VI. 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.⁷ For each SBES Audit or DIY project, EOne calculates gross savings using the standard equations defined in the CIRx Screening Tool⁸ or the custom calculations performed by energy auditors or EOne program component staff. For the CDI pilot, savings are based on unitary savings values.

4.2.1 Summary of Adjustments

As part of the 2023 evaluation, the Evaluator conducted desk reviews complemented by on-site visits (n=42) to establish adjustment ratios and determine evaluated savings.

In total, 25 lighting projects, 12 HVAC projects, and five projects from other measure categories were reviewed. The detailed desk review sampling methodology and protocol are detailed in Appendix VII.

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 average adjustment ratios per measure category. The adjustment ratios correspond to the evaluated savings divided by the tracked savings for all sampled projects within a measure category. These adjustment ratios were extrapolated to all energy savings for measure categories whose margins of error were below the targets of 10% at a confidence level of 90% (by multiplying the adjustment ratio by the tracked savings of the given measure category); this was the case for the lighting and HVAC categories.

⁷ 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).

⁸ The CIRx Screening Tool is a tool provided by EOne presenting the savings calculation methodologies, assumptions, and calculation parameters for measures implemented under SBES.



For the lighting measure category, the main adjustments were made to lighting usage hours determined through the site visits. The interactive effects factors were the root of most other adjustments made for lighting projects. The “IEpd” and “IE” values listed in the tracking sheet were often inconsistent. The corrections mainly consisted of adjusting the interactive effects factors based on the values per building type and heating fuel. Similar issues were found for ballast factors that sometimes included values that were inconsistent with the fixture types described in the tracking sheet. Both the interactive and ballast factor inconsistencies seemed to be due to data entry errors and how the data management system, the Customer Information System (CIS), addresses them. These inconsistencies were difficult to identify because the CIS currently does not provide good visibility on what is entered and what is automatically calculated. Other less common adjustments were made to peak coincidence factors and installed quantities. Overall, adjustment ratios of 1.070 and 0.917 were established for lighting energy and peak demand savings respectively. There was one measure that had large peak demand savings which were increased significantly as a result of the site visit – this measure was an outlier, so it was treated as a one-time adjustment. When combined with the adjustment ratio for all other measures, it led to an overall peak demand savings adjustment of 0.932 for DIY projects.

Desk reviews for HVAC measures led to minor adjustments consisting of correcting some of the tracked capacities and other variables such as the heating seasonal performance factor (HSPF) and seasonal energy efficiency ratio (SEER). Overall, adjustments ratios of 0.980 and 1.009 were established for energy and peak demand savings respectively.

Five projects from other measure categories, namely refrigeration, agriculture, and renewable generation, were reviewed as part of the sample. Due to the low number of measures reviewed for each measure category, adjustments were applied to individual projects and not extrapolated to the entire categories. In addition, an adjustment was made to account for heat pumps as described below Table 14.

Site visit reviews for the two refrigeration projects revealed that one project was actually incomplete due to some equipment not being received on time. That project was paid out before completion due to a mistake in the application treatment process. However, since the project was completed shortly after the on-site visit and satisfactory proofs of completion were submitted to the Evaluator, no savings deductions were applied. Minor corrections to equipment specifications led to an adjustment of 0.934 for energy savings and 0.974 for peak demand savings for those refrigeration projects.

The agricultural measure required adjustments due to a different fan model installed than what was specified in the tracking sheet; therefore, energy and peak demand savings were increased by a factor of 2.54 for that project.

Significant changes were made to certain parameters of the reviewed renewable generation measure since its design/application phase was not reflected in the tracked savings; the Evaluator reduced the energy savings by 7% for that project.

Savings are calculated differently for the CDI pilot than for the two SBES paths. Therefore, the Audit and DIY path adjustment ratios are not applicable to pilot savings. Instead, the Evaluator applied the 2019 adjustment ratios from EPI since they account for tracking errors that are expected to be similar between EPI and the pilot because they are offered through the same service providers.

Table 14 summarizes the adjustment ratios for the 2023 evaluation, first from the project reviews and second, how the ratios were extrapolated to the complete 2023 project population. For measure categories to which only one-time adjustments were applied (DIY – Agriculture, DIY – Refrigeration, and DIY – Renewable Generation), the ratios applied to all savings represent the overall impact of those one-time adjustments to all savings in the category.

Table 14: 2023 SBES Gross Savings Adjustments

Path and Measure Category	Energy Savings		Peak Demand Savings	
	Adjustment Ratio	Margin of Error	Adjustment Ratio	Margin of Error
Projects Sampled in Project Reviews				
Lighting	1.070	5.3%	0.917	8.9%
HVAC	0.980	4.4%	1.009	8.6%
Agriculture	2.540	N/A	2.540	N/A
Refrigeration	0.934	N/A	0.974	N/A
Renewable Generation	0.930	N/A	-	N/A
Ratios Applied to All Savings				
Audit - Lighting	1.070	5.3%	0.917	8.9%
DIY – Lighting	1.070	4.4%	0.932	8.6%
DIY & Audit - HVAC	0.980	4.4%	1.009	8.6%
DIY – Agriculture	1.107	N/A	1.077	N/A
DIY– Refrigeration	0.987	N/A	0.993	N/A
DIY– Renewable Generation	0.930	N/A	-	N/A
All other categories in DIY & Audit	1.000	N/A	1.000	N/A
CDI Pilot – A-type LED Lamps	0.960	5%	0.960	5%
CDI Pilot – Other Products	1.000	N/A	1.000	N/A

In addition to the above adjustment ratios, the Evaluator made two other adjustments to the HVAC measure category. The Evaluator revised the peak demand savings for 21 air-source heat pumps with nil peak demand savings tracked by EOne by using specific characteristics of each model.⁹ During the review of HVAC models, 14 of the 21 heat pump models were found not to be cold climate rated or lacked available information; therefore, these were left with no peak demand savings. The Evaluator calculated peak demand savings for the seven other heat pumps based on manufacturer rated characteristics adjusted to cold climate performance since they were identified to be in heat pump mode at cold temperatures.

The Evaluator also corrected the HSPF and SEER of heat pumps to correspond to the new metrics, HSPF2 and SEER2, which are required by Amendment 17 to the Energy Efficiency Regulations. To convert HSPF and SEER values, the Evaluator used the conversion factors developed by the CEE,¹⁰ which are outlined below.

Table 15: Factors for Converting SEER and HSPF to SEER2 AND HSPF2

Heat Pump Type	SEER2	HSPF2
Ducted	0.95	0.85
Non-ducted	1.00	0.90
Packaged	0.95	0.84

⁹ Heat pumps installed through SBES do not have a required minimum coefficient of performance (COP) at -15°C; therefore, the absence of such data does not mean heat pumps were not eligible.

¹⁰ Consortium for Energy Efficiency, *Converting Between Appendices M and M1*, 2023.



This change only impacted small heat pumps since large heat pumps (>65,000 Btu/hr) do not use SEER and HSPF values to estimate savings. The adjustments made to the SEER and HSPF values corresponded to additional adjustment ratios for the HVAC measure category energy savings of 0.993 in the Audit path and 0.895 in the DIY path. These energy savings adjustments are temporary – HSPF2 and SEER2 values will be tracked by EOne starting in 2024. Peak demand savings were not impacted by this change because their estimation does not rely on any of these metrics.

4.2.2 Unitary Energy and Peak Demand Savings

While savings from SBES Audit or DIY projects are established through calculations using data specific to each project, the CDI pilot relies on unitary savings values for each measure.

For the CDI pilot, the energy and peak demand unitary savings values used for the 2023 evaluation are presented alongside the underlying equations and assumptions in the 2020-2023 Measure Assessment. Those values have not been changed since the 2022 evaluation.

4.2.3 Installation Rates

While installation rates are accounted for in the adjustment ratios for SBES Audit and DIY projects, CDI pilot adjustment ratios do not encompass installation rates. For the pilot, the Evaluator assumed an installation rate of 100% since no activities aimed at establishing installation rates were conducted during the 2023 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 through the gross savings standard equation in the EOne CIRx Screening Tool. Since 2016, building-specific interactive effects factors have been taken into account for both energy and peak demand savings. In 2023, 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 corresponded to the situation observed on site. The adjustments are included in the adjustment ratios presented in Subsection 4.2.1 above.

For the CDI pilot, the Evaluator established average interactive effects factors to be applied to each measure in the 2020-2023 Measure Assessment; these have not been changed since 2022.

4.2.5 Effective Useful Life

As part of the 2020-2023 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 previous evaluations remained valid for the 2023 evaluation with the exception of lighting measures for which the baseline changes over the life of the measures were updated as part of the 2023 Measure Assessment update. The gross weighted average EUL value is equal to 15.4 years.

4.2.6 Evaluated Gross Savings

Table 16, Table 17, and Table 18 below present the evaluated total gross savings at the meter and at the generator for both SBES paths and the CDI pilot respectively. The savings at the generator were calculated by applying the appropriate line loss factor 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.¹¹

¹¹ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1. For municipal utility participants, the line loss factor of the most similar NS Power rate code was assumed.

Table 16: Evaluated 2023 SBES Gross Energy and Peak Demand Savings – Audit Path

Category of Measure	Commercial Kitchen	DHW	HVAC	Lighting	Agriculture	Total for All Categories
Energy Savings						
Tracked Gross Energy Savings Without Adjustment Ratio – at the Meter (GWh)	0.004	0.037	0.367	0.065	0.024	0.498
Adjustment Ratio on Energy Savings	1.000	1.000	0.980	1.070	1.000	-
Adjustment Ratio for HSPF2 Only	1.000	1.000	0.993	1.000	0.000	-
Overall Adjustment Ratio on Energy Savings, Including HSPF2 Adjustment	1.000	1.000	0.973	1.070	1.000	-
Gross Energy Savings – at the Meter (GWh)	0.004	0.037	0.357	0.069	0.024	0.492
Line Loss Factor	1.069	1.069	1.069	1.069	1.069	-
Gross Energy Savings – at the Generator (GWh)	0.004	0.040	0.382	0.074	0.026	0.526
Effective Useful Life (years)	11.6	14.9	16.6	14.1	15.4	-
Gross Lifetime Energy Savings – at the Generator (GWh)	0.051	0.594	6.330	1.048	0.398	8.422
Peak Demand Savings						
Tracked Gross Peak Demand Savings (MW)	0.001	0.010	0.053	0.010	0.007	0.081
Adjustment Ratio on Peak Demand Savings	1.000	1.000	1.009	0.917	1.000	-
Adjustment Ratio for Missing -15°C Data	1.000	1.000	1.183	1.000	1.000	-
Overall Adjustment Ratio on Demand Savings with COP -15°C Adjustment	1.000	1.000	1.194	0.917	1.000	-
Gross Peak Demand Savings – at the Meter (MW)	0.001	0.010	0.063	0.010	0.007	0.091
Line Loss Factor	1.096	1.096	1.096	1.096	1.096	-
Gross Peak Demand Savings – at the Generator (MW)	0.001	0.011	0.070	0.011	0.008	0.100

Table 17: Evaluated 2023 SBES Gross Energy and Peak Demand Savings – DIY Path

Category of Measure	Agriculture	Commercial Kitchen	DHW	HVAC	Lighting	Motors	Refrigeration	Renewable Generation	Total for All Categories
Energy Savings									
Tracked Gross Energy Savings Without Adjustment Ratio – at the meter (GWh)	0.066	0.005	0.002	2.350	5.097	0.015	0.153	0.096	7.785
Adjustment Ratio on Energy Savings	1.107	1.000	1.000	0.980	1.070	1.000	0.987	0.930	-
Adjustment Ratio for HSPF2 Only	1.000	1.000	1.000	0.895	1.000	1.000	1.000	1.000	-
Overall Adjustment Ratio on Energy Savings including HSPF2 Adjustment	1.107	1.000	1.000	0.878	1.070	1.000	0.987	0.930	-
Gross Energy Savings – at the Meter (GWh)	0.073	0.005	0.002	2.062	5.454	0.015	0.151	0.089	7.852
Line Loss Factor	1.071	1.071	1.071	1.071	1.071	1.071	1.071	1.071	-
Gross Energy Savings – at the Generator (GWh)	0.079	0.005	0.003	2.209	5.841	0.016	0.162	0.096	8.410
Effective Useful Life (years)	15.2	14.3	9.9	17.6	14.8	15.3	14.5	24.7	-
Gross Lifetime Energy Savings – at the Generator (GWh)	1.199	0.077	0.025	38.933	86.611	0.250	2.347	2.361	131.803
Peak Demand Savings									
Tracked Gross Peak Demand Savings (MW)	0.010	0.001	0.000	0.656	0.865	0.001	0.027	0.000	1.560
Adjustment Ratio on Peak Demand Savings	1.077	1.000	0.000	1.009	0.932	1.000	0.993	0.000	-
COP -15°C Adjustment Ratio Only	1.000	1.000	0.000	1.074	1.000	1.000	1.000	0.000	-
Overall Adjustment Ratio on Demand Savings with COP -15°C Adjustment	1.077	1.000	0.000	1.084	0.932	1.000	0.993	0.000	-
Gross Peak Demand Savings – at the Meter (MW)	0.011	0.001	0.000	0.711	0.806	0.001	0.027	0.000	1.557
Line Loss Factor	1.093	1.093	1.093	1.093	1.093	1.093	1.093	1.093	-
Gross Peak Demand Savings – at the Generator (MW)	0.012	0.001	0.000	0.777	0.8809	0.001	0.030	0.000	1.702

Table 18: Evaluated 2023 SBES Gross Energy and Peak Demand Savings – CDI Pilot

Measure Category	Lighting	Water Heating	Total for All Categories
Energy Savings			
Tracked Gross Energy Savings without Interactive Effects – at the Meter (GWh)	0.225	0.016	0.240
Adjustment Ratio on Energy Savings	0.96	1.00	-
Interactive Effects*	-4.7%	-3.2%	-
Gross Energy Savings – at the Meter (GWh)	0.207	0.015	0.222
Line Loss Factor	1.093	1.093	-
Gross Energy Savings – at the Generator (GWh)	0.227	0.016	0.243
Effective Useful Life (years)	2.4	9.9	-
Gross Lifetime Energy Savings – at the Generator (GWh)	0.541	0.163	0.704
Peak Demand Savings			
Tracked Gross Peak Demand Savings without Interactive Effects – at the Meter (MW)	0.037	0.003	0.040
Adjustment Ratio on Peak Demand Savings	0.96	1.00	-
Interactive Effects	-12.0%	-7.8%	-
Gross Peak Demand Savings – at the Meter (MW)	0.031	0.003	0.034
Line Loss Factor	1.134	1.134	-
Gross Peak Demand Savings – at the Generator (MW)	0.036	0.003	0.039
* Interactive effects for water heating measures are for information purposes only. The interactive effects vary based on participant space heating system; the values presented herein are the average interactive effects.			

Table 19 summarizes the gross energy and peak demand savings for each path, the CDI Pilot, and SBES as a whole.

Table 19: Evaluated 2023 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)	0.492	7.852	0.222	8.567
Line Loss Factor	1.069	1.071	1.093	-
Gross Energy Savings – at the Generator (GWh)	0.526	8.410	0.243	9.180
Effective Useful Life (years)	16.0	15.7	2.9	-
Gross Lifetime Energy Savings – at the Generator (GWh)	8.422	131.803	0.704	140.929
Peak Demand Savings				
Gross Peak Demand Savings – at the Meter (MW)	0.091	1.557	0.034	1.682
Line Loss Factor	1.096	1.093	1.134	-
Gross Peak Demand Savings – at the Generator (MW)	0.100	1.702	0.039	1.840

Figure 11 and Figure 12 below compare tracked gross savings to evaluated gross savings for energy and peak demand savings respectively. Evaluated gross energy savings are about 3% above tracked values, primarily due to the upward adjustments to the lighting measure category that resulted from the project review adjustment ratios. This was counterbalanced with adjustments to the HVAC measure category from project reviews as well as the adjustment to account for HSPF2. Evaluated gross peak demand savings are 1% above the tracked values again because of adjustments made to lighting measures as well as some missing peak demand savings that were added for heat pumps.

Figure 11: 2023 SBES Tracked and Evaluated Gross Energy Savings at the Generator

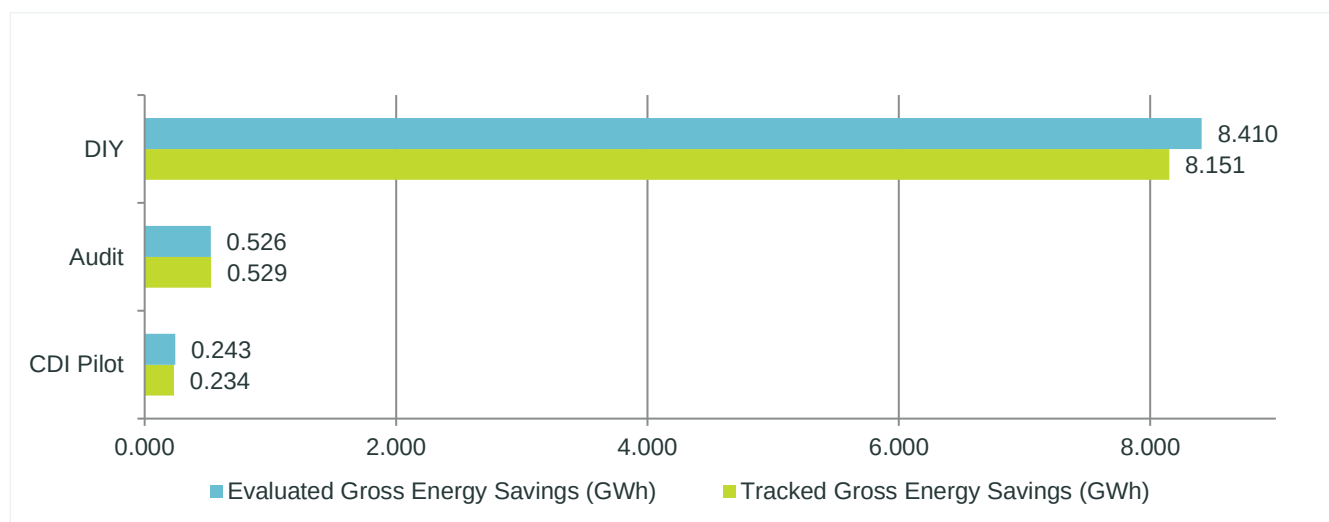
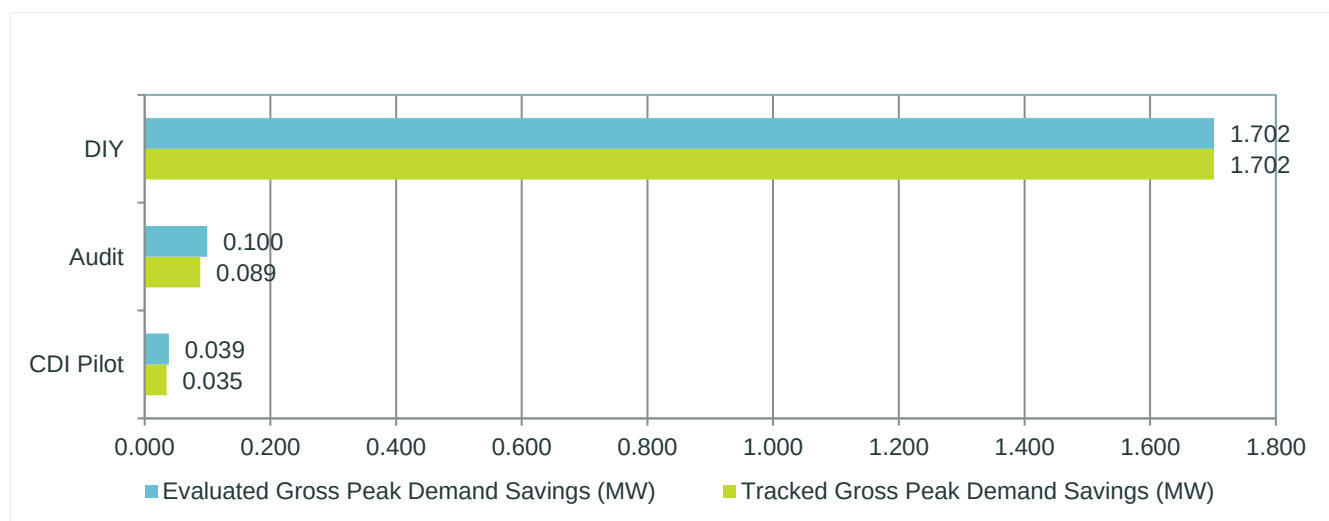


Figure 12: 2023 SBES Tracked and Evaluated Gross Peak Demand Savings at the Generator



As presented in Table 20, GHG emissions reductions were calculated by applying the Nova Scotia-specific factor¹² for GHG emissions generated by electricity production to SBES gross savings.

¹² At the time of writing, 2023 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2022 total system emissions data (5,770,500 CO₂ eq tonnes) and total electricity generation (10,456 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 December 1, 2023), Emera inc., Management's Discussion & Analysis, as at February 23, 2023 https://s25.q4cdn.com/978989322/files/doc_financials/2022/q4/Emera-Q4-2022-MD-A-FINAL-Feb-22%2723.pdf (Last accessed December 1, 2023).

Table 20: Evaluated 2023 SBES GHG Gross Emission Reductions

	Total
Gross Energy Savings – at the Generator (GWh)	9.180
Nova Scotia-specific GHG Emissions Factor for Electricity Production (tonnes of CO2 eq/GWh)	551.9
Gross Annual GHG Emission Reductions (tonnes of CO2 eq)	5,066

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 the program component, by estimating the net-to-gross ratio (NTGR). More precisely, 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.

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 for DIY and Audit projects were last assessed during the 2021 and 2019 evaluations respectively. The free-ridership levels were reassessed in 2023 using a self-report approach that involved asking participants a set of questions during a telephone survey.

The feedback collected from the participant survey was converted into an overall free-ridership level using the algorithms presented in Appendix VIII.

An updated free-ridership level could not be established for the Audit path based on the results of the 2023 participant survey due to the small number of Audit projects (eight) 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 20% with a margin of error 5.2% for 2023. The 2023 free-ridership level for the DIY path represents an increase compared to the 15% established in 2021 and 7% established in 2019. A key observation from participant responses indicates the free-ridership level doubled among lighting participants. Notably, a much higher proportion of participants had already planned to install high-efficiency lighting prior to learning about the program component (30% in 2023 compared to 3% in 2021).

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 21 that outlines the free-ridership levels used for the 2023 evaluation.

Table 21: 2023 SBES Free-ridership Levels

Project Path	Average Free-ridership Level	Margin of Error
DIY	20%	5.2%
Audit (based on 2019 results)	12%	6.5%
CDI Pilot	-	N/A

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. The Evaluator conducted desk reviews complemented with on-site visits or phone interviews, which also served to directly question participants about any potential spillover effects. It was found that the spillover level for 2023 was nil, the same as in 2021 and 2022. The algorithm used to determine the level of spillover is presented in Appendix IX.

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 established DIY and Audit path free-ridership levels, the NTGRs were estimated at 0.88 for the Audit path and 0.80 for the DIY path, as presented in Table 22. The NTGR for the CDI pilot was assumed to be 1.00.

Table 22: 2023 SBES NTGRs

Project Path	Free-ridership	Participant Spillover	NTGR
DIY	20%	0%	0.80
Audit	12%	0%	0.88
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:

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

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

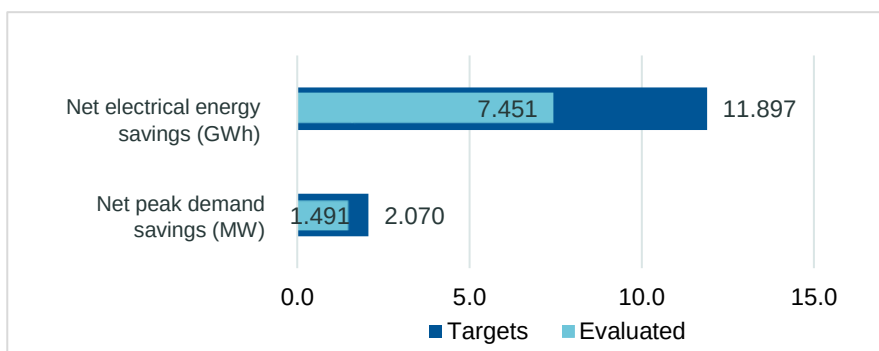
The detailed results are listed in Table 23. The net energy savings resulted in 4,112 tonnes of CO₂ eq in net annual GHG emission reductions.

Table 23: Evaluated 2023 SBES Net Energy and Peak Demand Savings

Measure Category	Audit	DIY	CDI Pilot	Total
Energy Savings				
Gross Energy Savings – at the Meter (GWh)	0.492	7.852	0.222	8.567
NTGR	0.88	0.80	1.00	-
Net Energy Savings – at the Meter (GWh)	0.433	6.298	0.222	6.953
Line Loss Factor	1.069	1.071	1.093	-
Net Energy Savings – at the Generator (GWh)	0.463	6.745	0.243	7.451
Effective Useful Life (years)	16.0	15.7	2.9	-
Net Lifetime Energy Savings – at the Generator (GWh)	7.411	105.706	0.704	113.821
Peak Demand Savings				
Gross Peak Demand Savings – at the Meter (MW)	0.091	1.557	0.034	1.682
NTGR	0.88	0.80	1.00	-
Net Peak Demand Savings – at the Meter (MW)	0.080	1.249	0.034	1.363
Line Loss Factor	1.0956	1.0930	1.1341	-
Net Peak Demand Savings – at the Generator (MW)	0.088	1.365	0.039	1.491

As outlined in Figure 13 below, SBES fell short of its targets of 11.897 GWh in net energy savings and 2.070 MW in peak demand savings by 37% and 28% respectively.

Figure 13: 2023 SBES Targets and Evaluated Results



4.4 Realization Rate

Table 24 compares the tracked energy and peak demand savings values established through this evaluation to those calculated in the 2023 tracking sheet. It also includes the realization rate, representing the ratio of evaluated net savings to tracked net savings, for both energy savings and peak demand savings.

Table 24: Comparison of 2023 SBES Tracked and Evaluated Savings at the Generator¹³

	Gross Savings		NTGR*	Net Savings		Realization Rate
	Value	Unit		Value	Unit	
Energy Savings						
Tracked Savings by EOne	8.915	GWh	0.86	7.629	GWh	98%
Evaluation Results	9.180	GWh	0.81	7.451	GWh	
Peak Demand Savings						
Tracked Savings by EOne	1.825	MW	0.85	1.559	MW	96%
Evaluation Results	1.840	MW	0.81	1.491	MW	
* The average NTGR values presented in this table correspond to the ratios of net savings to gross savings for SBES						

The evaluated gross and net energy savings were slightly different than the savings tracked by EOne.

The evaluated gross energy savings were 3% higher than the tracked savings due to the new adjustment ratios established for 2023 specifically attributed to the lighting category. Tracked net energy savings were slightly lower than the evaluated savings (2%) as a new NTGR was established for 2023 with higher free-ridership.

Peak demand savings were impacted similarly; the evaluated gross peak demand savings were higher (1%) than the tracked savings, and evaluated net peak demand savings were 4% lower than the tracked savings.

¹³ The results presented in Table 17 include savings for SBES and the CDI pilot.



5 SBES Key Findings and Recommendations

The main objectives of the 2023 SBES evaluation were as follows:

- › Collect information on participant and partner perspectives
- › 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 provides the Evaluator's key findings and recommendations in relation to the above objectives.

2023 SBES-Finding: Net electrical energy and peak demand savings did not meet targets for 2023.

In 2023, SBES achieved 7.451 GWh and 1.491 MW in net energy and peak demand savings respectively. SBES fell short of its targets of 11.897 GWh in net energy savings and 2.070 MW in peak demand savings by 37% and 28% respectively.

2023 SBES-Finding: Participation in SBES decreased in 2023, while energy savings per project remained flat compared to 2022.

SBES participation included 467 projects in 2023, which represent a 27% decrease compared to 2022. DIY projects continued to be the most popular representing 83% of all projects. Savings per project remained flat while gross energy and peak demand savings also decreased (29%) in line with participation compared to 2022.

2023 SBES-Finding: Following the SBES desk reviews and site visits, the Evaluator made minor adjustments to the energy and peak demand savings for all measure categories.

The desk reviews revealed that key measure parameters were generally well tracked with no extensive adjustments resulting from site visits. The Evaluator established adjustment ratios of 1.070 for energy savings and 0.917 for peak demand savings for lighting measures as well as 0.980 and 1.009 for HVAC measures based on the results of the desk reviews. The Evaluator also applied small additional adjustments to account for missing peak demand savings values and for HSPF2 and SEER2 corrections. The desk reviews did reveal certain data inconsistencies pertaining to inputs and calculations linked with the CIS, for instance for lighting interactive effects factors and ballast factors. While these adjustments only had minor impacts on the savings, they could be resolved by improving the CIS data entry process and automation.

2023 SBES Recommendation 1: Consider improvements to the CIS, namely by reviewing how missing entries are treated and extracting more information from the CIS to allow validating automated calculations.

2023 SBES-Finding: The free-ridership level for DIY increased by 5% in 2023 mainly due to an increase in free-ridership among lighting projects.

In 2023, the free-ridership level for DIY was established at 20% compared to the 15% established in the 2021 evaluation.

2023 SBES-Finding: Overall participant satisfaction is high and in the same range as recent years.



2023 SBES-Finding: Overdue projects may still be in progress.

The dropped-out or overdue participant interview process revealed that many participants with projects that have been in process for 12-18 months are still in progress. The majority of participants with such overdue projects told the Evaluator that their projects were in progress, and they intended to submit the rebate application after completing the work.

2023 SBES Recommendation 2: Consider implementing communication strategies for participants who are approaching their project expiration date.

2023 SBES-Finding: Stakeholders experience dissatisfaction with processing times.

Some SBES projects were impacted by longer-than-expected application processing times that caused subsequent delays or challenges to implementation.

Overdue participants indicated that application processing times had impacted their project schedules by creating issues with securing financing and ordering materials. Contractors were dissatisfied with application processing times, indicating that applications took six weeks on average and up to 20 weeks in some cases.

2023 SBES-Finding: Overall competing projects or high demand for construction services were not significant barriers completing energy efficiency projects under SBES.

Some contractors found competing projects or high demand for construction services to be a barrier to participation but overall these issues did not prevent them from supporting their clients.

CONCLUSION

Table 25 summarizes the participation level, net-to-gross ratios (NTGRs), evaluated gross and net savings at the generator, annual GHG emission reductions, as well effective useful life (EUL) values for Direct Installation.

Table 25: Overall 2023 Direct Installation Participation and Evaluated Savings¹⁴

	Participation Level		Gross Savings		NTGR*	Net Savings	
	Value	Unit	Value	Unit	Value	Value	Unit
SBES							
Energy Savings	467 ¹⁵	Projects	9.180	GWh	0.81	7.451	GWh
Lifetime Energy Savings			140.929	GWh	0.81	113.821	GWh
Peak Demand Savings			1.840	MW	0.81	1.491	MW
Annual GHG Emission Reductions			5,066	Tonnes of CO2 eq	0.81	4,112	Tonnes of CO2 eq
EUL			15.4	Years		15.3	Years
* The average NTGR values presented in this table correspond to the ratios of net savings to gross savings for SBES.							

As Figure 14 and Figure 15 below illustrate, Direct Installation did not meet its planned energy savings target of 11.897 GWh and peak demand savings target of 2.070 MW by 37% and 28% respectively. Furthermore, SBES participation decreased in 2023.

Figure 14: 2023 Direct Installation Targeted and Evaluated Net Energy Savings

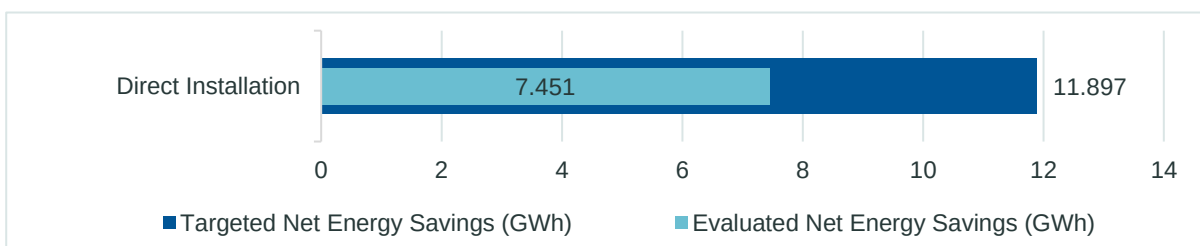
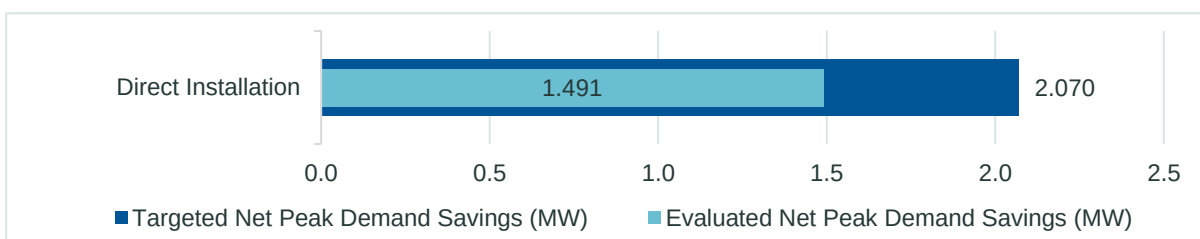


Figure 15: 2023 Direct Installation Targeted and Evaluated Net Peak Demand Savings



¹⁴ The results presented in this table include savings for the SBES program component and the CDI pilot.

¹⁵ 63 of the 467 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: EOne Staff Interview Guide

Appendix II SBES: Participant Survey Guide

Appendix III SBES: Participant Survey Results

Appendix IV SBES: Dropped-out Participant Interview Guide

Appendix V SBES: Contractor Interview Guide

Appendix VI SBES: 2023 Tracking Sheet Audit

Appendix VII SBES: Sampling Methodology and Protocol for Desk Reviews and Site Visits

Appendix VIII SBES: Free-ridership Algorithm

Appendix IX SBES: Spillover Algorithm

Appendix X SBES: 2023 Recommendations



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com





EfficiencyOne

DIRECT INSTALLATION PROGRAM

Appendix Report

2023 DSM EVALUATION

March 14, 2024

In collaboration with:





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APPENDIX I

SBES: Efficiency One Staff Interview Guide

Business Development Manager / Onsite Energy Manager- Interview Guide

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview Guide
Estimated Time to Complete	20 minutes
Target Audience	EOne Business Development Manager / OEM
Expected Number of Completions	1-2 / 1-2
Contact List Source	Efficiency Nova Scotia
Fielding Firm	Econoler
Estimated Timeline for fielding	October 26 th to November 17 th , 2023

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
What is the respondent's role in SBES?	A1
How is participant recruiting conducted?	B1-B5
› What are the interest and participation levels in new non-lighting measures?	B7, C1
What are the most common concerns or participation challenges faced by potential participants in SBES?	B6, D1
What opportunities exist to improve SBES recruiting and reach more participants?	D4-D5
› What opportunities exist to ensure project completion	
› What works well and what are the key challenges for the service?	
› Are there sufficient contractors available to complete the work?	D2-D3, C2

Introduction

Thank you for taking the time to speak with me today. I am interested in your opinion regarding Efficiency Nova Scotia's SBES programs, from your perspective as a [Business development manager/Onsite Energy Manager] involved in recruiting and supporting participants in the program.

We would appreciate your collaboration in answering questions related to your involvement in these programs. The information you provide will be used to help Efficiency Nova Scotia evaluate and improve the program. Our discussion should last approximately 20 minutes, depending on your responses. Is this a good time for you?

A. Role & Responsibilities

- 
- A1. Please tell me about your role as a [*business development manager / On site energy manger*] working with small businesses and facilities.

B. Participant Recruiting (BDM)

- B1. Please describe how you identify and engage potential new participants for the SBES program.
- B2. How do you typically describe the value or benefits of SBES to potential participants? **[ASK FOR MAIN BENEFITS PROVIDED TO PARTICIPANTS TO BE ABLE TO COMPARE TO BENEFITS RECALLED BY AND EFFECTIVE AMONG PARTICIPANTS]**
- B3. What messages or themes do you find are most relevant or attractive to potential participants in SBES?
- B4. Prior to starting the program, do you find potential participants tend to be interested in any specific savings measures? If so, which ones?

C. Challenges and Opportunities

- C1. In your experience, what are the most common concerns or participation challenges faced by potential participants in SBES that cause them not to participate?
- How do you address these concerns and challenges?
- C2. In your experience, what are the most common concerns or participation challenges faced by registered participants in SBES that lead to incomplete projects/participation?
- How would you address these concerns and challenges?
- C3. We have heard that availability of commercial contractors may be a challenge for SBES participants: contractors bid their projects but are not available when it is time to execute the work. To what extent has this been an issue for businesses that you work with?
- C4. What recommendations do you have to make it more valuable for contractors to market and execute SBES projects?
- C5. What industry sectors in Nova Scotia have the greatest potential to improve their energy performance through the SBES programs?
- C6. What feedback have you heard from participants about the SBES programs?
- C7. How, if at all, could the participant experience and process be improved for the SBES program?

Those are all the questions I have for you today. Would you like to add anything else regarding the programs or talk about any other topic that was not covered during the interview.

In-House Energy Auditor - Interview Guide

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview Guide
Estimated Time to Complete	20 minutes
Target Audience	EOne Business Development Manager / OEM
Expected Number of Completions	1-2 / 1-2
Contact List Source	Efficiency Nova Scotia
Fielding Firm	Econoler
Estimated Timeline for fielding	October 26 th to November 17 th , 2023

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
What is the respondent's role in SBES?	A1
How is participant recruiting conducted?	B1-B5
› What are the interest and participation levels in new non-lighting measures?	B7, C1
What are the most common concerns or participation challenges faced by potential participants in SBES?	B6, D1
What opportunities exist to improve SBES recruiting and reach more participants?	D4-D5
› What opportunities exist to ensure project completion	
› What works well and what are the key challenges for the service?	D2-D3, C2
› Are there sufficient contractors available to complete the work?	

Introduction

Thank you for taking the time to speak with me today. I am interested in your opinion regarding Efficiency Nova Scotia's SBES programs, from your perspective as a [Energy Auditor] involved in the program.

We would appreciate your collaboration in answering questions related to your involvement in these programs. The information you provide will be used to help Efficiency Nova Scotia evaluate and improve the program. Our discussion should last approximately 20 minutes, depending on your responses. Is this a good time for you?

D. Role & Responsibilities

D1. Please tell me about your role as a [Energy Auditor] working with small businesses and facilities.

E. Participant Recruiting (BDM)

- E1. Please describe how you identify and engage potential new participants for the SBES program.
- E2. How do you typically describe the value or benefits of SBES to potential participants? **[ASK FOR MAIN BENEFITS PROVIDED TO PARTICIPANTS TO BE ABLE TO COMPARE TO BENEFITS RECALLED BY AND EFFECTIVE AMONG PARTICIPANTS]**
- E3. What messages or themes do you find are most relevant or attractive to potential participants in SBES?
- E4. Adapt to Energy Auditor: "Do you find Audit participants tend to be interested in particular measures? If so, which ones?"

F. Challenges and Opportunities

- F1. In your experience, what are the most common concerns or participation challenges faced by potential participants in SBES that cause them not to participate?

Other issues or concerns that cause participants not to select the Audit path?

How do you address these concerns and challenges?
- F2. In your experience, what are the most common concerns or participation challenges faced by registered participants in SBES that lead to incomplete projects/participation?

How would you address these concerns and challenges?
- F3. We have heard that availability of commercial contractors may be a challenge for SBES participants: contractors bid their projects but are not available when it is time to execute the work. To what extent has this been an issue for businesses that you work with?
- F4. What recommendations do you have to make it more valuable for contractors to market and execute SBES projects?
- F5. What industry sectors in Nova Scotia have the greatest potential to improve their energy performance by participating in the SBES Audit pathway?
- F6. What feedback have you heard from participants about the SBES programs?
- F7. How, if at all, could the participant experience and process be improved for the SBES program?

Those are all the questions I have for you today. Would you like to add anything else regarding the programs or talk about any other topic that was not covered during the interview.

APPENDIX II

SBES: Participant Survey Guide

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Telephone Survey
Estimated Time to Complete	15 min
Target Audience	Participants who have completed SBES projects
Expected Number of Completions	50
Contact List Source	EfficiencyOne
Fielding Firm	Narrative Research
Estimated Timeline for fielding	October 26 th – November 17 th , 2023

Table 2: Research Objectives and Associated Questions

Research Objectives	Questions
Awareness and Motivations for participating	B1- B4
Free-ridership level for audit path and DIY path	C and D series
Cross-influence	E serie
Satisfaction	F1-F4
Recommendations	F5
Barriers	G1
Firmographics	H series

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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. 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 MQO 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 program information, your business installed **<MEASURE CATEGORY>** upgrades at **<SITE NAME>**. 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 program 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 >** upgrades at **<SITE NAME>**. For this project, Efficiency Nova Scotia offered you **<IF TOTAL ENS REBATE>0>** a **\$<TOTAL ENS REBATE>** rebate **<IF FINANCING=YES>** and provided a loan. When answering the survey questions, please consider 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
2. From an equipment vendor
3. From an energy auditor, recommissioning provider or energy consultant
4. From an Efficiency Nova Scotia account representative
5. At an event/trade show
6. Received an email or electronic newsletter
7. Received an informational brochure
8. From ENS's website
9. TV/radio ad
10. Friends or colleagues
11. 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: _____)
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 reduce energy costs
2. To advance an energy management plan or goals
3. To advance a climate plan or carbon reduction goals
4. To learn more about energy efficiency opportunities by obtaining an 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 one 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 the audit pathway 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. You had previously had an audit
96. Or something else? please specify: _____
98. Don't know
99. Refused

C. Free-Ridership for Audit Path

[IF PROJECT TYPE IS AUDIT IN SAMPLE, ASK C1 TO C9; OTHERWISE SKIP TO FREE-RIDERSHIP FOR DIY PATH (SECTION D)]

C1. BEFORE learning about Small Business Energy Solutions rebates and financing and having your facility evaluated by a Small Business Energy Auditor, had your business already decided to install the same energy-efficient upgrades that were installed as part of the Small Business Energy Solutions Program? Had you... **[READ OPTIONS IN ORDER – CODE ONLY ONE]**

1. Decided to install all of the upgrades
2. Decided to install some of the upgrades
3. Decided to not install any of the upgrades
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
98. Don't know
99. Refused

C3. **[IF C1<>1]** If your business had not received the free audit of your facility by a certified energy auditor, would you have identified the opportunity for the energy-efficient upgrades that you installed?

- 1. Yes
- 2. No **[GO TO SECTION F]**
- 98. Don't know
- 99. Refused

C4. **[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

- 98. Don't know
- 99. Refused

C5. **[IF TOTAL ENS REBATE>0 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 0% financing from Efficiency Nova Scotia, as well as 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 Financed" and 10 means that you "Definitely Would Have Paid and Financed."

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

- 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 C6 TO C9 SEQUENCE IN ORDER/DO NOT RANDOMIZE; REPEAT SCALE ONLY AS NECESSARY]

C6. If there was no program rebate, no financing, and no audit, what is the likelihood that you would have installed less efficient 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

- 98. Don't know
- 99. Refused

- C7. **[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

98. Don't know
99. Refused

- C8. **[ASK IF C4 OR C5 ≥5]** If there was no program rebate, no program financing, and no program 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

98. Don't know
99. Refused

- C9. 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 RANDOMIZE FACTORS; DO NOT ACCEPT A RANGE; REPEAT SCALE ONLY AS NECESSARY]**

Factor (READ AND RANDOMIZE)	Response
a. The free audit	___ Response ___ 98 Don't Know ___ 99 Refused
b. Information or advice from the small business energy auditor	___ Response ___ 98 Don't Know ___ 99 Refused
c. [IF TOTAL ENS REBATE>0] 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
- 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 and financing offered through the program, you had already made the decision to install the energy-efficient lighting upgrades? **[CODE ONE ONLY]**

- 1. Yes
- 2. No
- 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

- 98. Don't know
- 99. Refused

D4. **[IF TOTAL ENS REBATE >0 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 0% 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

- 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
- 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

- 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

- 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

- 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 RANDOMIZE FACTORS; DO NOT ACCEPT A RANGE; REPEAT SCALE ONLY AS NECESSARY]**

Factor (READ AND RANDOMIZE)	Response
a. [IF TOTAL ENS REBATE>0] 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 provided 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 Preferred Partners	___ Response ___ 98 Don't Know ___ 99 Refused

HVAC MEASURES SECTION

[IF PROJECT TYPE=DIY AND HVAC=YES, ASK D10 TO D16; OTHERWISE SKIP TO SECTION E]

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
98. Don't know
99. Refused

- D11. **[IF D100=YES]** Just to confirm: before you learned about the Small Business Energy Solutions Program and the rebates and financing offered through the program, you had already made the decision to install the same or equally efficient heat pumps? **[CODE ONE ONLY]**

1. Yes
2. No
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

98. Don't Know
99. Refused

- D13. **[IF TOTAL ENS REBATE>0 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 was rebated or financed through the Program?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

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

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 RANDOMIZE FACTORS; DO NOT ACCEPT A RANGE; REPEAT SCALE ONLY AS NECESSARY]**

Factor (READ AND RANDOMIZE)	Response
a. [IF TOTAL ENS REBATE>0] 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 provided 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 Preferred Partners	___ 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 2023, had your business at any time in the past participated in any Efficiency Nova Scotia programs?

- 1. Yes
- 2. No
- 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
- 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 the Small Business Energy Solutions Program.

- 1. Agree
- 2. Disagree
- 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
- 98. (Don't know)
- 99. (Refused)

E5. Before participating in the Small Business Energy Solutions program in **2023**, 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.

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
- 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 the Small Business Energy Solutions Program.

- 1. Agree
- 2. Disagree
- 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
- 98. (Don't know)
- 99. (Refused)

F. Satisfaction with Program

- F1. **[NET PROMOTER SCORE]** Using a scale from 0 to 10 where 0 is “Definitely would not” and 10 is “Definitely would”, what is the likelihood that you recommend the Small Business Energy Solutions program to other business owners or managers?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

- 98. (Don’t Know)
- 99. (Refused)

- F2. Using a scale from 0 to 10 where 0 is “not at all satisfied” and 10 is “completely satisfied” how would you rate your satisfaction with the program overall?

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

- 98. (Don’t Know)
- 99. (Refused)

- F3. **[IF F2<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]

- 96. RECORD VERBATIM: _____
- 98. (Don’t know)
- 99. (Refused)

- F4. On a scale of 0 to 10, where 0 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 TOTAL ENS REBATE>0]** 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 obtaining contractor bids
- f. The availability of the contractor you selected to complete the project
- g. The quality of the work performed by the contractor
- h. The quality and performance of the equipment that was installed
- i. The time it took for the program to process the paperwork and pay your rebate

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

- 97. (Not applicable)
- 98. (Don’t Know/Don’t recall)
- 99. (Refused)

F5. 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. Increase financing
7. Speed up process/receive rebate quicker
8. Offer more measures eligible for rebates
9. Lengthen timeframe to complete work
10. No recommendations
96. Other [SPECIFY: _____]
98. (Don't know)
99. (Refused)

G. Barriers

G1. To what extent do you consider the following as barriers preventing your business from installing other energy efficiency upgrades? Use a scale of 0 to 10, where 0 means 'not at all a barrier' and 10 means 'a major barrier'. **[RANDOMIZE]**

- a. Financial challenges, even after rebate, such as lack of funds, the time to recoup the investment, and so on.
- b. Time constraints or competing priorities for your business
- c. Concern that rebates are not available or that upgrades won't work as well as advertised
- d. Need for information or technical support to get a project idea off the ground
- e. Availability of qualified contractors to complete upgrade or renovation projects

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

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: _____]
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. Vacant building
96. (Other: please explain: _____)
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
98. (Don't know)
99. (Refused)

H4. Do you own or rent the facility?

1. Own
2. Rent
96. Other: please explain: _____)
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: _____)
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 III

SBES: Participant Survey Results

B. Awareness and Motivations for Participating

B1. How did you learn about Efficiency Nova Scotia's Small Business Energy Solutions Program?

	2023	2021
Sample Size	46	50
From a contractor	24%	-
From a contractor, equipment vendor, energy consultant*	-	24%
Through experience with the program	20%	14%
From ENS's website	20%	4%
Internet (general)	11%	12%
Friends or colleagues	11%	20%
Received an email or electronic newsletter	9%	6%
From an equipment vendor	7%	-
TV/radio ad	4%	4%
Received an informational brochure	4%	-
From an energy auditor, recommissioning provider or energy consultant	4%	-
At an event/trade show	2%	-
From an Efficiency Nova Scotia account representative	2%	10%
Other	9%	10%
Don't know	2%	2%

*Wording of this choice slightly change in 2023

Multiple responses

B2. Who initiated the discussion about participating in the Small Business Energy Solutions program? Would you say...

	2023	2021
Sample Size	46	50
You/your business initiated it	57%	44%
Your contractor initiated it	24%	28%
The idea arose in discussion between your business and your contractor	11%	16%
Someone from Efficiency Nova Scotia suggested the program	7%	6%
Other	2%	4%
Don't know	0%	2%

B3. What was the main reason your business was interested in participating in the Small Business Energy Solutions Program?

	2023	2021
Sample Size	46	50
To reduce energy costs	35%	32%
To upgrade measures/be more efficient	20%	22%
To get rebates	24%	10%
To advance an energy management plan or goals	0%	26%
Already planning to do upgrades	17%	0%
To address a climate plan or carbon reduction goals	0%	6%
To learn more about energy efficiency opportunities by obtaining an energy audit	2%	0%
Other	2%	4%

B4. 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.

	2023	2021
Sample Size	45	49
You did not know that an audit option was available	31%	39%
You knew about the audit but thought that your project did not require it	24%	20%
You had previously had an audit	20%	0%
You knew about the audit pathway but were not interested in it	13%	6%
Efficiency Nova Scotia said your project did not require an audit	2%	8%
Something else	4%	8%
Don't know	4%	18%

Base: DIY participants

C. Free-ridership for Audit Path

C1. BEFORE learning about the Small Business Energy Solutions rebates and financing and having your facility evaluated by a Small Business Energy Auditor, had your business already decided to install the same energy-efficient upgrades that were installed as part of the Small Business Energy Solutions Program? Had 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 [IF C1=1: ALL / IF C1=2: SOME OF] the energy efficiency upgrades that were installed as part of the Program?

	2023	2021
Sample Size	1 (#)	1 (#)
Decided to install some of the upgrades	1	-
Decided to not install any of the upgrades	-	1

Base: Respondents who had an audit

C3. [IF C1<>1] IF YOUR BUSINESS HAD NOT RECEIVED THE FREE AUDIT OF YOUR FACILITY BY A CERTIFIED ENERGY AUDITOR, WOULD YOU HAVE IDENTIFIED THE OPPORTUNITY FOR THE ENERGY-EFFICIENT UPGRADES THAT YOU INSTALLED?

No answer to this question in 2023

C4. 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."

	2023	2021
Sample Size	-	1 (#)
MEAN	.-	10.0

Mean excludes responses of 'Don't know' & 'Refused'.

Base: Respondents who had an audit and received a rebate for the energy-efficient upgrades

C5. 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 0% financing from Efficiency Nova Scotia, as well as 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 Financed” and 10 means that you “Definitely Would Have Paid and Financed.”

	2023	2021
Sample Size	1	-
MEAN	5.0	.-

Mean excludes responses of 'Don't know' and 'Refused'.

Base: Respondents who had an audit and received a rebate and financing for the energy-efficient upgrades

C6. If there was no program rebate, no financing, and no audit, what is the likelihood that you would have installed less efficient equipment or that you would have kept your old equipment instead of installing energy-efficient equipment in your facility?

	2023	2021
Sample Size	1	1
MEAN	10.0	3.0

Mean excludes responses of 'Don't know' and 'Refused'

Base: Respondents who had an audit

C7. 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?

	2023	2021
Sample Size	1	1
MEAN	2.0	8.0

Mean excludes responses of 'Don't know' and 'Refused'.

Base: Respondents who had an audit and who installed more than one measure

C8. If there was no program rebate, no program financing, and no program audit, what is the likelihood that you would have postponed making energy efficient upgrades to your facility by at least one year?

	2023	2021
Sample Size	1	1
MEAN	9.0	10.0

Mean excludes responses of 'Don't know' and 'Refused'.

Base: Respondents who had an audit and who would not likely have paid or financed the cost of the energy-efficient upgrades they installed in absence of SBES

C9A. 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...

The free audit

	2023	2021
Sample Size	1	1
MEAN	10.0	10.0

Mean excludes responses of 'Don't know' and 'Refused'.

C9B. Information or advice from the small business energy auditor

	2023	2021
Sample Size	1	1
MEAN	10.0	.

Mean excludes responses of 'Don't know' and 'Refused'.

C9C. The program rebate

	2023	2021
Sample Size	1	1
MEAN	10.0	10.0
Mean excludes responses of 'Don't know' and 'Refused'		
Base: Respondents who received a rebate.		

C9D. The program on-bill financing

	2023	2021
Sample Size	1	0
MEAN	10.0	.
Mean excludes responses of 'Don't know' and 'Refused'		
Base: Respondents who received a financing'..		

C9E. Information or advice provided by Efficiency Nova Scotia staff

	2023	2021
Sample Size	1	1
MEAN	10.0	.
Mean excludes responses of 'Don't know' and 'Refused'		

C9F. Information or advice provided by a contractor

	2023	2021
Sample Size	1	1
MEAN	5.0	10.0
Mean excludes responses of 'Don't know' and 'Refused'.		

C9G. The availability of a list of contractors through the Efficiency Trade Network

	2023	2021
Sample Size	1	1
Don't know	1	-
MEAN	.	.0
Mean excludes responses of 'Don't know' and 'Refused'.		

D. Free-ridership for DIY (Lighting and HVAC measures)

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 and financing offered through the program, you had already made the decision to install the energy-efficient lighting upgrades?

	2023	2021
Sample Size	19	41
Yes	47%	12%
No	53%	83%
Don't know	-	5%

Base : DIY respondents who installed energy-efficient lighting upgrades

D3. 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.”

	2023	2021
Sample Size	10	23
MEAN	6.3	4.0

Mean excludes responses of 'Don't know' and 'Refused'.

Base : DIY respondents who received a rebate

D4. 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 0% 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.”

	2023	2021
Sample Size	9	18
MEAN	4.9	2.7

Mean excludes responses of 'Don't know' and 'Refused'.

Base : DIY respondents who received a rebate and financing

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®?

	2023	2021
Sample Size	19	41
Yes	84%	61%
No	11%	37%
Don't know	5%	2%

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?

	2023	2021
Sample Size	19	41
MEAN	4.9	3.5

Mean excludes responses of 'Don't know' and 'Refused'.

D7. 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?

	2023	2021
Sample Size	19	41
MEAN	5.3	4.0

Mean excludes responses of 'Don't know' and 'Refused'.

Base : DIY respondents who installed more than one lighting measure

D8. 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?

	2023	2021
Sample Size	13	16
MEAN	7.2	5.4

Mean excludes responses of 'Don't know' and 'Refused'.

Base : DIY respondents who would not likely have paid or financed the full cost of the lighting upgrades in absence of SBES

D9A. 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...

The program rebate

	2023	2021
Sample Size	19	41
MEAN	8.5	8.4

Mean excludes responses of 'Don't know' and 'Refused'.

Base: Respondents who received a rebate

D9B. The program on-bill financing

	2023	2021
Sample Size	9	18
MEAN	7.5	7.4

Mean excludes responses of 'Don't know' and 'Refused'.

Base: Respondents who received on bill financing

D9C. Information or advice received by Efficiency Nova Scotia staff

	2023	2021
Sample Size	19	41
MEAN	5.5	6.0

Mean excludes responses of 'Don't know' and 'Refused'.

D9D. Information or advice provided by a contractor

	2023	2021
Sample Size	19	41
MEAN	9.1	8.0

Mean excludes responses of 'Don't know' and 'Refused'.

D9E. The availability of a list of contractors through the Efficiency Preferred Partners

	2023	2021
Sample Size	19	41
MEAN	4.9	5.0

Mean excludes responses of 'Don't know' and 'Refused'.

HVAC Measures Section

D10/D11. Had your business already decided to install heat pumps BEFORE learning about the Small Business Energy Solutions Program?

Just to confirm: before you learned about the Small Business Energy Solutions Program and the rebate and financing offered through the program, you had already made the decision to install heat pumps?

	2023	2021
Sample Size	20	8
Yes	20%	13%
No	65%	88%
Don't know	10%	0%
Refused	5%	0%

Base: DIY respondents who installed HVAC upgrades

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? 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.”

	2023	2021
Sample Size	16	6
MEAN	3.2	5.3

Mean excludes responses of 'Don't know' and 'Refused'.

Base: DIY respondents who installed HVAC upgrades and received a rebate for the heat pumps

D13. 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.”

	2023	2021
Sample Size	4	2
MEAN	1.7	1.0

Mean excludes responses of 'Don't know' and 'Refused'.

Base: DIY respondents who installed HVAC upgrades and received a rebate and financing for the heat pumps

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?

	2023	2021
Sample Size	20	8
MEAN	1.6	4.6

Mean excludes responses of 'Don't know' and 'Refused'.

D15. 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?

	2023	2021
Sample Size	7	4
MEAN	4.6	6.5

Mean excludes responses of 'Don't know' and 'Refused'.

Base: Respondents who would not likely have paid or financed the full cost of the heat pumps in absence of SBES

D16A. 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...

The program rebate

	2023	2021
Sample Size	20	8
MEAN	8.8	9.6

Mean excludes responses of 'Don't know' and 'Refused'.

Base: Respondents who received a rebate

D16B. The program on-bill financing

	2023	2021
Sample Size	4	2
MEAN	7.8	10.0

Mean excludes responses of 'Don't know' and 'Refused'.

Base: Respondents who received financing

D16C. Information or advice received by Efficiency Nova Scotia staff

	2023	2021
Sample Size	20	8
MEAN	7.5	6.8

Mean excludes responses of 'Don't know' and 'Refused'

D16D. Information or advice provided by a contractor

	2023	2021
Sample Size	20	8
MEAN	6.6	6.9

Mean excludes responses of 'Don't know' and 'Refused'

D16E. The availability of a list of contractors through the Efficiency Preferred Partners

	2023	2021
Sample Size	20	8
MEAN	4.8	4.0

Mean excludes responses of 'Don't know' and 'Refused'

E. Cross-Influence

E1. Before participating in the Small Business Energy Solutions program in 2023, had your business at any time in the past participated in any Efficiency Nova Scotia programs?

	2023	2021
Sample Size	46	50
Yes	41%	38%
No	46%	60%
Don't know	13%	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.

	2023	2021
Sample Size	19 (#)	19 (#)
Agree	16	16
Disagree	3	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 the Small Business Energy Solutions Program.

	2023	2021
Sample Size	4	3 (#)
Agree	3	2
Disagree	1	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.

	2023	2021
Sample Size	19 (#)	19 (#)
Agree	17	16
Disagree	2	3

E5. Before participating in the Small Business Energy Solutions program in 2023, had you at any time in the past seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?

	2023	2021
Sample Size	46	50
Yes	85%	80%
No	15%	20%

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.

	2023	2021
Sample Size	39	40
Agree	79%	88%
Disagree	21%	13%

Base: Respondents who previously saw ENS energy-efficiency promotional materials

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 the Small Business Energy Solutions Program.

	2023	2021
Sample Size	13 (#)	4 (#)
Agree	11	2
Disagree	2	2

Base: Respondents who previously saw ENS energy-efficiency promotional materials and respondents who were part of the DIY path or Audit path

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.

	2023	2021
Sample Size	39	40
Agree	92%	90%
Disagree	8%	10%

Base: Respondents who previously saw ENS energy-efficiency promotional materials

F. Satisfaction with SBES

F1. Using a scale from 0 to 10 where 0 is “Definitely would not” and 10 is “Definitely would”, what is the likelihood that you recommend the Small Business Energy Solutions program to other business owners or managers?

Net Score Promoter	2023
Sample Size	46
10 - Definitely would	85%
9	9%
8	4%
7	0%
6	0%
5	0%
4	0%
3	0%
2	0%
1	0%
0 - Definitely would not	2%
LIKELY % (ratings of 8,9,10)	98
MEAN	9.6

Mean excludes responses of 'Don't know' and 'Refused'.

F2. Using a scale from 0 to 10 where 0 is “not at all satisfied” and 10 is “completely satisfied” how would you rate your satisfaction with the program overall?*

	2023
Sample Size	46
MEAN	8.8

Mean excludes responses of 'Don't know' and 'Refused'.

* The 2021 results are not presented as the score scale changed in 2023.

F3. [IF F2<8] What is the most important reason you are not more satisfied with the program overall?

	2023
Sample Size	5 (#)
I was expecting to get rebates for equipment installed but did not	1
Process/program took too long	1
I would have liked a higher incentive/Incentive too low	1
Don't know	2

Base: Respondents who were not satisfied with SBES (F2<8)

F4A. [ASK IF TOTAL ENS REBATE > 0] On a scale of 0 to 10, where 0 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.*

The program rebate

	2023
Sample Size	46
MEAN	9.3

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'.

Base: Respondents who received a rebate.

*The 2021 results are not presented as the score scale changed in 2023.

F4B. The program financing

	2023
Sample Size	15
MEAN	9.8

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'.

Base: Respondents who received financing.

F4C. The program forms and documents

	2023
Sample Size	46
MEAN	8.7

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'.

F4D. The usefulness of the audit report

	2023
Sample Size	1
MEAN	10.0

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'.

Base: Respondents who received an audit report

F4E. The ease of obtaining contractor bids

	2023
Sample Size	46
MEAN	8.1

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'

F4F. The availability of the contractor you selected to complete the project

	2023
Sample Size	46
MEAN	9.2

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'

F4G. The quality of the work performed by the contractor

	2023
Sample Size	46
MEAN	9.4

Note: Mean calculated based on 0-10 scale, excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'.

F4H. The quality and performance of the equipment that was installed

	2023
Sample Size	46
MEAN	9.3

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'.

F4I. The time it took for the program to process the paperwork and pay your rebate

	2023
Sample Size	46
MEAN	8.2

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'

F5. Do you have any recommendations for improving the Small Business Energy Solutions program? Anything else?

	2023
Sample Size	46
Offer financing/help with cost	63%
Offer more measures eligible to rebates	15%
Increase rebates	9%
Monitor the status of the applications/Clarity on the delays to receive the rebates	7%
No recommendations	7%
Better marketing/awareness	7%
Simplify the program/Less paperwork	7%
Other	7%
Don't know	2%

G. Barriers

G1A. To what extent do you consider the following as barriers preventing your business from installing other energy efficiency upgrades? Use a scale of 0 to 10, where 0 means 'not at all a barrier' and 10 means 'a major barrier'.*

Financial challenge, even after rebate, such as lack of funds, taking too long to recoup the investment, and so on.

	2023
Sample Size	46
MEAN	6.0

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'.

*The 2021 results are not presented as the score scale changed in 2023.

G1B. Time constraints or competing priorities for your business

	2023
Sample Size	46
MEAN	5.3

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'.

G1C. Concern that rebates are not available or that upgrades won't work as well as advertised

	2023
Sample Size	46
MEAN	4.9

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'.

G1D. Need for information or technical support to get a project idea off the ground

	2023
Sample Size	46
MEAN	5.1

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'

G1E. Availability of qualified contractors to complete upgrade or renovation projects

	2023
Sample Size	46
MEAN	5.0

Mean excludes responses of 'Not applicable', 'Don't know/Don't recall' and 'Refused'.

H. Firmographics

H1. What is your job title or role?

	2023	2021
Sample Size	46	50
President/CEO/Owner	48%	38%
Manager	15%	18%
Other financial/administrative position	15%	12%
Director	4%	8%
Other facilities management/maintenance position	4%	-
Facilities Manager	4%	2%
Energy Manager	2%	-
Other	13%	26%

H2. What is the main activity of the facility where the energy efficiency improvements were installed under the Small Business Energy Solutions Program?

	2023	2021
Sample Size	46	50
Mercantile - Retail (Enclosed and Strip Malls)	0%	22%
Mercantile - Retail (Other than Mall)	15%	6%
Vacant building	0%	18%
Manufacturing	9%	10%
Property management	11%	6%
Farming	11%	6%
Service	7%	4%
Office	11%	0%
Religious Worship	2%	6%
Automotive repair	4%	2%
Warehouse and Storage	4%	2%
Lodging	7%	0%
Non-profit organization	4%	0%
Maintenance/Depot facility	0%	4%
Government	2%	2%
Health Care - Outpatient	2%	2%
Food Service (restaurant)	0%	4%
Education	2%	2%
Other	2%	0%
Financial institution	2%	0%
Recreation centre/Community hall	0%	2%
Museum/Art Gallery	2%	0%
Transportation	0%	2%
Food manufacturing	2%	0%

H3. Approximately how many full-time equivalent workers are employed at this facility?

	2023	2021
Sample Size	46	50
Fewer than 5	43%	32%
5 to 9	20%	22%
10 to 19	7%	18%
20 to 49	24%	18%
50 to 99	0%	2%
100 to 249	4%	0%
Don't know	2%	8%

H4. Do you own or rent the facility?

	2023	2021
Sample Size	46	50
Own	89%	74%
Rent	9%	22%
Other	2%	4%

H5. Is your business independent, or part of a larger company?

	2023	2021
Sample Size	46	50
Independent	76%	62%
Part of a larger company	24%	24%
Other	0%	14%

H6. How many locations does your business have in Nova Scotia?

	2023	2021
Sample Size	46	50
1	63%	56%
2-10	24%	26%
11-30	4%	8%
More than 30	2%	2%
Don't know	7%	8%
MEAN	5.0	4.7

Mean score excludes responses of 'Don't know'.

APPENDIX IV

SBES: Dropped Out Participant Interview Guide

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Semi-structured interviews
Estimated Time to Complete	20 minutes
Target Audience	Participants whose projects have been in process for 9-12 months
Expected Number of Completions	5
Contact List Source	Efficiency Nova Scotia
Fielding Firm	Narrative Research
Estimated Timeline for fielding	October 26th – November 17th, 2023

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
Have the participants made the decision not to implement measures through SBES?	B1-B5
Why did participants choose not to participate in the program?	C2, C3, C5
Participant engagement and motivation	D1-D3
Where in the process are participants dropping out or getting stuck? What challenges might they have experienced?	C1, C4, D5-D7
Do dropped-out participants have unmet expectations of ENS?	D9- D10
Do participants have a minimum payback or ROI threshold for investment decisions?	D12
What are the specific challenges for small businesses that rent their space?	F2
Do participants have business relationships with contractors?	F3
What is the level of satisfaction with the service among participants and contractors? (NPScore)	D4-D5
What works well and what are the key challenges for the service?	C1, C4, D5-D7
How could EOne improve the service?	D15

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

Hello, may I please speak with _____?

Hello, my name is _____, from Narrative Research, a Halifax-based Canadian research company. We are conducting an evaluation of the Small Business Energy Solutions Program provided by Efficiency Nova Scotia.

A. Context

As part of the evaluation, Efficiency Nova Scotia has asked us to speak to participants who initiated energy efficiency projects that were not completed. We noticed that your project located at [ADDRESS] in [CITY] appears to have been in progress for a while. We would like to discuss your experience in the Small Business Energy Solutions program so far.

Our questions will take no more than 20 minutes. Is it a good time to talk?

3. Person responsible available **[CONTINUE]**
4. Person responsible currently unavailable **[ARRANGE CALL BACK WITH THE RIGHT PERSON]**
99. Refused **[THANK AND TERMINATE]**

Confidentiality

Your responses are for research purposes only. We will not share your information in a way that could identify you or your company. Efficiency Nova Scotia is looking for feedback on why a participant may start a project, but not complete the project through the program. These questions will help Efficiency Nova Scotia improve their programs by addressing barriers to completion.

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?

B. Screening

- B1. Were you involved in the application process or the decision to participate in the Small Business Energy Solutions Program?
1. Yes, involved in the application process
 2. Yes, involved in the decision to participate
 3. (Not involved in either)
 98. (Don't know)

[IF CODE 1 NOT MENTIONED IN B1] Could you give me the name and contact information for the person who was involved with the application process? **[RECORD NAME AND CONTACT INFORMATION AND CALL BACK TO ASK QUESTIONS B1 TO B5]**

Name:

Phone:

Email:

B2. I'd like to confirm that your business started the application for Efficiency Nova Scotia's Small Business Energy Solutions program on **[APPLICATION DATE]**. We recognize that the application may have been completed by a contractor on your behalf. What is the status of the project located at **[ADDRESS]** in **[CITY]**? **[CODE OPEN-END INTO ONE OF THESE CATEGORIES]**

1. Project is in progress
2. Project is completed
3. Project stopped by Efficiency Nova Scotia
4. Project stopped or discontinued by client
5. Project stopped or discontinued by contractor
6. Project stopped or discontinued because of costs
7. Project stopped or discontinued because of someone or something else
98. (Don't know)

B3. **[ASK IF B2 = 1]** You said the Small Business Energy Solutions Program project is in progress. Please elaborate on what you mean by the project being in progress.

B4. **[ASK IF B2=2]** You said the Small Business Energy Solutions Program project is completed.

- a. Did you install all the upgrades identified by your contractor?
- b. **[IF B4A = YES OR NO]** Why or why not?
- c. Did you submit the project documentation to Efficiency Nova Scotia and request the Small Business Energy Solutions program rebate?
- d. **[IF B4D = NO]** Why not?

B5. **[ASK IF B1=3]** Why did Efficiency Nova Scotia stop your Small Business Energy Solutions Program project?

[PROCEED WITH INTERVIEW IF B1=1 (INVOLVED IN APPLICATION) AND B2=1, 4 OR 5]

C. Dropout Reasons

[ASK IF B2 = 1 "PROJECT IS IN PROGRESS"]

C1. Why has your business not yet completed the Small Business Energy Solutions program project for which you applied for on **[APPLICATION DATE]**?

[ASK IF B2 = 4 "PROJECT STOPPED OR DISCONTINUED BY CLIENT"]

C2. At what point did you decide to stop or discontinue your participation in the Small Business Energy Solutions Program? [PROBE BASED ON LIST BELOW]

[LIST OF PHASES FOR REFERENCE FOR INTERVIEWER, DO NOT READ:]

- › After filling out the online application
- › While you were selecting a contractor to work with
- › After you started working with the contractor
- › After you sent the Product Rebates Worksheets to Efficiency Nova Scotia
- › After you received the Pre-Approval report from Efficiency Nova Scotia
- › After installing the new equipment, you did not send the Project Completion Form and project documentation to Efficiency Nova Scotia and did not receive an incentive.

[ASK IF B2 = 5 “PROJECT STOPPED OR DISCONTINUED BECAUSE OF SOMEONE OR SOMETHING ELSE”]

C3. Why did your company decide not to proceed with the program? [If needed: Why did you decide not to install efficient equipment and get the resulting incentive?]

D. Experience with the Program

[ASK ALL]

Let's step back and go through your experience with the program.

D1. How did you learn about Efficiency Nova Scotia's Small Business Energy Solutions Program?
INTERVIEWER: 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)

D2. Did you experience any issues regarding the quality of the contractor's work?

D3. Did you have any issues with your contractor's availability to complete your project?

- D4. Now I have some questions about the program processes. If you did not go through one or more of these steps, let me know. Using the same 10-point scale where 0 is not at all satisfied and 10 is completely satisfied, please rate each of the following aspects of the program. So, how satisfied were you with... **INTERVIEWER: READ EACH ITEM.**

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

98. Don't Know
99. Refused
- a. The number of steps required to complete the program
- b. The time it took to get your application approved
- c. The range of equipment that qualifies for incentives
- d. The helpfulness of program staff at Efficiency Nova Scotia
- e. The length of time allowed by the program to complete your upgrades
- f. The effort it took to complete the required documentation such as worksheets, contractor quotes, and equipment receipts
- D5. During the process, did you have questions that were not resolved by your contractor or an Efficiency Nova Scotia staff person?
- a. If so, what questions remain unanswered?
- D6. What was the main challenge or barrier you faced to completing the Small Business Energy Solutions program?
- D7. Was there any type of support you expected to receive from the program, but that you did not receive?
- a. What type of support would you have liked to receive?
- b. Who would have been best to provide this type of support?
- D8. Could the program have done anything differently, or anything more, to encourage you to install energy efficient upgrades in your organization?

E. Spillover

I have just a few questions left.

E1. Since applying for the Small Business Energy Solutions program in [MONTH/YEAR], have you purchased and installed any energy saving upgrades without a rebate from Efficiency Nova Scotia?

1. Yes
2. No
98. (Don't know)
99. (Refused)

E2. **[ASK IF E1 = 1]** Please describe in detail each of the upgrades that were installed without a rebate. **[Record responses separately and follow with “How Many” where appropriate. “Anything else such as efficient lighting other than CFLs, high efficiency appliances, windows, or electronics, insulation or other efficiency items?”] Do not read 97-99**

Upgrades	Describe the upgrade in detail	How many did you install? For Insulation ask: How many SQ FT of insulation did you install?
Lighting – how many lamps and was the wattage difference between old and new lights?	[OPEN-ENDED]	[NUMERIC]
Chiller for refrigeration	[OPEN-ENDED]	[NUMERIC]
Chiller for HVAC system – can you give me any details?	[OPEN-ENDED]	[NUMERIC]
VFD for motors/fans	[OPEN-ENDED]	[NUMERIC]
Compressed air	[OPEN-ENDED]	[NUMERIC]
Insulation	[OPEN-ENDED]	[NUMERIC – SQ FT]
Windows	[OPEN-ENDED]	[NUMERIC]
Boiler	[OPEN-ENDED]	[NUMERIC]
Other	[OPEN-ENDED]	[NUMERIC]

- 
- E3. **[ASK IF E1 = 1]** To what extent did the experience in the Small Business Energy Solutions program influence your decision to install these upgrades that did not receive an incentive? Please use a 10 point scale, where 0 means that your participation in the Small Business Energy Solutions program had “No influence at all,” and 10 means it was “Extremely influential.”

0-10 SCALE WITH END POINT LABELS– RECORD NUMBER

[VOLUNTEERED]

- 98. Don't Know
- 99. Refused

- a. IF E2 = Lighting
- b. IF E2 = Chiller for refrigeration
- c. IF E2 = Chiller for HVAC system
- d. IF E2 = VFD for motors/fans
- e. IF E2 = Compressed air
- f. IF E2 = Insulation
- g. IF E2 = Windows
- h. IF E2 = Boiler
- i. IF E2 = Other

[ASK FOR EACH RESPONSE IN E3A-I= 5-10 (RESPONDENT INDICATES SPILLOVER - THEY WERE INFLUENCED BY PROGRAM TO INSTALL EE EQUIPMENT WITHOUT REBATES)]

- E4. Would it be ok if someone from the program evaluator, Econoler, called within the next month to ask you more specific questions about the equipment you installed without a rebate?
- 1. Yes, verify contact information _____
 - 2. No



F. About the Respondent

We are almost done. I have a few questions for you about your role and the company.

F1. What is your job title or role? **Interviewer: do not read, probe to code**

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: [OPEN-ENDED RESPONSE]
98. Don't know

F2. Does your company own or rent its facility at [LOCATION]?

1. Yes
2. No
98. (Don't know)
99. (Refused)

F3. Does your company have relationships with one or more lighting or mechanical contractors that you regularly turn to for advice or services?

1. Yes
2. No
98. (Don't know)
99. (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 V

SBES: Contractor Interview Guide

CONTRACTOR INTERVIEW GUIDE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Interview
Estimated Time to Complete	15 min
Target Audience	Contractors who participate in SBES projects
Expected Number of Completions	10
Contact List Source	EOne
Fielding Firm	Narrative Research
Estimated Timeline for fielding	October 26 th – November 17 th , 2023

Table 2: Research Objectives and Associated Questions

Research Objectives	Section
What is contractors' primary motivation to support businesses participating in SBES?	A1
How do contractors promote the program?	A2-A3
In what circumstances do contractors choose not to promote the program?	A4
What are the most important barriers to completing projects with SBES?	B1-B2
What is contractors' level of satisfaction with the program?	C1
How could EOne make the program more valuable for contractors?	C2-C3
Recommendations to improve the program	C4

To be adapted by Econoler **[Blue text]**

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

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



Introduction

Hello, may I speak with [Contact name]?

My name is _____ and I am calling from Narrative Research, a market research firm.

Efficiency Nova Scotia has mandated the evaluation of its Small Business Energy Solutions Program and they informed us that you or your team recently completed work for a business participating in the program. We are interested in your opinion from your perspective as a contractor. Our discussion should last about 15 minutes.

(IF NEEDED: As part of this program, a business you worked with may have received rebates and/or financing for energy efficient upgrades that you installed.)

1. Person responsible available **[CONTINUE]**
2. Person responsible currently unavailable **[ARRANGE CALL BACK WITH THE RIGHT PERSON]**
98. Don't know **[ASK TO SPEAK TO ANOTHER PERSON WHO WOULD KNOW ABOUT THE PROGRAM] [IF NEEDED: The program offers small businesses access to energy efficiency contractors, like yourself, and rebates for the installation of energy efficient upgrades. You or the client would have submitted documentation for approval before purchasing and installing your energy efficient upgrades.]**
99. Refused **[THANK AND TERMINATE]**

Do you have any questions before we start?

A. Awareness and Motivations for Participating

- A1. What is your primary motivation for helping your customers participate in the Efficiency Nova Scotia Small Business Energy Solutions program?
- A2. How, if at all, do you promote the program to your small business clients?
- A3. How often, if at all, do your clients ask you about the Small Business Energy Solutions program before you mention it to them?
- A4. In what circumstances might you choose not to recommend the program to a small business that is interested in energy efficiency?

B. Barriers

- B1. What is the most important barrier preventing your small business customers from improving the energy efficiency of their buildings or equipment?

- 
- B2. To what extent do the following factors prevent your company from completing more energy efficiency projects as part of the Small Business Energy Solutions program? Use a scale of 0 to 10, where 0 means that the factor is 'not at all a barrier' and 10 means it is 'a major barrier' in your decision.
- a. Supply chain-related delays for equipment
 - b. Limited number of qualified tradespeople
 - c. Competing projects or high demand for construction services
 - d. Not enough time to help customers with program paperwork and requirements.
- B3. **[IF B2A-D<6]** How is this factor impacting your clients that participate in the program?

C. Satisfaction with Program

- C1. On a scale of 0 to 10, where 0 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. The rebate amounts
 - b. The program application
 - c. The time for projects to be approved
 - d. Project documentation requirements
 - e. The program overall
- C2. **[IF C1A-E<8]** What is the main reason you are not more satisfied with this aspect? **[PROBE FOR SPECIFIC REASON.]**
- C3. Using a scale from 0 to 10 where 0 is "not valuable" and 10 is "extremely valuable" how valuable is the Small Business Energy Solutions program to your business?
- C4. **[IF C3>5]** What is valuable about the program for your business?
- C5. How could Efficiency Nova Scotia make the program more valuable for businesses like yours?
- C6. Other than what we have already discussed, what recommendations do you have to improve the Small Business Energy Solutions program?

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 VI

SBES: 2023 Tracking Sheet Audit

This appendix presents the main 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

Table 1 presents the corrected tracked savings resulting from all changes made by the Evaluator.

Table 1: 2023 SBES Corrected Tracked Savings

Program Component Results	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
SBES – Audit & DIY					
Gross Energy Savings – at the Generator	8.653	GWh	8.681	GWh	0.32%
Gross Peak Demand Savings – at the Generator	1.785	MW	1.790	MW	0.29%
Net Energy Savings – at the Generator	7.358	GWh	7.394	GWh	0.49%
Net Peak Demand Savings – at the Generator	1.519	MW	1.525	MW	0.35%
Commercial Direct Install (CDI) Pilot					
Gross Energy Savings – at the Generator	-	GWh	0.234	GWh	N/A
Gross Peak Demand Savings – at the Generator	-	MW	0.035	MW	N/A
Net Energy Savings – at the Generator	-	GWh	0.234	GWh	N/A
Net Peak Demand Savings – at the Generator	-	MW	0.035	MW	N/A
Total					
Gross Energy Savings – at the Generator	8.653	GWh	8.915	GWh	103.03%
Gross Peak Demand Savings – at the Generator	1.785	MW	1.825	MW	102.24%
Net Energy Savings – at the Generator	7.358	GWh	7.629	GWh	103.68%
Net Peak Demand Savings – at the Generator	1.519	MW	1.559	MW	102.65%

The SBES corrected tracked savings were slightly higher than the tracked values. This was mainly due to the missing calculated values at the generator, which were added by the Evaluator. While there were a number of discrepancies for adjustment ratios and NTGRs, the corrections were sometimes upward and sometimes downward; they therefore did not have a large impact on the corrected tracked savings.

As for the CDI pilot, no energy or peak demand savings at the generator were calculated in the tracking sheet.



APPENDIX VII

SBES: Sampling Methodology and Protocol for Desk Reviews and Site Visits

Sampling Methodology

As part of the 2023 evaluation, the Evaluator conducted 42 desk reviews of SBES projects complemented by on-site visits at the facilities of participants.

In total, 25 lighting projects, 12 HVAC projects, and five projects from other measure categories were reviewed. The Evaluator followed industry best practices as described by the Uniform Methods Project and designed a stratified random sampling plan to reduce variances by separating the population into homogeneous groups.¹ The sampling plan was developed based on the October 2023 tracking sheet that included all completed projects to date. The tracking sheet contained 1,160 projects implemented by a total of 298 participants.

Desk Review Protocol

The 2023 SBES desk review protocol was prepared based on the 2022 protocol. The measure-specific data sections provide the parameters required for savings calculations based on the data documented in the CIRx Screening Tool v1.5 and are completed with information gathered on site. These data consist of, but are not limited to, measure types, quantities, model numbers, capacities, runtime hours, and operation during peak demand periods. Most fields in the protocol were filled out prior to the on-site visits or telephone interviews, with the information in the project documentation provided by EOne. This saved time and additional details were only recorded if on-site conditions did not match the tracked information.

¹ Definition adapted from the National Renewable Energy Laboratory, "Chapter 11: Sample Design Cross-Cutting Protocol", The Uniform Methods Project, September 2014, p. 3, available at: <https://www.nrel.gov/docs/fy17osti/68567.pdf>, http://energy.gov/sites/prod/files/2015/02/f19/UMPCchapter23-estimating-net-savings_0.pdf (Last accessed 2022-12-21)

APPENDIX VIII

SBES: Free-Ridership Algorithm

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.

Table 1: FR – Audit Path

C3. If your business had not received the free audit of your facility by a certified energy auditor, would you have identified the opportunity for the energy-efficient upgrades that you installed?	IF 1. Yes: EMPTY IF 2. No OR DK OR REF: 0%
C4/C5. If your business had not received the rebate or the 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)	C4orC5 = Answer x 10% IF DK OR REF: C3orC4 = EMPTY
C6. 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)	C6 = (10 - Answer) x 10% IF DK OR REF: C5 = EMPTY
PA1 Score:	IF C3 = 0%, USE C3 OTHERWISE MEAN VALUE OF: (C4orC5; C6)
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
C9. Level of influence – 7 factors (Scale 0 to 10)	C9 = MAX(a; b; c; d; e; f; g)
PA3 Score:	(10 – C9) x 10%
C7. [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)	C7 = Answer x 10% IF 98 OR 99: C6 = EMPTY
C8. [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)	C8S = (10 - Answer) x 10% IF DK OR REF: C7 = EMPTY
PA4 Score:	Min (C6; C7)
Inconsistency Test PA1	IF ABS(C4orC5 – C6) ≥ 50% PA1 = MIN(C4orC5; C6)
Inconsistency Test PA2	IF C2 = 100% AND C4orC5 < 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

Table 2: 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. 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

Table 3: 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 IX

SBES: Spillover Algorithm

Table 1: SO – site visit

SO1. Have you installed additional energy efficiency measures other than those implemented through this program?	IF 1. Yes: CONTINUE IF 2. No OR DK OR REF: END
SO2. Did you receive, or plan on requesting, financing or rebates from other agencies other than ENS for these additional energy efficiency upgrades?	IF 2. No: CONTINUE IF 1. Yes OR DK OR REF: END
SO4. Describe these additional measures.	SO4 = SUM of kWh associated with each upgrade
Additional Upgrade Savings:	SO4
SO3. Did your experience with this program 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 X

SBES: 2023 Recommendations

This appendix summarizes all the recommendations made by the Evaluator as part of the 2023 SBES evaluation.

Section	Recommendations
Executive Summary	Recommendation #1: Consider improvements to the Customer Information System (CIS), namely by reviewing how missing entries are treated and extracting more information from the CIS to allow validating automated calculations.
Executive Summary	Recommendation #2: Consider implementing communication strategies for participants who are approaching their project expiration date.



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com



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EfficiencyOne

DEMAND RESPONSE PROGRAM

Final Report

2023 DSM EVALUATION

February 12, 2024



ECONOLUX

ABBREVIATIONS

BNI	Business, non-profit and institutional
DHW	Domestic hot water
DR	Demand response
DSM	Demand-side management
ENS	Efficiency Nova Scotia
EOne	EfficiencyOne
EUL	Effective useful life
GHG	Greenhouse gas
ISR	In-service rate
M&V	Measurement and verification
MA	Measure Assessment
MPE	Mean percent error
NS Power	Nova Scotia Power
NSUARB	Nova Scotia Utility and Review Board
NTGR	Net-to-gross 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.
Available Demand Response Capacity	The capacity which is available to NSP to reduce system peak demand. This capacity is calculated based on the first two hours of all events called between December and February, excluding weekends and holidays. If an event is shorter than two hours, only the first hour is used to measure the available DR capacity. Available DR capacity is evaluated on a per-participant basis, based on the average demand reduction observed for each event that the participant was scheduled to participate in. E1's total available DR capacity is the sum of each participant's available DR capacity.
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 base consumption.
Bias	Systematic deviations of measurements from the true value.
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.
Confidence interval	The estimated range of values that is likely to include unknown population parameters.
Demand response	Demand response measures generate savings in the form of available capacity or load reduction in response to events called by the electric utility (Nova Scotia Power) to reduce the load at strategic moments. These events can be called at any time and for any duration, although they are usually called for one to three hours during peak periods.
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 home 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 a home is through modelled home 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 equipment life and 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 CO2	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, gas 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 ratios, etc.) validated or measured during the evaluation process. Unless otherwise specified, evaluated savings are 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 a building (such as heating and cooling) due to the installation of an energy efficiency measure.
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 and 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 a program on the market (such as increased product availability, practices, and prices) that extends beyond changing program participant behaviours. 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 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. For industrial participants on an interruptible rate, peak demand savings may include savings on non-firm loads, i.e. loads that may be interrupted when Nova Scotia Power's 10-minute reserve is low.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	An error in measurement because 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.
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.
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 net-to-gross ratios. Those parameters, except 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. A 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).

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EXECUTIVE SUMMARY

This report presents the 2023 demand-side management (DSM) results of the Demand Response (DR) program administered by EfficiencyOne (EOne). This program is comprised of two components: Residential DR and Business, Non-profit, and Institutional (BNI) DR. Residential DR generated available DR capacity through the Domestic Hot Water (DHW) Direct Load Control pathway. BNI DR generated available DR capacity through the DR Aggregator pathway. Combined, these program components encourage homeowners and businesses to reduce their electric load during peak events called by Nova Scotia Power (NS Power) by providing financial incentives for the DR capacity made available for those events.

Evaluation Approach

The evaluation was aimed at calculating program component results, namely new and total available DR capacity. Table 1 summarizes the types of evaluation conducted for each program component and the corresponding methodology.

Table 1: Summary of Demand Response Program Evaluation

Program Component	Evaluation Type			Methodology
	Process	Market	Impact	
Residential Demand Response			Comprehensive	› Tracking sheet audit › Water heater controller meter data analysis › Measure Assessment (MA) update › Calculations using evaluation results
BNI Demand Response			Comprehensive	› Tracking sheet audit › Meter data analysis with project reviews and follow-up phone interviews › Calculations using evaluation results

Program Performance

Table 2 presents the participation levels and evaluated new and total available DR capacity for each program component and for the Demand Response program as a whole.

Table 2: Overall 2023 Demand Response Participation and Evaluated Results

	Participation Level		Evaluated Results	
	Value	Unit	Value	Unit
Residential DR				
New DR Capacity	63	Controllers	0.023	MW
Total DR Capacity	159	Controllers	0.058	MW
BNI DR				
New DR Capacity	9	Participants	2.365	MW
Total DR Capacity	9	Participants	2.365	MW
Total				
New DR Capacity			2.388	MW
Total DR Capacity			2.423	MW



Demand Response was aimed at achieving 3.000 MW of new and total available DR capacity at the generator for 2023. The program fell short of achieving the planned available DR capacity. Residential DR exceeded its target while BNI DR fell short of its target. BNI DR was the largest contributor to total program available DR capacity.

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

Residential DR Findings and Recommendations

This subsection presents the key findings and recommendations from the Residential DR evaluation.

2023 Res DR Finding: In 2023, Residential DR new available DR capacity amounted to 0.023 MW at the generator, while the total available DR capacity amounted to 0.058 MW at the generator, thus exceeding the planned new and available DR capacity of 0 MW.

2023 Res DR Finding: The evaluation revealed that the residential DHW load during a DR event is best estimated using the average load of the 10 eligible non-event days prior to the event without adjusting for the load observed a few hours before the event. This new baselining approach resulted in more accurate estimates although lower available DR capacity.

2023 Res DR Finding: The available DR capacity significantly differs depending on the time of day. The analysis showed that there was 20% more available DR capacity during morning events than evening events. In addition, less available DR capacity was observed in the last hour of four-hour events notably since the last hours tend to occur at a time when DHW demand is lower and more water heaters have to start up to maintain comfort.

2023 Res DR Finding: The metering data revealed that, on average, nearly one out of five controllers (in-service rate of 81% for Shifted controllers) did not generate available DR capacity during events. This was mainly because of connectivity issues since only four or fewer participants opted out of events.

2023 Res DR Recommendation 1: Ensure that the available DR capacity tracked by EOne includes the in-service rate as well as the unitary available DR capacity values.

2023 Res DR Finding: The evaluated available DR capacity determined by the Evaluator was lower than the available DR capacity tracked by EOne. This variation was due to a downward adjustment to the unitary available DR capacity resulting from the selection of a new baselining approach and lower available DR capacity per participant in the second year of participation.

BNI DR Findings and Recommendations

This subsection presents the key findings and recommendations from the BNI DR evaluation.

2023 BNI DR Finding: In 2023, BNI DR new and total available DR capacities were equal since the program was in its first year. The available DR capacities at the generator amounted to 2.365 MW, thus falling short of the targeted new and total available DR capacities of 3.0 MW.

2023 BNI DR Finding: Participation in DR events was very high with only one participant not participating in one event, which was due to the timeline being too short between receiving the notification and having to reduce the load.



2023 BNI DR Finding: Overall, the measurement and verification (M&V) guidelines developed by EOne were appropriate and were generally followed. The Evaluator concluded that the baseline methodology used by EOne (top six-of-ten with same-day scalar adjustment factor) was appropriate, although using an additive same-day adjustment would better follow best practices.

2023 BNI DR Recommendation 1: Use an additive same-day adjustment factor to establish the baseline load instead of a scalar same-day adjustment factor.

2023 BNI DR Finding: Evaluated available DR capacity considerably varied from event to event and rarely met the enrolled DR capacity. Available DR capacity is expected to be a reliable resource to reduce the electric system load during peak events; thus, it is important to establish robust estimates on expected available DR capacity (enrolled DR capacity) and avoid as much as possible large variability between event performance levels.

2023 BNI DR Recommendation 2: Establish enrolled capacity based on test events when feasible. This approach would be consistent with M&V guidelines. The Evaluator recognizes that it is possible that test events cannot be performed or that internal capacity requires other options. If that is the case, EOne should review the engineering calculations used to determine enrolled capacity to ensure they are realistic.

2023 BNI DR Finding: The available DR capacity significantly differs depending on the time of day with available DR capacity being higher during the morning peak period than the evening peak period.

2023 BNI DR Recommendation 3: Determine which participants are best suited for morning events only, evening events only, or morning and evening events. Events should be called based on each participant's potential, and enrolled capacity should be established based on the selected time of day.

2023 BNI DR Finding: The evaluated available DR capacity determined by the Evaluator was slightly higher than the available DR capacity tracked by EOne. The difference was due to the new definition of available DR capacity used for this evaluation using the first two hours of all events, while the tracked available DR capacity was established using all event hours.

Program Tracked and Evaluated Savings

Table 3 below shows a comparison of EOne tracked available DR capacity compared to evaluated results as well as the realization rate.

Table 3: Comparison of 2023 Tracked and Evaluated Savings at the Generator

		Available DR Capacity		Realization Rate
		Value	Unit	
Residential DR	New Available DR Capacity			
	Tracked Available DR Capacity by EOne	0.027	MW	85%
	Evaluation Results	0.023	MW	
	Total Available DR Capacity			
	Tracked Available DR Capacity by EOne	0.073	MW	79%
	Evaluation Results	0.058	MW	
BNI DR	Available DR Capacity			
	Tracked Available DR Capacity by EOne	2.254	MW	105%
	Evaluation Results	2.365	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 demand-side management (DSM) services for Nova Scotians. EOne provides energy efficiency, demand response (DR), and carbon mitigation services through the Efficiency Nova Scotia (ENS) franchise. Regulatory oversight is provided by the Nova Scotia Utility and Review Board (NSUARB). EOne receives funding for its electricity DSM activities from Nova Scotia Power (NS Power) ratepayers.

EOne has a DSM portfolio of three residential programs, three business, non-profit, and institutional (BNI) programs, and one DR program that are marketed to Nova Scotians through the ENS franchise. Each program has one or more program components. Econoler was commissioned by EOne to evaluate EOne's 2023 DSM program portfolio.

This evaluation report relates to the DR program comprised of the Residential DR and Business, Non-profit and Institutional (BNI) DR program components. Residential DR generated available DR capacity through the Domestic Hot Water (DHW) Direct Load Control pathway. BNI DR generated available DR capacity through the DR Aggregator pathway.

Table 4 lists the DR program components and the types of evaluations conducted in 2023.

Table 4: Types of Evaluations Conducted for Each Program Component, 2023

Program	Program Component	Pathway	2023		
			Process	Market	Impact
Demand Response	Residential Demand Response	DHW Direct Load Control			Comprehensive
	BNI Demand Response	DR Aggregator			Comprehensive

For the DR program, the Evaluator has prepared a DSM evaluation report presenting key findings as well as new and total available DR capacity. The savings generated through DR initiatives are called new and total available DR capacities. New DR capacity differs from total available DR capacity, the former corresponding to added DR capacity compared to the previous year while the latter corresponds to the total DR capacity that was still available during the evaluated period. Both metrics are presented in this report to align with EOne targets.

Available DR capacity differs from peak demand savings reported in other DSM evaluation reports since the former considers the potential load reduction that was made available instead of the actual load reduction that coincided with the actual utility peak. This distinction was made since EOne does not control the calling of events and thus does not control how the resources made available to NS Power are used to reduce peak demand.



Available DR capacity will be evaluated based on events called from December to February excluding weekends and holidays. Events called at anytime during the day (morning or evening) are included. Available DR capacity is measured over the first two hours of a DR event. Throughout this report, average available DR capacity is presented separately for morning and evening periods¹ for information purposes only, yet available DR capacity is evaluated on a per-participant basis based on the average demand reduction observed for each event that the participant was scheduled to participate in regardless of whether events are in the morning or evening. EOne's total available DR capacity is the sum of each participant's available DR capacity. In addition, reported available DR capacity corresponds to those that occurred during the winter and that ended during the evaluated year, e.g. the 2023 available DR capacity corresponds to the DR capacity made available between December 2022 and February 2023 inclusively.

¹ Available DR capacity for morning peak events includes all events prior to 12 p.m. and available DR capacity for evening peak events includes all events between 12 p.m. and 12 a.m. However, the events are typically called around 7 a.m. and 5 p.m.

1 Residential DR Overview

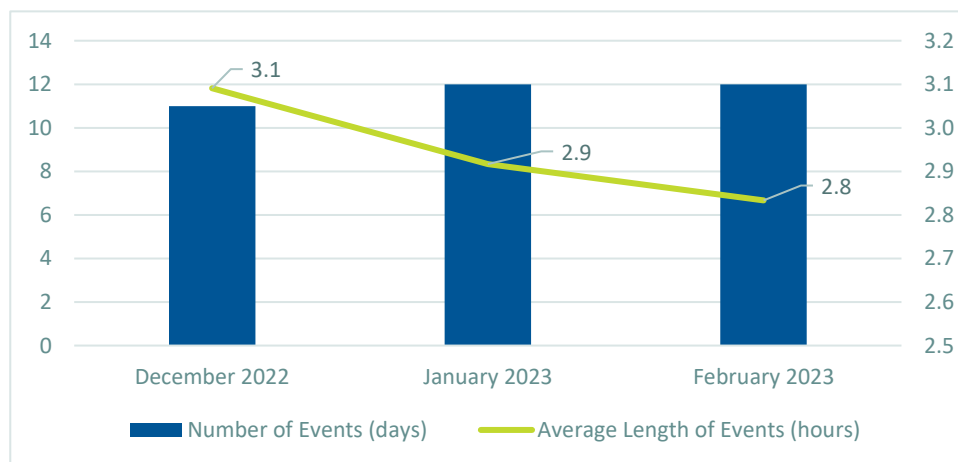
This section describes the Residential Demand Response (DR) program component, follows up on past evaluation recommendations, and provides an overview of Residential DR participation history.

1.1 Residential DR Description

In 2023, EOne officially launched the Residential DR program. Since the fall 2020, EOne implemented several pilot initiatives focused on reducing demand during the Nova Scotia peak period. One of them was the Domestic Hot Water (DHW) Direct Load Control Pilot launched in the fall 2020, which is now a pathway in the Residential DR program component.

Through the DHW Direct Load Control pathway, DHW load control devices are provided by the service provider, Shifted,² and installed in residential households by an installer (Trinity Energy Group), and DR events are called by NS Power. When events are called, Shifted's control software remotely turns off water heaters to reduce the load during event windows. The Shifted algorithm looks at energy usage and forecasting to determine if a tank needs reheating for customer comfort during a load reduction event. If the participant has DHW demand, i.e. they use hot water, the algorithm picks up that usage and predicts further usage for the rest of the event, and when some thresholds are met, it automatically opts out participants. Events can last from two to four hours and be called at anytime, although NS Power focuses on the peak period with most events starting at 7 am or 5 pm on weekdays. As presented in Figure 1, NS Power called 35 events during the 2022-23 winter peak season.

Figure 1: Overview of Residential DR Participation, 2022-2023



No target was set for Residential DR new and total available DR capacity at the generator in 2023.

1.2 Follow-up on Past Evaluation Report Recommendations

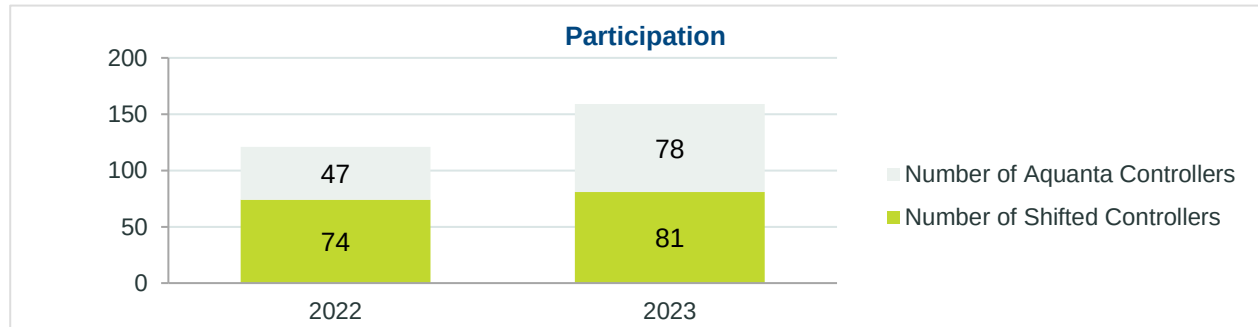
The Evaluator evaluated the DHW Direct Load Control Pilot for the first time in 2022 and did not issue improvement recommendations.

² During the first year of the pilot, Aquanta controllers were also installed. In 2023, EOne decided to continue only with Shifted controllers. Hence, EOne started switching Aquanta controllers to Shifted units.

1.3 Participation History

As presented in Figure 2 below, Residential DR had a total of 159 controllers (81 Shifted and 78 Aquanta) generating available DR capacity in 2023, which represents a 31% increase in the total number of controllers compared to 2022. Although Aquanta controllers are no longer being installed, many still generated available DR capacity in 2023. There were 63 new controllers (22 Shifted and 41 Aquanta) that contributed to the new available DR capacity in 2023. The new Aquanta controllers were installed prior to the decision to install only Shifted controllers.

Figure 2: Overview of Residential DR Participation, 2022-2023



2 Residential DR Evaluation Approach

The 2023 Residential DR evaluation comprised a condensed impact evaluation. The main objective of the 2023 Residential DR evaluation was as follows:

- › Calculate residential DR results, namely new and total available DR capacity

The Evaluator identified key research questions aimed at achieving this objective. Table 5 outlines the Residential DR evaluation objectives and maps them to the research questions and methods established by the Evaluator. Each method is described further below.

Table 5: 2023 Residential DR Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Establish available DR capacity results for the Domestic Hot Water Direct Load Control pathway	› Are the data in the tracking sheet complete, accurate, and consistent? › What was the average unitary available DR capacity achieved by participants with a Shifted device during DR events? › Did participants' systems³ respond to all DR events? › What is the new and total amount of available DR capacity enrolled in the pathway?	› Tracking sheet audit › Water heater controller meter data analysis › Measure Assessment (MA) update › Calculations using evaluation results

Tracking Sheet Audit

Prior to performing the available DR capacity calculation review, the Evaluator audited the final 2023 tracking sheet to ensure it was complete and the entered data were consistent. The results obtained are presented in Appendix I.

Water Heater Controller Meter Data Analysis

One of the main objectives of the 2023 evaluation was to update the baseline methodology and, as data permit, to improve the accuracy of 2022 unitary available DR capacity. To review the baseline methodology, the Evaluator used an in-house tool that serves to compare the predicted baseline to the actual baseline on days when no events were called. Building on the analysis conducted in 2022, the Evaluator analyzed 2022 and 2023 meter data from DHW Direct Load Control participants and performed several analyses to determine the average DR capacity per controller made available during DR events called by NS Power. The Evaluator analyzed several baseline definitions to determine the baseline that provides the most accurate prediction of the baseline. With this updated baseline, the Evaluator developed new unitary available DR capacity specifically for Shifted controllers since Aquanta controllers are no longer being installed. However, many of the Aquanta controllers installed in 2022 or early in 2023 still generated available DR capacity in 2023. For Aquanta controllers, the Evaluator relied on the 2022 unitary available DR capacity and in-service rates and applied these to the 2023 participation level. The detailed methodology and results obtained are presented in Subsection 3.2.2. The 2020-2022 Measure Assessment⁴ was updated accordingly.

³ Herein, systems refer to water heaters with a load control device.

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 collected data, the Evaluator calculated the new and total amount of available DR capacity as per the calculation methodology presented in Section 3 below.

Note on Margins 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 Residential DR evaluation, the Evaluator calculated the margins of error for unitary available DR capacity and in-service rates. 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 2023 DSM Programs Evaluation Executive Summary.

⁵ Precision refers to how reproducible a set of measurements is. Moreover, 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 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 Residential DR Impact Evaluation

The objective of the 2023 Residential DR impact evaluation was to determine new and total available DR capacity.

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 Appendix I. The tracked available DR capacity results presented in this report therefore refer to the corrected tracked available DR capacity obtained by the Evaluator.

3.2 Demand Response Capacity

For Residential DR, savings are referred to as available DR capacity and correspond to the load reduction made available for peak demand events in participants' homes. For the DHW Direct Load Control pathway, the Evaluator established in-service rates (ISRs) and unitary available DR capacity values that were multiplied by the number of controllers to obtain the evaluated available DR capacity. This subsection presents both the new and total available DR capacities generated through Residential DR.

3.2.1 In-service Rates

For the DHW Direct Load Control pathway, the ISR corresponds to the average percentage of systems⁷ that responded to DR events; it is obtained by dividing the number of online and active controllers by the total number of installed controllers. While only a few participants opted out of some events (between 1 and 4), a more substantial number of controllers had connectivity issues throughout the events, which impacted the number of systems actually providing load reductions.

The Shifted ISR was updated using 2023 data, while the Evaluator relied on the 2022 value for the Aquanta ISR. The overall ISR for Shifted was 81% while it was 82% for Aquanta, as presented in Table 6. The ISR remained stable compared to 2022 when the Evaluator established the Shifted ISR at 83%.

Table 6: Average In-service Rate

	Shifted	Aquanta
In-service Rate	81%	82%
Margin of Error	4%	2%

3.2.2 Unitary Available DR Capacity

For the DHW Direct Load Control pathway, EOne and the Evaluator rely on a unitary available DR capacity value, more precisely the average available DR capacity per controller. The main objectives of the 2023 evaluation were to update the baseline methodology and, as data permit, to improve the accuracy of 2022 unitary available DR capacity estimates for Shifted controllers as Aquanta controllers are no longer being installed. Building on the analysis conducted in 2022, the Evaluator analyzed 2022 and 2023 controller meter data to determine an average DR capacity per controller. The 2020-2022 Measure Assessment was updated accordingly.

⁷ Herein, systems refer to water heaters with a load control device.

Baseline Definition Selection

Baselines for DR events are often established based on an average of similar days prior to the actual event. This is the approach adopted by EOne, and the Evaluator aimed to refine this approach by considering multiple variations to the baseline scenarios and comparing the resulting baseline consumption to actual consumption on non-event days. Since events were called almost every time there were peak conditions on the electrical grid (i.e. on cold days), the Evaluator considered whether it was appropriate to use non-event days to test baseline definitions. An analysis of the DHW load on non-event days demonstrated that this load was not correlated to outdoor air temperature and, therefore, non-event days were comparable to event days. Appendix II details the baseline definition selection.

The Evaluator analyzed several baseline definitions herein called scenarios. For each scenario, the Evaluator established the mean percent error (MPE). The MPE provides a sense of how close the estimate average load is to the actual average load. The MPE is better as it gets closer to 0%, meaning that the average estimated consumption was close to actual consumption.

Since it was the best scenario for evening and the second best for mornings by a small margin, the Evaluator used the following scenario:

- › Average load of the 10 eligible non-event days prior to the event without adjusting for the load observed a few hours before the event.

This scenario is coherent with the finding that DHW loads are not influenced by outdoor air temperature and, therefore, the average of days prior to the event is expected to be representative of the baseline. The selected scenario has a MPE of 6.1% for mornings and 2.3% for evenings, while the previous baseline had a MPE of 18.5% and 14.2% respectively, thus meaning that the new baseline estimates predicted the load 12% more precisely than the previous baseline.

Average DR Capacity

Once the most accurate baseline methodology was selected, the Evaluator established the available DR capacity for each event in 2022 and 2023. As presented in Table 7 below, applying the new baseline methodology resulted in average available DR capacity per enrolled controller of 385 W with a margin of error below the 10% threshold. The Evaluator also included, for information purposes, the average available DR capacities for each event hour and throughout the events as well as differentiated between morning and evening events. However, the unitary available DR capacity value to use for reporting is the value for the first two hours of the events.

Table 7: Average Available DR Capacity per Controller

Event Period	Average Available DR Capacity (W)					
	1 st Hour	2 nd Hour	3 rd Hour	4 th Hour	Average Throughout Events	Average Throughout First Two Hours
Morning	497	363	356	245	407	430
Evening	424	294	336	217	344	359
Overall	451	319	343	224	367	385 ± 3%

As can be observed in the table above, available DR capacity tends to decrease over time. There are two main reasons for this. First, the baseline load at each hour of the day varies, for example the average load at 10 am is considerably lower than at 7 am and 8 am, thus leaving less load reduction potential. Second, more and more water heaters have to start up as the event progresses over time since participants continue using their hot water.

Compared to the unitary available DR capacity value of 559 W from the 2022 evaluation, the 2023 unitary values represent a decrease of 31%. The change in baseline methodology explains 17% of this reduction in available DR capacity, the rest being the result of lower available DR capacity in 2023 compared to 2022. Indeed, using the same methodology as in 2022 would have resulted in a unitary available DR capacity 14% lower than in 2022.

3.2.3 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. For the DHW Direct Load Control pathway, the Evaluator assumed that only negligible interactive effects occur since the temperature of the tank (which exchanges heat with ambient air) will only be lowered by a few degrees.

3.2.4 Effective Useful Life

As part of the 2020-2022 Measure Assessment activities, the Evaluator reviewed the effective useful life (EUL) values used in the calculation of electrical energy savings that are expected to persist over time. For the DHW Direct Load Control pathway, the EUL value established in 2022 evaluation remained valid for the 2023 evaluation. Although no electrical energy savings were expected from DR initiatives, the Evaluator established an EUL value since the available DR capacity can persist overtime.

For the DHW Direct Load Control pathway, an EUL value of 1 year should be used with total available DR capacity since participation includes all active controllers, not only new installed controllers; therefore, the available DR capacity of a participant will be counted each year and do not need to be extrapolated over their lifetime. The average number of winters during which participants subscribe to the program should be used as the EUL value with new available DR capacity. In 2023, 80% of participants reenrolled. Assuming a fixed drop-out rate of 20%, the Evaluator calculated an EUL of 7 years. It should be noted that the program being only in its second year, only limited data are available on how long participants will remain in the program, thus this EUL value should be used with caution.

3.2.5 Evaluated New and Total Available DR Capacity

Available DR capacity is obtained by multiplying the number of installed units by the ISR and the unitary available DR capacity value as presented in the equations below. In addition, some participants had their controller installed during the evaluated period. Available DR capacity for these participants was prorated based on the number of days that the controllers were installed during the 90-day period.

$$\text{Available DR Capacity} = \text{Number of Controllers} \times \text{ISR} \times \text{Unitary Savings} \times \%PPIC$$

$$\begin{aligned} \text{Portion of Peak Period with Installed Controllers (\%PPIC)} \\ = \frac{\text{Average Number of Peak Period Days with Installed Controllers}}{90 \text{ days}} \end{aligned}$$

Table 8 and Table 9 below respectively present the new and total available DR capacity results for Residential DR in 2023. The new and total available DR capacities amounted to 0.023 MW and 0.058 MW at the generator respectively.

The available DR capacity at the generator was estimated using the residential line loss factor. 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

Table 8: Evaluated 2023 Residential DR New Available DR Capacity

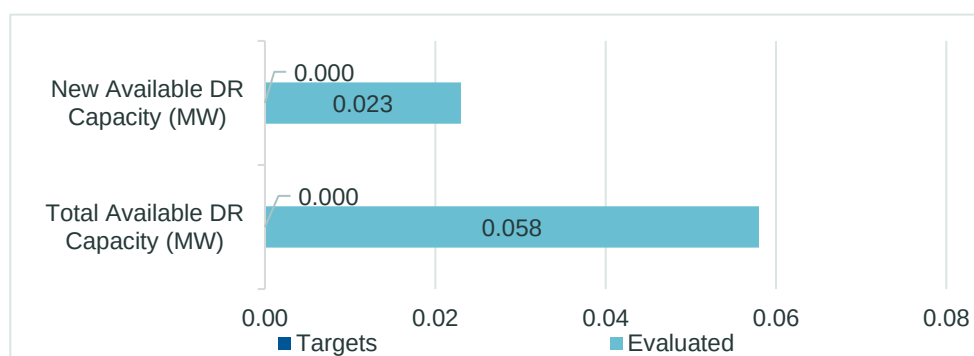
	Shifted	Aquanta	Total
Number of Units	22	41	63
In-service Rate (%)	81%	82%	-
Unitary Available DR Capacity (W/controller)	385	403	-
Portion of Peak Period with Installed Controllers	99%	98%	-
Available DR Capacity – at the Meter (MW)	0.007	0.013	0.020
Line Loss Factor	1.1466	1.1466	-
Available DR Capacity – at the Generator (MW)	0.008	0.015	0.023

Table 9: Evaluated 2023 Residential DR Total Available DR Capacity

	Shifted	Aquanta	Total
Number of Units	81	78	159
In-service Rate (%)	81%	82%	-
Unitary Available DR Capacity (W/controller)	385	403	-
Portion of Peak Period with Installed Controllers	98%	99%	-
Available DR Capacity – at the Meter (MW)	0.025	0.025	0.050
Line Loss Factor	1.1466	1.1466	-
Available DR Capacity – at the Generator (MW)	0.028	0.029	0.058

Figure 3 outlines the net evaluated and targeted available DR capacity.

Figure 3: 2023 Residential DR Targets and Evaluated Available DR Capacity



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

3.3 Realization Rate

Table 10 below compares the new and total available DR capacities established through this evaluation to those tracked in the 2023 tracking sheet. The realization rates, representing the ratio of evaluated available DR capacity to tracked available DR capacity, were established at 85% and 79% for new and total available DR capacity respectively.

**Table 10: Comparison of 2023 Residential DR Tracked and Evaluated
New and Total Available DR Capacities at the Generator**

	Available DR Capacity		Realization Rate Value
	Value	Unit	
New Available DR Capacity			
Tracked Available DR Capacity by EOne	0.027	MW	85%
Evaluation Results	0.023	MW	
Total Available DR Capacity			
Tracked Available DR Capacity by EOne	0.073	MW	79%
Evaluation Results	0.058	MW	

Evaluated new and total available DR capacities were 15% to 21% lower than the values tracked by EOne respectively. The differences are due to the updated unitary available DR capacity values.



4 Residential DR Key Findings and Recommendations

As mentioned previously, the main objective of the 2023 Residential DR evaluation was as follows:

- › Calculate Residential DR results, namely new and total available DR capacity.

This section provides the Evaluator's key findings in relation to this objective.

2023 Res DR Finding: Residential DR new and total available DR capacities exceeded targets.

In 2023, Residential DR new available DR capacity amounted to 0.023 MW at the generator, while the total available DR capacity amounted to 0.058 MW at the generator, thus exceeding the planned new and available DR capacity of 0 MW.

2023 Res DR Finding: The new baselining approach selected through the 2023 evaluation resulted in more accurate estimates.

The residential DHW load during a DR event is best estimated using the average load of the 10 eligible non-event days prior to the event without adjusting for the load observed a few hours before the event. This new baseline resulted in predicted loads that have small margins of error and is consistent with the observed DHW load patterns that are not influenced by outdoor air temperatures. This new baseline, in turn, resulted in lower available DR capacity.

2023 Res DR Finding: The available DR capacity significantly differs depending on the time of day.

The analysis showed that the available DR capacity per controller is 430 W for mornings and 359 W for evenings, which corresponds to 20% more available DR capacity in mornings. In addition, less available DR capacity was observed in the last hour of four-hour events, notably since the last hours tend to occur at a time when DHW demand is lower and more water heaters have to start up to maintain comfort.

2023 Res DR Finding: On average, four out of five controllers responded to DR events primarily due to connectivity issues.

The metering data revealed that, on average, nearly one out of five controllers (in-service rate of 81% for Shifted controllers) did not generate available DR capacity during events. This was mainly because of connectivity issues since only four or fewer participants opted out of events.

2023 Res DR Recommendation 1: Ensure that available DR capacity tracked by EOne include the in-service rate as well as the unitary available DR capacity values.

2023 Res DR Finding: The evaluated available DR capacity determined by the Evaluator was lower than the available DR capacity tracked by EOne.

The evaluated new and total available DR capacities were 15% and 21% lower than the values tracked by EOne respectively. This variation was due to a downward adjustment to the unitary available DR capacity resulting from the selection of a new baselining approach and lower available DR capacity per participant in the second year of participation.

5 BNI DR Overview

This section describes the Business, Non-profit, and Institutional (BNI) Demand Response (DR) program component, follows up on past evaluation recommendations, and provides an overview of BNI DR participation history.

5.1 BNI DR Description

In 2023, EOne officially launched the BNI DR program. Since the fall 2020, EOne implemented several pilot initiatives focused on reducing demand during the Nova Scotia peak period. One of them was the DR Aggregator Pilot launched in the fall 2022, which is herein considered a pathway within the BNI DR program component.

Through the DR Aggregator pathway, EOne hires aggregators that subscribe groups of BNI customers that can reduce their load upon request. While some participants were recruited through a different aggregator, IPKeys Power Partners was the aggregator in charge of the DR Aggregator Pilot for the period covered by this evaluation. When DR events are called by NS Power, aggregators either remotely control some energy consuming systems in participant buildings or they contact participants to deploy their load reduction procedure that was developed with support from their aggregator. The actions taken to reduce loads typically include shutting down electricity consuming systems such as: space heating or cooling (sometimes accompanied by pre-heating or pre-cooling), ventilation, water heating, or lighting.

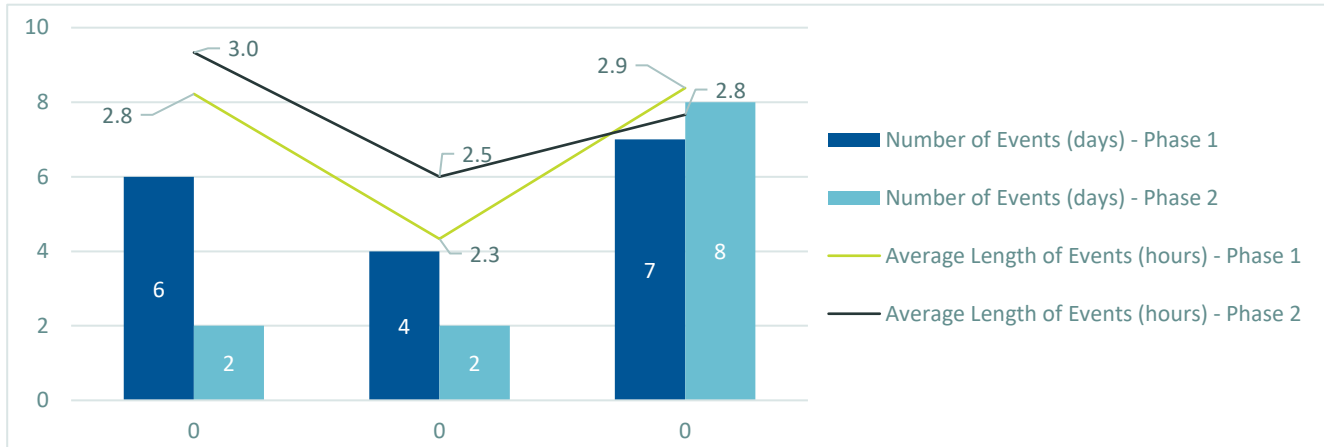
Participants were recruited in two phases with different event scheduling criteria that are presented in Table 11. Event criteria for Phase 2 participants will be used for new participants going forward.

Table 11: DR Aggregator Event Criteria

	Phase 1	Phase 2
Pilot Season	Winter is from December through February.	
Event Windows	From 7:00-11:00 am and 5:00-9:00 pm, Monday to Friday excluding holidays, during winter.	
Event Initiation Criteria	Events are called based on NS Power's day ahead forecasting of times of high load, often corresponding with colder temperatures.	
Number of Events	No maximum.	Maximum of 12 events per season.
Event Durations	Maximum event duration of 4 hours. All events must be entirely contained within the event windows.	
Event Frequency	No more than 3 events called within any given week (Monday to Friday).	No more than 1 event called per day. No more than 3 events called within any given week (Monday to Friday). No more than 2 events called on consecutive days.
Event Notification	NS Power provides notice to IPKeys by 4:00 pm the day before an event is scheduled.	

As presented in Figure 4 below, NS Power called 17 and 12 events during the 2022-23 winter peak season for Phase 1 and Phase 2 participants respectively.

Figure 4: DR Aggregator 2023 Events



BNI DR aimed at achieving 3.0 MW in new and total available DR capacities at the generator in 2023. While new and total available DR capacities are two metrics reported separately, no distinction is made between both throughout this section as they are equal due to this being the first year of the program.

Throughout this report, **enrolled** available DR capacity corresponds to the potential available DR capacity estimated by the aggregator when a participant is recruited, i.e. before participating in the program. **Tracked** available DR capacity corresponds to the available DR capacity established by EOne based on metering data, while **evaluated** available DR capacity corresponds to the available DR capacity established by the Evaluator.

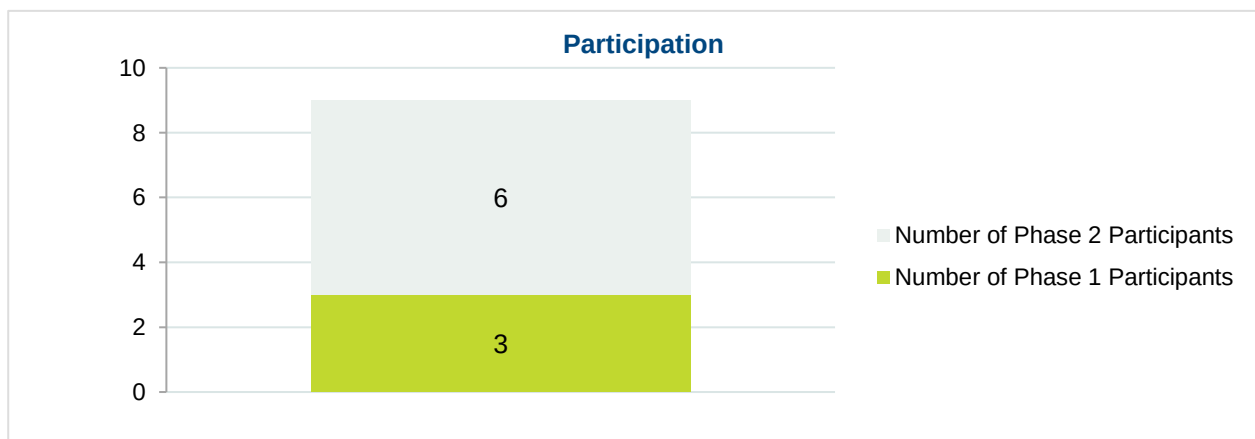
5.2 Follow-up on Past Evaluation Report Recommendations

The Evaluator evaluated BNI DR for the first time in 2023 and has therefore not issued previous improvement recommendations.

5.3 Participation History

As presented in Figure 5, BNI DR had a total of nine participants in 2023.

Figure 5: Overview of BNI DR 2023 Participation



Participation in Events

Through project reviews and follow-up calls with participants, the Evaluator confirmed that participants almost always participated in DR events. Only one participant mentioned not participating in an event because of the short timeline between receiving the notification and having to reduce the load. Also, one participant did not participate in the first events of the season as they were recruited later.

6 BNI DR Evaluation Approach

The 2023 BNI DR evaluation comprised a comprehensive impact evaluation. The main objective of the 2023 BNI DR evaluation was as follows:

- › Calculate BNI DR results, namely new and total available DR capacities

The Evaluator identified key research questions aimed at achieving this objective. Table 12 outlines the BNI DR evaluation objective and maps it to the research questions and methods established by the Evaluator. Each method is described further below.

Table 12: 2023 BNI DR Evaluation Approach

Evaluation Objectives	Research Questions	Methodology
Establish available DR capacity results for the DR Aggregator pathway	› Are the data in the tracking sheet complete, accurate, and consistent? › Did participants respond to all DR events? › Was each participant's available DR capacity estimates developed according to best practices? › Are the measurement and verification (M&V) guidelines appropriate for the types for project completed? › What is the most appropriate baseline load estimation approach for each participant? › How much available DR capacity did each participant achieve on average during events? › What was the evaluated available DR capacity for each DR event? › How does the evaluated available DR capacity compare to the enrolled available DR capacity for each participant? › How does the evaluated available DR capacity compare to tracked estimates? › What additional adjustments should be considered to improve tracked estimations? › What are the evaluated new and total available DR capacities achieved through the pathway?	› Tracking sheet audit › Meter data analysis (n=9) with project reviews (n=9) and follow-up phone interviews (n=8) › Calculations using evaluation results

Tracking Sheet Audit

Prior to performing the available DR capacity calculation review, the Evaluator audited the final 2023 tracking sheet to ensure it was complete and the entered data were consistent. The results obtained are presented in Appendix VI.

Meter Data Analysis with Project Reviews and Follow-up Phone Interviews

For each project, the Evaluator reviewed how tracked available DR capacities were established. The Evaluator reviewed the baseline methodology based on both data analysis results and findings from a literature review. The project reviews included short interviews with participants to validate implemented measures. The Evaluator also used this activity to analyze the available DR capacity per hour as well as during morning and evening events. The results obtained are presented in Subsection 7.2.1 below.

Calculations Using Evaluation Results

Building on all the above methods and collected data, the Evaluator calculated the new and total amount of available DR capacity.

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 precision⁹ of a measurement, while its associated confidence level indicates the probability of a measurement falling within the margin of error.¹⁰

Since all BNI DR projects were reviewed and no result was or will be extrapolated to other projects, no margin of error was calculated for BNI DR.

⁹ 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.

¹⁰ As part of this evaluation, the confidence levels and 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 BNI DR Impact Evaluation

The objective of the 2023 BNI DR impact evaluation was to determine new and total available DR capacities.

7.1 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 Appendix VI. The tracked available DR capacity results presented in this report therefore refer to the corrected tracked available DR capacity obtained by the Evaluator.

7.2 Demand Response Capacity

For BNI DR, savings are referred to as available DR capacity and correspond to the load reduction made available for peak demand events in participating businesses.

7.2.1 Meter Data Analysis and Project Reviews

Baseline Methodology Review

For the Aggregator pathway, available DR capacity is established by comparing the predicted loads (baseline) to the actual loads during DR events using meter data. Baselines for DR events are often established based on an average load during similar days prior to an actual event, which was the approach adopted by EOne. More precisely, the baseline was the average load during the same hours of the event for the six days with the highest loads among the ten eligible days prior to an event (top six-of-ten), to which a same-day scalar adjustment factor was applied. For the Aggregator pathway, the eligible days correspond to non-holiday weekdays excluding event days and days preceding an event.¹¹ The same-day scalar adjustment factor is a ratio comparing the average load of the selected baseline days for a two-hour window starting three hours before the event (e.g. the load during 2 pm and 3 pm for an event starting at 5 pm) to the load on the event day for the same hours.

The Evaluator analyzed the morning and evening consumption on cold days ($<0^{\circ}\text{C}$) for each participant individually to determine whether loads were weather dependent or not. Indeed, using a top six-of-ten baseline tends to overestimate baselines if loads are actually not higher than the average on peak days (i.e. if they were not weather dependent). In summary, one participant had strongly weather dependent loads and two others had moderately weather dependent loads, while the loads of the other participants were not weather dependent. While a top six-of-ten would ideally be applied only to weather dependent loads, the Evaluator tested and validated that the same-day adjustment factor significantly compensates for this overestimation on non-weather dependent loads. This was reinforced by findings from the literature such as: “In this regard, different quantitative assessments can be found in the literature, all concluding that applying a same-day adjustment significantly increases the accuracy, whereas other parameters (such as the values of X and Y) have a minor impact on the overall performance (in particular in case a same day adjustment is applied).”¹²

¹¹ For Phase 1 projects, days preceding event days were not excluded.

¹² Elia Group, *Baseline methodology assessment*, September 24, 2021, p.5.

Therefore, the Evaluator agreed that using a top six-of-ten baseline with a same-day adjustment factor was an acceptable baseline methodology. Its tendency to overestimate the available DR capacity for non-weather dependent loads is limited, and a ten-of-ten baseline would slightly underestimate the available DR capacity for weather-dependent loads. In addition, a top six-of-ten baseline is likely to produce realistic results on average for participants since the grid load as a whole is weather dependent.

The Evaluator analyzed the implemented measures to ensure that no significant change in consumption occurred during the same-day adjustment factor period. To do so, the Evaluator validated with participants, during follow-up interviews, which measures were taken when an event was called. While some participants confirmed pre-heating or pre-cooling, they all confirmed that it started one hour or less before the event; this confirmed the validity of the period used for the same-day adjustment factor. Although the Evaluator mostly agreed with the EOne baseline methodology, one adjustment to the methodology was made since it was recommended in almost all reference documents from the literature; the Evaluator used an additive same-day adjustment instead of a scalar adjustment.¹³ The baseline load was capped at zero, meaning it could not be negative (this cap was applied for one participant in one event).

Available DR Capacity

Table 13 below presents the evaluated average available DR capacity for each project using the revised baseline methodology as well as the enrolled and tracked available DR capacity. Throughout this report, enrolled available DR capacity corresponds to the potential available DR capacity estimated by the aggregator when a participant is recruited, i.e. before participating in the program. Tracked available DR capacity corresponds to the available DR capacity established by EOne based on metering data, while evaluated available DR capacity corresponds to the available DR capacity established by the Evaluator.

Table 13: Average Available DR Capacity per Project

Project	Average Available DR Capacity (kW)								Percentage Evaluated (Two First Hours) Compared to Enrolled	Percentage Evaluated (Two First Hours) Compared to Tracked
	Enrolled*	Tracked*	Evaluated							
			1 st Hour	2 nd Hour	3 rd Hour	4 th Hour	Average Throughout Events	Average Through Two First Hours		
1	500	1,045	1,383	1,005	1,001	23	1,082	1,194	239%	114%
2	715	705	670	645	685	284	641	658	92%	93%
3	100	39	13	22	57		23	18	18%	49%
4	150	31	25	28	38	10	28	26	18%	85%
5	275	59	62	72	58	28	63	67	24%	114%
6	385	180	224	190	129	-10	177	207	54%	118%
7	30	12	11	11	17	-1	12	11	37%	90%
8	30	37	18	39	70	55	39	29	96%	77%
9	20	18	20	23	24	16	22	22	108%	122%
Total	2,205	2,126	2,427	2,035	2,078	403	2,086	2,231	101%	105%
*Enrolled and tracked available DR capacity values were established by EOne based on the entire length of events. The definition of available DR capacity was modified after EOne estimated those values to include only the first two hours of these events.										

¹³ Additive adjustments add (or subtract) to the baseline load during an event the difference between the baseline and event load during the same-day adjustment period, while a scalar adjustment is a ratio between the baseline and event load during the same-day adjustment period and that multiplies the baseline load during event time.

Comparison of Enrolled and Evaluated Available DR Capacity

In a few years, available DR capacity is expected to be a reliable resource to reduce electric system loads during peak events; thus, it is important to establish good estimates of expected available DR capacity (enrolled DR capacity).

As presented in Table 13 above, two thirds of participants did not achieve their enrolled DR capacity. EOne indicated that the enrolled capacity values were estimated by the service provider based on engineering estimates for each piece of equipment that the facility planned on curtailing. Test events should instead be used, as per M&V guidelines, to establish the potential. While the DR Aggregator M&V Guidelines indicate that test events are to be performed to establish enrolled DR capacities, these test events were not carried out before the 2022-23 season due to time constraints. If no test events are completed and the enrolled capacity is based on calculations, EOne should review the aggregator calculations to ensure the realism of expected DR capacity.

Impact of Timing on Available DR Capacity

A major finding of this impact evaluation is that the timing of events significantly impacts the magnitude of available DR capacity achieved by participants.

Table 14 and Table 15 below respectively present the average morning and evening available DR capacity for each project.

Table 14: Average Morning Available DR Capacity per Project

Project	Average Available DR Capacity (kW)				
	1 st Hour	2 nd Hour	3 rd Hour	4 th Hour	Average Through Two First Hours
1	1,317	1,617	1,766	-	1,467
2	703	729	802	-	716
3	11	19	49	-	15
4	38	45	60	-	41
5	48	67	70	-	57
6	336	291	214	-	313
7	18	14	17	-	16
8	34	48	90	-	41
9	29	35	31	-	32
Total	2,534	2,865	3,099	-	2,700

Table 15: Average Evening Available DR Capacity per Project

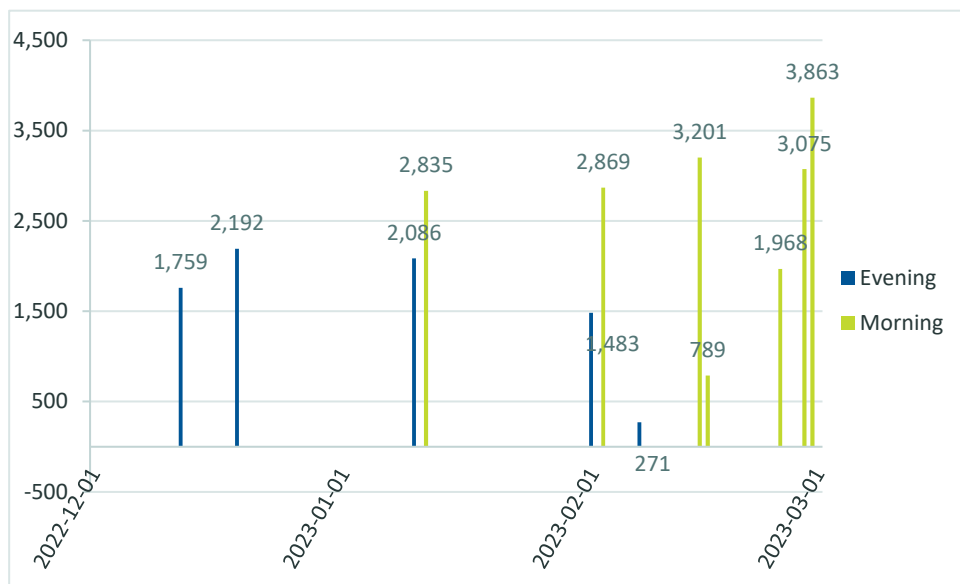
Project	Average Available DR Capacity (kW)				
	1 st Hour	2 nd Hour	3 rd Hour	4 th Hour	Average Through Two First Hours
1	1,475	148	-19	23	811
2	625	527	529	284	576
3	0	0	0	0	0
4	6	4	9	10	5
5	83	79	41	28	81
6	68	49	16	-10	58
7	8	10	17	-1	9
8	11	36	51	55	24
9	16	18	18	16	17
Total	2,292	871	661	403	1,581

As outlined in Table 14 and Table 15 above, available DR capacity significantly differs between morning and evening as well as between each hour. Indeed, morning available DR capacity was almost two times higher than evening available DR capacity. This is mainly due to Project 1, the largest project with nearly 50% of evaluated available DR capacity having little potential load reduction after 6 pm, therefore resulting in low available DR capacity for evening events. There were also multiple other instances indicating that the timing of the events had a large impact on available DR capacity, such as one participant having negative available DR capacity during evening events and positive available DR capacity during morning events while another generated more significant morning event available DR capacity after 9 am, etc.

Furthermore, the weekday when the event is called can have an impact on available DR capacity. For example, it was observed that a Monday event had considerably lower available DR capacity for one project, which was supported by the participant mentioning that they did not participate in one event because of the short timeline; indeed, likely not all businesses receive DR event warnings in time to implement their measures for Monday morning if warnings are sent during the weekend. Similarly, looking at load profiles, the Evaluator noticed that some businesses had higher loads during specific weekdays, such as an airport having a higher load on Fridays since there are more flights those days. This leads to higher potential for available DR capacity on those specific days, which a more advanced model could better capture, yet the limited number of data points makes it difficult to obtain reliable results and the adjustment factor limits the impacts of daily differences.

As presented in Figure 6 below, events did not generate constant available DR capacity. Notably, the February 7 2023 evening event generated very low available DR capacity and the February 15 2023 morning event generated less than half the available DR capacity of the other morning events. More details on available DR capacity per project per event are included in Appendix V.

Figure 6: Total Available DR Capacity per Event (Two First Event Hours)



7.2.2 Interactive Effects

In a building, 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. For the Aggregator pathway, interactive effects are included in the available DR capacity calculation since meter data encompass whole building consumption.

7.2.3 Effective Useful Life

Although no energy savings were expected under the Aggregator pathway, the Evaluator established an effective useful life (EUL) value to express for how many years available DR capacity might persist, i.e. as long as participants continue with the program. For the Aggregator pathway, an EUL value of one year should be used for total available DR capacity since participation includes all active participants, not only new participants; therefore, the available DR capacity of a participant is counted each year and does not need to be extrapolated over its lifetime. The average number of winters that participants subscribe to the pathway should be used as the EUL value with new available DR capacity. With no data yet available on how long a participant might continue in the program, an EUL of one year should also be used for new DR capacity.

7.2.4 Evaluated New and Available DR Capacities

Table 16 below presents the new and total available DR capacity results for Residential DR for 2023. While new and total available DR capacities are reported separately, no distinction is made below since they are equal due to the program being in its first year. Available DR capacity amounted to 2.365 MW at the generator.

The available DR capacity at the generator was estimated using the appropriate line loss factors for each participant based on their rate code. The values presented in Table 16 are therefore weighted average line loss factors. 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.¹⁴

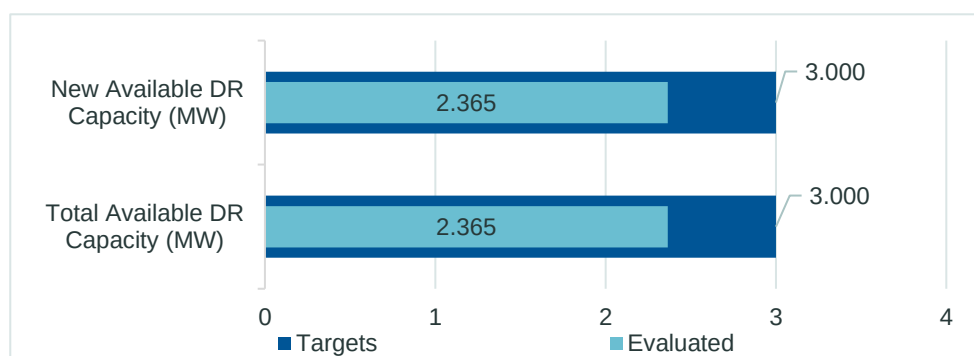
¹⁴ Nova Scotia Utility and Review Board, Matter M06555, 2014 Cost of Service Study Progress Update, Exhibit N-2.09, Appendix I1.

Table 16: Evaluated 2023 BNI DR Available Demand Response Capacity

Results	
Number of Participants	9
Available DR Capacity – at the Meter (MW)	2.231
Line Loss Factor	1.0598
Available DR Capacity – at the Generator (MW)	2.365

Figure 3 outlines the net evaluated and targeted available DR capacity.

Figure 7: 2023 BNI DR Targets and Evaluated Available DR Capacity



7.3 Realization Rate

Table 17 below compares the available DR capacity established through this evaluation to the value tracked in the 2023 tracking sheet. The realization rates, representing the ratio of evaluated available DR capacity to tracked available DR capacity, was established at 105%. The tracked and evaluated available DR capacity as well as the realization rates are the same for new and total available DR capacities.

Table 17: Comparison of 2023 BNI DR Tracked and Evaluated Available DR Capacities at the Generator

	Available DR Capacity		Realization Rate Value
	Value	Unit	
Available DR Capacity			
Tracked Available DR Capacity by EOne	2.254	MW	105%
Evaluation Results	2.365	MW	

The evaluated available DR capacity was 5% higher than the value tracked by EOne. The difference is due to the new definition of available DR capacity used for this evaluation using the first two hours of all events, while the tracked available DR capacity was established using all event hours. The Evaluator's change in methodology (additive same-day adjustment) resulted in a 2% reduction in available DR capacity when using the same definition.



8 BNI DR Key Findings and Recommendations

As mentioned previously, the main objective of the 2023 BNI DR evaluation was as follows:

- › Calculate BNI DR results, namely new and total available DR capacities

This section provides the Evaluator's key findings and recommendations in relation to this objective.

2023 BNI DR Finding: BNI DR fell short of the available DR capacity target.

In 2023, BNI DR new and total available DR capacities were equal since the program was in its first year. The available DR capacities at the generator amounted to 2.365 MW, thus falling short of the targeted new and total available DR capacities of 3.0 MW.

2023 BNI DR Finding: Participation in DR events was very high with only one participant not participating in one event.

As assessed through phone interviews with participants, only one participant reported not participating in an event, and this was due to the timeline being too short between receiving the notification and having to reduce the load.

2023 BNI DR Finding: Overall, the M&V guidelines developed by EOne are appropriate and were generally followed.

Following the meter data analysis and project reviews, the Evaluator concluded that the baseline methodology used by EOne (top six-of-ten with same-day scalar adjustment factor) is appropriate, although using an additive same-day adjustment would better follow best practices.

2023 BNI DR Recommendation 1: Use an additive same-day adjustment factor to establish the baseline load instead of a scalar same-day adjustment factor.

2023 BNI DR Finding: Evaluated available DR capacity considerably varied from event to event and rarely met the enrolled DR capacity.

Available DR capacity is expected to be a reliable resource to reduce the electric system load during peak events; thus, it is important to establish robust estimates on expected available DR capacity (enrolled DR capacity) and avoid as much as possible large variability between event performance levels. In 2023, the available DR capacity of only two participants met their enrolled DR capacity, indicating that enrolled DR capacity estimates could be improved. Also, a few events generated nearly 50% less available DR capacity compared to the typical amount observed in other events. Such variations in savings between events are expected to be lower when the number of enrolled customers will increase.

2023 BNI DR Recommendation 2: Establish enrolled capacity based on test events, when feasible.

This approach would be consistent with M&V guidelines. The Evaluator recognizes that it is possible that test events cannot be performed or that internal capacity require other options. If that is the case, EOne should review the engineering calculations used to determine enrolled capacity to ensure they are realistic.



2023 BNI DR Finding: The available DR capacity significantly differs depending on the time of day, with available DR capacity being higher during the morning peak period than the evening peak period.

The analysis revealed that the available DR capacity for mornings was over two times higher than for evenings. In addition, more available DR capacity was observed in the first hour of evening events notably because of one large project that had little potential after 6 pm, i.e. after business hours. Furthermore, it was observed that calling an event on a specific weekday can also have an impact on available DR capacity.

2023 BNI DR Recommendation 3: Determine which participants are best suited for morning events only, evening events only, or morning and evening events. Events should be called based on each participant's potential, and enrolled capacity should be established based on the selected time.

2023 BNI DR Finding: The evaluated available DR capacity determined by the Evaluator was slightly higher than the available DR capacity tracked by EOne.

The evaluated available DR capacity was 5% higher than the values tracked by EOne. The difference was due to the new definition of available DR capacity used for this evaluation using the first two hours of all events, while the tracked available DR capacity was established using all event hours. The Evaluator's change in methodology (additive same-day adjustment) actually resulted in a 2% reduction in available DR capacity when using the same definition.

CONCLUSION

Table 18 presents the participation levels and evaluated new and total available DR capacity for each program component and for the Demand Response program as a whole.

Table 18: Overall 2023 Demand Response Participation and Evaluated Results

	Participation Level		Evaluated Results	
	Value	Unit	Value	Unit
Residential DR				
New DR Capacity	63	Controllers	0.023	MW
Total DR Capacity	159	Controllers	0.058	MW
BNI DR				
New DR Capacity	9	Participants	2.365	MW
Total DR Capacity	9	Participants	2.365	MW
Total				
New DR Capacity			2.388	MW
Total DR Capacity			2.423	MW

Figure 8

and

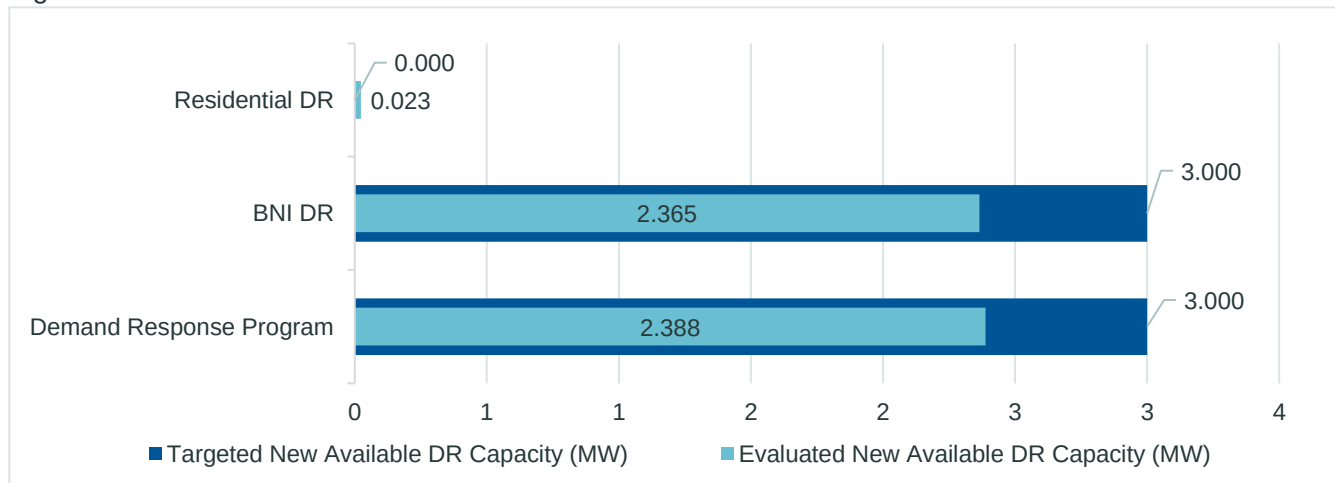


Figure 9 below respectively illustrate the new and total available DR capacity targets for each program component, Demand Response as a whole, as well as whether targets were achieved in 2023. The program fell short of achieving the planned available DR capacity. Residential DR exceeded its target while BNI DR fell short of its target. BNI DR was the largest contributor to total program available DR capacity.

Figure 8: 2023 Demand Response Program Targeted and Evaluated New Available DR Capacity

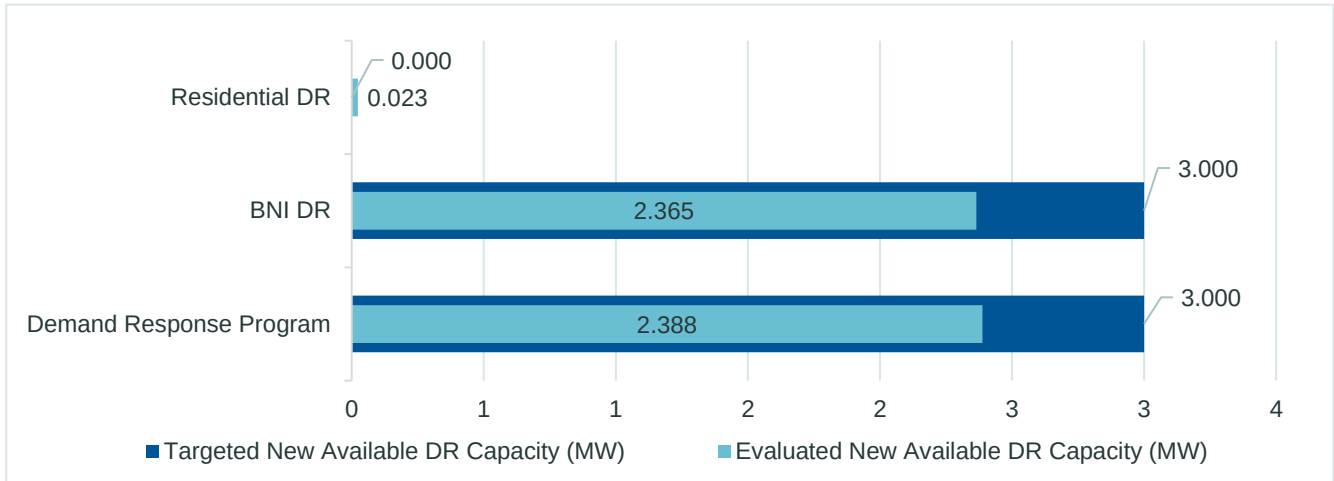
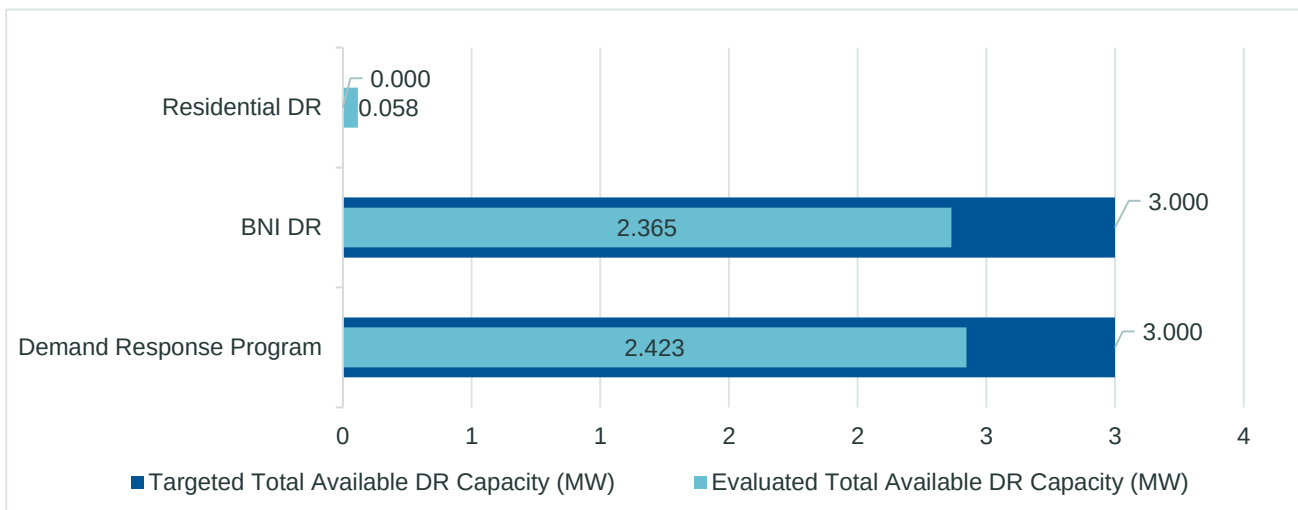


Figure 9: 2023 Demand Response Program Targeted and Evaluated Total Available DR Capacity





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The following are presented in the Demand Response Program – Appendices document.

Residential Demand Response

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Appendix II Residential DR: Baseline Definition Selection Details

Appendix III Residential DR: 2023 Recommendations

Business, Non-Profit, and Institutional Demand Response

Appendix IV BNI DR: Tracking Sheet Audit

Appendix V BNI DR: Available DR Capacity per Project per Event

Appendix VI BNI DR: 2023 Recommendations



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com





EfficiencyOne

DEMAND RESPONSE PROGRAM

Appendix Report

2023 DSM EVALUATION

February 12, 2024



ECONOLUX



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APPENDIX I

Residential DR: Tracking Sheet Audit

This document presents the detailed 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 (new and total available DR capacity at the generator) were consistent with previous evaluation results
 - › Validating that all calculation steps were performed consistently.

Table 3 presents the corrected tracked available DR capacities calculated by the Evaluator the values tracked by EOne.

Table 1: 2023 Residential DR Corrected Tracked Available New and Total DR Capacity

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
Residential DR					
Available New DR Capacity at the Generator	0.029	MW	0.027	MW	-8%
Available Total DR Capacity at the Generator	0.029	MW	0.073	MW	146%

The differences between the values tracked by EOne and the evaluated ones are explained by EOne only providing the total available DR capacity for Shifted controllers. Only accounting for the new participants, yet including both Shifted and Aquanta controllers, resulted in different new available DR capacity which ended up slightly lower than the tracked value. For the total available DR capacity, including both Aquanta and Shifted considerably increased the total available DR capacity.



APPENDIX II

Residential DR: Baseline Definition Selection Details

Baselines for demand response (DR) events are often established based on an average of similar days prior to the actual event. This was the approach adopted by EOne, and the Evaluator aimed to refine this approach by considering multiple variations to the baseline scenarios and comparing the resulting baseline consumption to actual consumption on non-event days.

The Evaluator analyzed several baseline definitions herein referred to as scenarios. For each scenario, the Evaluator compared the predicted electrical load to the actual load during analyzed peak hours on days when no events were called. The Evaluator used the aggregated 15-minute interval water heater electrical load data provided by EOne to perform calculations; these data provided the average consumption of all active participants every 15 minutes. After excluding event days, holidays, and weekends, 26 non-event days were available within the winter peak months to test the baselining approaches. The precision of each baseline scenario was tested separately for the morning and evening windows.

The parameters that vary between each scenario are presented below:

- › Type of baseline day selection (high or middle): The “high” scenarios consist of selecting the baseline days with the highest load among a set of days. The “middle” scenarios consist of selecting baseline days among a set of days while removing the days with the highest and lowest loads.
- › Number of selected baseline days (X): The number of days used to calculate the average baseline loads.
- › Number of considered baseline days (Y): The number of eligible days among which the selection is made. The considered days are the closest eligible days prior to the event. Eligible days exclude event days, holidays, and weekends.
- › Adjustment factor: An adjustment is made to the predicted load by comparing the load a few hours before the event to the average load during the same time of day for the baseline days.
 - › Adjustment window: The number of hours used to establish the adjustment factor.
 - › Lookback period: The number of hours before the event when the adjustment window starts. For example, for an event starting at 5 pm, a lookback period of nine hours means the hours selected for the adjustment window will start at 8 am, i.e. nine hours before the event.
 - › Adjustment cap: A cap used to set a maximum and minimum adjustment factor. For example, a cap of 20% corresponds to a minimum adjustment of $100\%-20\%=80\%$ and a maximum of $100\%+20\%=120\%$.

Table 2 summarizes the analyzed scenarios.

Table 2: Analyzed Baseline Scenarios

Scenario	High/Middle	Adjustment Window	Lookback Period	Adjustment Cap
EOne scenario	High 6 out of 10	6 hrs	9 hrs	-
Scenario 1	High 1 to 10 out of 10	6 hrs	9 hrs	-
Scenario 2		2 hrs	3 hrs	-
Scenario 3		6 hrs	9 hrs	20%
Scenario 4		No adjustment		
Scenario 5	Middle 2, 4, 6, and 8 out of 10	6 hrs	9 hrs	-
Scenario 6		2 hrs	3 hrs	-
Scenario 7		6 hrs	9 hrs	20%
Scenario 8		No adjustment		
Scenario 9	High 1 to 5 out of 5	6 hrs	9 hrs	-

For each non-event day and each scenario, the Evaluator established the percentage of error between the estimate and actual load for each 15-minute interval. The percentages of error were then averaged across all non-event days to obtain the mean percent error (MPE) for each 15-minute interval and then averaged again across all 15-minute intervals of the peak period to obtain the overall MPE for each scenario separately for both the morning and evening periods. The MPE provides a sense of how close the estimated average load is to the actual average load. The MPE is better as it gets closer to 0%, meaning that the average estimated consumption was close to actual consumption.

Figure 1 and Figure 2 below present the MPE for each tested baseline scenario for the morning and evening periods respectively. The baseline scenario used in the previous evaluation corresponds to the blue dots in the figures, and it can easily be observed that multiple other scenarios provide a lower MPE.

Figure 1: Mean Percent Errors of Baseline Scenarios for the Morning Period

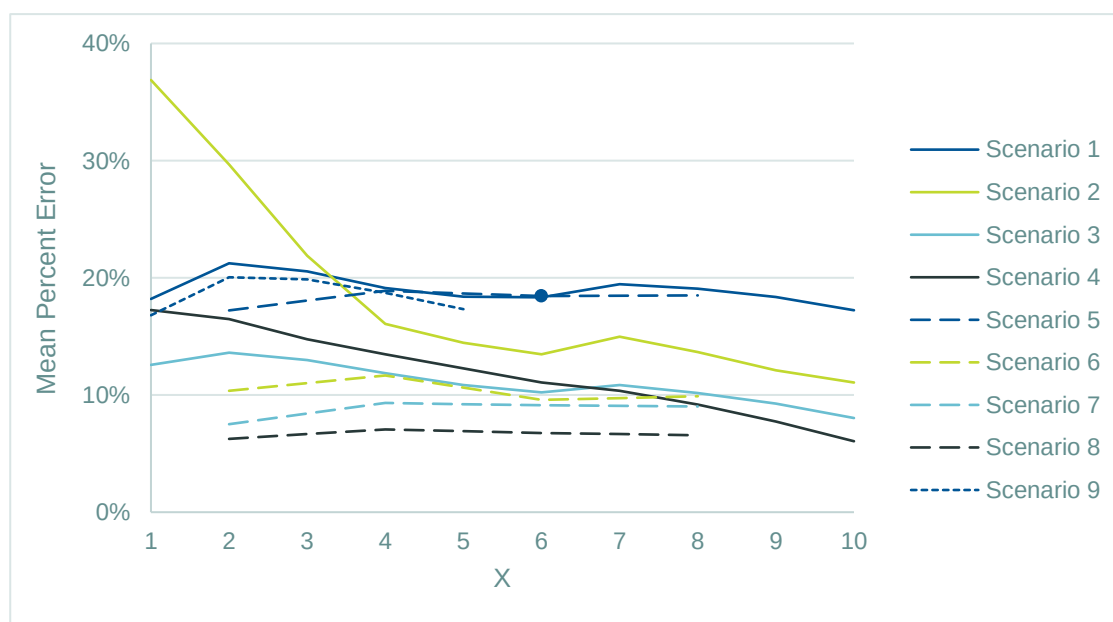
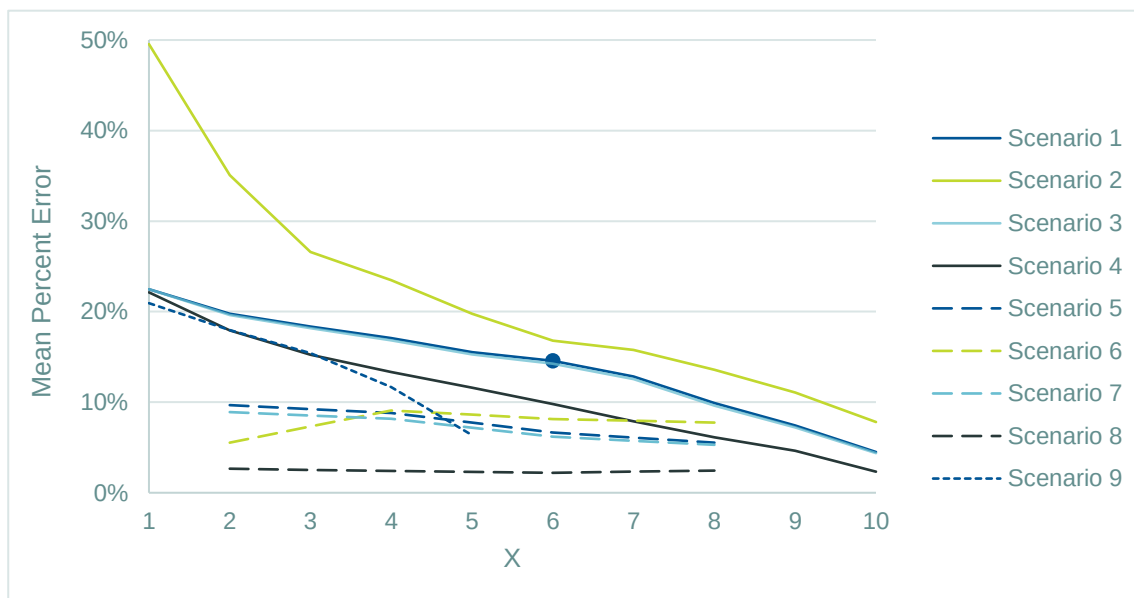


Figure 2: Mean Percent Errors of Baseline Scenarios for the Evening Period



Scenarios 4 and 8, which are the scenarios without an adjustment factor, are those resulting in the lowest MPE for both the morning and evening periods. This implies that the load of domestic hot water (DHW) heaters during peak hours is not impacted by the previous load earlier the same day, which also implies that the use of DHW is not strongly impacted by exterior temperature. Indeed, scenarios that are focused on estimating the best average load instead of selecting the highest loads were those resulting in the best estimates.

To support this finding, the Evaluator also analyzed the relation between the outside temperature and DHW load (Figure 3 and Figure 4 below),¹ which revealed that there is no significant correlation between the outside temperature and the DHW load. Indeed, the regression lines are mostly flat (except for December and March when the correlation is that DHW loads decrease as temperatures drop) and the coefficients of determination (R^2) are very low, below 0.1 in all cases. This indicates that the DHW load is not higher when the weather is colder; therefore, selecting the six-in-ten highest DHW load days in the baseline average overestimates the baseline. This also supports the use of non-event day data in selecting the best baseline scenario since it demonstrates that non-event days are expected to be similar to event days even if outdoor air temperatures differ.

¹ To determine if there was indeed a correlation between outdoor temperature and DHW, the Evaluator used hourly data from NRCAN and matched them with the aggregated Residential DR data. The figures indicate the correlations separately for each month. The reason why months were separated is because DHW load increases between December and March as aqueduct water temperatures drop; keeping all months together confused the effects of outdoor air temperature and water temperature.

Figure 3: Comparison Between Outside Temperature and Average DHW Load in Mornings

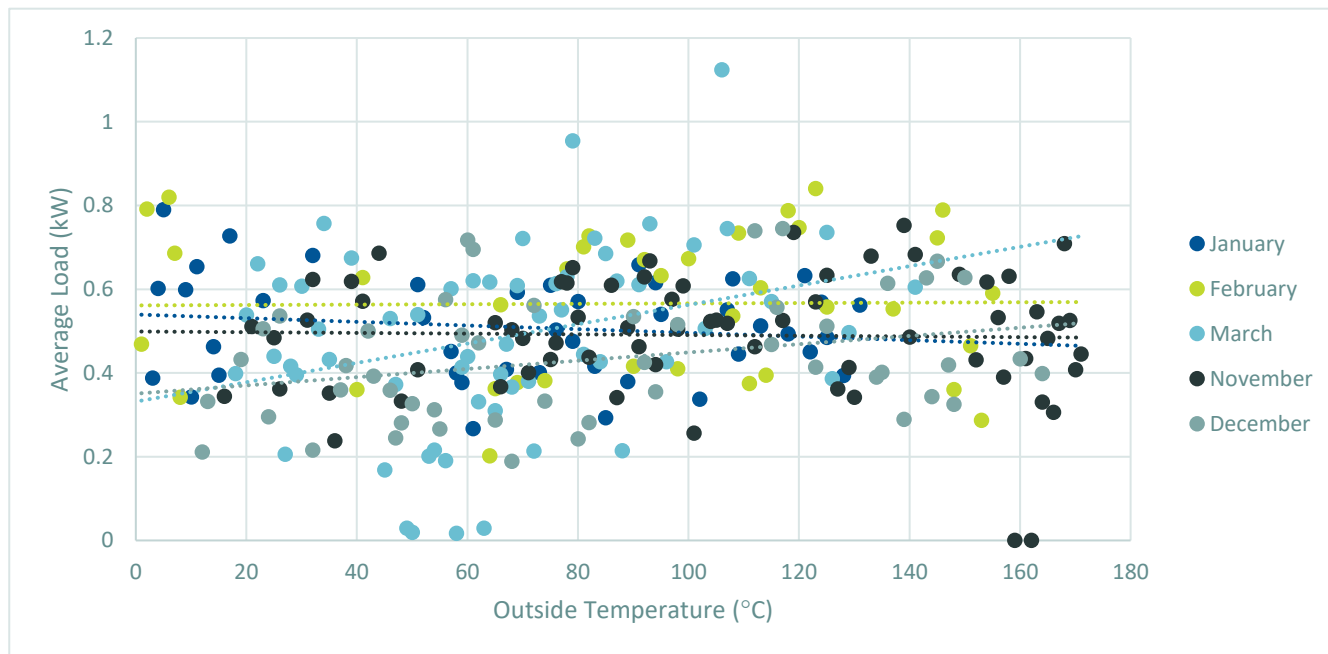
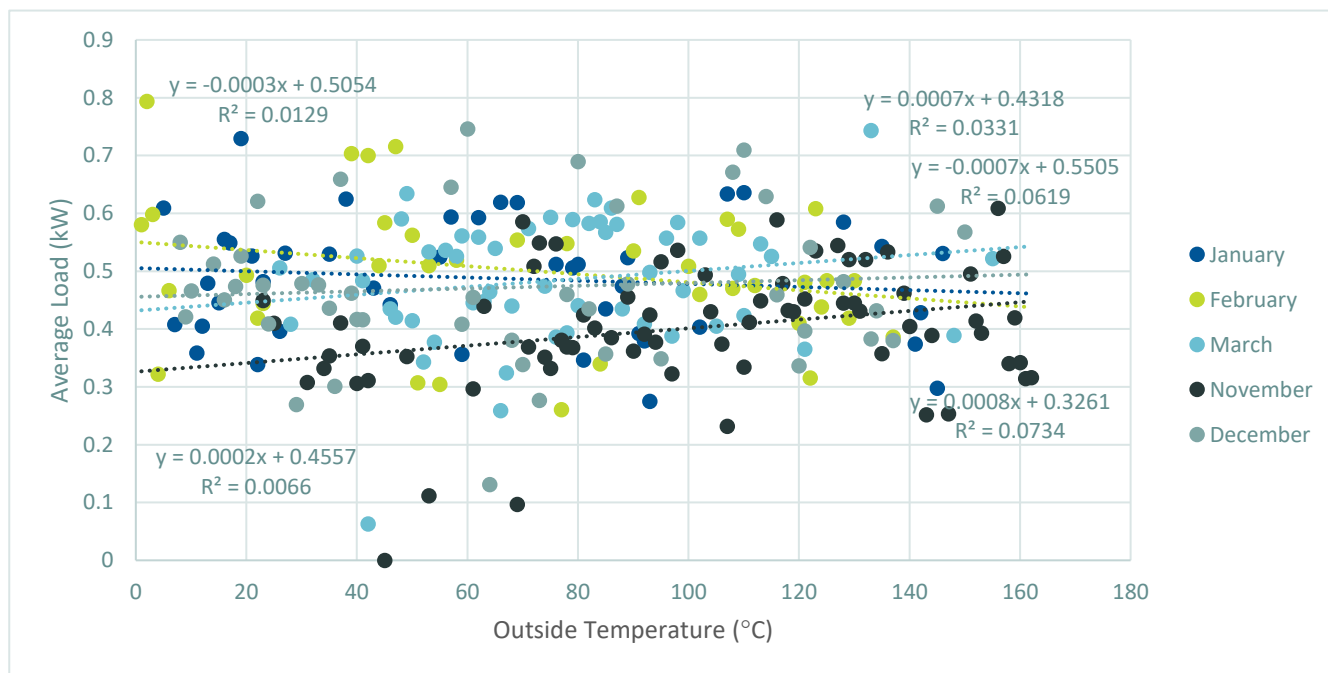


Figure 4: Comparison Between Outside Temperature and Average DHW Load in Evenings



The Evaluator used Scenario 4 with 10 out of 10 baseline days and no adjustment since it was the best scenario for evening and the second best for mornings by a small margin. The selected scenario has a MPE of 6.1% for mornings and 2.3% for evenings, while the previous baseline had a MPE of 18.5% and 14.2%, thus meaning that the new baseline estimates predicted loads 12% more precisely than the previous baseline.



APPENDIX III

Residential DR: 2023 Recommendations

This appendix summarizes all the recommendations made by the Evaluator as part of the 2023 evaluation of Residential DR.

Section	Recommendations
Executive Summary	2023 Res DR Recommendation 1: Ensure that available DR capacity tracked by EOne include the in-service rate as well as the unitary available DR capacity values.

APPENDIX IV

BNI DR: Tracking Sheet Audit

This document presents the detailed 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 (available DR capacity at the generator) were consistent with previous evaluation results
 - › Validating that all calculation steps were performed consistently

Table 3 presents the corrected tracked available DR capacity that would have resulted if the Evaluator had applied changes, yet the Evaluator made no change, which resulted in no difference between the available DR capacity tracked by EOne and the corrected tracked available DR capacity.

Table 3: 2023 BNI DR Corrected Tracked Available DR Capacity

Program Component Result	Value Tracked by EOne		Corrected Tracked Value		Relative Difference
	Value	Unit	Value	Unit	Value
New Available DR Capacity	2.254	MW	2.254	MW	0%
Total Available DR Capacity	2.254	MW	2.254	MW	0%

APPENDIX V

BNI DR: Available DR Capacity per Project per Event

Table 4 presents the available DR capacity for each project for the two first hours of each event as well as total available DR capacity for those periods. Grey cells are events for which Phase 1 or Phase 2 participants did not participate due to the different event schedule for both phases. Since not all events have the same number of participants, the total available DR capacity for each event should be compared with caution.

Table 4: Available DR Capacity per Project for the Two First Hours of Each Event

Event Date	Period of the Day	Available DR Capacity (kW) for Each Participant									
		#1	#2	#3	#4	#5	#6	#7	#8	#9	Total
2022-12-06	Evening							13	28	16	57
2022-12-09	Evening							-8	58	14	65
2022-12-12	Evening	1,543	-51	0	-1	164	134	10	-49	9	1,759
2022-12-15	Evening							8	37	18	63
2022-12-19	Evening	1,309	804	0	18	0	38	6	-6	23	2,192
2022-12-22	Evening							12	57	29	99
2023-01-10	Evening	930	970	0	1	117	59	3	-2	9	2,086
2023-01-11	Morning	2,306	41	0	23	62	275	11	89	28	2,835
2023-01-17	Evening							13	99	-3	109
2023-01-19	Evening							-2	40	8	46
2023-02-01	Evening	365	1,058	27	6	27	1				1,483
2023-02-02	Morning	2,317	152	27	14	36	322				2,869
2023-02-03	Evening							16	-61	36	-9
2023-02-07	Evening	-90	100	27	1	97	61	22	28	26	271
2023-02-08	Morning							12	28	25	66
2023-02-09	Evening							15	55	21	90
2023-02-13	Morning							13	57	38	108
2023-02-14	Morning	1,396	1,307	27	66	92	242	15	20	37	3,201
2023-02-15	Morning	5	261	65	69	60	257	29	11	32	789
2023-02-24	Morning	0	1,407	49	73	77	362				1,968
2023-02-27	Morning	2,134	514	-37	21	39	404				3,075
2023-02-28	Morning	2,114	1,330	31	24	33	331				3,863
Average		1,194	658	18	26	67	207	11	29	22	2,231

Table 5 presents the available DR capacity for each project for each event as well as total available DR capacity for each event. These available DR capacities include all hours of each event. The weighted averages account for the different lengths of each event.

Table 5: Available DR Capacity per Project per Event

Event Date	Period of the Day	Length in Hours	Available DR Capacity (kW) for Each Participant									
			#1	#2	#3	#4	#5	#6	#7	#8	#9	Total
2022-12-06	Evening	3							15	28	14	57
2022-12-09	Evening	2							-8	58	14	65
2022-12-12	Evening	2	1,543	-51	0	-1	164	134	10	-49	9	1,759
2022-12-15	Evening	3							14	43	17	74
2022-12-19	Evening	4	719	667	0	20	8	20	4	-5	20	1,453
2022-12-22	Evening	3							12	119	29	161
2023-01-10	Evening	2	930	970	0	1	117	59	3	-2	9	2,086
2023-01-11	Morning	3	2,305	103	0	22	55	259	8	122	30	2,904
2023-01-17	Evening	2							13	99	-3	109
2023-01-19	Evening	2							-2	40	8	46
2023-02-01	Evening	4	138	757	0	3	29	-9				918
2023-02-02	Morning	2	2,317	152	44	14	36	322				2,886
2023-02-03	Evening	2							16	-61	36	-9
2023-02-07	Evening	3	-91	128	0	1	92	60	22	17	23	253
2023-02-08	Morning	3							18	31	23	73
2023-02-09	Evening	3							17	43	19	79
2023-02-13	Morning	3							11	52	35	98
2023-02-14	Morning	3	1,706	1,293	44	64	98	204	16	28	42	3,497
2023-02-15	Morning	3	170	234	62	74	46	244	28	54	29	941
2023-02-24	Morning	3	645	1,450	52	73	88	334				2,641
2023-02-27	Morning	2	2,134	514	-37	21	39	404				3,075
2023-02-28	Morning	2	2,114	1,330	31	24	33	331				3,863
Weighted Average			1,082	641	17	28	63	177	12	38	22	2,080



APPENDIX VI

BNI DR: 2023 Recommendations

This appendix summarizes all the recommendations made by the Evaluator as part of the 2023 evaluation of BNI DR.

Section	Recommendations
Executive Summary	2023 BNI DR Recommendation 1: Use an additive same-day adjustment factor to establish the baseline load instead of a scalar same-day adjustment factor.
Executive Summary	2023 BNI DR Recommendation 2: Establish enrolled capacity based on test events when feasible. This approach would be consistent with M&V guidelines. The Evaluator recognizes that it is possible that test events cannot be performed or that internal capacity requires other options. If that is the case, EOne should review the engineering calculations used to determine enrolled capacity to ensure they are realistic.
Executive Summary	2023 BNI DR Recommendation 3: Determine which participants are best suited for morning events only, evening events only, or morning and evening events. Events should be called based on each participant's potential, and enrolled capacity should be established based on the selected time of day.



PROJECT NO. 6501

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com



2020-2023 DSM MEASURE ASSESSMENT

EFFICIENCYONE

2023 Evaluation Edition

March 12, 2024



ECONOLER

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)
BER-AR	Business Energy Rebates – Application Rebates (program component service)
BER-IR	Business Energy Rebates – Instant Rebates (program component service)
BNI	Business, non-profit, and institutional
CASHP	Central air-source heat pump
CDD	Cooling degree days
CEE	Consortium for Energy Efficiency
CEF	Combined energy factor
CFL	Compact fluorescent lamp
COP	Coefficient of performance
DCV	Demand-controlled ventilation
DEER	Database for Energy Efficiency Resources
DHW	Domestic hot water
DHWT	Domestic hot water timer
DOE	U.S. Department of Energy
DR	Demand Response
DSM	Demand-side management
DWHR	Drain water heat recovery
ECM	Electronically commutated motor
EER	Energy efficiency ratio
EISA	Energy Independence and Security Act
EMIS	Energy Management Information Systems (program component)
EOne	EfficiencyOne
EPI	Efficient Product Installation (program component)
EUL	Effective useful life
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
IESO	Independent Electricity System Operator
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
NEEP	Northeast Energy Efficiency Partnership
NERHOU	Northeast Residential Lighting Hours-of-Use study
NHC	New Home Construction (program component)
NRCan	Natural Resources Canada
NYDPS	New York Department of Public Service
NYSERDA	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

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MEASURE ASSESSMENT CHANGE LOG

Table 1: Measure Assessment Change Log

Change Type	Section	Description	Date
Update	2.2.3(7) Pipe Insulation	Update EUL value	2023-03-09
New Measure	2.3.3(10) Smart Thermostats for Electrical Heating Systems	Renamed from the smart thermostats for electric baseboards measure to smart thermostats for electrical heating systems and updated it to include smart thermostats for heat pumps and for in-floor radiant heating system	2023-03-09
New Measure	2.4.3(7) Efficient Washer-Dryer Combination Units	Added efficient washer-dryer combination units as a new measure in Instant Savings	2023-03-09
Update	2.1.3(5) LED Nightlights	Update interactive effects factor	2023-03-09
Update	3.3.3(2) Advanced RTU Controls	Update savings calculation methodology	2023-03-09
Update	2.1.3(1) LED Lamps	Update EUL values and rationale for using an equivalent EUL to account for LED lamps becoming the baseline in 2025	2023-03-09
	2.1.3(2) LED Fixtures		
	4.1 EUL - LED Lamps and Fixtures		
	Appendix II		
Update	2.6.3(4) Domestic Water Heater Load Controls	Update savings value based on 2022 metering data	2023-03-09
Update	2.4.3(6) Clothes Dryer Replacements	Update savings value and combined energy factor of baseline for ARet	2023-03-09
New Measure	3.5 Compressed Air Leak Repairs	Added compressed air leak repairs since a standard approach was developed for these Custom projects	2023-03-09
Update	All Sections with EPI Mail-out Kit Measures (2.1.3(1), 2.1.3(5), 2.2.3(4), 2.2.3(5), 2.2.3(7), and 2.3.3(7))	Updated sections with measures in the EPI Mail-out Kit pilot to include the assumptions for the pilot	2023-03-09
New Measure	2.1.3(6) Solar Fixtures	Added solar fixtures as an Instant Savings measure	2023-03-09
Update	2.4.3 (2) Refrigerator Retirements/Replacements 2.4.3 (3) Freezer Retirements/Replacements	Update savings calculation methodology, savings values, and savings parameter values	2023-03-09

Change Type	Section	Description	Date
New Measure	3.6 (1) Variable Frequency Drives for non-HVAC Applications	Added variable frequency drives for non-HVAC fans and pumps applications since this measure was added to the BER Application Rebates offering	2023-03-09
Update	2.4.3(4) Room Air Conditioner Retirements	Update savings values based on information from the 2022 tracking sheet and an updated source for the energy efficiency ratio of the retired equipment	2023-03-09
Update	2.4.3(5) Dehumidifier Replacements	Update savings values to consider the performance of replacement units installed in 2022	2023-03-09
Update	2.4.3(1) Clotheslines and Outdoor Drying Racks	Update number of loads based on more recent and regional data	2023-03-09
Update	0 Clothes Dryer Replacement/ENERGY STAR Certified Clothes Dryers	Update number of loads based on more recent and regional data as well as ARet efficiency levels	2023-03-09
Update	2.4.3(6) Efficient Clothes Washers	Update number of loads based on more recent and regional data	2023-03-09
Update	2.3.3(2) Central Air-source Heat Pumps	Update unitary peak demand savings value based on data from the 2022 tracking sheet	2023-03-09
Update	2.1.3(1) LED Lamps 2.1.3(2) LED Fixtures	Update unitary savings based on data from the Instant Savings 2022 tracking sheet	2023-03-09
Update	2.2.3(1) Drain Water Heat Recovery	Update unitary savings based on HOT2000 simulations	2023-03-09
Update	2.2.3(1) Solar Domestic Hot Water	Update unitary savings value for HEA	2023-03-09
Update	3.1.1 Interactive Effects 3.1.3 Lighting Measures	Update interactive effects factors for commercial lighting measures	2023-03-09
New Measure	2.3.3(8) Window Film Kits	Added window film kits as an EPI measure	2023-03-09
Removal	2.2.3(1) Drain Water Heat Recovery (for HEA only), 2.3.3(6) Solar Air Heating and Solar DHW (for HEA only) 2.2.3(4) Low-flow Showerheads (for IS only)	Measures no longer incented as of 2022.	2024-03-12
New Measure	2.4.3 (10) ENERGY STAR Certified Dishwashers	Addition of ENERGY STAR certified dishwashers for IS	2024-03-12
Removal	2.6.4 (1) Three-element Water Heater, (2) Domestic Water Heater Timer and (3) Electric Thermal Storage (for HEA only)	These products were incorrectly listed as being available under HEA, while they were not.	2024-03-12

Change Type	Section	Description	Date
Removal	Clothes Dryer Replacement (ARet)	No longer offered.	2024-03-12
Update	2.4.3 (2) Refrigerator Replacement and (3) Freezer Replacement	Measures are now listed under HomeWarming and MHEEP in place of ARet.	2024-03-12
Removal	Booster Pump (for BER Instant Rebates only)	No longer offered.	2024-03-12
Update	2.6.3 (4) Domestic Water Heater Load Control	Updated unitary savings values.	2024-03-12
Update	4 Effective Useful Life	Added AMH EUL values to the lists. Added MHEEP to the program for which a few EUL values were applicable.	2024-03-12
Update	2.3.3 (7) Air Sealing Kits	Name changed to Air Sealing Products, and savings are now presented per product rather than by kit	2024-03-12

KEY 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.
Available Demand Response Capacity	The capacity which is available to NSP to reduce system peak demand. This capacity is calculated based on the first two hours of all events called between December and February, excluding weekends and holidays. If an event is shorter than two hours, only the first hour is used to measure the available DR capacity. Available DR capacity is evaluated on a per-participant basis, based on the average demand reduction observed for each event that the participant was scheduled to participate in. E1's total available DR capacity is the sum of each participant's available DR capacity.
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 base consumption.
Bias	Systematic deviations of measurements from the true value.
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.
Confidence interval	The estimated range of values that is likely to include unknown population parameters.
Demand response	Demand response measures generate savings in the form of available capacity or load reduction in response to events called by the electric utility (Nova Scotia Power) to reduce the load at strategic moments. These events can be called at any time and for any duration, although they are usually called for one to three hours during peak periods.
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 home 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 a home is through modelled home 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 equipment life and 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 CO₂	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, gas 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 ratios, etc.) validated or measured during the evaluation process. Unless otherwise specified, evaluated savings are 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 a building (such as heating and cooling) due to the installation of an energy efficiency measure.

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 and 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 a program on the market (such as increased product availability, practices, and prices) that extends beyond changing program participant behaviours. 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 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. For industrial participants on an interruptible rate, peak demand savings may include savings on non-firm loads, i.e. loads that may be interrupted when Nova Scotia Power's 10-minute reserve is low.
Precision	The extent to which repeated measurements agree with one another.
Random sampling error	An error in measurement because 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.
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.
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 net-to-gross ratios. Those parameters, except 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. A 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 2020-2023 DSM Measure Assessment (MA) presents the results of 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 the EfficiencyOne (EOne) DSM program portfolio. A new MA will be published in 2024, coinciding with an in-depth review of all measures.

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 that can easily be referred to by program staff and useful to populate EOne's internal e-Technical Reference Manual (e-TRM)

Use and Application

For the evaluations conducted during the 2020-2022 demand-side management (DSM) cycle and for the first year of the 2023-2025 DSM cycle, the Evaluator will refer to the values presented in the 2020-2023 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 (EUL) values for all measures offered in EOne's program portfolio. Also, the savings for some programs targeting demand response (DR) are called available DR capacity. DR measures differ from demand reduction measures because they only generate savings when events are called while demand reduction measures generate peak demand savings throughout the peak demand period.

Development and Review Process

Savings are established using one or more of the following approaches: Literature reviews of TRMs; 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.

Many 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 2020-2023 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 MA:

- › LED lamps and fixtures for Instant Savings
 - Baseline and efficient wattages
- › 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 were also updated in 2021, 2022 or 2023 based on either applicable comprehensive evaluation results or changes to program offerings or delivery. Those include the unitary savings for heat pump water heaters, which were reviewed as part of the market transformation program design in 2023.

If new measures are introduced to the portfolio in a given year, they are reviewed as part of that year's evaluation, and the Evaluator updates the 2020-2023 MA accordingly. In the 2023 evaluation, one new measure was added to Instant Savings (ENERGY STAR® certified dishwashers).

¹ The number of units rebated in 2020 was too low to establish a value for 2021 and 2022.

² The average retired appliance efficiency levels and sizes are likely to evolve overtime as the year of manufacturing of these retired appliances becomes more recent.

Savings Calculations Equations

The savings calculations are based on the equations outlined below.

Electrical Energy Savings

The following equation is used to calculate electrical energy savings.

Electrical Energy Savings (kWh)

$$= \text{Unitary Energy Savings (kWh)} \times (1 + \text{Interactive Effects Factor for Energy Savings (\%)}) \times \text{Installation Rate or "In-service Rate" (\%)}$$

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.

The following equation is used to calculate peak demand savings.

Peak Demand Savings (W)

$$= \text{Unitary Peak Demand Savings (W)} \times (1 + \text{Interactive Effects Factor for Peak Demand Savings (\%)}) \times \text{"Installation Rate" or "In-service Rate" (\%)}$$

Available Demand Response Capacity

Available DR capacity differs from peak demand savings since the former considers the potential load reduction that was made available instead of the actual load reduction that coincided with the actual utility peak. This distinction was made since EOne does not control the calling of events and thus does not control how well the resources made available are used to reduce peak demand. Available DR capacity is calculated based on the following assumptions:

- › Capacity is evaluated based on events called from December to February excluding weekends and holidays. Events called at any time during the day (morning or evening) can be included.
- › Available demand response capacity is measured over the first two hours of a DR event.
- › If an event is longer than two hours, only the first two hours are used to measure capacity.
- › If an event is shorter than two hours, only the first hour is used to measure available capacity.
- › Available DR capacity is evaluated on a per-participant basis based on the average demand reduction observed for each event in which the participant was scheduled to participate.
- › EOne's total available DR capacity is the sum of each participant's available DR capacity.

The following equation is used to calculate available DR capacity.

$$\begin{aligned} \text{Available DR Capacity}(W) &= \text{Unitary Available DR Capacity } (W) \times (1 \\ &+ \text{Interactive Effects Factor for Peak Demand Savings } (\%)) \\ &\times \text{"Installation Rate "or" In – service Rate" } (\%) \end{aligned}$$

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 2 below lists the measures and associated programs included in the 2020-2023 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 2: 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	
Solar Domestic Hot Water	Green Heat
Heat Pump Water Heaters	HEA
	MHEEP
	Instant Savings
Drain Water Heat Recovery	MHEEP
Low-flow Showerheads	EPI
Faucet Aerators	EPI
Thermostatic Shower Valves	EPI
Pipe Insulation	EPI
Hot Water Tank Wraps	EPI

	Program Components
Space Heating	
Mini-split Heat Pumps	Green Heat
	HEA
	MHEEP
Central-air Source Heat Pumps	Green Heat
	HEA
Ground-source Heat Pumps	Green Heat
	HEA
Wood Stove/Fireplace Inserts	HEA
	Green Heat
Pellet Stove/Fireplace Inserts*	HEA
	Green Heat
Wood Furnaces/Boilers	HEA
	Green Heat
Pellet Furnaces/Boilers	HEA
	Green Heat
Solar Air Heating	Green Heat
Air Sealing Products	EPI
Window Film Kits	EPI
Programmable Thermostats	Instant Savings
	MHEEP
Smart Thermostat for Electric Heating Systems	Instant Savings
	EPI
Appliances	
Clotheslines and Outdoor Drying Racks	EPI
	Instant Savings
Refrigerator Retirement or Replacement	ARet
	Home Warming
	MHEEP
Freezer Retirement or Replacement	ARet
	Home Warming
	MHEEP
Room Air Conditioner Retirement	ARet
Dehumidifier Replacement or Retirement/ENERGY STAR® Certified Dehumidifier	ARet
	Instant Savings

	Program Components
ENERGY STAR Certified Clothes Dryer	Instant Savings
Efficient Clothes Washers	Instant Savings
Efficient Washer-Dryer Combination Units	Instant Savings
ENERGY STAR Certified Room Air Purifiers	Instant Savings
ENERGY STAR Certified Dishwashers	Instant Savings
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 Heaters	Green Heat
Domestic Water Heater Timers	Green Heat
Electric Thermal Storage	Green Heat
Domestic Water Heater Load Controls	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 Application Rebates
Space Heating	
Electric Thermal Storage	BER Application Rebates
	SBES
Advanced Rooftop Unit Controls	BER Application Rebates
Water Heating	
Low-flow Showerheads	SBES
Faucet Aerators	SBES

	Program Components
Thermostatic Shower Valves	SBES
Pipe Insulation	SBES
Hot Water Tank Wraps	SBES
Compressed Air	
Compressed Air Leak Repair	Custom
Variable Frequency Drives	
VFD for non-HVAC Applications	BER Application Rebates

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 3 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 3 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 3.

Table 3: Interactive Effects Factors for Residential Lighting Products Installed Indoors

Type of Home	% of Homes ³	Energy Interactive Effects Factor ⁴	Peak Demand Interactive Effects Factor ⁵
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%

³ Based on 2018-2019 EPI participants.

⁴ ADS ASSOCIÉS, *Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale*, report presented to Hydro-Québec, 1992

⁵ 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.

Type of Home

The detailed rationale for interactive effects for heating and cooling follows.

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.⁶ 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.

$$IE_{cooling} = 22\% / COP \times \% \text{ Conditioned Home Area}$$

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%.

⁶ 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).

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.

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 4, is multiplied by the corresponding interactive effects factor.

Table 4: Proportion of Lighting Products Used Indoors

Type of Product	Program Component	% Indoor	Source
A-type LED Lamps ⁷	EPI	97%	2021 EPI Tracking Sheet
Reflector and Decorative LED Lamps ⁸ (Except PAR38)		100%	2021 EPI Evaluation (on-site visits)
PAR38 LED Lamps		0%	
LED Nightlights		100%	Assumption
Reflector and Decorative LED Lamps ⁹	Instant Savings	92%	2016 Nova Scotia Socket Study ¹⁰
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)
Solar Fixtures		0%	Assumption
Indoor Motion Sensors		100%	
Outdoor Motion Sensors		0%	
Dimmer Switches		100%	
Solar Fixtures		0%	

Summary

Combining the values presented in Table 3 and Table 4, Table 5 summarizes the interactive effects factor established for each lighting measure.

⁷ Including 9 W, 9.5 W, 10 W, 18 W, and 7 W black-out bulb LED lamps installed through EPI.

⁸ Including PAR20, PAR30, GU10, G25, and chandelier E12 LED lamps installed through EPI.

⁹ Including ENERGY STAR certified non-A-type lamps rebated through Instant Savings.

¹⁰ Corporate Research Associates Inc., *2016 Socket Study*, Final Report prepared for Efficiency Nova Scotia, December 2016.

Table 5: Overall Interactive Effects Factors for Residential Lighting Measures

Measure	Type of Home	Interactive Effects Factors	
		Energy Savings	Peak Demand Savings
LED A-type Lamps ¹¹	Heat Pump Heating and Air Conditioning	$-20.0\% \times 97\% = -19.4\%$	$-90\% \times 97\% = -87.3\%$
	Electrical Heating with Air Conditioning	$-54.9\% \times 97\% = -53.3\%$	$90\% \times 97\% = -87.3\%$
	Electrical Heating Without Air Conditioning	$-58\% \times 97\% = -56.3\%$	$90\% \times 97\% = -87.3\%$
	No Electrical Heating with Air Conditioning	$3.1\% \times 97\% = 3.0\%$	$0\% \times 97\% = 0\%$
	With Neither Electrical Heating nor Air Conditioning	$0\% \times 97\% = 0\%$	$0\% \times 97\% = 0\%$
Reflector and Decorative LED Lamps and LED Nightlights ¹² (Except PAR38)	Heat Pump Heating and Air Conditioning	$-20.0\% \times 100\% = -20.0\%$	$-90\% \times 100\% = -90\%$
	Electrical Heating with Air Conditioning	$-54.9\% \times 100\% = -54.9\%$	$-90\% \times 100\% = -90\%$
	Electrical Heating Without Air Conditioning	$-58\% \times 100\% = -58\%$	$-90\% \times 100\% = -90\%$
	No Electrical Heating with Air Conditioning	$3.1\% \times 100\% = 3.1\%$	$0\% \times 100\% = 0\%$
	With Neither Electrical Heating nor Air Conditioning	$0\% \times 100\% = 0\%$	$0\% \times 100\% = 0\%$
PAR38 LED Lamps	Outdoor	$0\% \times 0\% = 0\%$	$0\% \times 100\% = 0\%$
Reflector and Decorative LED Lamps and LED Nightlights ¹³	Weighted Average	$-20.1\% \times 92\% = -18.5\%$	$-41.4\% \times 92\% = -38.1\%$
ENERGY STAR Certified LED Recessed Downlight Fixtures	Weighted Average	$-20.1\% \times 100\% = -20.1\%$	$-41.4\% \times 100\% = -41.4\%$
ENERGY STAR Certified LED Fixtures	Weighted Average	$-20.1\% \times 91\% = -18.3\%$	$-41.4\% \times 91\% = -37.7\%$
ENERGY STAR Certified LED Fixtures with Motion Sensors	Weighted Average	$-20.1\% \times 2\% = -0.4\%$	$-41.4\% \times 2\% = -0.8\%$
Solar Fixtures	Outdoor	$0\% \times 0\% = 0\%$	$0\% \times 0\% = 0\%$
Dimmer Switches	Weighted Average	$-20.1\% \times 100\% = -20.1\%$	$-41.4\% \times 100\% = -41.4\%$
Indoor Motion Sensors	Weighted Average	$-20.1\% \times 100\% = -20.1\%$	$-41.4\% \times 100\% = -41.4\%$
Outdoor Motion Sensors	Outdoor	$0\% \times 0\% = 0\%$	$0\% \times 0\% = 0\%$

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)¹⁴ 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,¹⁵ 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. This value was also used for dimmer switches and solar fixtures.

For 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 2020-2023 DSM cycle.

Table 6 summarizes the peak demand-to-energy ratios established for each lighting measure.

Table 6: 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		
Solar Fixtures		
Motion Sensors	0.000	RES-Lighting-Control-OccSensors, Navigant 2016-2018 DSM Plan

¹¹ Including 9 W, 9.5 W, 10 W, 18 W, and 7 W black-out bulb LED lamps installed through EPI.

¹² Including PAR20, PAR30, GU10, G25, chandelier E12 LED lamps, and LED nightlights installed through EPI.

¹³ Including ENERGY STAR certified Non-A-type lamps rebated through Instant Savings.

¹⁴ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69

¹⁵ Econoler, *Residential Lighting Metering Study*, December 14, 2017

2.1.3 Lighting Measures

(1) LED Lamps

Summary

Table 7 presents a summary of the values used to calculate A-type, reflector, and decorative LED lamp savings. The detailed methodology follows.

Table 7: 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	2.0	2.0	See Subsection 4.1
Electrical Savings Parameters				
Unitary Energy Savings [kWh/year] *	Vary depending on replaced and installed wattages. See Table 8 below	49.2	42.2	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 9 below	7.97	6.84	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%	
* Values for the EPI Mail-out Kit pilot are presented in the subsections below.				

Electrical Unitary Energy Savings

The equation below determines the unitary savings values of LED lamps for each pairing of old and new wattages. Table 8 lists the parameters and corresponding values used in the equation and the resulting unitary savings values.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{(\text{Old Wattage} - \text{New Wattage})[W] \times \text{HOU} \left[\frac{h}{\text{day}} \right] \times 365 \left[\frac{\text{day}}{\text{yr}} \right]}{1,000 \left[\frac{W}{kW} \right]}$$

Table 8: 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
9 W Installed Through the Mail-out Pilot	57.3	9	48.3		47.7
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

Type of LED	Old Wattage (W)	New Wattage (W)	Displaced Wattage (W)	Operating Hours (hrs/day)	Unitary Savings Value (kWh/year)
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)	51.1	4.6	46.5	2.9	49.2
ENERGY STAR Certified LED Non-A-type Lamps (excluding R, BR, and Decorative)	46.6	6.7	39.9	2.9	42.2

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 the Mail-out pilot, since the replaced lamps are unknown, an average baseline wattage of 57.3 W was used based on the average wattage of most popular lamps in EPI (29 W, 40 W, 43 W, 60 W, 72 W, and 100 W).

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)¹⁶ to better represent the real baseline wattages for LED lamps.

Since R, BR, and decorative lamps are only available in incandescent and LED, it was assumed that all LED R, BR, and decorative lamps replaced incandescent lamps. It should however be noted that the most popular lamp types in that category (ST19 lamps) are required to meet the Energy Efficiency Regulations on general service lamps¹⁷, which set maximum wattage at 43 W for a 60 W equivalent ST19 lamp for instance. In reality, 43 W ST19 lamps are not available on the market, which explains why this baseline is not used in the unitary savings calculations. Therefore, like previous years, the

¹⁶ National Renewable Energy Laboratory, *Uniform Methods Protocol Chapter 6: Residential Lighting Evaluation Protocol*, February 2014, pp. 6-20

¹⁷ NRCan, *General service lamps and modified spectrum incandescent lamps*, <https://natural-resources.canada.ca/energy/regulations-codes-standards/products/6869> (Last accessed January 25, 2024).

Evaluator selected to use incandescent decorative lamps as the baseline. The Evaluator noted this year, while looking for equivalent lamps, that incandescent decorative lamps were very difficult to find on major retailers' websites. While there might still be participants that replace incandescent lamps early, it is likely at this point that most incandescent lamps have already been replaced (since the standard has been in effect for 9 years). In the absence of non-LED options on the market, EOne should review models in this category and consider phasing out select models in 2024.

Other non-A-type lamps are primarily reflector lamps, for which some product types (primarily PAR20 and PAR30) are impacted by the Energy Efficiency Regulations on general service incandescent reflector lamps¹⁸. For those products, the regulation requires that halogen lamps be more efficient than traditional lamps; effectively, 50 W PAR20 lamps must now consume 39 W or less. The Evaluator assumed that all LED PAR20 lamps replaced standard compliant halogen lamps. Other popular product types include GU10 and PAR16 lamps, which are excluded from this regulation and for which the baseline wattage is the regular halogen wattage.

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)¹⁹ 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.²⁰

The Residential Lighting Evaluation Protocol of the Uniform Methods Project (UMP)²¹ 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.

¹⁸ NRCAN, *General service incandescent reflector lamps*, <https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/general-service-incandescent-reflector-lamps/6957> (Last accessed January 25, 2024).

¹⁹ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

²⁰ The snapback effect is an increase in usage following the installation of an efficient product because the operating cost is lower.

²¹ 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.
- › 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 9: 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

Type of LED	Unitary Energy Savings Value (kWh/year)	Peak Demand-to-energy Ratio (W/kWh)	Unitary Peak Demand Savings Value (W/year)
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
9 W Installed Through the Mail-out Pilot	47.7		7.72
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)	31.6	0.162	5.12
ENERGY STAR Certified LED Non-A-type Lamps (excluding R, BR, and Decorative)	42.2		6.84

Installation Rates

Table 10 lists the installation rate for EPI LED Lamps.

Table 10: EPI LED Lamp Installation Rate

Path	Installation Rate	Margin of Error	Source
Regular	94%	2.1%	2021 EPI evaluation (on-site visits)
Mail-out	77%	N/A	2022 EPI evaluation (proportion of regular EPI participants that received this measure multiplied by the installation rates from the IESO's Direct Mail pilot ²²)

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 since 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.

²² Cadmus. *Canadian Niagara Power: Draft Final Residential Direct Mail Pilot Evaluation*, prepared for the Independent Electricity System Operator (IESO), August 9, 2017

(2) LED Fixtures

Summary

Table 11 presents a summary of the values used to calculate the savings for motion sensors. The detailed methodology follows.

Table 11: 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]	2.0	2.0	2.9	See Subsection 4.1
Electrical Savings Parameters				
Unitary Energy Savings [kWh/year]	51.0	73.5	204.6	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]	8.3	11.91	33.15	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 12 lists the parameters and corresponding values used in the equation and the resulting unitary savings values.

$$\begin{aligned}
 & \text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] \\
 &= \frac{\left(\text{Wattage}_{\text{average equivalent}} [W] \times \text{HOU}_{\text{old}} \left[\frac{\text{hrs}}{\text{day}} \right] - \text{Wattage}_{\text{average}} [W] \times \text{HOU}_{\text{new}} \left[\frac{\text{hrs}}{\text{day}} \right] \right) \times 365 \left[\frac{\text{day}}{\text{yr}} \right]}{1,000 \left[\frac{W}{kW} \right]}
 \end{aligned}$$

Table 12: 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	11.8	60.0	48.2	2.9	2.9	51.0
ENERGY STAR Certified LED Fixtures	22.3	91.7	69.4			73.5
ENERGY STAR Certified LED Fixtures with Motion Sensors	20.3	132	111	4.75	2.92	205

Displaced Wattage

To establish the displaced wattage of each category of lighting fixture offered under Instant Savings, the Evaluator identified the best-selling models listed in the 2023 tracking sheet for each type of LED fixture.

The 10 best-selling models of LED recessed downlight fixtures represent over 82% of all recessed LED lamps sold through Instant Savings. All of these fixtures replace fixtures that would have housed small halogen reflector lamps, typically MR16 or PAR16. All fixtures were found to have lumen outputs well above that of standard 50W MR15 (which is around 400-450 lm). However, since fixtures are likely to be replaced one for one, the Evaluator selected a baseline wattage corresponding to the brightest reflector lamps typically used indoor, a 60 W MR16.

The Evaluator selected the 10 most popular models that represent 71% of all 2023 sales for ENERGY STAR Certified LED Fixtures without motion sensors. Most of these fixtures replace fixtures that would have housed incandescent A19 lamps. The Evaluator 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 13 below).

Table 13: 2022 ENERGY STAR Certified Lamp Light Output Equivalency to Incandescent Lamp Wattage²³

Old Incandescent Lamps (W)	ENERGY STAR Certified Lamp Light Output (Lumens)
40	450
60	800
75	1,100
100	1,600
150	2,600

The Evaluator analyzed the eleven best-selling models of ENERGY STAR certified LED fixtures with a motion sensor, which represent 98% (excluding solar fixtures) of all 2023 sales for this product category. The Evaluator found that 98% of those fixtures housed lamps that replaced halogen lamps, while 2% of them replaced incandescent lamps. As for ENERGY STAR certified LED fixtures without a motion sensor, the lumen output was used to establish the corresponding halogen wattage that would have produced a similar amount of light. Since most fixtures replaced large reflector lamps (similar to PAR30), the Evaluator selected halogen wattages that are compliant with the Energy Efficiency Regulations on general service incandescent reflector lamps²⁴.

Hours of Operation

The value for the daily hours of operation is based on the Northeast Residential Lighting Hours-of-Use Study (NERHOU),²⁵ which established an average use of 2.9 hours per day for efficient bulbs given the absence of a snapback effect.²⁶

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 2023, the Evaluator found that 98% of LED fixtures equipped with a motion sensor are designed for

²³ ENERGY STAR, *Learn About Brightness*, https://www.energystar.gov/products/lighting_fans/light_bulbs/learn_about_brightness (Last accessed December 21, 2018).

²⁴ NRCAN, *General service incandescent reflector lamps*, <https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/general-service-incandescent-reflector-lamps/6957> (Last accessed January 25, 2024).

²⁵ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

²⁶ The snapback effect is an increase in usage following the installation of an efficient product because the operating cost is lower.

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.

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 4.2
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.

$$\text{Energy Savings} \left[\frac{kWh}{yr} \right] = \frac{(\text{Average Wattage})[W] \times \%Dimmed \times HOU \left[\frac{h}{day} \right] \times 365 \left[\frac{day}{yr} \right]}{1,000 \left[\frac{W}{kW} \right]}$$

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 ²⁷
Dimmed Wattage [%]	20%	2011 OPA Prescriptive Measures and Assumptions List ²⁸
Daily Hours of Operation	2.7	NERHOU, 2011 ²⁹
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.

²⁷ 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)

²⁸ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011

²⁹ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69

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%		0%	See Subsection 2.1.1
Interactive Effects Factor for Peak Demand Savings	-41.4%		0%	See Subsection 2.1.1

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 ³⁰
Daily Hours of Operation	2.7	NERHOU, 2011 ³¹
Daily Reduction of Hours of Operation	54%	2011 OPA Prescriptive Measures and Assumptions List ³²
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.

$$\text{Energy Savings [kWh/yr]} = \text{Base Consumption} - \text{Reduced Consumption}$$

$$\text{Base Consumption [kWh/yr]} = ((\text{Average Wattage})[W] \times \text{HOU}[h/day] \times 365[\text{day/yr}]) / 1,000[W/kW]$$

$$\begin{aligned} \text{Reduced Consumption [kWh/yr]} \\ = ((\text{Average Wattage})[W] \times (1 - \% \text{Dimmed}) \times \text{HOU}[h/day] \times (1 - \% \text{HOU Reduction}) \\ \times 365[\text{day/yr}]) / 1,000[W/kW] \end{aligned}$$

The value for each parameter and resulting unitary savings value are summarized in Table 18 below.

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. ³³
Dimmed Wattage [%]	20%	2011 OPA Prescriptive Measures and Assumptions List ³⁴
Daily Hours of Operation	2.7	NERHOU, 2011 ³⁵
Daily Reduction of Hours of Operation	54%	2011 OPA Prescriptive Measures and Assumptions List ³⁶
Unitary Energy Savings [kWh/year]	53.6	Calculation

³⁰ 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).

³¹ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

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.

$$\text{Energy Savings} \left[\frac{kWh}{yr} \right] = \frac{(\text{Average Wattage})[W] \times (\text{Old HOU} - \text{New HOU}) \left[\frac{h}{day} \right] \times 365 \left[\frac{day}{yr} \right]}{1,000 \left[\frac{W}{kW} \right]}$$

The value for each parameter and resulting unitary savings value are summarized in Table 19.

Table 19: Unitary Savings Values for Outdoor Motion Sensors

Parameter	Value	Source
Average Wattage [W]	(85% × 275.6 W) + (15% × 55.5 W) = 242.6 W	Assumption: 85% of outdoor lighting is for security spotlights with an average wattage of 275.6 W ³⁷ 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 ³⁸
New Operating Time [hrs/day]	2.95	2011 OPA Prescriptive Measures and Assumptions List ³⁹
Unitary Energy Savings [kWh/year]	159	Calculation

Installation Rates

The installation rate is assumed to be 100%.

³² Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

³³ 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).

³⁴ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

³⁵ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

³⁶ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

³⁷ Representative lamp mix: (85% × 2 × 150 W incandescent) + (10% × 2 × 90 W halogen) + (5% × 2 × 26 W CFL) = 275.6 W.

³⁸ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

³⁹ Ibid.

(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		
* Values for the EPI Mail-out Kit pilot are presented in the subsections below.		

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.⁴⁰

$$Energy\ Savings\ \left[\frac{kWh}{yr}\right] = \frac{(Old\ Wattage - New\ Wattage)[W] \times HOU\ \left[\frac{h}{day}\right] \times 365\ \left[\frac{day}{yr}\right]}{1,000\ \left[\frac{W}{kW}\right]}$$

⁴⁰ Pennsylvania Public Utility Commission, Technical Reference Manual – State of Pennsylvania, August 2019, p. 7

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

Path	Installation Rate	Margin of Error	Source
Regular	94%	2.1%	2021 EPI evaluation (on-site visits)
Mail-out	50%	N/A	2022 EPI evaluation (proportion of regular EPI participants receiving this measure multiplied by installation rates from the IESO's Direct Mail pilot) ⁴¹

(6) Solar Fixtures

Summary

Table 23 presents a summary of the values used to calculate the savings for solar fixtures. The detailed methodology follows.

⁴¹ Cadmus. *Canadian Niagara Power: Draft Final Residential Direct Mail Pilot Evaluation*, prepared for the Independent Electricity System Operator (IESO), August 9, 2017.

Table 23: Solar Fixture Measure Summary

Parameter	Instant Savings	Reference
Measure Description and Identification		
Measure Description	LED Solar fixtures replacing non-LED fixtures connected to the grid	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	2.6	See Subsection 4.1
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	478	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]	77.4	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0	See Subsection 2.1.1
Interactive Effects Factor for Peak Demand Savings	0	See Subsection 2.1.1

Electrical Unitary Energy Savings

Since solar fixtures consume no electricity from the grid, all the electrical energy consumed by the baseline fixture is saved. Different unitary savings values apply according to the location of the lamps or fixtures, although the only solar fixtures currently offered are outdoor security fixtures with motion sensors.

The unitary savings value for solar fixtures with motion sensors is based on the outdoor motion sensor equation adapted as follows to consider the nil consumption of the new fixtures.

$$Energy\ Savings\ \left[\frac{kWh}{yr}\right] = \frac{Baseline\ Wattage\ [W] \times Old\ HOU\ \left[\frac{h}{day}\right] \times 365\ \left[\frac{day}{yr}\right]}{1,000\ \left[\frac{W}{kW}\right]}$$

The value for each parameter and resulting unitary savings value are summarized in Table 24.

Table 24: Unitary Savings Values for Solar Fixtures

Parameter	Value	Source
Average Wattage [W]	275.6 W	Assumption: Security spotlight average wattage assuming a representative mix ⁴²
Old Operating Time [hrs/day]	4.75	2011 OPA Prescriptive Measures and Assumptions List ⁴³
Unitary Energy Savings [kWh/year]	478	Calculation

Installation Rates

The installation rate is assumed to be 100%.

⁴² Representative lamp mix: $(85\% \times 2 \times 150 \text{ W incandescent}) + (10\% \times 2 \times 90 \text{ W halogen}) + (5\% \times 2 \times 26 \text{ W CFL}) = 275.6 \text{ W}$.

⁴³ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

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.

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 evaluation⁴⁴ 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. 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.

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.⁴⁵

⁴⁴ Econoler, *Residential Direct Install 2015 Evaluation*, March 3, 2016

⁴⁵ Minister of Justice, Canada, *Energy Efficiency Regulations*, 2016, <http://laws-lois.justice.gc.ca/PDF/SOR-2016-311.pdf> (Last accessed December 5, 2019)

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.⁴⁶

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%.

Table 25 summarizes the interactive effects factors for DHW insulation measures.

Table 25: 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%

⁴⁶ Refer to Subsection 2.1.1 for more details on COP assumptions

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 26 summarizes the interactive effects factors established for each water heating measure.

Table 26: 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				
Faucet Aerator		0%	0%	Assumption
Thermostatic Shower Valve				

Measure	Type of Home	Interactive Effects Factors for Energy Savings	Interactive Effects Factors for Peak Demand Savings	Source
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 27 summarizes the peak demand-to-energy ratios established for each water heating measure.

Table 27: 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 28 presents a summary of the values used to calculate drain water heat recovery (DWHR) savings. The detailed methodology follows.

Table 28: Drain Water Heat Recovery Measure Summary

Parameter	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

Parameter	MHEEP	Reference
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	599	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]	97.0	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	0%	See Subsection 2.2.1
Interactive Effects Factor for Peak Demand Savings	0%	See subsection 2.2.1

Electrical Unitary Energy Savings

The DWHR unitary savings values were determined using the HOT2000 simulation tool since it includes DWHR as an option. Although a typical single-family home and multifamily building were modelled, the savings for DWHR were the same regardless of the building type when looking at savings per occupant. The unitary savings values were obtained using the equation below and the values presented in Table 29 afterwards.

$$Energy\ Savings_{kWh} = Savings\ per\ Occupant \times Number\ of\ Person\ per\ Household$$

Table 29: Electrical Unitary Energy Savings Values for Drain Water Heat Recovery Systems

Parameter	MHEEP	Source
Number of Persons per Household [person]	3.6	2022 MHEEP tracking sheet
Number of Showers per Person per Day [shower]	0.67	Mayer, Oreo et al. ⁴⁷
Average Shower Duration ⁴⁸ [minutes]	8	DeOreo et al. ⁴⁹
Shower Flow Rate [litres/minute]	9.5	2019 Connecticut TRM ⁵⁰
Energy Savings per Occupant [kWh/person]	166.4	HOT2000 simulations
Unitary Energy Savings [kWh/year]	599	Calculated

⁴⁷ Mayer, P. W., Oreo W. B. et al., *Residential End Uses of Water*, published by the AWWA Research Foundation, 1999, pp. 99-102

⁴⁸ Ibid.

⁴⁹ 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

⁵⁰ United Illuminating Company and Connecticut Light & Power Company, *Connecticut Program Savings Document*, 15th Edition for 2019 Program Year, March 2019

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 30 presents a summary of the values used to calculate solar domestic hot water (solar DHW) savings. The detailed methodology follows.

Table 30: Solar Domestic Hot Water Measure Summary

Parameter	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]	N/A (Calculated using RETScreen)	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0	See Subsection 2.2.2
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 2.2.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 2.2.1

Electrical Unitary Energy Savings

The unitary savings value for solar DHW systems installed through Green Heat is calculated for each system.

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 31 presents a summary of the values used to calculate heat pump water heater (HPWH) savings. The detailed methodology follows.

Table 31: 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 non-electric space heating	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]	1,611	1,179	1,280	922	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]	261	191	207	149	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 taken from a metering study conducted for NEEA⁵¹. They include interactive effects. Instant Savings Average Unitary Energy Savings is a weighted average based on the share of space heating systems in Nova Scotia; it calculates the electric energy savings only, by taking into account the proportion of replaced water heaters that electric water heaters among households that have non-electric, electric resistance and heat pump space heating.

Following Table 32 lists the equation parameters and corresponding values, as well as the resulting unitary savings values.

Installation Rates

Installation rates for heat pump water heaters are estimated at 100% due to their relatively high cost.

⁵¹ Ecotope inc., *NEEA Heat Pump Water Heater Model Validation Study*, 2015.

Table 32: Electrical Unitary Savings Values for Heat Pump Water Heaters

Parameter	Symbol	HEA, MHEEP			Instant Savings			Source
		Non-Electrical Space Heating	Electric Resistance Space Heating	Heat Pump Space Heating	Non-Electrical Space Heating	Electric Resistance Space Heating	Heat Pump Space Heating	
Savings Including Interactive Effects [kWh/year]		1,611	1,179	1,280	1,611	1,179	1,280	2015 Ecotope inc. ⁵²
Share of Electrical Water Heaters in Nova Scotia	-	N/A			52%	97%	90%	Based on 2018, 2019 and 2020 EPI tracking sheets ⁵³
Unitary Energy Savings [kWh/year]	-	1,611	1,179	1,280	838	1,144	1,152	Calculation
Share of Space Heating Systems in Nova Scotia	-	N/A			58%	24%	14%	Statistics Canada ^{54,55}
Average Unitary Energy Savings [kWh/year]	-	1,611	1,179	1,280	922			Calculation

⁵² Ecotope inc., *NEEA Heat Pump Water Heater Model Validation Study*, 2015, p. 72

Average of 3 non-ducted models in heating zone 3 (most comparable to Nova Scotia). All water heaters are assumed to be in heated spaces since HEA tracking sheet shows that is the case for more than 98% of homes. Used Interior "EFAF" for electric resistance space heating, "interior HP" for heat pumps space heating and "interior gas" for non-electrical space heating.

⁵³ 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.

⁵⁴ Statistics Canada, *Table 153-0145 - Households and the Environment Survey, Primary Heating System, Canada, Provinces and Census Metropolitan Areas*, 2017, CANSIM, November 27, 2019.

⁵⁵ Data provided by Statistics Canada do not add to 100%.

(4) Low-flow Showerheads

Summary

Table 33 presents a summary of the values used to calculate low-flow showerhead savings. The detailed methodology follows.

Table 33: Low-flow Showerhead Measure Summary

Parameter	EPI						Reference
Measure Description and Identification							
Measure Description	Low-flow showerheads to reduce domestic hot water consumption						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%						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	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	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
* Values for the EPI Mail-out Kit pilot are presented in the subsections below.							

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.

$$\begin{aligned}
 \text{Energy Savings } \left[\frac{kWh}{year} \right] &= \text{DHW Reduction } \left[\frac{gal}{day} \right] \times \frac{1}{\eta} \times C_{p_{H2O}} \left[\frac{Btu}{lb \cdot ^\circ F} \right] \times \rho_{H2O} \left[\frac{lb}{ft^3} \right] \times \Delta T_{H2O} [^\circ F] \times n_{days} \left[\frac{days}{year} \right] \\
 &\times UC1 \left[\frac{kWh}{Btu} \right] \times UC2 \left[\frac{ft^3}{gal} \right] \times \%DWH_{elec}
 \end{aligned}$$

$$\begin{aligned}
 \text{DHW Reduction } \left[\frac{gal}{day} \right] &= (q_{base} - q_{low}) [gpm] \times \frac{n_{people} [person]}{n_{showerheads}} \times \%DHW \times t_{shower} \left[\frac{min}{shower} \right] \times n_{shower} \left[\frac{shower}{day \cdot person} \right]
 \end{aligned}$$

Table 34 below lists the parameters and corresponding values applied in the equations above for low-flow showerheads and the resulting unitary savings values.

Table 34: Electrical Unitary Energy Savings Values for Low-flow Showerheads

Parameter	Symbol	EPI		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)	EPI tracking sheet
Low-flow Rate [gpm]	q_{low}	1.5		2021 EPI Program Manual
Number of People per Household [person]	n_{people}	2.5	1.9	2020 EPI November tracking sheet
Average Number of Showers per Day per Person [shower/day/person]	n_{shower}	0.67		Mayer and Oreo ⁵⁶
Number of Showerheads per Household [showers]	$n_{showerheads}$	1.6	1	2021 EPI Evaluation (on-site visits)
Average Shower Time per Person [min/shower]	t_{shower}	7.8		DeOreo et al. ⁵⁷

⁵⁶ Mayer, P. W., Oreo W. B. et al., *Residential End Uses of Water*, published by the AWWA Research Foundation, 1999, pp. 99-102.

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.

Parameter	Symbol	EPI		Source
		Single-family Homes	Apartments	
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 _{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 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%		<u>EPI</u> : Units claimed in DSM savings are installed in homes with electrical water heaters.
Unitary Energy Savings [kWh/year]	Flow rate reduction of 0.5 gpm	187	227	Calculation
	Flow rate reduction of 0.75 gpm	281	341	Calculation
	Flow rate reduction of 1 gpm	374	455	Calculation

For the EPI Mail-out pilot, unitary savings of 374 kWh were used assuming a flow rate reduction of 1 gpm for a single-family home since this is the most common situation among EPI participants.

Installation Rates

Table 35 lists the installation rate for EPI low-flow showerheads.

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

⁵⁹ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174

Table 35: EPI Low-flow Showerhead Installation Rate

Path	Installation Rate	Margin of Error	Source
Regular	96%	5.1%	2021 EPI Evaluation (on-site visits)
Mail-out	16%	N/A	2022 EPI Evaluation (proportion of regular EPI participants receiving this measure multiplied by installation rates from the IESO's Direct Mail pilot ⁶⁰)

⁶⁰ Cadmus. *Canadian Niagara Power: Draft Final Residential Direct Mail Pilot Evaluation*, prepared for the Independent Electricity System Operator (IESO), August 9, 2017.

(5) Faucet Aerators

Summary

Table 36 presents a summary of the values used to calculate faucet aerator savings. The detailed methodology follows.

Table 36: 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
* Values for the EPI Mail-out Kit pilot are presented in the subsections below.			

Electrical Unitary Energy Savings

The equation below is used to calculate the annual unitary savings value for faucet aerators.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{(DHW_{base} - DHW_{efficient}) \left[\frac{\text{gal}}{\text{day}} \right] \times C_{p_{H_2O}} \left[\frac{\text{BTU}}{\text{lb}^{\circ}\text{F}} \right] \times \rho_{H_2O} \left[\frac{\text{lb}}{\text{ft}^3} \right] \times \Delta T_{H_2O} [^{\circ}\text{F}] \times n_{days} \left[\frac{\text{days}}{\text{yr}} \right] \times UC1 \left[\frac{\text{kWh}}{\text{BTU}} \right] \times UC2 \left[\frac{\text{ft}^3}{\text{gal}} \right]}{\eta}$$

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 37 lists the parameters and values applied in the three equations above for faucet aerators and the resulting unitary savings values.

Table 37: 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

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.

Parameter	Symbol	Value for Single-family Homes	Value for Apartments	Source
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]	$C_{p_{H_2O}}$	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

For the EPI Mail-out pilot, unitary savings of 110 kWh were used assuming a single-family home since that type of participant is the most common among EPI participants.

Installation Rates

Table 38 lists the installation rate for EPI faucet aerators.

Table 38: EPI Faucet Aerator Installation Rate

Path	Installation Rate	Margin of Error	Source
Regular	85%	6.8%	2021 EPI Evaluation (on-site visits)
Mail-out	18%	N/A	2022 EPI Evaluation (proportion of regular EPI participants receiving this measure multiplied by installation rates from the IESO's Direct Mail pilot ⁶⁷)

⁶⁶ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

⁶⁷ Cadmus. *Canadian Niagara Power: Draft Final Residential Direct Mail Pilot Evaluation*, prepared for the Independent Electricity System Operator (IESO), August 9, 2017.

(6) Thermostatic Shower Valve

Summary

Table 39 presents a summary of the values used to calculate thermostatic shower valve savings. The detailed methodology follows.

Table 39: 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.

$$\text{Energy Savings} \left[\frac{kWh}{year} \right] = \frac{\text{DHW Reduction} \left[\frac{gal}{year} \right] \times C_{p_{H2O}} \left[\frac{Btu}{lb \cdot ^\circ F} \right] \times \rho_{H2O} \left[\frac{lb}{ft^3} \right] \times \Delta T_{H2O} [^\circ F] \times n_{days} \left[\frac{days}{year} \right] \times UC1 \left[\frac{kWh}{Btu} \right] \times UC2 \left[\frac{ft^3}{gal} \right]}{\eta}$$

$$\text{DHW Reduction} \left[\frac{gal}{year} \right] = q \left[\frac{gal}{min} \right] \times n_{people} [person] \times \%_{DHW} \times t_w \left[\frac{min}{shower} \right] \times n_{shower} \left[\frac{shower}{day \cdot person} \right] \times \frac{1}{n_{showerhead}}$$

Table 40 below lists the parameters and corresponding values applied to the two equations above and the resulting unitary savings values for thermostatic shower valves.

Table 40: 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 ⁶⁸
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 ⁶⁹ Maine TRM ⁷⁰

⁶⁸ Mayer, P. W., W. B. Oreo et al., *Residential End Uses of Water*, published by the AWWA Research Foundation, 1999, pp. 99-102

⁶⁹ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 133

⁷⁰ Efficiency Maine, *Retail/Residential Technical Reference Manual Version 2019.1*, July 2018

Parameter	Symbol	Value for Single-family Homes	Value for Apartments	Source
Percentage of Hot Water Used in Showers	% _{DHW}	63%		DeOreo et al. ⁷¹
Number of Days per Year [days/year]	n _{days}	365		Convention
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
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 ⁷²
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 41 lists the installation rate for thermostatic shower valves.

Table 41: Thermostatic Shower Valve Installation Rate

Installation Rate	Margin of Error	Source
88%	13.2%	2021 EPI Evaluation (on-site visits)

⁷¹ 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.

⁷² Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

(7) Pipe Insulation

Summary

Table 42 presents a summary of the values used to calculate pipe insulation savings. The detailed methodology follows.

Table 42: 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]	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]	0.162	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		
* Values for the EPI Mail-out Kit pilot are presented in the subsections below.		

Electrical Unitary Energy Savings

As presented in Table 43, the annual unitary savings value for pipe insulation was identified through Ontario Power Authority (OPA) 2011⁷³ values and amounts, established at 12.7 kWh per linear foot.

Table 43: Unitary Savings Value for Pipe Insulation

Parameter	EPI
Unitary Energy Savings (per ft) [kWh/year]	12.7

⁷³ Ontario Power Authority (OPA), *OPA Prescriptive Measures and Assumptions List*, December 2010

Installation Rates

Table 44 lists the installation rate for EPI pipe insulation.

Table 44: EPI Pipe Insulation Installation Rate

Path	Installation Rate	Margin of Error	Source
Regular	100%	N/A	2021 EPI evaluation (assumption)
Mail-out	5%	-	2022 EPI evaluation (proportion of regular EPI participants receiving this measure multiplied by installation rates from the IESO's Direct Mail pilot ⁷⁴)

(8) Hot Water Tank Wrap

Summary

Table 45 presents a summary of the values used to calculate hot water tank wrap savings. The detailed methodology follows.

Table 45: 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			

⁷⁴ Cadmus. *Canadian Niagara Power: Draft Final Residential Direct Mail Pilot Evaluation*, prepared for the Independent Electricity System Operator (IESO), August 9, 2017.

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:

$$R_{\text{layer}} = \frac{\ln(r_e/r_i)}{2\pi k}$$

$$R_{\text{cyl}} = R_{\text{layer1}} + R_{\text{layer2}}$$

$$Q_{\text{cyl}} = \frac{T_i - T_e}{R_{\text{cyl}}} L$$

$$Q_{\text{top}} = \frac{A_{\text{top}} \times (T_i - T_e)}{R_{\text{top}}}$$

$$Q_{\text{total}} = Q_{\text{cyl}} + Q_{\text{top}}$$

$$\text{Energy Savings}_{\text{kWh}} = \frac{(Q_{\text{total}}) \cdot \text{HOU}}{\eta_{\text{heater}}}$$

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 46 lists the values applied in equations presented above to obtain the unitary savings for tank wraps.

Table 46: 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 ⁷⁵
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 ⁷⁶

⁷⁵ Giant Inc., *Engineering Submittal Data Sheet 172ETE Models*, <http://www.giantinc.com/tech-data/FT-172E-An.pdf> (Last accessed February 18, 2015)

⁷⁶ Ibid.

Parameter	Symbol	Value for Single-family Homes	Value for Apartments	Source
Layer 2: Tank Wrap				
External Radius of the Layer [m]	r _e	0.351	0.331	Estimated from Frost King Insulation Blanket Specifications ⁷⁷
Internal Radius of the Layer [m]	r _i	0.300	0.280	Giant ⁷⁸
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 ⁷⁹
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 ⁸⁰
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

⁷⁷ Frost King Weatherization Products, *Water Heater Insulation Blanket*, <http://www.frostking.com/water-heater-insulation-blanket/> (Last accessed January 4, 2014)

⁷⁸ Giant Inc., *Engineering Submittal Data Sheet 172ETE Models*, 16

⁷⁹ Ibid., 16.

⁸⁰ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174

Installation Rates

Table 47 lists the installation rate for EPI hot water tank wraps.

Table 47: 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 48, the interactive effects factors for each space heating measure are assumed to be nil.

Table 48: 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 Products			
Programmable Thermostat			
Smart Thermostat for Electrical Baseboards			

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 products, 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 2020-2023 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 49 summarizes the peak demand-to-energy ratios established for each space heating measure.

Table 49: Peak Demand-to-energy Ratios for Space Heating Measures

Measure	Peak Demand-to-energy Ratio (W/kWh)	Source
Mini-split Heat Pumps	N/A	N/A
Central Air-source Heat Pumps		
Ground-source Heat Pumps		
Wood Stoves/Fireplace Inserts		
Pellet Stoves/Fireplace Inserts		
Wood Furnaces/Boilers		
Pellet Furnace/Boilers		
Solar Air Heating	0.000	Assumption
Air Sealing Products	0.283	RES-Elec-Space Heat & Cool, Navigant 2016-2018 DSM Plan
Programmable Thermostats	0.000	Assumption based on literature review findings
Smart Thermostats		

2.3.3 Space Heating Measures

(1) Mini-split Heat Pumps

Summary

Table 50 presents a summary of the values used to calculate mini-split heat pump (MSHP) savings. The detailed methodology follows.

Table 50: 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

For Green Heat, 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.

For HEA and MHEEP, the energy savings are based on simulation outputs.

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 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 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 52 presents a summary of the values used to calculate central air-source heat pump (CASHP) savings. The detailed methodology follows.

Table 52: 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]	3,988	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 2022 and was able to identify those parameters for up to nine models. The average unitary peak demand savings for CASHPs were then calculated using the variables defined and listed in the equation and Table 53 below.

$$Peak\ Demand\ Savings_W = \frac{HC_{min}}{3.412} \times \left(\frac{1}{COP_{base\_min}} - \frac{1}{COP_{ee\_min}} \right)$$

Table 53: Unitary Peak Demand Savings Values for Central Air-source Heat Pumps

Variable	Symbol	Green Heat	Source
Rated heating capacity of the new heat pump at outdoor air temperature of -15°C [BTU/h]	HC_{min}	26,261	Average specification data for 7 models in the 2022 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}	2.076	Average specification data for 9 models in the 2022 Green Heat tracking sheet
Conversion factor [BTU/W·h]	3.412	3.412	Convention
Unitary Peak Demand Savings [W]	$Peak\ Demand\ Savings_W$	3,989	Calculation

Installation Rates

Installation rates for CASHPs are estimated at 100% due to their relatively high cost.

(3) Ground-source Heat Pumps

Summary

Table 54 presents a summary of the values used to calculate ground-source heat pump (GSHP) savings. The detailed methodology follows.

Table 54: 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 55 below.

$$\begin{aligned}
 \text{Energy Savings}_{kWh} &= \text{Heating Savings} + \text{Cooling Savings or Penalty} \\
 &= \left(\frac{HC}{1,000} \times \left(\frac{1}{HSPF2_{base}} - \frac{1}{COP_{ee} \times DRF \times 3.412} \right) \times FLH_{heat} \right) \\
 &\quad + \left(\frac{CC}{1,000} \times \left(\frac{1}{SEER2_{base}} \times AC - \frac{1}{EER_{ee} \times DRF \times GSER} \right) \times FLH_{cool} \right)
 \end{aligned}$$

Table 55: 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 [HSPF2 in BTU/W·h]	$HSPF2_{base}$	Elec. resistance: 3.412 MSHP: 7.4 CASHP: 7.0	Assumptions ⁸¹
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 ⁸²
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 [SEER2 in BTU/W·h]	$SEER2_{base}$	Room AC: 11.4 Central AC: 12.8 MSHP: 14.5 CASHP: 13.8	Assumptions ⁸³
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	Estimate based on the number of hours that a GSHP needs to operate to meet a heating load of 14,600 kWh (NS average)
Full cooling load hours [h/year]	FLH_{cool}	213	2020 Minnesota TRM ⁸⁴
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

⁸¹ Assuming a HSPF of 3.412 for electric resistance and an average HSPF1 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->

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 55. 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 COP_{base} variable in the formula below is the electrical baseline value regardless of the actual baseline equipment.

$$Peak\ Demand\ Savings_W = \left(1,000 \times HC \times \left(\frac{1}{COP_{base}} - \frac{1}{COP_{ee} \times DRF} \right) \right)$$

Installation Rates

Installation rates for GSHPs are estimated at 100% due to their relatively high cost.

[canada/about-energy-star-canada/energy-star-announcements/publications/heating-cooling-heat-pump/air-source-heat-pumps/6831](https://www.energy-star.ca/about-energy-star-canada/energy-star-announcements/publications/heating-cooling-heat-pump/air-source-heat-pumps/6831)).

⁸² Pennsylvania Public Utility Commission (PUC), *Technical Reference Manual*, August 2019, Subsection 2.2 – HVAC

⁸³ 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).

⁸⁴ 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 56 presents a summary of the values used to calculate wood and pellet stove and fireplace insert savings. The detailed methodology follows.

Table 56: 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.⁸⁵ 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.⁸⁶ The unitary energy savings values are presented in Table 57 below.

⁸⁵ The HOT2000 energy models were developed as part of the 2013 evaluation.

⁸⁶ 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 57: 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 ⁸⁶ 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.⁸⁷ 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 58.

Table 58: 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.

⁸⁷ Dunsy Energy Consulting, *Residential Fuel Substitution Pilot Program*, Final Report, December 2010

(5) Wood and Pellet Boilers and Furnaces

Summary

Table 59 presents a summary of the values used to calculate wood and pellet boiler and furnace savings. The detailed methodology follows.

Table 59: 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.⁸⁸ 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.⁸⁹ The unitary energy savings values are presented in Table 60 below.

⁸⁸ The HOT2000 energy models were developed as part of the 2013 evaluation.

⁸⁹ 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 60: 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		<u>Green Heat:</u> Assumption ⁸⁶ <u>HEA:</u> AHRI certified value
Unitary Energy Savings with Electrical Baseline [kWh/year]	<i>Energy Savings</i> $kWh (base\_elec)$	13,804	13,765	13,804	13,765	2013 Evaluation HOT2000 Energy Models
Unitary Energy Savings with Heat Pump Baseline [kWh/year]	<i>Energy Savings</i> $kWh (base\_hp)$	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.⁹⁰ 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 61 below.

Table 61: 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 62 presents a summary of the values used to calculate solar air heating savings. The detailed methodology follows.

⁹⁰ Dunsy Energy Consulting, *Residential Fuel Substitution Pilot Program*, Final Report, December 2010.

Table 62: Solar Air Heating Measure Summary

Parameter	Green Heat	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)	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	N/A	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 2.2.1
Interactive Effects Factor for Peak Demand Savings	0%	See Subsection 2.2.1

Electrical Unitary Energy Savings

The unitary savings value for solar air heating systems installed through Green Heat is calculated for each system.

Installation Rates

Installation rates for solar air heating are estimated at 100% due to their relatively high cost.

(7) Air Sealing Products

Summary

Table 63 presents a summary of the values used to calculate air sealing product savings. The detailed methodology follows.

Table 63: Air Sealing Product Measure Summary

Parameter	EPI								Reference
Measure Description and Identification									
Measure Description	Air sealing products 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
* Values for the EPI Mail-out Kit pilot are presented in the subsections below.									

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 2010.⁹¹ 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. 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. For the Mail-out pilot, averages between the values for electric resistance heated homes and heat pump heated homes were used.

Table 64 summarizes the savings for each measure included in air sealing products for electric resistance.

Table 64: Savings Values for Air Sealing Products in Electric Resistance and Heat Pump Heated Homes

Measure	Electric Resistance Heated Homes	Heat Pump Heated Homes	Mail-In Homes (average)	Source
Annual Energy Savings from Foam Gaskets [kWh/gasket]	9	<u>40.9</u>	<u>65.5</u>	<u>Electric Resistance:</u> Connecticut TRM ⁹² <u>Heat Pump:</u> Calculation
Annual Energy Savings from Door Sweeps [kWh/door]	173	78.6	N/A	
Annual Energy Savings from Window Air Sealing [kWh/foot]	9.9	67.7	108	
Annual Energy Savings from Door Weather Stripping [kWh/foot]	11.5	89.1	143	

⁹¹ United Illuminating Company and Connecticut Light & Power Company, *Connecticut Program Savings Document*, 15th Edition for 2019 Program Year, March 2019.

⁹² Ibid.

Installation Rates

Table 65 lists the installation rate for EPI air sealing products.

Table 65: EPI Air Sealing Product Installation Rate

Measure Description	Installation Rate	Margin of Error	Source
Regular Path			
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)
Mail-out Path			
Foam Gasket	18%	N/A	2022 EPI Evaluation (proportion of regular EPI participants receiving this measure multiplied by installation rates from the IESO's Direct Mail pilot ⁹³)
Window Air Sealing	1%	N/A	
Door Weather Stripping	3%	N/A	

⁹³ Cadmus. *Canadian Niagara Power: Draft Final Residential Direct Mail Pilot Evaluation*, prepared for the Independent Electricity System Operator (IESO), August 9, 2017

(8) Window Film Kits

Summary

Table 66 presents a summary of the values used to calculate window film kit savings. The detailed methodology follows.

Table 66: Window Film Kit Measure Summary

Parameter		EPI		Reference
Measure Description and Identification				
Measure Description		Windows film kits to reduce space heating consumption		N/A
Additional Notes	Heating System	Electrical Resistance Heated Homes	Heat Pump Heated Homes	
General Parameters				
Installation Rate		33%		Assumption
Effective Useful Life [years]		1		See Subsection 4.2
Electrical Savings Parameters				
Unitary Energy Savings [kWh/year]		333	151	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]		0.283		See Subsection 2.3.2
Unitary Peak Demand Savings [W]		94.3	42.9	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 of the window kit measure are calculated using the equations below.

$$\begin{aligned}
 \text{Energy Savings (kWh)} &= ES_{\text{sealing}} + ES_{\text{insulation}} \\
 ES_{\text{sealing}} &= \frac{n_{\text{window}} \times p_{\text{window}} \times ESPF_{\text{tape}}}{COP} \times \frac{HDD_{NS}}{HDD_{CT}} \\
 ES_{\text{insulation}} &= \frac{HDD_{NS} \times n_{\text{window}} \times A_{\text{window}} \times 24 \times ADJ}{COP \times 3,413} \times \left(\frac{1}{R_{\text{window}}} - \frac{1}{R_{\text{window}} + R_{\text{air}}} \right)
 \end{aligned}$$

Total energy savings for this measure were calculated by combining savings from insulation and sealing; for the number of units, it was assumed that each kit could be used to cover two two-foot by three-foot windows.

The energy savings per foot of tape (ESPF) used in the second equation for sealing was taken from Connecticut's 2021 Program Savings Document;⁹⁴ the value was adjusted to the Nova Scotia context by using a heating degree days (HDD) ratio between Connecticut and Nova Scotia.

For the savings generated by insulation, the resistance values of the window and the added air layer due to film shrinkage ($R_{\text{window}} + R_{\text{air}}$) were based on specific values provided by the 2022 Iowa Energy Efficiency Statewide Technical Reference Manual.⁹⁵ That TRM also provides an adjustment factor of 0.63 for wall insulation, used to account for overclaiming savings due to prescriptive engineering algorithms.

Table 67 presents the parameters used to calculate unitary energy savings for window film kits installed through EPI.

Table 67: Electrical Unitary Savings Calculations for Window Film Kits

Parameter	Symbol	Value for Electrical Resistance Heated Homes	Value for Heat Pump Heated Homes	Source
Number of windows insulated	n_{window}	2		Assumption that one window kit can typically cover two 2'x3' windows
Perimeter of insulated window [ft]	p_{window}	10		
Net area of insulated window [ft ²]	A_{window}	6		
Average annual heating degree days in Connecticut [°F·day]	HDD _{CT}	5,885		2021 Connecticut Program Savings Document, 18th Edition, p. 242
Average annual heating degree days in Nova Scotia [°F·day]	HDD _{NS}	6,765		Environment Canada, Halifax Stanfield International Airport, using an 18 °C heating balance point
Coefficient of performance	COP	1	2.2	Efficiency of a standard mini-split heat pump based on a HSPF Region V of 7.4

⁹⁴ Energize Connecticut. *Connecticut's 2021 Program Savings Document*, March 1. Available at: <https://energizect.com/sites/default/files/documents/Final%202022%20PSD%20FILED%20110122.pdf>.

⁹⁵ Iowa Utilities Board, *Iowa Energy Efficiency Statewide Technical Reference Manual*, January 2022. Available at: https://iub.iowa.gov/sites/default/files/documents/2021/09/iowa_trm_v6_vol_1_overview_and_user_guide_2069155_210820-161936.pdf.

Parameter	Symbol	Value for Electrical Resistance Heated Homes	Value for Heat Pump Heated Homes	Source
Energy savings per foot of tape [kWh/ft]	$EPSF_{tape}$	9.9		2021 Connecticut Program Savings Document, 18th Edition, p. 248
R-value of existing window [ft ² ·°F·h/Btu]	R_{window}	2		2022 Iowa TRM, Volume 2, p. 307
R-value of existing window [ft ² ·°F·h/Btu]	R_{air}	2.85		
Adjustment to account for overclaiming of savings [%]	ADJ	63%		
Energy savings from air sealing provided by the tape [kWh]	$ES_{sealing}$	228	103	Calculation
Energy savings from insulation provided by the film [kWh]	$ES_{insulation}$	106	48	
Unitary Energy Savings [kWh/year]	<i>Energy Savings_{kWh}</i>	333	151	Calculation

Installation Rates

With no data collected on the installation rate for this measure because it is a new EPI measure, the installation rate is assumed to be 33% since this measure was left behind for participants to install and window films are not simple to install.

(9) Programmable Thermostats

Summary

Table 68 presents a summary of the values used to calculate programmable thermostat savings. The detailed methodology follows.

Table 68: 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.⁹⁶ The savings values include energy savings generated by the thermostat's accuracy and temperature setback for three types of dwellings: single-family homes, 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.⁹⁷

⁹⁶ Econoler, *Évaluation du programme thermostats électroniques – Volet nouvelle construction au marché résidentiel*, Final Report presented to Hydro-Québec, February 9, 2009

⁹⁷ 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)

$$Energy\ Savings_{kWh} = \sum (Dwelling\ Proportion \times Total\ Savings)$$

Table 69 presents the parameters used to calculate unitary energy savings for programmable thermostats installed through Instant Savings.

Table 69: Electrical Unitary Savings Calculations for Programmable Thermostats

Parameters	Symbol	Instant Savings			Source
		Single-family	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--family homes.

Installation Rates

For Instant Savings, the installation rate is assumed to be 100%.

(10) Smart Thermostats for Electrical Heating Systems

Summary

Table 70 presents a summary of the values used to calculate smart thermostat savings. The detailed methodology follows.

Table 70: Smart Thermostat for Electrical Heating System Measure Summary

Parameter		Instant Savings, EPI, MHEEP			Reference
Measure Description and Identification					
Measure Description		Smart thermostats to reduce electric space heating consumption			N/A
Additional Notes	Controlled Heating System	Electric Baseboard	MSHP	Electric In-floor 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]		348	514	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%			See Subsection 2.3.1
Interactive Effects Factor for Peak Demand Savings					

Electrical Unitary Energy Savings

Some models of smart thermostats sold through Instant Savings or installed through EPI or MHEEP are compatible with electrical heating systems. They operate by connecting to a single baseboard, MSHP, or in-floor heating system as opposed to a central heating system. The equation below is used to calculate the unitary savings value for smart thermostats compatible with electrical heating systems and installed through Instant Savings, EPI or MHEEP.

$$Energy\ Savings_{kWh} = \frac{Heating\ Energy \times \%Savings}{Number\ of\ Rooms}$$

Since no studies specific to smart thermostats connected to electric baseboards, MSHPs, or electric in-floor heating systems were identified, the percentage of the 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 71 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 served to assess 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, MSHPs, and electric in-floor heating systems among Nest compatible systems.

**Table 71: Billing Analysis Savings Results for Smart Thermostats
for Electrical Heating Systems**

Jurisdiction	Measure	Sample Size	Heating Consumption Savings
Oregon ⁹⁸	Nest thermostats	185	12% (for ASHPs)
Bonneville Power Administration ⁹⁹	Nest thermostats	176	12% (for ASHPs)

As previously mentioned, electric baseboards, MSHPs, or electric in-floor heating systems are individually paired to a unique compatible smart thermostat. Therefore, the savings are divided by the average number of electrical heating systems within a dwelling, assuming there is one baseboard per room, one MSHP per floor, and one electric in-floor heating system per room.

⁹⁸ Apex Analytics LLC, *Energy Trust of Oregon Nest Thermostat Heat Pump Control Pilot Evaluation*, October 10, 2014, 123 p

⁹⁹ Bonneville Power Administration, *Nest Learning Thermostat Pilot Program Savings Assessment Bonneville Power Administration & Franklin Public Utility District*, November 16, 2016

Table 72 below presents the variables used for the unitary savings calculation and the resulting value.

Table 72: Electrical Unitary Energy Savings Calculation for Smart Thermostats for Electrical Heating Systems

Parameter	Symbol	Electric Baseboard	MSHP	Electric In-floor Heating	Source
Average heating energy consumption of a home [kWh/year]	<i>Heating Energy</i>	18,854			2018, 2019, and 2020 HEA tracking sheets ¹⁰⁰
Percentage of heating load saved by smart thermostats	<i>%Savings</i>	12%			Literature review of billing analyses
Factor to account for multiple thermostats installed in the same home	<i>FMT</i>	0.15	0.5	0.15	Assumption ¹⁰¹
Heating system coefficient of performance	<i>COP</i>	1	2.2	1	Assumption ¹⁰²
Unitary Energy Savings [kWh/year]	-	348	514	348	Calculation

Installation Rates

For Instant Savings, EPI and MHEEP, the installation rate is assumed to be 100%.

¹⁰⁰ 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.

¹⁰¹ Assuming 1 thermostat per room for electric baseboards and in-floor heating and 6.5 rooms on average based on Statistics Canada 2016 Census. For MSHP, Assuming 1 thermostat per indoor unit and 2 indoor units per home. Statistics Canada, Census Profile, 2016 Census, <https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/Page.cfm?Lang=E&Geo1=PR&Code1=12&Geo2=&Code2=&Data=Count&SearchType=Begin&SearchPR=01&B1=All> (last accessed December 3, 2019)

¹⁰² Assuming a COP of 1 for electric resistance (including baseboard and in-floor) 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>).

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.

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.¹⁰³ 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%)¹⁰⁴ 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.¹⁰⁵

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%.

¹⁰³ 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&n=14&page=4>, (Last accessed September 9, 2020).

¹⁰⁴ 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).

¹⁰⁵ The TRMs for California Municipal Utilities, Connecticut, Illinois, Maine, Massachusetts, Minnesota, 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 73 summarizes the interactive effectors factors established for appliances.

Table 73: Interactive Effects Factors for Appliances

Measure	Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings	Source
Clotheslines and Outdoor Drying Racks	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 Dehumidifiers			
Clothes Dryer Replacement/ ENERGY STAR® Certified Clothes Dryers			
Efficient Clothes Washers			
ENERGY STAR® Certified Room Air Purifiers			
ENERGY STAR® Certified Dishwashers			

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 2020-2023 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 74 summarizes the peak demand-to-energy ratios established for appliances.

Table 74: Peak Demand-to-energy Ratios for Appliances

Measure	Peak Demand-to-energy Ratio (W/kWh)	Source
Clothesline and Outdoor Drying Racks	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 Dryers	0.138	RES-Appliance-CW, Navigant 2016-2018 DSM Plan
Efficient Clothes Washers	0.138	RES-Appliance-CW, Navigant 2016-2018 DSM Plan
ENERGY STAR Certified Room Air Purifiers	0.171	Calculated by the Evaluator
ENERGY STAR Certified Dishwashers	0.341	Calculated using NREL ResStock end-use load profile ¹⁰⁶ for Maine and “dishwasher” end use and EOne’s definition of winter peak period

¹⁰⁶ National Renewable Energy Laboratory, *ResStock End-use Load Profiles Data Sets 2022.1 Release*, <https://resstock.nrel.gov/datasets> (Last accessed November 6, 2023)

2.4.3 Appliance Measures

(1) Clotheslines and Outdoor Drying Racks

Summary

Table 75 presents a summary of the values used to calculate clothesline and outdoor drying rack savings. The detailed methodology follows.

Table 75: 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]	71		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 76 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 76: Electrical Unitary Savings Values for Clotheslines and Outdoor Drying Racks

Parameter	Value	Source
Number of Laundry Loads per Year [loads/year]	197	2015 NRCan ¹⁰⁷
Proportion of Loads Dried on Clotheslines [%]	16.3%	OPA 2011 ¹⁰⁸
Energy Consumption per Load [kWh/load]	2.2	OPA 2011 ¹⁰⁹
Unitary Energy Savings [kWh/year]	71	Calculation

Installation Rates

For EPI, Table 77 lists the installation rate for clotheslines and outdoor drying racks.

Table 77: Clothesline and Outdoor Drying Rack Installation Rate

Installation Rate	Margin of Error	Source
86%	8.1%	EPI 2018 DSM and 2018/19 PNS Surveys ¹¹⁰

For Instant Savings, the installation rate is assumed to be 100%.

¹⁰⁷ NRCan, *2015 Survey of Household Energy Use*, Table 10.6. Calculated average annual dried loads for Atlantic, assuming 100 days of summer and 265 days of winter.

¹⁰⁸ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

¹⁰⁹ Ibid.

¹¹⁰ 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 78 presents a summary of the values used to calculate refrigerator retirement and replacement savings. The detailed methodology follows.

Table 78: Refrigerator Retirement/Replacement Measure Summary

Parameter	ARet		HomeWarming / MHEEP	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]	654	164	735	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]	90.3	22.6	101	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, average annual per-cubic-foot energy consumption is calculated using 2017 metering activity results¹¹¹ for appliances manufactured before 2002 and the results of NRCAN data analyses for appliances manufactured in or after 2002.

In 2022, over 60% of retired units were manufactured in 2007 or later, while only six units manufactured in 2007 or later were part of the 2017 metering sample. Furthermore, starting in 2023, the majority of retired units will be from 2008 and later given that the majority of appliances replaced by the program component are at least 15 years old. Therefore, new unitary savings values for refrigerators manufactured in 2002 or later were established in the 2022 evaluation using data extracted from NRCAN EnerGuide appliance directories from 2001 to 2012.¹¹² Model numbers in the tracking sheet were matched with EnerGuide data to extract energy consumption values. Given retired appliances manufactured in 2002 or later are on average 15 years old, the Evaluator increased the EnerGuide energy consumption level by 27% to account for the efficiency loss due to aging based on findings from a recently published metering study.¹¹³

Average annual consumption values by manufacture-year class^{114,115,116} were established and a weighted average was calculated based on 2023 tracking sheet data.¹¹⁷ The occupant adjustment factor is based on the metering protocol of the New York Department of Public Service¹¹⁸ and the part-use factor is calculated based on 2022 participant survey data.¹¹⁹

¹¹¹ Econoler, *Residential Efficient Product Rebates Program – 2017 DSM Evaluation*, Final Report presented to Efficiency Nova Scotia, March 15, 2018.

¹¹² Natural Resources Canada, *EnerGuide appliance directory*, <https://publications.gc.ca/site/eng/9.500453/publication.html>. (Last accessed November 30, 2022).

¹¹³ Paul A. et al., *Impact of aging on the energy efficiency of household refrigerating appliances*, *Applied Thermal Engineering*, Volume 205(117992), 25 March 2022. <https://doi.org/10.1016/j.applthermaleng.2021.117992> (Last accessed November 30, 2022)

¹¹⁴ 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

¹¹⁵ 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)

¹¹⁶ 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)

¹¹⁷ Based on the tracking sheet provided in September 2022, which includes participants from January to August 2022

¹¹⁸ 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

¹¹⁹ Econoler, *Residential Efficient Product Rebates Program – 2022 DSM Evaluation*, Final Report presented to Efficiency Nova Scotia, March 2023

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 2022 HomeWarming and MHEEP tracking sheet data and the energy consumption rating of each model as labeled by EnerGuide retrieved using the ENERGY STAR Product Finder Tool.¹²⁰

¹²⁰ 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 79 below presents the parameters of the above equations as well as the unitary savings calculations for the refrigerator retirement and replacement measures.

Table 79: Electrical Unitary Savings Values for Refrigerator Retirements/Replacements

Parameter	Symbol	Manufacture-year Class	ARet (Retirement)		HomeWarming / MHEEP (Replacement)	Source
			Full-sized Refrigerators (≥ 10 ft. ³)	Small Refrigerators (< 10 ft. ³)		
Annual Consumption per Size [kWh/ft ³]	ConsumptionPerSize	2002 and later	35.3			NRCan data analysis
		1995-2001	41.1			2017 metering activities, 1997 USDE, NRCan EE Regulations
		1994 and earlier	58.9			
Proportion of Refrigerators in 2023	%ManufactureSplit	2002 and later	82%	76%	0%	ARet: 2023 tracking sheet Replacement: Assumption
		1995-2001	11%	5%	0%	
		1994 and earlier	7%	19%	100%	
Average Annual Consumption per Size [kWh/ft ³]	AvgConsumptionPerSize	-	37.6	40.2	58.9	Calculation
Average Refrigerator Size [ft ³]	AvgSize	-	18.2	9.7	16.7	2023 tracking sheet
Occupant Adjustment Ratio	OAR	-	1.11			2019 NYDPS
Part-use Factor	PuF	-	0.86	0.38	N/A	2022 survey data
Consumption of the New Refrigerator [kWh]	NewConsumption	-	N/A		356	Average from 2022 tracking sheet
Unitary Energy Savings [kWh/year]	Energy Savings _{kWh}	-	654	164	735	Calculation

Installation Rates

The installation rates are assumed to be 100%.

(3) Freezer Retirements/Replacements

Summary

Table 80 presents a summary of the values used to calculate freezer retirement and replacement savings. The detailed methodology follows.

Table 80: Freezer Retirement/Replacement Measure Summary

Parameter	ARet		HomeWarming / MHEEP	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]	752	176	2,006	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]	103.8	24.3	277	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.

$$\text{Energy Savings}_{kWh} = \text{AvgConsumptionPerSize} \times \text{AvgSize} \times \text{OAR} \times \text{PuF} - \text{NewConsumption}$$

$$\text{AvgConsumptionPerSize} = \sum(\text{ConsumptionPerSize} \times \% \text{ManufactureSplit})$$

For regular and small freezers retired through ARet, the average annual per-cubic-foot energy consumption is calculated using 2017 metering activity results¹²¹ for appliances manufactured before 2002 and the results of NRCAN data analyses for appliances manufactured in or after 2002.

In 2022, over 60% of retired units were manufactured in 2007 or later, while only six units manufactured in 2007 or later were part of the 2017 metering sample. Furthermore, starting in 2023, most retired units will be from 2008 and later given that the majority of appliances replaced by the program component are at least 15 years old. Therefore, new unitary savings values for freezers manufactured in 2002 or later were established in the 2022 evaluation using data extracted from NRCAN EnerGuide appliance directories from 2001 to 2012.¹²² Model numbers in the tracking sheet were matched with EnerGuide data to extract the energy consumption values. Given retired appliances manufactured in 2002 or later are on average 15 years old, the Evaluator increased the EnerGuide energy consumption level by 27% to account for the efficiency loss due to aging based on findings from a recently published metering study.¹²³

Average annual consumption by manufacture-year class^{124,125,126} were established and a weighted average was calculated based on the 2023 tracking sheet data. The occupant adjustment factor is based on the metering protocol of the New York Department of Public Service¹²⁷ and the part-use factor is calculated based on the 2022 participant survey data.¹²⁸

¹²¹ Econoler, *Residential Efficient Product Rebates Program – 2017 DSM Evaluation*, Final Report presented to Efficiency Nova Scotia, March 15, 2018

¹²² Natural Resources Canada, *EnerGuide appliance directory*, <https://publications.gc.ca/site/eng/9.500453/publication.html>. (Last accessed November 30, 2022)

¹²³ Paul A. et al., *Impact of aging on the energy efficiency of household refrigerating appliances*, *Applied Thermal Engineering*, Volume 205 (117992), 25 March 2022. <https://doi.org/10.1016/j.applthermaleng.2021.117992> (Last accessed November 30, 2022)

¹²⁴ 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

¹²⁵ 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).

¹²⁶ 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).

¹²⁷ 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.

¹²⁸ Econoler, *Residential Efficient Product Rebates Program – 2022 DSM Evaluation*, Final Report presented to Efficiency Nova Scotia, March 2023.

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 2022 HomeWarming and MHEEP tracking sheet data and the energy consumption rating of each model as labeled by EnerGuide retrieved using the ENERGY STAR Product Finder Tool.¹²⁹

¹²⁹ 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 81 below presents the parameters of the above equations as well as the unitary savings calculations for the freezer retirement and replacement measures.

Table 81: Electrical Unitary Savings Values for Freezer Retirements/Replacements

Parameter	Symbol	Manufacture-year Class	ARet (Retirement)		HomeWarming / MHEEP (Replacement)	Source
			Regular Freezers (≥ 7 ft. ³)	Small Freezers (< 7 ft. ³)		
Annual Consumption per Size [kWh/ft ³]	ConsumptionPerSize	2002 and later	38.0			NRCan data
		1995-2001	56.2			2017 metering activities, 1997 USDE, NRCan EE Regulations
		1994 and earlier	117.8			
Proportion of Freezers in 2022	%ManufactureSplit	2002 and later	68%	85%	0%	ARet: 2023 tracking sheet Replacement: Assumption
		1995-2001	15%	11%	0%	
		1994 and earlier	17%	4%	100%	
Average Annual Consumption per Size [kWh/ft ³]	AvgConsumptionPerSize	-	54.4	43.0	118	Calculation
Average Freezer Size [ft ³]	AvgSize	-	14.0	9.7	17.3	2023 tracking sheet
Occupant Adjustment Ratio	OAR	-	1.11			2019 NYDPS
Part-use Factor	PuF	-	0.89	0.38	N/A	2022 survey data
Consumption of the New Freezer [kWh]	NewConsumption	-	N/A		256	Average from 2022 tracking sheet
Unitary Energy Savings [kWh/year]	Energy Savings kWh	-	752	176	2,006	Calculation

Installation Rates

The installation rates are assumed to be 100%.

(4) Room Air Conditioner Retirements

Summary

Table 82 presents a summary of the values used to calculate room air conditioner retirement savings. The detailed methodology follows.

Table 82: 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]	164	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 2022 tracking sheet data.

The hours of operation variable is based on NRCan's EnerGuide Room Air Conditioner Directory,¹³⁰ 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 2022. 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.

$$\begin{aligned} \text{Annual Hours of Operation } \left[\frac{\text{hr}}{\text{yr}} \right] &= (\%_{\text{people}} \times HOU)_{\text{Halifax}} + (\%_{\text{people}} \times HOU)_{\text{Yarmouth}} + (\%_{\text{people}} \times HOU)_{\text{Sydney}} \\ &+ (\%_{\text{people}} \times HOU)_{\text{Greenwood}} \end{aligned}$$

It is assumed that most air conditioners retired through ARet meet the energy efficiency ratio (EER) of 9.8 as per Natural Resources Canada values for stock room air conditioners units in 2007¹³¹ since 68% of the appliances retired through ARet were from 2007. To account for seasonal temperature changes, the EER of 9.8 should be multiplied by a factor of 1.11 in accordance with the Ecox Technical Information Bulletin on SEER.¹³²

Table 83 below presents the parameters of the above equations as well as the unitary savings calculations for the room air conditioner retirement measure.

Table 83: Electrical Unitary Savings Values for Room Air Conditioner Retirement

Parameter	Symbol	ARet	Source
Average Capacity of the Retired Equipment [BTU/h]	Q	5,832	2022 tracking sheet
Annual Hours of Use [h/year]	HOU	306	Calculated
Energy Efficiency Ratio of the Retired Equipment [BTU/W*h]	EER	9.8	2007 NRCan
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]	$SEER$	10.9	Calculated
Conversion Factor [W/kW]	1,000	1,000	Convention
Unitary Energy Savings [kWh/year]	$Energy Savings_{kWh}$	164	Calculation

¹³⁰ NRCan's Office of Energy Efficiency, *EnerGuide Room Air Conditioner Directory 2012*, May 2012, p. 88

¹³¹ Natural Resources Canada, *National Energy Use Database, Residential Sector, Nova Scotia, Table 27: Cooling System Stock by Type, New Unit Efficiencies, Stock Efficiencies and Unit Capacity Ratio, 2007-2012*

<https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=ns&rn=27&page=2> (last accessed December 2, 2022)

¹³² Ecox, *Technical Information Bulletin No. E-004-EN: SEER*, www.ecoxline.com (Last accessed March 3, 2016)

(5) Dehumidifier Replacements or Retirements/ENERGY STAR Certified Dehumidifiers

Summary

Table 84 presents a summary of the values used to calculate dehumidifier replacement or retirement and ENERGY STAR certified dehumidifier savings. The detailed methodology follows.

**Table 84: 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]	603	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]	202	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.¹³³ The new energy factor is based on the 2022 ARet tracking sheet. 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.

For Instant Savings, the base energy factor corresponds to the minimum energy factor required by Canadian regulations¹³⁴ 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 85 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 85: Electrical Unitary Savings Values for Dehumidifier Replacements or Retirements/
ENERGY STAR Certified Dehumidifiers**

Parameter	Symbol	ARet (ARet, 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	ARet 2011 OPA Instant Savings 2019 NRCan Regulation
Energy Factor of the New ENERGY STAR Certified Dehumidifier [L/kWh]	EF_{new}	1.7	1.8	ARet 2022 ARet tracking sheet Instant Savings 2020 Instant Savings tracking sheet
Unitary Energy Savings [kWh/year]	$Energy\ Savings_{kWh}$	603	45.2	Calculation

Installation Rates

The installation rates are assumed to be 100%.

¹³³ Ontario Power Authority (OPA). 2011 Prescriptive Measures and Assumptions, Released Version 1, March 2011.

¹³⁴ Natural Resources Canada, Regulations and Standards – Dehumidifiers, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6889> (Last accessed September 3, 2020)

ENERGY STAR Certified Clothes Dryers

Summary

Table 86 presents a summary of the values used to calculate ENERGY STAR Certified clothes dryer savings. The detailed methodology follows.

Table 86: ENERGY STAR Certified Clothes Dryer Measure Summary

Parameter	Instant Savings	Reference
Measure Description and Identification		
Measure Description	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]	12	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	113	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]	15.6	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 ENERGY STAR Certified clothes dryer measure are calculated using the equations below.

$$Energy\ Savings_{kWh} = ADL \times ALW \times \left(\frac{1}{CEF_{base}} - \frac{1}{CEF_{new}} \right)$$

The average number of dried loads (ADL) was calculated from the NRCAN 2015 Survey of Household Energy Use that contained data on the number of loads per province or region such as the Atlantic region.

The combined energy factor (CEF) of the new units is based on the weighted average CEF of the 10 most installed models in 2020.

The CEF of the base unit replaced through Instant Savings corresponds to the baseline prescribed by the U.S Department of Energy (DOE).¹³⁵

Table 87 below presents the parameters of the above equations as well as the unitary savings calculations for the ENERGY STAR Certified clothes dryer measure.

Table 87: Electrical Unitary Savings Values for ENERGY STAR Certified Clothes Dryer

Parameter	Symbol	Instant Savings	Source
Average Dried Loads per Year [load/year]	ADL	197	2015 NRCAN ¹³⁶
Average Load Weight [lbs/load]	ALW	8.45	2019 PUC TRM ¹³⁷
Combined Energy Factor of New Unit [lbs/kWh]	CEF_{new}	3.94	2020 tracking sheet
Combined Energy Factor of Baseline Unit [lbs/kWh]	CEF_{base}	3.11	DOE, 2015
Unitary Energy Savings [kWh/year]	$Energy\ Savings_{kWh}$	113	Calculation

Installation Rates

The installation rates are assumed to be 100%.

¹³⁵ 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>

¹³⁶ NRCAN, 2015 Survey of Household Energy Use, Table 10.6. Calculated average annual dried loads for Atlantic, assuming 100 days of summer and 265 days of winter

¹³⁷ Pennsylvania Public Utility Commission (PUC), *Technical Reference Manual*, August 2019, Subsection 2.4 – Appliances

(6) Efficient Clothes Washers

Summary

Table 88 presents a summary of the values used to calculate efficient clothes washer savings. The detailed methodology follows.

Table 88: 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]	125	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]	17.3	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.

$$\text{Clothes Washer Energy Consumption [kWh]} = \frac{\text{Number of Loads} \left[\frac{\text{Loads}}{\text{Year}} \right] * \text{Capacity [L]}}{\text{IMEF} \left[\frac{\text{L}}{\text{kWh}} \right]}$$

Table 89 below lists the parameters and corresponding values applied in the equations above for efficient and standard clothes washers and their resulting energy consumption.

Table 89: Clothes Washer Energy Consumption

Parameter	Value for Standard Clothes Washer	Value for Efficient Clothes Washer	Source
Number of Loads [Loads/Year]	218		2015 NRCan ¹³⁸
Capacity [L]	127		Weighted average capacity based on 10 most rebated models in 2020 and ENERGY STAR Certified Clothes Washers database ¹³⁹
Integrated Modified Energy Factor (IMEF) [L/kWh/cycle]	58.6	83.2	Standard: NRCan ¹⁴⁰ 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]	474	333	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 90, to apply correction factors separately at each stage.

Table 90: Energy Consumption Breakdown for Standard and Efficient Clothes Washers

Energy Consumption Breakdown for Clothes Washers	Proportion of Overall Consumption ¹⁴¹	Standard Clothes Washer Electricity Consumption (kWh/year)	Efficient Clothes Washer Electricity Consumption (kWh/year)
Water Heating System	24.8%	118	83
Clothes Dryer	68.1%	323	227
Clothes Washer Drum	7.1%	34	24
Total	100.0%	475	334

¹³⁸ NRCan, 2015 Survey of Household Energy Use, Table 10.6. Calculated average annual washed loads for Atlantic, assuming 100 days of summer and 265 days of winter

¹³⁹ ENERGY STAR, *ENERGY STAR Certified Residential Clothes Washers*, <https://www.energystar.gov/productfinder/product/certified-clothes-washers/> (Last accessed December 21, 2018)

¹⁴⁰ 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)

¹⁴¹ 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 91 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 91: 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.¹⁴²

Adjusted Energy Consumption

Table 92 and Table 93 present the calculations of total electricity consumption for standard and efficient clothes washers respectively.

¹⁴² Ad Hoc Recherche, *Rapport d'évaluation, Programme : Produits Mieux Consommer – Électroménagers Energy Star (Années 2008 et 2009)*, p. 19

Table 92: 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	118	0.804	0.67	64
Internal Clothes Dryer	323	-	-	323
Washing Machine Drum	34	-	-	34
Total	475	-	-	421

Table 93: 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	83	0.804	0.67	45
Internal Clothes Dryer	227	-	-	227
Washing Machine Drum	24	-	-	24
Total	333	-	-	296

Therefore, the unitary energy savings value is established using the energy consumption between standard and efficient clothes washers, as presented in Table 94.

Table 94: Electrical Unitary Savings Value for Clothes Washer

Parameters	Value
Adjusted Energy Consumption of Standard Clothes Washer [kWh/year]	421
Adjusted Energy Consumption of Efficient Clothes Washer [kWh/year]	296
Unitary Energy Savings [kWh/year]	125

Installation Rates

The installation rate is assumed to be 100%.

(7) Efficient Washer-Dryer Combination Units

Summary

Table 95 presents a summary of the values used to calculate efficient washer-dryer combination unit savings. The detailed methodology follows.

Table 95: Efficient Washer-Dryer Combination Units

Parameter	Instant Savings	Reference
Measure Description and Identification		
Measure Description	Efficient washer-dryer combination units 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]	236	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]	32.6	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 washer-dryer combination units, the current models available through the program consist of a dryer and a washer with separate drums that operate separately. Therefore, the energy savings are calculated by summing the savings obtained using the same methodology as for efficient dryers (see Subsection 0) and clothes washers (see Subsection 2.4.3(6)).

The electrical unitary energy savings of efficient clothes dryers are calculated using the equations below.

$$Energy\ Savings_{kWh} = ADL \times ALW \times (1/CEF_{base} - 1/(CEF_{new}))$$

The average number of dried loads (ADL) was calculated from the NRCAN 2015 Survey of Household Energy Use that contained data on the number of loads per province or region such as the Atlantic region. The CEF of the base unit replaced through Instant Savings corresponds to the baseline prescribed by the U.S. Department of Energy (DOE).¹⁴³ The CEF of the new units is based on the weighted average CEF of the installed models as of October 2022. Table 96 below presents the parameters of the above equations as well as the unitary savings calculations for the clothes dryer replacement measure.

¹⁴³ 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 96: Electrical Unitary Savings Values for the Efficient Clothes Dryer Component of Efficient Washer-Dryer Combination Units

Parameter	Symbol	Instant Savings	Source
Average Dried Loads per Year [load/year]	ADL	197	2015 NRCan ¹⁴⁴
Average Load Weight [lbs/load]	ALW	8.45	2019 PUC TRM ¹⁴⁵
Combined Energy Factor of New Unit [lbs/kWh]	CEF_{new}	3.94	2022 tracking sheet
Combined Energy Factor of Baseline Unit [lbs/kWh]	CEF_{base}	3.11	DOE, 2015
Unitary Energy Savings [kWh/year]	$Energy Savings_{kWh}$	113	Calculation

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.

First, the energy consumption values of both standard and efficient clothes washers are determined using the following equation.

$$Clothes\ Washer\ Energy\ Consumption\ [kWh] = \frac{Number\ of\ Loads\ \left[\frac{Loads}{Year}\right] * Capacity[L]}{IMEF\ \left[\frac{L}{kWh}\right]}$$

Table 97 below lists the parameters and corresponding values applied in the equations above for efficient and standard clothes washers and their resulting energy consumption.

¹⁴⁴ NRCan, 2015 Survey of Household Energy Use, Table 10.6. Calculated average annual dried loads for Atlantic, assuming 100 days of summer and 265 days of winter.

¹⁴⁵ Pennsylvania Public Utility Commission (PUC), *Technical Reference Manual*, August 2019, Subsection 2.4 – Appliances

Table 97: Clothes Washer Energy Consumption

Parameter	Value for Standard Clothes Washer	Value for Efficient Clothes Washer	Source
Number of Loads [Loads/Year]	218		2015 NRCan ¹⁴⁶
Capacity [L]	127		Weighted average capacity based on rebated models in 2022 and ENERGY STAR Certified Clothes Washers database ¹⁴⁷
Integrated Modified Energy Factor (IMEF) [L/kWh/cycle]	58.6	83.2	Standard: NRCan ¹⁴⁸ Efficient: Weighted average capacity based on rebated models in 2022 and ENERGY STAR Certified Clothes Washers database
Clothes Washer Energy Consumption [kWh/year]	474	337	Calculation

Both energy consumption values do not consider the proportion of hot water for clothes washers produced with electricity in Nova Scotia or 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 98, to apply correction factors separately at each stage.

Table 98: Energy Consumption Breakdown for Standard and Efficient Clothes Washers

Energy Consumption Breakdown for Clothes Washers	Proportion of Overall Consumption ¹⁴⁹	Standard Clothes Washer Electricity Consumption (kWh/year)	Efficient Clothes Washer Electricity Consumption (kWh/year)
Water Heating System	24.8%	118	84
Clothes Dryer	68.1%	323	229
Clothes Washer Drum	7.1%	34	24
Total	100.0%	474	337

¹⁴⁶ NRCan, 2015 Survey of Household Energy Use, Table 10.6. Calculated average annual washed loads for Atlantic, assuming 100 days of summer and 265 days of winter

¹⁴⁷ ENERGY STAR, *ENERGY STAR Certified Residential Clothes Washers*, <https://www.energystar.gov/productfinder/product/certified-clothes-washers/> (Last accessed December 21, 2018)

¹⁴⁸ 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)

¹⁴⁹ 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 99 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 99: 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 using heated water.¹⁵⁰

¹⁵⁰ Ad Hoc Recherche, *Rapport d'évaluation, Programme : Produits Mieux Consommer – Électroménagers Energy Star (Années 2008 et 2009)*, p. 19

Table 100 and Table 101 present the calculations of total electricity consumption for standard and efficient clothes washers respectively.

Table 100: 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	118	0.804	0.67	64
Internal Clothes Dryer	323	-	-	323
Washing Machine Drum	34	-	-	34
Total	474	-	-	421

Table 101: 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	84	0.804	0.67	45
Internal Clothes Dryer	229	-	-	229
Washing Machine Drum	24	-	-	24
Total	337	-	-	298

The unitary energy savings value is established using the difference between the energy consumption of standard and efficient clothes washers as presented in Table 102.

Table 102: Electrical Unitary Savings Value for the Clothes Washer Component of Efficient Washer-Dryer Combination Units

Parameters	Value
Adjusted Energy Consumption of Standard Clothes Washer [kWh/year]	421
Adjusted Energy Consumption of Efficient Clothes Washer [kWh/year]	298
Unitary Energy Savings [kWh/year]	123

Summing the unitary energy savings of 113 kWh and 123 kWh for efficient clothes dryers and washers respectively resulted in unitary energy savings of 236 kWh for efficient washer-dryer combination units.

Installation Rates

The installation rate is assumed to be 100%.

(8) ENERGY STAR Certified Room Air Purifiers

Summary

Table 103 presents a summary of the values used to calculate ENERGY STAR certified room air purifier savings. The detailed methodology follows.

Table 103: 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 104 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 104: Electrical Unitary Savings Values for ENERGY STAR Certified Room Air Purifiers

Parameter	Symbol	Instant Savings	Source
Clean Air Delivery Rate [cfm]	$CADR$	115	Weighted average of the 10 most sold models in the 2020 tracking sheet
Efficiency for Baseline Unit [cfm/W]	EF_{base}	1.00	Savings Calculator for ENERGY STAR Qualified Appliances ¹⁵¹
Efficiency for Efficient Unit [cfm/W]	EF_{eff}	2.81	Weighted average of the 10 most sold models in the 2020 tracking sheet
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 in the 2020 tracking sheet
Unitary Energy Savings [kWh/year]	$Energy Savings_{kWh}$	435	Calculation

Installation Rates

The installation rate is assumed to be 100%.

(9) ENERGY STAR Certified Dishwashers

Summary

Table 105 below presents a summary of the values used to calculate ENERGY STAR certified dishwasher savings. The detailed methodology follows.

¹⁵¹ 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).

Table 105: ENERGY STAR Certified Dishwasher Measure Summary

Parameter	Instant Savings	Reference
Measure Description and Identification		
Measure Description	ENERGY STAR certified dishwasher that uses less than 250 kWh and reduces 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]	14.2	See details below under Electrical Unitary Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0.0915	See Subsection 2.4.2
Unitary Peak Demand Savings [W]	1.3	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 dishwashers.

$$\begin{aligned}
 \text{Energy Savings } \left[\frac{\text{kWh}}{\text{year}} \right] &= \left(\text{Consumption}_{\text{base}} - \text{Consumption}_{\text{eff}} \right) \\
 &\times \left((\% \text{Operation} + (\% \text{Water Heating} \times \% \text{Electric})) \right) \times \frac{\text{Nb Loads}}{\text{Nb Loads Standard}}
 \end{aligned}$$

Table 106 lists the parameters and corresponding values applied in the equation above and the resulting unitary savings values. The baseline corresponds to all non-ENERGY STAR certified models available in Canada.

Table 106: Electrical Unitary Savings Values for ENERGY STAR Certified Dishwashers

Parameter	Symbol	Instant Savings	Source
Baseline Consumption [kWh]	Consumption _{base}	260	Average of standard, non-ES models in Natural Resources Canada, Searchable product list for dishwashers, retrieved January 22, 2024 ¹⁵²
Efficient Unit Consumption [kWh]	Consumption _{eff}	239	2023 Instant Savings Database (average of all models for which at least 10 units were sold)
Percentage of Dishwasher Energy Consumption Used for Unit Operation [%]	%Operation	44%	Illinois TRM 2022 ¹⁵³
Percentage of Dishwasher Energy Consumption Used for Water Heating [%]	%Water Heating	56%	Illinois TRM 2022 ¹⁵⁴
Percentage of DHW Savings that Are Electric [%]	%Electric	66%	The proportion of electrical DHW tanks in Nova Scotia is based on participant data collected in the 2018 and 2019 EPI tracking sheets.
Average Annual Number of Loads in Atlantic Region [loads]	Nb Loads	180	NRCAN, 2015 Survey of Household Energy Use ¹⁵⁵

¹⁵² NRCAN, Search: Dishwasher | Energy Efficiency Ratings | Natural Resources Canada, <https://oee.nrcan.gc.ca/pml-imp/index.cfm?action=app.search-recherche&appliance=DISHWASHERS> (Last accessed January 22, 2024)

¹⁵³ Illinois Energy Efficiency Stakeholder Advisory Group, 2022 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 10.0, Volume 2, September 2020, p. 21.

¹⁵⁴ Ibid.

¹⁵⁵ NRCAN, 2015 Survey of Household Energy Use, Table 10.4. Calculated average annual loads for Atlantic region.

Parameter	Symbol	Instant Savings	Source
Average Annual Number of Loads Assumed in EnerGuide Rating [loads]	Nb Loads Standard	215	NRCAN, 2013 "Choosing and Using Appliances with EnerGuide" ¹⁵⁶
Unitary Energy Savings [kWh/year]	Energy Savings [kWh/year]	14.2	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 107 summarizes the interactive effects factors for plug load control measures.

Table 107: 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			

¹⁵⁶ NRCAN, Choosing and Using Appliances with EnerGuide, available at <https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/energystar/EnerGuideappliances.pdf>, 2013, p.23.

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 2020-2023 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 108 summarizes the peak demand-to-energy ratios established for each plug load control measure.

Table 108: 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 109 presents a summary of the values used to calculate smart power controllers for audiovisual equipment savings. The detailed methodology follows.

Table 109: 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.¹⁵⁷ This study represents the most up-to-date research using treatment and control sites with a significantly large sample size.

As for Instant Savings, the unitary savings value is based on information provided in the 2016 Pennsylvania Public Utility Commission Technical Reference Manual (TRM),¹⁵⁸ which cites documents produced by the New York State Energy Research and Development Authority (NYSERDA) and Energy Center of Wisconsin.¹⁵⁹ 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 110 presents the annual unitary savings values for EPI and for Instant Savings and the source of those values.

Table 110: 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 ¹⁶⁰ Instant Savings: Pennsylvania TRM ¹⁶¹

Installation Rates

For EPI, Table 111 lists the installation rate for smart power controllers for audiovisual equipment.

Table 111: EPI Smart Power Controller for Audiovisual Equipment Installation Rate

Installation Rate	Margin of Error	Source
57%	10.6%	2017 EPI on-site visits ¹⁶²

For Instant Savings, the installation rate is assumed to be 100%.

¹⁵⁷ NMR Group Inc., *RLPNC 17-3: Advanced Power Strip Metering Study*, March 18, 2019

¹⁵⁸ Pennsylvania Public Utility Commission, *Technical Reference Manual*, February 2017

¹⁵⁹ 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

¹⁶⁰ NMR Group Inc., *RLPNC 17-3: Advanced Power Strip Metering Study*, March 18, 2019

¹⁶¹ Pennsylvania Public Utility Commission, *Technical Reference Manual*, February 2017.

¹⁶² The installation rate was not updated through the 2021 EPI site visits since this measure is no longer offer in EPI.

(2) Power Bars with Integrated Timer

Summary

Table 112 presents a summary of the values used to calculate power bar with integrated timer savings. The detailed methodology follows.

Table 112: Power Bars with Integrated Timer Measure Summary

Parameter	Instant Savings	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

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{year}} \right] = \text{Average Standby Wattage [W]} \times \frac{\text{kW}}{1,000 \text{ W}} \times \left(\text{Old Operating Time} - \text{New Operating Time} \left[\frac{\text{hrs}}{\text{day}} \right] \right) \times \text{Number of Days}$$

Table 113 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,¹⁶³ 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).

$$\begin{aligned}
 & \text{Energy Savings } \left[\frac{kWh}{\text{year}} \right] \\
 &= \text{Average Standby Wattage } [W] \times \frac{kW}{1,000 W} \\
 &\times (\text{Old Operating Time} - \text{New Operating Time}) \left[\frac{\text{hrs}}{\text{day}} \right] \times \text{Number of Days}
 \end{aligned}$$

Table 113: 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 114 below presents a summary of the values used to calculate heavy-duty outdoor timer savings. The detailed methodology follows.

¹⁶³ Ontario Power Authority (OPA), 2011 Prescriptive Measures and Assumptions Version 1, March 2011

Table 114: 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.¹⁶⁴ 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 115 presents the annual unitary savings value for Instant Savings.

Table 115: Electrical Unitary Savings Values of Heavy-duty Outdoor Timers

Parameter	Value	Source
Unitary Energy Savings [kWh/year]	122	OPA, 2012

Installation Rates

The installation rate is assumed to be 100%.

¹⁶⁴ Research into Action, *Final Report: 2012 Consumer Program Evaluation*, Report presented to OPA, October 11, 2013, p. 154

(4) ENERGY STAR Certified Pool Pumps

Summary

Table 116 presents a summary of the values used to calculate heavy-duty outdoor timer savings. The detailed methodology follows.

Table 116: 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.¹⁶⁵

Table 117 presents the annual unitary savings value for Instant Savings.

¹⁶⁵ Northeast Energy Efficiency Partnership (NEEP), *Mid-Atlantic Technical Reference Manual*, October 2017, p.250

Table 117: Unitary Savings Values of ENERGY STAR Certified Pool Pumps

Parameter	Value	Source
Unitary Energy Savings [kWh/year]	530	NEEP, 2017

Installation Rates

The installation rate is assumed to be 100%.

2.6 Demand Reduction

For one category of demand reduction measures, namely demand response measures, the peak demand savings are replaced by the available DR capacity that differs from peak demand savings because the available DR capacity considers the potential load reduction that was made available instead of the actual load reduction that coincided with the actual utility peak. Domestic water heater load control is currently the only demand response measure.

2.6.1 Interactive Effects

For demand reduction measures, interactive effects are assumed to be nil.

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 118 presents a summary of the values used to calculate three-element water heater (TEWH) savings. The detailed methodology follows.

Table 118: Three-element Water Heater Measure Summary

Parameter	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 study¹⁶⁶ 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.

Installation Rates

Installation rates for three-element water heaters are estimated at 100% due to their relatively high cost.

¹⁶⁶ 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

(2) Domestic Water Heater Timer

Summary

Table 119 presents a summary of the values used to calculate domestic water heater timer (DWHT) savings. The detailed methodology follows.

Table 119: Domestic Water Heater Timer Measure Summary

Parameter	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.¹⁶⁷

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.

¹⁶⁷ Nova Scotia Power. *2019 Load Forecast Report - Redacted*, April 30, 2019, p. 28

(3) Electric Thermal Storage

Summary

Table 120 presents a summary of the values used to calculate electric thermal storage savings. The detailed methodology follows.

Table 120: Electric Thermal Storage Measure Summary

Parameter	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	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

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.

$$\text{Peak Demand Savings}_W = \text{Maximum Storage Capacity in 8h / 16h}$$

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 121 presents a summary of the values used to calculate domestic water heater load control savings. The detailed methodology follows.

Table 121: 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	81%	See details below under Installation Rates
Effective Useful Life [years]	7	Applicable to new available DR capacity. 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
Available DR Capacity [W]	385 ± 3%	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 Available DR Capacity	0%	See Subsection 2.6.1

Electrical Unitary Energy Savings

No energy savings are expected from this measure.

Available DR Capacity

The unitary available DR capacity for domestic water heater load controls is based on the metering data analysis results from the 2023 Residential Demand Response evaluation. During the 2021-2022 and 2022-2023 heating seasons, EOne collected data for all participating units and all events. Using the metering data, it was established that each unit reduced demand by an average of 385 W during the two first hours when events were called.

In-service Rates

While all controllers remained installed, connectivity issues resulted in not all controllers generating savings when events were called, the impact of which was included through the in-service rates as listed in Table 122.

Table 122: Domestic Water Heater Load Control Measure In-service Rates

Type	In-service Rate	Margin of Error	Source
Shifted	81%	4%	Residential DR 2023 Evaluation

3 BNI MEASURE GROSS SAVINGS PARAMETERS

The following sections outline all necessary parameters to calculate gross energy savings for BER Instant Rebates and SBES direct install semi-prescriptive measures as well as measures added to the BER-AR and SBES offering during the

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 Application Rebates (BER-AR) and SBES in 2022 since no customer-specific information is available for BER Instant Rebates. In SBES and BER-AR, a standardized approach based on a methodology published in the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Journal¹⁶⁸ is used to calculate the interactive effects for lighting projects on a per building-type basis. Additionally, the interactive effects factors are multiplied by 57% to consider the limited interaction of recessed fixtures with heating and cooling systems;¹⁶⁹ this factor applies to lighting measure categories that include recessed fixtures, namely LED linear fixtures and LED linear lamps.

For indoor lighting measures offered through the SBES direct install offer, 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 2022.

For outdoor lighting measures, interactive effects are nil.

Table 123 summarizes the interactive effects factors established for each lighting measure.

¹⁶⁸ Rundquist, Robert A. et al., "Calculating Lighting and HVAC Interactions," ASHRAE Journal, November 1993, pp. 28-37

¹⁶⁹ Chantrasrisalai and Fisher, "Lighting heat gain parameters: Experimental results" in *HVAC&R Research*, 12(2), pp. 305-324

Table 123: Interactive Effects for BNI Lighting Measures

Measure		Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings
BER Instant Rebates			
Linear LED Fixtures	Recessed	$-8.7\% \times 57\% = -4.9\%$	$-16.1\% \times 57\% = -9.2\%$
	Non-recessed	-8.7%	-16.1%
Linear LED Lamps	Recessed	$-2.9\% \times 57\% = -1.6\%$	$-12.5\% \times 57\% = -7.1\%$
	Non-recessed	-2.9%	-12.5%
Outdoor LED Fixtures		0%	0%
Directional and Architectural LED Fixtures		4.0%	0%
Indoor Occupancy/Motion Sensors		-4.1%	-13.2%
Outdoor Motion Sensors		0%	0%
SBES			
LED Lamps		-17.9%	-31.8%
LED Nightlights		-17.9%	-31.8%

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 weighted average PCF value of all indoor lighting products installed through BER-AR and SBES in 2022 since no customer-specific information is available for BER Instant Rebates. The average PCF is 60%.

For indoor lighting measures offered through SBES, the PCF is based on the average PCF value of indoor lighting products installed through SBES in 2022. The average PCF is 54%.

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.

$$\text{Unitary Peak Demand Savings (W)} = \text{Unitary Demand Savings (W)} \times \text{Peak Coincidence Factor (\%)}$$

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 124 presents a summary of the values used to calculate A-type, reflector, and decorative LED lamp savings. These measures are only offered through the Commercial Direct Install (CDI) pilot and use unitary savings values rather than measure-specific calculations. The detailed methodology follows.

Table 124: LED Lamp Measure Summary

Parameter	SBES	Reference
Measure Description and Identification		
Measure Description	LED lamps installed through a direct installation approach 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 125 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 125 below	Calculated by multiplying the unitary savings value by the peak demand-to-energy ratio
Interactive Effects Factor for Energy Savings	-17.9%	See Subsection 2.1.1
Interactive Effects Factor for Peak Demand Savings	-31.8%	

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 125 below lists the parameters and corresponding values used in the equation and the resulting unitary savings values.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{(\text{Old Wattage} - \text{New Wattage})[W] \times \text{Operating Hours} \left[\frac{h}{\text{yr}} \right]}{1,000 \left[\frac{W}{\text{kW}} \right]}$$

Table 125: 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

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).

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 126: 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

Type of LED	Displaced Wattage (W)	Peak Coincidence Factor (%)	Unitary Peak Demand Savings Value (W)
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 and the measure is offered with direct installation services typically have installation rates close to 100% for lighting products.

(2) Linear LED Fixtures

Summary

Table 127 presents a summary of the values used to calculate linear LED fixture savings, followed by the detailed methodology.

Table 127: 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

Parameter	BER Instant Rebates		Reference
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 [%]	60%		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	-4.9%	See Subsection 3.1.1
	Non-recessed	-8.7%	
Interactive Effects Factor for Peak Demand Savings	Recessed	-9.2%	See Subsection 3.1.1
	Non-recessed	-16.1%	

Electrical Unitary Energy Savings

Table 128 lists the parameters and corresponding values used in the equation below to calculate unitary energy savings for LED linear fixtures.

$$\begin{aligned}
 \text{Energy Savings [kWh/yr]} &= ((\text{Baseline Wattage} \\
 &\quad - \text{New Wattage})[W] \times \text{HOU}[h/day] \times 365[day/yr]) / 1,000[W/kW]
 \end{aligned}$$

Table 128: 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 129 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-AR 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 129 presents the baseline wattage used to calculate the energy savings for each of these subcategories based on lumens output.

Table 129: 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 130 presents a summary of the values used to calculate linear LED lamps savings. The detailed methodology follows.

Table 130: 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 [%]	60%		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	-1.6%	See Subsection 3.1.1
	Non-recessed	-2.9%	
Interactive Effects Factor for Peak Demand Savings	Recessed	-7.1%	See Subsection 3.1.1
	Non-recessed	-12.5%	

Electrical Unitary Energy Savings

Table 131 lists the parameters and corresponding values used in the equation below to calculate unitary energy savings for LED linear lamps.

$$\begin{aligned}
 & \text{Energy Savings} \left[\frac{kWh}{yr} \right] \\
 &= \frac{(\text{Baseline Wattage [W]} \times \text{Ballast Factor} \times \text{Baseline Quantity} - \text{New Wattage [W]} \times \text{New Quantity}) \times HOU \left[\frac{h}{day} \right] \times 365 \left[\frac{day}{yr} \right]}{1,000 \left[\frac{W}{kW} \right]}
 \end{aligned}$$

Table 131: 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 132 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-AR 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 132 presents the baseline wattage used to calculate the energy savings based on the Duke Energy Fixture Wattage Table.¹⁷⁰

Table 132: 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,¹⁷¹ 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.

¹⁷⁰ Duke Energy Progress. Fixture Wattage Table. <http://www.ahutton.com/LED/Progress%20wattages.pdf>, (Last accessed November 21, 2018)

¹⁷¹ DNV-GL, *Massachusetts Commercial and Industrial Upstream Lighting Program: "In Storage" Lamps Follow-up Study*, March 2015

(4) Outdoor LED Fixtures

Summary

Table 133 presents a summary of the values used to calculate outdoor LED fixture savings. The detailed methodology follows.

Table 133: 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 134 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 134: 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 135 for wall-mounted area luminaires and Table 136 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 135.

Table 135: 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 136 below. The baseline technologies were derived from the Duke Energy Fixture Wattage Table.¹⁷²

¹⁷² Duke Energy, *Fixture Wattage Table*, <http://www.ahutton.com/LED/Progress%20wattages.pdf> (Last accessed, January 10, 2018)

Table 136: 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 137 presents a summary of the values used to calculate directional and architectural LED fixture savings. The detailed methodology follows.

Table 137: 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 [%]	60%	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	-4.0%	See Subsection 3.1.1
Interactive Effects Factor for Peak Demand Savings	-0%	See Subsection 3.1.1

Electrical Unitary Energy Savings

Table 138 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 138: 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 139 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-AR 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 139 presents the baseline wattage used to calculate the energy savings based on lumens output.

Table 139: Directional and Architectural LED Fixture Baseline Wattage

Category	Lumens	Baseline Wattage (W)
Track or Mono-point Directional Luminaires	≥ 250	60.4
Wall-wash Luminaires	517 - 1199	50.0
	≥ 1,200	100

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 140 presents a summary of the values used to calculate occupancy/motion sensor savings. The detailed methodology follows.

Table 140: 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 [%]	60%		100%	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	-4.1%		0%	See Subsection 3.1.1
Interactive Effects Factor for Peak Demand Savings	-13.2%		0%	See Subsection 3.1.1

Electrical Unitary Energy Savings

Table 141 lists the parameters and corresponding values used in the equation below for occupancy and motion sensors and the resulting unitary values.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \text{Connected Wattage (W)} \times \text{Savings Factor (\%)} \times \text{OTF} \times \text{HOU} / 1,000$$

Table 141: 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-AR 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 ¹⁷³
	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-AR 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%.

¹⁷³ Efficiency Vermont, *Technical Reference User Manual Measure Savings Algorithms and Cost Assumptions*, March 2015

(7) LED Nightlights

Summary

Table 142 presents a summary of the values used to calculate savings for LED nightlights. The detailed methodology follows.

Table 142: 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	-17.9%	See Subsection 3.1.1
Interactive Effects Factor for Peak Demand Savings	-31.8%	

Electrical Unitary Energy Savings

Table 143 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.¹⁷⁴

$$Energy\ Savings\ \left[\frac{kWh}{yr}\right] = \frac{(Old\ Wattage - New\ Wattage)[W] \times HOU\left[\frac{h}{day}\right] \times 365\left[\frac{day}{yr}\right]}{1,000\left[\frac{W}{kW}\right]}$$

¹⁷⁴ Pennsylvania Public Utility Commission, Technical Reference Manual – State of Pennsylvania, August 2019, p. 7

Table 143: 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

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 144 presents a summary of the values used to calculate circulator pump savings. The detailed methodology follows.

Table 144: 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 145 below lists the parameters used for the calculation of electrical energy unitary savings.

Table 145: 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 ¹⁷⁵
Unitary Energy Savings [kWh/year]	412	800	1,974	Calculation

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.

$$\text{Unitary Demand Savings [W]} = (\text{Unitary Energy Savings [kWh]}) / (\text{HOU [h]} \times 1,000)$$

¹⁷⁵ Assuming operation between October 1 and April 30 when outside air temperature is below 55 °F (12.8 °C)

The unitary peak demand unitary savings for circulator pumps are calculated using the parameters listed in Table 146.

Table 146: 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 147 presents a summary of the values used to calculate booster pump savings. The detailed methodology follows.

Table 147: Booster Pump Measure Summary

Parameter	BER-AR	Reference
Measure Description and Identification		
Measure Description	High efficiency booster pumps	N/A
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	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	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 148 below.

$$\text{Energy Savings}_{kWh} = 891.20 \times HP_{ee} + 3523.08 \times \Delta HP_{sys}$$

Table 148: Electrical Unitary Savings Values for Booster Pumps

Parameter	Symbol	BER-AR	Source
Rated horsepower of the new booster pump or pumping system [HP]	HP_{ee}	Specification data for each system	Tracking sheet
Reduction in the total rated horsepower of the system [HP]	ΔHP_{sys}	Specification data for each system	Tracking sheet
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]	<i>Energy Savings</i>_{kWh}	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 149 below, as well as variables from Table 148 above.

$$\text{Peak Demand Savings}_W = (172 \times HP_{ee} + 671 \times \Delta HP_{sys}) \times PCF$$

Table 149: Unitary Peak Demand Savings Values for Booster Pumps

Parameter	Symbol	BER-AR	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]	<i>Peak Demand Savings_w</i>	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 space heating 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.

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 0.

3.3.3 Space Heating Measures

(1) Electric Thermal Storage

Summary

Table 150 presents a summary of the values used to calculate electric thermal storage savings. The detailed methodology follows.

Table 150: Electric Thermal Storage Measure Summary

Parameter	BER-AR	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 151 presents a summary of the values used to calculate advanced rooftop unit (RTU) control savings. The detailed methodology follows.

Table 151: Advanced RTU Control Measure Summary

Parameter	BER-AR	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]	Calculation based on specification data for each installed system	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 152 and Table 153 further below.

$$\begin{aligned}
 \text{Energy Savings}_{kWh} &= \frac{1}{12,000} \times \left(\text{Capacity}_{cool} \times (AC \times CESF_{DCV} + VFD \times FESF_{VFD}) \right. \\
 &\quad \left. + \text{ElecHeat} \times \frac{\text{Capacity}_{heat} \times HESF_{DCV}}{COP_{heat}} \right)
 \end{aligned}$$

Table 152: Electrical Unitary Savings Values for Advanced RTU Controls

Parameter	Symbol	BER-AR	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	-
Indicator of a supply fan VFD added with advanced RTU controls	VFD	Advanced RTU controls with supply fan VFD: 1 Advanced RTU controls without supply fan VFD: 0	-
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 ¹⁷⁶
Rated cooling capacity of the cooling equipment [BTU/h]	$Capacity_{cool}$	Specification data for each system	-
Rated heating capacity of the heating equipment [BTU/h]	$Capacity_{heat}$	Specification data for each system	
Cooling energy savings factor for DCV [kWh/tonne]	$CESF_{DCV}$	Values from Table 153	2021 Illinois TRM, ¹⁷⁷ Government of Canada, ¹⁷⁸ 2016 EPR Evaluation ¹⁷⁹
Heating energy savings factor for DCV [kWh/tonne]	$HESF_{DCV}$		
Supply fan energy savings factor from VFD [kWh/ton]	$FESF_{VFD}$		
Conversion factor [BTU/tonne·h]	12,000	12,000	Convention

¹⁷⁶ 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>).

¹⁷⁷ Illinois Energy Efficiency Stakeholder Advisory Group, 2021 *Illinois Statewide Technical Reference Manual for Energy Efficiency Version 9.0, Volume 2*, September 2020, p. 393

¹⁷⁸ Government of Canada, Historical Climate Data. Retrieved from https://climate.weather.gc.ca/historical_data/search_historic_data_e.html

¹⁷⁹ Econoler, *Efficient Product Rebates 2016 DSM Evaluation*, March 8, 2017

Table 153: Advanced RTU Control Energy Savings Factors

Facility Type	Supply Fan Energy Savings Factors from VFD ¹⁸⁰ [kWh/ton]	Cooling Energy Savings Factors for DCV ¹⁸¹ [kWh/ton]	Heating Energy Savings Factors for DCV ¹⁸² [kWh/ton]
Convenience Store	927	9	1,826
Education - Community College/University	388	9	2,675
Education - Primary ¹⁸³	388	4	3,248
Education - Secondary ¹⁸³	388	7	3,474
Health/Medical – Clinic ¹⁸⁴	597	2	331
Health/Medical - Hospital ¹⁸³	597	2	372
Lodging ¹⁸⁴	597	2	331
Manufacturing	798	2	166
Multi-family ¹⁸³	597	1	320
Office - Low Rise	1,115	3	1,035
Office - Mid Rise ¹⁸³	1,115	4	1,152
Office - High Rise ¹⁸³	1,115	8	1,131
Restaurant	596	3	1,035
Retail - Large Dept. Store	715	6	952
Retail - Strip Mall	738	6	870
Warehouse	401	1	934
Other/Miscellaneous ¹⁸⁵	692	4	1,241

¹⁸⁰ Supply fan energy savings factors were calculated based on the difference between the normalized energy savings per cooling capacity values for the Chicago DCV and VFD w/3-speed fan control and DCV scenarios of the Advanced Rooftop Controls measure in the 2021 Illinois TRM.

¹⁸¹ Cooling energy savings factors for DCV were calculated based on the normalized energy savings per cooling capacity values for the Chicago DCV scenario of the Advanced Rooftop Controls measure in the 2021 Illinois TRM as well as the cooling degree days from Chicago (1,865°C·day, 2021 Illinois TRM) and Halifax (325°C·day, Government of Canada).

¹⁸² Heating energy savings factors for DCV were calculated based on the normalized energy savings per heating capacity values for the Chicago DCV scenario of the Advanced Rooftop Controls measure in the 2021 Illinois TRM as well as the heating degree days from Chicago (2,238°C·day, 2021 Illinois TRM) and Halifax (3,378°C·day, Government of Canada). Heating energy savings factors per capacity were multiplied by the COP assumption of 2.3 (2021 Illinois TRM) to obtain heating energy savings factors per capacity and COP.

¹⁸³ For primary and secondary education facilities, supply fan energy savings factors were assumed to be the same as for community college/university facilities, and cooling and heating energy savings factors were calculated based on the ratio of their full load heating and cooling hours and those of community college/university facilities (from the 2016 EPR Evaluation Report). Similarly, the savings factors for hospitals were based on the values for clinics, those for multi-family facilities were based on the values for lodging facilities, and those for mid-rise and high-rise offices were based on the values for low-rise offices.

Unitary Peak Demand Savings

The unitary peak demand savings for advanced RTU controls that include a supply fan VFD are calculated using the variables defined and listed in the equation as well as in Table 154 below. For the DCV portion of advanced RTU controls, no unitary peak demand savings that could be adapted to the Nova Scotia load shape were found in the literature. To claim DCV peak demand savings, metering or simulation data would have to be collected.

$$\text{Peak Demand Savings}_W = VFD \times HP \times 1,000 \times DSVG \times CF$$

Table 154: Unitary Peak Demand Savings Values for Advanced RTU Controls

Parameter	Symbol	BER-AR	Source
Indicator of a supply fan VFD added with the advanced RTU controls	<i>VFD</i>	Advanced RTU controls with supply fan VFD: 1 Advanced RTU controls without supply fan VFD: 0	-
Supply fan motor rated power [hp]	<i>HP</i>	Specification data for each system	-
Demand savings factor [kW/hp]	<i>DSVG</i>	0.252	2020 Massachusetts TRM
Peak coincidence factor [-]	<i>CF</i>	1.0	
Conversion factor [W/kW]	<i>1,000</i>	1,000	Convention

Installation Rates

Installation rates for advanced RTU controls are estimated at 100% due to their relatively high cost.

¹⁸⁴ Energy savings factors for assisted living facilities were used for clinics and lodging facilities as they were assumed to be similar.

¹⁸⁵ Energy savings factors for the Other/Miscellaneous category were estimated to be the average values of all other categories.

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 evaluation¹⁸⁶ 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.¹⁸⁷

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%.

¹⁸⁶ Econoler, *Residential Direct Install 2015 Evaluation*, March 3, 2016

¹⁸⁷ Minister of Justice, Canada, *Energy Efficiency Regulations*, 2016, <http://laws-lois.justice.gc.ca/PDF/SOR-2016-311.pdf> (Last accessed December 5, 2019)

Table 155 summarizes the interactive effects factors for water heating insulation measures.

Table 155: 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 156 summarizes the interactive effects factors established for each water heating measure.

Table 156: 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 157 lists the parameters and corresponding values applied in the above equations and the resulting peak demand-to-energy ratio.

Table 157: 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 158 summarizes the peak demand-to-energy ratio for water heating measures.

Table 158: 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 159 presents a summary of the values used to calculate low-flow showerhead savings. The detailed methodology follows.

Table 159: 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 160 below lists the parameters and corresponding values applied in the above equations for low-flow showerheads and the resulting unitary savings values.

Table 160: 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 161 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 161 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 161: 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 Weight: SBES 2021 tracking sheet
Health	2,528	0%	
Education	2,057	0%	
Commercial - Employee Shower	1,894	2%	
Other Commercial Except Fitness Center	3,029	12%	
Fitness Center	56,893	0%	
Weighted Average [Min/year]	3,419	-	Calculation

Installation Rates

Table 162 lists the installation rate for SBES low-flow showerheads.

Table 162: EPI Low-flow Showerhead Installation Rate

Installation Rate	Source
100%	Assumption

(2) Faucet Aerators

Summary

Table 163 presents a summary of the values used to calculate faucet aerator savings. The detailed methodology follows.

Table 163: 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 164 below lists the parameters and values applied in the two above equations for faucet aerators and the resulting unitary savings values.

Table 164: 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) ¹⁸⁸
Low-flow Rate [gpm]	q_{low}	0.94	
Baseline Hot Water Consumption [US gallons/year]	DHW_{base}	4,163	See Table 165 below
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 ¹⁸⁹
Unit Conversion #1 [L/US gallon]	UC1	3.79	Convention
Unit Conversion #2 [(kWh/BTU)x(ft ³ /L)]	UC2	0.00001035	Convention
Unitary Energy Savings [kWh/year]		269	Calculation

Table 165 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 165: 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

Installation Rates

For SBES faucet aerators, an installation rate of 95% is used based on the value in the 2021 Illinois Statewide TRM.

¹⁸⁸ Illinois Commerce Commission (2020). *2021 Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 9.0 – Volume 2: Commercial and Industrial Measures*, p. 131

¹⁸⁹ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174

(3) Thermostatic Shower Valve

Summary

Table 166 presents a summary of the values used to calculate thermostatic shower valve savings. The detailed methodology follows.

Table 166: 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.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{year}} \right] = \text{DHW Reduction} \left[\frac{\text{gal}}{\text{year}} \right] \times \text{EPG}_{\text{electric}} \left[\frac{\text{kWh}}{\text{gal}} \right]$$

$$\text{DHW Reduction} \left[\frac{\text{gal}}{\text{year}} \right] = q \left[\frac{\text{gal}}{\text{min}} \right] \times \%_{\text{DHW}} \times t_w \left[\frac{\text{min}}{\text{shower}} \right] \times \frac{SH_{\text{time}} \left[\frac{\text{min}}{\text{year}} \right]}{t_{\text{shower}} \left[\frac{\text{min}}{\text{shower}} \right]}$$

$$\text{EPG}_{\text{Electric}} \left[\frac{\text{kWh}}{\text{gal}} \right] = (\rho_{\text{H}_2\text{O}} \left[\frac{\text{lb}}{\text{ft}^3} \right] \times C_{p_{\text{H}_2\text{O}}} \left[\frac{\text{BTU}}{\text{lb}^\circ\text{F}} \right] \times \Delta T_{\text{H}_2\text{O}} [^\circ\text{F}] \times UC1 \left[\frac{\text{kWh}}{\text{BTU}} \right] \times UC2 \left[\frac{\text{ft}^3}{\text{gal}} \right]) / \eta$$

Table 167 lists the parameters and corresponding values applied to the two above equations and the resulting unitary savings values for thermostatic shower valves.

Table 167: 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/ft ³]	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 [ft ³ /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 168 lists the installation rate for thermostatic shower valves.

Table 168: Thermostatic Shower Valve Installation Rate

Installation Rate	Source
100%	Assumption

(4) Pipe Insulation

Summary

Table 169 presents a summary of the values used to calculate pipe insulation savings. The detailed methodology follows.

Table 169: 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 170, the annual unitary savings value for pipe insulation was identified through Ontario Power Authority (OPA) 2011¹⁹⁰ 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.

Table 170: Unitary Savings Value for Pipe Insulation

Parameter	SBES
Unitary Energy Savings (per ft) [kWh/year]	12.7

Installation Rates

The installation rate for SBES pipe insulation is assumed at 100%.

(5) Hot Water Tank Wrap

Summary

Table 171 presents a summary of the values used to calculate hot water tank wrap savings. The detailed methodology follows.

¹⁹⁰ Ontario Power Authority (OPA), *OPA Prescriptive Measures and Assumptions List*, December 2010

Table 171: 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 172 below lists the values applied in the above equations to obtain the unitary savings for tank wraps.

Table 172: 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 ¹⁹¹
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 ¹⁹²
Layer 2: Tank Wrap			
External Radius of the Layer [m]	r_e	0.351	Estimated from Frost King Insulation Blanket Specifications ¹⁹³
Internal Radius of the Layer [m]	r_i	0.300	Giant ¹⁹⁴
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 ¹⁹⁵
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 ¹⁹⁶
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

¹⁹¹ Giant Inc., *Engineering Submittal Data Sheet 172ETE Models*, <http://www.giantinc.com/tech-data/FT-172E-An.pdf> (Last accessed February 18, 2015)

¹⁹² Ibid.

Installation Rates

Table 173 shows the installation rate for SBES hot water tank wraps.

Table 173: SBES Hot Water Tank Wrap Installation Rate

Installation Rate	Source
100%	Assumption

¹⁹³ Frost King Weatherization Products, *Water Heater Insulation Blanket*, <http://www.frostking.com/water-heater-insulation-blanket/> (Last accessed January 4, 2014)

¹⁹⁴ Giant Inc., *Engineering Submittal Data Sheet 172ETE Models*, 16

¹⁹⁵ *Ibid.*, 16.

¹⁹⁶ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174

3.5 Compressed Air

3.5.1 Interactive Effects

Interactive effects are assumed to be nil for compressed air projects since compressors are usually in non-conditioned spaces.

3.5.2 Peak Demand Savings Factors

For compressed air measures, the methodology used to determine peak demand savings is detailed in the measure-specific subsections below.

3.5.3 Compressed Air Measures

(1) Compressed Air Leak Repair

Summary

Table 174 presents a summary of the values used to calculate compressed air leak repair savings. The detailed methodology follows.

Table 174: Compressed Air Leak Repair Measure Summary

Parameter	Custom	Reference
Measure Description and Identification		
Measure Description	Repair leaks in compressed air systems	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	2	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	Calculation based on performance data for each 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]	Calculation based on performance data for each system	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 compressed air leak repairs are calculated using the variables defined and listed in the equation and tables below.

$$\text{Unitary Savings [kWh/yr]} = \text{Size of Leak [cfm]} \times \text{Plant Efficiency [kW/(100 cfm)]} \times \text{HOU [h/yr]}$$

Table 175: Electrical Unitary Energy Savings Values for Compressed Air Leak Repairs

Parameter	Symbol	Value	Source
Size of Leak [cfm]	-	Varies per project	Reading on site
Plant Efficiency [kW/100 cfm]	-	Varies per project (If unknown, use 19.7 kWh/100 cfm)	Project documentation (UE Systems Calculations)
Hours of Use [h/yr]	HOU	Varies per project	Project documentation
Unitary Energy Savings [kWh/year]		Calculated based on specification data for each installed system	Calculation

Unitary Peak Demand Savings

Unitary peak demand savings for compressed air leak repairs are calculated using the equation below and the variables defined and listed in Table 175 above.

$$\text{Unitary Savings [kW]} = \text{Size of Leak [cfm]} \times \text{Plant Efficiency [kW/(100 cfm)]} \times \text{PCF}$$

Table 176: Electrical Unitary Peak Demand Values for Compressed Air Leak Repairs

Parameter	Symbol	Value	Source
Size of Leak [cfm]	-	Varies per project	Reading on site
Plant Efficiency [kW/100 cfm]	-	Varies per project (If unknown, use 19.7 kWh/100 cfm)	Project documentation (UE Systems Calculations)
Peak Coincidence Factor	PCF	Varies per project	Project Documentation
Unitary Energy Savings [kWh/year]		Calculated based on specification data for each installed system	Calculation

Installation Rates

For Custom measures, the installation rate is assumed to be 100%.

3.6 Variable Frequency Drives

3.6.1 Interactive Effects

Interactive effects are assumed to be nil for variable frequency drives (VFD) projects since this measure is implemented on equipment that are usually in non-conditioned spaces.

3.6.2 Peak Demand Savings Factors

For variable frequency drives measures, the methodology used to determine peak demand savings is detailed in the measure-specific subsections below.

3.6.3 Variable Frequency Drive Measures

(1) Variable Frequency Drives for non-HVAC Applications

Summary

Table 177 presents a summary of the values used to calculate savings for VFDs installed in non-HVAC applications. The detailed methodology follows.

Table 177: VFD Measure Summary

Parameter	BER-AR	Reference
Measure Description and Identification		
Measure Description	Variable frequency drive for non-HVAC applications	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	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	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 VFD for non-HVAC applications are calculated using the variables defined and listed in the equations and tables below.

$$Unitary\ Savings\left[\frac{kWh}{yr}\right] = \left(0.746\left[\frac{kW}{hp}\right] \times HP[hp] \times \frac{LF[\%]}{Eff[\%]}\right) \times HOU\left[\frac{h}{yr}\right] \times ESF[\%]$$

$$ESF = \sum_{0\%}^{100\%} (DutyCycle \times PLR_{Baseline}) - \sum_{0\%}^{100\%} (DutyCycle \times PLR_{Eff})$$

Table 178: Electrical Unitary Savings Values for VFD Pumps and Fans

Parameter	Symbol	Value	Source
Rated horsepower of the motor [HP]	HP	Varies per project	Project Documentation
Motor Load Factor [%]	LF	Varies per project (If unknown, use 75%)	Project Documentation, 2022 Minnesota TRM
Efficiency of motor [%]	Eff	Varies per project	Project Documentation
Annual operating hours [h/yr]	HOU		
Percent of motor runtime at each flow rate	DutyCycle	Varies per project (If unknown for each flowrate, use an average flowrate)	Project Documentation
Part Load Ratio for the baseline control strategy	PLR _{Baseline}	Based on baseline controls and flow rate profile	See Table 179 below
Part Load Ratio for the VFD	PLR _{Eff}	Based on VFD controls and flow rate profile	See Table 179 below
Energy Savings Factor	ESF	Calculation based on data from project documentation	Calculation
Conversion Factor [kW/hp]	-	0.746	Convention
Unitary Energy Savings [kWh/year]		Calculated based on specification data for each installed system	Calculation

Table 179: Part Load Ratio for Flow Rate Based on Control Types¹⁹⁷

Control Type	Flow rate (percentage of design flow)									
	0% to 10%	10% to 20%	20% to 30%	30% to 40%	40% to 50%	50% to 60%	60% to 70%	70% to 80%	80% to 90%	90% to 100%
Pump Baseline values (PLR_{Baseline})										
No Control	1.00									
Bypass Valve	0.90	0.90	0.91	0.91	0.93	0.93	0.95	0.96	0.98	1.00
Throttling Valve	0.80	0.81	0.82	0.83	0.85	0.87	0.90	0.93	0.96	1.00
Unknown Control Type	0.90	0.90	0.91	0.91	0.93	0.93	0.95	0.96	0.98	1.00
Pump VFD value (PLR_{Eff})										
Pump VFD	0.05	0.06	0.09	0.12	0.18	0.27	0.39	0.55	0.75	1.00
Fan Baseline values (PLR_{Baseline})										
No Control or Bypass Damper	1.00									
Discharge Dampers	0.46	0.55	0.63	0.70	0.77	0.83	0.88	0.93	0.97	1.00
Outlet Damper, Backward Inclined & Airfoil Fans	0.53	0.53	0.57	0.64	0.72	0.80	0.89	0.96	1.02	1.05
Inlet Damper Box	0.56	0.60	0.62	0.64	0.66	0.69	0.74	0.81	0.92	1.07
Inlet Guide Vane, Backward Inclined & Airfoil Fans	0.53	0.56	0.57	0.59	0.60	0.62	0.67	0.74	0.85	1.00
Inlet Vane Dampers	0.38	0.40	0.42	0.44	0.48	0.53	0.60	0.70	0.83	0.99
Outlet Damper, Forward Curved Fans	0.22	0.26	0.3	0.37	0.45	0.54	0.65	0.77	0.91	1.06
Eddy Current Drives	0.17	0.2	0.25	0.32	0.41	0.51	0.63	0.76	0.90	1.04
Inlet Guide Vane, Forward Curved Fans	0.21	0.22	0.23	0.26	0.31	0.39	0.49	0.63	0.81	1.04
Unknown Control Type	0.45	0.48	0.51	0.55	0.60	0.66	0.73	0.81	0.91	1.03
Fan VFD value (PLR_{Eff})										
Fan VFD	0.09	0.10	0.11	0.15	0.20	0.29	0.41	0.57	0.76	1.01

¹⁹⁷ Minnesota Department of Commerce Division of Energy Resources, *State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs Version 3.1*, January 2020, p. 691-692

Example: A process fan with discharge damper controls operates 85% of the time at 75% flow fraction, 5% of the time at 80% flow fraction, and 10% of the time at 95% flow fraction:

$$\sum_{0\%}^{100\%} (DutyCycle \times PLR) = (0.85 \times 0.93) + (0.05 \times 0.97) + (0.10 \times 1.00) = 0.939$$

Unitary Peak Demand Savings

The unitary peak demand savings for VFD for pumps and fans are calculated using the variables defined and listed in the equation and Table 180 as well as variables from above.

$$\begin{aligned} \text{Unitary Peak Demand Savings} \left[\frac{W}{yr} \right] \\ = \left(746 \left[\frac{W}{hp} \right] \times HP[hp] \times \frac{LF[\%]}{Eff[\%]} \right) \times (PLR_{Baseline,FFpeak} - PLR_{Eff,FFpeak}) \end{aligned}$$

In situations where the part load ratio during the peak demand period is unknown, unitary peak demand savings are calculated by multiplying the average demand savings by a peak coincidence factor of 0 or 1 based on business hours and using the equation below.

$$\text{Unitary Peak Demand Savings} \left[\frac{W}{yr} \right] = \left(0,746 \left[\frac{kW}{hp} \right] \times HP[hp] \times \frac{LF[\%]}{Eff[\%]} \right) \times ESF[\%] \times PCF$$

Table 180: Electrical Unitary Peak Demand Values for VFD for non-HVAC Applications

Parameter	Symbol	Value	Source
Part load ratio for the average flow fraction during the weekday peak time period	$PLR_{Baseline,FFpeak}$	Based on baseline control and flow fraction	Project documentation
Part load ratio for the average flow fraction during peak time period	$PLR_{Eff,FFpeak}$	Based on VFD control	Project documentation
Peak coincidence factor	PCF	If business is open during peak period: 1 Otherwise: 0	Project documentation
Unitary Peak Demand Savings [kWh/year]		Calculated based on specification data for each installed system	Calculation

Installation Rates

Installation rates for VFD for non-HVAC applications are estimated at 100% due to their relatively high cost.

3.7 Solar Photovoltaic

3.7.1 Interactive Effects

Interactive effects are assumed to be nil for solar photovoltaic (PV) projects since the equipment involved in such systems is typically installed outdoors.

3.7.2 Peak Demand Savings Factors

For solar PV projects, peak demand savings are nil since the solar PV energy production from those systems coinciding with the peak period is negligible.

3.7.3 Solar Photovoltaic Measures

(1) Solar Photovoltaic Systems

Summary

Table 181 presents a summary of the values used to calculate savings for solar PV projects. The detailed methodology follows.

Table 181: Summary of Solar PV Measures

Parameter	Custom Retrofit	Reference
Measure Description and Identification		
Measure Description	Solar PV systems for commercial, industrial, and agricultural facilities	N/A
Additional Notes	-	
General Parameters		
Installation Rate	100%	See details below under Installation Rates
Effective Useful Life [years]	22.4	See Subsection 4.2
Electrical Savings Parameters		
Unitary Energy Savings [kWh/year]	Calculation based on data for each installed system	See details below under Electrical Energy Savings
Peak Demand-to-energy Ratio [W/kWh]	0	See Subsection 3.7.2
Unitary Peak Demand Savings [W]	0	Ibid
Interactive Effects Factor for Energy Savings	0%	See Subsection 3.7.1
Interactive Effects Factor for Peak Demand Savings	0%	Ibid

Electrical Unitary Energy Savings

The electrical unitary energy savings for solar PV systems installed in commercial, industrial, and agricultural applications are calculated using the variables defined and listed in the equations and tables below. For each solar PV project, modelled energy production should be obtained either with PV Watts or RETScreen Expert and should include 14% of miscellaneous losses as pre-defined in both modelling tools.

$$\begin{aligned} & \text{Energy Savings per Project [kWh]} \\ &= \text{Modelled Energy Production [kWh]} * (1 - \text{Snow Loss Factor}) * \text{Adj. Ratio} \end{aligned}$$

Table 182: Electrical Savings Values for Solar PV Systems

Parameter	Symbol	Value	Source
Modelled Energy Production [kWh]	-	Varies per project	Project documentation
Snow Loss Factor [%]	-	For panel tilt angles $\geq 25^\circ$: 1%	Northern Alberta Institute of Technology ¹⁹⁸
		For panel tilt angles $< 25^\circ$: 4%	
Adjustment Ratio	Adj. Ratio	Projects modelled with PV Watts: 1.101	Custom Retrofit evaluation results (2023)
		Projects modelled with RETScreen Expert: 0.942	
Unitary Energy Savings [kWh/year]		Calculated based on data for each installed system	Calculation

Installation Rates

For Custom measures, the installation rate is assumed to be 100%.

¹⁹⁸ Northern Alberta Institute of Technology, *Solar Photovoltaic Array Reference Array Report*, March 31, 2016

4 EFFECTIVE USEFUL LIFE

This section outlines the EUL values used to calculate lifetime energy savings. This section also presents EUL values for demand reduction measures; these values are not used to calculate lifetime energy savings since those measures do not save energy. For demand response measures, the EUL represents the number of years for which the demand reduction is expected to persist. The EUL values should be used when calculating cost-effectiveness ratios for measures, in order to account for lifetime benefits.

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 183 and Table 184 summarize the equivalent EUL values for residential and BNI LED lamps and fixtures respectively.

Table 183: EUL Values for Residential LED Lamps and Fixtures

Measure	Program Component	Average Rated Lifetime (hours)	Annual HOU (hours/year)	Equipment Life (years)	2023 Equivalent EUL (years)
LED A19 Lamps					
9 W Replacing 25 W	EPI	25,000	986	25	2.0
9 W Replacing 29 W					2.0
9 W Replacing 40 W					1.6
9 W Replacing 43 W					2.0
9 W Replacing 60 W					1.7
9 W Replacing 72 W					2.0
9 W Replacing 100 W					1.7

Measure	Program Component	Average Rated Lifetime (hours)	Annual HOU (hours/year)	Equipment Life (years)	2023 Equivalent EUL (years)
9 W Replacing 150 W					1.4
9.5 W Replacing 25 W					2.0
9.5 W Replacing 29 W					2.0
9.5 W Replacing 40 W					1.6
9.5 W Replacing 43 W					2.0
9.5 W Replacing 60 W					1.7
9.5 W Replacing 72 W					2.0
9.5 W Replacing 100 W					1.7
9.5 W Replacing 150 W					1.4
18 W Replacing 75 W					1.9
18 W Replacing 100 W					1.7
7 W Blackout Bulbs Replacing 60 W					2.2
LED Reflector Lamps					
PAR20 7 W Replacing 50 W	EPI	25,000	986	25	2.0
PAR30 8 W Replacing 53 W					2.0
PAR30 8 W Replacing 75 W					2.0
PAR38 15 W Replacing 90 W					2.0
PAR38 15 W Replacing 120 W					2.0
PAR38 15 W Replacing 150 W					2.0
GU10 7 W Replacing 35 W					2.0
GU10 7 W Replacing 50 W					2.0
LED Decorative Lamps					
7 W G25	EPI	15,000	986	15	2.0
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	2.0
ENERGY STAR Certified LED Non-A-type Lamps (Excluding R, BR, and Decorative)		25,000		24	2.0

Measure	Program Component	Average Rated Lifetime (hours)	Annual HOU (hours/year)	Equipment Life (years)	2023 Equivalent EUL (years)
LED Fixtures					
ENERGY STAR Certified LED Recessed Downlight Fixtures	Instant Savings	35,400	1,059	33	2.0
ENERGY STAR Certified LED Fixtures without Motion Sensors		50,000	1,059	47	2.0
ENERGY STAR Certified LED Fixtures with Motion Sensors		49,044	1,066	46	2.9
Solar Fixtures	Instant Savings	N/A	N/A	10	2.6

Table 184: EUL Values for BNI LED Lamps and Fixtures

Measure	Program Component	Average Rated Lifetime (hours)	Annual HOU (hours/year)	Equipment Life	2023 Equivalent EUL
LED Linear Fixtures					
1 x 4 Luminaires	BER Instant Rebates, BER-AR, SBES	50,000	4,300	11.6	11.6
2 x 2 Luminaires and Retrofit Kits	BER Instant Rebates, BER-AR, SBES	50,000	4,300	11.6	11.6
2 x 4 Luminaires and Retrofit Kits	BER Instant Rebates, BER-AR, SBES	50,000	4,300	11.6	11.6
Linear Ambient and Low-bay Luminaires	BER Instant Rebates, BER-AR, SBES	50,000	4,300	11.6	11.6
High-bay Luminaires	BER-AR, SBES	100,000	4,300	23.3	23.3
Troffers	BER Instant Rebates, BER-AR, SBES	90,000	4,300	20.9	20.9
Stairwell and Passageway Luminaire	BER-AR, SBES	100,000	7,000	14.3	14.3

Measure	Program Component	Average Rated Lifetime (hours)	Annual HOU (hours/year)	Equipment Life	2023 Equivalent EUL
LED Linear Lamps					
2-foot Replacement Lamps	BER Instant Rebates, BER-AR, SBES	50,000	4,300	11.6	11.6
3-foot Replacement Lamps	BER Instant Rebates, BER-AR, SBES	50,000	4,300	11.6	11.6
4-foot Replacement Lamps	BER Instant Rebates, BER-AR, SBES	50,000	4,300	11.6	11.6
8-foot Replacement Lamps	BER Instant Rebates, BER-AR, SBES	50,000	4,300	11.6	11.6
U-bend	BER Instant Rebates, BER-AR, 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	1.8
LED Omnidirectional (A-lamp and Globe)	SBES	25,000	3,600	6.9	1.8
Four Pin-base Replacement Lamps for CFLs	BER-AR, SBES	50,000	4,300	11.6	11.6
9 W Replacing 25 W	SBES	25,000	3,600	6.9	2.0
9 W Replacing 29 W					2.0
9 W Replacing 40 W					1.6
9 W Replacing 43 W					2.0
9 W Replacing 60 W					1.7
9 W Replacing 72 W					2.0
9 W Replacing 100 W					1.7
9 W Replacing 150 W					1.4
9.5 W Replacing 25 W					2.0
9.5 W Replacing 29 W					2.0
9.5 W Replacing 40 W					1.6
9.5 W Replacing 43 W					2.0
9.5 W Replacing 60 W					1.7
9.5 W Replacing 72 W					2.0
9.5 W Replacing 100 W					1.7
9.5 W Replacing 150 W					1.4
18 W Replacing 75 W					1.9

Measure	Program Component	Average Rated Lifetime (hours)	Annual HOU (hours/year)	Equipment Life	2023 Equivalent EUL
18 W Replacing 100 W					1.7
7 W Blackout Bulbs Replacing 60 W					1.7
LED Reflector Lamps					
Small LED Reflector Lamps - PAR, MR, MRX 16	SBES	25,000	3,600	6.9	2.0
Small LED Reflector Lamps - PAR, R 20	SBES	25,000	3,600	6.9	2.0
Large LED Reflector Lamps - PAR, BR, R 30/30L	SBES	25,000	3,600	6.9	2.0
Large LED Reflector Lamps - PAR, BR, R 38/40	SBES	25,000	3,600	6.9	2.0
LED Downlight Fixtures					
LED Recessed	SBES	50,000	3,600	13.9	2.0
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	1.8
LED Outdoor Fixtures					
Outdoor Full-cut-off Wall-mounted Area Luminaires	BER Instant Rebates, BER-AR, SBES	75,000	4,380	17.1	17.1
Flood and Spot Luminaires	BER Instant Rebates, BER-AR, SBES	75,000	4,380	17.1	17.1
Fuel Pump Canopy Luminaires	BER-AR, SBES	50,000	4,380	11.4	11.4
LED Replacements for High-Intensity Discharge Lamps	BER-AR, SBES	50,000	4,380	11.4	11.4
Non-cut-off and Semi-cut-off Wall-mounted Area Luminaires	BER Instant Rebates, BER-AR, SBES	100,000	4,380	22.8	22.8
Pole/Arm-mounted Area Luminaires	BER-AR, SBES	60,000	4,380	13.7	13.7
Pole/Arm-mounted Decorative Luminaires	BER-AR, SBES	100,000	4,380	22.8	22.8
Parking Garage Luminaires	BER-AR, SBES	100,000	4,380	22.8	22.8
Case Lighting for Sign Retrofit Applications	BER-AR, SBES	50,000	4,300	11.6	11.6

Measure	Program Component	Average Rated Lifetime (hours)	Annual HOU (hours/year)	Equipment Life	2023 Equivalent EUL
LED Directional and Architectural Fixtures					
Track or Mono-point Directional Luminaires, LED Wall Wash Luminaires	BER Instant Rebates, BER-AR, SBES	50,000	4,300	11.6	11.6
Other LED Lighting					
Refrigerated Case Luminaires	BER-AR, SBES	70,000	4,300	16.3	16.3
LED Nightlights	SBES	100,000	4,380	22.8	22.8
Horticultural Lighting	BER-AR	50,000	6,000	8.3	8.3
Lighting	AMH	50,000	8,760	5.7	5.7

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 185 and Table 186 summarize the EUL values and their source for residential and BNI measures respectively.

Table 185: EUL Values and Sources for Non-LED Lighting Residential Measures

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

Measure Name	Program Component	EUL Value	Source
Refrigerator Replacements	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	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)
ENERGY STAR Certified Clothes Dryers	Instant Savings	12	ENERGY STAR Calculator, 2016 (Value for clothes dryers)
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)
Efficient Washer-Dryer Combination Units	Instant Savings	11	Minimum between clothes washer and dryer EUL values
ENERGY STAR Certified Room Air Purifiers	Instant Savings	9	ENERGY STAR Calculator, 2016 (Value for air purifiers)
ENERGY STAR Certified Dishwashers	Instant Savings	11	DEER, 2014 ¹⁹⁹ (Value for high efficiency dishwashers)

¹⁹⁹ 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
Appliance Upgrade	AMH	11	Values for appliance upgrades typically vary between 10 and 12 years, so a value of 11 years was assumed.
Lighting Controls			
Dimmer Switches	Instant Savings	10	IESO PMA List, 2019 (Value for dimmer switches)
Motion Sensors	Instant Savings	10	GDS, 2007 ²⁰⁰ (Table 1 – Residential Measures, value for occupancy sensors)
Water Heating			
Drain Water Heat Recovery	HEA, MHEEP	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 ²⁰¹ (Table 1, value for solar water heaters)
Heat Pump Water Heaters	NHC, HEA, MHEEP, Instant Savings	10	DEER, 2014 ²⁰² (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 are 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)
Water Heating	AMH	10	DEER, 2014 (Value for heat pump water heaters)

²⁰⁰ 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

²⁰¹ Retrieved from

https://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterDraftCriteriaAnalysis.pdf

²⁰² 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, AMH	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 ²⁰³ (up to 24 years for the inside component and more than 50 years for the ground loop) and by Natural Resources Canada ²⁰⁴ (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 ²⁰⁵ (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 Products	EPI	15	GDS, 2007 (Table 1 – Residential Measures, value for air sealing)
Window Film Kits	EPI	1	Assumption based on the unlikeliness that the same film would be removed and reapplied every year without it being damaged and replaced over time.
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, MHEEP	10	Various EUL values are used among jurisdictions. The common practice is to use the same EUL value as for programmable thermostats.

²⁰³ Retrieved from <https://energy.gov/energysaver/heat-and-cool/heat-pump-systems/geothermal-heat-pumps#306534-tab-1>

²⁰⁴ 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>

²⁰⁵ Retrieved from https://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterDraftCriteriaAnalysis.pdf

Measure Name	Program Component	EUL Value	Source
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	12	Hydro-Québec, 2011 ²⁰⁶
Domestic Water Heater Timers	Green Heat	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	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	Residential DR	7	This value is applicable to new available DR capacity. In 2023, 80% of participants reenrolled. Assuming a fixed drop-out rate of 20%, the Evaluator calculated an EUL of 7 years. This EUL is likely to be updated once more annual reenrollment data is available.

²⁰⁶ 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.
Building Envelope	AMH	25	GDS, 2007 – Insulation

Table 186: EUL Values and Sources for Non-LED Lighting BNI Measures

Measure Name	Program Component	EUL Value	Source
Lighting Controls			
Occupancy Sensors	BER Instant Rebates, BER-AR, SBES	10	GDS, 2007 (Table 2 – Commercial & Industrial Measures, value for occupancy sensors in new constructions)
Agricultural			
Agriculture Heat Pads	BER-AR, SBES	10	IESO PMA List, 2019 (Value for single creep heat pads)
Dairy Scroll Compressors	BER-AR, SBES	15	IESO PMA List, 2019 (Value for milk scroll compressors) KEMA, 2009 ²⁰⁷ (Value for scroll compressors for dairy refrigeration)
Energy Efficient Ventilation and Circulation Fans	BER-AR, SBES	15	GDS, 2007 (Appendix C) KEMA, 2009 (Value for ventilation fans, high efficiency)
Heat Reclaimer Units	BER-AR, SBES	15	Pennsylvania TRM, 2016 KEMA, 2009 (Value for process heat recovery)

²⁰⁷ 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
High-volume Low-speed Fans	BER-AR, 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-AR, SBES	10	KEMA, 2009 (Value for energy efficient livestock waterers) IESO PMA List, 2019 (Value for low-energy livestock waterers)
Milk Pre-coolers	BER-AR, SBES	15	KEMA, 2009 (Value for well water pre-coolers)
Natural and Dual Ventilation	BER-AR, SBES	15	IESO PMA List, 2019 (Value for dual and natural exhaust ventilation systems)
Tractor Engine-block Heater Timers	BER-AR, 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-AR, 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-AR, SBES	15	DEER, 2014 (Value for milking transfer pump variable speed drives)
Compressed Air			
Air Entraining Air Nozzles	BER-AR, SBES	15	KEMA, 2009 (Value for compressed air nozzles)
Cycling Air Dryers	BER-AR, SBES	10	KEMA, 2009 (Value for cycling air dryers)
No-loss Drains	BER-AR, SBES	15	ERS, 2005 ²⁰⁸ (Table 1-2, value for compressed air)
Compressed Air Leak Repairs	Custom	2	KEMA, 2009 ²⁰⁹ (Value for compressed air - service)
Air Compressor Replacement	Custom	15	ERS, 2005 (Table 1-2, value for compressed air – new construction)
HVAC			
Air-source Heat Pumps Greater Than or Equal to 65,000 BTU/hr	BER-AR, 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-AR, 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)

²⁰⁸ ERS. Measure Life Study. Prepared for the Massachusetts Joint Utilities. November 2005

²⁰⁹ 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
Air-to-water Heat Pumps	BER-AR, 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-AR, SBES	10	GDS, 2007 (Table 2 – Commercial & Industrial Measures, value for enthalpy economizers) ERS, 2005 (value for enthalpy economizers)
Ground-source Heat Pumps	BER-AR, SBES	25	Life expectancy estimated by the U.S. Department of Energy ²¹⁰ (up to 24 years for the inside component and more than 50 years for the ground loop) and by Natural Resources Canada ²¹¹ (about 20 to 25 years).
HVAC Hotel Occupancy Sensors	BER-AR, SBES	8	DEER, 2014 (Value for occupancy sensors)
Packaged Terminal Heat Pumps (PTHPs)	BER-AR, SBES	15	GDS, 2007 (Table 2 – Commercial & Industrial Measures, value for packaged AC/HP)
Water-source Heat Pumps	BER-AR, 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-AR, 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-AR	10	Illinois TRM, 2021 (Value for advanced RTU controls)
Kitchen			
Demand-controlled Kitchen Exhausts	BER-AR, 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-AR, SBES	Under-counter: 10 Door-type: 15 Convey 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

²¹⁰ Retrieved from <https://energy.gov/energysaver/heat-and-cool/heat-pump-systems/geothermal-heat-pumps#306534-tab-1>
²¹¹ 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
Freezers/Refrigerators	BER-AR, 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-AR, SBES	12	DEER 2014 (Value for fryers)
Griddles	BER-AR, SBES	12	DEER 2014 (Value for griddles)
Hot Food Holding Cabinets	BER-AR, SBES	12	DEER 2014 (Value for commercial insulated holding cabinets)
Ice Machines	BER-AR, SBES	10	DEER 2014 (Value for ice machines) KEMA, 2009 (Value for ice machines)
Ovens	BER-AR, SBES	12	DEER 2014 (Value for combination ovens or convection ovens)
Steam Cookers	BER-AR, SBES	12	DEER 2014 (Value for steam cookers)
Laundry			
Commercial Clothes Dryers (NG Conversion)	BER-AR, 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-AR, 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-AR, 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)
Motors and VFDs			
Energy Efficient Motors	BER-AR, SBES	15	DEER, 2014 (Value for HVAC fan motors)
Variable Frequency Drives	BER-AR, 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-AR, BER Instant Rebates, SBES	15	KEMA, 2009 (Value for well and pump)
Booster Pumps	BER-AR	15	KEMA, 2009 (Value for well and pump)

Measure Name	Program Component	EUL Value	Source
Refrigeration			
Brushless DC Motors	BER-AR, 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-AR, SBES	4	DEER, 2014 (Value for strip curtains for walk-ins)
Door Heater Controls	BER-AR, SBES	12	KEMA, 2009 (Value for anti-sweat heater controls) ERS, 2005 (Table 4-7, value for door heater controls)
Efficient Refrigeration Compressors	BER-AR, 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-AR, SBES	10	ERS, 2005 (Value for motor controls)
Intelligent Freezer Defrost Controls	BER-AR, SBES	10	ERS, 2005 (Value for motor controls)
Refrigerated Vending Machine Controllers	BER-AR, SBES	5	DEER, 2008, 2014 (Value for vending machine controllers) ERS, 2005 (Table 1-1, value for vending machine controllers)
Refrigeration Economizers	BER-AR, SBES	15	Illinois TRM, 2019 (Value for refrigeration economizers)
Vertical Refrigeration Open-to-closed Cooler Conversion	BER-AR, SBES	12	DEER, 2008 (Value for reach-in refrigerators/freezers)
Zero Energy Doors	BER-AR, 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-AR, SBES, Custom	15	KEMA, 2009 (Value for water heaters)
Heat Pump Water Heaters	BER-AR, 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-AR, SBES	20	ENERGY STAR, Save Money and More with ENERGY STAR Qualified Solar Water Heaters ²¹²
Solar Space Heating Systems	BER-AR, SBES	20	ENERGY STAR, Save Money and More with ENERGY STAR Qualified Solar Water Heaters
Solar Photovoltaic Panels	Custom Retrofit	22.4	Calculation ²¹³ Wisconsin TRM, 2023 ²¹⁴ (value for Solar Photovoltaic) NREL, 2012 ²¹⁵ (degradation rate of solar panel output)
Pool			
Efficient Pool Pumps	BER-AR, SBES	10	DEER, 2014 (Value for high-efficiency pool pumps)
IT & Datacenters			
Server-based Power Management Software	BER-AR, SBES	5	DEER 2014 (Value for power management software)
Server Virtualization and Decommissioning	BER-AR, SBES	4	Pennsylvania TRM, 2019 (Value for server virtualization)
ENERGY STAR Uninterruptible Power Supplies	BER-AR, SBES	10	California TRM, 2017 (Value for ENERGY STAR uninterrupted power supply)

²¹² Retrieved from: https://www.energystar.gov/products/water_heaters/water_heater_solar/benefits_savings

²¹³ This is an equivalent EUL value based on a 25-year solar panel useful life (footnote 214) and on an average 0.8%/year degradation rate of solar panel output (footnote 215). Applying this degradation rate over the 25-year useful life yields an equivalent EUL of 22.4 years.

²¹⁴ Public Utility Commission of Wisconsin, *Wisconsin Focus on Energy 2023 Technical Reference Manual*, State of Wisconsin, January 2023, p. 945

²¹⁵ National Renewable Energy Laboratory, *Photovoltaic Degradation Rates — An Analytical Review*, June 2012, p.5

Measure Name	Program Component	EUL Value	Source
New Construction (NC)			
<i>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).</i>			
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		
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. ²¹⁶ (Most conservative value for photovoltaics)
Renewable Power Generation (Wind)	Custom NC	20	NREL, Useful Life ²¹⁷ (Value for wind)
Building Optimization (BOpt)			
Changes to Control Parameters	Custom BOpt	3	SBW Consulting, 2010 ²¹⁸
Equipment Repairs	Custom BOpt	8	SBW Consulting, 2010 ²¹⁹
New Equipment Installations	Custom BOpt	12	SBW Consulting, 2010 ²²⁰
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.

²¹⁶ NREL. *Useful Life*. Retrieved from <https://www.nrel.gov/analysis/tech-footprint.html>

²¹⁷ NREL. *Useful Life*. Retrieved from <https://www.nrel.gov/analysis/tech-footprint.html>

²¹⁸ 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

²¹⁹ Ibid.

²²⁰ Ibid.



Measure Name	Program Component	EUL Value	Source
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

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.

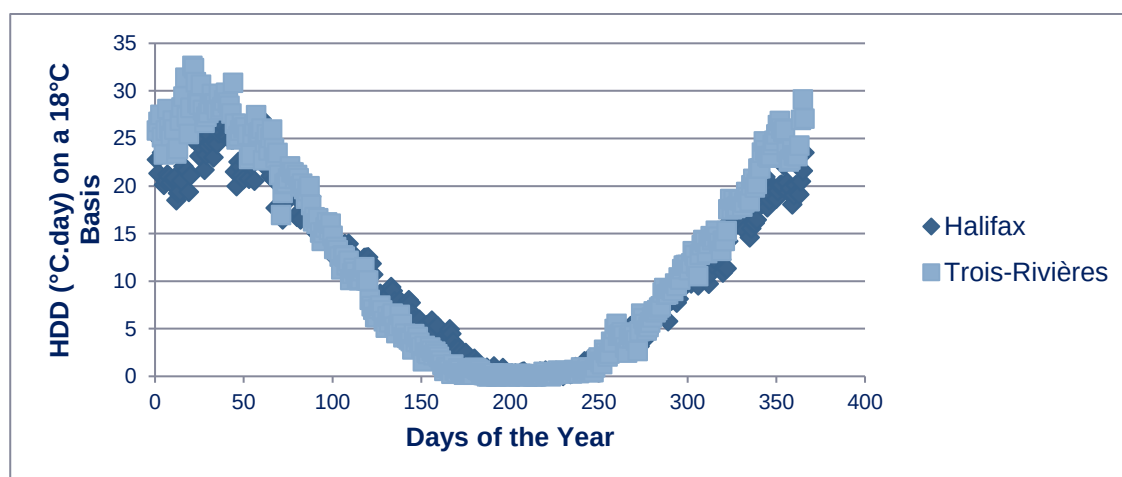
Verification of Climate Data Validity

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 based on 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.

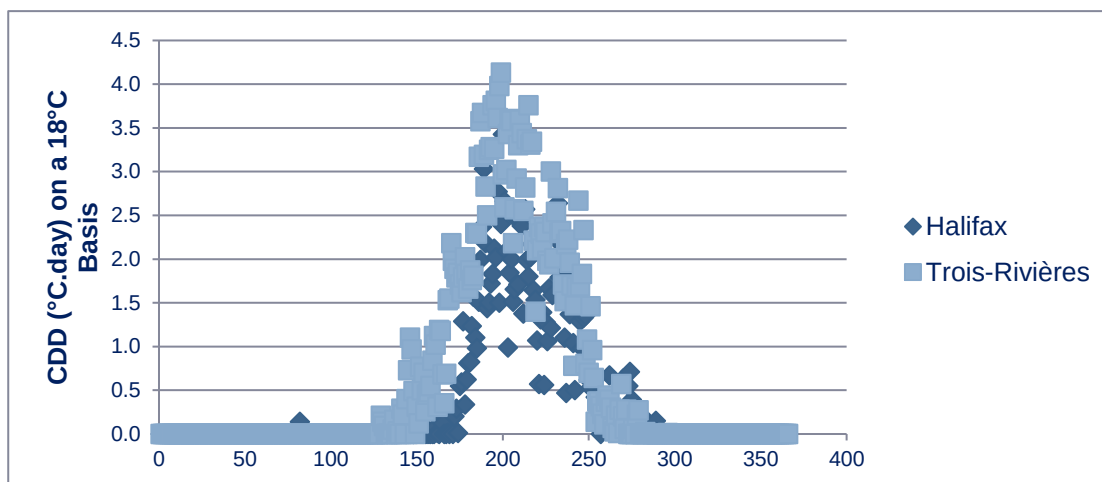
The following two figures show the average heating degree days (HDD) and cooling degree days (CDD) per day over a full year in Trois-Rivières²²¹ and Halifax, respectively.

Figure 1: HDD per day for Trois-Rivières and Halifax



²²¹ 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 2023 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, 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 187. 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 187: Equipment Life Value per LED Lamp and Fixture Types

LED Lamp and Fixture Type	Program Component	Average Rated Lifetime Hours (hours) ²²²	Annual HOU (hours/year) ²²³	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

²²² Based on manufacturer specification sheets for the most popular models installed through EPI in 2017.

²²³ 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 turn 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.²²⁴ 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. As of April 2022, the Biden administration restored the lighting standards for the extended definition of general service lamps (including decorative and reflector lamps) to the 45 lm/W efficiency standard. The standard will apply as of July 2023. In Canada, lighting has been added to the list of considered products for Amendments 18 and 19, which are planned to be at the pre-publication stage in early 2024. This would be consistent with the usual delay of approximately two years between Canadian and U.S. regulations as a new standard could be expected to be enforced in 2025.

While the latest U.S. regulation is set to establish a minimum efficiency level corresponding to a high-efficiency CFL, recent studies²²⁵ indicate that the U.S. market is rapidly moving away from CFL lamps toward LED lamps. Steady shipment volumes, high LED shipment shares, elevated free-ridership levels, retailers' impressions on market saturation, and the greater availability of LED technologies compared to non-LEDs are all factors leading the Evaluator to believe that the markets for both LED A-type as well as LED non-A-type lamps are close to maturity. Although the Canadian general service lamp minimum energy performance has not yet been updated, it is expected that it will result in a ban on halogen incandescent lamps once it is applied. The Evaluator then expects LED technology to become the standard, a standard that most of the market has already attained. For these reasons, the Evaluator expects the baseline for LED lamps to change in 2025; hence, 2024 is the last year with savings before the LED baseline is applied. The assumed baseline changes for A-type and non-A-type lamps are outlined in Table 188 below.

²²⁴ Illinois Energy Efficiency Stakeholder Advisory Group, *Illinois Statewide Technical Reference Manual for Energy Efficiency Version 8.0, Volume 3*, October 2019, p. 258

²²⁵ Illinois Energy Efficiency Stakeholder Advisory Group, *Illinois Statewide Technical Reference Manual for Energy Efficiency Version 8.0, Volume 3*, October 2019, p. 258

Table 188: LED Baseline Evolution

Baseline	Minimum Wattage Requirement	Years	Rationale
A-type			
Incandescent Baseline	N/A	2023 (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. ²²⁶ The remaining useful life of replaced functional incandescent light lamps is assumed to be half the rated life expectancy.
Halogen Incandescent Baseline – Canadian Legislation ^{227,228}	General service lamps with a luminous flux < 750 lumens: ≤29 W	2024	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		
LED Equivalent Baseline – American Legislation ²²⁹	45 lumens/W	2025 - end of product life	See rationale above.

²²⁶ 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)

²²⁷ 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)

²²⁸ Also equivalent to Incandescent Equivalent 1st Tier EISA 2007

²²⁹ 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	2023-2024	The current Canadian regulations allow halogen incandescent lamps for reflector lamps (R, BR) and decorative. Therefore, the first baseline corresponds to the baseline product, namely halogen incandescent lamps.
LED Equivalent Baseline – American Legislation ²³⁰	45 lumens/W	2025 - end of product life	See rationale above.
Reflector (GU, PAR, MR) Lamps			
Halogen Baseline	N/A	2023-2024	The current Canadian regulations allow halogen incandescent lamps for reflector lamps (GU, PAR, MR). Therefore, the first baseline corresponds to the baseline product, namely halogen lamps.
LED Equivalent Baseline – American Legislation ²³¹	45 lumens/W	2025 - end of product life	See rationale above.

Using the baseline evolution presented above, the following sections present the detailed calculations and resulting values for all LED lighting products.

²³⁰ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007

²³¹ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007

EPI

LED A-type Lamps

LED A-type lamps installed under EPI replace incandescent lamps. The calculation is based on 9 W lamps because they are the most common A-type lamps installed through EPI. The first baseline increase occurs one year following the anticipated burnout of incandescent lamps.²³² 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 2025. Starting in 2025 and for the remaining lifetime of those lamps (23 years), the baseline will be LED equivalent lamps as discussed above. The following equation is used to establish the equivalent EUL presented in Table 189.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Incandescent}} \times 1 \text{ Year} + \Delta W_{\text{Halogen}} \times 1 \text{ Year} + \Delta W_{\text{LED}} \times 23 \text{ Years}}{\Delta W_{\text{Incandescent}}}$$

Table 189: Equivalent EUL Calculation Summary for LED A19 Lamps

Replaced Lamp (W)	Typical Efficient Lamp (W)	Incandescent Baseline 1 Year (2023)		Halogen Incandescent Baseline – Canadian Legislation ^{233,234} 1 Year (2024)		LED Equivalent Baseline – American Legislation 23 Years (2025-2047)		Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
40	9	40	31	29	20	9	0	1.6
60	9	60	51	43	34	9	0	1.7
100	9	100	91	72	63	9	0	1.7

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 regulations (Amendments 18 & 19). Starting in 2025, the baseline wattage is therefore increased to a LED since the minimum efficiency level of 45 lumens/watt bans halogen lamps and the market moves away from CFL lamps. Therefore, these lamps will no longer generate savings starting in 2025 and only generate savings for the two years prior to the baseline increase, which results in an equivalent EUL of two years.

²³² 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.

²³³

²³⁴ Also equivalent to Incandescent Equivalent 1st Tier EISA 2007. 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)

Decorative Lamps

As for decorative lamps (G25 and chandelier lamps), the same approach as for reflector lamps is applied. While both types of lamps are not impacted by current Canadian regulations, they will be affected by the requirements of upcoming regulations (Amendments 18 & 19). Starting in 2025, the baseline wattage is therefore increased to a LED and will no longer generate savings. They only generate savings for the two years prior to the baseline increase, which results in an equivalent EUL of two years.

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 2025, the baseline wattage is increased to match that of LED technology since the minimum efficiency level of 45 lumens/watt bans halogen lamps and the market moves away from CFL lamps. Therefore, these lamps will no longer generate savings starting in 2025 and only generate savings for the two years prior to the baseline increase, which results in an equivalent EUL of two years.

LED Fixtures

As for LED fixtures without motion sensors (including recessed downlight 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, those lamps will be affected by the requirements of upcoming regulations (Amendments 18 & 19). Hence, starting in 2025, the baseline wattage is increased to a LED since the minimum efficiency level of 45 lumens/watt bans halogen lamps and the market moves away from CFL lamps. Therefore, like non-A-type lamps, LED fixtures will no longer generate savings starting in 2025 and only generate savings for the two years prior to the baseline increase, which results in an equivalent EUL of two years.

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 190.

Table 190: 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 2 Years (2023-2024)		LED Equivalent Baseline – American Legislation ²³⁵ 23 Years (2025-2047)		Lifetime Energy Savings (kWh)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
88.3	22.2	88.3	66.1	22.2	0	228

Then, the difference in hours of operation generated by the motion sensors was considered, as presented in Table 191.

Table 191: 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 487 kWh were divided by the first-year savings of 128 kWh to obtain an equivalent EUL of 3.8 years.

For solar fixtures, a measure life of 10 years was assumed based on the EUL values for motion sensors. While solar lamps initially remove the full wattage of the baseline lamps from the grid, the baseline wattage is assumed to become LED lamps starting in 2025. Therefore, the wattage of the outdoor fixtures with motion sensors was assumed starting in 2025 until the end of the measure life. An equivalent EUL was obtained using the equation and Table 192 below.

$$\text{Equivalent EUL} = (W_{\text{Initial}} \times 2 \text{ Years} + W_{\text{LED}} \times 8 \text{ Years}) / W_{\text{Initial}}$$

Table 192: Lifetime Energy Savings for Solar Fixtures

Initial Baseline Wattage (W) 2 Years (2023-2024)	LED Equivalent Baseline (W) – American Legislation 8 Years (2025-2032)	Measure Life (years)	Lifetime Energy Savings (kWh)	Equivalent EUL (years)
275.6	22.2	10.0	146	2.6

²³⁵ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007

SBES

LED General-use and Decorative Lamps

The methodology used to establish the equivalent EUL of general-use and decorative lamps is based on the information presented in Table 193 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 targets commercial participants, it is assumed that some participants might have incandescent lamps stocked and, therefore, the Evaluator increased the duration of this baseline to a full year.

As outlined in Table 192 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 2025. In other words, a second baseline increase will occur in 2025 (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 2024). Starting in 2025 and for the remaining lifetime of the fixture (4.9 years), the baseline will be a LED, which results in no additional savings. With the information presented in Table 193, the following equation served to set the equivalent EUL of general-use and decorative lamps at 1.8 years.

Equivalent EUL

$$= \frac{\Delta W_{\text{Halogen Incandescent and Incandescent}} \times 1 \text{ Year} + \Delta W_{\text{Halogen Incandescent}} \times 1 \text{ Year} + \Delta W_{\text{LED}} \times 4.9 \text{ Years}}{\Delta W_{\text{Halogen Incandescent and Incandescent}}}$$

Table 193: Baseline Evolution During the Effective Useful Life of LED General-use and Decorative Lamps

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Incandescent and Incandescent Baseline 1 Year (2023)		Halogen Incandescent Baseline – Canadian Legislation ^{236,237} 1 Year (2024)		LED Equivalent Baseline – American Legislation ²³⁸ 4.9 Years (2025-2029)		Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
52	9	52	43	43	34	9	0	1.8

²³⁶ 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)

²³⁷ Also equivalent to Incandescent Equivalent 1st Tier EISA 2007

²³⁸ 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 187 further 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 2025, the baseline wattage will be reduced to a LED starting in 2025 and for the remaining lifetime of the fixture (4.9 years). The equivalent EUL was calculated at 2.0 years based on the following equation and the information presented in Table 194.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen}} \times 2 \text{ Years} + \Delta W_{\text{LED}} \times 4.9 \text{ Years}}{\Delta W_{\text{Halogen}}}$$

Table 194: Baseline Evolution During the Effective Useful Life of LED Reflector Lamps

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Baseline 2 Years (2023-2024)		LED Equivalent Baseline - American Legislation ²³⁹ 4.9 Years (2025-2029)		Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
43	12	43	31	12	0	2.0

Non-recessed LED 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 2025. Starting in 2025 and for the remaining lifetime of the fixture (11.9 years), the baseline will be a LED, which results in no additional savings. The equation and Table 195 below present the information used to calculate the equivalent EUL of 1.8 years.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen Incandescent and Incandescent}} \times 1 \text{ Year} + \Delta W_{\text{Halogen Incandescent}} \times 1 \text{ Year} + \Delta W_{\text{LED}} \times 11.9 \text{ Years}}{\Delta W_{\text{Halogen Incandescent and Incandescent}}}$$

²³⁹ Ibid.

Table 195: 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 (2023)		Halogen Incandescent Baseline – Canadian Legislation ^{240,241} 1 Year (2024)		LED Equivalent Baseline - American Legislation ²⁴² 11.9 Years (2025-2036)		Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
52	9	52	43	43	34	9	0	1.8

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 of a 12 W LED reflector lamp replacing a 43 W halogen lamp. With the regulation planned to impact reflector lamps in 2025, 43 W halogen lamps will be the baseline technology for three years, after which LED lamps will become the baseline for the remaining lifetime of LED recessed downlight fixtures (11.9 years). The equivalent EUL was calculated at 2.0 years based on the information presented in Table 196.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen}} \times 2 \text{ Years} + \Delta W_{\text{LED}} \times 11.9 \text{ Years}}{\Delta W_{\text{Halogen}}}$$

Table 196: Baseline Evolution During the Effective Useful Life of LED Reflector Lamps in Downlight Fixtures

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Baseline 2 Years (2023-2024)		LED Equivalent Baseline - American Legislation ²⁴³ 11.9 Years (2025-2036)		Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
43	12	43	31	12	0	2.0

²⁴⁰ 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)

²⁴¹ Also equivalent to Incandescent Equivalent 1st Tier EISA 2007

²⁴² As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007

²⁴³ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007

