

2018 DSM EVALUATION REPORTS

EFFICIENCY NOVA SCOTIA

Final Report

March 27, 2019



TABLE OF CONTENTS

1	2018 DSM PROGRAMS EVALUATION EXECUTIVE SUMMARY
2	2018 DSM PROGRAMS EVALUATION EXECUTIVE SUMMARY APPENDICES
3	RESIDENTIAL EFFICIENT PRODUCT REBATES PROGRAM
4	RESIDENTIAL EFFICIENT PRODUCT REBATES PROGRAM APPENDICES
5	EXISTING RESIDENTIAL PROGRAM
6	EXISTING RESIDENTIAL PROGRAM APPENDICES
7	NEW RESIDENTIAL PROGRAM
8	NEW RESIDENTIAL PROGRAM APPENDICES
9	EFFICIENT PRODUCT REBATES PROGRAM
10	EFFICIENT PRODUCT REBATES PROGRAM APPENDICES
11	CUSTOM INCENTIVES PROGRAM
12	CUSTOM INCENTIVES PROGRAM APPENDICES
13	DIRECT INSTALLATION PROGRAM
14	DIRECT INSTALLATION PROGRAM APPENDICES
15	INTRODUCTION OF NEW CODES AND STANDARDS IN NOVA SCOTIA
16	INTRODUCTION OF NEW CODES AND STANDARDS IN NOVA SCOTIA APPENDICES

2018 DSM PROGRAMS EVALUATION

EXECUTIVE SUMMARY

EFFICIENCY NOVA SCOTIA

Final Report

March 18, 2019



ABBREVIATIONS

BNI	Business, non-profit and institutional
CRA	Corporate Research Associates
DA	Delivery agent
DIY	Do-it-yourself
DSM	Demand-side management
DHW	Domestic hot water
ENS	Efficiency Nova Scotia
EUL	Effective useful life
GHG	Greenhouse gas
HPWH	Heat pump water heater
LED	Light-emitting diode
MEPS	Minimum energy performance standards
MSHP	Mini-split heat pump
NSP	Nova Scotia Power
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.
Base case	To determine gross savings, a 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 base case may include such information as the hours of operation, wattage and the 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 the energy simulations and the actual energy consumption of the building or system.
Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
Displaced wattage	The displaced wattage is defined as the difference between the wattage values of the baseline equipment or product and the efficient equipment or product.
EnerGuide rating	An EnerGuide (official brand of Natural Resources Canada) rating is a standard measure of the home's energy performance. It is a measure of the efficiency of the building only and does not take into account occupant behaviour. It shows how energy efficient the home is through modelled heat losses of the home, based on several factors including building envelope characteristics, heated volume, heating systems and air leakage.
Effective useful life	The period a measure is expected to be in service and provide both energy and peak demand savings. This value combines the equipment life and the measure persistence, which includes factors such as business turnover or early retirement.
Equipment life	The number of years installed equipment will operate before it fails.
Equivalent CO ₂	A unit of measurement indicating the amount of carbon dioxide to which various kinds of emitted greenhouse gases are equivalent in terms of warming effects. In this report, the gases' global-warming potential is estimated over a timescale of 100 years.
Equivalent effective useful life	The number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. This value takes into account variations in annual energy savings throughout the effective useful life due to increased baselines.

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

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

TABLE OF CONTENTS

INTRODUCTION	1
1 EVALUATION OBJECTIVES AND SCOPE	3
2 EVALUATION METHODOLOGY	7
2.1 Interviews	7
2.2 Surveys	9
2.3 On-site Visits	10
2.4 Project File Reviews	11
2.5 Unitary Savings Review.....	12
2.6 Billing Analysis	12
2.7 Simulation Model Review	12
2.8 Metering Analysis	13
2.9 Effective Useful Life Review	13
2.10 Avoided GHG Emissions Quantification.....	13
3 IMPACT EVALUATION RESULTS.....	14
3.1 Individual Impact Evaluation Results.....	14
3.1.1 Residential DSM Programs	17
3.1.2 Business, Non-profit and Institutional DSM Programs.....	20
3.1.3 Codes and Standards	23
3.2 Net-to-gross Ratio.....	23
3.3 Lifetime Energy Savings	26
3.4 Greenhouse Gas Emission Reductions.....	27
4 DSM PORTFOLIO PERFORMANCE.....	28
4.1 Participant and Partner Satisfaction	28
4.2 Annual Savings Performance	30
4.3 Savings Performance for the 2016-2018 DSM Plan	31
4.4 Historical Portfolio Analysis	33
5 MARKET EVOLUTION	37
6 RECOMMENDATIONS	40

LIST OF TABLES

Table 1: Types of Evaluations Conducted for Each Program Component	4
Table 2: 2018 Interviews Completed	8
Table 3: 2018 Participant Surveys	10
Table 4: 2018 On-site Visits	11
Table 5: 2018 Evaluated Results and Tracked Energy Savings at the Generator	15
Table 6: 2018 Evaluated Results and Tracked Peak Demand Savings at the Generator	16
Table 7: 2018 Free-ridership, Spillover and NTGRs	24
Table 8: 2018 Evaluated Net Lifetime Energy Savings at the Generator	26
Table 9: 2018 Evaluated Avoided GHG Emissions	27
Table 10: 2018 Satisfaction Results	28
Table 11: 2018 Planned Savings and Evaluated Results	30
Table 12: 2016-2018 DSM Net Savings Targets and Evaluated Results	32
Table 13: Evaluated Net Energy Savings at the Generator, 2014-2018	34
Table 14: Evaluated Net Peak Demand Savings at the Generator, 2014-2018	35
Table 15: Crosscutting Recommendation on ENS Programs	40
Table 16: Recommendations on Residential Program Components	41
Table 17: Recommendations on Business, Non-profit and Institutional Program Components	44

INTRODUCTION

Efficiency Nova Scotia (ENS) is operated by EfficiencyOne, an independent, non-profit organization. ENS 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 various segments of the population. ENS has a demand-side management (DSM) portfolio of three residential programs and three business, non-profit and institutional (BNI) programs. Each program has one or more program component that ENS markets to Nova Scotians. ENS receives funding for its activities from Nova Scotia Power (NSP) and the Province of Nova Scotia. The funds received from NSP cover the costs of activities designed to help reduce electricity consumption, whereas funds from the Province of Nova Scotia are primarily used for activities designed to help reduce the use of other fuels.

Econoler was commissioned to evaluate the ENS 2018 DSM program portfolio comprised of six electricity efficiency programs and assess the impacts of energy efficiency codes and standards introduced in Nova Scotia. To carry out this assignment, Econoler collaborated with Research Into Action, Equilibrium Engineering and Corporate Research Associates (CRA). 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 impact evaluation calculations, as well as preparing and reviewing evaluation reports. Research Into Action carried out the process evaluations, while Equilibrium Engineering conducted the on-site visits and contributed to certain impact evaluation analyses. CRA conducted interviews and surveys with participants and partners, as well as analyzed and reported on the data collected from these activities. Throughout this report, this team is referred to as the Evaluator.

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

The evaluation revealed that the ENS DSM program portfolio achieved a total of 151.393 GWh in net electrical energy savings and 25.542 MW in net peak demand savings at the generator in 2018. These savings represent 92,659 tonnes of CO₂ eq in terms of annual avoided GHG emissions. The total net lifetime energy savings amount to 1,778.605 GWh. In addition to the savings generated by ENS DSM programs, Codes and Standards were found to have achieved energy savings of 23.809 GWh and peak demand savings of 4.008 MW at the generator.²

¹ Throughout this report, energy savings always refer to first-year energy savings rather than lifetime energy savings, unless specified otherwise.

² Energy and peak demand savings generated through Codes & Standards are not claimed since they are not the result of activities directly conducted by ENS.

The purpose of this report is to present the evaluation results of the overall ENS DSM program portfolio, along with the results of each program and their components and services. The following sections summarize evaluation objectives and scope, evaluation methodologies, impact evaluation results, overall DSM portfolio performance, market evolution, and recommendations to enhance the program component portfolio.

1 EVALUATION OBJECTIVES AND SCOPE

The objectives of the 2018 evaluation of ENS DSM program components were to:

- › Assess the effectiveness of program component design and delivery
- › Determine the extent to which program component implementation is proceeding as planned (i.e. ensuring that equipment is installed and working as expected)
- › Determine gross energy and peak demand savings at the generator
- › Determine net-to-gross ratios (NTGRs)
- › Determine net energy and peak demand savings at the generator
- › Determine lifetime energy savings
- › Quantify avoided GHG emissions linked to electricity savings
- › Analyze the market evolution of LED lamps and mini-split heat pumps (MSHPs)

Table 1 below outlines the various programs assessed as part of the 2017 and 2018 evaluations, along with their respective components and the types of evaluations conducted. 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 program component, which includes the Retrofit, New Construction and Building Optimization services, as well as for Business Energy Rebates comprised of two services, namely Mail-in and Instant Rebates.

In Table 1, “C” represents a complete evaluation, and “R” indicates that reduced evaluation activities were performed compared to 2017.

Table 1: Types of Evaluations Conducted for Each Program Component

Program	Program Component	2017			2018		
		Process	Market	Impact	Process	Market	Impact
Residential							
Residential Efficient Product Rebates Program	Appliance Retirement			R		C	C
	Instant Savings		R	R		C	C
Existing Residential Program ^a	Home Energy Assessment		C	C			R
	Green Heat	C	C	C		C	C
	Efficient Product Installation		C	C		C	R
New Residential Program	New Home Construction		C	C	C		C
BNI							
Efficient Product Rebates Program	Business Energy Rebates		C	R	C	C	C
Custom Incentives Program	Custom	C ^b	C	R	C ^c	C	C
	Energy Management Information Systems		C	C		C	C
	Strategic Energy Management ^d					C	C
Direct Installation Program	Small Business Energy Solutions		C	C		R	R
^a The Existing Residential Program also includes the First Nations program component, but no participants had yet completed the participation process or generated electrical savings as of December 31, 2018, so this component was not evaluated in 2018. ^b The process evaluation specifically targeted the Retrofit service of Custom in 2017. ^c The process evaluation specifically targeted the New Construction service of Custom in 2018. ^d Due to the start date of the latest Strategic Energy Management cohort, Strategic Energy Management did not have any participants who achieved savings in 2017; therefore, no evaluation was conducted for that year.							

The types of conducted evaluations were chosen based on an analysis of 2018 evaluation objectives, key results of the previous evaluations, and recent changes made to each program component. Based on this analysis and as outlined in Table 1, the Evaluator, in collaboration with ENS, decided to partially reduce the scope of market and impact evaluations for three program components, namely Home Energy Assessment, Efficient Product Installation, and Small Business Energy Solutions. The rationale for selecting the evaluation type conducted for each component is discussed below.

Process Evaluations

The Evaluator recommended that the New Construction service of Custom, New Home Construction, and Business Energy Rebates would benefit the most from a process evaluation in 2018.

During the last few evaluations, participants and builders expressed moderate levels of satisfaction with New Home Construction and were critical of the incentive levels and participation process. Indeed, New Home Construction has undergone several changes in recent years, including changes in incentive levels. Additionally, the number of completed houses has been decreasing since 2014 despite the number of registrations remaining high. In light of these findings and the changes made to the New Home Construction program component, the Evaluator recommended in the 2017 Evaluation Report that a process evaluation of this component be conducted in 2018.

Business Energy Rebates represents the most savings in the ENS portfolio, with over 46 GWh in savings in 2017. Importantly, this component generates 86 percent of savings from lighting measures that are expected to be partially phased out in future years as LED lighting becomes the standard practice. A process evaluation was therefore recommended for this component to identify the reasons that prevent participants from installing measures other than lighting, and identify participants suggestions to maximize the diversification of measures. In addition to this first key research topic, the Evaluator also identified overlapping measures between the Business Energy Rebates Mail-in and Instant Rebates services as a second key research topic for the 2018 process evaluation.

The New Construction service of Custom was also selected for a process evaluation. Similar to New Home Construction in the residential sector, New Construction has had low participation levels for some years. In response to this issue, ENS modified the participation process and incentive structure in 2017. The 2018 process evaluation aimed to assess the effectiveness of these changes and identify further opportunities for increasing participation.

Market and Impact Evaluations

When choosing the market and impact evaluation activities to be conducted for 2018, Econoler considered the research themes that required deeper analysis and those that were fully addressed by previous evaluations. This section explains why certain program components have a reduced market and/or impact evaluation scope.

Results of the market evaluation for Home Energy Assessment have been similar from year to year and few changes were made to program component design since the 2017 evaluation. Hence, conducting a market evaluation would have been of little value. Therefore, the Evaluator elected not to conduct a participant survey for Home Energy Assessment in 2018, which constituted the main data-collection activity for the market evaluation in 2017. The NTGR, a key impact parameter, was not reassessed in 2018 and the Evaluator instead used the same NTGR value as in 2017. For this reason, the impact evaluation scope for Home Energy Assessment was indicated as “reduced” in Table 1 although more effort was allocated to another element of the impact evaluation, namely simulation reviews.

Small Business Energy Solutions is in a similar situation as Home Energy Assessment. The 2017 market evaluation revealed high satisfaction with the program component, and the free-ridership level was low and steady. While some changes were made to the participation process in 2018, the effects of these will not be observable until 2019. For those reasons, the Evaluator elected not to conduct a participant survey in 2018 and instead used the same NTGR value as in 2017. Since the NTGR was not reassessed in 2018, the impact evaluation scope for Small Business Energy Solutions was indicated as “reduced” in Table 1.

The impact evaluation scope for Efficient Products Installation was considered reduced because on-site visits were not conducted in 2018. Since the installation rate was not reassessed in 2018 and the Evaluator used the same installation rate values as in 2017, the impact evaluation scope for Efficient Products Installation was indicated as “reduced” in Table 1. This is justified because the products offered in 2018 were very similar to previous years, while the delivery method and delivery agents (DAs) remained the same as in 2017. In addition, the results of site visits were consistent over the past few years since the program has reached high maturity.

The other program components each underwent a complete market and impact evaluation.

2 EVALUATION METHODOLOGY

This section presents the methodology used and the activities carried out to evaluate ENS DSM program components and services.

The Evaluator first reviewed all relevant documentation, particularly focusing on the modifications that ENS made to implement the recommendations from previous evaluations. Subsequently, a series of data-collection activities were undertaken to complete the process, market and impact evaluations where applicable. These activities are described below.

For evaluation activities that yield quantitative results based on a sample, the Evaluator aimed to achieve a maximum margin of error of 10 percent at a confidence level of 90 percent. Margins of error are presented and discussed in individual program reports where applicable. As part of this evaluation, the Evaluator calculated the margins of error for survey samples, installation rates, savings adjustment ratios, measured energy consumption values, and free-ridership levels. Examples of calculations used to establish margins of error are presented in Appendix II. In a few cases, results with a margin of error greater than 10 percent were used by the Evaluator; the reasons for these choices are explained in each report where such a situation occurred.

2.1 Interviews

The 2018 evaluation methodology included interviews with ENS program managers, partners, participants, and industry associations. Between August 2018 and January 2019, the Evaluator conducted 92 interviews with various stakeholders. Summaries of completed interviews for each program component are presented in Table 2 below. Interviews conducted during on-site visits are not included in this table and instead included only in the on-site visit count.

Table 2: 2018 Interviews Completed

Program Component or Service	2018 Interviews Completed					
	Program Manager	Distributors/ Contractors	Participants	Retailers	Energy Advisors/ Service Providers	Associations
Appliance Retirement	1	-	-	-	-	-
Instant Savings	1	-	-	9	-	-
Home Energy Assessment	1	-	-	-	-	-
Green Heat	1	6	-	-	-	-
Efficient Product Installation	1	-	-	-	-	-
New Home Construction	1	-	-	-	-	-
Business Energy Rebates	1	26	-	-	-	-
Custom	1	-	-	-	8	-
Energy Management Information Systems	1	-	1	-	-	-
Small Business Energy Solutions	1	-	-	-	-	-
Codes and Standards	1	-	-	-	-	32
Total	10	32	1	9	8	32

2.2 Surveys

Using contact information provided by ENS, CRA conducted phone surveys with participants, as well as an intercept survey with purchasers of light-emitting diode (LED) lamps and fixtures at retail stores.

Phone Surveys

Between September and December 2018, CRA conducted phone surveys with participants of four program components. The contents of the surveys varied from one program component to another. The surveys were used to collect information on the following major aspects:

- › Participation motivations
- › Barriers to the installation of products, measures, or upgrades
- › Satisfaction with the program component and ENS
- › Recommendations for improvement
- › Potential for additional energy efficient products
- › Free-ridership (including the cross-influence from ENS promotion and other programs)
- › Participant spillover
- › Demographics and firmographics

Intercept Survey

As part of the Instant Savings evaluation, an in-store intercept survey was conducted with participants who purchased eligible LED lamps and fixtures. The in-store interviews were conducted throughout the 2018 fall campaign at five participating retail chains.

The intercept participant survey generated feedback on the following aspects of Instant Savings:

- › LED lamp and LED fixture purchases and expected uses
- › Awareness about Instant Savings
- › Awareness about ENS
- › Free-ridership on LED A-type lamps
- › Awareness about rebated products
- › Consumer in-store LED fixture shopping experience and influence of Instant Savings
- › Demographics

Table 3 presents a summary of the surveys completed for each program component as well as the number of respondents in each survey.

Table 3: 2018 Participant Surveys

Program Component	2018 Surveys Completed	
	Participant Survey Respondents	Intercept Survey Respondents
Appliance Retirement	200	-
Instant Savings	-	194
Green Heat	90	-
Efficient Product Installation	100	-
Business Energy Rebates	120*	-
Total	510	194
* 70 Mail-in participants and 50 Instant Rebates participants.		

2.3 On-site Visits

For the 2018 evaluation, the Evaluator visited a total of 211 participant sites in the summer and fall of 2018. For all BNI program components, the objective of the on-site visits was to collect data to establish or validate some of the parameters used in the savings calculations, namely installation rates, interactive effects, participant spillover, and the technical characteristics of implemented measures. The Evaluator then used the results of the site visits to perform project file reviews (see Subsection 2.4) and adjust savings accordingly if needed. For Home Energy Assessment and New Home Construction, the Evaluator conducted on-site visits and reviewed the simulation files of selected projects to determine the completeness and accuracy of the information in the files by comparing it with the information collected during the on-site visits. This review was qualitative and aimed at gaining insights on energy assessment documentation and processes, not at calculating any adjustments to savings. For Green Heat, the on-site visits were used to validate the proper functioning of equipment and the accuracy of tracked information on each home's heating system. For Appliance Retirement, the Evaluator also conducted one visit to the recycling facility where retired appliances are dismantled and recycled to ensure that the metering process was conducted properly once appliances reached the recycling facility.

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

Table 4: 2018 On-site Visits

Program Component	On-site Visits Completed in 2018
Appliance Retirement	1
Home Energy Assessment	10
Green Heat	25
New Home Construction	10
Business Energy Rebates	78
Custom	32
Energy Management Information Systems	1
Strategic Energy Management	4
Small Business Energy Solutions	50
Total	211

2.4 Project File Reviews

For those program components whose savings were established based on custom calculations for each measure installed, the Evaluator reviewed the savings calculations of a sample of projects. These calculations consist of either engineering calculations based on the specifications of the baseline and efficient measures, or the outcomes of a measurement and verification procedure based on metered data. To ensure the accuracy of the calculations used, this activity included a review of project documentation (specification sheets, modelling reports, the ENS CIRx Screening Tool, etc.), generally accompanied by an on-site visit to better understand the context in which measures were operating. Where appropriate, the Evaluator made modifications to the equations or parameter values used.

The resulting adjustments were sometimes extrapolated to all program component tracked savings or the savings of non-sampled projects of the same category (e.g. lighting projects). This methodology was applied to Custom, Small Business Energy Solutions, and the Mail-in Rebates service of Business Energy Rebates.

2.5 Unitary Savings Review

For those program components whose savings were established on a unitary basis, the Evaluator reviewed the savings presented in the tracking sheet. First, consistency with the savings results of the previous evaluation was validated. The Evaluator then updated those savings, if necessary. In some cases, the Evaluator relied on calculations presented in the technical reference manuals of other jurisdictions, while, in other cases, product specifications were used to obtain customized savings based on engineering calculations. For program components that offered a large variety of products, the most popular products were sampled to establish the average characteristics of each product category (e.g. lamp wattage, etc.). The unitary savings for Efficient Product Installation, as well as some of the measure categories under Appliance Retirement, Green Heat and Instant Savings, were reviewed using this methodology. For Business Energy Rebates Instant Rebates and some measures in Instant Savings, the unitary savings from the 2017 evaluation, which had been determined using this methodology, were applied again in 2018.

2.6 Billing Analysis

Billing analyses were used for two purposes in 2018. For Green Heat, a billing analysis was conducted again with participants who had a centrally ducted air-source heat pump installed in previous years to establish the average energy savings achieved and improve the accuracy of the billing analysis performed as part of the 2017 evaluation. Unfortunately, due to issues with tracked data, this analysis was inconclusive and the results from 2017 were used again to establish evaluated savings.

Another billing analysis was performed with Home Energy Assessment participants to calibrate the energy consumption results in the HOT2000 software. The billing analysis compared those participants' energy consumption as a function of heating and cooling degree days for a one-year period prior to the initial assessment of their home. The results of this billing analysis were used to calibrate energy consumption values in two program components that rely on HOT2000 to calculate savings, namely Home Energy Assessment and New Home Construction.

2.7 Simulation Model Review

Simulation model reviews were performed for four New Construction projects completed in 2018 to thoroughly verify the accuracy of energy models. This activity involved reviewing simulation models against as-built drawings, project documentation, and results of on-site verifications. The resulting adjusted models were then used to obtain evaluated savings.

2.8 Metering Analysis

For Appliance Retirement, the Evaluator ensured that the appliances retired in 2018 were adequately metered by developing a sampling plan and conducting a site visit to the appliance recycling facility to observe the metering process. An analysis of the raw data obtained from the metering activities determined that the temperature in the metering room had varied significantly outside of the acceptable range as per the metering protocol; this prevented the Evaluator from using the 2018 metering results, hence, 2017 metering results were applied to 2018 retired appliances data to obtain evaluated results for 2018.

2.9 Effective Useful Life Review

To establish the persistence of energy savings over time, the Evaluator determined the effective useful life (EUL) values to be used in all program components. For most program components, the Evaluator simply applied the EUL values established as part of the 2017 evaluation to the 2018 evaluated energy savings to obtain evaluated lifetime energy savings.

For program components where an equivalent EUL had been calculated to account for the impact of upcoming energy efficiency regulations on the baseline efficiency of lighting products, the Evaluator recalculated the equivalent EUL values since regulation enforcement dates are approaching. The equivalent EUL values were recalculated for Efficient Product Installation, Instant Savings, Business Energy Rebates, and Small Business Energy Solutions.

For Strategic Energy Management, an equivalent EUL value was established for the first time based on a literature review and an analysis of projects. This value was not evaluated in 2017 since the program component did not have any participants.

2.10 Avoided GHG Emissions Quantification

The impacts of ENS activities on avoided GHG emissions were estimated for all program components by using a Nova Scotia-specific factor for GHG emissions generated by electricity production.³ Since data for 2018 was not available at the time of writing, the Evaluator relied on 2017 data from NSP. The factor was obtained by dividing NSP total system emissions in 2017, which were 6,725,126 CO₂ eq tonnes, by NSP total electricity generation of 10,978 GWh. This yielded a factor of 0.6126 kg of avoided CO₂ eq per net annual kWh saved at the generator. For New Construction, adjustments were made to the calculations to account for increased or reduced fossil fuel consumption since some projects included fuel-switching measures (where electricity savings occur by using a fuel other than electricity).

³ The quantification of avoided GHG emissions only considers avoided electricity generation. Additional fuel consumed as a result of fuel-switching measures, such as those found in New Construction (of the Custom Incentives program), are not considered in this methodology.

3 IMPACT EVALUATION RESULTS

This section presents an analysis of the impact evaluation results for all program components by comparing the 2018 tracked energy and peak demand savings with those evaluated. The evaluated net-to-gross ratios, lifetime energy savings, and GHG emission reductions are also presented in the subsections below.

3.1 Individual Impact Evaluation Results

Table 5 and Table 6 below summarize the evaluated energy and peak demand savings as well as the corresponding savings tracked by ENS for each program component offered in 2018. For evaluated energy and peak demand savings, initial gross savings correspond to savings before the Evaluator applied installation rates, in-service rates, interactive effects factors, or savings adjustment ratios where applicable. The adjusted gross savings correspond to savings once these parameters were applied. The net savings were calculated by multiplying adjusted gross savings by the NTGR. Lifetime energy savings are equal to the savings generated by the efficient measure over its EUL.

Table 5: 2018 Evaluated Results and Tracked Energy Savings at the Generator

DSM Program	DSM Program Component	2018 Energy Savings (GWh)						
		Evaluated					ENS	
		Annual Initial Gross Savings	Annual Adjusted Gross Savings	NTGR	Annual Net Savings	Lifetime Net Energy Savings	Annual Tracked Gross Savings	Annual Tracked Net Savings
Residential Efficient Product Rebates	Appliance Retirement	4.568	4.568	0.58	2.657	19.822	4.736	2.763
	Instant Savings	24.262	24.262	0.90	21.930	189.336	23.653	19.967
Existing Residential	Home Energy Assessment	8.599	6.366	0.90	5.724	114.488	8.607	6.429
	Green Heat	8.826	9.078	0.47	4.227	76.292	8.826	5.294
	Efficient Product Installation	15.914	13.997	0.91	12.777	107.988	16.093	13.480
New Residential	New Home Construction	5.901	4.806	0.94	4.515	135.671	5.901	4.451
Residential Subtotal		68.071	63.077	0.82	51.831	643.597	67.817	52.385
Efficient Product Rebates	Business Energy Rebates	101.271	100.648	0.75	75.298	852.117	101.271	77.208
Custom Incentives	Custom	16.416	14.315	0.81	11.603	156.077	16.416	14.944
	Energy Management Information Systems	1.637	1.616	1.00	1.616	3.655	1.681	1.637
	Strategic Energy Management	1.681	1.548	0.94	1.455	4.365	1.681	1.681
Direct Installation	Small Business Energy Solutions	11.852	10.937	0.88	9.589	118.794	11.852	9.673
BNI Subtotal		132.857	129.065	0.77	99.562	1,135.008	132.901	105.143
Portfolio Total		200.928	192.141	0.79	151.393	1,778.605	200.719	157.528
Codes & Standards		23.809	23.809	-	23.809	23.809	-	-
Total (Portfolio and C&S)		224.736	215.950	0.81	175.201	1,802.414	200.719	157.528

Table 6: 2018 Evaluated Results and Tracked Peak Demand Savings at the Generator

DSM Program	DSM Program Component	2018 Peak Demand Savings (MW)				
		Evaluated				ENS
		Annual Initial Gross Savings	Annual Adjusted Gross Savings	NTGR	Annual Net Savings	Annual Tracked Net Savings
Residential Efficient Product Rebates	Appliance Retirement	0.640	0.640	0.59	0.378	0.394
	Instant Savings	2.901	2.901	0.89	2.572	2.290
Existing Residential	Home Energy Assessment	2.433	1.800	0.89	1.600	1.819
	Green Heat	8.361	8.647	0.47	4.042	4.954
	Efficient Product Installation	1.676	1.614	0.91	1.463	1.536
New Residential	New Home Construction	1.670	1.360	0.94	1.278	1.260
Residential Subtotal		17.681	16.964	0.67	11.333	12.253
Efficient Product Rebates	Business Energy Rebates	17.751	14.846	0.76	11.327	13.762
Custom Incentives	Custom	1.814	1.695	0.71	1.200	1.636
	Energy Management Information Systems	0.024	0.051	1.00	0.051	0.024
	Strategic Energy Management	0.000	0.199	0.95	0.190	0.000
Direct Installation	Small Business Energy Solutions	2.499	1.635	0.88	1.441	2.039
BNI Subtotal		22.089	18.425	0.77	14.209	17.461
Portfolio Total		39.770	35.389	0.72	25.542	29.714
Codes & Standards		4.008	4.008	-	4.008	-
Total (Portfolio and C&S)		43.778	39.397	0.75	29.550	29.714

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

3.1.1 Residential DSM Programs

Residential Efficient Product Rebates

In 2018, Residential Efficient Product Rebates achieved net electrical energy and peak demand savings at the generator of 24.588 GWh and 2.951 MW, respectively. The two components under this program are Appliance Retirement and Instant Savings. Their savings results are described below.

Appliance Retirement

A total of 5,595 appliances were retired or replaced through ARet in 2018, generating 2.657 GWh in net electrical energy savings and 0.378 MW in net peak demand savings. The total number of appliances retired in 2018 was slightly lower than in 2017 due to a decrease in the number of retired freezers. Consequently, savings also decreased compared to 2017.

Both the evaluated gross energy and peak demand savings were 4 percent lower than those tracked by ENS. This difference was mainly due to the lower gross unitary savings value established for refrigerators, which was caused by a different distribution of retired refrigerator ages based on the 2018 tracking sheet data and a lower part-use factor established through the 2018 participant survey compared to 2017 values.

The evaluated net energy and peak demand savings were 4 percent lower than those tracked by ENS for the same reasons as gross evaluated savings. Also, the lower NTGR obtained for freezers resulted in lower evaluated net unitary savings.

Instant Savings

In 2018, 669,550 products were sold through Instant Savings which represents fewer sales than in 2017. Although the overall savings achieved by Instant Savings in 2018 were higher than in 2017, due to higher average savings per product. LED A-type lamps remained the most popular product with 66 percent of all products sold, although fewer quantities were sold through Instant Savings in 2018 than in 2017. In 2018, Instant Savings generated 21.930 GWh in net electrical energy savings and 2.572 MW in net peak demand savings at the generator.

Both the evaluated gross energy and peak demand savings were 3 percent higher than the tracked gross savings. This slight difference was mainly due to the increase in gross unitary savings associated with LED A-type lamps and LED R, BR and decorative lamps that the Evaluator adjusted by 12 and 7 percent, respectively. This increase in the unitary savings values of LED A-type lamps resulted mostly from the increase in displaced wattage.

The evaluated net energy savings were 10 percent higher than the tracked value and the evaluated net peak demand savings were 12 percent higher than the tracked value. This difference was due to the increase in the NTGR resulting from a higher spillover level established for 2018.

Existing Residential

In 2018, the net energy savings of Existing Residential reached 22.728 GWh while the net peak demand savings amounted to 7.105 MW at the generator. Existing Residential is comprised of Home Energy Assessment, Green Heat, and Efficient Product Installation. The results of these three program components are discussed below.

Home Energy Assessment

The Evaluator determined that Home Energy Assessment achieved 5.724 GWh in net electrical energy savings and 1.600 MW in net peak demand savings at the generator with 791 participants in 2018.

Both the evaluated energy and peak demand savings were 13 percent lower than those tracked by ENS. This difference was mainly explained by the updated overestimation ratios used to adjust the modelled space heating consumption values generated by the HOT2000 software.

The evaluated net energy savings were 11 percent lower than those tracked by ENS and the evaluated net peak demand savings were 12 percent lower than those tracked by ENS. The evaluated net savings were also lower than those tracked by ENS due to both the aforementioned reasons and an adjustment in the number of unconverted D assessment participants.

Green Heat

The 2018 Green Heat participation level was much higher than in previous years with 3,055 measures installed. MSHPs were still the most popular measure, accounting for 92 percent of measures installed. The Evaluator found that the program component achieved 4.227 GWh in net electrical energy savings and 4.042 MW in net peak demand savings in 2018.

The evaluated gross energy savings were 3 percent above the tracked gross energy savings. This was mainly due to the adjustments made by the Evaluator for the unitary savings of MSHPs installed in fully electrically heated households, which accounted for 73 percent of total savings. The evaluated gross peak demand savings were slightly adjusted upward by 3 percent because of minor adjustments made to the tracked values of heat pump measures since some participants had nil tracked values.

The evaluated net energy savings were 22 percent below the tracked value. This difference was due to the significant decrease in the NTGR compared to the tracked value. ENS used the 2017 average NTGR to track net savings in 2018, which was based on a majority of participants that took part in a previous version of Green Heat that required pre-approval, and this participation process resulted in lower free-ridership. The evaluated net peak demand savings were 18 percent below the tracked value, also because of the decrease in the NTGR.

Efficient Product Installation

In 2018, Efficient Product Installation achieved 12.777 GWh in net electrical savings and 1.463 MW in net peak demand savings. In total, 10,813 households participated in Efficient Product Installation in 2018, through which a total of 274,115 efficient products were installed. The decline in participation levels over the years was mainly due to the decreasing pool of potential participants. In efforts to stimulate the participation level, ENS issued a free clothesline to all participants who signed up for Efficient Product Installation between July and November 2018, with 3,246 clotheslines being distributed. ENS also offered LED holiday lights in exchange for incandescent holiday lights during February and from October to December 2018. In 2018, ENS also diversified its product offering to include additional non-A-type lamps and non-lighting products such as thermostatic shower valves.

The evaluated gross energy savings were 3 percent lower than the tracked value. The small decreases in both the overall installation rate (from 0.90 to 0.88), as well as the unitary savings adjustments, contributed to the slight difference between tracked and evaluated gross energy savings. The evaluated gross peak demand savings were 2 percent lower than the tracked value. This difference was mainly due to adjustments to the unitary savings values for low-flow showerheads, faucet aerators, and thermostatic shower valves.

Both the evaluated net energy and peak demand savings were 5 percent lower than the tracked net savings for the same reasons as gross energy savings, as well as because of a small decrease in the overall NTGR value.

New Residential

New Residential, comprised of New Home Construction and the Passive House pilot, achieved net energy savings of 4.515 GWh and net peak demand savings of 1.278 MW at the generator in 2018.

New Home Construction

A total of 652 participants completed projects and generated electrical savings under New Home Construction in 2018, including seven participants who completed a project through the Passive House pilot. Combined, New Home Construction and the Passive House pilot achieved 4.515 GWh in net energy savings and 1.278 MW in net peak demand savings at the generator.

Both evaluated gross energy and peak demand savings were 3 percent lower than the tracked values. This difference was mainly explained by the updated overestimation ratios used to adjust the modelled space heating consumption values generated by the HOT2000 software for New Home Construction.

The evaluated net energy and peak demand savings were higher than those tracked by ENS due to the increase in the NTGR value for New Home Construction regular participants (0.95) compared to the tracked value (0.90). For Passive House participants, the NTGR used by ENS for tracking was also 0.90 and was revised to 0.39 in accordance with the NTGR value established specifically for this pilot in the 2017 evaluation.

3.1.2 Business, Non-profit and Institutional DSM Programs

Efficient Product Rebates

Efficient Product Rebates comprises one component, Business Energy Rebates. In 2018, Business Energy Rebates achieved 75.298 MWh in net energy savings and 11.327 MW in net peak demand savings at the generator.

Business Energy Rebates

Business Energy Rebates delivers incentives through two services, namely Mail-in and Instant Rebates. In 2018, a total of 366 Mail-in projects were implemented by 257 unique participants. For Instant Rebates, a total of 506,533 rebated products were sold by distributors in 2018, constituting a 60 percent increase over 2017 levels. The program achieved 75.298 GWh in net energy savings at the generator and 11.327 MW in net peak demand savings at the generator.

The evaluated gross energy savings were 1 percent below tracked savings and the evaluated gross peak demand savings were 16 percent below tracked savings. For Mail-in, some minor adjustments were made to gross savings, which affected some of the most popular measure categories, namely lighting, motors, and variable frequency drives. The adjustment made to the Mail-in gross peak demand savings was however more significant, which partially explains the larger downward adjustment for peak demand savings than for energy savings in Business Energy Rebates. As for Instant Rebates, the Evaluator made minor downward adjustments to unitary savings and interactive effects factors, which affected both energy and peak demand savings. Additionally, the evaluated peak coincidence factor for indoor measures was reduced, which resulted in more reduced gross peak demand savings than energy savings.

The evaluated net energy savings were 2 percent lower than the tracked values as a result of both Mail-in and Instant Rebates being adjusted downward (6% and 1% respectively). The evaluated net peak demand savings were 18 percent lower than the tracked values. In addition to the revisions made to gross savings, the slight decrease in NTGR explains the difference between tracked and evaluated net savings.

Custom Incentives

In 2018, Custom Incentives achieved 14.674 GWh in net energy savings and 1.440 MW in net peak demand savings at the generator through its three components, namely Custom, Energy Management Information Systems, and Strategic Energy Management.

Custom

In 2018, the suite of services offered through Custom was broken down as follows: Retrofit; New Construction; and Building Optimization. Overall, 79 projects generated savings, 69 of which were completed. The Evaluator determined that Custom achieved 11.603 GWh in net electrical energy savings and 1.200 MW in net peak demand savings at the generator in 2018. Retrofit accounted for 77 percent of Custom savings in 2018.

The evaluated gross energy savings were 13 percent below the tracked value. This reduction was mostly due to New Construction and Building Optimization whose gross energy savings were reduced by 30 percent and 25 percent respectively. As for Retrofit, which accounted for 78 percent of Custom gross savings, a smaller adjustment was made to savings, resulting in a reduction of approximately 5 percent. The gross peak demand savings were adjusted downward by a larger margin than energy savings, especially for Retrofit, for which peak demand savings were reduced by 22 percent.

The NTGR was also revised downward because free-ridership for Retrofit increased compared to previous years and the evaluated free-ridership for New Construction was also higher than the value tracked by ENS. Overall, the evaluated net energy savings for Custom were 22 percent below the tracked value. The decrease in the NTGR was more severe for peak demand savings than for energy savings because a greater portion of peak demand savings was achieved in New Construction, which had the lowest NTGR of all three services. Overall, the evaluated net peak demand savings for Custom were 31 percent below the tracked value.

Energy Management Information Systems

Two participants generated savings in 2018; one was a continuing participant that began with Energy Management Information Systems in 2015 and the other was a new participant that reported savings through a special Energy Management Information Systems project. The Evaluator determined that Energy Management Information Systems achieved 1.616 GWh in net electrical energy savings and 0.051 MW in net peak demand savings at the generator in 2018.

The evaluated gross energy savings were 1 percent lower than the tracked savings due to the minor changes made by the Evaluator to the energy savings calculation of the new participant. Also, the savings of the new project were incorrectly tracked by ENS, resulting in slightly lower savings. Conversely, the large increase in gross peak demand savings (100%) was attributable to the addition of peak demand savings to the abovementioned new project for which ENS did not have a tracked value.

The evaluated net energy and peak demand savings were adjusted by the same factors as gross savings, since the NTGR is equal to 1 for this program component.

Strategic Energy Management

Four participants generated savings in 2018, all of whom were new participants. The Evaluator determined that Strategic Energy Management achieved 1.455 GWh in net electrical energy savings and 0.190 MW in net peak demand savings at the generator.

The evaluated gross energy savings were 8 percent below the tracked values mainly because the savings attributable to capital projects were not correctly tracked and accounted for by ENS. Moreover, the Evaluator adjusted the savings downward from one capital project that installed lighting through Business Energy Rebates Instant Rebates since the savings for the installed product were revised by the Evaluator. This adjustment could not be tracked by ENS since it occurred after the tracking sheet was submitted. Since no peak demand savings were tracked, the evaluated gross peak demand savings were higher than the tracked value.

Furthermore, the deduction made to the net savings of that same project resulted in net savings being 13 percent below tracked savings. Again, since no peak demand savings were tracked, the evaluated net peak demand savings were higher than the tracked value.

Direct Installation

Direct Installation comprises one program component, Small Business Energy Solutions. In 2018, Small Business Energy Solutions achieved 9.589 GWh in net energy savings and 1.441 MW in net peak demand savings at the generator.

Small Business Energy Solutions

A total of 529 Small Business Energy Solutions projects were completed in 2018, which represented a 30 percent increase over 2017.

The tracked gross energy savings were adjusted downward by 8 percent as a result of discrepancies found during site visits. Overall, the gross peak demand savings were adjusted downward by 35 percent as a result of the evaluation, with the Audit path savings being increased and the DIY path savings being decreased.

The evaluated net energy savings were approximately 1 percent below the corresponding tracked value. The tracked NTGR was significantly below the NTGR value established in 2017, which the Evaluator used again for the 2018 evaluation. This explains why the tracked net energy savings were underestimated. The evaluated net peak demand savings were 29 percent higher than the tracked value. The upward adjustment to the NTGR value explains why the difference between tracked and evaluated values is smaller than for gross peak demand savings.

3.1.3 Codes and Standards

The Evaluator focused on the impacts on the Nova Scotia market of federal and provincial regulations such as the Natural Resources Canada Amendment 13 regarding the introduction of minimum energy performance standards (MEPS) for some products and increased MEPS for others.

The overall energy and peak demand savings for Codes and Standards were established at 23.809 GWh and 4.008 MW respectively at the generator. The savings associated with ENS programs are based on increases in product efficiency compared to the minimum efficiency standard or the current baseline of that product category, whereas C&S savings result from an increase in the regulated minimum efficiency standard. Thus, evaluated savings from C&S do not overlap with those of ENS programs.

3.2 Net-to-gross Ratio

The NTGRs, outlined in Table 5 and Table 6 above, were applied to the gross savings to estimate net savings. NTGRs were established based on the levels of free-ridership and, in some cases, spillover. NTGR estimations were based on a self-reporting approach. Appendix III presents examples of the calculations used to establish the free-ridership, spillover, and NTGR values in the 2018 evaluation.

Free-ridership levels were established for most program components by conducting surveys or in-depth interviews. These surveys or interviews included a set of questions used to establish program component attributions for the free-ridership calculations. Subsequently, a weighted average based on each respondent's savings was used to estimate overall program component free-ridership levels. As was the case in 2016 and 2017, the free-ridership calculation methodology took into account the impact of cross-influence of previous participation in other ENS program components. For a few program components or services, the Evaluator did not establish free-ridership levels. In Building Optimization, Energy Management Information Systems, and Strategic Energy Management, the limited market penetration of these components and the limited knowledge of participants on recommissioning or energy management information systems prior to participation explained why free-ridership was considered to be nil.

The impact evaluation included an assessment of spillover levels for program components wherein spillover was a factor. For all program components, with the exception of Instant Savings and New Home Construction, the spillover levels corresponded to participant spillover. Participant spillover assessments were conducted through telephone surveys or interviews conducted during on-site visits. In all cases, participants were asked if they had implemented additional energy efficiency measures without receiving funding or assistance from ENS. If so, participants were 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 these 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 quantity of additional savings attributable to the component by the total quantity of savings achieved by the component for all survey respondents.

For Instant Savings, the Evaluator measured market effects, which include participant and non-participant spillover for LED lamps. The Evaluator used interviews with retailers to establish the number of LED lamps sold outside of the Instant Savings campaigns and the proportions of those sales that were indirectly attributable to Instant Savings. Similarly, the market effects for New Home Construction were 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.

Based on the established free-ridership and spillover levels, the NTGR was calculated using the following equation:

$$NTGR = (1 - \% \text{ free-ridership} + \% \text{ spillover})$$

Table 7 below summarizes the free-ridership and spillover levels used in the 2018 evaluation as well as the resulting NTGRs for each program component.

Table 7: 2018 Free-ridership, Spillover and NTGRs

Program Component		Free-ridership Levels	Spillover Levels	NTGR
Appliance Retirement ^a	Refrigerators	-	0%	0.57
	Freezers	-		0.48
	Air Conditioners	-		0.53
	Small Refrigerators	-		0.69
	Small Freezers	-		0.69
	HomeWarming Appliances	-	-	1
Instant Savings	LED Lamps	39%	25%	0.86
	All Other Products	-	-	1
Home Energy Assessment ^b	N/A	25%	1%	0.76
Green Heat	MSHPs	54%	-	0.46
	Centrally-ducted Heat Pumps	29%	-	0.71
	Solar and Biomass Measures	58%	-	0.42
	HPWHs	-	-	1

Program Component		Free-ridership Levels	Spillover Levels	NTGR
Efficient Product Installation	LED Lighting Non-low Income Tenants	26%	4%	0.78
	LED Lighting Non-low Income Owners	23%	3%	0.80
	LED Lighting Low-income Participants	-	-	1
	Low-flow Showerheads Non-Low Income Tenants	0%	4%	1.04
	Low-flow Showerheads Non-low Income Owners	9%	3%	0.94
	Low-flow Showerheads Low-income Participants	-	-	1
	Other Products - Non-low Income Tenants	0%	4%	1.04
	Other Products - Non-low Income Owners	0%	3%	1.03
	Other Products - Low-income Participants	-	-	1
New Home Construction ^b	Regular Participants	29%	24%	0.95
	Passive House Pilot Participants	61%	0%	0.39
Business Energy Rebates – Mail-in Rebate	N/A	17%	0%	0.83
Business Energy Rebates – Instant Rebates	LED Linear Fixtures	29%	-	0.71
	LED Downlight Fixtures	34%		0.66
	LED Linear Lamps	37%		0.63
	LED General-use and Decorative Lamps	32%		0.68
	All Other Products	-	-	1
Custom	Custom Retrofit	14%	0%	0.86
	New Construction	36%	-	0.64
	Building Optimization	-	-	1
Energy Management Information Systems	N/A	-	-	1
Strategic Energy Management	N/A	-	-	1
Small Business Energy Solutions ^b	Audit Path	7%	0%	0.93
	DIY Path	13%		0.87
^a For Appliance Retirement, the Evaluator complied with Uniform Methods Project guidelines and no free-ridership level was calculated.				
^b Net-to-gross ratios were determined based on the results of past evaluations.				

Free-ridership levels for LED products, which are offered across several program components and represent most of 2018 energy savings, remained high in 2018. This result is discussed in Section 5 below, entitled Market Evolution.

3.3 Lifetime Energy Savings

The Evaluator reviewed the effective useful life values for measures offered by ENS and their associated lifetime energy savings. The Evaluator found that the DSM portfolio generated 1,778.605 GWh in lifetime energy savings. As presented in Table 8 below, the weighted average EUL of measures offered in the ENS portfolio is 11.7 years. Program components with measures affecting building envelopes, such as insulation, generate significant lifetime savings due the persistence of these types of measures. For example, New Home Construction has an average EUL of 30.0 years, and while this program component accounts for 3 percent of annual net energy savings, it generates 8 percent of portfolio lifetime energy savings. Similarly, Home Energy Assessment has an average EUL of 20.0 years, and while it contributes to 4 percent of annual energy savings, it generates 6 percent of lifetime energy savings. Programs composed of mainly lighting measures, such as Instant Savings and Efficient Product Installation, generate lower lifetime energy savings compared to annual savings due to the shorter equivalent EUL of these types of products.

Table 8: 2018 Evaluated Net Lifetime Energy Savings at the Generator

DSM Program	Program Component	Annual Net Energy Savings (GWh)	Lifetime Net Energy Savings (GWh)	Weighted Average EUL (years)
Residential				
Residential Efficient Products Rebates	Appliance Retirement	2.657	19.822	7.5
	Instant Savings	21.930	189.336	8.6
Existing Residential	Home Energy Assessment	5.724	114.488	20.0
	Green Heat	4.227	76.292	18.1
	Efficient Product Installation	12.777	107.988	8.5
New Residential	New Home Construction	4.515	135.671	30.0
Residential Subtotal		51.831	643.597	12.4
BNI				
Efficient Products Rebates	Business Energy Rebates	75.298	852.117	11.3
Custom Incentives	Custom	11.603	156.077	13.5
	Energy Management Information Systems	1.616	3.655	2.3
	Strategic Energy Management	1.455	4.365	3.0
Direct Installation	Small Business Energy Solutions	9.589	118.794	12.4
BNI Subtotal		99.562	1,135.008	11.4
Portfolio Total		151.393	1,778.605	11.7

3.4 Greenhouse Gas Emission Reductions

The Evaluator established the reduced GHG emissions due to the DSM portfolio at 92,659 tonnes of CO₂ eq in terms of annual avoided GHG emissions. Table 9 presents the GHG emission reductions of each program component in 2018.

Table 9: 2018 Evaluated Avoided GHG Emissions

DSM Program	Program Component	Avoided GHG Emissions (CO ₂ eq Tonnes)
Residential		
Residential Efficient Products Rebates	Appliance Retirement	1,628
	Instant Savings	13,434
Existing Residential	Home Energy Assessment	3,507
	Green Heat	2,589
	Efficient Product Installation	7,827
New Residential	New Home Construction	2,766
Residential Subtotal		31,752
BNI		
Efficient Products Rebates	Business Energy Rebates	46,128
Custom Incentives	Custom	7,024
	Energy Management Information Systems	891
	Strategic Energy Management	891
Direct Installation	Small Business Energy Solutions	5,874
BNI Subtotal		60,907
Portfolio Total		92,659
Codes & Standards		14,585
Total (Portfolio and C&S)		107,244

4 DSM PORTFOLIO PERFORMANCE

This section presents an analysis of how evaluated savings compare to ENS planned savings at both the portfolio and program component levels. Satisfaction results, annual savings performance, savings performance for the 2016-2018 DSM Plan, as well as historical performance and contribution of individual program components to portfolio savings are also outlined in this section.

4.1 Participant and Partner Satisfaction

Once again in 2018, the evaluation revealed very high participant satisfaction with ENS and its programs. Most participants were pleased with their interactions with program partners, specifically in terms of professionalism and quality of work. As for partners, most were satisfied with their interactions with ENS and value program involvement. Table 10 below presents satisfaction scores obtained in the 2018 evaluation for program components where this metric was measured.

Table 10: 2018 Satisfaction Results

DSM Program	Program Component	Participant Satisfaction	Partner Satisfaction
Residential			
Residential Efficient Products Rebates	Appliance Retirement	9.6	-
	Instant Savings	-	8.6
Existing Residential	Green Heat	9.0	-
	Efficient Product Installation	9.3	-
BNI			
Efficient Products Rebates	Business Energy Rebates - Mail-in	9.1	-
	Business Energy Rebates - Instant Rebates	-	7.7
Custom Incentives	Custom - Retrofit	8.7	-
	Custom - New Construction	8.8	-
	Custom - Building Optimization	9.3	-
	Energy Management Information Systems	8.0	-
	Strategic Energy Management	8.1	-

The average satisfaction ratings provided by participants for all program components were above 8.0 on a 10-point scale. This rating increased in 2018 for all program components, except for Strategic Energy Management and Energy Management Information Systems (although the number of participants in those components was very low, which might explain the variations since the previous evaluation).

Partner satisfaction with both Instant Savings and Business Energy Rebates Instant Rebates increased in 2018. Satisfaction with Instant Savings, after decreasing in 2017 due to the addition of a product price floor that caused frustration among certain retailers, is back to previous levels with retailers citing appreciation for marketing and advertising and their overall relationship with the DA. As for Business Energy Rebates Instant Rebates, distributors who were less satisfied mentioned the time and work required to administer the rebates and keep track of which exact measures are eligible for rebates as the main reasons for dissatisfaction. These opinions on Business Energy Rebates Instant Rebates are consistent with what was expressed in previous evaluations.

The Evaluator also conducted process evaluations for one program component and one service, Business Energy Rebates and Custom New Construction respectively, which included in-depth interviews with program partners. One-third of interviewed Business Energy Rebates Mail-in contractors experienced challenges, their feedback indicating that the process was too time-consuming and they had difficulties explaining the service to customers. As for Custom New Construction, service providers were generally satisfied with the overall service. Most, however, noted some level of dissatisfaction with the participation process, mostly relating to understanding service requirements at the various project stages.

4.2 Annual Savings Performance

Table 11 presents the ENS planned savings,⁴ evaluated results, and the variances resulting from the 2018 evaluation.

Table 11: 2018 Planned Savings and Evaluated Results

DSM Program	Program Component	Mid-course Planned Savings		Evaluated Results*		Variance	
		GWh	MW	GWh	MW	GWh (%)	MW (%)
Residential							
Residential Efficient Products Rebates	Appliance Retirement	3.1	0.4	2.657	0.378	-13%	-5%
	Instant Savings	16.2	2.1	21.930	2.572	35%	22%
Existing Residential	Home Energy Assessment	7.5	2.1	5.724	1.600	-23%	-24%
	Green Heat	3.6	3.8	4.227	4.042	16%	6%
	Efficient Product Installation	17.1	2.0	12.777	1.463	-25%	-27%
	First Nations Pilot	0.4	0.1	0.000	0.000	-100%	100%
New Residential	New Home Construction	4.6	1.3	4.515	1.278	-1%	-2%
Residential Subtotal		52.4	11.8	51.831	11.333	-1%	-4%
BNI							
Efficient Products Rebates	Business Energy Rebates	50.6	7.9	75.298	11.327	49%	43%
Custom Incentives	Custom	24.2	4.2	11.603	1.200	-52%	-71%
	Energy Management Information Systems	0.9	0.2	1.616	0.051	77%	-75%
	Strategic Energy Management	0.7	0.1	1.455	0.190	108%	90%
Direct Installation	Small Business Energy Solutions	9.6	1.7	9.589	1.441	0%	-15%
BNI Subtotal		86.0	14.1	99.562	14.209	16%	1%
Portfolio Total		138.3	25.9	151.393	25.542	9%	-1%
* Numbers may not add up due to rounding.							

The ENS portfolio of DSM program components achieved 151.393 GWh in total net energy savings at the generator, 9 percent higher than the planned energy savings for 2018. The total portfolio net peak demand savings of 25.542 MW fell short of the planned demand savings by 1 percent.

⁴ Mid-course planned savings adjusted by ENS.

Residential programs achieved 51.831 GWh in net energy savings and 11.333 MW in net peak demand savings at the generator. Energy savings were 1 percent lower than planned due to lower than expected savings in all program components other than Instant Savings and Green Heat. While Instant Savings rebated fewer products than in 2017, it achieved higher overall savings due to increased savings per product. Instant Savings generated the largest share (42%) of residential portfolio savings, compensating for shortfalls in other program components. The 2018 Green Heat participation level was much higher than in previous years, which contributed to achieving and surpassing planned energy savings. Efficient Product Installation fell short of the energy savings target by 25 percent. Its participation levels continue to decline, mainly due to the decreasing pool of potential participants in the province and fewer opportunities for incandescent lamp replacements. The First Nations Home Energy Efficiency Pilot did not have any participants who achieved savings in 2018; therefore, no savings were achieved. New Home Construction did not achieve planned energy savings because of lower than anticipated savings for participants with heat pumps. In 2018, the Evaluator updated the overestimation ratio (used to adjust the modelled space heating consumption values generated by the HOT2000 software) which resulted in lower savings for participants with heat pumps.. Appliance Retirement and Home Energy Assessment both experienced lower than expected participation levels and savings per participant, and both missed planned energy savings by 6 and 24 percent respectively.

Residential peak demand savings were 4 percent lower than planned in 2018. Similar to energy savings, Instant Savings and Green Heat outperformed established targets for 2018, thereby compensating for underperformance in other residential programs. Green Heat generated the largest share (36%) of residential net peak demand savings.

The ENS BNI programs achieved 99.562 GWh net energy savings at the generator, thus exceeding planned energy savings by 16 percent. All program components achieved energy savings goals, with the exception of Custom that fell short of target by 52 percent due to lower than expected participation and decreased savings per participant compared to recent years.

Business Energy Rebates achieved the highest savings level in its history, notably by rebating 60 percent more products than in 2017. Small Business Energy Solutions continued its trend of increased year-to-year participation, thus enabling it to meet planned energy savings, although it fell 15 percent short of planned peak demand savings. Energy Management Information Systems and Strategic Energy Management both outperformed planned energy savings due to planned savings being lower than in past years. BNI programs met mid-course planned peak demand savings values, achieving a combined 14.209 MW in net peak demand savings at the generator.

4.3 Savings Performance for the 2016-2018 DSM Plan

The ENS portfolio of DSM program components met the three-year net energy and peak demand targets established in the 2016-2018 DSM plan by achieving 419.005 GWh in net energy savings and 75.190 MW net peak demand savings at the generator. Table 12 outlines the 2016-2018 DSM Plan targets and the evaluation results for this period.

Table 12: 2016-2018 DSM Net Savings Targets and Evaluated Results

DSM Program	As Approved Target Savings		Evaluated Results*		Variance	
	GWh	MW	GWh	MW	GWh (%)	MW (%)
Residential						
Residential Efficient Products Rebates	37.6	3.3	84.540	13.085	125%	295%
Existing Residential	125.7	22.9	78.454	21.246	-38%	-7%
New Residential	11.7	3.3	11.794	3.338	1%	0%
Residential Subtotal	175.0	29.5	174.788	37.668	0%	28%
BNI						
Efficient Products Rebates	98.3	15.8	159.678	25.707	62%	63%
Custom Incentives	102.5	13.0	62.939	7.941	-39%	-39%
Direct Installation	30.1	4.1	21.599	3.874	-28%	-6%
BNI Subtotal	230.9	32.9	244.217	37.522	6%	14%
Portfolio Total	405.9	62.5	419.005	75.190	3%	20%

Residential programs achieved 174.788 GWh in net energy savings at the generator during the 2016-2018 period. Residential energy savings met targets driven by higher than expected savings from Residential Efficient Products Rebates, which outperformed the energy savings target by 125 percent. This program generated nearly half of the total residential portfolio energy savings. Existing Residential missed energy savings targets by 38 percent while New Residential exceeded energy savings targets by 1 percent.

Residential programs achieved 37.668 MW in net peak demand savings at the generator during the 2016-2018 period. Programs exceeded peak demand savings targets except for Existing Residential. Nonetheless, Existing Residential represented over half of the total peak demand savings achieved by the residential portfolio, caused mainly by the popularity of MSHPs over this period and the changes introduced in 2017 to remove participation barriers in Green Heat.

BNI programs achieved 244.217 GWh in net energy savings at the generator during the 2016-2018 period. BNI energy savings exceeded targets by 6 percent. Although Custom Incentives and Direct Installation did not achieve energy savings targets, higher than expected energy savings from Efficient Product Rebates mitigated these shortfalls. Efficient Product Rebates exceeded energy savings targets by 62 percent and achieved approximately two-thirds of total BNI portfolio net energy savings.

BNI programs achieved 37.522 MW in net peak demand savings at the generator during the 2016-2018 period and exceeded targets by 14 percent. Similar to net energy savings, the outperformance of Efficient Product Rebates, which surpassed targets by 63 percent, mitigated the shortfalls in Custom Incentives and Direct Installation.

The positive results over the 2016-2018 period are largely due to the success of Residential Efficient Product Rebates and Efficient Product Rebates, which each exceeded both energy and peak savings targets by at least 62 percent. Both programs' upstream components, namely Instant Savings and Business Energy Rebates Instant Rebates surpassed expectations due to the growing popularity of LED products and the widespread reach offered by their delivery channels. Despite high free-ridership levels for LED products, the quantity of rebated products allowed ENS to not only outperform targets for this program component and service respectively, but also meet overall portfolio targets.

4.4 Historical Portfolio Analysis

This section presents year-over-year program performance and the contribution of individual program components to portfolio savings, as presented in Table 13 and Table 14 provide a historical overview of component performance and changes in DSM portfolio composition from 2014 to 2018.

Table 13: Evaluated Net Energy Savings at the Generator, 2014-2018

DSM Program	DSM Program Component	Energy (GWh)					Energy (% of Total Portfolio)				
		2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
Residential											
Residential Efficient Product Rebates	Appliance Retirement	3.941	3.002	2.722	3.094	2.657	3%	2%	2%	2%	2%
	Instant Savings	9.360	10.121	34.593	19.543	21.930	6%	7%	25%	15%	14%
Existing Residential	LED Holiday Light Exchange	0.192	0.115	--	--	--	0%	0%	--	--	--
	Home Energy Assessment	5.785	4.723	4.872	7.007	5.724	4%	3%	4%	5%	4%
	Green Heat ^a	1.534	1.872	3.992	2.980	4.227	1%	1%	3%	2%	3%
	HomeWarming ^b	2.311	-	--	-	-	2%	--	--	-	-
	Efficient Product Installation (Residential Direct Install ^c)	24.607	15.675	16.360	17.877	12.777	16%	11%	12%	14%	2%
	Efficient Product Installation (Rental Properties and Condos Service ^d)	2.720	3.287	2.638			2%	2%	2%		
New Residential	New Home Construction	4.572	3.988	3.908	3.371	4.515	3%	3%	3%	3%	3%
Home Energy Report	Home Energy Report	25.437	27.183	--	--	--	17%	20%	--	--	--
Residential Subtotal		80.459	69.966	69.085	53.872	51.831	53%	51%	51%	41%	34%
BNI											
Efficient Product Rebates	Business Energy Rebates ^e	24.610	36.446	37.797	46.583	75.298	16%	26%	28%	36%	50%
Custom Incentives	Custom ^f	28.638	20.709	21.571	21.005	11.603	19%	15%	16%	16%	8%
	Energy Management Information Systems	5.006	3.786	2.018	1.402	1.616	3%	3%	2%	1%	1%
	Strategic Energy Management	-	--	2.269	--	1.455	--	--	2%	--	--
Direct Installation	Small Business Energy Solutions	13.175	7.034	4.123	7.887	9.589	9%	5%	3%	6%	6%
BNI Subtotal		71.429	67.975	67.778	76.877	99.562	47%	49%	50%	59%	66%
Portfolio Total		151.888	137.941	136.863	130.749	151.393	100%	100%	100%	100%	100%

^a 2012, 2013 and 2014 Green Heat results include the Solar component. In early 2015, ENS incorporated the Solar program component into Green Heat.

^b HomeWarming was called Low-income Homeowner until the end of 2014.

^c 2011 Residential Direct Install results correspond to the Efficient Product – Low-income Renters pilot, which offered a similar mix of products as Residential Direct Install.

^d Rental Properties and Condos and Residential Direct Install were combined into Efficient Product Installation as of 2017.

^e 2011 Business Energy Rebates includes the sum of the savings for Mail-in Rebates under Business Energy Rebates and Instant Rebates under Smart Lighting Choices.

^f Custom includes Custom Retrofit, Custom New Construction and, in 2014-2015, Existing Building Commissioning.

Table 14: Evaluated Net Peak Demand Savings at the Generator, 2014-2018

DSM Program	DSM Program Component	Peak Demand (MW)					Peak Demand (% of Total Portfolio)				
		2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
Residential											
Residential Efficient Product Rebates	Appliance Retirement	0.627	0.477	0.363	0.443	0.378	2%	2%	1%	2%	1%
	Instant Savings	1.479	1.599	6.77	2.558	2.572	6%	7%	26%	11%	10%
Existing Residential	LED Holiday Light Exchange	0.414	0.174	--	--	--	2%	1%	--	--	--
	Home Energy Assessment	1.423	1.162	1.378	1.981	1.600	5%	5%	5%	8%	6%
	Green Heat ^a	0.594	0.587	2.282	3.073	4.042	2%	3%	9%	13%	16%
	HomeWarming ^b	0.539	-	--	--	--	2%	--	--	--	--
	Efficient Product Installation (Residential Direct Install) ^c	5.734	3.652	2.73	2.129	1.463	21%	16%	11%	9%	6%
	Efficient Product Installation (Rental Properties and Condos Service) ^d	0.634	0.766	0.568			2%	3%	2%		
New Residential	New Home Construction	1.175	1.025	1.106	0.954	1.278	4%	5%	4%	4%	5%
Home Energy Report	Home Energy Report	2.892	3.724	--	--	--	11%	16%	--	--	--
Residential Subtotal		15.511	13.166	15.197	11.138	11.333	57%	58%	59%	47%	44%
BNI											
Efficient Product Rebates	Business Energy Rebates ^e	4.880	5.903	7.094	7.286	11.327	18%	26%	27%	31%	44%
Custom Incentives	Custom ^f	4.116	2.479	2.258	3.637	1.200	15%	11%	9%	15%	5%
	Energy Management Information Systems	-	--	0.082	0.255	0.051	--	--	0%	1%	0%
	Strategic Energy Management	-	--	0.269	--	0.190	--	--	1%	--	1%
Direct Installation	Small Business Energy Solutions	2.570	1.125	1.070	1.363	1.441	10%	5%	4%	6%	6%
BNI Subtotal		11.566	9.507	10.773	12.541	14.209	43%	42%	42%	53%	56%
Portfolio Total		27.077	22.673	25.970	23.679	25.542	100%	100%	100%	100%	100%

^a 2012, 2013 and 2014 Green Heat results include the Solar component. In early 2015, ENS incorporated the Solar program component into Green Heat.

^b HomeWarming was called Low-income Homeowner until the end of 2014.

^c 2011 Residential Direct Install results correspond to the Efficient Product – Low-income Renters pilot, which offered a similar mix of products as Residential Direct Install.

^d Rental Properties and Condos and Residential Direct Install were combined into Efficient Product Installation as of 2017.

^e 2011 Business Energy Rebates includes the sum of the savings for Mail-in rebate under Business Energy Rebates and Instant Rebates under Smart Lighting Choices.

^f Custom includes Custom Retrofit, Custom New Construction and, in 2014-2015, Existing Building Commissioning.

In 2018, ENS achieved a total of 151.393 GWh in net energy savings and 25.542 MW in net peak demand savings at the generator. These values represented continued annual growth in both energy savings (16%) and peak demand savings (8%) over previous years. Compared to the 2017 evaluation, residential programs experienced a 4 percent decrease in energy savings and a 2 percent increase in peak demand savings. Both energy and peak demand savings achieved by BNI programs increased compared to 2017 levels, by 30 percent in net energy savings and 13 percent in net peak demand savings.

The relative share of overall energy savings deriving from each sector shifted steadily over the five years from 2014 to 2018, as indicated in Table 12 further above. The residential sector represented a slight majority of total energy savings in 2014, whereas the BNI sector made up nearly two-thirds of total savings in 2018.

For residential programs, the overall contribution of two program components among the entire DSM portfolio has changed since 2014, namely Efficient Product Installation and Green Heat. The former went from generating 18 percent of energy savings and 23 percent of peak demand savings in 2014 (when including Rental Properties and Condos, which has since been merged with Efficient Product Installation) to only 2 percent of energy savings and 6 percent of peak demand savings in 2018. The opposite is true for the latter, which gained prominence, especially in terms of peak demand savings. This program component achieved 2 percent of DSM portfolio peak demand savings in 2014, whereas it achieved 16 percent in 2018.

As for BNI program components, the prominence of Business Efficiency Rebates and Custom varied the most over the past five years. Business Efficiency Rebates benefited from the most important increase in savings among the entire DSM portfolio. In 2014, it achieved 16 percent in energy savings and 18 percent in peak demand savings. In 2018, energy savings represented 50 percent of the DSM portfolio and peak demand savings represented 44 percent. As for Custom, the share of energy and peak demand savings decreased over this period, falling from 19 percent of energy savings to 8 percent, and from 15 percent of peak demand savings to 5 percent.

The share of savings generated by LEDs increased steadily since ENS transitioned in 2015 toward these products as the primary lighting technology eligible for incentives under the portfolio. Instant Savings, Efficient Product Installation, and Business Energy Rebates, which combined represented 66 percent of ENS energy savings in 2018, achieved the majority of their net energy savings through lighting measures, and LED technologies in particular (83% for Instant Savings, 63% for Efficient Product Installation and 89% for Business Energy Rebates). These percentages were very similar to those obtained in the 2016 and 2017 evaluations. This finding is further discussed in the Recommendations section further below.

5 MARKET EVOLUTION

Since the 2017 evaluation, market indicators were analyzed and monitored for three distinct measures in three distinct program components to identify when various program component offerings should be adapted or removed. These measures were:

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

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

Instant Savings: LED lamps

ENS has been active in the Nova Scotia residential LED market since 2011 through Instant Savings. A socket study conducted in 2016 indicated that residential LED lamp socket saturation was 21 percent for permanent fixture lamps and 24 percent for plug-in lamps and that 59 percent of Nova Scotians had at least one LED lamp in their homes. In 2016, LED lamp shipments accounted for approximately one-third of all lamps shipped to Atlantic Canada, while LED lamp shipments accounted for half of all lamps shipped to Atlantic Canada in 2017. A-types remained the dominant LED lamp type of all lamps shipped to Atlantic Canada, although the share of non-A-types increased in 2017. Since it is not known how increased Atlantic LED shipments translate to LED socket saturation in Nova Scotia, more recent socket data would help to establish the LED lamp adoption rate. Instant Savings data indicate that LED lamp prices decreased from just over \$20 in 2012 to about \$3.30 in 2017, making LED lamps much more cost competitive. In 2018, a slight increase was noted with the average LED price being approximately \$3.70 per unit, indicating a levelling out of LED pricing in general. In addition, LED lamps are available at major retailers as well as at independent stores, as indicated by the various types of retailers that participate in Instant Savings. As part of the 2018 Instant Savings evaluation, the Evaluator calculated a 39 percent free-ridership level for LED lamps.

The 2018 evaluation revealed that the LED lamp market continues to be in a growth phase and is approaching maturity. A-type bulbs have reached maturity ahead of other LED lamp types. A-type lamps experience continued growth, but their overall share in LED shipments has begun to decrease and their prices, which are now more competitive with alternative technologies, have started to stabilize. Evaluation findings support the ENS decision to remove rebates on A-type lamps as of 2019.

Business Energy Rebates: LED Lighting

ENS has been active in the LED market of the BNI sector through Business Energy Rebates since 2010. Following a similar trend as the residential market, the share of LED technology among lighting shipments has grown drastically for the commercial and industrial sectors in Atlantic Canada, reaching 56 percent in 2017, a 6 percent increase over 2016. Linear LED lamps make up the majority of Atlantic LED shipments. From 2015 to 2018, prices declined significantly for all LED product categories. In addition, the majority of distributors in Nova Scotia carry LED products, indicating that this technology is widely available to BNI customers across the province. As part of the Business Energy Rebates evaluation, the Evaluator calculated free-ridership for four LED products and found that free-ridership ranged between 29 and 37 percent in 2018.

The increased share of LEDs in the BNI market, price reductions, widespread availability, and high free-ridership levels indicate that the barriers to LED lighting continue to decline. The Evaluator concluded that LEDs remain in a growth phase in the BNI market, although some LED products are approaching maturity. Upcoming regulatory changes will further push general-use and decorative lamps, reflector lamps, and downlight fixtures toward maturity. These regulatory changes and their effects on savings confirm the ENS decision to gradually remove decorative lamps, general-use lamps, reflector lamps, downlight fixtures, and LED wall sconces from the Business Energy Rebates offering as of 2019. Of the LED technologies analyzed, the market for LED linear fixtures is the least evolved and has the most growth potential. LED linear lamps and fixtures are not impacted by upcoming regulations.

Green Heat: Mini-split Heat Pumps

In October 2015, Green Heat was expanded to include MSHPs. The addition of MSHPs considerably boosted participation as soon as the measure was introduced. In 2017, Green Heat underwent a series of changes, mainly consisting of a new delivery process that eliminated the preapproval process, new eligibility criteria for cold-climate MSHPs, and a change in the incentive structure for four of the five heat pumps incented by the program component, which served to include MSHPs in the offering. Additionally, MSHPs are now offered to both electrically and non-electrically heated homes, whereas only electrically heated homes qualified for this incentive prior to August 2017.

In 2017, an estimated 24 percent of all Nova Scotians had a heat pump as either a primary or secondary heating source. Distributors indicated that MSHP sales grew considerably in 2018, in part driven by hot, humid weather in Nova Scotia. The distributors expect growth in 2019, although they predict the rate of MSHP sales growth to be decreasing, with a larger portion of market demand being driven by new constructions and the replacement market.

Distributors reported that MSHPs have become an increasingly attractive option for Nova Scotians due to factors such as the proven technology, increased reliability at colder temperatures, the air-conditioning option, and longer warranties than older models. In addition, distributors reported that Green Heat eligible MSHPs are becoming more and more the norm, with lower efficiency MSHPs being more common for new constructions and for air-conditioning applications only.

Participating distributors reported that Green Heat qualified MSHPs constituted nearly 80 percent of 2017 MSHPs sales. The Evaluator estimated that nearly one-quarter of MSHPs sold in Nova Scotia received an incentive from ENS through either Green Heat or Home Energy Assessment.

The results of the market evolution analysis suggest that the MSHP market is transforming from a steady growth phase to a product maturity phase as more and more Nova Scotians adopt MSHPs.

6 RECOMMENDATIONS

Once again, the Evaluator commends ENS on its ability to quickly and effectively implement the recommendations formulated and submitted as part of past evaluations. The 2018 evaluation revealed that two-thirds of former recommendations made for each program component had already been implemented at the time of evaluation and that the majority of remaining recommendations were being implemented. The 2017 crosscutting recommendation consisted of fostering the implementation of non-lighting energy efficiency measures. ENS acted on this recommendation in many ways, such as by including market and process evaluation activities on this theme into the 2018 evaluation scope of work. ENS has also actively pursued non-lighting projects and measures, for instance through the work of Business Development Managers to drive BNI participation in target industries, which has proved successful in engaging new segments for program components such as Custom. The Evaluator finds that strategies to engage participants who require more support and help them achieve savings beyond the most common energy efficiency measures are not yet fully effective. For example, the participation levels in Strategic Energy Management and Energy Management Information Systems remain fairly low, and the number of audit path projects in Small Business Energy Solutions decreased since 2017. The Evaluator believes that these components should be the next area of focus in the diversification strategy.

The results of the portfolio diversification strategy are not yet visible in terms of energy savings; 67 percent of savings are still attributable to lighting measures. This is understandable since this challenge is complex and the diversification strategy must be applied over multiple years.

The Evaluator expects the portfolio composition to change significantly in 2019 since ENS is discontinuing, effective January 2019, support for certain measures that contribute the most to the high levels of savings. These measures include A-type lamps in Instant Savings and general service lamps (including A-type, decorative and reflector lamps, as well as downlight luminaires) in Business Energy Rebates. As part of the 2018 evaluation, the Evaluator has one crosscutting recommendation that addresses this important change, as outlined in Table 15.

Table 15: Crosscutting Recommendation on ENS Programs

No.	Recommendation
CR-R1.	Monitor the market evolution for lighting products that were recently removed from ENS offerings. The recent changes to lighting product eligibility in Instant Savings and Business Energy Rebates are likely to have a major impact on the savings achieved by those program components and the portfolio as a whole. While market evolution data were collected in previous years and used to support the decision to modify ENS offerings, the impact of ceasing interventions in a market is never fully known. The Evaluator recommends that ENS collect data and track market evolution in a timely manner in upcoming months to allow for quick adjustments if the market does not evolve as expected. This data may be collected through sales figures from participating retailers and distributors or other market research strategies such as interviews with market actors.

Recommendations on individual program components are outlined in individual reports as well as in Table 16 and Table 17 below.

Table 16: Recommendations on Residential Program Components

No.	Recommendation
ARet-R1.	Continue to perform the metering activity and ensure the metering protocol is followed. In the 2017 evaluation, the Evaluator recommended continuing the metering activity to increase the sample size of each age category and lower margins of error of measured appliance consumption. ENS continued the metering activity in 2018, although in-depth analysis indicated that the metered consumption data were inconsistent and could not be used as is. The Evaluator therefore recommends continuing the metering activities in 2019. Moreover, the metering protocol should be closely followed to ensure that the obtained data provide accurate results, notably by ensuring that metering is conducted in a room with controlled temperature.
ARet-R2.	Develop and implement a protocol on the heat gun usage process. The Evaluator recommends that ENS formalize the heat gun usage process by developing a protocol for its use. The protocol should describe the appliances to be accepted or rejected based on the metered temperature and the data to be tracked. This protocol would ensure that all non-working appliances, i.e. appliances with inside temperature below target values, are properly identified, tracked, and excluded from the metering sample as well as program component results.
IS-R1.	Perform a socket study through on-site visits to document energy savings potential related to lighting. Market data point to increasingly high penetration rates of LED lamps and fixtures in Nova Scotia homes. To document the remaining energy savings potential related to lighting in existing homes, the Evaluator recommends conducting a socket study in Nova Scotia homes. The socket study, conducted through on-site visits, should serve to collect information such as the number and type of lamps installed in homes. This study would be helpful for all program components that offer residential lighting measures by providing insights on the current state of lighting market.
IS-R2.	Continue monitoring LED market indicators. Despite the removal of A-type lamps from the Instant Savings offering as of 2019, the Evaluator recommends continuing to monitor the evolution of all LED lamps. Market indicators such as the market shares and prices of lighting technologies should still be collected to understand the changes occurring in the market after A-type lamps are removed. Monitoring market indicators would also help with remaining current on the overall state of the lighting market, which is in a period of change.
HEA-R1.	Conduct a billing analysis to review the overestimation ratio when a sufficient participant sample becomes available. The billing analysis conducted in 2018 was initially aimed at estimating a new overestimation ratio (OR) for the new version of HOT2000, although it revealed that the space heating systems in place, particularly heat pumps, had a much more significant impact on the overestimation than the difference between the versions of HOT2000 that are used. The Evaluator believes that further analyses should be conducted to evaluate the impact of the different HOT2000 versions on the ORs and confirm whether there is no significant difference in the ORs established for the D and E assessment periods. The Evaluator believes that version 11 of HOT2000 will progressively be used more in upcoming years and will enable conducting a billing analysis on a sample of participants large enough to consider: (1) D assessments and E assessments; (2) the various versions of HOT2000 (i.e. versions 11.3; 11.4; 11.5); and (3) evaluate the impact of the different heating systems in place, including the presence of wood or pellet stoves. Since overestimations significantly impact HEA net energy and peak demand savings, the Evaluator recommends conducting a billing analysis when a large enough participant sample becomes available.

No.	Recommendation
HEA-R2.	Share evaluation findings with the EAs to ensure sustained quality simulations. As part of the 10 HEA on-site visits and HOT2000 simulation reviews, the Evaluator noted that significant improvements have been achieved in both the quantity of measurements and the accuracy of collected data since the last review in 2016. In 2018, the Evaluator found that EAs performed well in recording household energy component data and complied with the new EnerGuide requirements. While reviewing project files, the Evaluator noted some recurrent mistakes in the HOT2000 simulations (see Subsection 3.1). The Evaluator recommends sharing feedback on the improved accuracy of data collection and aspects of the project review process that could be improved with EAs to continue working toward higher quality simulations.
GH-R1.	Improve the accuracy of the information in the tracking sheet. While reviewing the data for the ducted air-source heat pump (ASHP) billing analysis, the Evaluator noticed that the information on primary and secondary heating systems found in the tracking sheet was unreliable. Two reasons were identified for this issue: 2017 participants considered in the billing analysis used a previous version of the application form, which did not clearly identify which system (new or old) was being described. There were also numerous data entry errors between the application form and the tracking sheet. The information on heating systems is essential to the billing analysis. The Evaluator found that the technical characteristics (such as heating capacity) of some heat pumps were not consistent with the values found in the reference measures list. The Evaluator therefore recommends improving the quality assurance processes for the Green Heat tracking sheet.
GH-R2.	Continue monitoring barriers to the adoption of high-efficiency MSHPs to adapt the program component offer or plan for an exit strategy. The market indicators presented in the Market Evolution section of this report reveal the growing popularity of mini-split heat pumps (MSHPs) in Nova Scotia. Results also indicate that the rebate is less and less important in fostering the development of the MSHPs market and that the latter is growing due to factors external to Green Heat. Evaluation results also highlight that Green Heat still had some influence on how efficient the MSHPs purchased were in 2018. In this context, the Evaluator suggests that ENS continue incenting high-efficiency MSHP models in the short term, while monitoring barriers to high-efficiency MSHPs to understand if interventions in the market are still useful or if the measure needs to be removed or limited to those segments with lower high-efficiency MSHPs penetration rates, such as new constructions and multi-unit buildings.
EPI-R1.	Better inform participants about thermostatic shower valves. In 2018, ENS expanded EPI product offerings by including thermostatic shower valves. The evaluation revealed a moderate satisfaction level with this new product. Due to the novelty of this product, the Evaluator recommends that ENS continue working with service providers to deliver high-quality information to participants regarding thermostatic shower valves. The information can be shared verbally upon installation or a pamphlet can be left behind. Experience demonstrates that improving product information can help lower product removal. It can also improve satisfaction levels since participants value receiving information about the products installed.

No.	Recommendation
NHC-R1.	Increase support and guidance to builders by exploring ways to further involve DAs and EAs in the NHC participation process. As evidenced by the process evaluation, DAs and EAs are valuable partners in new home construction programs and their involvement in projects can be a key factor in project success and builder satisfaction. They have the knowledge and expertise to, among other things, assist builders with registration and offer technical assistance during construction, such as measure suggestions and on-site verifications of measure installations. ENS should review the NHC participation process and identify areas where DAs and EAs can be further involved. While the Evaluator believes that EAs and DAs are also key allies in the recruitment of new builders, achieving the goal of generating more projects under NHC must first involve an assessment of current processes to ensure they are in line with builder expectations and needs.
NHC-R2.	Be flexible, as much as possible, with timeline requirements that may be difficult for builders to meet. Interviews with other program administrators revealed that flexibility with builders is key to program success. For example, providing exceptions to the requirement to register within 30 days of receiving a building permit and offering extensions to builders that need more than 12 months to complete a project without having to re-register are important aspects to builders and can be a deal breaker for certain builders.
NHC-R3.	Share evaluation findings with the EAs to ensure sustained quality simulations and that all required documentation is included in participant files. As part of the 10 NHC on site visits and HOT2000 simulation reviews, the Evaluator noted that improvements had been achieved in the accuracy of simulations since the last review in 2016. Conversely, the Evaluator identified errors affecting the energy consumption in each file reviewed. Moreover, the Evaluator noted that building plans or as-built reports, containing the characteristics of each house component, were still missing for the majority of the files reviewed despite the recommendation made in the 2016 Evaluation Report to ensure that all required documentation be included in participant files. These findings should be shared with the EAs to continue working toward higher quality simulations, and particular effort should be invested in investigating concrete solutions on how all the required documentation could be included in the participant files.
NHC-R4.	Conduct a billing analysis to review overestimation ratios (ORs) when a sufficient NHC participant sample becomes available. The current ORs used for NHC were obtained from a billing analysis of Home Energy Assessment (HEA) participant data. In past years, no billing analyses were conducted with NHC participants since only a few participants had their as-built energy consumption value available. The HEA billing analysis conducted in 2018 was initially aimed at estimating an OR for the new version of HOT2000, although it revealed that the space heating systems in place, particularly heat pumps, had a much more significant impact on the OR than the difference between the versions of HOT2000 that are used. Since more NHC projects will be completed under the HOT2000 version 11 rating system in upcoming years, the Evaluator recommends conducting a billing analysis specific to NHC participants when a large enough sample becomes available to both consider the various versions of HOT2000 (i.e. versions 11.3; 11.4; 11.5) and evaluate the impact of the different heating systems in place.
NHC-R5.	Ensure the tracked savings are accurate. Prior to reviewing the gross savings calculations, the Evaluator identified several issues in the 2018 tracking sheet, including with values that had been entered manually. The Evaluator reviewed all the formulas used for the tracked savings calculations and when revisions were required, the Evaluator shared the revisions with ENS. For future years, the Evaluator recommends that ENS apply these formulas to track NHC savings and ensure they are consistently applied to all participants in the tracking sheet.

Table 17: Recommendations on Business, Non-profit and Institutional Program Components

No.	Recommendation
BER-R1.	Review BER logic model and eligibility criteria to ensure that the intended projects and participants go through each service. As evidenced by the process evaluation, no project types are exclusive to either service and many sold measures overlap the two services. Despite these similarities, the Evaluator also found that a significant proportion of Instant Rebates measures are installed in residential applications that would not be eligible for a Mail-in incentive. A review of the logic model and eligibility criteria would clarify the purpose of the similarities and differences between the two services and realign BER design in relation to its objectives. This review would result in a better definition of target participants and measures, which would in turn improve BER performance as well as the accuracy of the performance and savings assessment.
BER-R2.	Implement a system that enables connecting Instant Rebates sales data to participants. While ENS implemented the Evaluator's past recommendations to improve Instant Rebates participant tracking, the information to fully capture the actual Instant Rebates market is still fairly limited, rendering it challenging to adjust savings assumptions to represent average conditions. One challenge, in particular, is clearly knowing whether Instant Rebates measures were purchased by contractors or end users and how many units were purchased by each of these types of participants. The Evaluator recommends that ENS implement a system that allows tracking sales and linking them to participating individuals. This would enable the Evaluator to collect more specific data from these individuals and gain a better sense of what their sales represent compared to overall service sales.
BER-R3.	Investigate ways to liaise more clients with non-lighting contractors. Contractors are key players in achieving the goal of implementing more non-lighting measures through BER and ENS programs overall. Fewer interviewed participants have go-to non-lighting contractors than lighting contractors for potential projects. The Evaluator recommends findings ways to connect participants to non-lighting contractors and training the latter to further promote non-lighting projects.
BER-R4.	Analyze the incentive levels for non-lighting measures with a higher payback period. Meeting company payback thresholds remains a key barrier to implementing non-lighting measures among participants. The Evaluator recommends that ENS assess possible ways of pushing more participants toward non-lighting measures that typically have longer payback periods. While actively promoting the energy and non-energy benefits of measures might be enough to push some participants to implement non-lighting measures, for other participants whose companies require specific payback thresholds before any energy efficiency project is approved, an ENS review of incentive levels for at least a few high-potential measures might be needed.
CUSTOM-R1.	Improve communication to SPs and participants about the various New Construction steps and corresponding service requirements. As previously mentioned, the key aspect of New Construction mentioned as problematic by participants and SPs is the lack of clear communication about service steps and requirements, with one SP mentioning not understanding the basecase against which efficient designs need to be assessed. Additionally, there is a perception that projects cannot fit within the New Construction service timeline, which pushes some clients away from the service according to SPs. Clearer and sustained information about New Construction is recommended. Improved communication should include a clear and concise process chart, along with detailed checklists of what is required at each step of the participation process as well as timelines to complete each step. Clearer directions on the appropriate modelling approach would also reduce adjustments made to tracked savings and improve the quality of energy models. Given the small number of completed projects each year, the Evaluator encourages as much as possible a personalized follow-up approach and regular check-ins on projects to ensure that they progress how they should.

No.	Recommendation
CUSTOM-R2.	Further engage new and existing SPs and make them stronger advocates for New Construction. Interviewed SPs often could not accurately recall their membership status with ENS' Efficiency Trade Network (ETN). In addition, the relative lack of modellers, architects and general contractors within the ETN suggests that there is an opportunity to engage those parties more in the service. Having more professionals in the ETN would allow ENS another communication channel to reach these professionals and share information about New Construction. Recruiting modellers, architects and general contractors and making the service more top-of-mind could be particularly important to expanding New Construction participation because such professionals are typically involved in the early stages of construction projects and may influence decisions to participate in the service. ENS could also engage with new trade associations and enhance relationships with associations they already know. This would serve to reinforce the service ENS offers to professionals. Reaching out to trade associations should not be limited to Nova Scotia because some SPs come from other provinces to work on projects.
EMIS/SEM-R1.	Review program delivery to improve participant understanding and mastery of energy performance tracking. Despite being satisfied with EMIS and SEM, many participants in both program components mentioned feeling they need more assistance with ongoing analysis and they lack resources to continue tracking and maintaining facility energy consumption levels on their own. Another indication of high dependence on service providers is that one 2017 EMIS participant stopped producing monthly reports for the second half of 2017 because the service provider could no longer remotely access their energy management information system. Furthermore, many SEM participants do not anticipate continuing their energy management efforts, particularly in terms of tracking energy performance, without the support of a service provider. The Evaluator believes that these examples indicate that EMIS and SEM participants heavily rely on their service providers to maintain their efforts and that the program components do not achieve the full potential of changing energy management practices. Therefore, it is recommended that EMIS and SEM delivery methods be reviewed to better equip participants to understand and fully master energy performance tracking methods. In addition to increasing the persistency of savings, this is also likely to improve participant satisfaction with EMIS and SEM since participants would feel less overwhelmed by the amount and complexity of the data provided to them through EMIS or SEM.

LIST OF APPENDICES

The following are presented in the 2018 DSM Programs Evaluation Executive Summary – Appendices.

Appendix I - Overall : Bibliography

Appendix II - Overall : Calculation of Margins of Error

Appendix III - Overall : NTGR Calculations



ECONOLER

2018 DSM PROGRAMS EVALUATION

EXECUTIVE SUMMARY

EFFICIENCY NOVA SCOTIA

Appendix Report

March 18, 2019



TABLE OF CONTENTS

APPENDIX I BIBLIOGRAPHY 1

APPENDIX II CALCULATION OF MARGINS OF ERROR..... 8

APPENDIX III NTGR CALCULATIONS 15

APPENDIX I BIBLIOGRAPHY

Program Components	Bibliographic References
Appliance Retirement	ECOX. <i>Technical Information Bulletin No. E-004-EN: SEER</i> , www.ecoxline.com (Last accessed March 3, 2016).
	EMERA INC., <i>Management's Discussion & Analysis</i> as at February 9, 2018 http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693 (Last accessed November 28, 2018).
	NATIONAL RENEWABLE ENERGY LABORATORY (NREL). <i>The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. Chapter 7: Refrigerator Recycling Evaluation Protocol</i> , Prepared by the Camus Group, September 2017.
	NATURAL RESOURCES CANADA. <i>Energy Efficiency Ratings: Search – Freezers</i> , http://oee.nrcan.gc.ca/pml-lmp/index.cfm?action=app.download-telecharger&appliance=FREEZERS (Last accessed January 9, 2019).
	NATURAL RESOURCES CANADA'S OFFICE OF ENERGY EFFICIENCY. <i>Air Conditioning Your Home</i> , 2003.
	NOVA SCOTIA POWER. <i>Total System Emissions</i> , https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx (Last accessed November 28, 2018).
	STATISTICS CANADA. <i>Table 38-10-0019-01 – Air conditioners</i> , https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3810001901 (Last accessed November 6, 2018).
	STATISTICS CANADA. Residential Sector, Nova Scotia, Table 14: Total Households by Building Type and Energy Source, http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=ns&m=14&page=4 (Last accessed December 3, 2018).
Instant Savings	ADS ASSOCIÉS. <i>Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale</i> , Report presented to Hydro-Québec, 1992.
	CORPORATE RESEARCH ASSOCIATES INC., <i>2016 Socket Study</i> , Final Report Prepared for Efficiency Nova Scotia, December 2016.
	ECONOLER. <i>Residential Lighting Metering Study</i> , report presented to Efficiency Nova Scotia, 2017.
	ECONOLER. <i>Instant Savings Evaluation Reports</i> , 2012-2017 and 2018.
	ECONOLER. <i>Instant Savings tracking sheets provided by ENS</i> , 2016-2017.
	ELECTRO-FEDERATION CANADA. <i>Lamp Data - Consumer Channel and C&I Channel 2004-2017</i> .
	EMERA INC., <i>Management's Discussion & Analysis</i> as at February 9, 2018 http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693 (Last accessed November 28, 2018).
	EVERETT ROGERS. <i>Diffusion of Innovations</i> , 1983.
	NATIONAL RENEWABLE ENERGY LABORATORY (NREL). <i>Uniform Methods Protocol Chapter 23: Estimating Net Savings: Common Practices</i> , p. 3, September 2014.
	NATURAL RESOURCES CANADA. <i>Amendment 14, October 2018</i> , http://www.nrcan.gc.ca/energy/regulations-codes-standards/18419 (Last accessed December 6, 2018).
	NATURAL RESOURCES CANADA. <i>“General Service Lamps and Modified Spectrum Incandescent Lamps”</i> , www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869 (Last accessed January 26, 2018).

Program Components	Bibliographic References
	NOVA SCOTIA POWER. <i>Total System Emissions</i> , https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx (Last accessed November 28, 2018).
	ROSENBERG M. AND HOEFGEN L. <i>Market Effects and Market Transformation: Their Role in Energy Efficiency Program Design and Evaluation</i> , Prepared for the California Institute of Energy and the Environment, 2009.
	STATISTICS CANADA. <i>Table 153-0145 - Households and the Environment Survey, Primary Heating System, Canada, Provinces and Census Metropolitan Areas</i> , 2015, CANSIM, November 1, 2018.
	STATISTICS CANADA. <i>Table 153-0147 - Households and the Environment Survey, Air-conditioners, Canada, Provinces and Census Metropolitan Areas</i> , 2015, CANSIM, November 1, 2018.
Home Energy Assessment	CENTER FOR ENERGY ADVANCEMENT THROUGH TECHNOLOGY INNOVATION (CEATI). <i>Drain Water Heat Recovery Energy Savings Calculator</i> , available at http://www.ceati.com/calculator/ (Last accessed November 15, 2017).
	EMERA INC. <i>Management's Discussion & Analysis as at February 9, 2018</i> , http://investors.emera.com/Cache/1500095769.PDF?Y=&O=PDF&D=&fid=1500095769&T=&iid=4072693 (Last accessed November 26, 2018).
	MAYER, P. W., W. B. OREO and AL., <i>Residential End Uses of Water</i> , AWWA Research Foundation, 1999.
	NATIONAL RENEWABLE ENERGY LABORATORY (NREL). <i>The Uniform Methods Project, Chapter 23: Estimating Net Savings, Common Practices</i> , September 2014.
	NATURAL RESOURCES CANADA. <i>Residential Sector – Nova Scotia - Heating System Stock by Building Type and Heating System Type</i> , http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=ns&rn=21&page=4 (Last accessed February 07, 2019).
	NOVA SCOTIA POWER. <i>Total System Emissions</i> , http://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx . (Last accessed November 26, 2018).
Green Heat	EMERA INC. <i>Management's Discussion & Analysis as at February 9, 2018</i> , http://investors.emera.com/Cache/1500095769.PDF?Y=&O=PDF&D=&fid=1500095769&T=&iid=4072693 (Last accessed November 28, 2018).
	EVERETT ROGERS. <i>Diffusion of Innovations</i> , 1983.
	NATIONAL RENEWABLE ENERGY LABORATORY (NREL). <i>The Uniform Methods Project, Chapter 23: Estimating Net Savings: Common Practices</i> , September 2014.
	NOVA SCOTIA POWER. <i>Heat Pump Financing</i> , https://www.nspower.ca/en/home/for-my-home/heating-solutions/heat-pumps/heat-pump-financing.aspx (Last accessed December 4, 2018).
	NOVA SCOTIA POWER. <i>Total System Emissions</i> , http://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx . (Last accessed November 28, 2018).
	NOVA SCOTIA UTILITY AND REVIEW BOARD. Matter M08087. NSP Response to E1 IR-4 Att 1.
	NOVA SCOTIA UTILITY AND REVIEW BOARD. Matter M08670. NSP Response to Synapse IR-05 Att 5 ELECTRONIC.
	ROSENBERG M. AND HOEFGEN L. <i>Market Effects and Market Transformation: Their Role in Energy Efficiency Program Design and Evaluation</i> . Prepared for California Institute of Energy and the Environment, 2009.

Program Components	Bibliographic References
Efficient Product Installation	ADS ASSOCIÉS. <i>Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale</i> , report presented to Hydro-Québec, 1992.
	CORPORATE RESEARCH ASSOCIATES INC. <i>2016 Socket Study</i> , Final Report Prepared for Efficiency Nova Scotia, December 2016.
	DEOREO ET AL. (2016). <i>Residential End Uses of Water</i> , Version 2: Executive Report, published by Water Research Foundation, http://www.waterrf.org/PublicReportLibrary/4309A.pdf (March 16, 2017).
	ELECTRO-FEDERATION CANADA. <i>Lamp Data - Consumer Channel and C&I Channel 2004-2017</i> .
	EMERA INC. <i>Management's Discussion & Analysis as at February 9, 2018</i> , http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693 (Last accessed November 28, 2018).
	ECONOLER. <i>Low Income 2017/18 Province of Nova Scotia Evaluation</i> , June 4, 2018.
	ECONOLER, <i>Residential Lighting Metering Study</i> , report presented to Efficiency Nova Scotia, 2017.
	MINISTER OF JUSTICE. Canada, <i>Energy Efficiency Regulations, 2016</i> , http://laws-lois.justice.gc.ca/PDF/SOR-2016-311.pdf . (Last accessed December 6, 2018).
	NATIONAL RENEWABLE ENERGY LABORATORY (NREL). <i>The Uniform Methods Project, Chapter 23: Estimating Net Savings, Common Practices</i> , September 2014.
	NOVA SCOTIA POWER. Open Access Same-Time Information System, <i>Hourly Total Net Nova Scotia Load</i> , < http://oasis.nspower.ca/en/home/oasis/monthly-reports/hourly-total-net-nova-scotia-load.aspx > (Last accessed January 18, 2016).
	NOVA SCOTIA POWER. <i>Total System Emissions</i> , https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx (Last accessed November 28, 2018).
New Home Construction	CANADA MORTGAGE AND HOUSING CORPORATION. <i>Housing Market Information Portal</i> , https://www03.cmhc-schl.gc.ca/hmiportal/en/#Profile/12/2/Nova%20Scotia (Last accessed January 24, 2019).
	CORPORATE RESEARCH ASSOCIATES INC. <i>ENS New Home Construction Program Qualitative Study</i> . Draft Report. July 2018.
	EMERA INC. <i>Management's Discussion & Analysis as at February 9, 2018</i> , http://investors.emera.com/Cache/1500095769.PDF?Y=&O=PDF&D=&fid=1500095769&T=&iid=4072693 (Last accessed November 28, 2018).
	NOVA SCOTIA POWER. <i>Total System Emissions</i> , http://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx . (Last accessed November 28, 2018).
	HOUSING, BUILDINGS, COMMUNITIES AND SIMULATION GROUP at CanmetENERGY, a division of NRCan: http://198.103.48.154/eng/software_tools/hot2000.html (Last accessed October 31, 2016).
	NOVA SCOTIA BUILDING CODE LEGISLATION. <i>Nova Scotia Building Code Regulations – Users Version, 2014</i> , https://novascotia.ca/dma/firesafety/buildingcode/docs/141020FINALUSERSNSBCR141231.pdf (Last accessed December 11, 2017).

Program Components	Bibliographic References
Business Energy Rebates	DATABASE FOR ENERGY EFFICIENCY RESOURCES (DEER). <i>DEER 2014 EUL Table</i> , 2014.
	DNV-GL. <i>Massachusetts Commercial and Industrial Upstream Lighting Program: "In Storage" Lamps Follow-up Study</i> , March 2015.
	DUKE ENERGY PROGRESS. <i>Energy Efficiency for Business - Fixture Wattage Table</i> , 2013, available at http://www.ahutton.com/LED/Progress%20wattages.pdf (Last consulted on November 21, 2018).
	EFFICIENCY VERMONT. <i>Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions</i> , March 16, 2015.
	ELECTRO-FEDERATION CANADA. <i>Lamp Data - Consumer Channel and C&I Channel 2004–2017</i> , March 2017.
	EMERA INC. Management's Discussion & Analysis as at February 10, 2017, http://investors.emera.com/Cache/1500095769.PDF?Y=&O=PDF&D=&fid=1500095769&T=&iid=4072693 . (Last accessed December 28, 2018).
	EVERETT M ROGERS, <i>Diffusion of Innovations – Fifth Edition</i> , August 16, 2003.
	NATIONAL RENEWABLE ENERGY LABORATORY (NREL). <i>The Uniform Methods Project, Chapter 23: Estimating Net Savings: Common Practices</i> , September 2014, p. 3, available at http://energy.gov/sites/prod/files/2015/02/f19/UMPCchapter23-estimating-net-savings_0.pdf
	NATURAL RESOURCES CANADA. <i>Amendment 14</i> , October 2018. http://www.nrcan.gc.ca/energy/regulations-codes-standards/18437 (Last accessed December 06, 2018).
	NATURAL RESOURCES CANADA. <i>Forward Regulatory Plan 2017-19</i> . http://www.nrcan.gc.ca/energy/regulations-codes-standards/18318 (Last accessed February 28, 2018).
	NATURAL RESOURCES CANADA. <i>General Service Lamps and Modified Spectrum Incandescent Lamps: Energy Efficiency Regulations</i> , http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869 (Last accessed December 06, 2018).
	NOVA SCOTIA POWER. Total System Emissions, http://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx . (Last accessed December 28, 2018).
	ROSENBERG AND HOEFGEN. <i>Market Effects and Market Transformation: Their Role in Energy Efficiency Program Design and Evaluation</i> . Prepared for California Institute of Energy and the Environment, 2009.
	RUNDQUIST, Robert A. et al. <i>Calculating Lighting and HVAC Interactions</i> , in <i>ASHRAE Journal</i> , November 1993.
Custom	TECMARKET WORKS. <i>The California Evaluation Framework</i> , June 2004.
	EMERA INC. Management's Discussion & Analysis as at February 10, 2017, http://investors.emera.com/Cache/1500095769.PDF?Y=&O=PDF&D=&fid=1500095769&T=&iid=4072693 (Last accessed December 17, 2017).
	EMERA INC. Management's Discussion & Analysis as at February 9, 2018, http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693 (Last accessed November 28, 2018).
	NATIONAL RENEWABLE ENERGY LABORATORY (NREL). <i>The Uniform Methods Project, Chapter 23: Estimating Net Savings: Common Practices</i> , 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).
	NOVA SCOTIA POWER. Total System Emissions, http://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx . (Last accessed November 28, 2018).
	RESEARCH INTO ACTION. <i>Practices and Procedures Evaluation: Efficiency Trade Network</i> , Final Report. November 26, 2018.
	ROBERTS J. AND TSO B. (SBW CONSULTING). <i>Do Savings from Retrocommissioning Last? Results from an Effective Useful Life Study</i> , ACEEE Summer Study on Energy Efficiency in Buildings, 2010.
	EFFICIENCY VALUATION ORGANIZATION, <i>Core Concepts, International Performance Measurement and Verification Protocol</i> , October 2016.

Program Components	Bibliographic References
Energy Management Information System	EMERA INC. Management's Discussion & Analysis as at February 9, 2018, http://investors.emera.com/Cache/1500095769.PDF?Y=&O=PDF&D=&fid=1500095769&T=&iid=4072693 (Last accessed November 28, 2018).
	NOVA SCOTIA POWER. Total System Emissions, http://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx (Last accessed November 28, 2018).
Strategic Energy Management	CADMUS. Perspectives on SEM Evaluation Northeast SEM Collaborative Workshop, November 8, 2017.
	CONSORTIUM FOR ENERGY EFFICIENCY. 2017 Strategic Energy Management Program Summary, May 3, 2018.
	EMERA INC. Management's Discussion & Analysis as at February 9, 2018, http://investors.emera.com/Cache/1500095769.PDF?Y=&O=PDF&D=&fid=1500095769&T=&iid=4072693 (Last accessed November 28, 2018).
	NOVA SCOTIA POWER. "Total System Emissions", http://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx (Last accessed November 28, 2018).
Small Business Energy Solutions	DATABASE FOR ENERGY EFFICIENCY RESOURCES (DEER). DEER 2014 EUL TABLE, 2014.
	EMERA INC., "Management's Discussion & Analysis as at February 9, 2018", http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693 (Last accessed November 28, 2018).
	NATIONAL RENEWABLE ENERGY LABORATORY (NREL). <i>The Uniform Methods Project, Chapter 23: Estimating Net Savings: Common Practices</i> , September 2014, p. 3, available at http://energy.gov/sites/prod/files/2015/02/f19/UMPCchapter23-estimating-net-savings_0.pdf (Last accessed November 25, 2016).
	NOVA SCOTIA POWER. Total System Emissions, http://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx (Last accessed November 28, 2018).
Codes & Standards	ADS ASSOCIÉS. <i>Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale</i> , report presented to Hydro-Québec, 1992.
	CANETA RESEARCH. <i>NECB 2015 Update to Economic Analysis for Archetype Buildings</i> , 2017, available at https://docplayer.net/86714351-Necb-2015-update-to-economic-analysis-for-archetype-buildings.html (Last accessed February 18, 2019).
	CONSTRUCTION INNOVATION. <i>Changes in Part 9 of NCB 2015</i> , 2016, available at https://www.nrc-cnrc.gc.ca/ci-ic/en/article/v20n1-4/ (Last accessed February 18, 2019).
	CORPORATE RESEARCH ASSOCIATES. <i>2011 ENS socket study</i> , Final Report Prepared for Efficiency Nova Scotia, December 2011.
	DALHOUSIE UNIVERSITY. <i>Wood construction and NBC Part 9 for Housing and Small Buildings</i> , liableble at https://www.dal.ca/faculty/cce/programs/continuing-technical-education/courses/wood-construction-and-nbc-part-9-for-housing-and-small-buildings.html (Last accessed March 6, 2019).
	DMD & ASSOCIATES LTD. <i>Nova Scotia LED Roadway Lighting Pilot Installations</i> , March 19, 2010, available at http://docshare01.docshare.tips/files/25144/251443242.pdf (Last accessed February 5, 2019).
	DMD AND ASSOCIATES LTD. <i>Energy Efficient Street Lighting Strategies for Nova Scotia Municipalities</i> , July 16, 2009, available at https://unsm.ca/doc_download/1543-street-lighting-final-report-2009-07-16.html (Last accessed February 5, 2018).
	ECONOLER. <i>Residential Lighting Metering Study</i> , report presented to Efficiency Nova Scotia, 2017.
	EMERA INC., Management's Discussion & Analysis as at February 9, 2018, http://investors.emera.com/Cache/1500095769.PDF?Y=&O=PDF&D=&fid=1500095769&T=&iid=4072693 (Last accessed November 28, 2018).

Program Components	Bibliographic References
	ENVIRONMENT CANADA. <i>Clean Air Regulatory Agenda: Background</i> , available at www.ec.gc.ca/default.asp?lang=En&n=56D4043B-1&news=295B1964-9737-4F80-B064-B3088D9910BE (Last accessed February 6, 2019).
	ICF CONSULTING CANADA, <i>Market Study: General Service Fluorescent Lamps (GSFLs)</i> , Report Prepared for the Office of Energy Efficiency, Natural Resources Canada, 2015.
	ILLUMINATING ENGINEERING SOCIETY (IES) OF NORTH AMERICA. available at http://www.ies.org/ (Last accessed February 21, 2019).
	NATIONAL LIGHTING PRODUCT INFORMATION PROGRAM. <i>Streetlights for Local Roads</i> , February 2011, available at http://www.lrc.rpi.edu/programs/NLPIP/PDF/VIEW/SR_StreetlightsLocal.pdf (Last accessed February 5, 2019).
	NATIONAL RESEARCH COUNCIL CANADA. <i>Energy Efficiency in Housing and Small Buildings – General Introduction</i> , March 2013, available at http://www.nrc-cnrc.gc.ca/eng/solutions/advisory/codes_centre/presentations/2013/overview2013.html (Last accessed February 5, 2018).
	NATIONAL RESEARCH COUNCIL CANADA. <i>National Energy Code of Canada for Buildings 2015, 2017</i> , available at https://www.nrc-cnrc.gc.ca/eng/publications/codes_centre/2015_national_energy_code_buildings.html (Last accessed February 18, 2019).
	NATIONAL RESEARCH COUNCIL CANADA. <i>Model Code Adoption Across Canada</i> , available at https://www.nrc-cnrc.gc.ca/eng/solutions/advisory/codes_centre/code_adoption.html (Last accessed February 17, 2019).
	NATURAL RESOURCES CANADA. <i>A cost-benefit analysis</i> , Canada Gazette, Part II, 2016.
	NATURAL RESOURCES CANADA. <i>Amendment to Canada's Energy Efficiency Regulations for Lighting Products</i> , January 2014, available at http://www.nrcan.gc.ca/energy/regulations-codes-standards/12342 (Last accessed February 5, 2018).
	NATURAL RESOURCES CANADA. <i>Clothes Washers (and household-style commercial)</i> , 2018, available at http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6925 (Last accessed February 6, 2019).
	NATURAL RESOURCES CANADA. <i>Energy Efficiency Act: Regulations Amending the Energy Efficiency Regulations</i> , 2011, available at http://canadagazette.gc.ca/rp-pr/p2/2011/2011-10-12/html/sor-dors182-eng.html (Last accessed February 6, 2019).
	NATURAL RESOURCES CANADA. <i>Guide to Canada's Energy Efficiency Regulations</i> , 2017, available at http://www.nrcan.gc.ca/energy/regulations-codes-standards/6861 (Last accessed February 5, 2018).
	NATURAL RESOURCES CANADA. – Amendment 12B, January 2014, <i>Registration and publication of Regulations amending Canada's Energy Efficiency Regulations</i> , 2017, available at http://www.nrcan.gc.ca/energy/regulations-codes-standards/12342 (Last accessed February 6, 2019).
	NATURAL RESOURCES CANADA. – Amendment 13, December 2016, <i>Registration and publication of Regulations amending Canada's Energy Efficiency Regulations</i> , 2017, available at http://www.nrcan.gc.ca/energy/regulations-codes-standards/18419 (Last accessed February 6, 2019).
	NATURAL RESOURCES CANADA. <i>General service incandescent reflector lamps</i> , 2018, available at https://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6957 (Last accessed February 6, 2019).
	NATURAL RESOURCES CANADA. <i>Publication of Regulations Amending Canada's Energy Efficiency Regulations</i> , 2011, available at http://oee.nrcan.gc.ca/regulations/14566 (Last accessed February 5, 2018).
	NATURAL RESOURCES CANADA. <i>Survey of Commercial and Institutional Energy Use – Buildings 2009</i> , December 2012, available at https://oee.nrcan.gc.ca/publications/statistics/scieu09/scieu_e.pdf (Last accessed January 15, 2018).
	NAVIGANT. <i>Market Analysis for Incandescent Reflector Lamps, Final Report</i> , Prepared for Natural Resources Canada, 2015.

Program Components	Bibliographic References
	NOVA SCOTIA CANADA, <i>Energy-efficient Appliances Regulations made under Section 5 of the Energy-efficient Appliances Act</i> , available at https://www.novascotia.ca/just/regulations/regs/eeappliances.htm (Last accessed February 5, 2018).
	NOVA SCOTIA CANADA. <i>New Law Means Road Lighting in Nova Scotia Must Be LED</i> , 2012, available at http://novascotia.ca/news/release/?id=20120912004 (Last accessed February 6, 2019).
	NOVA SCOTIA CANADA. <i>Nova Scotia Building Code Regulations</i> , 2017, available at https://novascotia.ca/just/regulations/regs/bcregs.htm (Last accessed February 6, 2019).
	NOVA SCOTIA POWER, <i>Street and Area Lighting</i> , available at http://www.nspower.ca/en/home/about-us/electricity-rates-and-regulations/rates/street-and-area-lighting.aspx (Last accessed January 29, 2017).
	NOVA SCOTIA POWER. <i>Total System Emissions</i> , http://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx (Last accessed November 28, 2018).
	OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY. <i>Demonstration Assessment of Lighting-Emitting Diode (LED) Roadway Lighting</i> , December 2011, available at https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/2011_gateway_fdr-drive.pdf (Last accessed February 2019).
	OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY. <i>Demonstration of LED Street Lighting</i> , June 2013, available at http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2013_gateway-msslc_kc.pdf (Last accessed February 5, 2019).
	OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY. <i>SSL Demonstration: Roadway Lighting Philadelphia</i> , June 2013, available at http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/philadelphia_brief.pdf (Last accessed February 2019).
	OFFICE OF THE FIRE MARSHALL. <i>Nova Scotia Building Code Regulations Energy Efficiency Requirements</i> , 2017, available at https://ecologyaction.ca/sites/ecologyaction.ca/files/images-documents/Joe%20Rogers%20Energy%20Efficiency%2020170517.pdf (Last accessed February 18, 2019).
	STATISTICS CANADA. <i>Catalogue No. 64-001-X, Building Permits</i> , December 2015, available at http://www.statcan.gc.ca/pub/64-001-x/64-001-x2015012-eng.pdf (Last accessed January 15, 2019).
	STATISTICS CANADA. <i>Catalogue Table 026-0002 Building permits, dwelling units by type of dwelling and area</i> , 2016, available at http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=260002 (Last accessed January 15, 2019).
	STATISTICS CANADA. <i>Population and Dwelling Count Highlight Tables, 2016 Census</i> , available at https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/hltfst/pd-pl/Table.cfm?Lang=Eng&T=101&S=50&O=A (Last accessed February 4, 2019).

APPENDIX II

CALCULATION OF MARGINS OF ERROR

This appendix presents some examples of how the Evaluator has established the margins of error of participant surveys, installation rates, adjustment ratios, free-ridership levels and measured energy consumption levels. The following examples taken from the 2017 evaluation are consistent with the methodology used for the 2018 evaluation. For the margins of error of the participant survey and installation rates, the examples are from the 2017 Efficient Product Installation (EPI) program component, the margin of error of the adjustment ratios are from the 2017 Business Energy Rebates (BER) Mail-in program component, and the margins of error of the free-ridership levels and measured energy consumptions are from the 2017 Green Heat program component.

Margin of Error of the Surveys

The 2017 EPI non-low-income survey margin of error was established by using the following formula, which corresponds to the margin of error calculation for a proportion (i.e. a value between 0 percent and 100 percent):

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

Where:

- › $Z\alpha$ is the coefficient used at a specific confidence level.
- › p is the proportion (typically conservatively established 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.

This example's sample size is 100. Therefore, a $Z\alpha$ coefficient of 1.645 was used, as presented in Table 1 below.

Table 1: Distribution of Coefficients t

Sample size	Confidence Level		
	95%	90%	80%
2	12.71	6.31	3.08
3	4.30	2.92	1.89
4	3.18	2.35	1.64
5	2.78	2.13	1.53
10	2.26	1.83	1.38
15	2.14	1.76	1.35
20	2.09	1.73	1.33
25	2.06	1.71	1.32
30	2.05	1.70	1.31
∞*	1.96	1.64	1.28

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

By using the formula mentioned above and assuming a confidence level of 90 percent, a proportion of 0.50, and a total number of EPI non-low-income participants equal to 7,625, the margin of error was established at 8.2 percent.

$$8.2\% = 1.64 \times \sqrt{\frac{0.50 \times (1 - 0.50)}{100}} \times \sqrt{\frac{7,625 - 100}{7,625 - 1}}$$

In 2018, this calculation was performed for all participant surveys.

Margin of Error of the Installation Rates

What follows is a description of the steps followed by the Evaluator to calculate this margin of error, using the example of the installation rate for light-emitting diode (LED) lamps in EPI.

Calculation of the Weighted Average of Installation Rates

The weighted average was calculated by using the following formula:

$$\text{Weighted Average IR} = \frac{\sum_{i=1}^N \text{Installation Rate}_i \times \text{Number of Tracked LED Lamps}_i}{\text{Total Number of Tracked LED Lamps}} = 98\%$$

Where N is the total number of on-site visits and i represents each individual participating household visited. The Evaluator established the LED lamps' average installation rate at 98 percent.

Calculation of the Weighted Standard Deviation

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

$$\begin{aligned} & \text{Weighted Standard Deviation IR} \\ &= \sqrt{\frac{\sum_{i=1}^N \text{Number of Tracked LED Lamps}_i \times (\text{Installation Rate}_i - \text{Weighted Average IR})^2}{\frac{(N'-1) \times \sum_{i=1}^N \text{Number of Tracked LED Lamps}_i}{N'}}} = 0.085 \end{aligned}$$

Where N' represents the on-site visits for which the number of tracked LED lamps was higher than zero. In the case of LED lamps, N is 110 and N' is equal to 109.

Calculation of the Margin of Error

The margin of error of the LED lamps' installation rate was established by using the following formula, which applies to samples drawn from an infinite population (defined as being at least 10 times larger than the sample size):

$$\text{Margin of Error IR} = \frac{\text{Weighted Standard Deviation} \times t}{\sqrt{N}} = \pm 1.3\%$$

Where N is the number of surveyed participants (the sample size), while the coefficient t was determined by using **Erreur ! Source du renvoi introuvable.** It should be noted that for sample sizes bigger than 30, the coefficient z (1.64 at a confidence level of 90%) was used.

By using the formula shown above, the margin of error for the installation rate of LED lamps was established at 1.3 percent.

This calculation was performed only for EPI in the 2018 evaluation.

Margin of Error of the Adjustment Ratios

What follows is a description of the steps followed to calculate the margin of error for the adjustment ratio applied to energy savings, using the example of lighting measures from the 2017 BER Mail-In evaluation.

Calculation of the Weighted Average of Adjustment Ratios

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

$$\text{Weighted Average AR} = \frac{\sum_{i=1}^N \text{Adjustment Ratio}_i \times \text{Tracked Energy Savings}_i}{\text{Total Tracked Energy Savings}} = 0.927$$

Where N is the total number of evaluated measures (73) and i represents each individual measure evaluated. The Evaluator established the lighting measures' weighted average adjustment ratio at 0.927.

Calculation of the Weighted Standard Deviation

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

Weighted Standard Deviation AR

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

$$= 0.360$$

Where N represents the number of measures reviewed as part of the impact evaluation and N' represents the number of reviewed measures for which the tracked energy savings were higher than zero. In the case of lighting measures, N is 73 and N' is 73. The weighted standard deviation for the adjustment ratio of energy savings for lighting measures was established at 0.360.

Calculation of the Margin of Error

The margin of error of the lighting measures' adjustment ratio was established by using the following formula, which applies to samples drawn from a small population (defined as being less than 10 times the sample size):

$$\text{Margin of Error AR} = \frac{\text{Weighted Standard Deviation} \times t}{\sqrt{\frac{N(M-1)}{(M-N)}}} = \pm 6.4\%$$

Where M is the population size and the coefficient t was determined by using Table 1 **Erreur ! Source du renvoi introuvable.** Since N is larger than 30, the coefficient z was used in place of the coefficient t .

By using the formula shown above and a population size of 503, the margin of error for the adjustment ratio applied to the energy savings generated by lighting products was established at 6.4 percent.

In 2018, this calculation was performed for the following program components and service: Small Business Energy Solutions (SBES), BER Mail-In service and Custom (Retrofit service).

Margin of Error of the Free-ridership Levels

The Evaluator used the margin of error calculation of the free-ridership level for biomass and solar measures installed through Green Heat in 2017 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:

$$\text{Weighted Average FR} = \frac{\sum_{i=1}^N \text{Free Ridership Level}_i \times \text{Revised Gross Energy Savings}_i}{\text{Total Revised Gross Energy Savings}} = 36\%$$

Where N is the total number of surveyed participants who installed biomass or solar measures and i represents each individual participant surveyed. The Evaluator established the weighted average free-ridership level at 36 percent.

Calculation of the Weighted Standard Deviation

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

$$\begin{aligned} \text{Weighted Standard Deviation FR} &= \sqrt{\frac{\sum_{i=1}^N \text{Revised Gross Energy Savings}_i (\text{Free Ridership}_i - \text{Weighted Average FR})^2}{\frac{(N'-1) \sum_{i=1}^N \text{Revised Gross Energy Savings}_i}{N'}}} \\ &= 0.262 \end{aligned}$$

Where N' represents the number of surveyed participants who had energy savings higher than zero. In the case of biomass and solar measures, both N and N' are 16. The weighted standard deviation for the free-ridership level of biomass and solar measures was established at 26.2 percent.

Calculation of the Margin of Error

The margin of error of the free-ridership level of biomass and solar measures was established by using the following formula, which applies to samples drawn from a small population:

$$\text{Margin of Error FR} = \frac{\text{Weighted Standard Deviation} \times t}{\sqrt{\frac{N(M-1)}{(M-N)}}} = \pm 4.9\%$$

Where N is the sample size, M is the population size and the coefficient t was determined by using Table 1. Since the sample size was 16, the corresponding t coefficient was established at 1.75 for a confidence interval of 90 percent. By using the formula shown above and a population size of 86, the margin of error for the free-ridership level of biomass and solar measures was established at 4.9 percent.

This calculation was performed for all program components whose free-ridership level was measured in 2018, except for the following program components: Building Optimization (BOpt), Energy Management Information Systems (EMIS), Strategic Energy Management (SEM), Small Business Energy Solutions (SBES), Home Energy Assessment (HEA) and Appliance Retirement (ARet). The free-ridership levels of BOpt, EMIS and SEM were not measured because they are considered to be nil. The free-ridership levels from past evaluations were used for SBES and HEA and the free-ridership levels for Appliance Retirement were not measured as a percentage for each participant.

Margin of Error for Measured Energy Consumption

The Evaluator used the margin of error calculation of the unitary savings value established for mini-split heat pumps (MSHPs) installed through Green Heat in fully electrically heated households in 2017. This methodology was applied to calculate the margins of error of metered results. Below are the steps followed to calculate this margin of error.

Calculation of the Average of Unitary Savings Values

The simple average was calculated by using the following formula:

$$\text{Average Unitary Savings} = \frac{\sum_{i=1}^N \text{Unitary Savings}_i}{N} = 0.179 \frac{\text{kWh}}{\text{Btu/h}}$$

Where N is the number of fully electrically heated participating households for which the unitary savings value was calculated, and i represents each of those households. The Evaluator established the average unitary savings value at 0.179 kWh/Btu/h.

Calculation of the Standard Deviation

Since the simple average was used to establish the unitary savings value of MSHPs, the Evaluator used the standard deviation. The following formula was used to calculate the standard deviation.

$$\begin{aligned} \text{Standard Deviation Unitary Savings} &= \sqrt{\frac{\sum_{i=1}^N (\text{Unitary Savings}_i - \text{Average Unitary Savings})^2}{(N - 1)}} \\ &= 0.149 \frac{\text{kWh}}{\text{Btu/h}} \end{aligned}$$

The standard deviation of the unitary savings value for MSHPs installed in fully electrically heated households was established at 0.149 kWh/Btu/h.

Calculation of the Margin of Error

The margin of error of the unitary savings value was established by using the following formula, which applies to samples drawn from an infinite population.

$$\text{Margin of Error Unitary Savings} = \frac{\text{Weighted Standard Deviation} \times t}{\sqrt{N}} = \pm 0.022 \frac{\text{kWh}}{\text{Btu/h}}$$

Where N is the sample size, while the coefficient t was determined by using Table 1. Since the sample size is bigger than 30, the coefficient z was used.

By using the formula shown above, the margin of error for the unitary savings of MSHPs installed in fully electrically heated households was established at 0.022 kWh/Btu/h.

In 2018, this calculation was performed for Green Heat (as part of an air-source heat pump billing analysis) and Appliance Retirement (as part of the measurement of the retired appliances' energy consumption).

APPENDIX III NTGR CALCULATIONS

This appendix provides some examples to illustrate the Evaluator's calculations of free-ridership, participant spillover and net-to-gross ratio values in the 2018 evaluation. To demonstrate how to apply the algorithm for calculating these values, this appendix provides examples from the EPI program component and Custom Retrofit service. The Evaluator used a similar approach in assessing the free-ridership, participant spillover and net-to-gross ratio of other program components. More details can be found in the evaluation reports of the individual program components. The following pages present screenshots of the attached Excel document.

NTGR Calculations



Appendix_NTGR_final
.xlsx

How to open the Excel file: Word: Double click on the icon

Efficient Product Rebates - LED Bulbs, Owners							
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
FR2. If ENS had not installed these [LED bulbs/low flow showerheads] at no charge as part of the EPI Service, would you have paid the full cost of the LED bulbs, which is approximately \$4 per bulb? (Scale 0 to 10)	FR2 = Answer x 10% IF DK OR REF: FR2a = EMPTY	4	40%	5	50%	7	70%
FR3a. If the service had not been offered, what is the likelihood that you would have taken the initiative to purchase [LED bulbs/low flow showerheads] at a store and then installed them yourself in your home? (Scale 0 to 10)	FR3 = Answer x 10% IF DK OR REF: FR2a = EMPTY	4	40%	5	50%	7	70%
PA1 Score	MEAN VALUE OF: (FR2a; FR3)	-	40%	-	50%	-	70%
FR1. Did you or anyone in your household have specific plans to purchase and install [LED bulbs/low flow showerheads] prior to learning about the EPI Service?	IF 1. Yes: Use FR1a IF 2. No OR DK OR REF: FR1a = 0%	2	-	1	-	2	-
FR1a. [ASK IF FR1=YES] I just want to make sure - Before you learned about the EPI Service, you had already made the decision to purchase and install [LED bulbs/low flow showerheads] in your home?	IF 1. Yes: FR1a=100% IF 2. No OR DK OR REF: FR1a = 0%	-	0%	1	100%	-	0%
PA2 Score	FR1a	-	0%		100%		0%
FR4. Level of influence (Scale 0 to 10)	FR4 = MAX(FR4a; FR4b)	-	10	-	8	-	9
Factor a. The installation of energy efficient products, at no-charge, offered by the service		10		8		9	
Factor b. Information or advice provided by the service staff		7		7		9	
PA3 Score	(10 - FR4) x 10%	-	0%	-	20%	-	10%

FR3b. If the service had not been offered, what is the likelihood that you would have postponed replacing [your bulbs with LEDs/your showerheads]? (Scale 0 to 10)	FR3b = (10 - ANSWER) x 10% IF DK OR REF: FR2c = EMPTY	-	-	7	30%	5	50%
PA4 Score	FR3b	-	-	-	30%	-	50%
FR3c [ASK IF LED bulbs/low flow showerheads and/or showerwands QUANTITY >1] If the service had not been offered, what is the likelihood that you would have purchased and installed all [QUANTITY] [LED bulbs/showerheads] that were installed through EPI? (Scale 0 to 10)	FR3c = ANSWER x 10% IF DK OR REF: FR2c = EMPTY	0	0%	9	90%	3	30%
PA5 Score	FR3c		0%		90%		30%
Inconsistency Test PA1	IF ABS(FR2 - FR3a) ≥ 50%: PA1 = MIN (FR2 ; FR3a)	-	40%	-	50%	-	70%
Inconsistency Test PA2	IF FR1a = 100% AND FR2 OR FR3a < 70%: PA2 = EMPTY	-	0%	-		-	0%
Free-ridership	MEAN VALUE OF: (PA1 ; PA2 ; PA3; PA4 ; PA5)	-	10%	-	48%		32%
CI2/CI4 [Your previous participation in an ENS program or service and what you learned by participating in this program]/[The energy efficiency promotional materials distributed by ENS] greatly influenced your decision to have energy-efficient products installed in your home. (Scale 0 to 10)	CI = MAX(CI2 ; CI4)	-	10	-	6	8	8
		10		6		8	
Revised Free-ridership	IF CI ≥ 7 AND CI < 9, FR*75% IF CI ≥ 9, FR*50%	-	5%	-	48%	-	24%

NTGR calculation for non-low-income participants, LED lighting			
Free-ridership level (%) for LED lighting, for owners	$FR_{LED,owners} = \frac{\sum_{i=1}^n (FR_i \times Gross\_Savings_i)}{\sum_{i=1}^n Gross\_Savings_i}$	Where n represents each surveyed participant	
	$FR_{LED,owners} =$	23%	
Overall free-ridership level (%) for LED lighting	$FR_{LED} = FR_{LED,owners} \times \%Gross\_Savings_{Owners} + FR_{LED,tenants} \times \%Gross\_Savings_{tenants}$		
	$FR_{LED} =$	23%	
Spillover level (%) applied to all products, for owners	$SO_{owners} = \frac{\sum_{i=1}^n SO\_Savings_i}{\sum_{i=1}^n Gross\_Savings_i}$		
	$SO_{owners} =$	3%	
Overall Spillover level (%) applied to all products	$SO_{NLI} = SO_{owners} \times \%Gross\_Savings_{Owners} + SO_{tenants} \times \%Gross\_Savings_{tenants}$		
	$SO_{NLI} =$	3%	
NTGR calculation, non-low-income	$NTGR_{LED,NLI} = 1 - FR_{LED,NLI} + SO_{NLI}$		
	$NTGR_{LED} =$	0.80	
Overall NTGR calculation, LED lighting	$NTGR_{LEDtotal} = F = NTGR_{LED,NLI} \times \%Gross\_Savings_{LED,NLI} + NTGR_{LED,LI} \times \%Gross\_Savings_{LED,LI}$		
NTGR for low-income participants assumed to be 1.	$NTGR_{LEDtotal}$	0.86	

Custom Retrofit							
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
FR2a. If the program support or financial incentive had not been offered, what is the likelihood that you would have implemented exactly the same energy efficiency measures that you implemented through Custom Retrofit? (Scale 0 to 10)	FR2a = Answer x 10% IF DK OR REF: FR2a = EMPTY	3	30%	3	30%	3	30%
FR3. If your organization had not received the [FINANCIAL INCENTIVES], would you have paid the full cost of the energy efficiency measures you implemented? (Scale 0 to 10)	FR3 = Answer x 10% IF DK OR REF: FR2a = EMPTY	1	10%	6	60%	3	30%
FR5b-c. Without the incentive, was the payback period short enough for the project to be implemented?	IF2. No: FR3 / 2 OTHERWISE: FR3	NA	-	NA	-	NA	-
PA1 Score	MEAN VALUE OF: (FR2a; FR3)	-	20%	-	45%	-	30%
FR1b. Before participating in Custom Retrofit, had your organization decided to implement the specific energy efficiency measures that were implemented through Custom Retrofit?	IF 1. Yes: Use FR1c IF 2. No OR DK OR REF: FR1c = 0%	NA	0%	2	-	2	-
FR1c. [ASK IF FR1b=YES] I just want to make sure - Before you decided to participate in Custom Retrofit, you had already made the decision to implement the energy efficiency measures you implemented through Custom Retrofit?	IF 1. Yes: FR1c=100% IF 2. No OR DK OR REF: FR1c = 0%	-	0%	-	0%	-	0%
PA2 Score	FR1c	-	0%	-	0%	-	0%
FR6. Level of influence (Scale 0 to 10)	FR4 = MAX(FR4a; FR4b; FR4c; FR4d; FR4e)	-	9	-	8	-	9
Factor a. The program rebate		9		8		9	
Factor b. Recommendations and technical assistance provided by Efficiency Nova Scotia		9		2		3	
Factor c. Confidence in the project		9		4		9	
Factor d. Study		-		8		-	
Factor e. OEM		-		-		-	
PA3 Score	(10 - FR4) x 10%	-	10%	-	20%	-	10%

FR2c. If the program support or financial incentive had not been offered, what is the likelihood that you would have postponed the implementation of the energy efficiency measures by at least one year? (Scale 0 to 10)	FR2c = (10 - ANSWER) x 10% IF DK OR REF: FR2c = EMPTY	10	0%	8	20%	7	30%
PA4 Score	FR2c	-	0%	-	20%	-	30%
Inconsistency Test PA1	IF ABS(FR2a - FR3) ≥ 50%: PA1 = MIN OF (FR2a ; FR3)	-	20%	-	45%	-	30%
Inconsistency Test PA2	IF FR1c = 100% AND FR2a OR FR3 < 70%: PA2 = EMPTY	-	0%	-	0%	-	0%
Free-ridership	IF PA4 < MEAN (PA1; PA2; PA3) FR = MEAN (PA1; PA2; PA3; PA4) OTHERWISE FR = MEAN (PA1; PA2; PA3)	-	8%	-	21%	-	13%
FR8a/FR10a. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] was a major factor in your decision to implement this measure. (Scale 0 to 10)	CI = IF(MAX(FR8a; FR10a) ≥ 8 : 1) + IF(MAX(FR8b; FR10b) ≥ 8 : 1) + IF(MAX(FR8c; FR10c) ≥ 8 : 1)	-	0	1	0	9	1
FR8b/FR10b [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted you to ask for a contractor or technical staff member to examine the energy efficiency options for your facility. (Scale 0 to 10)		-		5		5	
FR8c/FR10c. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted you to take into account the cost-effectiveness of an energy efficiency measure by evaluating the various options [for your organization/before participating in the Custom program]. (Scale 0 to 10)		-		5		5	
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	-	8%	-	21%	-	13%

Overall free-ridership level (%) for the program component		$FR = \frac{\sum_{i=1}^n (FR_i \times Gross\_Savings_i)}{\sum_{i=1}^n Gross\_Savings_i}$					
		FR =	14%				
Overall spillover level (%) for the program component		$SO_{total} = \frac{\sum_{i=1}^n SO\_Savings_i}{\sum_{i=1}^n Gross\_Savings_i}$	Where n represents the number of participants surveyed				
		SO_{total} =	0%				
NTGR calculation							
	NTGR = 1-FR_{total}+SO_{total}	NTGR=	86%				

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

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

Where n represents the number of participants surveyed
FR calculated for 3 categories of participants:
Audit, DIY-Lighting and DIY-HVAC

$$FR_{Total} = \frac{FR_{Audit} \times Gross\_Savings_{Audit} + FR_{DIY-Lighting} \times Gross\_Savings_{DIY-Lighting} + FR_{DIY-HVAC} \times Gross\_Savings_{DIY-HVAC}}{Gross\_Savings_{Total}}$$

$$FR_{total} = 12\%$$

Spillover Algorithm		Example participant (none with spillover this year)	
Questions	Calculation Algorithm	Answer	Calculation Result
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	1	-
SO2. Did you receive, or plan on requesting, financing or rebates from other agencies other than Efficiency Nova Scotia for these additional energy efficiency upgrades?	IF 2. No: CONTINUE IF 1. Yes OR DK OR REF: END	2	-
SO4. Describe these additional measures.	SO4 = SUM of kWh associated with each upgrade	Measures implemented before participating in BER program	0
Additional Upgrade Savings	SO4	-	0
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%	0	0%
Attribution Level	SO3	-	0%
Spillover Savings	SO3 x SO4	-	0%

Overall spillover level (%) for the program component

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

Where n represents the number of participants surveyed

$$SO_{total} = 0\%$$

NTGR calculation

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

$$NTGR = 88\%$$



ECONOLER

RESIDENTIAL EFFICIENT PRODUCT REBATES PROGRAM

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Final Report

March 15, 2019



ABBREVIATIONS

ARet	Appliance Retirement
BNI	Business, non-profit and institutional
CFL	Compact fluorescent lamp
CRA	Corporate Research Associates
DA	Delivery agent
DSM	Demand-side management
EISA	Energy Independence and Security Act
ENS	Efficiency Nova Scotia
EPI	Efficient Product Installation
EUL	Effective useful life
GHG	Greenhouse gas
HRCE	Halifax Regional Centre for Education
HRSB	Halifax Regional School Board
LED	Light-emitting diode
NERHOU	Northeast Residential Hours-of-Use
NRCan	Natural Resources Canada
NSP	Nova Scotia Power
NTGR	Net-to-gross ratio
PF	Power factor
SEER	Seasonal energy efficiency ratio
SKU	Stock keeping unit
TRM	Technical Reference Manual
UEC	Unitary energy consumption
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.
Base case	To determine gross savings, a 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 base case may include such information as the hours of operation, wattage and the 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 the energy simulations and the actual energy consumption of the building or system.
Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
Displaced wattage	The displaced wattage is defined as the difference between the wattage values of the baseline equipment or product and the efficient equipment or product.
EnerGuide rating	An EnerGuide (official brand of Natural Resources Canada) rating is a standard measure of the home's energy performance. It is a measure of the efficiency of the building only and does not take into account occupant behaviour. It shows how energy efficient the home is through modelled heat losses of the home, based on several factors including building envelope characteristics, heated volume, heating systems and air leakage.
Effective useful life	The period a measure is expected to be in service and provide both energy and peak demand savings. This value combines the equipment life and the measure persistence, which includes factors such as business turnover or early retirement.
Equipment life	The number of years installed equipment will operate before it fails.
Equivalent CO ₂	A unit of measurement indicating the amount of carbon dioxide to which various kinds of emitted greenhouse gases are equivalent in terms of warming effects. In this report, the gases' global-warming potential is estimated over a timescale of 100 years.
Equivalent effective useful life	The number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. This value takes into account variations in annual energy savings throughout the effective useful life due to increased baselines.

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

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

TABLE OF CONTENTS

EXECUTIVE SUMMARY	X
INTRODUCTION	1
1 ARET OVERVIEW.....	3
1.1 Description.....	3
1.2 Follow-up on 2017 Evaluation Report Recommendations	4
1.3 Participation History	5
2 ARET EVALUATION OBJECTIVES AND METHODOLOGY	7
3 ARET MARKET EVALUATION	10
4 ARET IMPACT EVALUATION.....	11
4.1 Metering Review	11
4.2 Calculation Methodology.....	13
4.3 Refrigerator Unitary Savings.....	14
4.4 Freezer Unitary Savings	15
4.5 Room Air Conditioner Unitary Savings.....	17
4.6 Small Appliance Retirement.....	17
4.7 Appliances Replaced Through HomeWarming	19
4.7.1 Refrigerator Replacement	19
4.7.2 Freezer Replacement.....	20
4.7.3 Dehumidifier Replacement	20
4.8 Summary of Unitary Savings Values.....	20
4.9 Peak Demand Savings	21
4.10 Interactive Effects	22
4.11 Effective Useful Life	23
4.12 Overall Gross Savings	24
4.13 Participant Spillover.....	26
4.14 NTGR Calculation.....	27
4.15 Overall Net Savings.....	27
5 ARET RECOMMENDATIONS	31
6 INSTANT SAVINGS OVERVIEW.....	32
6.1 Description.....	32

6.2	Follow-up on 2017 Evaluation Report Recommendations	33
6.3	Participation History	34
7	INSTANT SAVINGS EVALUATION OBJECTIVES AND METHODOLOGY	36
8	INSTANT SAVINGS MARKET EVALUATION	39
8.1	Partner Perspectives.....	39
8.1.1	Satisfaction with Instant Savings	39
8.1.2	Influence of Instant Savings and Barriers.....	41
8.2	Participant Perspectives.....	43
9	INSTANT SAVINGS IMPACT EVALUATION.....	46
9.1	Gross Savings	46
9.1.1	Unitary Savings Values	46
9.1.2	Peak Demand Savings.....	48
9.1.3	Interactive Effects.....	50
9.1.4	Effective Useful Life.....	52
9.1.5	Revised Gross Savings	53
9.2	Net-to-gross Ratio	56
9.2.1	Free-ridership	56
9.2.2	Spillover.....	56
9.2.3	NTGR Calculation	57
9.3	Net Savings.....	58
10	INSTANT SAVINGS MARKET EVOLUTION.....	62
10.1	Market Indicators.....	62
10.1.1	Market Shares of Lighting Technologies in Atlantic Canada	62
10.1.2	LED Lamps Rebated by Instant Savings.....	63
10.1.3	Socket Saturation and Replacement Behaviour.....	64
10.1.4	LED Prices	64
10.1.5	Codes and Standards.....	66
10.2	Measured Free-ridership	66
10.3	Market Evolution Summary	67

11	INSTANT SAVINGS RECOMMENDATIONS	69
12	OVERALL SAVINGS OF THE RESIDENTIAL EFFICIENT PRODUCT PROGRAM	70
	CONCLUSION	71

LIST OF TABLES

Table 1: Overall Participation and Savings for Residential Efficient Product Rebates	x
Table 2: ARet Equivalent Net-to-gross Ratios	xiv
Table 3: Comparison of ARet Tracked and Evaluated Savings at the Generator	xiv
Table 4: Instant Savings Net-to-gross Ratio	xvii
Table 5: Comparison of Instant Savings Tracked and Evaluated Savings at the Generator	xviii
Table 6: Types of Evaluations Conducted for Each Program Component	2
Table 7: Implementation Status of the 2017 Recommendations for ARet	4
Table 8: ARet Survey Sample Size and Margins of Error	9
Table 9: ARet Metering Sample Size by Appliance Manufacture-year and Type	11
Table 10: Retired Unit Average Energy Consumption by Appliance Manufacture-year and Type	12
Table 11: Tracked Savings by Appliance Type	14
Table 12: Final Energy Consumption Values for Refrigerators	15
Table 13: Net Savings per Refrigerator	15
Table 14: Final Energy Consumption Values for Freezers	16
Table 15: Net Savings per Freezer	16
Table 16: Net Savings per Room Air Conditioning Unit	17
Table 17: Final Energy Consumption Values for Small Appliances	18
Table 18: Net Savings per Small Refrigerator	18
Table 19: Net Savings per Small Freezer	19
Table 20: Tracked and Revised Unitary Savings by Appliance Type	21
Table 21: Peak-demand-to-energy Ratios by Appliance Type	22
Table 22: ARet Equivalent Effective Useful Life Values	24
Table 23: Revised Gross Energy and Peak Demand Savings by Appliance Type	25
Table 24: Effects and Equivalent NTGR	27
Table 25: Evaluated Net Energy and Peak Demand Savings by Appliance Type	29
Table 26: Comparison of ARet Tracked and Evaluated Savings at the Generator	30
Table 27: List of Rebates by Product	33
Table 28: Implementation Status of 2017 Recommendations for Instant Savings	34
Table 29: Number of Rebated Products Sold Under Instant Savings, 2017-2018	35
Table 30: Retailer Satisfaction with Aspects of Instant Savings	40
Table 31: Retailer Satisfaction with the DA	41
Table 32: Influence of Instant Savings on LED Lamps	42
Table 33: Summary of Tracked and Revised Unitary Savings Values for Instant Savings	47
Table 34: Peak Demand-to-energy Ratios by Product Category	49
Table 35: Interactive Effects Calculations for Lighting Products Installed Indoors	50
Table 36: Interactive Effects Factors for LED Lamps, Fixtures and Other Indoor Devices	51
Table 37: Adjusted Peak Demand-to-energy Ratios by Lighting Product Category	52
Table 38: Revised Equivalent Effective Useful Life Values by Product Category	53
Table 39: Revised Gross Energy and Peak Demand Savings by Product Category for Instant Savings	54

Table 40: Evaluated Net Energy and Peak Demand Savings by Product Category for Instant Savings	59
Table 41: Comparison of Instant Savings Tracked and Evaluated Savings at the Generator	61
Table 42: ENS Rebated LED Lamp Replacement Intention	64
Table 43: Average LED Prices by Lamp Type	65
Table 44: Free-ridership Level for LED Lamps	66
Table 45: Overview of Key Factors in Program Planning	67
Table 46: Overall Participation and Savings for Residential Efficient Product Rebates.....	70

LIST OF FIGURES

Figure 1: Overview of ARet Performance, 2012-2018	xii
Figure 2: Overview of Instant Savings Performance, 2012-2018	xvi
Figure 3: Overview of Participation in ARet, 2012-2018	5
Figure 4: Summary of Gross Savings for ARet, 2012-2018.....	6
Figure 5: ARet Methodological Model	7
Figure 6: Logic Model of the UMP for Net Savings Calculation	13
Figure 7: Summary of Participation in Instant Savings, 2012-2018	35
Figure 8: Instant Savings Methodological Model	36
Figure 9: Importance of Factors in LED Fixture Purchase Decision Process	44
Figure 10: Influence of Factors on LED Fixture Purchase Decision	45
Figure 11: Atlantic Canada Consumer Lighting Shipments by Type of Technology	62
Figure 12: Atlantic Canada Consumer LED Shipments by Lamp Type	63
Figure 13: ENS Instant Savings Rebated LED Lamps	63
Figure 14: Average LED Lamp Prices in Instant Rebates (All Lamp Types)	65
Figure 15: Residential Market Evolution for LED Lamps	68

EXECUTIVE SUMMARY

This report presents the results of the 2018 demand-side management (DSM) evaluation of the Residential Efficient Product Rebates program comprised of two components: (1) Appliance Retirement (ARet); and (2) Instant Savings.

Table 1 lists the number of participants, as well as the gross savings and net savings for each Residential Efficient Product Rebates program component and the whole program.

Table 1: Overall Participation and Savings for Residential Efficient Product Rebates

	Participation Level	Gross Savings	NTGR	Net Savings
ARet				
Energy Savings	5,595 appliances	4.568 GWh	0.58	2.657 GWh
Lifetime Energy Savings ¹		35.043 GWh	0.57	19.822 GWh
Peak Demand Savings		0.640 MW	0.59	0.378 MW
Instant Savings				
Energy Savings	669,550 products sold	24.262 GWh	0.90	21.930 GWh
Lifetime Energy Savings		208.193 GWh	0.91	189.336 GWh
Peak Demand Savings		2.901 MW	0.89	2.572 MW
Total				
Energy Savings		28.830 GWh		24.588 GWh
Lifetime Energy Savings		243.236 GWh		209.158 GWh
Peak Demand Savings		3.542 MW		2.951 MW

Appliance Retirement

Efficiency Nova Scotia (ENS) promotes the retirement of inefficient household appliances, including full-sized and small refrigerators, full-sized and small freezers, and room air conditioners. ARet is designed to educate Nova Scotians about the cost of maintaining old appliances and encourage them to retire inefficient appliances by offering free pick-ups from their homes and a cash incentive.

The following incentives are offered through ARet:

- › \$30 for each retired refrigerator
- › \$30 for each retired freezer
- › \$10 for each retired air conditioner
- › \$10 for each retired small refrigerator or freezer

¹ Throughout this report, energy savings always refer to first-year energy savings rather than lifetime energy savings unless specified otherwise.

In addition, the replacement of inefficient dehumidifiers, refrigerators and freezers paid by DSM funds through HomeWarming are claimed under ARet.

In 2018, ENS continued to work with representatives of the Halifax Regional Centre for Education (HRCE), formerly known as the Halifax Regional School Board (HRSB), up to March 31, 2018, to retire inefficient appliances in schools.

The 2018 evaluation of ARet was based on a program component documentation review, an interview with the program manager, one visit to the recycling facility, a participant survey, and a unitary savings review.

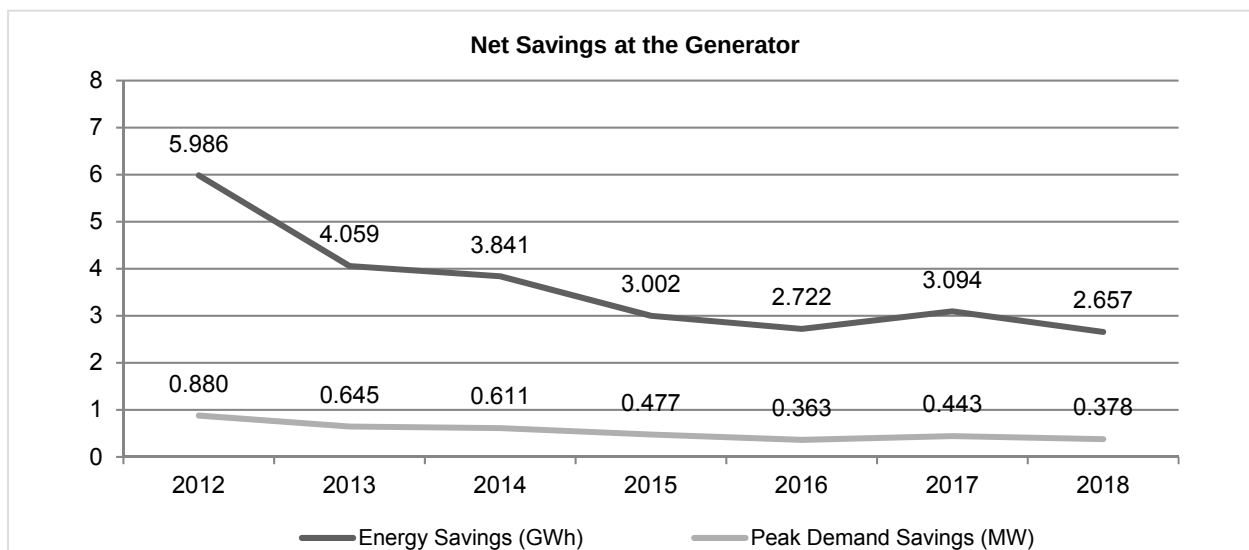
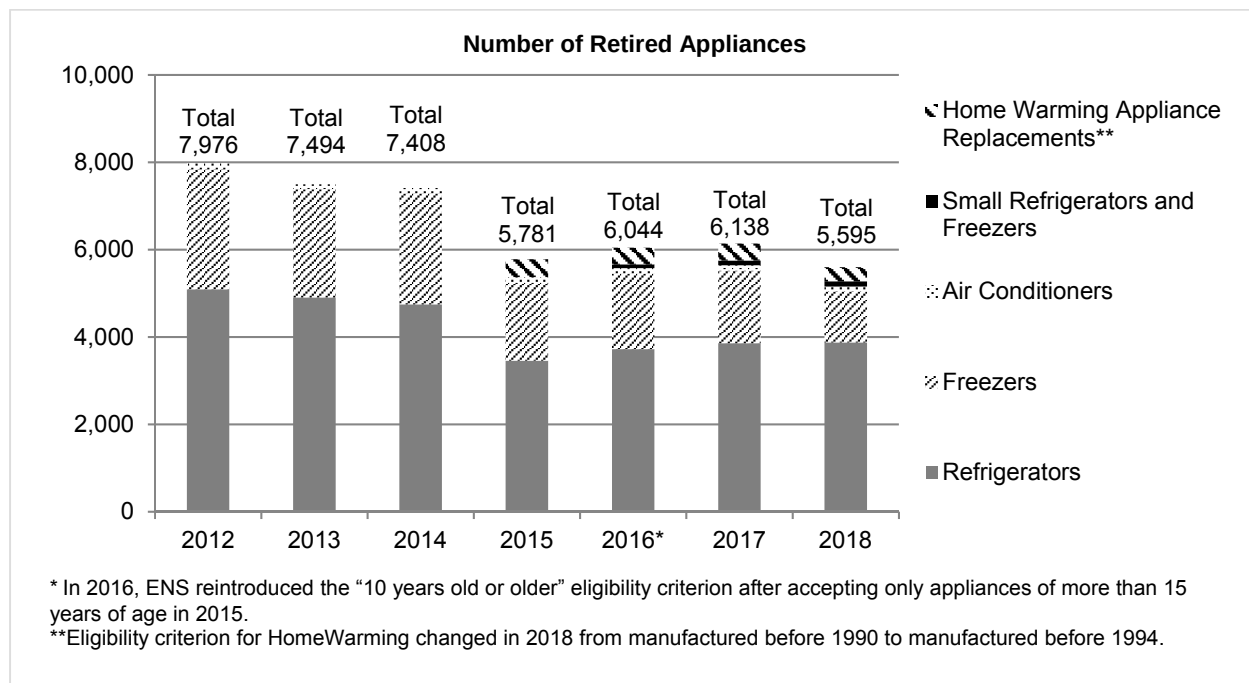
ARet Key Findings

ARet Performance

ARet aimed to achieve 3.1 GWh in net electrical energy savings and 0.4 MW in net peak demand savings at the generator in 2018. The Evaluator determined that ARet achieved 2.657 GWh in net electrical energy savings and 0.378 MW in net peak demand savings at the generator in 2018. These savings represent 1,628 tonnes of CO₂ eq in terms of annual avoided greenhouse gas (GHG) emissions. ARet's net lifetime energy savings were established at 19.822 GWh, which yields a weighted average equivalent effective useful life (EUL) value of 7.5 years.

A total of 5,275 appliances were retired through ARet in 2018, including 3,874 refrigerators, 1,166 freezers, 114 air conditioning units, and 121 small refrigerators/freezers. Additionally, 60 refrigerators, 165 freezers, and 95 dehumidifiers were replaced through HomeWarming. Altogether, 5,595 inefficient appliances were retired or replaced through ARet and HomeWarming in 2018, as illustrated by the performance overview in Figure 1 below. The total number of appliances retired in 2018 was slightly lower than in 2017 due to a decrease in the number of retired freezers. Consequently, savings also decreased compared to 2017.

Figure 1: Overview of ARet Performance, 2012-2018



ARet Market Evaluation Highlights

Overall, ARet achieved a very high level of satisfaction among participants, who provided an average satisfaction rating of 9.6 on a 10-point scale. The convenience of the pick-up service, mentioned as the main reason why participants chose ARet to dispose of their appliances, is also the main reason for their satisfaction with the program component.

In 2018, a new version of the online booking portal was launched by ENS. The survey revealed that three in 10 (30%) participants booked their appliance pick-up appointment through the new online booking portal. Satisfaction with the portal is high, with users providing an average rating of 9.3 on a 10-point scale.

ARet Energy Savings

For the 2018 evaluation, the Evaluator revised the unitary savings values of appliances retired through ARet and HomeWarming using a methodology similar to that used in previous evaluations, except that induced consumption is no longer accounted for, as per updated Uniform Methods Project (UMP) guidelines. Although ENS conducted metering activities in 2018 and started using heat guns to measure appliance internal temperature at the time of pick-up, the Evaluator relied on the 2017 metering results to calculate the energy consumption of retired appliances. As explained in Subsection 4.1, too many variations in 2018 consumption data were observed due to temperature variations in the room where the metering was conducted. Although the 2017 metered energy consumption values were used, the proportion of units in each manufacture-year class and the average volumes for each appliance type, as per the 2018 tracking sheet, were used to update gross unitary savings values. Moreover, the part-use factors, free-ridership levels, secondary market impacts, and spillover level were updated based on the 2018 participant survey results.

The revised parameters resulted in lower net unitary savings values for refrigerators and freezers retired through ARet and higher net unitary savings values for air conditioners and small appliances. Refrigerators, which remain the biggest contributor to ARet savings, had lower unitary savings due to the age of appliances retired in 2018 and a lower part-use factor established through the 2018 participant survey. The unitary savings values for appliances retired through HomeWarming remained approximately the same as in 2017.

To establish an equivalent net-to-gross ratio (NTGR), the Evaluator took into consideration the free-ridership values and secondary market impact values applicable to the unitary savings and the spillover level applicable to the program's overall gross savings by using the following formula:

$$NTGR_{equiv} = \frac{Net\ Unitary\ Savings}{Gross\ Unitary\ Savings} + Spillover\ \%$$

Table 2 presents the equivalent NTGR for each appliance type.

Table 2: ARet Equivalent Net-to-gross Ratios

Appliance Type	Number of Units	Gross Savings	Effects		Net Unitary Savings (kWh)	Participant Spillover	Equivalent NTGR
		Consumption of Retired Appliances (kWh)	Free-ridership (kWh)	Secondary Market Impact (kWh)			
Refrigerators	3,874	687	240	58	389	0%	0.57
Freezers	1,166	945	425	70	450		0.48
Air Conditioners	114	218	90	13	115		0.53
Small Refrigerators	60	188	51	8	129		0.69
Small Freezers	61	316	85	12	219		0.69

As for the appliances replaced through HomeWarming, a NTGR of 1 was assumed considering the nature of HomeWarming (direct replacement) and participant demographics.

The impact evaluation revealed that ARet generated 2.657 GWh in net electricity savings and 0.378 MW in net peak demand savings at the generator in 2018, as summarized in Table 3.

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

	Initial Gross Savings	Adjusted Gross Savings	NTGR*	Net Savings
Energy Savings				
Tracked Savings from ENS	4.736 GWh	4.736 GWh	0.58	2.763 GWh
Evaluation Results	4.568 GWh	4.568 GWh	0.58	2.657 GWh
Peak Demand Savings				
Tracked Savings from ENS	0.665 MW	0.665 MW	0.59	0.394 MW
Evaluation Results	0.640 MW	0.640 MW	0.59	0.378 MW

*NTGRs varied 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 overall evaluated net energy savings are 4 percent lower than those tracked by ENS. This difference is mainly due to the lower gross unitary savings value established for refrigerators, which was caused by a different distribution of retired refrigerator ages based on the 2018 tracking sheet data and a lower part-use factor established through the participant survey results compared to 2017 values.

The evaluated net peak demand savings were also 4 percent lower than the tracked net peak demand savings for the same reasons as for the energy savings.

ARet Recommendations

Despite operating in the market for several years, ARet continues to achieve considerable levels of participation and savings by encouraging the retirement of inefficient appliances. In addition to the general recommendations made for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator has two major recommendations to improve ARet, which are presented below and are also outlined in Appendix VI.

2018 ARet-R1. Continue to perform the metering activity and ensure the metering protocol is followed. In the 2017 evaluation, the Evaluator recommended continuing the metering activity to increase the sample size of each age category and lower margins of error of measured appliance consumption. ENS continued the metering activity in 2018, although in-depth analysis indicated that the metered consumption data were inconsistent and could not be used as is. The Evaluator therefore recommends continuing the metering activities in 2019. Moreover, the metering protocol should be closely followed to ensure that the obtained data provide accurate results, notably by ensuring that metering is conducted in a room with controlled temperature.

2018 ARet-R2. Develop and implement a protocol on the heat gun usage process. The Evaluator recommends that ENS formalize the heat gun usage process by developing a protocol for its use. The protocol should describe the appliances to be accepted or rejected based on the metered temperature and the data to be tracked. This protocol would ensure that all non-working appliances, i.e. appliances with inside temperature below target values, are properly identified, tracked, and excluded from the metering sample as well as program results.

Instant Savings

Instant Savings is carried out with the help of one delivery agent (DA) and participating retailers to offer rebates to consumers on the purchase of various energy efficient products that include ENERGY STAR® certified light-emitting diode (LED) lamps and fixtures, programmable thermostats, refrigerators, and clothes washers. In 2018, ENS added ENERGY STAR certified room air purifiers, dehumidifiers,² and smart thermostats to the list of eligible products. Rebates on eligible products were offered during two campaigns that took place in the spring and fall, while rebates on appliances were offered throughout the year.

The 2018 evaluation of Instant Savings was based on a program component documentation review, interviews with nine retailers, an intercept survey of 194 participants conducted during the fall campaign, and a unitary savings review.

² ENERGY STAR certified room air purifiers and dehumidifiers were available for a part of 2017 as part of a pilot offering.

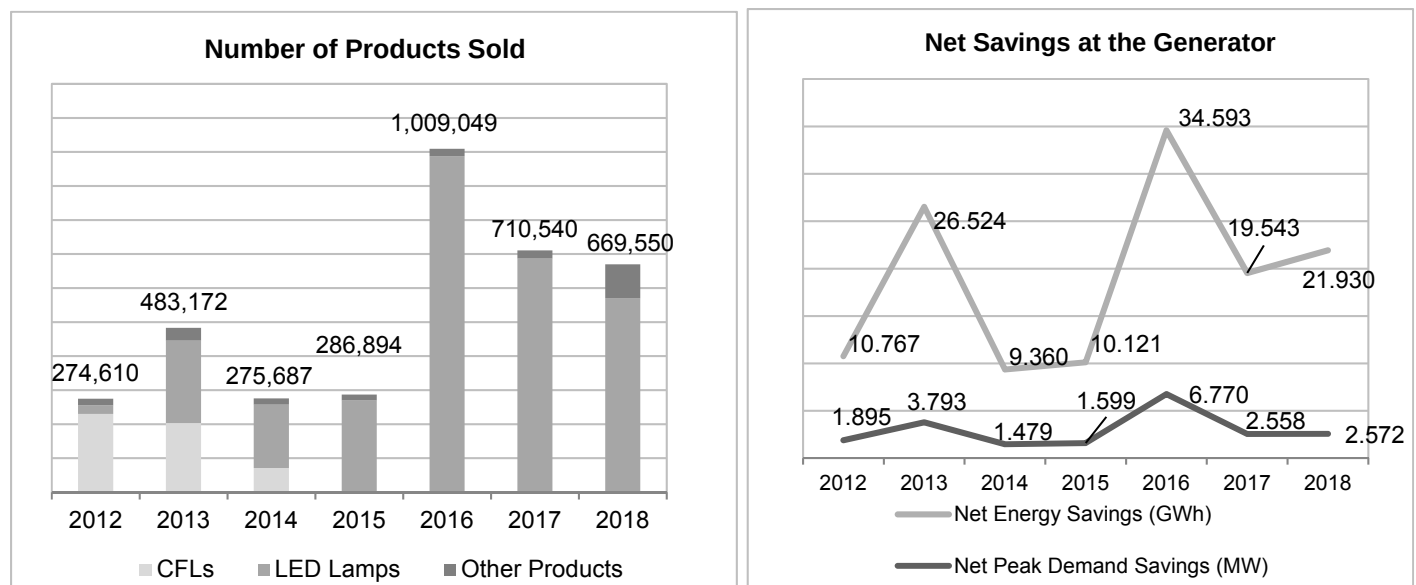
Instant Savings Key Findings

Instant Savings Performance

Instant Savings aimed to achieve 16.2 GWh in net electrical energy savings and 2.1 MW in net peak demand savings at the generator in 2018. The Evaluator determined that Instant Savings achieved 21.930 GWh in net electrical energy savings and 2.572 MW in net peak demand savings at the generator in 2018. These savings represent 13,434 tonnes of CO₂ eq in terms of annual avoided GHG emissions. Instant Savings net lifetime energy savings were established at 189.336 GWh, which yields a weighted average EUL value of 8.6 years.

In 2018, 669,550 eligible products were sold in participating stores across Nova Scotia, as depicted in Figure 2. LED lamps were still a very popular product under Instant Savings, with 570,599 ENERGY STAR certified LED lamps purchased including 443,233 A-type and 127,366 non-A-type LED lamps. Despite the popularity of ENERGY STAR certified LED lamps, the number of A-type LED lamps sold decreased by 15 percent in 2018. In contrast, sales increased for all other product categories rebated through Instant Savings. This indicated that ENS efforts to diversify product offerings beyond A-type lamps were successful.

Figure 2: Overview of Instant Savings Performance, 2012-2018



Instant Savings Market Evaluation Highlights

Overall satisfaction with Instant Savings is high among retailers, after decreasing in 2017 due to the addition of a product price floor that caused frustration among certain retailers. Retailers are particularly very satisfied with Instant Savings marketing and advertising and with their overall relationship with the DA.

Similar to previous years, the participant intercept survey indicated that ENS marketing was the most common way for participants to find out about Instant Savings, primarily through in-store promotions, followed by radio ads, store flyers, TV commercials and word-of-mouth.

As part of the 2018 evaluation, the Evaluator gained insights to better understand the influence of Instant Savings on in-store lighting fixture offerings and purchases. Interviewed retailers were of the opinion that Instant Savings had moderate influence on consumer choices to purchase ENERGY STAR certified fixtures with integrated LED lighting over other types of lighting fixtures. As for surveyed participants, most who bought LED fixtures only considered fixtures with LED lighting when shopping. Surveyed participants said that energy consumption was the most important factor in their decision to buy LED fixtures, although the quality of light provided, as well as the price and appearance of the fixture also obtained high ratings.

Instant Savings Energy Savings

Using a combination of program data, engineering algorithms, and values from the technical literature, the Evaluator validated the unitary savings values used by ENS for each product category rebated through Instant Savings and, where necessary, revised them. The unitary savings values used for ENERGY STAR certified LED lamps and fixtures, which generate by far most of the savings, as well as those used for each type of large appliance, were updated.

Net energy savings, which result from applying a NTGR, represent the savings that can be reliably attributed to the program component. The NTGR was measured for the best-selling product, ENERGY STAR certified LED lamps, and included free-ridership and spillover. As outlined in Table 4, the intercept survey revealed a free-ridership level of 39 percent, which is higher than the 32 percent obtained from the 2017 evaluation. This increase is explained by the fact that a larger proportion of participants were likely to buy LED lamps in the absence of the discount offered through Instant Savings. Retailer interviews and sales data revealed a spillover level of 25 percent, which represents an increase compared to the 2017 level of 16 percent. In 2018, the NTGR for ENERGY STAR certified LED lamps was established at 0.86. For all other products, a NTGR of 1.00 was used. Considering the increasing number of products other than LED lamps sold through Instant Savings, notably LED fixtures, free-ridership will need to be calculated for other products in future evaluations to ensure that the NTGR assessment continues to cover a significant portion of program component savings.

Table 4: Instant Savings Net-to-gross Ratio

Product Category	Free-ridership	Spillover	NTGR
LED Lamps	39%	25%	0.86
All Other Products	-	-	1.00

In 2018, Instant Savings generated 21.930 GWh in net energy savings and 2.572 MW in net peak demand savings at the generator. Table 5 compares tracked and evaluated savings at the generator.

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

	Initial Gross Savings	Revised Gross Savings	NTGR*	Net Savings
Energy Savings				
ENS Tracked Savings	23.653 GWh	23.653 GWh	0.84	19.967 GWh
Evaluation Results	24.262 GWh	24.262 GWh	0.90	21.930 GWh
Peak Demand Savings				
ENS Tracked Savings	2.809 MW	2.809 MW	0.82	2.290 MW
Evaluation Results	2.901 MW	2.901 MW	0.89	2.572 MW

*NTGRs varied for each product category. The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by installed gross savings (with interactive effects taken into account).

The evaluated gross energy savings are 3 percent higher than the tracked gross energy savings. This slight difference is mainly due to the increase in gross unitary savings associated with LED A-type lamps and LED R, BR and decorative lamps that were increased by 12 and 7 percent respectively in the 2018 evaluation. This increase in the unitary savings values of LED A-type lamps results mostly from the increase in displaced wattage. The evaluated net energy savings are 10 percent higher than the tracked net energy savings. This difference is due to the increase in the NTGR resulting from a higher spillover level established for 2018, compared to the 2017 NTGR value used for ENS tracking.

The evaluated net peak demand savings are 12 percent higher than those tracked by ENS for the same reason as the increase in the net energy savings.

Market Evolution

ENS has been active in the LED market since 2011 through Instant Savings. For a second year, the Evaluator completed a market evolution assessment to inform the level of LED lamp market adoption in Nova Scotia.

The popularity of LED lamps continues to increase. The most recent data from Electro-Federation Canada indicated that LED lamp shipments accounted for over half of all residential lighting shipments to Atlantic Canada in 2017. A-type lamps remain the most popular LED lamp, although their share decreased slightly from 2016 to 2017 as other LED lamp types grew in popularity.

Average LED prices appear to be stabilizing. Since 2012, the average LED price has declined, although 2018 data from Instant Savings tracking sheet indicated a slight increase in the price of LED lamps. The availability of LED lamps was already optimal in 2017, as indicated by the various retailers participating in Instant Savings. In addition, an ever-widening range of LED lamps and products are becoming available.

The 2018 evaluation further suggested that the market for LED lamps continues to be in a growth phase and is moving closer to maturity. A-type lamps appear to have reached maturity before other LED types, as indicated by both the small decrease in their share of shipments to Atlantic Canada and their flattening and relatively low price (\$3.70 per unit). Although it is uncertain how increased Atlantic LED shipments translate to LED socket saturation in Nova Scotia, updated socket information would serve to further refine this analysis.

Instant Savings Recommendations

The evaluation revealed that Instant Savings again succeeded to achieve high levels of participation and savings in 2018. Some indicators such as low LED prices and a slight decrease in A-type LED lamp sales suggest that A-type lamps have reached maturity in the Nova Scotia market. Evaluation findings support the ENS decision to remove rebates on A-type lamps as of 2019. The biggest challenges for Instant Savings in the coming years will be to continue diversifying product offerings and investing efforts in energy efficient products for which Instant Savings can influence purchase decisions. In addition to the general recommendations made for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator makes the following recommendations aimed at optimizing Instant Savings. These recommendations are also presented in Appendix XIV.

2018 Instant-R1 Perform a socket study through on-site visits to document energy savings potential related to lighting. Market data point to increasingly high penetration rates of LED lamps and fixtures in Nova Scotia homes. To document the remaining energy savings potential related to lighting in existing homes, the Evaluator recommends conducting a socket study in Nova Scotia homes. The socket study, conducted through on-site visits, should serve to collect information such as the number and type of lamps installed in homes. This study would be helpful for all program components that offer residential lighting measures by providing insights on the current state of lighting market.

2018 Instant-R2 Continue monitoring LED market indicators. Despite the removal of A-type lamps from the Instant Savings offering as of 2019, the Evaluator recommends continuing to monitor the evolution of all LED lamps. Market indicators such as the market shares and prices of lighting technologies should still be collected to understand the changes occurring in the market after A-type lamps are removed. Monitoring market indicators would also help with remaining current on the overall state of the lighting market, which is in a period of change.

INTRODUCTION

Efficiency Nova Scotia (ENS) is operated by EfficiencyOne, an independent, non-profit organization. ENS 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 various segments of the population. ENS has a demand-side management (DSM) portfolio of three residential programs and three business, non-profit and institutional (BNI) programs. Each program has one or more program components that ENS markets to Nova Scotians. ENS receives funding for its activities from Nova Scotia Power (NSP) and the Province of Nova Scotia. The funds received from NSP cover the costs of activities designed to help reduce electricity consumption, whereas funds from the Province of Nova Scotia are primarily used for activities designed to help reduce the use of other fuels.

Econoler was commissioned to evaluate ENS's 2018 DSM program portfolio comprised of six electricity efficiency programs and assess the impacts of energy efficiency codes and standards introduced in Nova Scotia. To carry out this assignment, Econoler collaborated with Research Into Action, Equilibrium Engineering and Corporate Research Associates (CRA). 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 impact evaluation calculations, as well as preparing and reviewing evaluation reports. Research Into Action carried out the process evaluations, while Equilibrium Engineering conducted the on-site visits and contributed to some impact evaluation analyses. CRA conducted interviews and surveys with participants and partners, as well as analyzed and reported on the data collected from these activities. Throughout this report, this team is referred to as the Evaluator.

Table 6 below lists the various programs assessed as part of the 2018 evaluation and indicates their respective components and the types of evaluations conducted. In this table, "C" means a complete evaluation and "R" indicates that reduced evaluation activities were performed. Moreover, Section 1 of the DSM Programs Evaluation Executive Summary presents the scope of work in further detail, along with the rationale for the types of evaluations performed for each program component.

Table 6: Types of Evaluations Conducted for Each Program Component

Program	Program Component	2017			2018		
		Process	Market	Impact	Process	Market	Impact
Residential Efficient Product Rebates Program	Appliance Retirement			R		C	C
	Instant Savings		R	R		C	C
Existing Residential Program	Home Energy Assessment		C	C			R
	Green Heat	C	C	C		C	C
	Efficient Product Installation		C	C		C	R
New Residential Program	New Home Construction		C	C	C		C
Efficient Product Rebates Program	Business Energy Rebates		C	R	C	C	C
Custom Incentives Program	Custom	C*	C	R	C**	C	C
	Energy Management Information Systems		C	C		C	C
	Strategic Energy Management***					C	C
Direct Installation Program	Small Business Energy Solutions		C	C		R	R
* The process evaluation specifically targets the Retrofit service of the Custom program component. ** The process evaluation specifically targets the New Construction service of the Custom program component. *** Due to the start date of the latest Strategic Energy Management (SEM) cohort, SEM did not have any participants who achieved savings in 2017; therefore, no evaluation was conducted for 2017.							

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

This evaluation report is for the Residential Efficient Product Rebates program, which is comprised of two components: Appliance Retirement (ARet) and Instant Savings. In 2017, both program components underwent reduced impact evaluations. In 2018, ARet and Instant Savings underwent complete market and impact evaluations. Each program component description, evaluation methodology and main evaluation findings are presented in the following sections.

1 ARET OVERVIEW

This evaluation report first discusses the ARet evaluation results and then the results from the Instant Savings evaluation.

This section describes ARet, follows up on the 2017 evaluation recommendations and gives an overview of its participation history.

1.1 Description

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

In addition to removing old appliances from participants' homes, ARet recycles these appliances by transporting them to a local recycling depot where over 95 percent of the components are recycled. ARCA Canada Inc. is the delivery agent (DA) responsible for appliance transportation and recycling. To have appliances picked up, participants must register by calling a toll-free number or register online using the 2018 new version of the booking portal available on the ENS website, both of which are managed by the DA. All website booking, scheduling and maintenance activities are wholly the responsibility of the DA.

Eligible appliances must be plugged in and still in working condition and must be 10 years of age or older. In 2018, this meant that eligible appliances had to be manufactured before 2008. In addition, full-sized refrigerators must have a standard size between 10 and 25 cubic feet. To save fuel and ensure that the trip is worthwhile for the pick-up team, room air conditioners and small refrigerators and freezers are only picked up when a participant retires either one full-sized refrigerator or full-sized freezer at the same time. To participate in ARet, participants must own the appliance(s) to be retired.

The following rebates are offered through ARet:

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

In addition, the replacement of inefficient dehumidifiers, refrigerators and freezers paid for by DSM funds through HomeWarming are claimed under ARet. HomeWarming is administered by ENS and provides energy efficiency upgrades (building envelope measures and appliance replacements) at no cost to income-eligible owners of non-electrically heated homes. HomeWarming funding for building envelope measures is provided by the Province of Nova Scotia (PNS), while funding to replace old, inefficient appliances with new high-efficiency models is provided by DSM funds.

In 2018, ENS continued to work with representatives of the Halifax Regional Centre for Education (HRCE), formerly known as the Halifax Regional School Board (HRSB) until March 31, 2018, to retire inefficient appliances in schools.

ARet aimed to achieve 3.1 GWh in net electricity savings and 0.4 MW in peak demand savings for 2018.

1.2 Follow-up on 2017 Evaluation Report Recommendations

ARet was evaluated in 2017 and recommendations were made by the Evaluator for its improvement. Table 7 below provides a brief summary of the implementation status of each recommendation presented in the Executive Summary section of the 2017 evaluation report.

Table 7: Implementation Status of the 2017 Recommendations for ARet

2017 Recommendations	Status
2017 ARet-R1. Continue to perform the metering activity to increase sample sizes.	Implemented
2017 ARet-R2. Improve the process for tracking appliances retired through the pilot.	Implemented

To address 2017 ARet-R1, ENS performed a new round of metering in 2018 and implemented the changes to the metering protocol suggested by the Evaluator. ENS worked with the Evaluator to establish sample sizes that would result in reasonable margins of error. The power factor (PF) is now measured during the entire metering period and a heat gun is used to measure appliance internal temperature at the time of pick-up. The metering results are further discussed in Subsection 4.1.

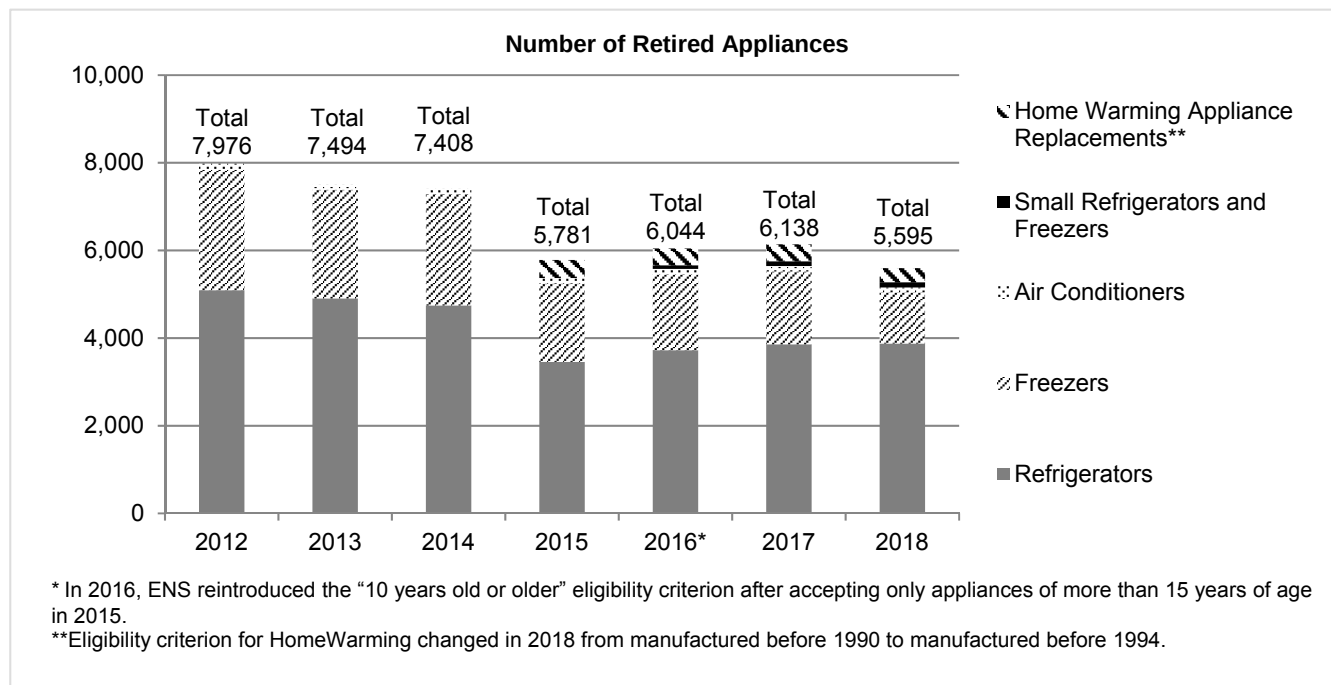
The appliances retired in HRCE schools were formerly part of a pilot project conducted in 2016 and 2017, which consisted of conducting an audit of all refrigeration appliances (refrigerators and freezers) in schools to identify appliance retirement opportunities. In 2018, only four appliances were retired from HRCE schools. These appliances were included in the regular ARet tracking sheet and a note was added to identify them in the tracking sheet in response to 2017 ARet-R2.

1.3 Participation History

In 2018, 5,275 appliances were retired through ARet, including 3,874 refrigerators, 1,166 freezers, 114 air conditioning units and 121 small refrigerators or freezers.³ Additionally, 60 refrigerators, 165 freezers and 95 dehumidifiers were replaced through HomeWarming. A total of 5,595 appliances were retired or replaced through ARet and HomeWarming, as summarized in Figure 3 below. The total number of appliances retired in 2018 was slightly lower than in 2017 due to a decrease in the number of retired freezers, resulting in decreased savings compared to 2017 as shown in Figure 4 further below. In 2018, ARet achieved 4.568 GWh in gross energy savings and 0.640 MW in gross peak demand savings.

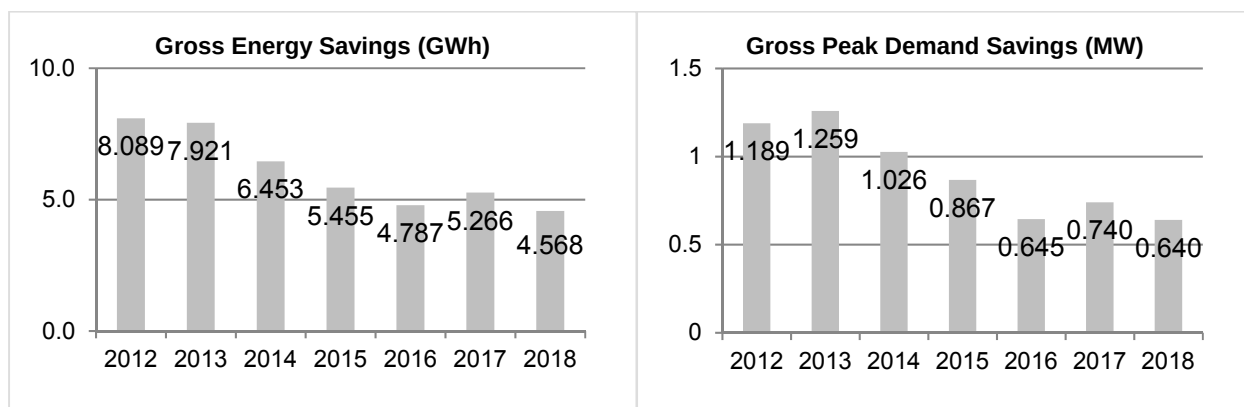
Since 2012, 46,436 old and inefficient appliances have been retired from homes and schools and recycled so that they could not be refurbished, sold second-hand, or left plugged in. As shown in Figure 3, the number of retired appliances has remained fairly constant since 2015. A similar number of retired appliances can be expected in the next few years since the expected life of more recent appliances is less than 15 years. This suggests that ARet is still useful in encouraging the retirement of inefficient appliances.

Figure 3: Overview of Participation in ARet, 2012-2018



³ These figures include the four appliances retired from HRCE schools.

Figure 4: Summary of Gross Savings for ARet, 2012-2018



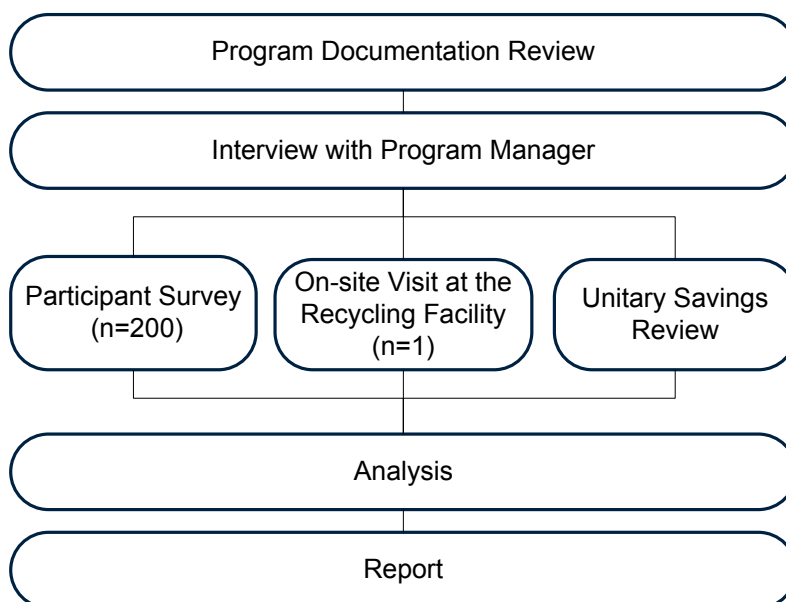
2 ARET EVALUATION OBJECTIVES AND METHODOLOGY

The main objectives of the ARet evaluation are as follows:

- › Reporting on participant perspectives
- › Calculating program results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions

This section presents the methodology used and the activities carried out for the ARet 2018 evaluation to achieve the aforementioned objectives. Figure 5 illustrates the research strategy employed and data-collection activities carried out during the evaluation.

Figure 5: ARet Methodological Model



The Evaluator reviewed the program component documentation and then met with the program manager in September 2018 to verify the implementation status of the previous evaluation recommendations and learn about the program component changes made in 2018. Based on the information obtained from this meeting, a list of questions and topics to be included in the data-collection instruments was prepared.

Once the meeting with the program manager and the program component documentation review were completed, specific evaluation activities were undertaken, as described in the following subsections.

For evaluation activities that were based on a sample and yielded quantitative results, the Evaluator aimed to achieve a maximum margin of error of 10 percent at a confidence level of 90 percent. 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 percent of the time. Thus, the margin of error indicates the relative level of precision⁴ of the measurement, while its associated confidence level indicates the probability of a measurement falling within this margin of error.⁵

As part of the ARet evaluation, the Evaluator calculated the margins of error of both the survey samples and the energy consumption metering data.⁶ The margins of error are listed further below. Examples of the calculations used to establish margins of error are provided in Appendix II of the 2018 DSM Programs Evaluation Executive Summary.

Participant Survey

In October 2018, CRA conducted a telephone survey with a total of 200 participants. The average length of the survey was nine minutes. All five types of appliances covered by ARet (refrigerators, freezers, air conditioners, and small refrigerators and freezers) were covered by the survey. The questionnaire and complete survey results are presented in Appendix I and Appendix II respectively. All the appendices are presented in the Residential Efficient Product Rebates Program – Appendices document.

The participant survey was meant to collect feedback about the following aspects of ARet:

- › Usage of appliance before retirement
- › Appliance replacement
- › Reasons for participation
- › Free-ridership
- › Spillover
- › Satisfaction with ARet and the online booking portal
- › Recommendations for improvement
- › Demographics

The total number of ARet participants was 4,633 for 2018. Drawing a random sample of 200 from a population of 4,633 yields a margin of error of 5.7 percent at a 90 percent confidence level, as presented in Table 8 below.

⁴ 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.

⁵ 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.

⁶ As discussed in Subsection 4.1, the results of the 2018 metering activities were not used for this evaluation. Only the 2017 margins of error are therefore presented in this report.

Table 8: ARet Survey Sample Size and Margins of Error

Type of Appliance	Population	Sample Size (n)	Sampling Error at 90% Confidence Level
Refrigerators	3,664	80	±9.2%
Freezers	1,106	78	±9.1%
Air conditioners	84	22	±15.5%
Small refrigerators and freezers	111	20	±17.1%
Total participants	4,633^{7,8}	200	±5.7%

On-site Visit at the Recycling Facility

In the spring of 2018, the Evaluator conducted one visit at the recycling facility where the appliances retired through ARet are decommissioned and recycled. The main purpose of this visit was to ensure that metering was conducted properly once appliances were delivered to the recycling facility.

Unitary Savings Review

For ARet, the Evaluator reviewed the unitary savings of the retired refrigerators, freezers, air conditioners and small appliances based on the metering data collected by ENS and information found in the literature or in appliance directories. Based on survey results, free-ridership and secondary market impacts were assessed, the results of which were incorporated into the calculations to obtain a per-unit net energy savings value.

For appliances replaced through HomeWarming, the data collected in the tracking sheet, manufacturer information, and ARet metering results were used to establish the energy consumption differences between the old and new appliances.

⁷ For the ARet survey, the Evaluator determined a population of 4,633 unique participants based on their address. These participants all retired at least one appliance, with some of them retiring more than one appliance. For the purposes of the survey, participants who retired more than one appliance were asked to answer in relation to only one of their retired appliances.

⁸ The categories of household appliances were not mutually exclusive. As a result, the total number of participants in the appliance groups was not equal to the total number of participants.

3 ARET MARKET EVALUATION

A survey was conducted as part of the ARet evaluation. In addition to the questions designed for impact evaluation purposes, the 200 survey participants were asked questions regarding their motivations for participating in ARet, as well as their satisfaction and suggestions for improvement.

The main reason participants chose ARet to dispose of their appliances was the convenience of the pick-up service (40%), followed by the desire to receive the incentive (19%).

The majority of participating households (61%) booked their appliance pick-up appointment over the phone, while three in 10 (30%) used the online booking portal. Satisfaction with the online booking portal is high, with users providing an average rating of 9.3 on a 10-point scale where 1 indicates “not at all satisfied” and 10 “completely satisfied”.

When asked what happened to the appliances picked up through ARet, two in three (66%) participants stated that the appliance is recycled or that the hazardous materials are disposed of, indicating that most participants were informed about the recycling aspect of ARet.

Most participants chose to replace their refrigerator (83%) or stand-alone freezer (65%) retired through ARet, although small appliance and air conditioner replacements were less common. Of the participants who replaced their appliances, the majority (82%) opted for either a model bearing the ENERGY STAR Canada registered trademark or a high-efficiency model.

The level of satisfaction with ARet was extremely high, with participants rating on average 9.6 on a 10-point scale where 1 indicates “not at all satisfied” and 10 “completely satisfied”. The convenience of the pick-up service, mentioned above as the main reason why participants chose ARet to dispose of their appliances, is also the main reason for their satisfaction with the program component (66%). Participants were also satisfied with the service they received. They cited the good overall service (32%), the efficient and prompt service (8%) and the friendly service (6%) as reasons for their satisfaction. The small number of participants (six participants) who were less satisfied cited disparate reasons that do not allow identifying opportunities for improvement.

The majority of participants (72%) did not make any recommendations on how to improve ARet. For those who did make suggestions, better advertisements (8%) and accepting a wider variety of products (8%) were most often mentioned.

4 ARET IMPACT EVALUATION

This section presents the findings of the metering review and the results of the impact evaluation for 2018, which are aimed at determining gross and net electrical energy and peak demand savings.

4.1 Metering Review

As recommended in the 2017 Evaluation Report, ENS continued to meter retired appliances in 2018. The Evaluator validated that the appliances were metered adequately by: (1) developing an appliance sampling plan; (2) assisting ENS in implementing the 2017 recommendations concerning new metering equipment; (3) conducting one site visit to the appliance recycling facility to observe the metering processes; and (4) treating the raw data obtained from the metering activities to calculate average energy consumption.

Metering activities for the 2018 evaluation were based on a targeted sample of full-sized fridges and freezers per manufacture-year class. The Evaluator recommended that 140 appliances be metered in 2018, with sample size targets broken down by appliance type and manufacture-year class as presented in Table 9.

Table 9: ARet Metering Sample Size by Appliance Manufacture-year and Type

Appliance Type and Manufacture-year Class	Sample Target	Metered Sample ⁹
Refrigerators		
1994 and earlier	30	31
1995-2001	30	23
2002 and later	40	33
Freezers		
1994 and earlier	20	33
1995 and later	20	16

In 2017, the use of new metering equipment improved the quality of metered data, although PF measurements were still collected using instantaneous values that were not truly representative of the entire metering period. The Evaluator therefore recommended that ENS conduct continuous PF measurements for 2018. In response to the suggested improvement, ENS purchased new loggers (HOBO® UX120-018) capable of continuously measuring AC current, voltage, amperage, PF and total kWh.

⁹ The metered sample presented in Table 9 includes only the number of appliances for which all the necessary information was available to allow the Evaluator to complete the analysis. Four appliances were excluded on that basis. Overall, ENS metered 140 appliances.

During the recycling facility visit, the Evaluator met with ENS to review the site data-collection form, review equipment setup, and conduct a trial process run with the new metering equipment. The Evaluator observed ENS as staff went through the metering protocol step-by-step, including setting up and completing the metering process. Overall, the Evaluator was satisfied that ENS had successfully implemented the use of new metering equipment and was compliant with the documented metering process. However, the visit revealed that the metering room had been relocated to the rear of the warehouse in close proximity to a large loading bay door. The metering data later revealed that room temperature varied above and below the target temperature of 21°C (as defined in the metering protocol), probably as a result of the location of the metering room and the lack of adequate temperature control.

When analyzing the metering data, the Evaluator noticed significant differences between the 2017 and 2018 metered consumption levels. After thoroughly investigating the possible causes of these differences, the Evaluator concluded that the cause was likely the uncontrolled room temperature. In fact, the average metered room temperature in 2018 was nearly 3°C lower than in 2017.

Consequently, the Evaluator elected to rely on the 2017 average metered energy consumption, as presented in Table 10 below. While an average PF was used in 2017 based on an average of instantaneous measurements, the 2018 data obtained with the new loggers allowed the Evaluator to confirm that this average PF was appropriate.

Table 10: Retired Unit Average Energy Consumption by Appliance Manufacture-year and Type

Manufacture-year Class	Average Energy Consumption	2017 Final Sample Size	Margin of Error
Refrigerators			
1994 and earlier	58.9 kWh/cu. ft	13	23.9%
1995-2001	41.1 kWh/cu. ft	20	18.1%
2002 and later	49.2 kWh/cu. ft	20	18.9%
Freezers			
1994 and earlier	117.8 kWh/cu. ft	12	21.4%
1995 and later	56.2 kWh/cu. ft	23	19.3%

Since neither the 2017 nor 2018 metering data allowed establishing average energy consumption data with acceptable margins of error, the Evaluator recommends continuing metering activities in 2019 and relocating the metering room to ensure a controlled temperature.

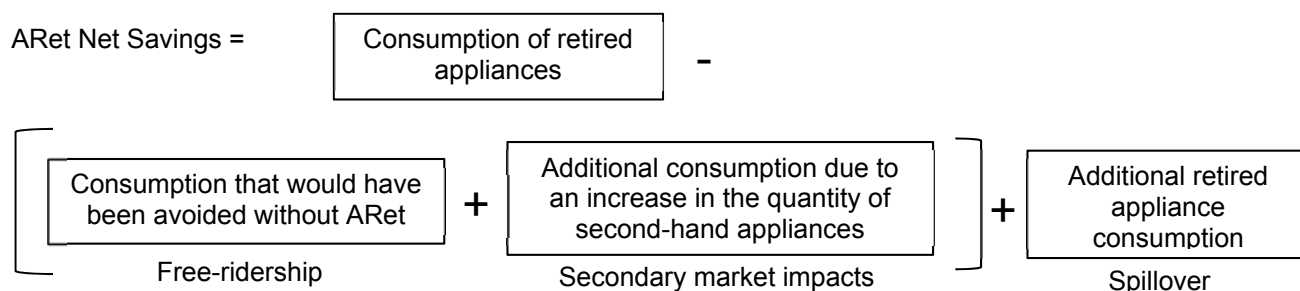
In 2018, ENS also began using heat guns on a trial basis to meter appliance inside temperature at the moment of pick up. The Evaluator welcomes the acquisition of this new equipment and recommends formalizing the heat gun usage process by developing a usage protocol. The protocol should describe the appliances to be accepted or rejected based on the metered temperature and the data to be tracked. This protocol would ensure that all non-working appliances, i.e. appliances with inside temperatures below target values, are properly identified, tracked and excluded from the metering sample as well as program results.

4.2 Calculation Methodology

The ARet impact evaluation was conducted using the savings calculation methodology developed for the 2013 evaluation to comply with the general guidelines of the Uniform Methods Project (UMP) for refrigerator recycling evaluation.¹⁰ However, the chapter on refrigerator recycling evaluation was updated in the most recent version of the UMP and induced consumption is no longer accounted for.¹¹ The Evaluator therefore adjusted the ARet evaluation methodology accordingly.

The logic model of the UMP methodology is summarized in Figure 6 below.

Figure 6: Logic Model of the UMP for Net Savings Calculation



In Figure 6 above, the retired appliance consumption is equivalent to the gross savings multiplied by the part-use factor, while free-ridership and secondary market impact values are used to calculate the per-unit net energy savings value. Spillover is not evaluated on a per-unit basis and is applied to ARet overall net savings for each type of appliance.

Table 11 below summarizes the tracked savings values used by ENS for ARet in 2018. The values for refrigerators, freezers and air conditioners are based on the results of the 2017 evaluation.

¹⁰ 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, April 2013.

¹¹ 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.

Table 11: Tracked Savings by Appliance Type

Appliance Type	Metered Energy Consumption (kWh)	Occupant Adjustment Factor	Part-Use Factor	Gross Unitary Savings (kWh)	Net Unitary Savings (kWh)	Ratio of Net to Gross	Participant Spillover	Equivalent NTGR
Refrigerators	828	1.12	0.81	751	410	0.55	1%	0.55
Freezers	960	1.12	0.75	863	465	0.54		0.55
Air conditioners	258	N/A	N/A	215	66	0.31		0.32
Small fridges	390	1.12	0.63	209	103	0.49		0.50
Small freezers	450	1.12	0.63	327	162	0.50		0.50

For the 2018 evaluation, the Evaluator updated these tracked savings values using a methodology similar to that used in the previous five evaluations. This methodology is described in detail for each type of appliance in the following subsections. Although ENS conducted metering activities in 2018, the Evaluator relied on the 2017 metering results to calculate the energy consumption of retired appliances, as explained in Subsection 4.1. The proportion of units in each manufacture-year class and the average volumes for each appliance type, as per the 2018 tracking sheet, were used to update the gross unitary savings values. Moreover, the part-use factors, free-ridership levels, secondary market impacts, and spillover level were updated based on the 2018 participant survey results. Since only four appliances were retired in HRCE schools in 2018, the Evaluator applied the same unitary savings as the other appliances retired through ARet.

The algorithm underlying free-ridership calculations is presented in Appendix III.

The unitary savings values for the appliances retired through HomeWarming were also reviewed based on the information specific to the units retired in 2018.

The following subsections summarize the calculations made by the Evaluator to review the unitary savings values. The details of those calculations are presented in Appendix IV.

4.3 Refrigerator Unitary Savings

This subsection summarizes the main parameters used to determine the unitary savings of full-sized refrigerators retired through ARet in 2018.

The Evaluator revised the gross unitary savings value by updating the following key parameters:

- › The average energy consumption of retired refrigerators
- › The average energy consumption of replacement refrigerators
- › Part-use factors

As presented in Table 12 below, the revised part-use factor was established at 0.70. By multiplying this factor of 0.70 by the measured refrigerator average annual energy consumption value (982 kWh/year), the retired refrigerator annual energy consumption value was established at 687 kWh. For replacement refrigerators, the measured consumption corresponding to retired refrigerators of the most recent manufacture-year class was also multiplied by the part-use factor to obtain an annual energy consumption level of 265 kWh.

Table 12: Final Energy Consumption Values for Refrigerators

	Measured Consumption (kWh/year)	Part-use Factor	Final Consumption (kWh/year)
Retired Refrigerators	982	0.70	687
Replacement Refrigerators	378	0.70	265

Two effects were considered to calculate the net unitary savings of refrigerators, namely free-ridership and secondary market impacts. Table 13 below summarizes the net unitary savings calculation for refrigerators retired through ARet. This resulted in an overall net savings value of 389 kWh per unit retired.

Table 13: Net Savings per Refrigerator

Would Have Kept the Unit	%	Discard Scenario	%	Would-be Acquirer Finds an Alternative Unit	%	Alternative Type	%	Overall Proportion	Energy Consumption (kWh/year)		Savings
									Without ARet	With ARet	Net Reduction
Yes	41							41%	687	0	687
No	59	Transferred	41	Yes	50	Old Unit	50	6%	687	687	0
						New Unit	50	6%	687	265	422
				No	50			12%	687	0	687
		Disposed	59					35%	0	0	0
Weighted Average (kWh/unit)											389

4.4 Freezer Unitary Savings

This subsection summarizes the main parameters used to evaluate the unitary savings of full-sized freezers retired in 2018 and how both gross and net unitary savings were determined.

The Evaluator revised the gross unitary savings value tracked by ENS by updating the same key parameters as for refrigerators, namely the average energy consumption of retired and replacement freezers, as well as the part-use factors.

As outlined in Table 14 below, the part-use factor for freezers is 0.72. By multiplying this part-use factor by retired freezer measured annual energy consumption value (1,312 kWh/year), the retired freezer final average annual consumption value was established at 945 kWh. The same calculation was performed for replacement freezers, and their average annual energy consumption value was established at 216 kWh.

Table 14: Final Energy Consumption Values for Freezers

	Measured Consumption (kWh/year)	Part-use Factor	Final Consumption (kWh/year)
Retired Freezers	1,312	0.72	945
Replacement Freezers	300	0.72	216

Two effects were considered to calculate the net unitary savings for freezers, namely free-ridership and secondary market impacts. Table 15 below summarizes the unitary savings calculation for freezers retired through ARet. This resulted in an overall net savings value of 450 kWh per unit retired.

Table 15: Net Savings per Freezer

Would Have Kept the Unit	%	Discard Scenario	%	Would-be Acquirer Finds an Alternative Unit	%	Alternative Type	%	Overall Proportion	Energy Consumption (kWh/year)		Savings
									Without ARet	With ARet	Net Reduction
Yes	31							31%	945	0	945
No	69	Transferred	35	Yes	50	Old Unit	50	6%	945	945	0
						New Unit	50	6%	945	216	729
				No	50			12%	945	0	945
		Disposed	65					45%	0	0	0
Weighted Average (kWh/unit)											450

4.5 Room Air Conditioner Unitary Savings

This subsection summarizes the main parameters used to evaluate the unitary savings of room air conditioners retired in 2018.

To revise the unitary savings value for air conditioners, the Evaluator updated the variables used in the unitary savings calculation, namely retired room air conditioner capacity (based on the units retired in 2018), hours of operation (according to local data provided by Natural Resources Canada [NRCAN] for four Nova Scotia cities, namely Halifax, Yarmouth, Sydney, and Greenwood), and seasonal energy efficiency ratios (SEER, based on an article published by NRCAN¹² and the Ecox Technical Information Bulletin).¹³ As a result, the average annual energy consumption for retired room air conditioners was established at 218 kWh and the average energy consumption of replacement room air conditioners at 156 kWh.

Two effects were taken into account to calculate the net savings value for retired air conditioners, namely free-ridership and secondary market impacts. Table 16 below summarizes the unitary savings calculation for room air conditioners retired through ARet. This resulted in an overall savings value of 115 kWh per unit retired.

Table 16: Net Savings per Room Air Conditioning Unit

Would Have Kept the Unit	%	Discard Scenario	%	Would-be Acquirer Finds an Alternative Unit	%	Alternative Type	%	Overall Proportion ¹⁴	Energy Consumption (kWh/year)		Savings
									Without ARet	With ARet	Net Reduction
Yes	45							45%	218	0	218
No	55	Transferred	25	Yes	50	Old Unit	50	3%	218	218	0
						New Unit	50	3%	218	156	62
				No	50			7%	218	0	218
		Disposed	75					41%	0	0	0
Weighted Average (kWh/unit)											115

4.6 Small Appliance Retirement

This subsection summarizes the main parameters used to determine the unitary savings of small refrigerators and small freezers retired through ARet in 2018.

¹² NRCAN's Office of Energy Efficiency. *Air Conditioning Your Home*, 2003, p. 15.

¹³ Ecox, *Technical Information Bulletin No. E-004-EN: SEER*, www.ecoxline.com (Last accessed March 3, 2016).

¹⁴ The sum does not equal 100% due to rounding.

The Evaluator revised the gross unitary savings value tracked by ENS by updating the same key parameters as for refrigerators. The part-use factor was established at 0.42, which is lower than the value calculated in the 2016 evaluation. This reduction is due to a greater proportion of participants (32% in 2018 vs 11% in 2016) answering that their small appliance was never used while a lesser proportion (21% in 2018 vs 44% in 2016) mentioned using it full-time.

The final annual energy consumption values are summarized in Table 17.

Table 17: Final Energy Consumption Values for Small Appliances

	Measured Consumption (kWh/year)	Part-use Factor	Final Consumption (kWh/year)
Retired Small Refrigerators	448	0.42	188
Replacement Small Refrigerators	173	0.42	73
Retired Small Freezers	752	0.42	316
Replacement Small Freezers	182	0.42	76

Two effects were taken into account to calculate the net savings value for retired small appliances, namely free-ridership and secondary market impacts. Considering the smaller number of participants in this appliance category and thus the smaller sample of respondents in the survey, small fridges and small freezers were analyzed together in the net savings calculation.

Table 18 and Table 19 summarize the unitary savings calculations for the small appliances retired through ARet.

Table 18: Net Savings per Small Refrigerator

Would Have Kept the Unit	%	Discard Scenario	%	Would-be Acquirer Finds an Alternative Unit	%	Alternative Type	%	Overall Proportion	Energy Consumption (kWh/year)		Savings
									Without ARet	With ARet	Net Reduction
Yes	60							60%	188	0	188
No	40	Transferred	33	Yes	50	Old Unit	50	3%	188	188	0
						New Unit	50	3%	188	73	115
				No	50			7%	188	0	188
		Disposed	67					27%	0	0	0
Weighted Average (kWh/unit)											129

Table 19: Net Savings per Small Freezer

Would Have Kept the Unit	%	Discard Scenario	%	Would-be Acquirer Finds an Alternative Unit	%	Alternative Type	%	Overall Proportion	Energy Consumption (kWh/year)		Savings
									Without ARet	With ARet	Net Reduction
Yes	60							60%	316	0	316
No	40	Transferred	33	Yes	50	Old Unit	50	3%	316	316	0
						New Unit	50	3%	316	76	240
				No	50			7%	316	0	316
		Disposed	67					27%	0	0	0
Weighted Average (kWh/unit)											219

4.7 Appliances Replaced Through HomeWarming

This subsection summarizes the methodology used and the calculations made to determine the unitary savings of refrigerators, freezers and dehumidifiers replaced through HomeWarming in 2018.

HomeWarming offers income-eligible participants the opportunity to replace their old refrigerators, freezers and dehumidifiers with more efficient models. The HomeWarming guidelines were updated in 2018 and now indicate that refrigerators and freezers eligible for replacement must be manufactured in 1994 or earlier. Replacement savings are claimed under ARet.

Based on the nature of HomeWarming (direct replacement) and its participant demographics, a net-to-gross ratio (NTGR) of 1.00 was assumed.

4.7.1 Refrigerator Replacement

Using an annual per-cubic-foot consumption of 58.9 kWh/cu. ft, the Evaluator established that old refrigerators consume on average 1,121 kWh per year. This calculation is based on the metered consumption of refrigerators in the oldest manufacture-year class (see Subsection 4.2), the average size of the old refrigerators retired through HomeWarming in 2018 (rounded up to 17 cu. ft), and the occupant adjustment factor of 1.12 (but not the part-use factor).

By applying the average annual per-cubic-foot consumption value of ENERGY STAR certified refrigerators installed through HomeWarming in 2018, the Evaluator established the new refrigerator unitary energy consumption (UEC) at 348 kWh. No occupant adjustment factor was applied because the UEC ratings of new ENERGY STAR certified refrigerators already account for this occupancy adjustment.

Based on the ENERGY STAR certified refrigerator average annual consumption value, replacing an old refrigerator with a new model results in unitary savings of 773 kWh per year, as shown in the following equation.

$$\text{Revised Unitary Savings} = \left(58.9 \frac{\text{kWh}}{\text{cu. ft}} \times 17.0 \text{ cu. ft} \times 1.12 \right) - 348 \text{ kWh} = 773 \text{ kWh}$$

4.7.2 Freezer Replacement

To establish the unitary savings of freezers replaced through HomeWarming, the Evaluator used the same approach as for refrigerators replaced through HomeWarming. The Evaluator used the average annual consumption value of 117.8 kWh/cu. ft, which corresponds to the average annual per-cubic-foot consumption metered for the oldest manufacture-year class of freezers (see Subsection 4.2). By applying the average size of retired freezers in 2018 (12.6 cu. ft) and the occupant adjustment factor of 1.12 (but not the part-use factor), the average consumption of retired freezers was established at 1,662 kWh per year.

The Evaluator established a weighted average energy consumption value of 277 kWh/cu. ft for the new efficient freezers installed through HomeWarming, based on the energy consumption of each model in the NRCAN list of compliant models¹⁵ and total number of installed appliances of each model as listed in the 2018 tracking sheet. Given the average consumption of 277 kWh per year for new freezers, replacing an old freezer with a new model results in unitary savings of 1,385 kWh per year, as shown in the following equation.

$$\text{Revised Unitary Savings} = \left(117.8 \frac{\text{kWh}}{\text{cu. ft}} \times 12.6 \text{ cu. ft} \times 1.12 \right) - 277 \text{ kWh} = 1,385 \text{ kWh}$$

4.7.3 Dehumidifier Replacement

The Evaluator reviewed the tracked unitary savings value used by ENS for dehumidifiers. All parameters used were still applicable and the Evaluator therefore maintained the unitary savings of 660 kWh per year for old dehumidifiers replaced with new models, as tracked by ENS and established in the 2017 evaluation.

4.8 Summary of Unitary Savings Values

Table 20 below presents the tracked and revised savings values for each appliance type retired through ARet or replaced under HomeWarming in 2018. As previously mentioned, the same unitary savings as the appliances retired through ARet were applied to the four appliances retired from HRCE schools.

¹⁵ Natural Resources Canada, *Energy Efficiency Ratings: Search – Freezers*, <http://oee.nrcan.gc.ca/pml-imp/index.cfm?action=app.download-telecharger&appliance=FREEZERS> (Last accessed January 9, 2019).

Table 20: Tracked and Revised Unitary Savings by Appliance Type

Appliance Type	Gross Unitary Savings (kWh/yr)		Net Unitary Savings (kWh/yr)	
	Tracked	Revised	Tracked	Revised
Refrigerator (ARet)	751	687	410	389
Freezer (ARet)	863	945	465	450
Room Air Conditioner (ARet)	215	218	66	115
Small Refrigerator (ARet)	209	188	103	129
Small Freezer (ARet)	327	316	162	219
Refrigerator (HomeWarming)	705	773	705	773
Freezer (HomeWarming)	1,399	1,385	1,399	1,385
Dehumidifier (HomeWarming)	660	660	660	660

The gross unitary savings value for refrigerators retired through ARet was revised downward mainly due to a lower part-use factor established through 2018 participant survey results.

As for freezers retired through ARet, the increased gross unitary savings value results from more old freezers (1994 and earlier) having been retired compared to 2017 (55% in 2018 vs 37% in 2017). This increase was offset by the negative impact of a downward revision to the NTGR for freezers, which resulted in a slight reduction of the net unitary savings value.

Although the gross unitary savings value for air conditioners changed only slightly, the net unitary savings value considerably increased due to lower free-ridership level and secondary market impacts compared to the value used in the 2017 evaluation.

The gross unitary savings values for small appliances slightly decreased because of the lower part-use factor obtained through the 2018 participant survey. Still, the net unitary savings were higher than in 2017 since free-ridership was considerably lower.

As for HomeWarming measures, their unitary savings values remained relatively stable compared to the tracked values, with only refrigerator unitary savings notably increasing compared to 2017 mostly because the average size of retired refrigerators increased slightly.

4.9 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-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.

For ARet, the peak demand savings were calculated using the on-peak demand-to-energy ratios developed by Navigant in the 2016-2018 DSM Plan. These ratios were established for various measure categories based on modelled system-coincident peak demand savings and energy savings for a projected deployment of measures. Navigant used local data to establish the ratios for 2018. The Evaluator considers that the approach used by Navigant to establish the on-peak demand-to-energy ratios is valid and therefore these ratios were used to estimate the peak demand savings for ARet. For air conditioners, for which no ratio was calculated in the Navigant model, the Evaluator assumed a ratio of zero since it is very unlikely that this type of appliance operates during the peak demand period.

Table 21 presents the on-peak demand-to-energy ratios established for each appliance type.

Table 21: Peak-demand-to-energy Ratios by Appliance Type

Type of Appliance Retired	Peak-demand-to-energy Ratio	Source
Refrigerator	0.138	RES-Appliance-Fridge, Navigant 2016-2018 DSM Plan
Freezer	0.138	RES-Appliance-Fridge, Navigant 2016-2018 DSM Plan
Air Conditioner	0.000	Calculated by the Evaluator
Dehumidifier	0.335	RES-Appliance-Dehumidifier, Navigant 2016-2018 DSM Plan

4.10 Interactive Effects

Interactive effects occur in a conditioned space when an implemented energy-efficiency measure has an impact on the energy consumption of other elements in the system, such as heating and cooling equipment. In the case of ARet, retirement of old appliances causes an increase in the heating load in the winter and a decrease in the cooling load in the summer since the compressor of the old appliance releases significantly more waste heat than a newer, more efficient model. If an inefficient appliance is retired without being replaced, these 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.¹⁶ 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.

¹⁶ Natural Resources Canada, *Energy Efficiency Ratings: Search - Freezers*, <http://oee.nrcan.gc.ca/pml-imp/index.cfm?action=app.download-telecharger&appliance=FREEZERS> (Last accessed January 9, 2019).

A number of other factors can also affect the interactive effects of the program component:

- › The focus of this ARet evaluation is on electricity savings. In Nova Scotia, fewer than 28 percent of households use electricity as their primary heating source.¹⁷ Therefore, the negative interactive effects on the heating load only affect approximately one-third of participating households.
- › A significant number of appliances retired through ARet, such as refrigerators and freezers, are built into or leaned against an exterior wall. Rather than contributing to the 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 (32%¹⁸) 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.¹⁹

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

4.11 Effective Useful Life

For 2018, the evaluated equivalent effective useful life (EUL) values correspond to those established through a thorough literature review conducted as part of the 2017 evaluation. These values remain valid in 2018.

Table 22 summarizes the equivalent EUL values for each type of appliance. In summary, all tracked equivalent EUL values were adequate and no changes were applied by the Evaluator. The revised equivalent EUL values are applied to each product's gross and net first-year energy savings to obtain the gross and net lifetime energy savings. As a result, the weighted average EUL values of gross and net savings differ (see Subsections 4.12 and 4.15).

¹⁷ Statistics Canada, *Residential Sector, Nova Scotia, Table 14: Total Households by Building Type and Energy Source*, <http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=ns&rn=14&page=4> (Last accessed December 3, 2018).

¹⁸ Statistics Canada, *Table 38-10-0019-01 – Air conditioners*, <https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3810001901> (Last accessed November 6, 2018).

¹⁹ The TRMs for California Municipal Utilities, Connecticut, Maine, Massachusetts, Vermont, Illinois, Mid-Atlantic, Northwest Power and Conservation Council, and Minnesota were consulted and only Northwest Power and Conservation Council applies interactive effect factors for freezers and refrigerators (although only for new rebated appliances and not for recycled appliances).

Table 22: ARet Equivalent Effective Useful Life Values

Appliance	Tracked Equivalent EUL (years)	Revised Equivalent EUL (years)	Revised Gross Lifetime Unitary Savings (kWh)
Refrigerator Retirement (ARet)	8	No change	5,496
Freezer Retirement (ARet)	8	No change	7,560
Air Conditioner Retirement (ARet)	3	No change	654
Small Refrigerator Retirement (ARet)	8	No change	1,504
Small Freezer Retirement (ARet)	8	No change	2,528
Refrigerator Replacement (HomeWarming)	5	No change	3,865
Freezer Replacement (HomeWarming)	4	No change	5,540
Dehumidifier Replacement (HomeWarming)	5	No change	3,300

4.12 Overall Gross Savings

The gross energy and peak demand savings resulting from the retirement of old appliances through ARet (including appliances retired in HRCE schools) and the appliance replacements through HomeWarming are listed in Table 23 below. The total gross energy and peak demand savings amounted to 4.568 GWh and 0.640 MW respectively at the generator, which represents 35.043 GWh in lifetime energy savings. As a result, the weighted average EUL value for gross energy savings is 7.7 years.

For the appliances retired through ARet, the line loss factor applied was 1.099, which represents the average of line loss factors associated with the rate code of participants (who have a residential rate code in 97% of the cases). For appliances retired through HomeWarming, a line loss factor of 1.100 was applied since all participants have residential rate codes. The line loss values were provided by Nova Scotia Power and the proportion of residential participants versus that of commercial participants was calculated with the data in the tracking sheet.

Table 23: Revised Gross Energy and Peak Demand Savings by Appliance Type

	Appliance Retirement					HomeWarming			
	Refrigerators	Freezers	Room Air Conditioners	Small Refrigerators	Small Freezers	Refrigerators	Freezers	Dehumidifiers	Total
Energy Savings									
Number of Units Retired	3,874	1,166	114	60	61	60	165	95	5,595
Unitary Savings (kWh)	687	945	218	188	316	773	1,385	660	-
Gross Energy Savings – at the Meter (GWh)	2.661	1.102	0.025	0.011	0.019	0.046	0.229	0.063	4.156
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.100	1.100	1.100	-
Gross Energy Savings – at the Generator (GWh)	2.925	1.211	0.027	0.012	0.021	0.051	0.251	0.069	4.568
Equivalent Effective Useful Life (years)	8.0	8.0	3.0	8.0	8.0	5.0	4.0	5.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	23.399	9.688	0.082	0.099	0.169	0.255	1.006	0.345	35.043
Peak Demand Savings									
Energy-to-demand Ratio	0.138	0.138	0.000	0.138	0.138	0.138	0.138	0.335	-
Gross Peak Demand Savings – at the Meter (MW)	0.367	0.152	0.000	0.002	0.003	0.006	0.032	0.021	0.582
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.100	1.100	1.100	-
Gross Peak Demand Savings – at the Generator (MW)	0.404	0.167	0.000	0.002	0.003	0.007	0.035	0.023	0.640

4.13 Participant Spillover

For ARet, participant spillover occurs when participants decide to retire or replace other appliances pursuant to participating in the program component and due to its influence.

During the telephone survey, participants were asked if they had retired additional appliances after participating in ARet. If yes, they were then asked how they had disposed of the old appliances. When participants answered that they had transferred the appliance (e.g. they sold it or gave it away), the savings associated with the additional retired appliance were equal to the weighted average of the transfer scenario savings. If participants answered that they had discarded the appliance, the additional savings were equal to the unitary gross savings for the retired appliance.

Then, another question was asked to verify ARet's influence on participants' decisions to dispose of additional appliances without receiving a rebate. Depending on the level of influence declared during the survey, a proportion of the savings related to the additional retired appliance was attributed to ARet.

The Evaluator also considered that participant spillover occurred when other appliances ineligible for a rebate were picked up when the ENS representative came to retrieve the appliance to be retired through the program component. Participants were also asked what these other appliances were, whether they were in working condition or not, and what they would have done with these ineligible appliances if they had not been disposed of through ENS. Depending on the answer to the last question, the energy savings associated with the disposal scenario, the transfer scenario or the gross unitary savings of the appliance were used.

The level of participant spillover was calculated for each participant using the equation below. The energy savings (kWh) associated with the additional retired appliances were estimated using the adjusted unitary savings values reviewed in this evaluation for each type of appliance.

$$\% SO = \frac{(kWh \text{ Associated with the Additional Retired Appliances} \times \text{Attribution Level} + kWh \text{ Associated with the Additional Non Eligible Savings})}{(kWh \text{ Associated with the Appliances Retired Through the Program Component})}$$

The methodology used to calculate the level of participant spillover is presented in Appendix V.

Among the 200 participants surveyed, two reported that one or several additional appliances were picked up by ENS and that they would have sold them or given them away if they had not been retrieved by ENS, while none reported having retired an appliance that they would have kept if they had not participated in ARet. The total savings resulting from these additional retirements amounted to 770 kWh. This amount was divided by the total energy savings generated by all surveyed participants, resulting in a participant spillover level of 0 percent. By comparison, the spillover level measured in 2016, 2015, and 2014 was respectively 1 percent, 3 percent, and 4 percent.

4.14 NTGR Calculation

Given the methodology used to obtain net savings, the NTGR could not be calculated as a sum of the percentages of all the effects values. As required by the UMP calculation methodology, the savings associated with each possible “with ARet” and “without ARet” scenario were calculated, and then a weighted average was calculated to obtain the average net savings per unit. Consequently, the deduction in gross savings due to each kind of effect depends on not only the percentage of the participants affected, but also the difference in savings associated with each scenario.

To obtain an equivalent NTGR that takes into account both effects that were applied to the unitary savings and the spillover applied to the overall gross savings of ARet, the following equation was used:

$$NTGR_{equiv} = \frac{Net\ Unitary\ Savings}{Gross\ Unitary\ Savings} + Spillover\%$$

The detailed calculation results are presented in Table 24 below.

Table 24: Effects and Equivalent NTGR

Appliance Type	Number of Units	Gross Savings	Effects		Net Unitary Savings (kWh)	Participant Spillover	Equivalent NTGR
		Consumption of Retired Appliances (kWh)	Free-ridership (kWh)	Secondary Market Impact (kWh)			
Refrigerators	3,874	687	240	58	389	0%	0.57
Freezers	1,166	945	425	70	450		0.48
Air Conditioners	114	218	90	13	115		0.53
Small Refrigerators	60	188	51	8	129		0.69
Small Freezers	61	316	85	12	219		0.69

As for the appliances replaced through HomeWarming, a NTGR of 1 was assumed considering the nature of HomeWarming (direct replacement) and participant demographics.

4.15 Overall Net Savings

The net energy savings were estimated by multiplying the gross savings by the NTGR, as shown in the equation below.

$$\text{Net Energy Savings} = \text{Gross Energy Savings} \times \text{NTGR}_{\text{equiv}}$$

Overall, the total net energy and net peak demand savings for ARet amounted to 2.657 GWh and 0.378 MW at the generator respectively. By applying 0.6126 kg CO₂ eq/kWh, which is Nova Scotia's specific factor²⁰ for GHG emissions generated by electricity production, it was estimated that the net energy savings resulted in 1,628 tonnes of avoided CO₂ eq annually. The net lifetime energy savings were established at 19.822 GWh, which yields a weighted average EUL value of 7.5 years for net energy savings.

The detailed savings results are shown in Table 25 below.

²⁰ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes), while total electricity generation (10,978 GWh) was found in the following two sources:

Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018).

Emera Inc., *Management's Discussion & Analysis* as at February 9, 2018

<http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

Table 25: Evaluated Net Energy and Peak Demand Savings by Appliance Type

	Appliance Retirement					HomeWarming			
	Refrigerators	Freezers	Room Air Conditioners	Small Refrigerators	Small Freezers	Refrigerators	Freezers	Dehumidifiers	Total
Energy Savings									
Revised Gross Energy Savings – at the Meter (GWh)	2.661	1.102	0.025	0.011	0.019	0.046	0.229	0.063	4.156
Equivalent NTGR	0.57	0.48	0.53	0.69	0.69	1.00	1.00	1.00	-
Net Energy Savings – at the Meter (GWh)	1.517	0.529	0.013	0.008	0.013	0.046	0.229	0.063	2.418
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.100	1.100	1.100	-
Net Energy Savings – at the Generator (GWh)	1.667	0.581	0.014	0.009	0.015	0.051	0.251	0.069	2.657
Effective Useful Life (years)	8.0	8.0	3.0	8.0	8.0	5.0	4.0	5.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	13.338	4.650	0.043	0.068	0.117	0.255	1.006	0.345	19.822
Peak Demand Savings									
Total Gross Peak Demand Savings – at the Meter (MW)	0.367	0.152	0.000	0.002	0.003	0.006	0.032	0.021	0.582
Equivalent NTGR	0.57	0.48	0.53	0.69	0.69	1.00	1.00	1.00	-
Total Net Peak Demand Savings – at the Meter (MW)	0.209	0.073	0.000	0.001	0.002	0.006	0.032	0.021	0.344
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.100	1.100	1.100	-
Total Net Peak Demand Savings – at the Generator (MW)	0.230	0.080	0.000	0.001	0.002	0.007	0.035	0.023	0.378

Table 26 compares the tracked and evaluated savings at the generator.

Table 26: Comparison of ARet Tracked and Evaluated Savings at the Generator

	Initial Gross Savings	Revised Gross Savings	NTGR*	Net Savings
Energy Savings				
ENS Tracked Savings	4.736 GWh	4.736 GWh	0.58	2.763 GWh
Evaluation Results	4.568 GWh	4.568 GWh	0.58	2.657 GWh
Peak Demand Savings				
ENS Tracked Savings	0.655 MW	0.655 MW	0.59	0.394 MW
Evaluation Results	0.640 MW	0.640 MW	0.59	0.378 MW

*NTGRs varied 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 overall evaluated net energy savings are 4 percent lower than those tracked by ENS. This difference is mainly due to the lower gross unitary savings value established for refrigerators, which was caused by a different distribution of retired refrigerator ages based on the 2018 tracking sheet data and a lower part-use factor established through the 2018 participant survey results compared to 2017 values. Also, the lower NTGR obtained for freezers resulted in lower evaluated net unitary savings.

The evaluated net peak demand savings were also 4 percent lower than the tracked net peak demand savings for the same reasons as for the energy savings.

Despite operating in the market for several years, ARet continues to achieve considerable levels of participation and savings by encouraging the retirement of inefficient appliances.

5 ARET RECOMMENDATIONS

Despite operating in the market for several years, ARet continues to achieve considerable levels of participation and savings by encouraging the retirement of inefficient appliances. In addition to the general recommendations made for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator has two major recommendations to improve ARet, which are presented below and are also outlined in Appendix VI.

2018 ARet-R1. Continue to perform the metering activity and ensure the metering protocol is followed. In the 2017 evaluation, the Evaluator recommended continuing the metering activity to increase the sample size of each age category and lower margins of error of measured appliance consumption. ENS continued the metering activity in 2018, although in-depth analysis indicated that the metered consumption data were inconsistent and could not be used as is. The Evaluator therefore recommends continuing the metering activities in 2019. Moreover, the metering protocol should be closely followed to ensure that the obtained data provide accurate results, notably by ensuring that metering is conducted in a room with controlled temperature.

2018 ARet-R2. Develop and implement a protocol on the heat gun usage process. The Evaluator recommends that ENS formalize the heat gun usage process by developing a protocol for its use. The protocol should describe the appliances to be accepted or rejected based on the metered temperature and the data to be tracked. This protocol would ensure that all non-working appliances, i.e. appliances with inside temperature below target values, are properly identified, tracked, and excluded from the metering sample as well as program results.

6 INSTANT SAVINGS OVERVIEW

The following sections present the Instant Savings evaluation results.

This section describes the program component, follows up on 2017 evaluation recommendations and presents participation history.

6.1 Description

Instant Savings offers instant cash rebates to consumers who purchase eligible energy efficient products. Instant Savings is carried out with the help of one DA, as well as nine national retailers and 33 independent retailers that offer eligible products at over 180 locations across Nova Scotia.

In 2018, rebates on eligible products were offered during two campaigns that took place in the spring from April 6 to May 20, 2018, and in the fall from September 28 to November 10, 2018. Similar to 2017, rebates on appliances were offered throughout 2018.

During the fall 2017 campaign, ENS tested new products related to indoor air quality to assess retailer and consumer responses to them. Pursuant to this test, ENERGY STAR certified room air purifiers and ENERGY STAR certified dehumidifiers were added to the list of eligible products in 2018.

In the fall campaign of 2018, ENS added ENERGY STAR certified smart thermostats. As outlined in Table 27 below, a rebate of \$75 was offered on this product. For that same campaign, ENS also increased the rebate amount for single and multi-pack programmable thermostats by \$3 and \$9 respectively.

Table 27 summarizes the energy efficient products offered by Instant Savings and their respective rebate amounts. For each product category, a list of eligible stock keeping units (SKUs) needs to be previously approved by ENS.

Table 27: List of Rebates by Product

Products Offered during Campaigns	Spring Rebate	Fall Rebate
ENERGY STAR Certified LED A-type Lamps (1-2 packs/packs of 3 or more)	\$2/\$5	\$2/\$5
ENERGY STAR Certified LED Non-A-type Lamps (1-2 packs/packs of 3 or more)	\$3/\$7	\$3/\$7
ENERGY STAR Certified Recessed Downlight Fixtures (1-2 packs/packs of 3 or more)	\$8/\$20	\$8/\$20
ENERGY STAR Certified LED Fixtures with or without Motion Sensors	\$10	\$10
Dimmer Switches (single packs/packs of 2 or more)	\$3/\$6	\$3/\$6
Indoor and Outdoor Motion Sensors	\$5	\$5
Power Bars with Integrated Timers	\$5	\$5
Load Sensing Power Bars (smart strips)	\$10	\$10
Heavy-duty Outdoor Timers	\$8	\$8
Programmable Thermostats for Electrical Baseboard Heaters (1-2 packs/packs of 3 or more)	\$12/\$36	\$15/\$45
ENERGY STAR Certified Smart Thermostats	-	\$75
Outdoor Clothesline Kits and Outdoor Drying Racks	\$5	\$5
ENERGY STAR Certified Room Air Purifiers	\$30	\$30
Products Offered Year-round	Year-round Rebate	
ENERGY STAR Certified Dehumidifiers	\$30	
Refrigerators (qualifying models use 20 kWh per cubic foot of adjusted volume or less)	\$75	
Clothes Washers (qualifying models are on the ENERGY STAR Most Efficient 2018 list)	\$75	

In 2018, Instant Savings was advertised through point-of-purchase materials and signage, the ENS website and other media including radio remotes (live radio personalities at a local store), television commercials, social media, as well as print and online advertising. As in previous years, consumer engagement events were held in participating retail stores during the campaign periods to both provide information about Instant Savings and cross-promote other ENS programs and services.

Instant Savings aimed to achieve 16.2 GWh in net electrical energy savings and 2.1 MW in net peak demand savings at the generator for 2018.

6.2 Follow-up on 2017 Evaluation Report Recommendations

Instant Savings was evaluated in 2017 and improvement recommendations were made by the Evaluator. Table 28 below provides a brief summary of the implementation status of each recommendation presented in the Executive Summary section of the 2017 Evaluation Report.

Table 28: Implementation Status of 2017 Recommendations for Instant Savings

2017 Recommendations	Status
2017 Instant-R1. Continue providing program component support to expand the share of LED bulbs in the Nova Scotia residential lighting market while beginning to plan an exit strategy for A-type bulbs.	Implemented
2017 Instant-R2. Continue monitoring market indicators and collect additional information to further characterize the LED market.	Implemented

In 2017, the Evaluator recommended shifting the focus on products other than A-type bulbs to expand the share of products with lower market adoption (2017 Instant-R1). ENS implemented this recommendation by removing rebates on A-type light-emitting diode (LED) lamps as of December 31, 2018. In 2019, rebates offered through Instant Rebates will be focused on non-A-type LED lamps, LED fixtures and other non-lighting products. In addition, the number of retailers offering year-round rebates on appliances including refrigerators, clothes washers, dehumidifiers and smart thermostats has increased.

Recommendation 2017 Instant-R2 involves continuing to monitor various key market indicators and collecting information to further characterize the LED market. As part of the evaluation assignment, ENS asked the Evaluator to conduct a market evolution assessment by analyzing key indicators gathered through retailer interviews, retailer sales data, an intercept survey, and other available data. An update to this market evolution assessment, using data from 2018, is presented in Section 10.

6.3 Participation History

In 2018, a total of 669,550 eligible products were sold in participating stores across Nova Scotia, which represents a small decrease compared to 2017. LED lamps were still the most popular products under Instant Savings, with 443,233 A-type lamps and 127,366 Non-A-type LED lamps sold in 2018.

Based on market trends and the changing baselines associated with LED lighting products, ENS also developed an exit strategy for A-series LED lamps in 2018. As presented in Table 29 below, the number of A-type LED lamps sold decreased by 13 percent in 2018, while the sales of other rebated products significantly increased. Notably, the number of appliances sold increased by 220 percent, which is attributable to the ENERGY STAR certified dehumidifiers and ENERGY STAR certified room air purifiers that were newly introduced in 2017 and rebated year-round in 2018.

Table 29: Number of Rebated Products Sold Under Instant Savings, 2017-2018

Product Categories	2017	2018	Variation
ENERGY STAR Certified A-type LED lamps	512,096	443,233	↓ 13%
ENERGY STAR Certified Non-A-type LED lamps	139,872	127,366	↓ 9%
ENERGY STAR Certified LED Fixtures ^a	34,667	59,931	↑ 73%
Controls ^b	18,132	26,051	↑ 44%
Clothesline Kits and Outdoor Drying Racks	1,470	1,627	↑ 11%
Appliances ^c	3,541	11,342	↑ 220%
ENERGY STAR Certified Bathroom Fans ^d	762	-	-
Total	710,540	670,024	↓ 6%

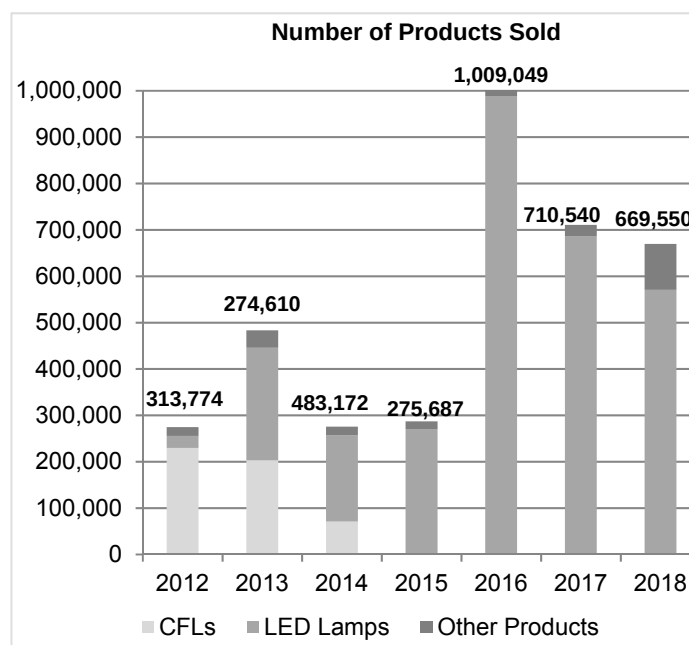
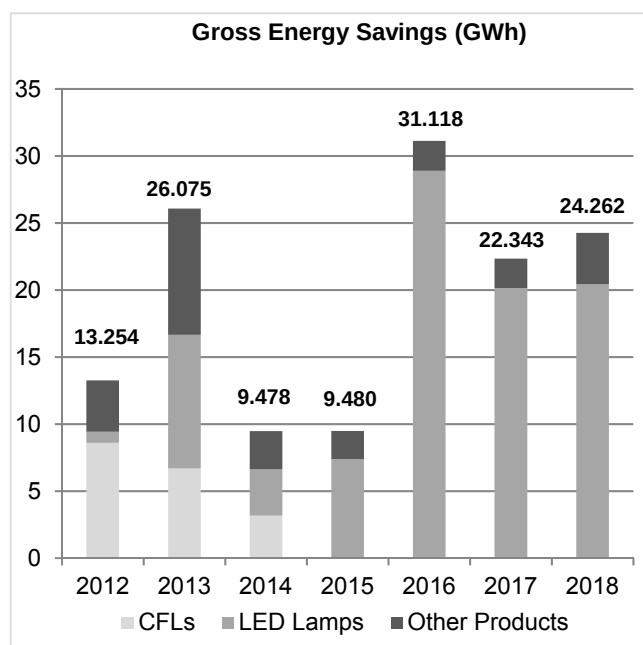
^a Including ENERGY STAR certified LED fixtures with and without motion sensors and ENERGY STAR certified LED recessed downlight fixtures.

^b Including dimmer switches, indoor and outdoor motion sensors, heavy-duty outdoor timers, power bars with timers, programmable thermostats and smart power bars.

^c Including ENERGY STAR certified clothes washers, refrigerators, ENERGY STAR certified dehumidifiers, and ENERGY STAR certified room air purifiers.

^d ENERGY STAR certified bathroom fans were removed in 2018.

As illustrated in Figure 7 below, Instant Savings achieved 24.262 GWh in gross energy savings in 2018, which represents an increase of 9 percent compared to 2017 levels. Higher unitary savings per product offset the slightly lower number of products sold.

Figure 7: Summary of Participation in Instant Savings, 2012-2018


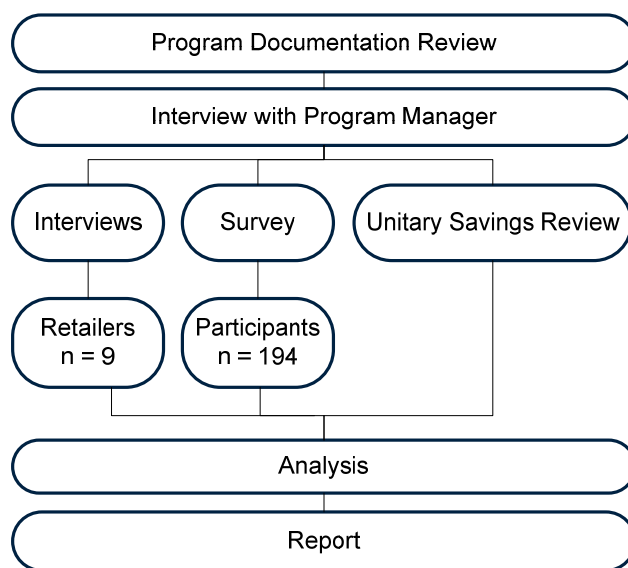
7 INSTANT SAVINGS EVALUATION OBJECTIVES AND METHODOLOGY

The main objectives of the Instant Savings evaluation are as follows:

- › Reporting on participant and partner perspectives
- › Calculating program results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions
- › Analyzing the market evolution of LED lamps

This section presents the methodology used and the activities carried out for the 2018 Instant Savings evaluation to achieve the aforementioned objectives. As illustrated in Figure 8, various data-collection activities were used throughout the evaluation.

Figure 8: Instant Savings Methodological Model



The Evaluator reviewed program component documentation and then met the program manager in September 2018 to verify the implementation status of previous evaluation recommendations and learn about primary program component changes. Based on the information obtained from this meeting, a list of questions and topics to be included in the data-collection instruments was prepared.

Once these activities were completed, specific evaluation activities were undertaken, as described in the following subsections.

For evaluation activities that yield quantitative results based on a sample, the Evaluator aimed to achieve a maximum margin of error of 10 percent at a confidence level of 90 percent. 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 percent of the time. Thus, the margin of error indicates the relative level of precision of a measurement, while its associated confidence level indicates the probability of a measure falling within this margin of error.

As part of the Instant Savings evaluation, the Evaluator calculated the margins of error for survey samples and free-ridership rates. The margins of error are presented alongside the results in the applicable sections. Examples of calculations used to establish margins of error are provided in Appendix II of the 2018 DSM Programs Evaluation Executive Summary.

Interviews with Retailers

In the fall of 2018, CRA conducted in-depth interviews with nine retailers. These interviews were used to: (1) measure spillover in the form of market effects for LED Lamps; (2) understand the process retailers underwent as part of their participation in Instant Savings; (3) determine retailer perceptions of and satisfaction with Instant Savings; and (4) understand the in-store lighting fixture offerings and energy efficient fixtures promoted.

The guide used for the interviews with retailers is presented in Appendix VII. Note that all appendices are presented in the Residential Efficient Product Rebates Program – Appendices document.

Participant Survey

A participant intercept survey was conducted by CRA staff in Halifax with 163 consumers who purchased qualifying LED lamps and 31 who purchased LED fixtures during the fall campaign, for a total of 194 survey participants. The in-store interviews were conducted throughout the 2018 fall campaign at five participating retail banners. The average survey length was 10 minutes. The questionnaire and complete participant survey results are presented in Appendices VIII and IX respectively.

The intercept participant survey generated feedback on the following aspects of Instant Savings:

- › LED lamp and LED fixture purchases and expected uses
- › Awareness about Instant Savings
- › Awareness about ENS
- › Free-ridership on LED A-type lamps
- › Awareness about rebated products
- › Consumer in-store LED fixture shopping experience and influence of Instant Savings
- › Demographics

The intercept survey sample of 194 participants yields a margin of error of ± 5.9 percent at a 90 percent confidence level.

Unitary Savings Review

The Evaluator reviewed the unitary savings values used in the tracking sheet for each product category rebated through Instant Savings in 2018. Technical reference manuals (TRMs) and public evaluation reports of jurisdictions similar to ENS were consulted with a focus on the most recent and accurate sources. Product technical data from the tracking sheet and data collected during the participant survey were also used to revise unitary savings values.

8 INSTANT SAVINGS MARKET EVALUATION

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

8.1 Partner Perspectives

As part of the Instant Savings evaluation, nine interviews were conducted with nationwide retailers.

8.1.1 Satisfaction with Instant Savings

This subsection presents retailers' overall satisfaction with Instant Savings as well as feedback specific to program component marketing, eligible products, campaign preparation process, rebate amounts, rebate processing and tracking, and the relationship with the DA.

All satisfaction ratings were established using a 10-point scale where 1 indicates "not at all satisfied" and 10 indicates "completely satisfied".

Overall Instant Savings, Marketing and Advertising

Overall satisfaction with Instant Savings was high across retailers, with an average rating of 8.6 on a 10-point scale. Seven retailers rated a score of eight to 10, while one retailer rated a seven and another declined to provide a score. The satisfaction level has returned to the 2016 level after being lower in 2017 due to the addition of a product price floor that caused frustration among some retailers.

Retailers also expressed high satisfaction with Instant Savings marketing and advertising, providing an average rating of 8.6. Five retailers scored this aspect at least an eight on a 10-point scale, with two retailers providing a score of seven and two declining to comment due to a lack of awareness. Moreover, one retailer mentioned that they would like to receive more support from the utility with setting up the in-store campaign material displays.

Product Selection, Preparation Process, and Rebate Amounts

Retailers were generally satisfied with the selection of products included in Instant Savings, with an average satisfaction rating of 7.8 on a 10-point scale. Among the nine retailers, six provided a satisfaction score of at least eight, while two provided a rating of six and one a score of five. One retailer believed that the products rebated should be diversified to include more products other than lighting, for example hot water heaters and windows. A retailer mentioned that the number of eligible SKUs had significantly increased, thus making the SKU approval process more cumbersome and time consuming. Another retailer believed that the rebates should be available for products in the process of being ENERGY STAR certified. ENS requires that the item be ENERGY STAR certified by the time the campaign begins.

With a few exceptions, retailers were generally satisfied with the campaign preparation process, resulting in an average satisfaction score of 7.9. Six retailers provided a score of eight or above, while two others provided a score of six and five and one declined to comment.

There was generally a high degree of satisfaction with the rebate amounts, with an average satisfaction rating of 8.0. Despite the high level of retailer satisfaction, two of them suggested that, while the rebate amounts on lamps were adequate, they would like to see a higher rebate on lighting fixtures to align with the higher product price.

Rebate Processing, Tracking and Reporting

Retailers offered moderately high levels of satisfaction with the rebate processing, tracking and reporting processes, with an average score of 7.3. Dissatisfaction stemmed from the need to review the listing of SKUs mid-campaign and the length of time required to fill out the reporting template and receive the rebate payment. One less satisfied retailer believed that too much information needs to be included in the reports, thereby making the process cumbersome, and that the process is further impeded by the inconsistent approach across provinces. This retailer suggested the implementation of a web-based platform to facilitate the reporting process and ensure greater consistency in reporting across provinces.

Table 30 provides an overview of average satisfaction ratings with various aspects of Instant Savings.

Table 30: Retailer Satisfaction with Aspects of Instant Savings

Aspects of Instant Savings	2016		2017		2018	
	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size
Overall satisfaction with Instant Savings	8.5	8	7.0	8	8.6	8
Campaign preparation process	7.6	8	6.3	8	7.9	8
Program marketing and advertising	8.7	7	7.2	6	8.6	7
Products covered by the program	8.4	8	8.3	8	7.8	9
Rebate amounts*	7.6	8	6.8	8	8.0	8
Rebate processing, tracking and reporting**	7.8	8	7.4	8	7.3	7
Scale: 1 = Not at all satisfied; 10 = Completely satisfied Base: Retailers who provided a rating * Different wording in 2016: Discount amounts ** Different wording in 2016: Discount processing, tracking and reporting						

Relationship with the DA

Retailers are very pleased with their overall relationship with the DA. The satisfaction score across retailers averages 8.6.

There were mixed levels of satisfaction with the timeliness of the program component information provided by the DA and ENS, resulting in an average satisfaction score of 6.9. While four retailers provided a rating ranging from eight to 10, the other retailers scored this aspect a seven, five, four and three. One retailer declined to provide a score. The four retailers who provided lower ratings indicated that the current notice period is insufficient to ensure proper product inventory levels and flyer advertisement. Those retailers are under the impression that the notice period is less than six months. As in previous years, retailers considered a six-month notice more adequate.

Despite some criticism about the SKU list approval process, retailers were generally satisfied with the SKU approval process, providing an average satisfaction score of 7.6. Five retailers provided a score of eight to 10, while the other retailers gave a score of seven, six and four and one declined to comment.

There was generally a high degree of satisfaction with retailer-initiated marketing (e.g. weekly flyers) and the approval process by the DA and ENS, resulting in an average rating of 8.0. Seven retailers offered a rating of eight or above, while the other two retailers rated a seven and one. The dissatisfaction of these two retailers stemmed from the delay caused by the approval process and the time taken by the DA and ENS to approve the retailer's marketing material.

Table 31 provides an overview of the average satisfaction ratings on the relationship with the DA.

Table 31: Retailer Satisfaction with the DA

Relationship Aspects with the DA	2016		2017		2018	
	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size
Overall relationship with the DA	9.3	8	8.1	8	8.6	8
Approval process of retailer-initiated marketing materials	n/a	n/a	n/a	n/a	8.0	9
SKU list approval process	6.1	8	6.6	8	7.6	8
Timeliness in providing program component information*	7.4	8	5.3	8	6.9	8
Scale: 1 = Not at all satisfied; 10 = Completely satisfied						
Base: Retailers who provided a rating						
* Different wording in 2017 and 2016: Timeliness of program component information provided to you						

8.1.2 Influence of Instant Savings and Barriers

This subsection presents the retailers' opinions on the influence of Instant Savings on various factors relating to LED lamps and fixtures, such as consumer and staff knowledge about the products, as well as the quantity and variety of products stocked in-store. Retailers also expressed their opinions on what prevents consumers from buying energy efficient products.

LED Lamps

All retailers were asked to assess the influence of Instant Savings on a variety of factors using a 0 to 10 scale where 0 indicates “no influence at all” and 10 indicates “a great deal of influence”.

Overall, Instant Savings was seen as beneficial in enhancing consumer knowledge about LED lamps and their benefits (average influence rating of 8.0), although it was not perceived as increasing sales staff knowledge about this technology (average influence rating of 6.5). Retailers mentioned that the rebate helps steer consumers toward these products and the point-of-sales materials and in-store displays contribute to educating consumers. While Instant Savings encourages sales staff to stay informed on LED technology to address consumer questions, retailers believe that the program component does not provide direct training opportunities. It should be noted that ENS offered an online training module for store staff during the campaigns.

Retailers were divided regarding the influence of Instant Savings on the variety of LED lamps stocked in-store (average rating of 7.4). Company policy or supplier relationships were mentioned as reasons explaining the program component’s limited influence on the diversity of SKUs carried. Other retailers indicated that they carry all rebated SKUs to stay competitive in the marketplace and respond to consumer demand; this would not be the case without Instant Savings. While most retailers also mentioned increasing their quantity of stocked LED lamps during the campaign periods to meet consumer demand as a result of Instant Savings, a few indicated that store size limits their ability to increase their inventory of LED lamps (average rating of 7.4).

Table 32 provides an overview of the average ratings on each assessed influence factor.

Table 32: Influence of Instant Savings on LED Lamps

Influence Factors	2018	
	Mean	Sample Size
Consumer knowledge of LED lamps and technology	8.0	8
Quantity of LED lamps stocked in-store	7.4	8
Variety of LED lamps stocked in-store	7.4	9
Staff knowledge of LED lamps and technology	6.5	9
Scale: 0 = Not at all influential; 10 = Very influential Base: Retailers who provided a rating		

LED Lighting Fixtures

Instant Savings was perceived as having a moderate influence on consumer choices of ENERGY STAR fixtures with integrated LED lighting over other types of lighting fixtures (average rating of 6.8 on a scale where 0 means “not at all important” and 10 means “extremely important”). To explain the moderate influence, retailers believed that consumers primarily chose these products based on aesthetic considerations rather than price and that the rebate amounts in proportion to the product prices are relatively low.

Retailers generally believe that Instant Savings has little influence on the quantity of LED fixture models offered in their stores. Instant Savings was seen as having a moderate influence on staff knowledge of these products as well as moderately increasing consumer interest in ENERGY STAR fixtures with integrated LED lighting.

Barriers

When asked to identify what prevents consumers from purchasing energy efficient products, retailers identified a variety of barriers. Cost was the most commonly cited barrier and considered the most important impediment to product adoption. Other barriers included limited consumer awareness or education, limited product assortment, and product style preferences.

8.2 Participant Perspectives

An intercept participant survey was conducted as part of the Instant Savings evaluation. A total of 194 interviews were completed with LED purchasers during the 2018 fall campaign. In contrast to previous campaigns, a distinction was made between consumers who purchased LED lamps (n=163) and those who purchased LED fixtures (n=31).

Over six in 10 (63%) respondents had heard of Instant Savings, with in-store promotions (37%) remaining the main source of awareness, followed by radio ads (15%), store flyers (15%), TV ads (14%), and word-of-mouth (14%).

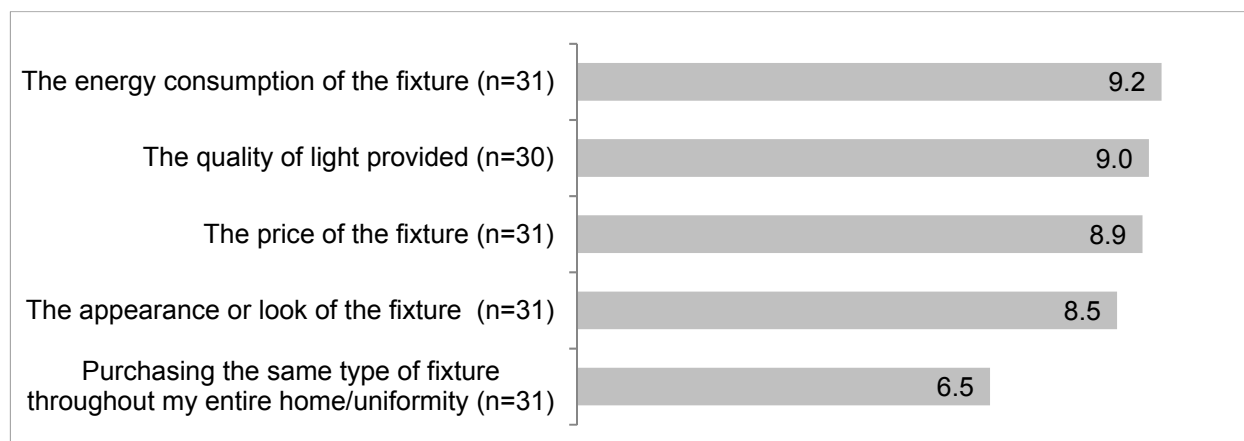
Among those who purchased LED lamps, nearly all (94%) mentioned already having LED lamps installed in their homes, while the average number of lamps purchased increased to eight lamps per person during the 2018 fall campaign compared to 6.2 lamps in the fall 2017 campaign. Purchased lamps are mainly intended to replace LED (33%), standard incandescent (27%), or compact fluorescent lamps (CFLs) (25%). Participants who planned to replace existing LED lamps mostly did so to replace burned-out lamps (70%). A small number of participants (n=16) purchased LED lamps to replace working LEDs, most often due to a dislike for the lighting provided by said lamps.

Nine in 10 (91%) LED lamp purchasers were aware of the rebate before paying at the cash register. The main means through which purchasers learned about the LED rebates was through in-store signage (77%), and nearly all respondents (96%) recalled seeing stickers, shelf signs or posters promoting the LED rebates in the light bulb section of the store.

Among those who purchased LED fixtures, most bought fixtures without motion sensors and had the intention to install them inside their home. A similar proportion of LED fixture purchasers (90%) than LED lamp purchasers were aware of the rebate before paying at the cash register. The reasons for fixture purchases were largely to replace an existing fixture (49%) and install a new fixture (45%). Most often, the existing fixtures being replaced used standard incandescent lamps (42%) or CFL lamps (29%).

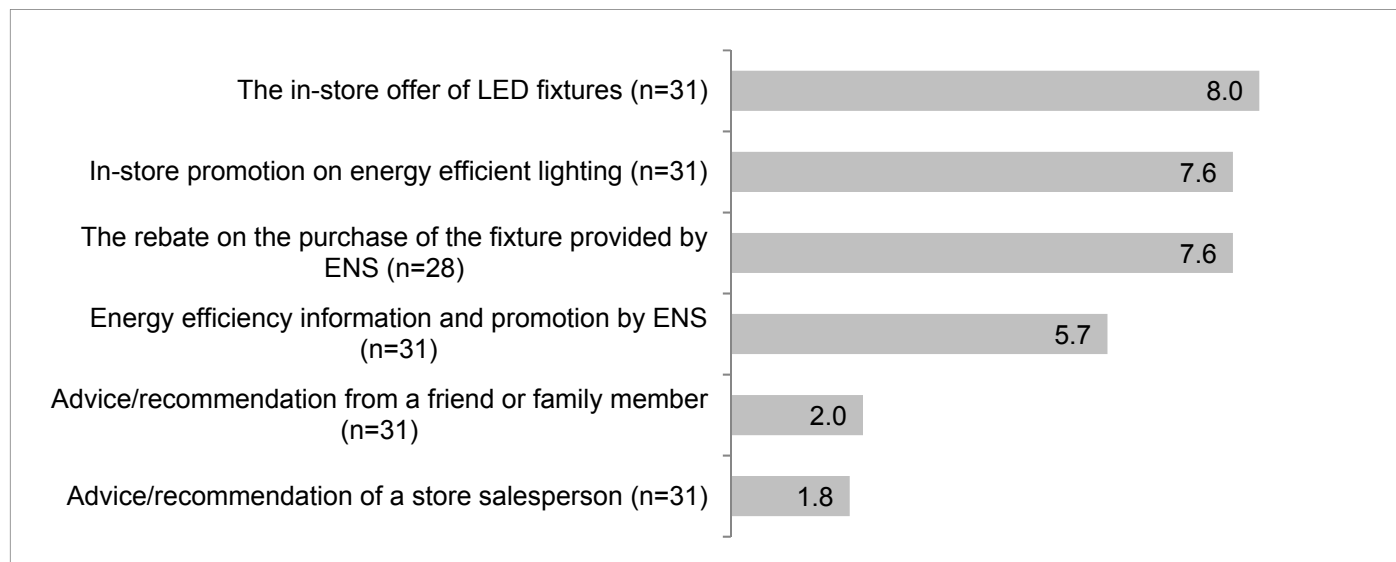
Close to nine in 10 (87%) respondents who bought LED fixtures only considered fixtures with LED lighting when shopping. As indicated in Figure 9 below, energy consumption was the most important factor in the decision process (a mean score of 9.2 on a 10-point scale where 1 means “not at all important” and 10 means “very important”). It should be noted that retailers expressed a different view than consumer respondents since retailers judged aesthetics as the most important consideration in the choice of products. From a methodology standpoint, the importance of certain factors in the decision to purchase a fixture might have ranked differently if asked through a non-participant survey, since Instant Savings participants might be more inclined to favour reducing energy consumption than the general population.

Figure 9: Importance of Factors in LED Fixture Purchase Decision Process



Note on scale: 1 = Not at all important; 10 = Very important.

Most respondents found that LED fixtures are as aesthetic or more aesthetic than non-LED fixtures (89%) and that they provide better quality lighting (72%). As indicated in Figure 10 below, the in-store offer on LED fixtures was said to be highly influential on the purchase decision (mean score of 8.0 on a scale where 0 means “not at all influential” and 10 means “very influential”).

Figure 10: Influence of Factors on LED Fixture Purchase Decision


Note on scale: 0 = Not at all influential; 10 = Very influential.

Additionally, more than one-half of respondents (54%) were aware of products other than LED lamps and LED fixtures that were rebated through Instant Savings. A wide range of energy efficient products were identified by participants as being part of Instant Savings, with programmable thermostats (23%) scoring the highest, followed by power bars or smart strips (18%), and dimmer switches (18%).

9 INSTANT SAVINGS IMPACT EVALUATION

The objective of the 2018 Instant Savings impact evaluation is to determine the gross and net electrical energy and peak demand savings.

9.1 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 The Evaluator revised the gross savings tracked by ENS by reviewing the unitary savings values, peak demand-to-energy ratios and interactive effects factors. The EUL values established during the 2017 evaluation were used again for the 2018 evaluation to calculate lifetime energy savings, with an adjustment to the equivalent EUL calculation for LED lamps and fixtures.

9.1.1 Unitary Savings Values

The Evaluator reviewed the unitary savings values used in the tracking sheet for each product category rebated through Instant Savings. Using a combination of program data, engineering algorithms, and values from the technical literature, the Evaluator validated the tracked savings values and, where necessary, revised them.

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

- › For ENERGY STAR certified LED lamps and fixtures, the products that generate by far the most savings for the program component, the unitary savings values were updated to take into account the wattage values of the most popular products sold and, for LED lamps, the different replacement scenarios identified through the participant intercept survey.
- › For smart thermostats, a product category added to the list of eligible products in the 2018 fall campaign, the Evaluator analyzed the possibility of claiming electrical savings for a portion of the products sold since all models can be installed on electrical heat pump systems. However, it is difficult to install smart thermostats on mini-splits heat pump systems, which constitute nearly 90 percent of heat pumps installed in Nova Scotia.²² Therefore, the Evaluator assumed that almost all smart thermostats were installed on furnaces. Furthermore, non-electrical furnaces make up over 85 percent of furnaces in Nova Scotia,²³ so the Evaluator decided to only report non-electrical savings for this product.
- › For load sensing power bars, the unitary savings value was increased since the majority of units sold in 2018 had seven plugs or more (compared to 6 plugs in 2017).

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

²² Nova Scotia Utility and Review Board, Matter M08670. NSP Response to Synapse IR-05 Att 5 ELECTRONIC.

²³ Statistics Canada, *Table 153-0145 - Households and the Environment Survey, Primary Heating System, Canada, Provinces and Census Metropolitan Areas*, 2015, CANSIM, November 1, 2018

- › For clotheslines and outdoor drying racks, the unitary savings value was adjusted to align the average number of washing loads with the value established through a literature review during the 2018 Efficient Product Installation (EPI) evaluation. The updated value for the number of washing loads was used to calculate clothes washer savings.
- › For each type of large appliance, the unitary savings values were updated to include the most popular models sold in 2018.

The unitary savings remain unchanged for all other products since their parameters have remained mostly stable over the last years and more recent or accurate sources for calculating such savings were not found in the literature.

Table 33 below summarizes the tracked and revised energy savings values for each product category rebated through Instant Savings. Appendix X provides a detailed description of inputs and unitary savings calculations.

Table 33: Summary of Tracked and Revised Unitary Savings Values for Instant Savings

Product	Tracked Savings (kWh/yr)	Revised Savings (kWh/yr)
ENERGY STAR Certified LED A-type Lamps	24.9	27.8
ENERGY STAR Certified LED Non-A-type Lamps (R, BR and Decorative)	41.3	44.2
ENERGY STAR Certified LED Non-A-type Lamps (excluding R, BR and Decorative)	48.0	47.3
ENERGY STAR Certified LED Recessed Downlight Fixtures	47.8	54.2
ENERGY STAR Certified LED Fixtures	85.3	66.5
ENERGY STAR Certified LED Fixtures with Motion Sensors	273	216
Dimmer Switches	17.0	No change
Indoor Motion Sensors	45.8	No change
Indoor Motion Sensors with Dimmer Switches	53.6	No change
Outdoor Motion Sensors	159	No change
Power Bars with Integrated Timers	53.7	No change
Load Sensing Power Bars (Smart Strips)	53.8	58.7
Heavy-duty Outdoor Timers	122	No change
Programmable Thermostats	221	No change
Clotheslines and Outdoor Drying Racks	150	104
Efficient Refrigerators	49.0	45.0
Efficient Clothes Washers	188	191
ENERGY STAR Certified Room Air Purifiers	480	518

Product	Tracked Savings (kWh/yr)	Revised Savings (kWh/yr)
ENERGY STAR Certified Dehumidifiers	81.3	No change

When analyzing the tracking sheet, the Evaluator identified certain smart devices among the standard eligible products offered through Instant Savings. Examples of these smart devices are Wi-Fi LED lamps and outdoor timers with wireless controls. The quantity of smart devices remains minimal, representing less than 1 percent of all products sold through Instant Savings in 2018. Moreover, the Evaluator could not find publicly available studies presenting relevant savings data for these products. Therefore, the Evaluator recommends both continuing to apply the unitary savings value associated with the standard product and starting to track smart devices in different product categories to more easily follow their evolution since these products are expected to become more popular. Among the smart devices identified, a few smart plug units were found, but Econoler considered that those products do not generate savings.

9.1.2 Peak Demand Savings

Peak demand savings correspond to the demand savings that coincide in time with the peak demand of the electricity system. The projected electricity peak demand period in Nova Scotia is between 5 p.m. and 7 p.m. from December to February on non-holiday weekdays.

For most Instant Savings products, 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 Navigant ratios were used to estimate peak demand savings for Instant Savings products, except for the following: lighting products; outdoor motion sensors; clotheslines and drying racks; and room air purifiers.

For lighting products, the Evaluator finds that the recommendation formulated in the 2017 evaluation report is still valid and thus recommends applying the Northeast Residential Lighting Hours-of-Use Study (NERHOU) ratio of 0.162 W/kWh to all indoor and outdoor lamps. In the 2017 evaluation, the Evaluator conducted a lighting metering study, the Residential Lighting Metering Study,²⁴ among 75 EPI participating homes and compared the results to other studies found in the literature. The Evaluator recommended using the NERHOU ratio because it is very close to the value of 0.161 W/kWh established by the Residential Lighting Metering Study. In addition, the margin of error in the NERHOU study was 1 percent, which is lower than the 10 percent in the Residential Lighting Metering Study.

The Evaluator assumed a peak demand-to-energy ratio of zero for clotheslines and outdoor drying racks

²⁴ Econoler, *Residential Lighting Metering Study*, report presented to Efficiency Nova Scotia, 2017.

since these products are not likely used during cold winter days during which peak conditions occur. In the case of outdoor motion sensors, it was assumed that most movement around the house occurs around the peak demand period. Therefore, the peak demand savings during this period are minimal because the lights are turned on most of the time with or without the motion sensor. Consequently, the peak demand-to-energy ratio was set at zero.

For room air purifiers, which run approximately 16 hours per day, the Evaluator assumed that this product runs during the peak period. Therefore, a peak demand-to-energy ratio of 0.171 was established based on an annual operating hours value of 5,840.

Table 34 presents the peak demand-to-energy ratios established for each product category.

Table 34: Peak Demand-to-energy Ratios by Product Category

Product Category	Peak Demand-to-energy Ratio	Source
Lighting Products (ENERGY STAR Certified LED Lamps, ENERGY STAR Certified LED Recessed Downlight Fixtures, ENERGY STAR Certified LED Fixtures with and Without Motion Sensors, Dimmer Switches)	0.162	Northeast Residential Lighting Hours-of-Use Study
Indoor Motion Sensors	0.000	RES-Lighting-Control-OccSensors, Navigant 2016-2018 DSM Plan
Indoor Motion Sensors with Dimmer Switches	0.000	RES-Lighting-Control-OccSensors, Navigant 2016-2018 DSM Plan
Outdoor Motion Sensors	0.000	Calculated by the Evaluator
Power Bars with Integrated Timers	0.000	RES-Plug Load-Controls, Navigant 2016-2018 DSM Plan
Load Sensing Power Bars (Smart Strips)	0.000	RES-Plug Load-Controls, Navigant 2016-2018 DSM Plan
Heavy-duty Outdoor Timers	0.000	RES-Plug Load-Controls, Navigant 2016-2018 DSM Plan
Clotheslines and Outdoor Drying Racks	0.000	Calculated by the Evaluator
Programmable Thermostats	-0.399	RES-HVAC-Controls, Navigant 2016-2018 DSM Plan
Efficient Refrigerators	0.138	RES-Appliance-Fridge, 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 Dehumidifiers	0.335	RES-Appliance-Dehumidifier, Navigant 2016-2018 DSM Plan

9.1.3 Interactive Effects

Interactive effects occur in a home when the implementation of energy efficiency measures has an impact on the energy consumption of other elements such as heating and cooling. In the case of Instant Savings, replacing incandescent lighting products with LED lamps causes an increase in the heating load in the winter and a decrease in the cooling load in the summer.

Lighting Products and Controls

The interactive effects factors used by ENS for energy savings are based on a methodology developed by the Evaluator in 2015 and were still valid for 2018. As for peak demand savings, the Evaluator adjusted the methodology in 2017 to apply interactive effects factors only to products whose peak demand-to-energy ratios did not already account for interactive effects. This methodology remained valid for the 2018 evaluation. Therefore, the Evaluator adjusted peak demand-to-energy ratios for LED lamps and fixtures as well as outdoor motion sensors so that they included interactive effects. The approach for adjusting peak demand-to-energy ratios for these products is further described in Table 35 below.

Table 35 lists the interactive effects factors used for lighting products installed indoors.

Table 35: Interactive Effects Calculations for Lighting Products Installed Indoors

Parameter	% of Homes ^{25,26}	Energy Interactive Effects Factor ²⁷	Peak Demand Interactive Effects Factor
Electrical Heating with Air Conditioning	33% x 32% = 11%	-54.4%	-90.0%
Electrical Heating Without Air Conditioning	33% x 68% = 22%	-58.0%	-90.0%
No Electrical Heating with Air Conditioning	67% x 32% = 21%	3.6%	0.0%
Neither Electrical Heating Nor Air Conditioning	67% x 68% = 46%	0.0%	0.0%
Weighted Interactive Effects Factor	100%	-18.0%	-29.7%

²⁵ The proportion of air-conditioned homes is drawn from Statistics Canada, *Table 153-0147 - Households and the Environment Survey, Air-conditioners, Canada, Provinces and Census Metropolitan Areas, 2015*, CANSIM, November 1, 2018.

²⁶ The proportion of homes that are electrically heated is drawn from Statistics Canada, *Table 153-0145 - Households and the Environment Survey, Primary Heating System, Canada, Provinces and Census Metropolitan Areas, 2015*, CANSIM, November 1, 2018.

²⁷ ADS ASSOCIÉS, *Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale*, Report presented to Hydro-Québec, 1992.

The interactive effects above occur only when products are installed inside the house. Since ENERGY STAR Certified LED lamps and ENERGY STAR certified LED fixtures installed through the program component are also used for outdoor lighting, the interactive effects factors for these products were adjusted to take this into account. The proportions of LED lamps installed indoors and outdoors were determined using the 2016 Socket Study²⁸ that surveyed 1,008 Nova Scotia residents. The proportions of ENERGY STAR certified LED fixtures installed indoors and outdoors were determined using the information provided in the tracking sheet for the 10 most popular products sold through Instant Savings in 2018.

As for ENERGY STAR certified LED recessed downlight fixtures, the Evaluator assumed they are all installed indoors. Lighting controls sold through the program component, i.e. dimmer switches and indoor motion sensors, also cause interactive effects similar to efficient lamps, which were therefore considered. The Evaluator used the same interactive effects factor as lighting products.

Table 36 presents the interactive effects factors for LED products.

Table 36: Interactive Effects Factors for LED Lamps, Fixtures and Other Indoor Devices

Category of Product	Indoor %	Outdoor %	Energy Interactive Effects Factor	Peak Demand Interactive Effects Factor
ENERGY STAR Certified LED Lamps	92%	8%	$92\% \times -18.0\% + 8\% \times 0\% = -16.6\%$	$92\% \times -29.7\% + 8\% \times 0\% = -27.3\%$
ENERGY STAR Certified LED Recessed Downlight Fixtures	100%	0%	-18.0%	-29.7%
ENERGY STAR Certified LED Fixtures Without Motion Sensors	87%	13%	$87\% \times -18.0\% + 13\% \times 0\% = -15.7\%$	$87\% \times -29.7\% + 13\% \times 0\% = -25.8\%$
ENERGY STAR Certified LED Fixtures with Motion Sensors	17%	83%	$17\% \times -18.0\% + 83\% \times 0\% = -3.1\%$	$17\% \times -29.7\% + 83\% \times 0\% = -5.0\%$
Dimmer Switches	100%	0%	-18.0%	-29.7%
Indoor Motion Sensors	100%	0%	-18.0%	-29.7%
Indoor Motion Sensors with Dimmers	100%	0%	-18.0%	-29.7%

The interactive effects factors were then integrated to the peak demand-to-energy ratios for lighting products, as outlined in Table 37.²⁹

²⁸ Corporate Research Associates Inc., *2016 Socket Study*, Final Report prepared for Efficiency Nova Scotia, December 2016.

²⁹ Adjusted peak demand-to-energy ratio = peak demand-to-energy ratio $\times$ (1 + interactive effects factor for peak demand savings) / (1 + interactive effects factor for energy savings).

Table 37: Adjusted Peak Demand-to-energy Ratios by Lighting Product Category

Product Category	Peak Demand-to-energy Ratio	Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings	Adjusted Peak Demand-to-energy Ratio
ENERGY STAR Certified LED Lamps	0.162	-16.6%	-27.3%	0.141
ENERGY STAR Certified LED Recessed Downlight Fixtures	0.162	-18.0%	-29.7%	0.139
ENERGY STAR Certified LED Fixtures Without Motion Sensors	0.162	-15.7%	-25.8%	0.143
ENERGY STAR Certified LED Fixtures with Motion Sensors	0.162	-3.1%	-5.0%	0.159
Dimmer Switches	0.162	-18.0%	-29.7%	0.139

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 also considered negligible.

9.1.4 Effective Useful Life

As part of the 2018 evaluation, the Evaluator reviewed the EUL values used by ENS in the calculation of energy savings that are expected to persist over time. Except for smart thermostats introduced to Instant Savings in 2018, the EUL values were consistent with those established as part of the 2017 evaluation through a literature review and remained valid for the 2018 evaluation.

For LED lamps and fixtures, equivalent EUL values were calculated since these lamp types are expected to experience increased baselines during their lifetimes, which reduces their EUL. Using the same EUL and calculation methodology as in 2017, updated equivalent EUL values were calculated for 2018. Additional details on how equivalent EUL values for LED lamps and fixtures were established are provided in Appendix XI.

Table 38 below summarizes the tracked and revised equivalent EUL values used by ENS and the Evaluator respectively. The revised equivalent EUL values are applied to each product's gross and net first-year energy savings to obtain gross and net lifetime energy savings. As a result, the weighted average EUL values of gross and net savings differ (see Subsections 9.1.5 and 9.3).

Table 38: Revised Equivalent Effective Useful Life Values by Product Category

Product Category	Tracked Equivalent EUL (Years)	Revised Equivalent EUL (Years)	Revised Gross Lifetime Unitary Savings (kWh)
ENERGY STAR Certified LED A-type Lamps	9	8.4	195
ENERGY STAR Certified LED Non-A-type Lamps (R, BR and Decorative)	8	7.1	262
ENERGY STAR Certified LED Non-A-type Lamps (Excluding R, BR and Decorative)	9	7.7	304
ENERGY STAR Certified LED Recessed Downlight Fixtures	9	7.6	338
ENERGY STAR Certified LED Fixtures Without Motion Sensors	10	9.8	549
ENERGY STAR Certified LED Fixtures with Motion Sensors	9	8.9	1,863
Dimmer Switches	10	No change	139
Indoor Motion Sensors	10	No change	376
Indoor Motion Sensors with Dimmer Switches	10	No change	440
Outdoor Motion Sensors	10	No change	1,590
Power Bars with Integrated Timers	4	No change	215
Load Sensing Power Bars (Smart Strips)	4	No change	235
Heavy-duty Outdoor Timers	10	No change	1,220
Clotheslines and Outdoor Drying Racks	10	No change	1,040
Programmable Thermostats	10	No change	2,210
Efficient Refrigerators	12	No change	540
Efficient Clothes Washers	14	No change	2,674
ENERGY STAR Certified Room Air Purifiers	9	No change	4,662
ENERGY STAR Certified Dehumidifiers	12	No change	976

9.1.5 Revised Gross Savings

The Evaluator calculated the annual gross savings based on the revised unitary savings values established for each product sold in 2018. The results are presented in Table 39 further below.

Table 39 also presents the gross savings at the generator, estimated using a line loss factor of 1.100 between the meter and the generator. This line loss factor was provided by NSP and corresponds to the value used for residential consumers. The gross energy savings at the generator were established at 24.262 GWh, which translates into 208.193 GWh in lifetime energy savings. As a result, the weighted average EUL value for gross energy savings is 8.6 years. The total gross peak demand savings were estimated at 2.901 MW at the generator.

Table 39: Revised Gross Energy and Peak Demand Savings by Product Category for Instant Savings

Product Category	LED A-type Lamp	LED Non-A-type Lamp		LED Recessed Downlight	LED ENERGY STAR Fixture		Dimmer Switch	Indoor Motion Sensor	Motion Sensor with Dimmer Switch	Outdoor Motion Sensor	Power Bar with Timer
		R, BR and Decorative	Other		Without Motion Sensor	With Motion Sensor					
Number of Units											
Number of Units – Spring	233,089	31,094	35,707	12,261	19,180	1,692	5,376	103	-	566	216
Number of Units – Fall	210,144	29,934	30,631	10,775	15,525	498	5,722	174	16	1,125	3,621
Number of Units – Spring + Fall	443,233	61,028	66,338	23,036	34,705	2,190	11,098	277	16	1,691	3,837
Energy Savings											
Unitary Savings Value (kWh)	27.8	44.2	47.3	54.2	66.5	216	17	45.8	53.6	159	53.7
Interactive Effects Factor	-16.6%	-16.6%	-16.6%	-18.0%	-15.7%	-3.1%	-18.0%	-18.0%	-18.0%	0.0%	0.0%
Gross Energy Savings – at the Meter (GWh)	10.276	2.250	2.617	1.024	1.946	0.458	0.155	0.010	0.001	0.269	0.206
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100
Gross Energy Savings – at the Generator (GWh)	11.304	2.475	2.879	1.126	2.140	0.504	0.170	0.011	0.001	0.296	0.227
Effective Useful Life (years)	8.4	7.1	7.7	7.6	9.8	8.9	10.0	10.0	10.0	10.0	4.0
Gross Lifetime Energy Savings – at the Generator (GWh)	94.954	17.570	22.165	8.559	20.973	4.487	1.702	0.114	0.008	2.958	0.907
Peak Demand Savings											
Peak Demand-to-energy Ratio	0.141	0.141	0.141	0.139	0.143	0.159	0.139	0.000	0.000	0.000	0.000
Gross Peak Demand Savings – at the Meter (MW)	1.449	0.317	0.369	0.142	0.278	0.073	0.022	0.000	0.000	0.000	0.000
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100
Gross Peak Demand Savings – at the Generator (MW)	1.594	0.349	0.406	0.157	0.306	0.080	0.024	0.000	0.000	0.000	0.000

Revised Gross Energy and Peak Demand Savings by Product Category for Instant Savings (Continued)

Product Category	Smart Power Bar	Heavy-duty Outdoor Timer	Programmable Thermostat	Clothesline	Efficient Refrigerator	Efficient Clothes Washer	Room Air Purifier	Dehumidifier	Total for All Products
Number of Units									
Number of Units – Spring	394	340	478	1,484	563	971	142	1,544	345,200
Number of Units – Fall	269	4,518	3,133	143	723	754	274	6,371	324,824
Number of Units – Spring + Fall	663	4,858	3,611	1,627	1,286	1,725	416	7,915	669,550
Energy Savings									
Unitary Savings Value (kWh)	58.7	122	221	104	45	191	518	81.3	-
Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
Gross Energy Savings – at the Meter (GWh)	0.039	0.593	0.798	0.169	0.058	0.329	0.215	0.643	22.057
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	-
Gross Energy Savings – at the Generator (GWh)	0.043	0.652	0.878	0.186	0.064	0.362	0.237	0.708	24.262
Effective Useful Life (years)	4.0	10.0	10.0	10.0	12.0	14.0	9.0	12.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	0.171	6.519	8.778	1.861	0.764	5.074	2.133	8.494	208.193
Peak Demand Savings									
Peak Demand-to-energy Ratio	0.000	0.000	-0.399	0.000	0.138	0.138	0.171	0.335	-
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	-0.318	0.000	0.008	0.045	0.037	0.216	2.638
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	-
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	-0.350	0.000	0.009	0.050	0.041	0.237	2.901

9.2 Net-to-gross Ratio

The NTGR serves to determine net savings, i.e. the energy savings that can be reliably attributed to a program component. More precisely, the NTGR represents the positive or negative impacts of free-ridership and spillover effects on gross savings. In the case of Instant Savings, free-ridership and spillover are considered for one specific product – LED lamps. This product was selected since it is the best-selling product category of the program component, accounting for 69 percent of total tracked gross savings.

9.2.1 Free-ridership

In the case of Instant Savings, the Evaluator assessed the free-ridership level by determining which LED lamps would still have been bought by participants in the absence of the program component. The free-ridership level was assessed using a self-reporting approach that involved asking participants who had purchased LED lamps a series of questions during the intercept survey.

The free-ridership level is calculated using an algorithm that assesses the likelihood for participants to have purchased LED lamps without the discount offered through Instant Savings. The algorithm considers all applicable variables of the decision-making process, including awareness of the discount, efficiency, cost, timing and quantity.

The intercept survey revealed a free-ridership level of 39 percent for LED lamps sold through Instant Savings in 2018, with a margin of error of 4.7 percent. This level is higher than the 32 percent obtained during the 2017 evaluation. The 2018 intercept survey revealed that a larger proportion of participants were likely to buy LED lamps in the absence of the discount offered through Instant Savings than in 2017. Indeed, more participants were unaware of the discount before paying at the cash register or had the intention to buy LED lamps regardless of the discount. More precisely, 9 percent of surveyed participants were unaware of the discount in 2018, compared to 6 percent in 2017.

The algorithm underlying free-ridership calculations is presented in Appendix XII.

As for all other types of products rebated through Instant Savings, the Evaluator considered the free-ridership value for those products to be nil. Given the increasing number of products other than LED lamps sold through Instant Savings, free-ridership assessments may have to be adjusted in future evaluations to consider calculating free-ridership levels for other products.

9.2.2 Spillover

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

The retailer interviews were used to estimate the level of spillover by measuring the market effects attributable to the program component for LED lamps, including A-type and non-A-type LED lamps. For the 2018 evaluation, retailers were asked to provide their sales numbers for all ENERGY STAR certified LED lamps sold throughout the year, not only the models selected for rebate.

The methodology used to calculate the level of spillover is presented in Appendix XIII. It consists of estimating the number of LED lamps 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 number of LED lamps sold without receiving an Instant Savings rebate represents 81 percent of total LED sales in 2018, which constitutes a considerable increase compared to 41 percent in 2017. By contrast, the proportion of sales that can be attributed to Instant Savings (attribution level) decreased from 23 percent in 2017 to 6 percent in 2018. Overall, this resulted in a spillover level of 25 percent for 2018. Although the attribution level is lower, the bigger proportion of LED lamps sold without receiving a rebate renders the 2018 spillover level higher than the 2017 value of 16 percent.

One possible explanation for the reduction in the attribution level is that Instant Savings has now been running for several years and market barriers to LED lamps have been reduced, especially for A-type lamps, thus diminishing the influence of Instant Savings on the LED lamp sales. Still, the retailers continue to recognize the impact of Instant Savings in increasing consumer knowledge as well as the variety and quantity of ENERGY STAR certified LED lamps stocked in-store. This evolution of the lighting market, especially on LED prices, can also explain the bigger proportion of LED lamps sold without receiving an Instant Savings rebate. Furthermore, another factor may have contributed to the latter. For the 2018 evaluation, questions were asked not only to consider the LED lamps sold outside of the Instant Savings campaigns, but also the models that are not on the SKU list that might have been sold during either campaign without receiving a rebate.

9.2.3 NTGR Calculation

The NTGR is calculated using the following equation:

$$NTGR = (1 - \% \text{ free-ridership} + \% \text{ spillover})$$

Using this equation, the NTGR for LED lamps was estimated at 0.86. For all other products, a 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 renders it difficult for retailers to estimate program component influence on their sales. Moreover, the segments of the population for these products are smaller, which renders it more difficult to reach these consumers through an intercept or general population survey.

9.3 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 presented above to the gross savings, as demonstrated in the following equation.

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

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

The Evaluator determined that Instant Savings achieved 21.930 GWh in net energy savings and 2.572 MW in net peak demand savings at the generator. By applying 0.6126 kg CO₂ eq/kWh, which is Nova Scotia's specific factor³⁰ for GHG emissions generated by electricity production, it was estimated that the net energy savings resulted in 13,434 tonnes of avoided CO₂ eq annually. The net lifetime energy savings were established at 189.336 GWh, which yields a weighted average EUL value of 8.6 years for net energy savings. The detailed results are presented in Table 40 below.

³⁰ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes), while total electricity generation (10,978 GWh) was found in the following two sources:

Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018).

Emera Inc., *Management's Discussion & Analysis* as at February 9, 2018, <http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

Table 40: Evaluated Net Energy and Peak Demand Savings by Product Category for Instant Savings

Product Category	LED A-type Lamp	LED Non-A-type Lamp		LED Recessed Downlight	LED ENERGY STAR Fixture		Dimmer Switch	Indoor Motion Sensor	Motion Sensor with Dimmer Switch	Outdoor Motion Sensor	Power Bar with Timer
		R, BR and Decorative	Other		Without Motion Sensor	With Motion Sensor					
Energy Savings											
Revised Gross Energy Savings – at the Meter (GWh)	10.276	2.250	2.617	1.024	1.946	0.458	0.155	0.010	0.001	0.269	0.206
NTGR	0.86	0.86	0.86	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net Energy Savings – at the Meter (GWh)	8.838	1.935	2.251	1.024	1.946	0.458	0.155	0.010	0.001	0.269	0.206
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100
Net Energy Savings – at the Generator (GWh)	9.722	2.128	2.476	1.126	2.140	0.504	0.170	0.011	0.001	0.296	0.227
Effective Useful Life (years)	8.4	7.1	7.7	7.6	9.8	9.4	10.0	10.0	10.0	10.0	4.0
Net Lifetime Energy Savings – at the Generator (GWh)	81.661	15.110	19.062	8.559	20.973	4.487	1.702	0.114	0.008	2.958	0.907
Peak Demand Savings											
Revised Gross Peak Demand Savings – at the Meter (MW)	1.449	0.317	0.369	0.142	0.278	0.073	0.022	0.000	0.000	0.000	0.000
NTGR	0.86	0.86	0.86	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net Peak Demand Savings – at the Meter (MW)	1.246	0.273	0.317	0.142	0.278	0.073	0.022	0.000	0.000	0.000	0.000
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100
Net Peak Demand Savings – at the Generator (MW)	1.371	0.300	0.349	0.157	0.306	0.080	0.024	0.000	0.000	0.000	0.000

Evaluated Net Energy and Peak Demand Savings by Product Category for Instant Savings (Continued)

Product Category	Smart Power Bar	Heavy-duty Outdoor Timer	Programmable Thermostat	Clothesline	Efficient Refrigerator	Efficient Clothes Washer	Room Air Purifier	Dehumidifier	Total for All Products
Energy Savings									
Revised Gross Energy Savings – at the Meter (GWh)	0.039	0.593	0.798	0.169	0.058	0.329	0.215	0.643	22.057
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-
Net Energy Savings – at the Meter (GWh)	0.039	0.593	0.798	0.169	0.058	0.329	0.215	0.643	19.937
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	-
Net Energy Savings – at the Generator (GWh)	0.043	0.652	0.878	0.186	0.064	0.362	0.237	0.708	21.930
Effective Useful Life (years)	4.0	10.0	10.0	10.0	12.0	14.0	9.0	12.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	0.171	6.519	8.778	1.861	0.764	5.074	2.133	8.494	189.336
Peak Demand Savings									
Revised Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	-0.318	0.000	0.008	0.045	0.037	0.216	2.638
NTGR	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	-0.318	0.000	0.008	0.045	0.037	0.216	2.339
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100	1.100	1.100	-
Net Peak Demand Savings – at the Generator (MW)	0.000	0.000	-0.350	0.000	0.009	0.050	0.041	0.237	2.572

Table 41 compares the energy and peak demand savings established by this evaluation with the savings calculated in the 2018 tracking sheet.

Table 41: Comparison of Instant Savings Tracked and Evaluated Savings at the Generator

	Initial Gross Savings	Revised Gross Savings	NTGR*	Net Savings
Energy Savings				
ENS Tracked Savings	23.653 GWh	23.653 GWh	0.84	19.967 GWh
Evaluation Results	24.262 GWh	24.262 GWh	0.90	21.930 GWh
Peak Demand Savings				
ENS Tracked Savings	2.809 MW	2.809 MW	0.82	2.290 MW
Evaluation Results	2.901 MW	2.901 MW	0.89	2.572 MW

*NTGRs varied for each product category. The NTGRs presented in this table correspond to the rounded averages obtained by dividing net savings by installed gross savings (with interactive effects taken into account).

The evaluated gross energy savings are 3 percent higher than the tracked gross energy savings. This slight difference is mainly due to the increase in gross unitary savings associated with LED A-type lamps and LED R, BR and decorative lamps that were increased by 12 and 7 percent respectively. This increase in the unitary savings values of LED A-type lamps results mostly from the increase in displaced wattage. The evaluated net energy savings are 10 percent higher than the tracked value. This difference is due to the increase in the NTGR resulting from a higher spillover level established for 2018.

The evaluated net peak demand savings are 12 percent higher than those tracked by ENS for the same reason as the increase in the net energy savings.

10 INSTANT SAVINGS MARKET EVOLUTION

ENS has been active in the LED lamp market since 2011 through Instant Savings. The 2016 evaluation revealed indicators that market barriers to LED lamps had been reduced, especially for A-type LED lamps. A market evolution assessment was completed as part of the 2017 evaluation, which served to analyze key market indicators and present a technology diffusion curve illustrating the market adoption of LED lamps in Nova Scotia. The aim of this section is to update the data collected as part of the 2017 evaluation and provide up-to-date insights regarding the market transformation of LED lamps in Nova Scotia.

10.1 Market Indicators

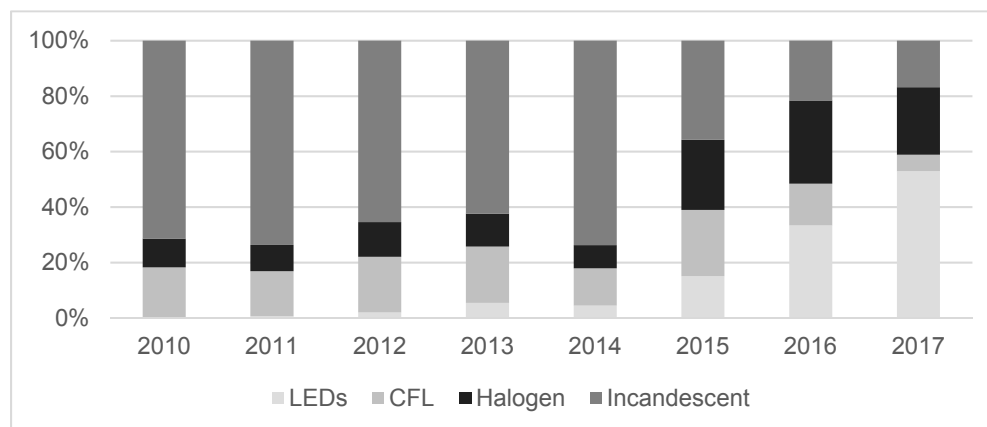
The Evaluator analyzed available market data and established key market indicators to understand the state of the LED market in Nova Scotia.

10.1.1 Market Shares of Lighting Technologies in Atlantic Canada

The residential lighting market continues to be dominated by four main technologies: incandescent, halogen, CFL and LED lamps. Atlantic shipment data indicates that the popularity of LED lamps continues to increase. In terms of market share, as shown in Figure 11 below, LEDs had the highest market share and comprised over half of residential lighting shipments (52%) in 2017. The share of LEDs increased from 33 percent in 2016 to 52 percent in 2017.

The market share of all other lighting types decreased from 2016 to 2017. CFLs lost significant market share, dropping from 15 percent in 2016 to 6 percent in 2017. Incandescent lamps fell from 22 percent in 2016 to 16 percent in 2017. While halogen lighting had seen increases in market share during previous years because they served to replace incandescent lamps, their market shares also decreased from 30 percent in 2016 to 24 percent in 2017.

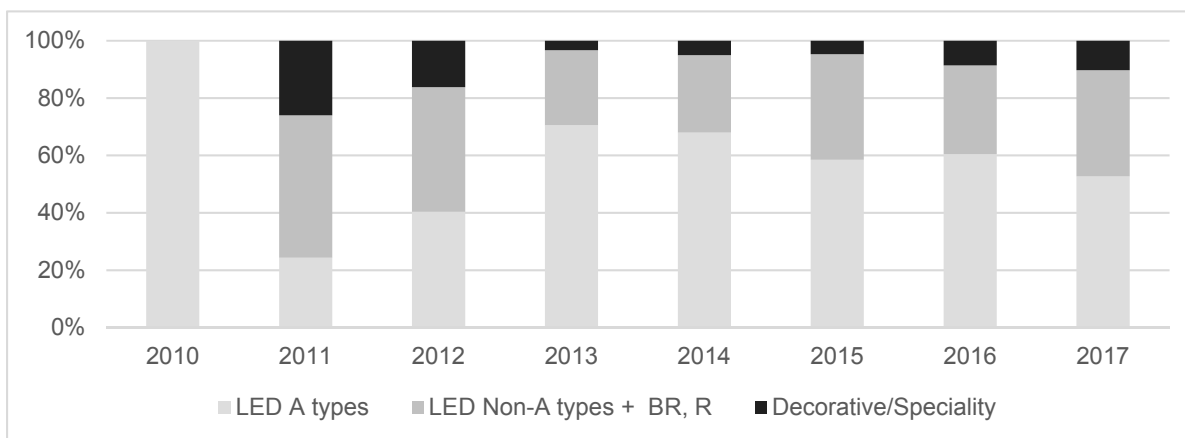
Figure 11: Atlantic Canada Consumer Lighting Shipments by Type of Technology



Source: Electro-Federation Canada, Lamp Data - Consumer Channel and C&I Channel 2004-2017.

Figure 12 below breaks down LED shipments in the Atlantic region by lamp type. Non-A type lamps are typically reflector lamps and replace halogen reflector lamps; BR and R lamps are also reflector lamps, although they primarily replace incandescent lamps. From 2016 to 2017, there was a small change in share of LED shipments, with the share of A-types decreasing slightly from 60 percent in 2016 to 53 percent in 2017 and the share of non-A type lamps increasing from 31 percent in 2016 to 37 percent in 2017. The share of decorative and specialty lamps remained relatively consistent.

Figure 12: Atlantic Canada Consumer LED Shipments by Lamp Type

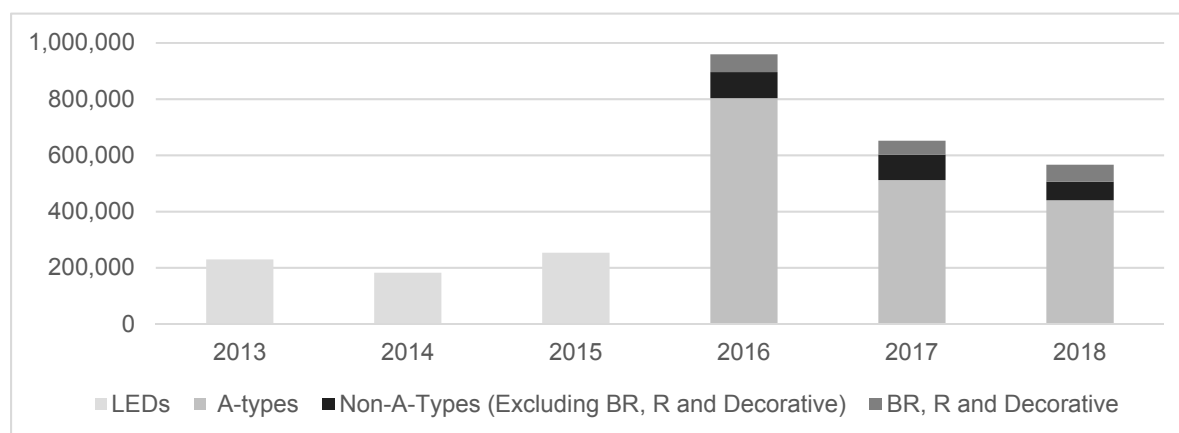


Source: Electro-Federation Canada, Lamp Data - Consumer Channel and C&I Channel 2004-2017.

10.1.2 LED Lamps Rebated by Instant Savings

Figure 13 illustrates the number of LED lamps rebated by Instant Savings since 2013, broken down by lamp type where data is available. A-type lamps continue to account for most of the LED lamps rebated by Instant Savings.

Figure 13: ENS Instant Savings Rebated LED Lamps



Source: 2013-2017 Evaluation Reports for Instant Savings and 2018 results.

10.1.3 Socket Saturation and Replacement Behaviour

No further information with respect to socket saturation has become available since the 2017 evaluation. The 2016 Socket Study³¹ found that the incidence of households with at least one LED lamp was 59 percent in 2016 for Nova Scotia, up significantly since the 2011 study. LED lamps increased from accounting for only 4 percent of all permanent fixture lamps in homes to 24 percent in 2016 and from only 3 percent to 21 percent for plug-in lamps. Moreover, CFLs and incandescent lamps remained the dominant lamp types installed in Nova Scotian homes in 2016.

As part of the participant intercept survey described in Section 7, LED purchasers reported whether these lamps would be used for early replacement, that is to replace a bulb that has not burned out, or to replace a burned-out bulb. Table 42 below indicates a shift in the replacement behaviour since LED lamps are increasingly being installed in homes. Since 2015, the percentage of LED lamps intended to replace burned-out lamps has increased, while the percentage of early replacements has decreased.

Table 42: ENS Rebated LED Lamp Replacement Intention

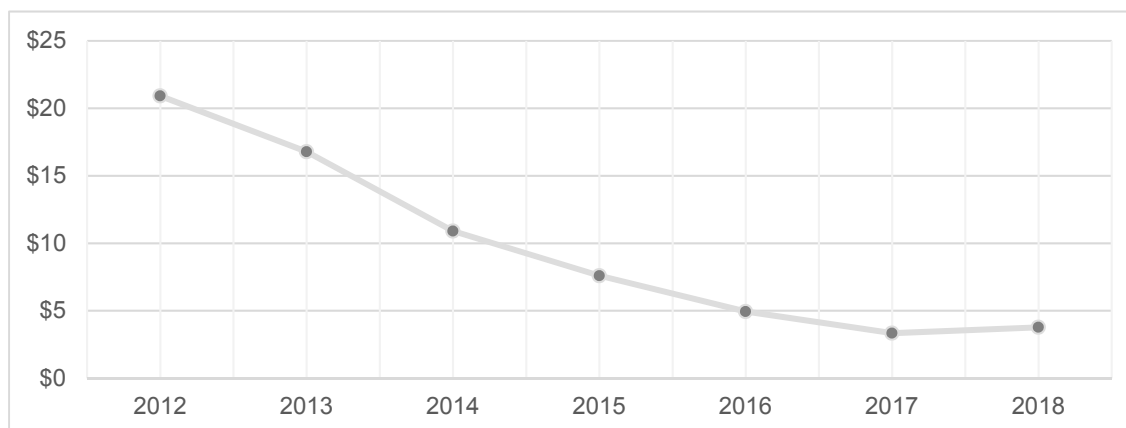
Replacement Intention	2015	2016	2017	2018
Early Replacement	81%	77%	70%	59%
Replace on Burn-out	19%	23%	30%	41%

10.1.4 LED Prices

Figure 14 below illustrates the evolution in the price of LED lamps sold through Instant Rebates (before a rebate is applied). From 2012 to 2017, average LED prices decreased from just over \$20 in 2012 to about \$3.30 in 2017, making LED lamps much more cost competitive. In 2018, a slight increase was noted with the average LED price being about \$3.70 per unit, indicating a levelling out of LED pricing in general.

As mentioned in the 2017 Evaluation Report, the LED lamp price decrease over recent years can be explained by the increasing proportion of multipacks in Instant Savings LED lamp sales and the introduction of the LED product category in discount stores, which caused consumers to expect lower prices.

³¹ Corporate Research Associates Inc., *2016 Socket Study*, Final Report prepared for Efficiency Nova Scotia, December 2016.

Figure 14: Average LED Lamp Prices in Instant Rebates (All Lamp Types)


Sources: 2012-2015 Instant Savings Evaluation Reports; 2016-2018 Instant Savings tracking sheets.

As demonstrated above in Figure 13, A-type lamps accounted for most LED lamps rebated through Instant Savings. Table 43 below demonstrates that A-type lamps were the least expensive type of lamp with an average unit price of \$3.10 in 2018, while R-type lamps were the most expensive type with an average unit price of \$8.62 in 2018. The other lamp types had an average unit price ranging from \$5.00 to \$6.00.

Analyzing average LED lamp prices over the years revealed that the significant decreases in prices observed prior to 2017 shifted to a slight increase 2018, particularly for BR lamps that went from an average price of \$4.73 in 2017 to \$5.95 in 2018. The Evaluator analyzed the Instant Savings tracking sheet to understand this upward trend and found that the retail unit price of two of the most popular models of BR lamps increased between 2017 and 2018.

Table 43: Average LED Prices by Lamp Type

Lamp Type	2016 (\$)	2017 ³² (\$)	2018 (\$)
A-type	5.26	3.04	3.10
Non A-type	7.55	4.60	5.50
BR	9.78	4.73	5.95
R	10.19	7.36	8.62
Decorative	7.81	4.12	4.98

The average incentive provided by Instant Savings for LED A-type lamps in 2018 was \$1.05. The incentives bring the average price of A-type LED lamps down to about \$2.05 per lamp.

³² 2017 LED prices of BR and R lamps were updated to correct data entry errors.

10.1.5 Codes and Standards

The ultimate indicator of market transformation is the adoption of more stringent codes and standards. Currently, general service lamps³³ are required to meet an efficiency level that corresponds to halogen incandescent lamps (for instance, a standard 60 W incandescent lamp is no longer allowed, and its equivalent is a 43 W halogen incandescent lamp). This minimum energy performance standard has been enforced since early 2014 and early 2015, depending on lamp wattages. The latest amendment to the Canadian Energy Efficiency Regulations (Amendment 14 published on October 31, 2018)³⁴ did not have any significant impact on the efficiency of lamps rebated through Instant Savings. Furthermore, NRCAN has considered updating the general service lamp minimum energy performance requirement in Amendment 17, which is planned for pre-consultation in 2019. This update will most likely align Canadian regulations with the next American Energy Independence and Security Act (EISA) regulation update (planned for 2020), which will effectively ban the import and fabrication of halogen incandescent lamps as a result of the minimum acceptable efficiency level being higher than halogen incandescent efficiency. Regardless, the timing of the regulation will likely not coincide with the upcoming EISA regulations. It is more likely that general service lamp minimum performance standards will be enforced in Canada sometime after 2020.

10.2 Measured Free-ridership

The Evaluator analyzed the free-ridership level to gain insights into the evolution of LED lamp market adoption in Nova Scotia. The 2018 intercept survey revealed a free-ridership level of 39 percent for LED lamps sold through Instant Savings. While the free ridership level is up 7 percent over 2017 levels, it is only marginally higher than the 37 percent obtained in 2015. Therefore, while a larger proportion of participants were likely to buy LED lamps in the absence of the program in 2018, this increase is not far beyond the range of values previously seen for the program component, as shown in Table 44.

Table 44: Free-ridership Level for LED Lamps

Free-ridership	2015	2016	2017	2018
ENERGY STAR Certified LED Lamps	37%	33%	32%	39%

³³ The Energy Efficiency Regulation on general-service lamps covers most A-type lamps. Natural Resources Canada, *General Service Lamps and Modified Spectrum Incandescent Lamps*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869> (Last accessed January 26, 2018).

³⁴ Natural Resources Canada, *Amendment 14, October 2018*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/18419> (Last accessed December 6, 2018).

10.3 Market Evolution Summary

Rosenburg and Hoefgen (2009) made recommendations on market transformation program planning and suggested analyzing certain factors, as outlined in Table 45 below, to identify whether program-based support should be withdrawn or reduced in light of changes observed in the market.³⁵

Table 45: Overview of Key Factors in Program Planning

Factor	Results
Market share of LED lamps	LED lamp shipments accounted for over half of all lamps shipped to Atlantic Canada in 2017, up considerably from 2016. The mix of LED lamp shipments changed in 2017, with the share of non-A-types increasing. LED lamp residential socket saturation was 21% for permanent fixture lamps and 24% for plug-in lamps in Nova Scotia in 2016. 59% of Nova Scotians had at least one LED lamp in 2016. No socket data was available for 2017 and 2018.
Recent trends in prices and availability	LED lamp prices have declined significantly since 2012. The average price of A-type LED lamps is estimated at \$3.10. Data indicated a slight uplift in the price of LED lamps in 2018 due to some popular models having higher retail prices in 2018 than in 2017. LED lamps are available at major retailers as well as independent stores, as indicated by the various kinds of retailers participating in Instant Savings. An ever-widening range of LED lamps and products are becoming available.
Likelihood of inclusion in a near-term code or standard	Canada is considering updating the general service lamp minimum energy performance requirement in Amendment 17, which is planned for pre-consultation in 2019. This update is expected to effectively ban halogen incandescent lamps from being manufactured or imported once the standard comes into force (date unknown at this time).
Market readiness of more efficient substitute technology	No substitute that is more efficient than LED lamps has become available.

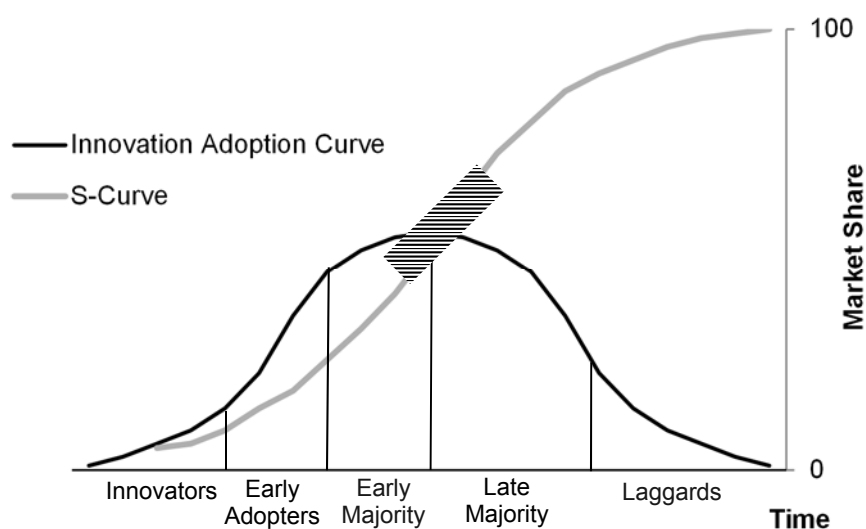
Figure 15 further below provides a qualitative indication of the adoption stages of LED lamps in Nova Scotia. It demonstrates that as successive groups of consumers adopt the new technology (indicated by the innovation adoption curve in black),³⁶ the LED market share (as indicated by the S-curve in grey) will eventually reach full saturation.

³⁵ Rosenburg M. and Hoefgen L, *Market Effects and Market Transformation: Their Role in Energy Efficiency Program Design and Evaluation*, Prepared for the California Institute of Energy and the Environment, 2009.

³⁶ Everett Rogers, *Diffusion of Innovations*, 1983.

The 2017 evaluation found the market to be in a growth phase and approaching maturity as more and more residents adopt LED lamps. As shown by the hatched portion in Figure 15, 2018 data suggests that the market for LED lamps continues to be in a growth phase, although it is moving closer to maturity.³⁷ LED lamp shipments grew to over 50 percent of market share in 2017, thus demonstrating that the barriers to LED adoption continue to weaken. A-type bulbs have reached maturity ahead of other LED lamp types. While A-type lamps experience continued growth, their overall share in LED shipments has begun to decrease and their prices, which are now more competitive with alternative technologies, have started to stabilize. Since it is not known how increased Atlantic LED shipments translates to LED socket saturation in Nova Scotia, more recent socket information would help to further refine this analysis.

Figure 15: Residential Market Evolution for LED Lamps



³⁷ Figure 15 is a qualitative assessment of the LED lamps market only. As such, it does not represent the exact market share of LED lamps in Nova Scotia.

11 INSTANT SAVINGS RECOMMENDATIONS

The evaluation revealed that Instant Savings again succeeded to achieve high levels of participation and savings in 2018. Some indicators such as low LED prices and a slight decrease in A-type LED lamp sales suggest that A-type lamps have reached maturity in the Nova Scotia market. Evaluation findings support the ENS decision to remove rebates on A-type lamps as of 2019. The biggest challenges for Instant Savings in the coming years will be to continue diversifying product offerings and investing efforts in energy efficient products for which Instant Savings can influence purchase decisions. In addition to the general recommendations made for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator makes the following recommendations aimed at optimizing Instant Savings. These recommendations are also presented in Appendix XIV.

2018 Instant-R1 Perform a socket study through on-site visits to document energy savings potential related to lighting. Market data point to increasingly high penetration rates of LED lamps and fixtures in Nova Scotia homes. To document the remaining energy savings potential related to lighting in existing homes, the Evaluator recommends conducting a socket study in Nova Scotia homes. The socket study, conducted through on-site visits, should serve to collect information such as the number and type of lamps installed in homes. This study would be helpful for all program components that offer residential lighting measures by providing insights on the current state of lighting market.

2018 Instant-R2 Continue monitoring LED market indicators. Despite the removal of A-type lamps from the Instant Savings offering as of 2019, the Evaluator recommends continuing to monitor the evolution of all LED lamps. Market indicators such as the market shares and prices of lighting technologies should still be collected to understand the changes occurring in the market after A-type lamps are removed. Monitoring market indicators would also help with remaining current on the overall state of the lighting market, which is in a period of change.

12 OVERALL SAVINGS OF THE RESIDENTIAL EFFICIENT PRODUCT PROGRAM

Table 46 summarizes the participation levels, as well as gross and net savings for each Residential Efficient Product Rebates program component and the whole program.

Table 46: Overall Participation and Savings for Residential Efficient Product Rebates

	Participation Level	Gross Savings	NTGR	Net Savings
ARet				
Energy Savings	5,595 appliances	4.568 GWh	0.58	2.657 GWh
Lifetime Energy Savings		35.043 GWh	0.57	19.822 GWh
Peak Demand Savings		0.640 MW	0.59	0.378 MW
Instant Savings				
Energy Savings	669,550 products sold	24.262 GWh	0.90	21.930 GWh
Lifetime Energy Savings		208.193 GWh	0.91	189.336 GWh
Peak Demand Savings		2.901 MW	0.89	2.572 MW
Total				
Energy Savings		28.830 GWh		24.588 GWh
Lifetime Energy Savings		243.236 GWh		209.158 GWh
Peak Demand Savings		3.542 MW		2.951 MW

CONCLUSION

In 2018, the Residential Efficient Product Rebates program aimed to achieve 19.3 GWh in net electrical energy savings and 2.5 MW in peak demand savings at the generator. The Evaluator determined that the Residential Efficient Product Rebates program achieved 24.588 GWh in net electrical energy savings and 2.951 MW in net peak demand savings at the generator in 2018. These savings represent 15,062 tonnes of CO₂ eq in terms of annual avoided GHG emissions. The net lifetime energy savings were established at 209.158 GWh. Although ARet did not achieve its planned savings, Instant Savings significantly exceeded theirs, resulting in the program surpassing its planned energy and peak demand savings for 2018. As in previous years, Instant Savings was the largest contributor to program net savings, accounting for 89 percent of program savings.

The following subsections summarize the main findings for each of the two components comprising the Residential Efficient Product Rebates program.

Appliance Retirement

A total of 5,595 appliances were retired or replaced through ARet in 2018, generating 2.657 GWh in net electrical energy savings and 0.378 MW in net peak demand savings. The total number of appliances retired in 2018 was slightly lower than in 2017 due to a decrease in the number of retired freezers. Consequently, savings also decreased compared to 2017.

Again in 2018, participants were very satisfied with ARet. The new online booking portal had a successful launch with nearly 30 percent of participants using it to book their pick-up appointment.

Although ENS conducted metering activities to establish the average consumption of retired refrigerators and freezers, the Evaluator relied on the 2017 metering results to calculate ARet savings since too many variations were observed in the 2018 data due to temperature variations in the rooms where metering was conducted. The Evaluator updated the part-use factors, free-ridership levels, secondary market impacts, and spillover level based on the 2018 participant survey results. The revised parameters led to lower net unitary savings values for refrigerators and freezers retired through ARet and higher net unitary savings values for air conditioners and small appliances.

The downward adjustments to refrigerator and freezer net unitary savings and the lower number of retired freezers resulted in ARet not achieving the planned energy savings of 3.1 GWh and 0.4 MW in electrical energy and peak demand savings respectively.

Instant Savings

In 2018, Instant Savings aimed to achieve 16.2 GWh in net electrical energy savings and 2.1 MW in net peak demand savings at the generator. The Evaluator established that Instant Savings achieved 21.930 GWh in net electrical energy savings and 2.572 MW in net peak demand savings at the generator in 2018, thus exceeding its planned savings.

In 2018, 669,550 products were sold through Instant Savings. This represents fewer sales than in 2017, but the overall savings achieved by Instant Savings were higher than in 2017 due to higher average savings by product. LED A-type lamps remained the most popular product with 66 percent of all products sold, although fewer quantities were sold through Instant Savings in 2018 than in 2017. The higher 2018 unitary savings value established for this product, along with increased sales of other rebated products such as fixtures and appliances, contributed to Instant Savings exceeding its planned savings.

Again in 2018, satisfaction with Instant Savings was high among retailers and they were very satisfied with Instant Savings marketing and advertising as well as with their overall relationship with the DA. ENS marketing remained the most common way for participants to find out about Instant Savings, primarily through in-store promotions, followed by radio ads, store flyers, TV commercials and word-of-mouth.

The market evolution analysis revealed that the LED lamp market continues to be in a growth phase and is moving closer to maturity. Moreover, some indicators such as low LED prices and a slight decrease in A-type LED lamp sales suggest that A-type lamps have reached maturity in the Nova Scotia market. Evaluation findings support the ENS decision to remove rebates on A-type lamps as of 2019.

The biggest challenges for Instant Savings in the coming years will be to continue diversifying product offerings beyond LED lamps and investing efforts in energy efficient products for which Instant Savings can influence purchase decisions.

LIST OF APPENDICES

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

Appliance Retirement

Appendix I ARet: Participant Survey Questionnaire

Appendix II ARet: Participant Survey Results

Appendix III ARet: Algorithm for Free-Ridership Calculation

Appendix IV ARet: Unitary Savings Calculations

Appendix V ARet: Participant Spillover Methodology

Appendix VI ARet: 2018 Recommendations

Instant Savings

Appendix VII IS: Interview Guide with Retailer Partners

Appendix VIII IS: Participant Intercept Survey Questionnaire

Appendix IX IS: Participant Survey Results

Appendix X IS: Unitary Savings Calculations

Appendix XI IS: Detailed Calculations of Equivalent Effective Useful Life for Led Lamps and Fixtures

Appendix XII IS: Algorithm for Free-Ridership Calculation

Appendix XIII IS: Spillover Methodology

Appendix XIV IS: 2018 Recommendations



RESIDENTIAL EFFICIENT PRODUCT REBATES PROGRAM

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Appendix Report

March 15, 2019



TABLE OF CONTENTS

APPENDIX I ARET: PARTICIPANT SURVEY QUESTIONNAIRE.....	1
APPENDIX II ARET: PARTICIPANT SURVEY RESULTS	15
APPENDIX III ARET: ALGORITHM FOR FREE-RIDERSHIP CALCULATION	32
APPENDIX IV ARET: UNITARY SAVINGS CALCULATIONS.....	33
APPENDIX V ARET: PARTICIPANT SPILLOVER METHODOLOGY	56
APPENDIX VI ARET: 2018 RECOMMENDATIONS.....	58
APPENDIX VII IS: INTERVIEW GUIDE WITH RETAILER PARTNERS	59
APPENDIX VIII IS: PARTICIPANT INTERCEPT SURVEY QUESTIONNAIRE	69
APPENDIX IX IS: PARTICIPANT SURVEY RESULTS	86
APPENDIX X IS: UNITARY SAVINGS CALCULATIONS	100
APPENDIX XI IS: DETAILED CALCULATIONS OF EQUIVALENT EFFECTIVE USEFUL LIFE FOR LED LAMPS AND FIXTURES.....	118
APPENDIX XII IS: ALGORITHM FOR FREE-RIDERSHIP CALCULATION	123
APPENDIX XIII IS: SPILLOVER METHODOLOGY.....	126
APPENDIX XIV IS: 2018 RECOMMENDATIONS.....	129

APPENDIX I

ARET: PARTICIPANT SURVEY QUESTIONNAIRE

SCREENING QUESTIONS

Could I 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 _____ from Corporate Research Associates, 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 had participated in the Appliance Retirement Program in 2018.

Are you the person who was most involved with this program?

(IF NEEDED: As part of this program, someone would have come to your house and picked up your old fridges, freezers or air conditioners to recycle it).

[IF NO, ASK TO SPEAK TO THE APPROPRIATE PERSON]: “May I please speak to the person who knows the most about this program?”]

We would appreciate your help in answering questions related to your participation in this program. The information you provide will be used to help Efficiency Nova Scotia evaluate and improve the program. Is this a good time for you?

(IF NEEDED: You may have recently been contacted by Corporate Research Associates or by an Efficiency Nova Scotia representative about your experience with the service. This survey is different as it focuses on other aspects of your participation in the service.)

(IF NEEDED: The survey will take about fifteen minutes.)

1. Yes [CONTINUE]
2. No, I don't remember the program / Don't know [PROMPT: “Are you sure? Someone would have come to your home and picked up your old appliance to recycle it. You would also have received a \$30 incentive or more?” RECODE AS “YES” IF THE PROMPT WORKS; IF RESPONDENT STILL SAYS NO: Is there someone else in the household who would know about having participated in this Efficiency Nova Scotia program?
3. 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: _____]

Verification and Recall (V Series)

V1. Our records indicate that your household participated in Appliance Retirement Program, which removed and recycled

[INSERT NUMBER FROM VARIABLE “RF” IN THE SAMPLE] full-sized fridge(s)

[INSERT NUMBER FROM VARIABLE “FZ” IN THE SAMPLE] stand-alone freezer(s)

[INSERT NUMBER FROM VARIABLE “SMF” IN THE SAMPLE] small fridge (s)

[INSERT NUMBER FROM VARIABLE “SMZ” IN THE SAMPLE] small stand-alone freezer(s)

[INSERT NUMBER FROM VARIABLE “AC” IN THE SAMPLE] air conditioner(s)

from your home in 2018. Is this correct?

[Definition for small fridges and freezers if needed: Must be under 10 cubic feet and the participant would have received a \$10 incentive for each small appliance removed]

1. Yes [GO TO APPLIANCE SECTION]
2. No, does not recall participating [PROBE: “Let me clarify. Someone would have come to your home and picked up your old appliance to recycle it. You would also have received a \$30 incentive or more. [IF PERSIST AS NO, THANK, TERMINATE AND RECORD]
3. No, different quantities (GO TO V2)
4. (Don’t know) [PROBE: “Let me clarify. Someone would have come to your home and picked up your old appliance to recycle it. You would also have received a \$30 incentive or more. IF PERSIST AS NO, THANK, TERMINATE, RECORD AND KEEP DATA.

V2. [ASK IF V1=3] Thinking only about the appliances that were picked up through the Appliance Retirement Program, which quantities are wrong? The [READ BELOW 1 = YES, this quantity is wrong, 2 = NO, this quantity is correct, 98 = Don’t Know] IF NO OR DK TO ALL APPROPRIATE A/B/C/D/E, ASK V1 AGAIN. (THIS WILL VARY DEPENDING ON PREVIOUS RESPONSES – NOT ALL RESPONDENTS WILL GET A-E)

- a. Number of full-sized fridges picked up
- b. Number of full-sized stand-alone freezers picked up
- c. Number of small fridges picked up
- d. Number of small stand-alone freezers picked up
- e. Number of air conditioners picked up

V3. [IF V2a. = YES] How many full-sized fridges were picked up in 2018 through the Appliance Retirement Program? [Record number, 98=Don’t Know, 99= Refused] _____

V4. [IF V2b. = YES] How many full-sized stand-alone freezers were picked up in 2018 through the Appliance Retirement Program? [Record number, 98=Don’t Know, 99=Refused]_____

V5. [IF V2c. = YES] How many small fridges were picked up in 2018 through the Appliance Retirement Program? [Record number, 98=Don’t Know, 99= Refused] _____

V6. [IF V2d. = YES] How many small stand-alone freezers were picked up in 2018 through the Appliance Retirement Program? [Record number, 98=Don't Know, 99=Refused]_____

V7. [IF V2e. = YES] How many air conditioners were picked up in 2018 through the Appliance Retirement Program? [Record number, 98=Don't Know, 99=Refused]_____

IF ZERO FOR ALL OF V3/V4/V5/V6/V7, AND NO QUANTITY VERIFIED IN V1, THANK, TERMINATE, AND RECORD DATA. IF DON'T KNOW/REFUSED FOR ALL V3/V4/V5/V6/V7, AND NO VALID QUANTITY IN V1, THANK AND TERMINATE.

Appliance Section

APPLIANCE	QUOTA
FULL-SIZED FRIDGE (RF)	n=75
FULL-SIZED FREEZER (FZ)	n=75
SMALL FRIDGE (SMF) OR FREEZER (SMZ)	n=20 ¹
AIR CONDITIONER (AC)	n=30 ²
TOTAL	n=200

[PROGRAMMER: EACH RESPONDENT WILL BE ASKED ABOUT **ONLY ONE APPLIANCE**. IF AIR CONDITIONER, SMALL FRIDGE OR SMALL FREEZER, ASK ABOUT THESE APPLIANCES FIRST. SEE THE SEQUENCE BELOW]

SMALL FRIDGES (SMF)

[IF V1=1 and SMF>0 OR IF V5>0 (had small fridge removed), ASK ABOUT SMALL FRIDGES, OTHERWISE ASK FOR SMALL FREEZERS]

SMALL FREEZERS (SMZ)

[IF V1 = 1 and SMZ > 0 OR IF V6>0 (had small freezer removed), ASK ABOUT SMALL FREEZERS, OTHERWISE ASK FOR AIR CONDITIONERS]

AIR CONDITIONERS (AC)

[IF V1=1 and AC>0 OR IF V7>0 (had air conditioner removed) ASK ABOUT AIR CONDITIONERS, OTHERWISE ASK FOR FRIDGES]

FULL-SIZED FRIDGES (RF)

[IF V1=1 and RF>0 OR IF V3>0 (had full-sized fridge removed), ASK ABOUT FRIDGES, OTHERWISE ASK FOR FREEZERS]

FULL-SIZED FREEZERS (FZ)

[IF V1 = 1 and FZ > 0 OR IF V4>0 (had full-sized freezer removed), ASK FOR FREEZERS, OTHERWISE SKIP TO REPLACEMENT SECTION]

¹ SMF and SMZ participants: respectively 39 as of September 2018. We will try to get as many as we can for the survey.

² AC participants: 58 as of September 2018. We will try to get as many as we can for the survey.

ONE APPLIANCE

[READ IF $V1 = 1$ and $RF/FZ/SMF/SMZ/AC = 1$ OR IF $V3/V4/V5/V6/V7=1$], Now, I'd like you to think about the [full-sized fridge/full-sized stand-alone freezer/ small fridge/small stand-alone freezer/ air conditioner] you had removed through the program in 2018.

MORE THAN ONE APPLIANCE

[READ IF $V1 = 1$ and $RF/FZ/SMF/SMZ/AC > 1$ OR IF $V3/V4/V5/V6/V7>1$] You've told me that you had more than one [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioners] removed through the program. For purposes of this survey, pick just one of the [full sized fridge/full-sized stand-alone freezer/ small fridge/small stand-alone freezer/air conditioners] removed and keep only that one [full-sized fridge/full-sized stand-alone freezer/ small fridge/small stand-alone freezer/air conditioners] clearly in your mind as you answer the next few questions.

Part-use Section (U Series)**[ASK U1 FOR FULL-SIZED FRIDGES (RF) ONLY]**

U1. Was the fridge removed through the program the main one used in the home, a second fridge used at least part of the time, or a fridge not used at all?

[IF NECESSARY: "A main or primary fridge would typically be located in the kitchen, plugged in or "on" all the time, and used for regular household purposes. A secondary or spare fridge is typically located somewhere other than in the kitchen and may be plugged in or on all or only part of the time."]

[NOTE: If respondent recently bought a new fridge and was just waiting for the previously used one to be picked up by the program, it should be classified as "Main/Primary"]

1. Used as Main/Primary
2. Used as a Spare/Secondary at date of pickup
3. Not being used
98. (Don't know) [PROBE: READ CLARIFICATION AND TRY TO CLASSIFY STATUS OF FRIDGE]
99. (Refused)

[ASK QUESTIONS U2-U4 FOR ALL APPLIANCES]

U2. Approximately how old was the [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] you had removed through the program? [RECORD IN YEARS. ENTER "00" IF LESS THAN ONE YEAR OLD.]

_____ (Record years)

98. (Don't know) [PROBE: ANY IDEA WHAT YEAR IT WAS PURCHASED? *INTERVIEWER SHOULD THEN DO THE MATH*]
99. (Refused)

U3. Which of the following describes the condition of the [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] when you decided to have it picked up? [READ]

1. It worked well
2. It worked okay, but had some problems
3. It did not work
98. (Don't know)
99. (Refused)

U4. During the last year, how many months was the [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] plugged in and running?

_____ [RECORD MONTHS; RANGE: 1-12; HALF A MONTH=.5]

96. (Kept running all the time) [THEN RECORD 12 MONTHS]
97. (Never plugged in or running) [THEN RECORD 0 MONTH]
98. (Don't know)
99. (Refused)

[ASK QUESTION U5 FOR AIR CONDITIONERS (AC) ONLY]

U5. [ASK IF U4 =1-11] You told me that you used to turn on your air conditioner for [INSERT U4] months. On what basis did you decide to turn on your air conditioner? [DO NOT READ - ALLOW MULTIPLE BUT DO NOT ASK FOR]

1. (According to the temperature/When it was warm)
2. (During night time)
3. (On weekends)
96. (Other, specify _____)
98. (Don't know)
99. (Refused)

Free-Ridership Section (FR Series)

FR1. Had you **already** planned to dispose of this [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] **before** you heard about Efficiency Nova Scotia's Appliance Retirement Program? By dispose of, I mean getting the appliance out of your home by selling it, giving it away, having someone pick it up, or taking it to the dump or a recycling center yourself.

1. Yes
2. No [GO TO REPLACEMENT SECTION]
98. (Don't know)
99. (Refused)

FR2a. Now suppose that the Appliance Retirement Program had not been available. Would you have disposed of your [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioners] 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)

FR3. [ASK FOR FULL-SIZED FRIDGES (RF) AND IF FR2a=2] If you had kept the [fridge], would you have placed it in the kitchen or somewhere else?

1. Kitchen
2. Somewhere else
98. (Don't know)
99. (Refused)

FR4. [ASK IF FR2a=1] How would you have disposed of the [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] if the program had not been available? Would you...

(READ LIST IN RANDOM ORDER)

1. Have sold it or given it to a private party [example: friend, family member, kijiji]
2. Have left it on the curb with a "free" sign
3. Have it removed by the dealer supplying your new appliance
4. Have taken it to a dump or recycling center
5. Have it picked up by the waste management company during spring or fall large collection day
96. Or disposed of it in some other way: specify: _____)
98. (Don't know)
99. (Refused)

FR7. What is the main reason you chose the Efficiency Nova Scotia program to dispose of your appliance? [DO NOT READ. RECORD ONLY ONE RESPONSE]

1. (Convenience/Easy to get rid of)
2. (Free pick-up service)
3. (Savings on electric bill)
4. (To ensure it was recycled)
5. (Incentive)
6. (Recommended by family or friend)
96. Other, specify: _____
98. (Don't know)
99. (Refused)

Replacement Section (RE Series)

RE1. Did you replace the [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] that you removed through the program in 2018?

1. Yes
2. No [GO TO SPILLOVER SECTION]
98. (Don't know) [GO TO SPILLOVER SECTION]
99. (Refused) [GO TO SPILLOVER SECTION]

RE3a. Was the replacement [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] new or used?

[NOTE TO INTERVIEWERS: A replacement unit from within the house should be coded 2 'Used']

1. New
2. Used
98. (Don't know) [SKIP TO SO SECTION]
99. (Refused) [SKIP TO SO SECTION]

RE3b. [ASK IF RE3a = 2] How did you get this replacement [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner]? [READ AND RANDOMIZE, BUT ASK 96 LAST] ACCEPT ONE RESPONSE ONLY

1. Purchased it from a used appliance store or a private party (for example, through classified ads or kijiji)
2. Appliance was given to me by a friend or family member
3. Appliance came from another location in the house
96. Or some other way (Specify:_____)
98. (Don't know)
99. (Refused)

RE4. Was the replacement [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] an ENERGY STAR® or high-efficiency model?

1. Yes
2. No
98. (Don't know)
99. (Refused)

Spillover Section (SO Series)

SO1. When the Efficiency Nova Scotia representative came to pick up your [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioners], did he also pick up any **other** appliances that were **not eligible** for an incentive? Examples would be dehumidifier, kitchen stove, clothes dryer or clothes washers, for instance.

- 1. Yes
- 2. No [GO TO SO5]
- 98. (Don't know) [GO TO SO5]
- 99. (Refused) [GO TO SO5]

SO2. [ASK IF SO1=1] What other appliances were picked up? [DON'T READ, allow multiple responses]

- 1. (Dehumidifier)
- 2. (Clothes washer)
- 3. (Clothes dryer)
- 4. (Kitchen stove)
- 96. (Other, specify: _____)
- 98. (Don't know)
- 99. (Refused)

SO3. [ASK FOR EACH ANSWER GIVEN TO SO2] Was this [INSERT RESPONSE FROM SO2] in working order? [DON'T READ, allow multiple responses]

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

SO4. [ASK FOR EACH ANSWER GIVEN TO SO2] What would you have done with this [INSERT RESPONSE FROM SO2] if it had not been picked up by the Efficiency Nova Scotia representative? Would you have...? ROTATE 1-4 – ALWAYS SAY 5 LAST

- 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
- 5. Or would you have done something else? (specify:_____)
- 98. (Don't know)
- 99. (Refused)

[ASK TO ALL]

SO5 Since participating in Appliance Retirement Program, have you disposed of other appliances without receiving an incentive?

1. Yes
2. No [GO TO SATISFACTION SECTION]
98. (Don't know) [GO TO SATISFACTION SECTION]
99. (Refused) [GO TO SATISFACTION SECTION]

SO6. How many **[READ OPTIONS IN ORDER]** have you disposed of without receiving an incentive since participating in the Appliance Retirement Program? [CODE ONE ONLY PER STATEMENT - USE "98" FOR DON'T KNOW AND "99" FOR REFUSED.]

[RECORD NUMBER OF EACH APPLIANCE. RANGE: 0-10]

- a. Other full-sized fridges
- b. Other full-sized stand-alone freezers
- c. Other small fridges
- d. Other small stand-alone freezers
- e. Other air conditioners
- f. Dehumidifiers

[GO TO PROGRAM SATISFACTION SECTION IF 0 OR 98 OR 99 TO ALL OF SO6]

[ASK SO7 FOR EACH OF SO6a-f > 0]

SO7. How did you dispose of this/these **[INSERT RESPONSE FROM SO6]**? Did you... [READ IN RANDOM ORDER 1-5, ALWAYS READ 96 LAST AND CODE SEPARATELY FOR EACH TYPE OF APPLIANCE AS IN SO6]

1. Sell it or give it to a private party [example: friend, family member, kijiji]
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 did you dispose of it some other way? (specify: _____)
98. (Don't know)
99. (Refused)

[ASK SO8 FOR EACH OF SO6a-f > 0 AND SO7=3, 4 or 5]

SO8. Was this/these **[INSERT RESPONSE FROM SO6]** still in working order at the moment of its disposal? [CODE SEPARATELY FOR EACH TYPE OF APPLIANCE AS IN SO6]

1. Yes
2. No
98. (Don't know)
99. (Refused)

SO9. [ASK SO9 FOR EACH OF SO6a-f > 0 AND SO7=3, 4 or 5]

What would you have done with this **[INSERT RESPONSE FROM SO6]** if you had not participated in the Appliance Retirement program 2018? 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
5. (Other, specify: _____)
98. (Don't know)
99. (Refused)

Program Satisfaction (S Series)

And now a few questions about the Appliance Retirement Program overall.

S1. What do you think happens to appliances after they are picked up by the program? PROBE: Anything else? [DON'T READ; MULTIPLE RESPONSE]

1. (Appliance is recycled)
2. (Hazardous materials (CFCs, refrigerants, Freon) within appliance are disposed of)
3. (Appliance is trashed)
4. (Appliance is sold for reuse)
96. (Other, specify: _____)
98. (Don't know)
99. (Refused)

[IF RESPONDENT ASKS 'WHAT HAPPENS,' READ "After the program picks up an appliance, they take it to a facility and remove all environmentally hazardous materials, such as capacitors, mercury switches and refrigerants. Ninety-five percent of the unit is recycled including the metal, rubber, plastic and coolants."]

S2. Using a scale from 1 to 10 where 1 is "not at all satisfied" and 10 is "completely satisfied" how would you rate your satisfaction with the program overall? [RECORD NUMBER, 98=Don't know, 99 Refused] DO NOT ACCEPT A RANGE

S3a. [IF S2 <8] What was the most important reason you were not more satisfied with the program overall? [DO NOT READ. PROBE FOR SPECIFIC REASONS. ACCEPT MULTIPLE RESPONSE]

1. (The time it took to pick-up appliance)
2. (Had to reschedule pick-up)
3. (My appliances was/were not eligible)
4. (Too difficult or long to sign up)
5. (Had to have it plugged in before pick-up)
6. (Incentive is too small)
7. (It was hard to schedule a pick-up time)
96. (Other, specify: _____)
98. (Don't know)
99. (Refused)

S3b. [IF S2 ≥8] What was the most important reason you were satisfied with the program overall? [DO NOT READ. PROBE FOR SPECIFIC REASONS. ACCEPT MULTIPLE RESPONSE]

1. (Convenient/Easy to get rid of appliance)
2. (Good service)
3. (Savings on electric bill)
4. (Incentive)
5. (Appliance was disposed of properly / recycled)
96. (Other, specify: _____)
98. (Don't know)
99. (Refused)

S4a. How did you book your appliance pick-up appointment? [READ, ACCEPT ONE RESPONSE ONLY]

1. Over the phone
2. Book online
3. Both
98. (Don't know)
99. (Refused)

S5. [IF S4a=2 or 3] 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 online booking portal? [RECORD NUMBER, 98=Don't know, 99 Refused] DO NOT ACCEPT A RANGE

- S6. [IF S5 <8] What was the most important reason you were not more satisfied with the online booking portal? [DO NOT READ. PROBE FOR SPECIFIC REASONS. ACCEPT MULTIPLE RESPONSE]
1. (Had to reschedule pick-up)
 2. (Too difficult or long to book)
 3. (It was hard to schedule a pick-up time)
 96. (Other, specify)
 98. (Don't know)
 99. (Refused)
- S4. Do you have any recommendations for improving the Appliance Retirement Program? PROBE: Anything else?
1. (Accept a wider variety of products)
 2. (Improve scheduling/shorten wait for pick-up/Increase pick-ups)
 3. (Offer more information on efficient appliances)
 4. (Better advertising)
 5. (Better/stronger incentives)
 6. (No recommendation)
 96. (Other, specify: _____)
 98. (Don't know)
 99. (Refused)

Demographics (D Series)

These final questions are asked for statistical purposes only. The information collected is strictly confidential.

- D1. What type of residence do you live in? [READ RESPONSES 1-7, 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 (Single story apartment building)
 6. Apartment building that has fewer than five stories
 7. Apartment building that has five or more stories
 96. Or something else [SPECIFY: _____]
 98. (Don't know)
 99. (Refused)
- D2. How many bedrooms are in your home? [88=DK; Enter zero for a studio apartment with no bedrooms]

D3. Do you own or rent this home?

1. Own/buying
2. Rent/lease
3. Other (Describe) _____

D4. Do you pay the electric bills for your home?

1. Yes
2. No
98. (Don't Know)
99. (Refused)

D6. Including yourself, how many people live in this residence on a full-time basis?

Number of people: _____ [NOTE: DON'T ALLOW ZERO FOR A RESPONSE]

D7. In what age category do you fall? Are you... [READ LIST; SELECT ONE RESPONSE]

1. 18 to 24
2. 25 to 34
3. 35 to 44
4. 45 to 54
5. 55 to 64
6. 65 or over
100. (Refused)

D8. What is the highest level of education you have completed? [DO NOT READ]

1. (Less than high school graduation certificate)
2. (High school graduation certificate and/or some postsecondary)
3. (Trades certificate or diploma)
4. (College certificate or diploma)
5. (University certificate or diploma)
98. (Don't know)
99. (Refused)

D9. Which of the following income categories best describes your total annual household income before taxes in 2017? Stop me when I reach the right category. [READ LIST; SELECT ONE RESPONSE]

1. Less than \$15,000
2. \$15,000 - \$24,999
3. \$25,000 - \$34,999
4. \$35,000 - \$49,999
5. \$50,000 - \$69,999
6. \$70,000 - \$79,999
8. \$80,000 or more
98. (Don't know)
99. (Refused)

D10. **[DO NOT READ]** Gender

1. Male
2. Female

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!

[IF RESPONDENT ASKS TO BE CONTACTED BY EFFICIENCY NOVA SCOTIA, COLLECT NAME AND PHONE NUMBER]

NAME: _____

PHONE NUMBER: _____

NOTE: REITERATE TO THE RESPONDENT THAT INDIVIDUAL SURVEY RESPONSES WOULD NOT BE PROVIDED TO EFFICIENCY NOVA SCOTIA FOR CONFIDENTIALITY REASONS.

APPENDIX II

ARET: PARTICIPANT SURVEY RESULTS

The participant survey results are presented in the following tables.

- U1. Was the refrigerator removed through the program the main one used in the home, a second refrigerator that was being used at least part of the time, or a refrigerator that was not being used at all?

Use of Retired Refrigerators	2018
Sample Size	80
Used as primary/main	79%
Used as secondary/spare	18%
Not being used	4%
Base: Respondents who retired a full-sized refrigerator Responses sum to more than 100% due to rounding	

- U2. Approximately how old was the [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] you had removed through the program?

Age of Appliance	2018				
	Refrigerators (%)	Stand-alone Freezers (%)	Air Conditioners (%)	Small Refrigerators (#)	Small Freezers (#)
Sample Size	80	78	22	10	10
Less than 10 years	5%	1%	50%	3	-
10-12 years	26%	15%	32%	2	1
13-15 years	21%	17%	-	1	4
16-20 years	24%	19%	9%	2	2
21-25 years	8%	12%	-		-
26+ years	8%	28%	-		1
Don't know/Refused	9%	8%	9%	2	2
Average	16.6	22.3	8.7	12.0	17.3
Don't know/Refused removed from average calculations Responses sum to more than 100% due to rounding					

U3. Which of the following describes the condition of the [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] when you decided to have it picked up by the program?

Condition of Appliance	2018				
	Refrigerators (%)	Stand-alone Freezers (%)	Air Conditioners (%)	Small Refrigerators (#)	Small Freezers (#)
Sample Size	80	78	22	10	10
Worked well	44%	58%	59%	3	8
Worked okay, but had some problems	56%	38%	27%	5	2
It did not work	-	4%	14%	1	-
Don't know/Refused	-	-	-	1	-

U4. During the last year, how many months was the [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] plugged in and running?

Months Running in Last Year	2018				
	Refrigerators (%)	Stand-alone Freezers (%)	Air Conditioners (%)	Small Refrigerators (#)	Small Freezers (#)
Sample Size	80	78	22	10	10
0 months/Never plugged in or running	3%	17%	50%	2	4
1-3 months	11%	5%	45%	3	-
4-11 months	10%	18%	-	4	2
12 months/Kept running all the time	74%	59%	-	1	3
Don't know	3%	1%	5%	-	1
Average	9.9	8.6	0.9	4.7	5.6
Don't know/Refused removed from average calculations Responses sum to more than 100% due to rounding					

U5. You told me that you used to turn on your air conditioner for [INSERT U4] months. On what basis did you decide to turn on your air conditioner?

Decision to Turn on Air Conditioner	2018
Sample Size	10
According to the temperature/When it was warm	9
Others	1
Base: Respondents who retired an air conditioner Multiple responses	

FR1. Had you already planned to dispose of this [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] before you heard about Efficiency Nova Scotia's Appliance Retirement program? By dispose of, I mean getting the appliance out of your home by selling it, giving it away, having someone pick it up, or taking it to the dump or a recycling center yourself.

Already Made Decision to Dispose of the Appliance Prior to Hearing About ARet	2018
Sample Size	200
Yes	59%
No	36%
Don't know/Refused	6%
Responses sum to more than 100% due to rounding	

FR2a. Now suppose that the Appliance Retirement program that you used to dispose of this [full-sized fridge/full-sized standalone freezer/small fridge/small stand-alone freezer/air conditioner] had not been available. Would you have disposed of your [full-sized fridge/full-sized/stand-alone freezer/small fridge/small stand-alone freezer/air conditioners] even if the program had not been available?

Would Have Disposed of Appliance without ARet	2018
Sample Size	129
Yes	94%
No	5%
Don't know	1%
Base: Respondents who planned to dispose of the appliance prior to hearing about ARet	

FR3. If you had kept the [fridge], would you have placed it in the kitchen or somewhere else?

Location Refrigerator would be Placed if Kept	2018
Sample Size	4 (#)
Somewhere else (other than kitchen)	4
Base: Respondents who would not have disposed of refrigerator without ARet	

FR4. How would you have disposed of the [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] if the program had not been available? Would you have...

How Appliance Would Have Been Disposed of Without ARet	2018
Sample Size	121
Taken it to a dump or recycling center	25%
Have it picked up by the waste management company during spring or fall large collection day	25%
Sold it or given it to a private party [example: friend, family member, kijiji]	22%
Left it on the curb with a 'free' sign	10%
Disposed of it in some other way	7%
Have it removed by the dealer supplying your new appliance	6%
Don't know	6%
Base: Respondents who would have disposed of appliance without ARet Responses sum to more than 100% due to rounding	

FR7. What is the main reason you chose the Efficiency Nova Scotia program to dispose of your appliance?

Reason for Choosing ARet to Dispose of Appliance	2018
Sample Size	129
Convenience/Easy to get rid of	40%
Incentive	19%
To ensure it was recycled	9%
Recommended by family or friend	8%
Free pick-up service	7%
Ensure it was disposed of properly/safely	5%
Read/heard about program through media	3%
Savings on electric bill	2%
Wanted to get rid of appliance	2%
Used the service before/Familiar with ENS	1%
Others	4%
Don't know	1%
Base: Respondents who planned to dispose of the appliance prior to hearing about ARet Responses sum to more than 100% due to rounding	

RE1. Did you replace the [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] that you turned in through Efficiency Nova Scotia's Appliance Retirement program in 2018?

Replacement	2018				
	Refrigerators (%)	Stand-alone Freezers (%)	Air Conditioners (%)	Small Refrigerators (#)	Small Freezers (#)
Sample Size	80	78	22	10	10
Yes	83%	65%	55%	3	3
No	18%	35%	45%	7	7
Responses sum to more than 100% due to rounding					

RE3a. Was the replacement [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] new or used?

Replacement	2018				
	Refrigerators (%)	Stand-alone Freezers (%)	Air Conditioners (#)	Small Refrigerators (#)	Small Freezers (#)
Sample Size	66	51	12	3	3
New	80%	86%	67%	2	3
Used	20%	14%	33%	1	-
Base: Respondents who replaced appliances retired through ARet					

RE3b. How did you get this replacement [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner]?

Reason for Replacing Appliance	2018			
	Refrigerators (#)	Stand-alone Freezers (#)	Air Conditioners (#)	Small Refrigerators (#)
Sample Size	13	7	4	1
Appliance was given to me by a friend or family member	6	3	4	1
Purchased it from a used appliance store or a private party (for example, through classified ads or kijiji)	6	3	-	-
Appliance came from another location in the house	1	-	-	-
Or some other way	-	1	-	-
Base: Respondents who replaced an appliance retired through ARet with a used appliance				

RE4. Was the replacement [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioner] an ENERGY STAR or high efficiency model?

The Replacement Appliance Was an ENERGY STAR certified or High-Efficiency Model	2018				
	Refrigerators (%)	Stand-alone Freezers (%)	Air Conditioners (#)	Small Refrigerators (#)	Small Freezers (#)
Sample Size	66	51	12	3	3
Yes	83%	82%	9	3	2
No	5%	2%	-	-	-
Don't know	12%	16%	3	-	1
Base: Respondents who replaced appliances retired through ARet					

SO1. When the Efficiency Nova Scotia representative came to pick up your [full-sized fridge/full-sized stand-alone freezer/small fridge/small stand-alone freezer/air conditioners], did he also pick up any other appliances that were not eligible for an incentive? Examples would be dehumidifier, kitchen stove, clothes dryer or clothes washers, for instance.

Other Appliances Picked Up	2016	2018
Sample Size	198	200
Yes	2%	2%
No	97%	99%
Don't know/Refused	1%	-
Responses sum to more than 100% due to rounding		

SO2. What other appliances were picked up?

Other Appliances That Were Picked Up	2016 (#)	2018 (#)
Sample Size	4	3
Dehumidifier	2	1
Portable air conditioner	-	1
Clothes dryer	-	1
Clothes washer	-	1
Small stand-alone freezer	1	-
Others	1	-
Base: Respondents who had other appliances picked up that did not qualify for an incentive		
Multiple response		

SO3. Was this [INSERT RESPONSE FROM SO2] in working order?

Were Other Appliances in Working Order	2018 (#)
Sample Size	3
Yes	3
No	1
Base: Respondents who had other appliances picked up that did not qualify for an incentive Multiple response	

SO4. What would you have done with this [insert response from SO2] if it had not been picked up by the Efficiency Nova Scotia representative? Would you have...?

What Would Have Done with Appliance Had It Not Been Picked Up by ENS	2018 (#)
Sample Size	3
Had it picked up by the waste management company during spring or fall collection day	1
Sold it or given it away	3
Base: Respondents who had other appliances picked up that did not qualify for an incentive Multiple response	

SO5. Since participating in Efficiency Nova Scotia's Appliance Retirement program, have you disposed of other appliances without receiving an incentive?

Disposed of Other Appliances Without Receiving a Rebate	2016	2018
Sample Size	198	200
Yes	14%	16%
No	85%	84%
Don't know	1%	1%
Responses sum to more than 100% due to rounding		

SO6. How many [READ OPTIONS IN ORDER] have you disposed of without receiving an incentive since participating in Efficiency Nova Scotia's Appliance Retirement Program?

Average Number of Appliances Disposed of Without Receiving a Rebate Since Participating in ARet	2018	
	Sample Size	Average
Full-sized refrigerators	9	2.1
Full-sized stand-alone freezers	2	2.0
Air conditioners	4	2.0
Dehumidifiers	5	2.0
Small fridges	8	1.0
Small stand-alone freezers	3	1.0
Base: Respondents who had other appliances disposed of since participating in ARet that did not qualify for an incentive None/Don't know/Refused removed from average calculations		

SO7. How did you dispose of this/these [INSERT RESPONSE FROM SO6]? Did you...

How Disposed of Appliances That Did Not Receive Incentive	2018					
	Other Full-sized Refrigerators (#)	Other Full-sized Stand-Alone Freezers (#)	Other Air Conditioners (#)	Other Small Fridges (#)	Other Small Stand-alone Freezers (#)	Dehumidifiers (#)
Sample Size	7	2	3	6	1	4
Have it picked up by the waste management company during spring or fall large collection day	4	1	1	3	1	-
Sell it or give it to a private party [example: friend, family member, kijiji]	-	-	-	-	-	-
Leave it on the curb with a 'free' sign	-	-	-	1	-	2
Take it to a dump or recycling center yourself	3	-	1	1	-	2
Have it removed by the dealer supplying your new appliance	-	-	-	1	-	-
Contacted ENS/Had ENS pick it up	-	1	-	-	-	-
Some other way	-	-	1	-	-	-
Don't know	-	-	-	-	-	-
Base: Respondents who had other appliances disposed of since participating in AREt that did not qualify for an incentive						

SO8. Was this/these [INSERT RESPONSE FROM SO6] still in working order at the moment of its disposal?

Appliance in Working Order When Disposed	2018				
	Other Full-sized Refrigerators (#)	Other Full-sized Stand-Alone Freezers (#)	Other Air Conditioner (#)	Other Small Refrigerators (#)	Dehumidifiers (#)
Sample Size	7	1	2	5	2
Yes	4	-	1	2	2
No	3	1	1	3	-
Base: Respondents who disposed of appliances since participating in ARet without receiving an incentive and disposed of it by removing it through a dealer, taking it to the dump or recycling center, or having it picked up by a waste management company					

SO9. What would you have done with this [INSERT RESPONSE FROM SO6] if you had not participated in the Appliance Retirement program 2018? Would you have...?

What Would Have Done With Appliances if Not Participated in ARet	2018				
	Other Full-sized Refrigerators (#)	Other Full-sized Stand-Alone Freezers (#)	Other Air Conditioner (#)	Other Small Refrigerators (#)	Dehumidifiers (#)
Sample Size	7	1	2	5	2
Recycled it or taken it to the dump	6	1	2	4	2
Don't know	1	-	-	1	-
Base: Respondents who disposed of appliances since participating in ARet without receiving an incentive and disposed of it by removing it through a dealer, taking it to the dump or recycling center, or having it picked up by a waste management company					

S1. What do you think happens to appliances after they are picked up by the program?

What Happens to Appliances	2015	2016	2018
Sample Size	200	198	200
Appliance is properly recycled	74%	66%	66%
Appliance is recycled	67%	54%	61%
Hazardous materials within appliance are disposed of	28%	32%	24%
Appliance is trashed	11%	12%	13%
Appliance is sold for reuse	7%	7%	13%
Appliance is given to someone who needs it	-	6%	4%
Appliance is refurbished	-	2%	5%
Others	5%	8%	2%
Don't know/Refused	16%	19%	17%
Multiple responses			

S2. Using a scale from 1 to 10 where 1 is “not at all satisfied” and 10 is “completely satisfied” how would you rate your satisfaction with the program overall?

Satisfaction with ARet Overall	2015	2016	2018
Sample Size	200	197	200
8-10	93%	92%	97%
5-7	6%	7%	3%
1-4	2%	2%	-
Mean	9.4	9.4	9.6
Don't know/Refused removed from calculation			

S3a. What was the most important reason you were not more satisfied with the program overall?

Reasons for Being Less Satisfied with ARet	2015 (#)	2016* (#)	2018 (#)
Sample Size	15	16	6
The time it took to pick-up appliance	4	2	2
Incentive is too small	1	3	1
Appliance could have been reused/given to someone else	-	2	-
Did not provide enough information	-	2	1
Too long before getting rebate	-	2	1
Had to reschedule pick-up	2	1	-
It was hard to schedule a pick-up time	1	1	-
Had to have it plugged in before pick up	1	1	-
My appliances were not eligible	2	-	-
Too difficult or long to sign up	2	-	-
House was damaged when appliance was removed	-	-	1
No reason/No dissatisfied	-	2	-
Others	2	3	1
Don't know	1	1	-
Base: Respondents who were less than satisfied [IF S2<8] Multiple responses *Slight wording change in 2016			

S3b. What was the most important reason you were satisfied with the program overall?

Reasons for Being Satisfied with ARet	2016	2018
Sample Size	182	194
Convenient/Easy to get rid of appliance	69%	66%
Good service	29%	32%
Appliance was disposed of properly/safely	5%	19%
Incentive	15%	16%
Efficient/prompt service	8%	8%
Appliance gets recycled	5%	1%
Friendly service/people	2%	6%
Savings on electric bill	2%	2%
Others	7%	3%
Don't know	1%	-
Base: Respondents who were satisfied [IF S2 ≥8] Multiple responses		

S4a. How did you book your appliance pick-up appointment?

Method for Booking Pick-up Appointment	2018
Sample Size	200
Over the phone	61%
Book online	30%
Both	8%
Don't know	2%
Responses sum to more than 100% due to rounding	

S5. 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 online booking portal?

Satisfaction with Online Booking Portal	2018
Sample Size	74
Mean	9.3
Base: Respondents who booked their appointment online	

S6. What was the most important reason you were not more satisfied with the online booking portal?

Reason for being Less Satisfied with Online Booking Portal	2018
Sample Size	5
Too difficult or long to book	3
Too many questions/asked for a lot of information	2
Others	1
Base: Respondents who booked their appointment online and gave a rating of less than 8 in S6 Multiple Responses	

S4. Do you have any recommendations for improving the Appliance Retirement Program?
Anything else?

Recommendations to Improve ARet	2015	2016	2018
Sample Size	200	198	200
Better advertising	4%	3%	8%
Accept a wider variety of products	4%	5%	8%
Better/stronger incentives	3%	3%	3%
Improve scheduling/Shorten wait for pick-up/Increase pick-ups	12%	9%	3%
Continue the program/Happy with the program	-	-	2%
Offer more information on efficient appliances	-	-	2%
Offer more information on the program	-	-	2%
Offer more information on what happens to appliances after they are picked up	-	-	2%
Better communication	2%	1%	1%
Offer more information on incentives	-	1%	-
Offer more information on the products recommended	2%	-	-
Others	10%	6%	4%
No recommendations	69%	73%	67%
Don't know/Refused	1%	2%	5%
Multiple responses			

D1. What type of residence do you live in?

Type of Home	2015	2016	2018
Sample Size	200	198	200
Detached single-family home	88%	85%	85%
Semi-detached house	4%	3%	3%
Townhouse or duplex which share adjacent walls	4%	3%	4%
Mobile home or house trailer	2%	4%	2%
Apartment building that has fewer than 5 stories	1%	2%	1%
Apartment building that has 5 or more stories	1%	1%	2%
Others	1%	1%	2%
Don't know/Refused	-	1%	1%

D2. How many bedrooms are in your home?

Number of Bedrooms	2015	2016	2018
Sample Size	200	198	200
0 (studio)	-	1%	1%
1	3%	1%	3%
2	13%	14%	16%
3	51%	48%	48%
4 or more	32%	33%	29%
Don't know/Refused	2%	4%	3%

D3. Do you own or rent this home?

Home Ownership	2015	2016	2018
Sample Size	200	198	200
Own/Buying	94%	90%	90%
Rent/lease	6%	6%	9%
Others	1%	5%	2%
Responses sum to more than 100% due to rounding			

D4. Do you pay the electric bills for your home?

You Pay Electricity Bills	2015	2016	2018
Sample Size	200	198	200
Yes	98%	94%	97%
No	2%	3%	3%
Don't know/Refused	1%	3%	1%
Responses sum to more than 100% due to rounding			

D6. Including yourself, how many people live in this residence on a full-time basis?

Household Size	2015	2016	2018
Sample Size	200	198	200
1	19%	20%	24%
2	44%	40%	40%
3	20%	16%	19%
4	11%	15%	12%
5	5%	4%	5%
6 or more	1%	1%	1%
Don't know/Refused	1%	5%	2%
Responses sum to more than 100% due to rounding			

D7. In what age category do you fall? Are you...

Age of Respondent	2015	2016	2018
Sample Size	200	198	200
18 to 24	1%	1%	1%
25 to 34	8%	3%	8%
35 to 44	8%	11%	13%
45 to 54	18%	22%	17%
55 to 64	26%	27%	25%
65 or over	38%	34%	37%
Don't know/Refused	2%	4%	1%
Responses sum to more than 100% due to rounding			

D8. What is the highest level of education you have completed?

Level of Education	2015	2016	2018
Sample Size	200	198	200
Less than high school graduate certificate	9%	13%	9%
High school graduate certificate and/or some post-secondary education	28%	24%	27%
Trade certificate/diploma	10%	7%	5%
College certificate/diploma	17%	18%	21%
University certificate/diploma	32%	32%	35%
Don't know/Refused	5%	7%	4%
Responses sum to more than 100% due to rounding			

D9. Which of the following income categories best describes your total annual household income before taxes in 2017?

Household Income	2015	2016	2018
Sample Size	200	198	200
Less than \$15,000	2%	3%	4%
\$15,000 to \$24,999	12%	6%	8%
\$25,000 to \$34,999	11%	11%	8%
\$35,000 to \$49,999	11%	14%	11%
\$50,000 to \$69,999	14%	13%	13%
\$70,000 to \$79,999	4%	6%	7%
\$80,000 or more	22%	21%	28%
Don't know/Refused	25%	28%	24%
Responses sum to more than 100% due to rounding			

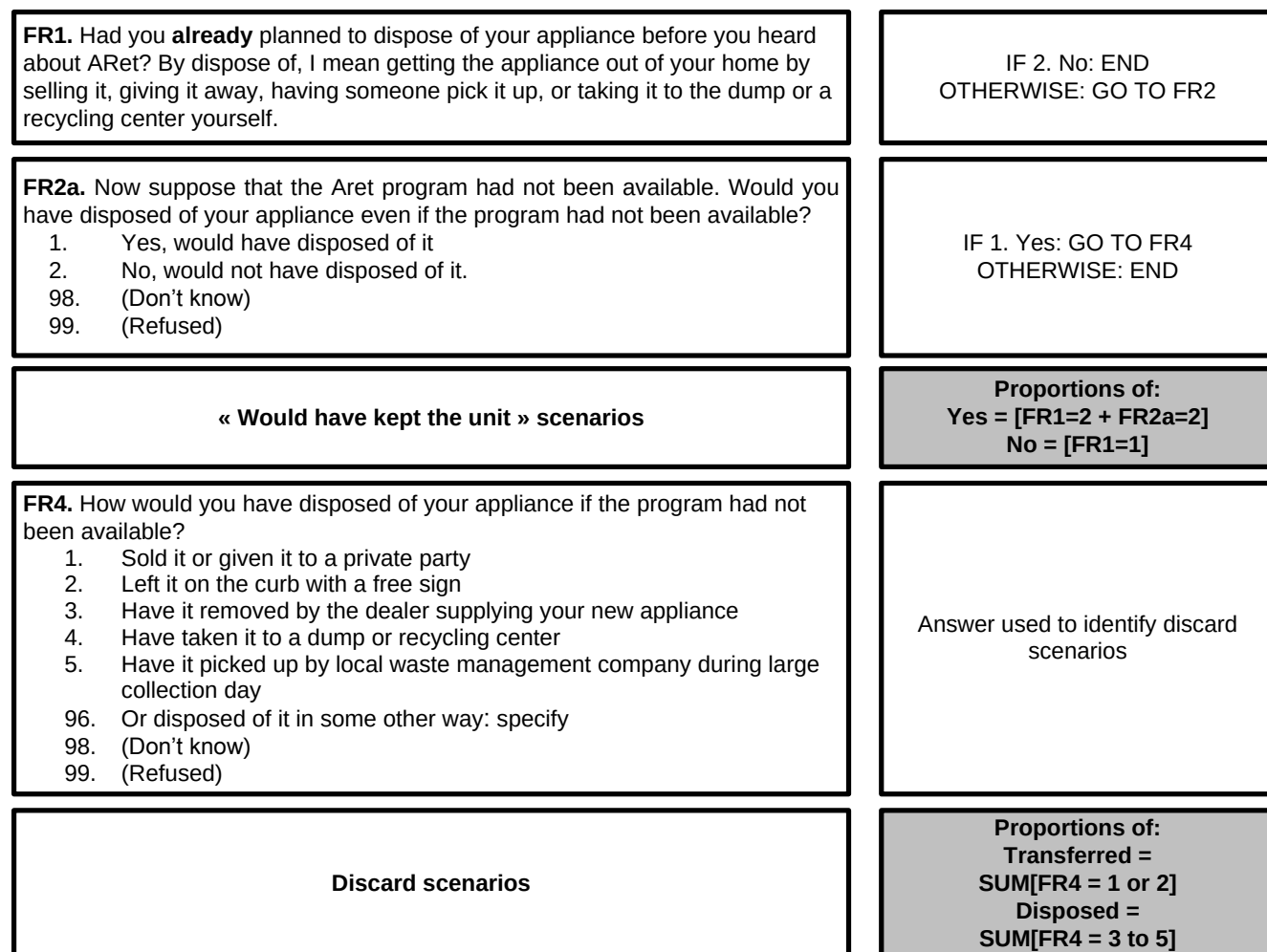
D10. Gender

Gender	2015	2016	2018
Sample Size	200	198	200
Female	51%	46%	45%
Male	50%	54%	56%
Responses sum to more than 100% due to rounding			

APPENDIX III

ARET: ALGORITHM FOR FREE-RIDERSHIP CALCULATION

The figure below presents the algorithm for calculating the free-ridership level. The participant survey questionnaire included questions designed to assess if each participant would have disposed of their appliance in the absence of ARet and how they would have done so, if applicable.



APPENDIX IV

ARET: UNITARY SAVINGS CALCULATIONS

This appendix presents the detailed calculations and assumptions used to establish the unitary savings for appliances retired through Appliance Retirement or replaced through Instant Savings.

Refrigerator Unitary Savings

This section presents the methodology and calculations used to determine the unitary savings of full-sized refrigerators retired through AREt in 2018. The calculations of the gross unitary savings are first described, followed by the net unitary savings.

Gross Unitary Savings

The Evaluator revised the gross unitary savings value by updating the following key parameters:

- › The average energy consumption of retired refrigerators
- › The average energy consumption of replacement refrigerators
- › Part-use factors

Average Energy Consumption of Retired Refrigerators

As mentioned in the main report, the Evaluator relied on the results of 2017 metering activities to estimate the average annual per-cubic-foot energy consumption values of the appliances retired in 2018. To provide more accurate estimates of average annual consumption, the Evaluator classified metered refrigerators by manufacture year based on the approximate years in which the energy efficiency regulations and standards for refrigerators were introduced, i.e. in approximately 1994 and in 2001.^{3,4,5} Table 1 below lists the average annual per-cubic-foot energy consumption values established based on 2017 metering activities. The average consumption values for each manufacture-year class were assigned weight based on their respective proportion of retired refrigerators in the 2018 tracking sheet. As a result, the overall average consumption value was established at 51.6 kWh/cu. ft.

³ 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.

⁴ Natural Resources Canada, *Refrigerators, Refrigerators-Freezers and Wine Chillers - Energy Efficiency Regulations*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6877> (Last accessed January 17, 2019).

⁵ Natural Resources Canada, *Registration and Publication of Regulations Amending Canada's Energy Efficiency Regulations*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/6965> (Last accessed January 17, 2019).

Table 1: Average Metered Annual Consumption for Retired Refrigerators

Manufacture-year Class	Average Per-cubic-foot Annual Consumption (kWh/cu. ft)	Proportion of Refrigerators in the 2018 Tracking Sheet*
2002 and later	49.2	50%
1995-2001	41.1	17%
1994 and earlier	58.9	34%
Average Annual Consumption	51.6 kWh/cu. ft	

*The sum does not equal 100% due to rounding.

The average size of the refrigerators retired in 2018 was 17 cubic feet based on the values documented in the 2018 tracking sheet. Therefore, the Evaluator calculated the average annual consumption value as follows:

$$\text{Average Annual Consumption of Retired Refrigerators} = 51.6 \frac{\text{kWh}}{\text{cu. ft}} \times 17 \text{ cu. ft} = 877 \text{ kWh}$$

Based on the metering protocol of the New York Department of Public Service,⁶ an occupant adjustment factor of 1.12 was applied to the annual energy consumption value in the equation shown above. This occupant adjustment factor was also used in previous impact evaluations and compensates for the difference between metering conditions and actual usage conditions in a residential setting such as refrigerator door openings since an appliance's energy consumption increases as the number of door openings increases.

By applying this occupant adjustment factor of 1.12, the average annual energy consumption value was established at 982 kWh per year.

Average Energy Consumption of Replacement Refrigerators

The average annual energy consumption of replacement refrigerators was used to take into account the effects of the secondary market. To do so, refrigerators were divided into new and used categories, as well as high and standard efficiencies. Three different annual energy consumption levels were assigned to these categories, as shown in Table 2 below. Based on the Uniform Methods Project (UMP) methodology, it was assumed that the new standard-efficiency refrigerators consume about the same amount of energy as high-efficiency refrigerators.

Table 2: Energy Consumption Level Assigned to Each Replacement Appliance Category

Replacement Appliance Category	High Efficiency	Standard Efficiency
New	New - Efficient	New - Standard
Used	New - Standard	Used - Standard

⁶ 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*, October 15, 2010, p. 20.

The “New - Efficient” energy consumption value was established by multiplying (1) the average per-cubic-foot energy consumption of refrigerators sold through Instant Savings in 2018 (21.1 kWh/cu. ft) by (2) the average volume of the refrigerators retired through the program component (17 cu. ft). The “New - Standard” energy consumption value was established based on the maximum allowable energy consumption values of the types of units equivalent to those sold through Instant Savings, according to the Canadian energy-efficiency standard in force.⁷ For the “Used - Standard” level, as with last year, the energy consumption of the most recent age category of retired refrigerators (in this case, manufactured after 2001) was applied. Table 3 lists the average annual energy consumption for all replacement categories.

Table 3: Average Annual Energy Consumption by Replacement Refrigerator Category

Replacement Refrigerator Category	High Efficiency (kWh/year)	Standard Efficiency (kWh/year)
New	359	400
Used	400	937

The 2018 participant survey results were used to establish the types of refrigerators used to replace the retired units (new or used, high or standard efficiency). Based on the answers from surveyed participants, the average annual energy consumption value of replacement refrigerators was established at 378 kWh per year, as summarized in Table 4.

Table 4: Average Annual Consumption for Refrigerator Replacement

Type of Replacement	Annual Energy Consumption (kWh/year)	Proportion
New High-efficiency Refrigerator	359	81%
Used High-efficiency Refrigerator	400	14%
New Standard-efficiency Refrigerator	400	3%
Used Standard-efficiency Refrigerator	937	2%
Average Annual Consumption	378 kWh/year	

⁷ 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).

Part-use Factor

Part-use factors⁸ are applied to adjust the savings calculations to account for the fact that not all refrigerators are plugged in year-round. The secondary refrigerator in a principal residence or the primary refrigerator in a secondary residence is likely to be unplugged over certain periods of the year. Since these are eligible for the program component, their savings were calculated and an overall part-use factor was applied in the calculations.

The 2018 participant survey data was used to estimate the amount of time during which participants had their refrigerators plugged in year-round prior to retirement. To make this estimate, the Evaluator used the number of months during which the refrigerator was in use in the past year, based on participants' declarations, and established a ratio. Table 5 below outlines the levels of use established based on the results of the survey and the resulting part-use factors.

Table 5: Calculation of Part-use Factors for Refrigerators

	Primary		Secondary		Overall	
Proportion	79%		21%		100%	
	Proportion	Part-use Factor	Proportion	Part-use Factor	Proportion	Part-use Factor
Not in use	0%	0.00	13%	0.00	3%	-
Used part-time	15%	0.38	50%	0.28	22%	-
Used full-time	85%	1.00	38%	1.00	75%	-
Total⁹	100%	0.91	100%	0.52	100%	0.82

The 2018 participant survey revealed that the retired units are mostly primary (79%), which is different than what was observed in 2016 with only half (52%) of retired units being primary ones. In addition, the 2018 survey indicated that fewer secondary units (38%) were used full time than in 2018 (70%). These elements might indicate that participants now mostly use ARet to retire their main refrigerator once they decide to replace it rather than to get rid of secondary refrigerators. Regardless, the 2018 overall part-use factor (0.82) is similar to the value established in 2016 (0.85).

Then, the possible use of non-recycled refrigerators was assessed when establishing a weighted average of ARet's part-use factor, as presented in Table 6 below.

⁸ According to the UMP, the part-use factors for refrigerators that would have run full-time is 1.0, and 0.0 for those that would have not run at all. The part-use factor for refrigerators that would have been used for a portion of the year varies between 0.0 and 1.0.

⁹ The sum of answers in this table and ensuing tables may not add up to 100 percent due to rounding.

Table 6: Likely Use of Refrigerators and Corresponding Part-use Factors

Use Prior to Recycling	Likely Use If Not Recycled	Part-use Factor	Proportion
Primary	Kept (as a primary unit)	0.91	0%
	Kept (as a secondary unit)	0.52	31%
	Discarded	0.82	48%
Secondary	Kept	0.52	11%
	Discarded	0.82	11%
Overall		0.70	100%

As presented in Table 7 below, the calculations result in a part-use factor of 0.70. By multiplying this factor of 0.70 by the measured refrigerator average annual energy consumption value (982 kWh/year), the retired refrigerator annual energy consumption value is established at 687 kWh. By using the same calculation method, replacement refrigerator annual energy consumption level is established at 265 kWh. The final annual consumption values are listed in Table 7 below.

Table 7: Final Energy Consumption Values for Refrigerators

	Measured Consumption (kWh/year)	Part-use Factor	Final Consumption (kWh/year)
Retired Refrigerator	982	0.70	687
Replacement Refrigerator	378	0.70	265

Net Unitary Savings

Two effects were considered to calculate the net unitary savings for refrigerators, namely free-ridership and secondary market impacts. These two effects are examined below. As previously mentioned, participant spillover is calculated separately from the unitary savings of each appliance category in ARet and is discussed in Subsection 4.13 of the main report.

Free-ridership

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

To determine the consumption level associated with free-ridership, the Evaluator surveyed participants regarding the actions that they would have taken in the absence of ARet, such as selling it to a private party, giving it away to a charity organization or a family member, or transporting it to a landfill site or a recycling centre.

Table 8 below summarizes the various discarding scenarios and the proportion of participants who would have disposed of their refrigerators without the program component. These participants are therefore identified as free-riders. More details on the algorithm used to establish these scenarios are presented in Appendix IV.

Table 8: Discarding Scenarios and Refrigerator Proportions

Would Have Kept the Unit	Proportion	Discard Scenario	Proportion	Total Proportion
Yes	41%			41%
No	59%	Transferred	41%	24%
		Disposed	59%	35%

Secondary Market Impacts

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

Scenario 1

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

Scenario 2

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

Table 9 below summarizes all the possible scenarios regarding appliances that would have been sold or given away to the secondary market, and their corresponding energy impacts. The proportions used for each of these scenarios are default values suggested by the UMP for cases where no general population survey is conducted. These assumptions could be refined in future evaluations, based on further market research, but the cost of conducting such research should be taken into account in the decision-making process.

Table 9: Proportions of Secondary Market Impacts for Refrigerators

Would-be Acquirer Finds an Alternative Unit	Proportion	Alternative Type	Proportion	Second Market Impact Value
Yes	50%	Old Unit	50%	Consumption value of retired appliances
		New Unit	50%	Consumption value of new standard-efficiency appliances
No	50%			Nil

Net Unitary Savings Calculation

Table 10 below presents the unitary savings value calculated for refrigerators retired through ARet. This unitary savings value was obtained by calculating a weighted average of all the scenarios and their corresponding savings. This resulted in an overall net savings value of 389 kWh per unit retired.

Table 10: Net Savings per Refrigerator

Would Have Kept the Unit	%	Discard Scenario	%	Would-be Acquirer Finds an Alternative Unit	%	Alternative Type	%	Overall Proportion	Energy Consumption (kWh/year)		Savings
									Without ARet	With ARet	Net Reduction
Yes	41							41%	687	0	687
No	59	Transferred	41	Yes	50	Old Unit	50	6%	687	687	0
						New Unit	50	6%	687	265	422
		No		No	50			12%	687	0	681
		Disposed	59					35%	0	0	0
Weighted Average (kWh/unit)											389

Freezer Unitary Savings

This section presents the methodology employed and the calculations made to evaluate the unitary savings of the full-sized freezers retired in 2018 and describes how the gross unitary savings and the net unitary savings were determined.

Gross Unitary Savings

The Evaluator revised the gross unitary savings value tracked by ENS by updating the same key parameters as for refrigerators.

Average Energy Consumption of Retired Freezers

As with refrigerators, the Evaluator revised the annual energy consumption value of retired freezers using the data from the 2017 metering activity. The Evaluator also categorized the metered freezers by manufacture year based on the years in which the energy efficiency regulations and standards for refrigerators were introduced, i.e., in approximately 1994 and in 2001.^{10,11,12} Moreover, the Evaluator combined the two most recent age categories into one since the results did not significantly differ.

Table 11 below lists the average annual per-cubic-foot energy consumption values established based on the 2017 metering activity. The average consumption values for each manufacture-year class were assigned weight based on their respective proportion among all the retired freezers in the 2018 tracking sheet. As a result, the average consumption value was established at 90.1 kWh per cu. ft.

Table 11: Average Metered Annual Consumption for Retired Refrigerators

Manufacture-year Class	Average Per-cubic-foot Annual Consumption (kWh/cu. ft)	Proportion of Refrigerators in the 2018 Tracking Sheet
1995 and later	56.2	45%
1994 and earlier	117.8	55%
Average Annual Consumption	90.1 kWh/cu. ft	

The average size of retired freezers in Nova Scotia in 2018 was 13 cubic feet based on the 2018 tracking sheet. Therefore, the Evaluator calculated the average annual consumption as follows:

$$\text{Average Annual Consumption of Retired Freezers} = 90.1 \frac{\text{kWh}}{\text{cu. ft}} \times 13 \text{ cu. ft} = 1,171 \text{ kWh}$$

To account for the difference between the metering conditions and on-site conditions in a residential setting (i.e., door openings), the same occupant adjustment factor used for refrigerators, 1.12, was applied to the metered consumption of retired freezers, resulting in an average annual consumption value of 1,312 kWh per year.

Average Energy Consumption of Replacement Freezers

Three energy consumption levels are assigned to freezer replacement categories based on the same principles as discussed in the previous subsection on refrigerators.

¹⁰ 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.

¹¹ Natural Resources Canada, *Refrigerators, Refrigerators-Freezers and Wine Chillers - Energy Efficiency Regulations*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6877> (Last accessed January 17, 2019).

¹² Natural Resources Canada, *Registration and Publication of Regulations Amending Canada's Energy Efficiency Regulations*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/6965> (Last accessed January 17, 2019).

As in the 2017 evaluation, the Evaluator first calculated the maximum energy consumption of a 13-cubic-foot freezer for both chest and upright freezers by applying the Canadian standard¹³ and then calculated the weighted average based on the proportion of each type of retired freezers as per the 2018 tracking sheet. This resulted in a revised new standard-efficiency freezer consumption value of 321 kWh. To estimate the energy consumption of the equivalent new high-efficiency freezer, this value of 321 kWh was reduced by 10 percent since the ENERGY STAR certification requires freezers to be 10 percent more efficient than the U.S. standard. Hence, the same logic was applied to the Canadian standard, resulting in a new high-efficiency freezer energy consumption value of 289 kWh.

For the “Used - Standard” level, the metered energy consumption of the most recent age category of retired freezers (in this case, manufactured after 1994) was applied.

The results of these calculations are presented in Table 12.

Table 12: Average Annual Energy Consumption by Replacement Freezer Category

Replacement Freezer Category	High Efficiency (kWh/year)	Standard Efficiency (kWh/year)
New	289	321
Used	321	818

¹³Natural Resources Canada, *Freezers - Energy Efficiency Regulations*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6941> (Last accessed January 9, 2019).

As with refrigerators, the 2018 participant survey results were used to establish the types of freezers used to replace retired units (new or used, high- or standard- efficiency). Based on these results, the replacement freezer average annual energy consumption value was established at 300 kWh, as summarized in Table 13.

Table 13: Average Annual Consumption for Freezer Replacement

Type of Replacement	Annual Energy Consumption (kWh/year)	Proportion
New High-efficiency Freezer	289	88%
Used High-efficiency Freezer	321	9%
New Standard-efficiency Freezer	321	0%
Used Standard-efficiency Freezer	818	2%
Average Annual Consumption	300 kWh/year	

Part-use Factor

All freezers were considered as primary; this means that they were all assumed to have had the same level of use. Therefore, only one part-use factor value was calculated for freezers, based on the results of the 2018 participant survey. To establish the value of the part-use factor for freezers used part-time, participants were asked about the number of months per year during which they had kept their freezers plugged in, and the results were used to obtain a weighted average. The calculation details are presented in Table 14.

Table 14: Calculation of Part-use Factors for Freezers

Level of Use	Proportion	Part-use Factor
Not in use	17%	0.00
Used part-time	23%	0.50
Used full-time	60%	1.00
Total	100%	0.72

As outlined in Table 15 below, the part-use factor for freezers is 0.72. By multiplying this part-use factor by retired freezer measured annual energy consumption value (1,312 kWh/year), the retired freezer final average annual consumption value was established at 945 kWh. The same calculation was performed for replacement freezers, and their average annual energy consumption value was established at 216 kWh. The final annual average consumption values are listed in Table 15.

Table 15: Final Energy Consumption Values for Freezers

	Measured Consumption (kWh/year)	Part-use Factor	Final Consumption (kWh/year)
Retired Freezers	1,312	0.72	945
Replacement Freezers	300	0.72	216

Net Unitary Savings

Two effects were considered to calculate the net unitary savings for freezers, namely free-ridership and secondary market impacts. These two effects are examined below.

Free-ridership

Table 16 presents the different discarding scenarios and the proportion of participants who would have disposed of their freezers without ARet and who are therefore identified as free-riders.

Table 16: Discarding Scenarios and Proportions for Freezers

Would Have Kept the Unit	Proportion	Discard Scenario	Proportion	Total Proportion
Yes	31%			31%
No	69%	Transferred	35%	24%
		Disposed	65%	45%

Secondary Market Impacts

The secondary market impacts were calculated in a manner similar to that used for refrigerators. Table 17 presents all the possible scenarios in which appliances would have been transferred to the secondary market and their corresponding energy impacts.

Table 17: Proportions of Secondary Market Impacts for Freezers

Would-be Acquirer Finds an Alternative Unit	Proportion	Alternative Type	Proportion	Second Market Impact Value
Yes	50%	Old Unit	50%	Consumption value of retired appliances
		New Unit	50%	Consumption value of new standard-efficiency appliances
No	50%			Nil

The assumptions made for refrigerators were also made for the proportions presented in this table, as suggested by the UMP.

Net Unitary Savings Calculation

Table 18 below presents the unitary savings value calculated for freezers retired through ARet. This unitary savings value was obtained by calculating a weighted average of all the scenarios and their corresponding savings. This resulted in an overall net savings value of 450 kWh per unit retired.

Table 18: Net Savings per Freezer

Would Have Kept the Unit	%	Discard Scenario	%	Would-be Acquirer Finds an Alternative Unit	%	Alternative Type	%	Overall Proportion	Energy Consumption (kWh/year)		Savings
									Without ARet	With ARet	Net Reduction
Yes	31							31%	945	0	945
No	69	Transferred	35	Yes	50	Old Unit	50	6%	945	945	0
						New Unit	50	6%	945	216	729
			No	50			12%	945	0	945	
		Disposed	65					45%	0	0	0
Weighted Average (kWh/unit)											450

Room Air Conditioner Unitary Savings

This section presents the methodology employed and the calculations made to evaluate the unitary savings of room air conditioners retired in 2018.

Gross Unitary Savings

ENS uses a gross unitary savings value of 215 kWh per year for the retirement of a room air conditioner, which is in accordance with the literature review findings presented in the 2017 Evaluation Report. The annual energy consumption of a room air conditioner is determined by dividing the product of the appliance capacity (Q) and the hours of operation by the seasonal energy efficiency ratio (SEER), as illustrated in the following equation.

$$\text{Annual Energy Consumption} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{Q \left[\frac{\text{Btu}}{\text{hr}} \right] \times \text{HOU} \left[\frac{\text{hr}}{\text{yr}} \right]}{\text{SEER} \left[\frac{\text{Btu}}{\text{W} \cdot \text{hr}} \right] \times 1,000 \left[\frac{\text{W}}{\text{kW}} \right]}$$

In the above equation, the retired room air conditioner capacity (Q), hours of operation and SEER are assumed to be respectively 6,146 Btu/hr (based on the units retired in 2017), 312 hours/yr (according to local data provided by Natural Resources Canada [NRCAN] for four Nova Scotia cities, namely Halifax, Yarmouth, Sydney, and Greenwood) and 8.9 Btu/W·hr (based on an article published by NRCAN¹⁴ and the Ecox Technical Information Bulletin on SEER).¹⁵

Average Consumption of Retired Room Air Conditioners

The Evaluator reviewed the assumptions used by ENS for the calculation of the average energy consumption of replaced room air conditioners.

Hours of Operation

In the 2017 evaluation, the Evaluator used the annual hours of operation of room air conditioners found through the literature review of the 2015 evaluation; that literature review compared different studies about climate zones similar to Nova Scotia. Since no major metering studies for room air conditioners have been published in recent years, the Evaluator has continued to rely on the 2015 literature review and maintained the conclusion that NRCAN's hours of use are the most appropriate values.

NRCAN's EnerGuide Room Air Conditioner Directory¹⁶ provides local data for four cities in Nova Scotia, namely Halifax, Yarmouth, Sydney and Greenwood. Room air conditioner hours of use are calculated using the annual energy consumption equation and such variables as annual energy consumption, capacity and the energy efficiency ratio listed on the NRCAN website. The hours of operation per year established by NRCAN for Halifax, Yarmouth, Sydney and Greenwood are respectively 346, 144, 250 and 374. Since the hours of operation vary widely from one location to another, the Evaluator recalculated this variable for this evaluation 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 2018. The participants' postal codes recorded in the tracking sheet were used to determine their locations. The following formula was used to calculate the weighted average hours of operation across the province:

$$\begin{aligned} \text{Annual Hours of Operation} \left[\frac{\text{hr}}{\text{yr}} \right] &= (\%_{\text{people}} \times \text{HOU})_{\text{Halifax}} + (\%_{\text{people}} \times \text{HOU})_{\text{Yarmouth}} + (\%_{\text{people}} \times \text{HOU})_{\text{Sydney}} \\ &+ (\%_{\text{people}} \times \text{HOU})_{\text{Greenwood}} \end{aligned}$$

Using the equation above, the annual hours of operation were established at 328 hours.

¹⁴ NRCAN's Office of Energy Efficiency. *Air Conditioning Your Home*, 2003, p. 15.

¹⁵ Ecox, *Technical Information Bulletin No. E-004-EN: SEER*, www.ecoxline.com (Last accessed March 3, 2016).

¹⁶ NRCAN's Office of Energy Efficiency, *EnerGuide Room Air Conditioner Directory 2012*, May 2012, p. 88.

Capacity

With the information available in the tracking sheet, the retired unit average capacity was established at 5,905 Btu/hr.

SEER

The 2018 ARet tracking sheet indicated that 96 percent of retired room air conditioners were manufactured after 1995. Therefore, the assumption that most air conditioners retired through ARet met the efficiency level of 8 (in effect since 1995) is still considered valid. To account for seasonal temperature changes, the Evaluator decided to use a SEER rather than an energy efficiency ratio (EER). To do so, the EER of 8 is multiplied by a factor of 1.11, in accordance with the Ecox Technical Information Bulletin on SEER.¹⁷ The resulting SEER is 8.9 Btu/W·hr.

Using the hours of operation value of 328 per year, a room air conditioner capacity of 5,905 Btu/hr and a SEER of 8.9, the average annual energy consumption for retired room air conditioners was established at 218 kWh.

Average Energy Consumption of Replacement Room Air Conditioners

The Evaluator assumed that the replacement units meet the current minimum level of energy efficiency required to meet ENERGY STAR performance levels, which is an EER of 11.2 Btu/W·hr for units with a capacity below 8,000 Btu/hr.¹⁸ This assumption is supported by the fact that the majority of participants who replaced their retired units declared, in the participant survey, that they had bought a new high-efficiency model. The corresponding SEER is 12.4 Btu/W·hr.

To calculate the average energy consumption of replacement room air conditioners, the Evaluator used the same capacity (5,905 Btu/hr) and hours of operation (328 hr/year) as those used for retired room air conditioners, which resulted in an annual energy consumption value of 156 kWh.

Part-use Factor

No part-use factor was applied to the annual energy consumption calculations because all room air conditioners are assumed to operate 328 hours per year during the cooling season.

Net Unitary Savings

Two effects were taken to calculate the net savings value for retired air conditioners, namely free-ridership and secondary market impacts, as described below.

¹⁷ Ecox, *Technical Information Bulletin No. E-004-EN: SEER*, www.ecoxline.com (Last accessed March 3, 2016).

¹⁸ ENERGY STAR, *ENERGY STAR Program Requirements for Room Air Conditioners: Eligibility Criteria Version 4.0*, October 26, 2015.

Free-ridership

Table 19 presents the discarding scenarios and the proportion of participants who would have disposed of their air conditioners without the program component. These participants are identified as free-riders.

Table 19: Discarding Scenarios and Proportions for Room Air-conditioners

Would Have Kept the Unit	Proportion	Discard Scenario	Proportion	Total Proportion
Yes	45%			45%
No	55%	Transferred	25%	14%
		Disposed	75%	41%

Secondary Market Impacts

Room air conditioner secondary market impacts were calculated in a manner similar to the calculations for refrigerators and freezers. Table 20 presents all the possible scenarios for room air conditioners that would have been transferred to the secondary market and their corresponding energy impacts.

Table 20: Proportions of Secondary Market Impacts for Room Air Conditioners

Would-be Acquirer Finds an Alternative Unit	Proportion	Alternative Type	Proportion	Secondary Market Impacts Value
Yes	50%	Old Unit	50%	Consumption value of retired appliances
		New Unit	50%	Consumption value of new standard-efficiency appliances
No	50%			Nil

The same assumptions for refrigerators and freezers were also made for the proportions listed in the table above.

Net Unitary Savings Calculation

Table 21 below presents the unitary savings value calculated for room air conditioners retired through ARet after free-ridership and secondary market impacts were deducted. This unitary savings value is obtained by calculating a weighted average of all the scenarios. This resulted in an overall savings value of 115 kWh per unit retired.

Table 21: Net Savings per Room Air Conditioning Unit

Would Have Kept the Unit	%	Discard Scenario	%	Would-be Acquirer Finds an Alternative Unit	%	Alternative Type	%	Overall Proportion ¹⁹	Energy Consumption (kWh/year)		Savings
									Without ARet	With ARet	Net Reduction
Yes	45							45%	218	0	218
No	55	Transferred	25	Yes	50	Old Unit	50	3%	218	218	0
						New Unit	50	3%	218	156	62
				No	50			7%	218	0	218
		Disposed	75					41%	0	0	0
Weighted Average (kWh/unit)											115

Small Appliance Retirement

This section presents the methodology used and the calculations made to determine the unitary savings of small refrigerators and small freezers retired through ARet in 2018. The gross unitary savings are discussed first, followed by the net unitary savings.

Gross Unitary Savings

The Evaluator revised the gross unitary savings value tracked by ENS by updating the same key parameters as for refrigerators.

Average Energy Consumption of Small Appliances Retired

The Evaluator used the same methodology as in the 2017 evaluation to establish the unitary savings of small appliances. This methodology involves using the average of the full-sized appliance metered annual per-cubic-foot consumption values to revise the small appliance annual energy consumption value.

Small Refrigerators

For small refrigerators, the average consumption values of each manufacture-year class were assigned a weight based on their proportion accounted for by retired small refrigerators in the 2018 tracking sheet. As a result, the average consumption value was established at 50.0 kWh/cu. ft, as presented in Table 22.

¹⁹ The sum does not equal 100% due to rounding.

Table 22: Average Annual Consumption of Retired Small Refrigerators

Manufacture-year Class	Average per-cubic-foot Annual Consumption (kWh/cu. ft)	Proportion of Small Refrigerators
2002 and later	49.2	73%
1995-2001	41.1	10%
1994 and earlier	58.9	17%
Average Annual Consumption	50.0 kWh/cu. ft	

The average size of retired small refrigerators in 2018 was eight cubic feet based on the values found in the 2018 tracking sheet. Therefore, the Evaluator calculated the average annual consumption as follows:

$$\text{Average Annual Consumption of Retired Small Refrigerators} = 50.0 \frac{\text{kWh}}{\text{cu. ft}} \times 8 \text{ cu. ft} = 400 \text{ kWh}$$

To account for the difference between the metering conditions and the on-site conditions in a residential setting (i.e., door openings), the same occupant adjustment factor used for full-sized appliances, 1.12, was applied to the metered consumption of small refrigerators, resulting in an average annual consumption of 448 kWh per year.

Small Freezers

For small freezers, the average consumption values of each manufacture-year class were assigned a weight based on their proportion accounted for by the retired small freezers in the 2018 tracking sheet. As a result, the average consumption value was established at 83.9 kWh/cu. ft, as presented in Table 23.

Table 23: Average Annual Consumption of Retired Small Freezers

Manufacture-year Class	Average per-cubic-foot Annual Consumption (kWh/cu. ft)	Proportion of Small Freezers
1995 and later	56.2	55%
1994 and earlier	117.8	45%
Average Annual Consumption	83.9 kWh/cu. ft	

Based on the 2018 tracking sheet, the average size of retired small freezers is eight cubic feet. Therefore, the Evaluator calculated their average annual consumption as follows:

$$\text{Average Annual Consumption of Retired Freezers} = 83.9 \frac{\text{kWh}}{\text{cu. ft}} \times 8 \text{ cu. ft} = 671 \text{ kWh}$$

By applying the occupant adjustment factor of 1.12, the average annual consumption was established at 752 kWh per year.

Average Energy Consumption of Replacement Small Appliances

Using an approach consistent with that used for retired full-sized appliances, the Evaluator calculated the average consumption values for each replacement category by dividing the annual energy consumption values of full-size appliances by their average cubic-foot volume. The Evaluator then multiplied those results by the average cubic-foot volume of small-size appliances. Table 24 presents the calculation results.

Table 24: Average Annual Energy Consumption by Category of Small Appliance Replacement

Type of Replacement	Average Consumption of Full-size Appliance Replacement Units (kWh/cu. ft)	Small Appliances	
		Average Size (cu. ft)	Average Consumption (kWh/year)
New High Efficiency	359 kWh / 17 cu. ft = 21.1	8	169
Used High Efficiency	400 kWh / 17 cu. ft = 23.5		188
New High Efficiency	289 kWh / 13 cu. ft = 22.2	8	178
Used High Efficiency	321 kWh / 13 cu. ft = 24.7		198

The 2018 participant survey results were used to identify the types of small refrigerators or freezers that replaced retired units (new or used, high or standard efficiency). All surveyed participants declared that they chose either a new or used high-efficiency model. Small fridges and small freezers were analyzed together to establish the replacement scenario proportions due to the smaller sample surveyed.

Based on these results, the average annual energy consumption values of replacement small refrigerators and freezers were established at 173 kWh and 182 kWh respectively, as summarized in Table 25.

Table 25: Average Annual Consumption for Small Appliance Replacements

Type of Replacement	Annual Energy Consumption (kWh/year)		Proportion
	Small Refrigerator	Small Freezer	
New High Efficiency	169	178	80%
Used High Efficiency	188	198	20%
Average Annual Consumption	173	182	100%

Part-use Factor

The 2018 participant survey results were used to estimate the annual amount of time participants had their small appliances plugged in prior to retirement. To establish the small appliance part-use factor, participants were asked about the number of months per year during which they kept their small appliances plugged in. Their answers were used to establish a weighted average. The calculation details are listed in Table 26.

Table 26: Calculation of Part-use Factors for Small Appliances

Level of Use	Proportion	Part-use Factor
Not in use	32%	0.00
Used part-time	47%	0.45
Used full-time	21%	1.00
Total	100%	0.42

The weighted average part-use factor of 0.42 is lower than the value calculated in the 2016 evaluation. This reduction is due to more survey respondents (32% in 2018 vs 11% in 2016) answering that their small appliance was never used, while fewer respondents (21% in 2018 vs 44% in 2016) mentioned using it full time.

The energy consumption values established for retired and replacement appliances were adjusted by multiplying the part-use factor by the measured consumption levels. The final annual energy consumption values are summarized in Table 27.

Table 27: Final Energy Consumption Values for Small Appliances

	Measured Consumption (kWh/year)	Part-use Factor	Final Consumption (kWh/year)
Retired Small Refrigerators	448	0.42	188
Replacement Small Refrigerators	173	0.42	73
Retired Small Freezers	752	0.42	316
Replacement Small Freezers	182	0.42	76

Net Unitary Savings

Two effects were taken into account to calculate the net savings value for retired small appliances, namely free-ridership and secondary market impacts, as described below. Considering the smaller number of participants in this appliance category and thus the smaller sample of respondents in the survey, small fridges and small freezers were analyzed together in the net savings calculation.

Free-ridership

Table 28 below presents the discarding scenarios and the proportion of participants who would have disposed of their small appliances without ARet. These participants are identified as free-riders.

Table 28: Discarding Scenarios and Proportions of Small Appliances

Would Have Kept the Unit	Proportion	Discard Scenario	Proportion	Total Proportion
Yes	60%			60%
No	40%	Transferred	33%	13%
		Disposed	67%	27%

Secondary Market Impacts

The small appliance secondary market impacts were calculated in a manner similar to that used for refrigerators and freezers. Table 29 presents all the possible scenarios in which appliances would have been transferred to the secondary market and their corresponding energy impacts.

Table 29: Proportions of Secondary Market Impacts for Small Appliances

Would-be Acquirer Finds an Alternative Unit	Proportion	Alternative Type	Proportion	Secondary Market Impact Value
Yes	50%	Old Unit	50%	Consumption value of retired appliances
		New Unit	50%	Consumption value of new standard-efficiency appliances
No	50%			Nil

The assumptions made for refrigerators were also made for the proportions presented in this table, as suggested by the UMP.

Net Unitary Savings Calculation

Table 30 and Table 31 present the unitary savings values calculated for the small appliances retired through ARet. These unitary savings values were obtained by calculating a weighted average of all the scenarios and their corresponding savings.

Table 30: Net Savings per Small Refrigerator

Would Have Kept the Unit	%	Discard Scenario	%	Would-be Acquirer Finds an Alternative Unit	%	Alternative Type	%	Overall Proportion	Energy Consumption (kWh/year)		Savings
									Without ARet	With ARet	Net Reduction
Yes	60							60%	188	0	188
No	40	Transferred	33	Yes	50	Old Unit	50	3%	188	189	0
						New Unit	50	3%	188	73	115
				No	50			7%	188	0	188
		Disposed	67					27%	0	0	0
Weighted Average (kWh/unit)											129

Table 31: Net Savings per Small Freezer

Would Have Kept the Unit	%	Discard Scenario	%	Would-be Acquirer Finds an Alternative Unit	%	Alternative Type	%	Overall Proportion	Energy Consumption (kWh/year)		Savings
									Without ARet	With ARet	Net Reduction
Yes	60							60%	316	0	316
No	40	Transferred	33	Yes	50	Old Unit	50	3%	316	316	0
						New Unit	50	3%	316	76	240
				No	50			7%	316	0	316
		Disposed	67					27%	0	0	0
Weighted Average (kWh/unit)											219

Appliances Replaced through HomeWarming

This subsection describes the methodology used and the calculations made to determine the unitary savings of refrigerators, freezers and dehumidifiers replaced through HomeWarming in 2018.

HomeWarming offers income-eligible participants the opportunity to replace their old refrigerators, freezers and dehumidifiers with more efficient models. The HomeWarming guidelines were updated in 2018 and now indicate that refrigerators and freezers eligible for replacement must be manufactured in 1994 or earlier. The replacement savings are claimed under ARet.

Based on the nature of HomeWarming (direct replacement) and its participant demographics, a net-to-gross ratio (NTGR) of 1.00 was assumed.

Refrigerator Replacement

Since refrigerators eligible for replacement through HomeWarming correspond to the oldest age category used in the 2017 metering activities, the revised unitary savings value is based on the average annual per-cubic-foot consumption metered for refrigerators in that age category, i.e. 58.9 kWh/cu. ft. This consumption value was multiplied by the average size of the old refrigerators retired through HomeWarming in 2018 (rounded up to 17 cu. ft) and the occupant adjustment factor of 1.12. It was assumed that all refrigerators retired through HomeWarming were primary refrigerators since it was a program component criterion and therefore no part-use factor was applied. As a result, the Evaluator established that old refrigerators consume on average 1,121 kWh per year.

By applying the average annual per-cubic-foot consumption value of ENERGY STAR certified refrigerators installed through HomeWarming in 2018, the Evaluator established the new refrigerator unitary energy consumption (UEC) value at 348 kWh. No occupant adjustment factor was applied because the UEC ratings of new ENERGY STAR certified refrigerators already account for this occupancy adjustment.

Based on the ENERGY STAR certified refrigerator average annual consumption value, replacing an old refrigerator with a new model results in unitary savings of 773 kWh per year, as shown in the following equation.

$$\text{Revised Unitary Savings} = \left(58.9 \frac{\text{kWh}}{\text{cu. ft}} \times 17.0 \text{ cu. ft} \times 1.12 \right) - 348 \text{ kWh} = 773 \text{ kWh}$$

Freezer Replacement

To establish the unitary savings of freezers replaced through HomeWarming, the Evaluator used the same approach as for refrigerators replaced through HomeWarming. The Evaluator used the average annual consumption value of 117.8 kWh/cu. ft, which corresponds to the average annual per-cubic-foot consumption metered for the oldest age category of freezers. By applying the average size of the freezers retired in 2018 (12.6 cu. ft) and the occupant adjustment factor of 1.12 (but not the part-use factor), the average consumption of retired freezers was established at 1,662 kWh per year.

The Evaluator established a weighted average energy consumption value of 277 kWh/cu. ft for the new efficient freezers installed through HomeWarming based on the energy consumption of each model in the NRCAN list of compliant models²⁰ and each model's total number of installed units as per the 2018 tracking sheet. Given the average consumption of 277 kWh per year for new freezers, replacing an old freezer with a new model results in unitary savings of 1,385 kWh per year, as shown in the following equation.

$$\text{Revised Unitary Savings} = \left(117.8 \frac{\text{kWh}}{\text{cu. ft}} \times 12.6 \text{ cu. ft} \times 1.12 \right) - 277 \text{ kWh} = 1,385 \text{ kWh}$$

²⁰ Natural Resources Canada, *Energy Efficiency Ratings: Search – Freezers*, <http://oee.nrcan.gc.ca/pml-imp/index.cfm?action=app.download-telecharger&appliance=FREEZERS> (Last accessed January 9, 2019).

Dehumidifier Replacement

The revised unitary savings value for dehumidifier is calculated using the following algorithm:

$$\text{Unitary Savings } \left[\frac{\text{kWh}}{\text{year}} \right] = \left(\text{Average Water Removal Capacity } \left[\frac{\text{L}}{\text{day}} \right] \times \right. \\ \left. \text{Average Operating Days } \left[\frac{\text{days}}{\text{year}} \right] \right) \times \left(\frac{1}{\text{Energy Factor Old Dehumidifier}} - \right. \\ \left. \frac{1}{\text{Energy Factor ENERGY STAR Dehumidifier}} \right) \left[\frac{\text{kWh}}{\text{L}} \right]$$

Since October 2016, the ENERGY STAR certified dehumidifiers in the Canadian market with a water removal capacity of less than 35 L/day need to have an energy factor of 2.00 L/kWh or higher. This energy factor value was used in both the 2017 and 2018 evaluations by the Evaluator.

The assumptions for old units are based on the 2011 Ontario Power Authority (OPA) Prescriptive Measures and Assumptions report.²¹ An average water removal capacity of 3.87 L/day and an average of 168 operating days per year were applied. In that same report, the energy factor of old units was established at 0.66 L/kWh. These values were used again in 2018 to determine the unitary savings because they were determined using information collected and metered in the field, which should be considered more accurate than more recent studies which present theoretical values only.

Therefore, the Evaluator maintained the unitary savings of 660 kWh per year for old dehumidifiers replaced with new models.

²¹ Ontario Power Authority (OPA). *2011 Prescriptive Measures and Assumptions*, Released Version 1, March 2011.

APPENDIX V

ARET: PARTICIPANT SPILLOVER METHODOLOGY

Participant spillover was measured using a participant survey. For ARet, participant spillover occurs when participants decide to retire or replace other appliances on their own pursuant to participating in the program and due to its influence. Another form of spillover also occurs when other appliances that were not eligible for a rebate were disposed of when the ENS representative picked up the appliance to be retired through the program component.

During the telephone survey, participants were asked if they had retired additional appliances after participating in ARet. A question was used to verify the eligibility of the additional retirements by asking how they disposed of the old appliances. Participants were also asked if non-eligible appliances were picked up during participation, whether these were in working condition or not, and what they would have done with these ineligible appliances if they had not been picked up by ENS. Depending on the answer to the last question, the energy savings associated with the disposal scenario, the transfer scenario or the gross unitary savings of the appliance were used.

Subsequently, another question was asked to verify the influence of the program component on participants' decisions to dispose of additional appliances without receiving a rebate. Depending on the level of influence obtained during the survey, a portion of the savings related to the additional retirements was attributed to the program component.

The energy savings (kWh) associated with the additional retirements were estimated using the adjusted unitary savings values reviewed in this evaluation for each type of appliance.

The figure below illustrates the methodology used to calculate the spillover level.

SO1. When the ENS representative came to pick up your appliance, did he also pick up any other appliances that were not eligible for an incentive?	IF SO1 = 1. Yes: CONTINUE IF SO1 = 2. No OR DK OR REF: GO TO SO5
SO2. What other appliances were picked up?	SO2 = SUM (kWh associated with each eligible appliance retired)
SO3. [ASK FOR EACH ANSWER GIVEN TO SO2] Was this appliance in working order?	FOR EACH APPLIANCE IN SO2: IF SO3 = 1. Yes CONTINUE IF SO3 = 2. No OR DK OR REF: GO TO SO5
SO4. [ASK FOR EACH ANSWER GIVEN TO SO2] What would you have done with this appliance if it had not been picked up by ENS representative? 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 5. Or would you have done something else? 98. (Don't know) 99. (Refused)	FOR EACH APPLIANCE IN SO2: IF SO4 = 1 or 3: Savings associated with disposal scenario IF SO4 = 2: Gross unitary savings of each appliance IF SO4 = 4: Savings associated with transfer scenario IF SO4 = DK OR REF: EMPTY
Additional Non-eligible Savings:	SUM SO4
SO5. Since participating in ARet, have you disposed of other appliances <u>without receiving an incentive</u> ?	IF SO5 = 1. Yes: CONTINUE IF SO5 = 2. No OR DK OR REF: END
SO6. How many appliances have you disposed of <u>without receiving a incentive</u> since participating in ARet?	Record answer for each appliance type
SO8. [ASK FOR EACH ANSWER GIVEN TO SO6] Was this appliance in working order at the moment of its disposal?	FOR EACH APPLIANCE IN SO6: IF SO8 = 1. Yes CONTINUE IF SO8 = 2. No OR DK OR REF: END
SO7. [ASK FOR EACH ANSWER GIVEN TO SO6] 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 5. Have it picked up by the waste management company during spring or fall large collection day 96. Or did you dispose of it some other way? 98. (Don't know) 99. (Refused)	FOR EACH APPLIANCE IN SO6: IF SO7 = 3, 4 OR 5: CONTINUE OTHERWISE: END
SO9. [ASK FOR EACH ANSWER GIVEN TO SO6a-f > 0 AND SO7=3, 4 or 5] What would you have done with this appliance if you had not participated in ARet in 2018? 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 5. (Other, specify) 98. (Don't know) 99. (Refused)	FOR EACH APPLIANCE IN SO6: IF SO9 = 1 or 3: Savings associated with disposal scenario IF SO9 = 2: Gross unitary savings of each appliance IF SO9 = 4: Savings associated with transfer scenario IF SO9 = DK OR REF: EMPTY
Additional Non-incented Savings	SUM SO9
Final Spillover Level = $\frac{\text{SUM SO4} + \text{SUM SO9 for All Respondents}}{\text{SUM of Program Savings for All Respondents}}$	

APPENDIX VI

ARET: 2018 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2018 evaluation of the Appliance Retirement (ARet) program component. There were no incomplete 2017 recommendations at the time of evaluation.

Sections	2018 Recommendations
Executive Summary	1 Continue to perform the metering activity and ensure the metering protocol is followed. In the 2017 evaluation, the Evaluator recommended continuing the metering activity to increase the sample size of each age category and lower margins of error of measured appliance consumption. ENS continued the metering activity in 2018, although in-depth analysis indicated that the metered consumption data were inconsistent and could not be used as is. The Evaluator therefore recommends continuing the metering activities in 2019. Moreover, the metering protocol should be closely followed to ensure that the obtained data provide accurate results, notably by ensuring that metering is conducted in a room with controlled temperature.
	2 Develop and implement a protocol on the heat gun usage process. The Evaluator recommends that ENS formalize the heat gun usage process by developing a protocol for its use. The protocol should describe the appliances to be accepted or rejected based on the metered temperature and the data to be tracked. This protocol would ensure that all non-working appliances, i.e. appliances with inside temperature below target values, are properly identified, tracked, and excluded from the metering sample as well as program component results.

APPENDIX VII

IS: INTERVIEW GUIDE WITH RETAILER PARTNERS

Hello, may I please speak with _____?

INTRODUCTION

Hello, my name is _____, from Corporate Research Associates, an Atlantic Canadian research company. We are conducting an evaluation of the Instant Savings Program provided by Efficiency Nova Scotia.

IDENTIFICATION AND SCREENING OF RESPONDENT

The records we received from Efficiency Nova Scotia show your company has participated in their Instant Savings program. Can I please speak with the person most responsible for managing inventory and sales of LED light bulbs and LED fixtures that received rebates through the Instant Savings program? This person may also be the person dealing with Efficiency Nova Scotia or their delivery partner, the Summerhill group. Would that person be you?

- Person responsible available [CONTINUE]
- Person responsible currently unavailable [ARRANGE CALL BACK WITH THE RIGHT PERSON]
- No person responsible for stocking or management of products [CONTINUE INTERVIEW WITH CORPORATE MANAGER - CONTINUE]
- Don't know [CONTINUE INTERVIEW WITH CORPORATE MANAGER - CONTINUE]
- Refused [THANK AND TERMINATE]

Confidentiality

Your responses are for research purposes only. We will not share your information with any party in a way that could identify you or your company.

Recording of the Interview

I would like to record our interview so that I make sure I capture everything you say accurately. Is that all right with you?

Context

Since the beginning of 2018, Efficiency Nova Scotia has held two promotional campaigns for the Instant Savings program, where customers can get rebates for products including LED bulbs and LED fixtures. They ran a spring promotion from April 6 to May 20 and a fall promotion that started on September 28 and will end on November 10.

SECTION L –A-TYPE LED BULBS

[ASK IF **A-TYPE** RETAILER]

- L1. First, I would like to discuss the number of individual **A-type** LED bulbs – not packages of bulbs – your company will sell in 2018. We are interested in **all of your sales** of A-type LED bulbs, **not only the models on the SKU list** of Instant Savings rebate eligible products.

By A-type LED bulbs, we refer to standard LED bulbs which are only screw-in bulbs. Most have a pear-like shape or they are smart LED bulbs.

OPTION A [ASK IF **ALL** A-TYPE TOTAL SALES = YES]

- A. According to the data you provided to Efficiency Nova Scotia, you sold approximately [**ALL** A-TYPE TOTAL SALES] A-type LED bulbs for the first half of the year.

- a. Is this representative of your anticipated sales pattern for the entire year in 2018; that is do you think that your sales of A-type LED bulbs for the first half of the year will represent about 50% of your annual sales of A-type LED bulbs in 2018?

☐ Yes

☐ No – Of all the A-type LED bulbs you anticipate selling in 2018, roughly what percentage of bulbs will have been sold during the first half of the year?

_____ %

- b. This number seems to cover all of your sales of A-type LED bulbs, not only the models on the SKU list of Instant Savings rebate eligible products. Is this correct?

☐ Yes

☐ No – Roughly what percentage of your sales of A-type LED bulbs is missing?

_____ %

OPTION B [ASK IF **ALL** A-TYPE TOTAL SALES = NO]

- B. How many A-type LED bulbs did you sell during the first six months of 2018?

- a. Is this representative of your anticipated sales pattern for the entire year in 2018; that is do you think that your sales of A-type LED bulbs for the first half of the year will represent about 50% of your annual sales of A-type LED bulbs in 2018?

☐ Yes

☐ No – Of all the A-type LED bulbs you anticipate selling in 2018, roughly what percentage of bulbs will have been sold during the first half of the year?

_____ %

OPTION C [ASK IF DIFFICULTY TO ANSWER OPTION B AND IF **REBATE ELIGIBLE** A-TYPE TOTAL SALES =YES]

C. According to the data you provided to Efficiency Nova Scotia, you sold approximately **[REBATE ELIGIBLE A-TYPE TOTAL SALES]** rebate eligible A-type LED bulbs for the first half of the year.

a. What percentage of all your sales of A-type LED bulbs do you think these sales of rebate eligible A-type LED bulbs represent?

_____ %

b. Is this number of rebate eligible A-type LED bulbs sold during the first half of the year representative of your anticipated sales pattern for the entire year in 2018; that is do you think that your sales of rebate eligible A-type LED bulbs for the first half of the year will represent about 50% of your annual sales of rebate eligible A-type LED bulbs in 2018?

☐ Yes

☐ No – Of all the rebate eligible A-type LED bulbs you anticipate selling in 2018, roughly what percentage of bulbs will have been sold during the first half of the year?

_____ %

L2. [ASK IF **A-TYPE** RETAILER] Now thinking about your anticipated sales next year, in 2019, what do you forecast for A-type LED bulbs sales [SELECT ONE AND ASK WHY]?

☐ More sales in 2019 compared to 2018

☐ About the same sales as 2018

☐ Fewer sales in 2019 compared to 2018

L3. [ASK IF **A-TYPE** RETAILER] Now I would like to discuss the selection of **A-type** LED models to be on the SKU list for a rebate during the 2018 Instant Savings campaigns.

A. According to our information, your company selected [A-TYPE SPRING SKU] different SKUs to be eligible for a rebate during the 2018 spring campaign and [A-TYPE FALL SKU] during the fall campaign? Is this correct?

☐ Yes

☐ No - Record actual number of SKUs rebate eligible for the spring and/or fall campaigns

B. What percentage of all **A-type** LED models (SKUs) offered in your store do you think these selected models (SKUs) represent?

C. How did you proceed for the selection of rebate eligible models (SKUs)?

SECTION N – NON-A-TYPE LED BULBS

[ASK IF **NON A-TYPE** RETAILER]

N1. Now I would like to discuss the number of individual **Non A-type** LED bulbs – not packages of bulbs – your company will sell in 2018. We are interested in **all of your sales** of Non A-type LED bulbs, **not only the models on the SKU list** of Instant Savings rebate eligible products.

By **Non-A-type** LED bulbs, we refer to those bulbs which do not have a pear-like shape. Non-A-type LED bulbs can either have a screw-in or pin base. They are often used to replace halogens, reflector lamps or incandescent lamps for recessed fixtures.

OPTION A [ASK IF ALL NON A-TYPE TOTAL SALES = YES]

A. According to the data you provided to Efficiency Nova Scotia, you sold approximately [ALL NON A-TYPE TOTAL SALES] Non A-type LED bulbs for the first half of the year.

i. Is this representative of your anticipated sales pattern for the entire year in 2018; that is do you think that your sales of Non A-type LED bulbs for the first half of the year will represent about 50% of your annual sales of LED Non A-type bulbs in 2018?

☐ Yes

☐ No – Of all the Non A-type LED bulbs you anticipate selling in 2018, roughly what percentage of bulbs will have been sold during the first half of the year?

_____ %

ii. This number seems to cover all of your sales of Non A-type LED bulbs, not only the models on the SKU list of Instant Savings rebate eligible products. Is this correct?

☐ Yes

☐ No – Roughly what percentage of your sales of Non A-type LED bulbs is missing?

_____ %

OPTION B [ASK IF ALL NON A-TYPE TOTAL SALES = NO]

B. How many Non A-type LED bulbs did you sell during the first six months of 2018?

i. Is this representative of your anticipated sales pattern for the entire year in 2018; that is do you think that your sales of Non A-type LED bulbs for the first half of the year will represent about 50% of your annual sales of Non A-type LED bulbs in 2018?

☐ Yes

☐ No – Of all the Non A-type LED bulbs you anticipate selling in 2018, roughly what percentage of bulbs will have been sold during the first half of the year?

_____ %

OPTION C [ASK IF DIFFICULTY TO ANSWER OPTION B AND IF **REBATE ELIGIBLE** NON A-TYPE TOTAL SALES =YES]

C. According to the data you provided to Efficiency Nova Scotia, you sold approximately **[REBATE ELIGIBLE NON A-TYPE TOTAL SALES]** rebate eligible Non A-type LED bulbs for the first half of the year.

i. What percentage of all your sales of Non A-type LED bulbs do you think these sales of rebate eligible Non A-type LED bulbs represent?

_____ %

ii. Is this number of rebate eligible Non A-type LED bulbs sold during the first half of the year representative of your anticipated sales pattern for the entire year in 2018; that is do you think that your sales of rebate eligible Non A-type LED bulbs for the first half of the year will represent about 50% of your annual sales of rebate eligible Non A-type LED bulbs in 2018?

☐ Yes

☐ No – Of all the rebate eligible Non A-type LED bulbs you anticipate selling in 2018, roughly what percentage of bulbs will have been sold during the first half of the year?

_____ %

N2. [ASK IF **NON A-TYPE** RETAILER] Now thinking about your anticipated sales next year, in 2019, what do you forecast for Non A-type LED bulbs sales [SELECT ONE AND ASK WHY]?

☐ More sales in 2019 compared to 2018

☐ About the same sales as 2018

☐ Fewer sales in 2019 compared to 2018

N3. [ASK IF **NON A-TYPE** RETAILER] Now I would like to discuss the selection of **Non A-type** LED models to be on the SKU list for a rebate during the 2018 Instant Savings campaigns.

A. According to our information, your company selected **[NON A-TYPE SPRING SKU]** different SKUs to be eligible for a rebate during the 2018 spring campaign and **[NON A-TYPE FALL SKU]** during the fall campaign? Is this correct?

☐ Yes

☐ No - Record actual number of SKUs rebate eligible for the spring and/or fall campaigns

B. What percentage of all **Non A-type** LED models (SKUs) offered in your store do you think these selected models (SKUs) represent?

C. How did you proceed for the selection of rebate eligible models (SKUs)?

SECTION I – INSTANT SAVINGS PROGRAM'S IMPACT

[ASK TO ALL]

I1a. For the next questions, please take in consideration both A-type and non-A-type LED bulbs.

What proportion of all LED bulbs you sold so far in 2018 were not ENERGY STAR certified?

_____ %

I1b. [ASK IF I1a >0%] Why do you carry non-ENERGY STAR LED bulbs?

I2. I would like to understand the influence Instant Savings has had on staff and consumer knowledge, as well as product offerings. Using a 0-10 scale, where 0 means “not at all” and 10 means “a great deal”, to what extent has Instant Savings...

a. Helped increase sales staff knowledge of LED bulbs and their benefits

Scale:

Please explain your response:

b. Helped increase consumers knowledge of LED bulbs and their benefits

Scale:

Please explain your response:

c. Influenced the variety of LED bulbs stocked in your stores

Scale:

Please explain your response:

d. Influenced the quantity of LED bulbs stocked in your stores

Scale:

Please explain your response:

13. The Instant Savings rebates are offered only during the spring and fall campaigns and only on selected products. The program may have an impact on non-rebate eligible LED bulbs sales year-round as well as on rebate eligible LED bulbs sales outside of the campaigns. Efficiency Nova Scotia promotes energy efficient products and services year-round, through, its advertising, website, and other energy efficiency programs.

[Note to interviewer – use the following if needed to get retailers talking:

- For instance, your sales people may have a better knowledge of LEDs, thus being more apt to recommend these products to customers outside of the campaigns; or perhaps
- your offer of LEDs may be more attractive 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].

With this in mind, about what percentage of the total number of LED bulbs you sold, outside of those that received a rebate, can you directly or indirectly attribute to Efficiency Nova Scotia's programs and promotion – in essence, sales you would not have had during the months of January through March, mid-May through September, and mid-November through December, if the program had never existed, as well as sales of non-rebate eligible LED bulbs throughout the year?

[SINCE THE FALL REBATE CAMPAIGN IS NOT OVER YET, ASK THE RESPONDENT TO ANSWER BASED ON A PROJECTION]

Enter %:

[If interviewee cannot provide an exact percentage, ask for a range (e.g. 0-10%, 10-20%, etc.)

Please explain your answer:

SECTION F – ENERGY EFFICIENT FIXTURES

[ASK TO ALL]

I have a few questions about your lighting fixtures offered in-store and energy efficient fixtures promoted by the Instant Savings Program. As a reminder, the energy efficient 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.

F1. What proportion of the lighting fixture models you carry in-store are:

a. ENERGY STAR, hard-wired, with integrated LED lighting _____ %

b. Other types of lighting fixtures _____ %

IF F1a and F1b = 0% SKIP TO SATISFACTION

F2. [ASK IF F1b > 0%] Among the other types of lighting fixtures, what proportion are

a. Fixtures without any bulbs included _____ %

b. Fixture with LED bulbs included _____ %

c. Fixtures with non-LED bulbs included _____ %

F3a. What proportion of all ENERGY STAR hard-wired fixtures with integrated LED lighting sold during both campaigns were or will be eligible for a rebate?

_____ %

F3b. [ASK IF F3a < 100%] Why are some ENERGY STAR hard-wired fixtures with integrated LED lighting not eligible for a rebate?

F4. How do you determine which models of lighting fixtures to carry in store? [Probe: Importance of the program, consumer interest, market trend]

F5. I am interested in understanding your views on the impact of Instant Savings on customers' product choice. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", to what extent does Instant Savings influence your customers to choose an ENERGY STAR hard-wired fixture with integrated LED lighting over other types of lighting fixtures?

RECORD RATING: _____

RECORD EXPLANATION:

F6. In your opinion, what impact has Instant Savings had, if any, on ...

- the quantity of LED fixtures models offered in-store?

Please explain your response:

- your staff's overall knowledge of these products?

Please explain your response:

- The interest of customers for ENERGY STAR hard-wired fixtures with integrated LED lighting

Please explain your response:

- F7. Based on what you know, what prevents consumers from purchasing ENERGY STAR hard-wired fixtures with integrated LED lighting? What is the single most important barrier? Are there other reasons? [PROBE: Price, range of model, look of the fixtures, etc.]

SECTION S – SATISFACTION

[ASK TO ALL]

- S0. On a scale of 1 to 10, where 1 is “not at all satisfied” and 10 is “completely satisfied”, please rate your satisfaction in regard to the following aspects of the Instant Savings program in Nova Scotia.

Aspects of the program	a. Score 1 = not at all satisfied 10 = completely satisfied NA = Not applicable	b. Reason If rating of 7 or lower, please share the reason(s) for your score.
S1. The overall program operated by Efficiency Nova Scotia		
S2. The preparation process to the campaign		
S3. The program marketing and advertising		
S4. The products covered by the program		
S5. The rebate amounts		
S6. The rebate processing, tracking and reporting		
S7. The overall relationship with Summerhill		
S8. Timeliness of program information provided to you by Summerhill and Efficiency Nova Scotia		
S9. The retailer initiated marketing material (e.g. weekly flyers) approval process by Summerhill and Efficiency Nova Scotia		
S10. The SKU list approval process by Summerhill and Efficiency Nova Scotia		

SECTION BR – BARRIERS AND RECOMMENDATIONS

[ASK TO ALL]

The last questions will allow us to help ENS improve the Instant Savings program.

BR1. In your opinion, what prevents consumers from buying energy efficient products in general? What is the single most important barrier? How if at all has that changed in the past year?

BR2. And finally, what suggestions do you have, if any, to increase participation in the program?

END: That concludes my questions. Thank you for your time and your collaboration.

APPENDIX VIII

IS: PARTICIPANT INTERCEPT SURVEY QUESTIONNAIRE

SELECT LOCATION:

Home Depot

Not Home Depot

Introduction and Eligibility

Hello, my name is _____ and I am with Corporate Research Associates. Today we are conducting a short survey about energy efficiency. We are gathering information from customers who just purchased L-E-D energy efficient lights or LED energy efficient fixtures.

[NOTE FOR THE HOME DEPOT STORE LOCATIONS: Please know that this survey was commissioned by Efficiency Nova Scotia, not the Home Depot, but that the results will be shared with the Home Depot Canada in all confidentiality.]

- I1. Did you purchase L-E-D bulbs or L-E-D fixtures today? [CODE ONE ONLY] INTERVIEWER TO SHOW PICTURES ON SIGNAGE TO RESPONDENT TO CLARIFY.
1. L-E-D bulbs [WILL CONTINUE WITH L-E-D BULB SURVEY]
 2. L-E-D fixtures [WILL CONTINUE WITH L-E-D FIXTURE SURVEY]
 3. Both [WILL CONTINUE WITH L-E-D FIXTURE SURVEY]
 4. No [THANK AND TERMINATE].
 98. (Don't Know) [ASK AGAIN. IF STILL DK, THANK AND TERMINATE].
 99. (Refused) [THANK AND TERMINATE].

LED Bulb Survey ASK IF I1=1

- I1a. What type of L-E-Ds did you buy today? Was it... [CODE ALL THAT APPLIES - **SHOW PICTURES TO ALL RESPONDENTS**]

NOTE TO THE INTERVIEWERS: PICTURES ARE EXAMPLES. There could be other types of LED bulbs slightly different from the photos here.

1. Standard LED bulb (Pear-shaped bulbs or smart bulbs)
2. Another type of LED bulb
3. Non-LED bulbs/products [THANK AND TERMINATE IF ONLY THIS CATEGORY MENTIONED]
99. Refused [CONTINUE]

Standard LED Bulb		Another Type of LED Bulb			
					
Pear-shaped bulb	Smart LED bulb	Bulbs for pot-lights	Reflector bulb	Chandeliers	Globe bulb

[READ FOLLOWING SENTENCE IF I1a =1 and 2] Please answer my following questions about the non-pear-shaped bulbs only.

ASK OF EVERYONE

I1b. How many L-E-Ds did you purchase today? [ENTER THE NUMBER OF BULBS NOT PACKAGES. PROBE TO AVOID ACCEPTING A RANGE]

Enter number of L-E-Ds bought: _____

98. (Don't Know) [THANK AND TERMINATE]

99. (Refused) [THANK AND TERMINATE]

I2. To the best of your knowledge, was the price of this/these L-E-D light bulb(s) discounted at the cash register? [CODE ONE ONLY]

1. Yes

2. No [ASK AGAIN. IF STILL SAYS NO, THANK AND TERMINATE]

98. (Don't Know) [ASK AGAIN. IF STILL DK, THANK AND TERMINATE]

99. (Refused) [THANK AND TERMINATE]

I3. The survey will take about five minutes. You will receive a \$5 cash incentive as a thank you for your cooperation. Would you be willing to answer the survey?

1. Yes [CONTINUE – GO TO P1]

2. No [THANK AND TERMINATE]

Purchase (P Series)

P1. Are there any L-E-Ds currently installed in your home? [CODE ONE ONLY]

1. Yes
2. No
98. (Don't Know)
99. (Refused)

P3a. [I1a=1 AND I1b=1 bulb] For which of the following reasons did you buy this L-E-D bulb? Do you plan on installing it... **[READ – CODE ONE ONLY - SHOW PICTURES TO ALL RESPONDENTS]**

1. To replace another L-E-D bulb
2. To replace a CFL bulb
3. To replace a standard incandescent bulb (those bulbs typically have wattages of 40 W, 60 W or 100 W).
4. To replace an efficient incandescent bulb (those bulbs look the same as incandescent bulbs but typically have wattages of 29 W, 43 W or 72 W) [NOTE TO INTERVIEWERS: IF THE RESPONDENT SAYS HALOGEN INCANDESCENT, CODE 4].
5. Into a new lamp or light fixture
97. (Other [SPECIFY _____])
98. (Don't Know)
99. (Refused)

To replace an L-E-D bulb	To replace a CFL bulb	To replace an incandescent bulb	To replace an 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

P3b. [IF P3a =1]. Do you plan on installing this L-E-D bulb... [READ – CODE ONE ONLY]

1. To replace an L-E-D bulb once it burns out
2. To replace an L-E-D bulb that is still working
97. (Other [SPECIFY _____])
98. (Don't Know)
99. (Refused)

P3c. [IF P3a = 2 or 3 or 4]. Do you plan on installing this L-E-D bulb... [READ – CODE ONE ONLY]

1. To replace a bulb once it burns out
2. To replace a bulb that is still working
97. (Other [SPECIFY _____])
98. (Don't Know)
99. (Refused)

P4a. [I1a=1 AND I1b >1 (more than 1 bulb)] For which of the following reasons did you buy these [INSERT NUMBER OF LEDs FROM I1b] L-E-D bulbs? How many, if any, of these [[INSERT NUMBER OF LEDs FROM I1b] L-E-D bulbs will be installed... **[TOTAL NUMBER OF BULBS RECORDED CAN'T BE HIGHER THAN COUNT IN I1b] [SHOW PICTURES TO ALL RESPONDENTS]** NOTE TO INTERVIEWER – ALL CATEGORIES NEED A NUMBER, ADD IN ZEROS FOR ANY THAT WERE NOT SELECTED.

1. To replace another L-E-D bulb
2. To replace a CFL bulb
3. To replace a standard incandescent bulb (those bulbs typically have wattages of 40 W, 60 W or 100 W).
4. To replace an efficient incandescent bulb (those bulbs look the same as incandescent bulbs but typically have wattages of 29 W, 43 W or 72 W). [NOTE TO INTERVIEWERS: IF THE RESPONDENT SAYS HALOGEN INCANDESCENT, CODE 4].
5. Into a new lamp or light fixture
97. (Other [SPECIFY _____])
98. (Don't Know)
99. (Refused)

P4b. [IF P4a1 >0]. Concerning the L-E-D bulbs that you will use to replace existing L-E-D bulbs: do you plan on installing these bulbs mostly ... [READ – CODE ONE ONLY]

1. To replace L-E-D bulbs once they burn out
2. To replace L-E-D bulbs that are still working
97. (Other [SPECIFY _____])
98. (Don't Know)
99. (Refused)

P4c. [IF P4a2 or P4a3 or P4a4 >0]. Concerning the bulbs that you will use to replace existing non- L-E-D bulbs: do you plan on installing these L-E-D bulbs mostly ... [READ – CODE ONE ONLY]

1. To replace bulbs once they burn out
2. To replace bulbs that are still working
97. (Other [SPECIFY _____])
98. (Don't Know)
99. (Refused)

P5. [IF P4b=2 or P3b=2]. Why do you plan on replacing L-E-D bulbs that are still working? [DO NOT READ]

1. Bulbs burn too fast
2. Dislike lighting of these bulbs
97. (Other [SPECIFY _____])
98. (Don't Know)
99. (Refused)

Awareness of Program and Efficiency Nova Scotia (AW Series)

AW1. 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? [CODE ONE ONLY]

1. Yes [GO TO CS1]
2. No [GO TO FR SECTION]
98. (Don't Know) [GO TO FR SECTION]
99. (Refused) [GO TO FR SECTION]

CS1. [ASK IF AW1=1] How did you find out about this program? [DON'T READ; ALLOW MULTIPLE RESPONSE BUT DO NOT PROBE FOR MULTIPLE]

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

AW4. [ASK IF AW1=1] Besides the L-E-D bulbs that you purchased today, are you aware of any other energy efficiency products that are discounted by Efficiency Nova Scotia as part of their Instant Savings program? [CODE ONE ONLY]

- 1. Yes [GO TO AW5]
- 2. No [GO TO FR SECTION]
- 98. (Don't Know) [GO TO FR SECTION]
- 99. (Refused) [GO TO FR SECTION]

AW5. [ASK IF AW4=1] What are those products? Any others? [DO NOT READ RESPONSES – CODE AS MANY AS APPLY]

- 1. (L-E-D fixtures)
- 2. (Smart L-E-D)
- 3. (Clothes Line)
- 4. (Dimmer switches)
- 5. (Motion sensors)
- 6. (Power bars or Smart strips)
- 7. (Heavy-duty timers)
- 8. (Programmable thermostats)
- 9. (Smart thermostats)
- 10. (Refrigerators)
- 11. (Clothes washers)
- 12. (Air purifiers)
- 13. (Dehumidifiers)
- 96. (Other, SPECIFY: _____)
- 98. (Don't Know)
- 99. (Refused)

Free-Ridership (FR Series)

[READ FOLLOWING SENTENCE IF I1a=1 and 2] The next series of questions is specifically about the non-pear-shaped L-E-D bulbs you purchased.

ASK OF EVERYONE

FR0a. You bought L-E-Ds today. Efficiency Nova Scotia offered a discount on packages of L-E-Ds. Before paying at the cash register, were you aware that a discount was offered on the purchase of L-E-Ds? [CODE ONE ONLY]

- 1. Yes [GO TO FR0c]
- 2. No [GO TO FR0b]
- 98. (Don't Know) [GO TO FR0b]
- 99. (Refused) [GO TO FR0b]

FR0b. [ASK IF NOT AWARE OF THE DISCOUNT (FR0a=2, DK, REF)] I just want to make sure I understand - You did not know about the discount on specific packages of L-E-Ds 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 D]
- 98. (Don't know) [GO TO SECTION D]
- 99. (Refused) [GO TO SECTION D]

[ASK THE FOLLOWING FR QUESTIONS IF AWARE OF THE DISCOUNT (FR0a=1) OR (FR0b=1), OTHERWISE SKIP TO SECTION D]

FR0c. Before the beginning of the rebate campaign on September 28th, were you aware that discounts on L-E-Ds would be offered this fall?

- 1. Yes
- 2. No [SKIP TO FR0e]
- 98. (Don't Know) [SKIP TO FR0e]
- 99. (Refused) [SKIP TO FR0e]

FR0d. [ASK IF YES IN FR0c] Did you postpone your purchase of L-E-Ds to take advantage of the discount?

- 1. Yes
- 2. No
- 98. (Don't Know)
- 99. (Refused)

FR0e. How did you learn about the discount offered on the purchase of specific packages of L-E-Ds?

[DO NOT READ RESPONSES – CODE AS MANY AS APPLY]

1. (TV ads)
2. (Print ads)
3. (Radio ads)
4. (Radio remote – live radio personalities at a local store)
5. (In-store signage)
6. (Store flyer)
7. (Store personnel)
8. (Efficiency Nova Scotia website)
9. (Facebook/Social Media)
10. (Online advertisement on smart phone, computer or tablet)
11. (YouTube video)
12. (Billboards, digital billboards and other outdoor advertising)
13. (Display screens in office buildings (in lobbies, elevators or waiting rooms))
14. (Word of Mouth)
15. (Through an Efficiency Nova Scotia representative during an in-store customer engagement event)
16. (From previous participation)
96. (Other [SPECIFY: _____])
98. (Don't Know)
99. (Refused)

FR0f. Did you see the stickers, shelf signs or posters in the light bulb section of the store promoting the discount offered on L-E-Ds? [CODE ONE ONLY]

1. Yes
2. No
98. (Don't know)
99. (Refused)

FR1. You mentioned that you were aware, before paying at the cash register, that a discount was offered on the purchase of L-E-Ds. Did knowing this play a part in your decision to buy L-E-Ds today? [CODE ONE ONLY]

1. Yes
2. No
98. (Don't know)
99. (Refused)

FR2a. If the discount on L-E-Ds had NOT been offered, what would you have bought today? Would you have... [READ, CODE ONE ONLY]

- 1. Bought L-E-Ds anyway
- 2. Bought other type of bulbs
- 3. Not bought any bulbs
- 98. (Don't know)
- 99. (Refused)

FR2b. [ASK IF FR2a=2 AND I1a=1] Which type(s) of bulb would you have purchased instead today? [READ - ALLOW MULTIPLE - SHOW PICTURES IF NEEDED]

- 1. Incandescent
- 2. Halogen
- 3. CFLs
- 96. Other, SPECIFY: _____
- 98. (Don't know)
- 99. (Refused)

FR3. How likely would you have been to buy the L-E-Ds that you purchased today 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 L-E-Ds" and a 10 indicating that you "Definitely Would Have Bought these L-E-Ds." [PROBE TO AVOID ACCEPTING A RANGE]

___ Response ___ 98 Don't Know ___ 99 Refused

FR4. If the discount had NOT been offered, when would you have purchased the L-E-Ds that you purchased today? Would it have been...? [CODE ONE ONLY]

- 1. [ASK IF FR0d=1] Earlier
- 2. Definitely today
- 3. Probably today
- 4. Probably at a later date
- 5. Definitely at a later date
- 96. (Would not have purchased them at all) [SKIP to D Series]
- 98. (Don't Know)
- 99. (Refused)

FR5. Without the discount, would you have definitely purchased the same number of L-E-Ds, probably purchased the same number, probably purchased fewer or definitely purchased fewer? [CODE ONE ONLY]

1. Definitely the same number
2. Probably the same number
3. Probably fewer
4. Definitely fewer
98. (Don't know)
99. (Refused)

LED Fixture Survey ASK IF I1=2-3

I1a. What type of L-E-D fixtures did you buy today? Was it... [READ ALL BEFORE CODING - CODE ALL THAT APPLIES - **SHOW PICTURES TO ALL RESPONDENTS**]

1. L-E-D recessed fixture
2. L-E-D fixture without motion sensors
3. L-E-D fixture with motion sensors (typically used outdoor) [THANK AND TERMINATE IF ONLY THIS CATEGORY MENTIONED]
4. Non-L-E-D fixtures/products [THANK AND TERMINATE IF ONLY THIS CATEGORY MENTIONED]
99. Refused [CONTINUE]

1. L-E-D recessed fixtures



2. L-E-D fixtures (without motion sensors)



3. L-E-D fixture with motion sensors



11b. [ASK IF I1a=1] How many L-E-D recessed fixtures did you purchase today? [ENTER THE NUMBER OF FIXTURES NOT PACKAGES. PROBE TO AVOID ACCEPTING A RANGE]

Enter number of L-E-D recessed fixtures bought: ____

98. (Don't Know) Thank and Terminate

99. (Refused) Thank and Terminate

I1c. [ASK IF I1a=2] How many L-E-D fixtures did you purchase today? [ENTER THE NUMBER OF FIXTURES NOT PACKAGES. PROBE TO AVOID ACCEPTING A RANGE]

Enter number of L-E-D fixtures bought: _____

98. (Don't Know) Thank and Terminate

99. (Refused) Thank and Terminate

I2. To the best of your knowledge, was the price of this/these L-E-D fixture(s) discounted at the cash register? [CODE ONE ONLY]

2. Yes

2. No [ASK AGAIN. IF STILL SAYS NO, THANK AND TERMINATE]

98. (Don't Know) [ASK AGAIN. IF STILL DK, THANK AND TERMINATE]

99. (Refused) [THANK AND TERMINATE]

I3. The survey will take about five minutes. You will receive a \$5 cash incentive as a thank you for your cooperation. Would you be willing to answer the survey?

1. Yes [CONTINUE – GO TO P1a]

2. No [THANK AND TERMINATE]

Purchase (P Series)

P0. Will the L-E-D fixture(s) you bought be installed indoor or outdoor? **[READ – CODE ONE ONLY]**

1. Indoor

2. Outdoor

3. (Both)

97. (Other [SPECIFY _____])

98. (Don't Know)

99. (Refused)

P1a. [IF I1b and I1c=1] For which of the following reasons did you buy this L-E-D fixture? **[READ – CODE ONE ONLY]**

1. To replace a fixture that was still functional

2. To replace a fixture that was broken

3. To install in a place that did not have a fixture before

98. (Other [SPECIFY _____])

98. (Don't Know)

99. (Refused)

P1b. [IF I1b and I1c>1 (more than 1 fixture)] For which of the following reasons did you buy these [INSERT NUMBER OF L-E-D fixtures FROM I1b and I1c] L-E-D fixtures? How many, if any, of these [Of the [INSERT NUMBER OF L-E-D fixtures FROM I1b and I1c] L-E-D fixtures will be installed... **[TOTAL NUMBER OF FIXTURES RECORDED CAN'T BE HIGHER THAN COUNT IN I1b and I1c]** NOTE TO INTERVIEWER – ALL CATEGORIES NEED A NUMBER, ADD IN ZEROS FOR ANY THAT WERE NOT SELECTED.

1. To replace a fixture that was still functional
2. To replace a fixture that was broken
3. To install in a place who did not have a fixture before
98. (Other [SPECIFY _____])
98. (Don't Know)
99. (Refused)

P2. [DO NOT ASK IF P1a=3 or P1b =3] What types of bulbs were installed in the fixtures that you plan on replacing? **[READ – CODE AS MANY AS APPLY - SHOW PICTURES]**

1. L-E-D bulbs
2. CFL bulbs
3. Standard incandescent bulbs (those bulbs typically have wattages of 40 W, 60 W or 100 W).
4. Efficient incandescent bulbs (those bulbs look the same as incandescent bulbs but typically have wattages of 29 W, 43 W or 72 W) [NOTE TO INTERVIEWERS: IF THE RESPONDENT SAYS HALOGEN INCANDESCENT, CODE 4].
97. (Other [SPECIFY _____])
98. (Don't Know)
99. (Refused)

L-E-D bulb	CFL 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

Awareness of Program and Efficiency Nova Scotia (AW Series)

AW1. 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? [CODE ONE ONLY]

1. Yes [GO TO CS1]
2. No [GO TO IN SECTION]
98. (Don't Know) [GO TO IN SECTION]
99. (Refused) [GO TO IN SECTION]

CS1. [ASK IF AW1=1] How did you find out about this program? [DON'T READ; ALLOW MULTIPLE RESPONSE BUT DO NOT PROBE FOR MULTIPLE]

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

AW4. [ASK IF AW1=1] Besides the L-E-D fixtures that you purchased today, are you aware of any other energy efficiency products that are discounted by Efficiency Nova Scotia as part of their Instant Savings program? [CODE ONE ONLY]

1. Yes [GO TO AW5]
2. No [GO TO IN SECTION]
98. (Don't Know) [GO TO IN SECTION]
99. (Refused) [GO TO IN SECTION]

AW5. [ASK IF AW4=1] What are those products? Any others? [DO NOT READ RESPONSES – CODE AS MANY AS APPLY]

1. (L-E-D bulbs)
2. (Smart L-E-D)
3. (Clothes Line)
4. (Dimmer switches)
5. (Motion sensors)
6. (Power bars or Smart strips)
7. (Heavy-duty timers)
8. (Programmable thermostats)
9. (Smart thermostats)
10. (Refrigerators)
11. (Clothes washers)
12. (Air purifiers)
13. (Dehumidifiers)
96. (Other, SPECIFY: _____)
98. (Don't Know)
99. (Refused)

Influence of the program (IN Series)

IN1. When shopping for your fixture, did you look at fixtures with L-E-D lighting only or did you look at fixtures with any type of lighting?

1. Fixtures with L-E-D lighting only
2. Fixtures with any type of lighting
98. (Don't Know)
99. (Refused)

IN2. How important were the following aspects in your decision to purchase L-E-D fixture(s)? Please answer on a scale of 1 to 10, where 1 means “not at all important” and 10 means ‘very important’. [ROTATE. RECORD RESPONSE BETWEEN 1 AND 10. 98=DON'T KNOW, 99=REFUSED]

- a. The price of the fixture
- b. The appearance or look of the fixture
- c. The quality of light provided
- d. Purchasing the same type of fixture throughout my entire home/uniformity
- e. The energy consumption of the fixture

IN3. [ASK IF IN2b>5] While shopping for your fixture, did you find that L-E-D fixtures were as aesthetically pleasing as non-L-E-D fixtures? Were the L-E-D fixtures... [READ]?

1. Less aesthetic
2. As aesthetic, or
3. More aesthetic than non-L-E-D fixtures
97. (I noticed no difference)
98. (Don't Know)
99. (Refused)

IN4. [ASK IF IN2c>5] While shopping for your fixture, did you find that L-E-D fixtures provide ...? [READ]

1. Lower quality light than non-L-E-D fixtures
2. Same quality light as non-L-E-D fixtures
3. Better quality light than non-L-E-D fixtures
97. (I noticed no difference)
98. (Don't Know)
99. (Refused)

IN5. Efficiency Nova Scotia offered a discount on L-E-D fixtures today. Before paying at the cash register, were you aware that a discount was offered on the purchase of L-E-D fixtures? [CODE ONE ONLY]

1. Yes
2. No
98. (Don't Know)
99. (Refused)

IN6. On a scale of 0 to 10, where 0 means not at all influential and 10 means very influential, how influential were the following factors in your decision to purchase the L-E-D fixture that you purchased today? [ROTATE, EXCEPT FOR G - ALWAYS KEEP G FOR LAST]

- a. Energy efficiency information and promotion by Efficiency Nova Scotia
- b. In-store promotion on energy efficient lighting
- c. Advice/recommendation of a store salesperson
- d. Advice/recommendation from a friend or family member
- e. [ASK ONLY IF YES IN IN2] The rebate on the purchase of the fixture provided by Efficiency Nova Scotia
- f. The in-store offer of L-E-D fixtures
- g. Any other influence factor?

Demographics (D Series) ASK ALL

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

[ASK ALL RESPONDENTS]

D1. What type of residence do you live in? [READ FIRST SEVEN RESPONSES; SELECT ONE RESPONSE]

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. Or another type [SPECIFY: _____]
98. (Don't know)
99. (Refused)

D2. Do you own or rent this residence? [CODE ONE ONLY]

1. Own/buying [GO TO D4]
2. Rent/lease [GO TO D3]
96. (Other (Describe)) _____ [GO TO D4]
99. (Refused) [GO TO D4]

D3. Do you or does your landlord pay the electric bills for your residence? [CODE ONE ONLY]

1. (I pay the electric bills)
2. (My landlord pays the electric bills)
96. (Other [Describe _____])
98. (Don't Know)
99. (Refused)

D4. Do you allow me to record your gender? [DO NOT READ.CODE ONE ONLY]

1. (Male)
2. (Female)
99. (Refused)

END. Those are all the questions I have for you. I thank you very much for your time and cooperation. Here is your \$5 for participating in our survey.

APPENDIX IX

IS: PARTICIPANT SURVEY RESULTS

The participant survey results are presented in the following tables.

I1. Did you purchase L-E-D bulbs or L-E-D fixtures today?

Product Purchased	2018
Sample Size	194
LED Bulbs	84%
LED fixtures	14%
Both	2%

I1a. What type of L-E-Ds did you buy today? Was it...?

Type of LEDs Purchased	2018
Sample Size	163
Standard LED bulb (Pear-shaped bulbs or smart bulbs)	80%
Another type of LED bulb	26%
Base: Respondents who purchased LED bulbs only Multiple response	

I1b. How many L-E-Ds did you purchase today?

Number of LED Bulbs Purchased	2016	2017	2018
Sample Size	217*	100	163
1-2 LEDs	19%	18%	6%
3-4	29%	29%	35%
5-7	23%	10%	9%
8-10	14%	31%	31%
11 or more	15%	12%	11%
Average	6.8	6.2	8.0
Base: Respondents who purchased LED bulbs only *A number of respondents are missing this question in the 2016 Spring data as it was optional Don't know/Refused excluded from Average calculations			

P1. Are there any L-E-Ds currently installed in your home?

LED Lamps Currently Installed	2016	2017	2018
Sample Size	246	100	163
Yes	87%	90%	94%
No	13%	7%	6%
Don't know	-	3%	
Base: Respondents who purchased LED bulbs only			

P3a/P4a. For which of the following reasons did you buy this/these L-E-D bulb(s)? Do you plan on installing it...?

Reason for Purchasing LED Bulbs	2016	2017	2018
Sample Size	246	100	163
To replace another LED bulb	9%	15%	33%
To replace a standard incandescent bulb	40%	24%	27%
To replace a CFL bulb	34%	48%	25%
To replace an efficient incandescent bulb/halogen bulb	11%	3%	9%
Into a new lamp or light fixture	6%	7%	3%
For some other reason	-	3%	3%
Base: Respondents who purchased LED bulbs only Question wording change in 2018			

P3b/P4b. Concerning the L-E-D bulbs that you will use to replace existing L-E-D bulbs: do you plan on installing these bulbs mostly ...?

Existing LED Bulb Replacement Timing	2018
Sample Size	60
To replace L-E-D bulbs once they burn out	70%
To replace L-E-D bulbs that are still working	27%
Other	3%
Base: Respondents who purchased LED bulbs to replace existing LEDs bulbs The percentages shown are the percent of light bulbs purchased, not the percentage of respondents	

P3c/P4c. Concerning the L-E-D bulbs that you will use to replace existing non-L-E-D bulbs: do you plan on installing these bulbs mostly ...?

Non-LED Bulb Replacement Timing	2018
Sample Size	102
To replace non-L-E-D bulbs once they burn out	31%
To replace non-L-E-D bulbs that are still working	67%
Other	2%
Base: Respondents who purchased LED bulbs to replace non-LEDs bulbs	

P5. Why do you plan on replacing L-E-D bulbs that are still working?

Reason For Replacing Working LED Bulbs	2018
Sample Size	16 (#)
Dislike lighting of these bulbs	6
Back up bulbs	4
Want bulbs to match	2
Bulbs burn too fast	2
Dislike appearance of the bulbs	1
Don't know	1
Base: Respondents who purchased LED bulbs to replace existing LEDs bulbs that are still working	

AW1. Have you ever heard of the Efficiency Nova Scotia program that offers instant savings at the cash register for the purchase of energy efficient lighting, controls or appliances?

Instant Savings Awareness	2015	2016	2017	2018
Sample Size	255	246	100	194
Yes	69%	58%	63%	63%
No	31%	41%	36%	37%
Don't know	1%	1%	1%	-
Question wording change in 2018				

CS1. How did you find out about this program?

Sources of Awareness	2015	2016	2017	2018
Sample Size	175	142	63	123
In-store promotions	47%	40%	32%	37%
Radio ads	9%	11%	2%	15%
Store flyer	-	1%	11%	15%
TV ads	19%	12%	16%	14%
Word of mouth	11%	15%	13%	14%
Through an ENS representative during an in-store customer engagement event	2%	6%	10%	10%
Print ads	18%	14%	5%	9%
ENS website	9%	10%	13%	5%
Store personnel	6%	11%	-	5%
Online advertising	-	5%	5%	4%
Radio remote – live radio personalities at a local store	-	-	-	4%
Facebook or other social media	1%	7%	6%	3%
Someone visiting my home	-	-	-	3%
Through NS Power	-	-	-	2%
Billboards and other outdoor advertising	-	-	-	1%
Another ENS program	-	-	5%	-
Others	7%	2%	3%	2%
Don't know	1%	1%	-	1%
Base: Respondents who were aware of Instant Savings Multiple responses				

AW4. Besides the L-E-D bulbs/fixtures that you purchased today, are you aware of any other energy efficiency products that are discounted by Efficiency Nova Scotia as part of their Instant Savings program?

Aware of Other Discounted Products	2018
Sample Size	123
Yes	54%
No	46%
Don't know	1%
Base: Respondents who are aware of Instant Savings Responses do not sum to 100% due to rounding	

AW5. What are those products? Any others?

Other Products Discounted	2018
Sample Size	66
Programmable thermostats	23%
Power bars or Smart strips	18%
Dimmer switches	18%
Refrigerators	12%
Smart thermostats	12%
L-E-D fixtures*	12%
Heat pump	11%
L-E-D bulbs**	9%
Clothes washers	8%
Shower heads	5%
Motion sensors	5%
Clothes Line	5%
Hot water tank	3%
Dehumidifiers	3%
Air purifiers	2%
Heavy-duty timers	2%
Smart L-E-D	2%
Other	3%
Don't know	9%
Base: Respondents who are aware of other products discounted by Instant Savings *Mentioned by those who purchased LED bulbs **Mentioned by those who purchased LED fixtures Multiple responses	

FR0a. You bought L-E-Ds today. Efficiency Nova Scotia offered a discount on packages of L-E-Ds. Before paying at the cash register, were you aware that a discount was offered on the purchase of L-E-Ds?

FR0b. I just want to make sure I understand - You did not know about the discount on specific packages of L-E-Ds before paying at the register?

Discount Awareness	2015	2016*	2017	2018
Sample Size	255	246	100	163
Yes, was aware of discount before paying	79%	90%	94%	91%
No, was not aware of discount before paying	21%	10%	6%	9%
Base: Respondents who purchased LED bulbs				
*Slight wording change in 2016				

FR0c. Before the beginning of the rebate campaign, which began on September 28th, were you aware that discounts on L-E-Ds would be offered this fall?

Program Awareness	2016*	2017	2018
Sample Size	109	94	152
Yes, aware that discounts would be offered this fall	16%	15%	10%
No, not aware that discounts would be offered this fall	81%	82%	90%
Don't know	4%	3%	-
Base: Respondents who were aware of discount prior to purchase			
*Results are from 2016 fall campaign only			

FR0d. Did you postpone your purchase of L-E-Ds to take advantage of the rebate?

Postponed Purchase of LEDs to Take Advantage of Rebate	2016* (#)	2017 (#)	2018 (#)
Sample Size	17	14	15
Yes	12	5	10
No	5	9	5
Base: Respondents who were aware of discount prior to campaign beginning			
*Results are from 2016 fall campaign only			

FR0e. How did you learn about the discount offered on the purchase of specific packages of L-E-Ds?

Learn of Discount	2015	2016	2017	2018
Sample Size	201	221	94	152
In-store signage*	79%	66%	78%	77%
Store flyer	-	1%	9%	16%
Store personnel	18%	15%	16%	7%
TV ads	4%	3%	3%	5%
Word of mouth	4%	5%	1%	5%
Radio ads	3%	5%	-	3%
Print ads	8%	6%	1%	3%
Through an ENS representative during an in-store engagement event	1%	9%	6%	1%
Facebook/Social media	-	2%	-	1%
Radio remote – live radio personalities at a local store *	-	-	-	1%
Billboards and other outdoor advertising*	-	-	-	1%
Online advertisement	-	2%	1%	-
ENS website	2%	1%	-	-
From previous participation	-	1%	-	-
Others	-	-	1%	-
Don't know	-	-	2%	-
Base: Respondents who were aware of discount prior to purchase Multiple responses *Wording change in 2018				

FR0f. Did you see the stickers, shelf signs or posters in the light bulb section of the store promoting the discount offered on L-E-Ds?

In-store Promotion Awareness	2015	2016	2017	2018
Sample Size	201	221	94	152
Yes	90%	88%	94%	96%
No	10%	11%	5%	4%
Don't know	-	-	1%	-
Base: Respondents who were aware of discount prior to purchase				

FR1. You mentioned that you were aware, before paying at the cash register, that a discount is offered on the purchase of L-E-Ds. Did knowing this play a part in your decision to buy L-E-Ds today?

Discount Influenced Purchase	2015	2016	2017	2018
Sample Size	201	221	94	152
Yes	88%	87%	85%	88%
No	11%	12%	15%	13%
Don't know	-	1%	-	
Base: Respondents who were aware of discount prior to purchase Responses do not sum to 100% due to rounding				

FR2a. If the discount on L-E-Ds had NOT been offered today, what would you have bought today?
Would you have...?

Purchases if Discount Had Not Been Offered	2015	2016	2017	2018
Sample Size	201	221	94	152
Not bought any bulbs	70%	59%	55%	56%
Bought L-E-Ds anyway	26%	37%	38%	41%
Bought other type of bulbs	4%	4%	5%	2%
Don't know	-	-	1%	1%
Base: Respondents who were aware of discount prior to purchase				

FR2b. Which type(s) of bulb would you have purchased instead today?

Other Type of Bulb That Would Have Been Purchased	2015 (#)	2016 (#)	2017 (#)	2018 (#)
Sample Size	9	9	5	3
Halogen	2	3	2	-
Incandescent	2	2	1	3
CFLs	2	1	-	-
Others	-	1	1	-
Don't know	3	2	1	-
Base: Respondents who were aware of discount prior to purchase, and who would have bought another type of bulb if discount had not been offered				

FR3. How likely would you have been to buy the L-E-Ds that you purchased today 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 L-E-Ds” and a 10 indicating that you “Definitely Would Have Bought these L-E-Ds.”

Likelihood of Buying LEDs without Discount	2015		2016*		2017		2018	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Likelihood of buying LEDs if discount had not been offered	201	3.1	221	3.5*	94	4.2	152	4.5
Base: Respondents aware of discount prior to purchase Don't know/Refused excluded from calculations *Slight wording change in fall 2016								

FR4. If the discount had NOT been offered, when would you have purchased the L-E-Ds that you purchased today? Would it have been...?

Length of Time Before Purchasing LEDs	2015	2016	2017	2018
Sample Size	201	221	94	152
Earlier	-	-	-	1%
Definitely today	14%	16%	21%	18%
Probably today	8%	10%	9%	15%
Probably at a later date	30%	33%	32%	32%
Definitely at a later date	39%	39%	34%	32%
Would not have purchased them at all	8%	2%	4%	1%
Don't know	-	-	-	1%
Base: Respondents aware of discount prior to purchase				

FR5. Without the discount, would you have definitely purchased the same number of L-E-Ds, probably purchased the same number, probably purchased fewer or definitely purchased fewer?

Number of Bulbs Likely To Purchase Without Discount	2015	2016	2017	2018
Sample Size	184	216	90	150
Definitely the same number	20%	17%	24%	21%
Probably the same number	17%	13%	18%	20%
Probably fewer	14%	24%	30%	27%
Definitely fewer	47%	45%	28%	29%
Don't know	2%	1%	-	3%
Base: Respondents who were aware of discount prior to purchase, and would have purchased bulbs at some point without discount				

I1A. What type of L-E-Ds fixtures did you buy today? Was it...?

Type of LED Fixtures Purchased	2018
Sample Size	31
LED recessed fixture	19%
LED Fixture without motion sensors	84%
Base: Respondents who purchased LED fixtures Multiple response	

I1B2. How many L-E-D recessed fixtures did you purchase today?

Number of LED Recessed Fixtures Purchased	2018 (#)
Sample Size	6
1-2	3
3-4	1
5-7	-
8-10	1
11 or more	1
Average	4.7
Base: Respondents who purchased LED recessed fixtures	

I1C2. How many L-E-D fixtures did you purchase today?

Number of LED Fixtures Purchased	2018
Sample Size	26
1-2	58%
3-4	35%
5-7	8%
Average	2.4
Base: Respondents who purchased LED fixtures without motion sensors	

P0. Will the L-E-D fixture(s) you bought be installed indoor or outdoor?

Intended Location of Fixtures	2018
Sample Size	31
Indoor	94%
Outdoor	3%
Both	3%
Base: Respondents who purchased LED fixtures	

P1a/P1b. For which of the following reasons did you buy this/these L-E-D fixtures?

Reason for Purchasing LED Fixtures	2018
Sample Size	31
To replace a fixture that was still functional	49%
To install in a place that did not have a fixture before	45%
To replace a fixture that was broken	5%
Base: Respondents who purchased LED fixtures Responses do not sum to 100% due to rounding	

P2. What types of bulbs were installed in the fixtures that you plan on replacing?

Types of Bulbs in Replaced Fixtures	2018
Sample Size	24
Standard incandescent bulbs	42%
CFL bulbs	29%
LED bulbs	25%
Efficient incandescent bulbs	4%
Don't know	4%
Base: Respondents who replaced existing fixtures Multiple responses	

IN1. When shopping for your fixture, did you look at fixtures with L-E-D lighting only or did you look at fixtures with any type of lighting?

Types of Fixtures Considered	2018
Sample Size	31
Fixtures with L-E-D lighting only	87%
Fixtures with any type of lighting	13%
Base: Respondents who purchased LED fixtures	

IN2A. How important were the following aspects in your decision to purchase L-E-D fixture(s)? Please answer on a scale of 1 to 10, where 1 means “not at all important” and 10 means ‘very important’?

Importance of Factors in Purchase Decision	2018	
	Sample Size	Mean
Mean (1 = “Not at all important” 10 = “Very important”)		
The energy consumption of the fixture	31	9.2
The quality of light provided	30	9.0
The price of the fixture	31	8.9
The appearance or look of the fixture	31	8.5
Purchasing the same type of fixture throughout my entire home/uniformity	31	6.5
Base: Respondents who purchased LED fixtures Responses of don't know excluded from mean calculation		

IN3 While shopping for your fixture, did you find that L-E-D fixtures were as aesthetically pleasing as non-L-E-D fixtures? Were the L-E-D fixtures...?

Aesthetics of LED Fixtures	2018
Sample Size	28
Less aesthetic	7%
As aesthetic	64%
More aesthetic than non-L-E-D fixtures	25%
Noticed no difference	4%
Base: Respondents who rated the look or appearance of fixtures as important (>5)	

IN4. While shopping for your fixture, did you find that L-E-D fixtures provide...?

Light Quality of LED Fixtures	2018
Sample Size	29
Same quality light as non-L-E-D fixtures	24%
Better quality light than non-L-E-D fixtures	72%
Don't know	3%
Base: Respondents who rated the quality of light provided as important (>5) Responses do not sum to 100% due to rounding	

IN5. Efficiency Nova Scotia offered a discount on L-E-D fixtures today. Before paying at the cash register, were you aware that a discount was offered on the purchase of L-E-D fixtures?

Aware of Discount	2018
Sample Size	31
Yes	90%
No	10%
Base: Respondents who purchased LED fixtures	

IN6. On a scale of 0 to 10, where 0 means not at all influential and 10 means very influential, how influential were the following factors in your decision to purchase the L-E-D fixture that you purchased today?

Influence of Factors in Purchase Decision	2018	
	Sample Size	Mean
Mean (0 = “Not at all influential” 10 = “Very influential”)		
The in-store offer of L-E-D fixtures	31	8.0
In-store promotion on energy efficient lighting	31	7.6
The rebate on the purchase of the fixture provided by Efficiency Nova Scotia	28*	7.6
Energy efficiency information and promotion by Efficiency Nova Scotia	31	5.7
Advice/recommendation from a friend or family member	31	2.0
Advice/recommendation of a store salesperson	31	1.8
Base: Respondents who purchased LED fixtures		
*Respondents who purchased LED fixtures and were aware of the ENS discount before purchase		

D1. What type of residence do you live in?

Type of Home	2015	2016	2017	2018
Sample Size	255	246	100	194
Detached single-family house	80%	86%	74%	89%
Apartment or condo building that has fewer than five stories	4%	3%	11%	2%
Semi-detached house	7%	5%	10%	3%
Townhouse or duplex which shares adjacent walls	5%	1%	4%	2%
Mobile home or house trailer	2%	2%	1%	2%
Apartment or condo building that has five or more stories	2%	3%	-	3%

D2. Do you own or rent this residence?

Home Ownership	2015	2016	2017	2018
Sample Size	255	246	100	194
Own/buying	92%	92%	87%	91%
Rent/lease	8%	8%	13%	9%

D3. Do you or does your landlord pay the electric bills for your residence?

You Pay Electric Bills	2015	2016	2017	2018
Sample Size	21	18	13	17
I pay the electricity bill	95%	94%	69%	82%
My landlord pays the electricity bill	5%	6%	31%	18%
Base: Respondents who rent or lease their home				

D4. Gender

Gender	2015	2016	2017	2018
Sample Size	254	245	100	194
Male	59%	62%	53%	54%
Female	41%	38%	47%	46%
Refused excluded from calculations				

APPENDIX X

IS: UNITARY SAVINGS CALCULATIONS

This appendix presents the detailed calculations and assumptions used to establish the unitary savings for measures offered through Instant Savings.

LED Lamps

For this product, distinct unitary savings values were calculated for light-emitting diode (LED) A-type lamps, LED R, BR and decorative lamps and other LED non-A-type lamps sold through Instant Savings, based on the fact that R, BR and decorative lamps replace incandescent lamps, other non-A-types replace halogen lamps, and A-types replace both incandescent and compact fluorescent lamps (CFL). The three unitary savings values were determined by the use of the general lighting equation (Equation 1):

$$\text{Annual Unitary Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{\text{Displaced Wattage [W]} \times \text{HOU} \left[\frac{\text{h}}{\text{day}} \right] \times 365 \left[\frac{\text{day}}{\text{yr}} \right]}{1,000 \left[\frac{\text{W}}{\text{kW}} \right]} \quad (1)$$

As part of the 2018 evaluation, the Evaluator revised the displaced wattages for the three lamp categories and validated that the hours of operation value is still appropriate.

Displaced Wattage

The average displaced wattage values for the three lamp categories are established for two types of baselines: early replacement and replace on burn-out baselines. This methodology is recommended in the principles of the Uniform Methods Project (UMP)²² to better represent the real baseline wattage for LED lamps.

Questions were included in the 2018 intercept survey to collect the following information:

- › Do participants mostly replace lamps that are still in working condition (early replacement) or do they replace burned out lamps (replace on burn-out)?
- › When participants replace lamps that are still in working condition, what types of lamps are replaced?

These two questions are essential to establishing the baselines because they correspond to the least efficient lamps that would have been used if the program component had not been offered.

These questions were included in the fall campaign intercept survey, and the answers obtained are summarized in Table 32 below.

²² National Renewable Energy Laboratory, *Uniform Methods Protocol Chapter 6: Residential Lighting Evaluation Protocol*, February 2014, pp. 6-20.

Table 32: Results of the Intercept Survey for Establishing the LED Lamp Baselines

Question	Number of Respondents	Number of Lamps	Percentage of Lamps
Do you plan on installing these LED bulbs...²³			
To replace bulbs once they burn out?	72	491	41%
To replace bulbs that are still working?	82	721	59%
For respondents who are replacing working bulbs: How many, if any, of these LED bulbs will be used to replace...²⁴			
LED lamps	16	180	25%
CFLs	28	236	33%
Efficient incandescent lamps	7	59	8%
Standard incandescent lamps	38	233	33%
Total	89	708	100%²⁵

In light of these findings, two types of baselines were defined.

Early Replacement Baseline: The survey revealed that 59 percent of LED lamps purchased by participants replaced working lamps. Since those lamps were assumed to have an average remaining useful life of at least one year, the applicable baseline wattage was assumed to be that of the early replacement baseline and was calculated based on the following two elements:

- › The proportion of every type of lamp being replaced, based on the results of the intercept survey.
- › The average wattage of LED lamps purchased, which was converted into equivalent CFL, efficient incandescent and standard incandescent wattages, as applicable, according to the type of lamp being replaced.

The equivalent efficient incandescent, standard incandescent, and CFL wattage values were obtained by researching the recommended equivalencies for the 10 most popular products for each category of LED lamps. The Evaluator applied a conversion factor to the equivalent standard incandescent wattage to obtain the equivalent wattage of CFLs. In the case of LED lamps replacing other LED lamps, the wattage of the LED lamps replaced was considered to be the same wattage as that of the LED lamps sold through Instant Savings, thereby resulting in a displaced wattage of 0 W.

²³ 15 participants, or 9 percent of total respondents, answered, “Don’t know” or did not answer. Their answers were excluded from the calculations.

²⁴ 13 bulbs were used for a new fixture, or for some other reason, and were excluded from the calculation of the percentage of lamps for each option.

²⁵ Sum of answers may not add up to 100 percent due to rounding.

The Evaluator assumed that the LED lamps replacing LED lamps were A-type lamps since it is unlikely that non-A-type lamps reached the end of their life considering their recent appearance on the market. In addition, no other technology than incandescent and LED is available to replace R, BR and decorative lamps, so it was assumed that all these lamp types replaced incandescent lamps. Since other non-A-type lamps are only available in halogen and LED, it was also assumed that all LED lamps replaced halogen lamps for this product category. Therefore, the percentages of all replaced lamps obtained with the survey results were assigned to A-type lamps.

The wattage calculation details are presented in Table 33 below.

Table 33: Wattage Calculations for the Early Replacement Baseline

Purchased LED lamps		Replaced Lamps									
LED Product Category	Average Wattage	Standard Incandescent		Efficient Incandescent		CFL		Halogen		LED	
		Average Wattage	%	Average Wattage	%	Average Wattage	%	Average Wattage	%	Average Wattage	%
LED A-type Lamps	9.2	60.4	33%	43.3	8%	13.1	33%	-	-	9.2	25%
LED Non-A-type Lamps (R, BR and Decorative)	6.2	48.0	100%	-	-	-	-	-	-	-	-
LED Non-A-type Lamps (excluding R, BR and Decorative)	6.8	-	-	-	-	-	-	51.5	100%	-	-

Based on the above calculations, the baseline wattages for the early replacement scenario were established at 30.2 W for LED A-type, 48.0 W for R, BR and decorative lamps, and 51.5 W for the other LED non-A-type lamps.

Replace On Burn-out Baseline: For the 41 percent of LED lamps that replaced burned out lamps, it was assumed that participants would have purchased lamps meeting the current Canadian federal energy efficiency regulation on general service lamps. Again, for all three product categories, the 10 most popular LED lamp models were used for savings calculations. For each of these models, the wattage of the minimal efficiency lamp was defined, which was in turn used to calculate the weighted average equivalent wattage for each lamp category.

To determine the wattage of equivalent minimal-efficiency lamps, the Evaluator considered the current federal regulation on general service lamps.²⁶ Currently, this regulation does not cover LED non-A-type lamps, which resulted in the displaced wattages of both scenarios being equal for these lamps.

The replace on burn-out baseline was therefore defined as follows in Table 34.

²⁶ Natural Resources Canada, *General Service Lamps*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869> (Last accessed November 1, 2018).

Table 34: Replace On Burn-out Baseline by LED Lamp Type

LED Lamp Type	Baseline Technology
A	Efficient incandescent as per Federal Regulations on General Service Lamps
GU	Standard halogen
PAR	Standard halogen
R and BR	Standard incandescent
Decorative	Standard incandescent

The resulting replace on burn-out baseline wattages, based on the weighted average of the equivalent wattage for each of the 10 most popular LED lamp models, were established at 43.3 W for A-type lamps, 48.0 W for R, BR and decorative lamps, and 51.5 W for other non-A-type lamps.

Table 35 below outlines the overall displaced wattages for all categories of LED lamps.

Table 35: Calculations for Displaced Wattages

	Proportion	Baseline Wattage (W)	LED Lamp Wattage (W)	Displaced Wattage (W)
LED A-type Lamps				
Early Replacement Scenario	59%	30.2	9.2	21.0
Replace On Burn-out Scenario	41%	43.3	9.2	34.1
Total LED A-type Lamps	100%	35.5	9.2	26.3
LED Non-A-type Lamps (R, BR and Decorative)				
Early Replacement Scenario	59%	48.0	6.2	41.8
Replace On Burn-out Scenario	41%	48.0	6.2	41.8
Total LED Non-A-type Lamps (R, BR and Decorative)	100%	48.0	6.2	41.8
LED Non-A-type Lamps (excluding R, BR and Decorative)				
Early Replacement Scenario	59%	51.5	6.8	44.7
Replace On Burn-out Scenario	41%	51.5	6.8	44.7
Total LED Non-A-type Lamps (excluding R, BR and Decorative)	100%	51.5	6.8	44.7

As shown in Table 35, the overall displaced wattages for LED A-type lamps, LED R, BR and decorative lamps, and other LED non-A-type lamps were established at 26.3 W, 41.8 W and 44.7 W respectively.

Hours of Operation

The value for the daily hours of operation is based on the Northeast Residential Lighting Hours-of-Use Study (NERHOU)²⁷ study, which found that the average usage is 2.9 hours per day for efficient bulbs without the snapback effect.²⁸

The Residential Lighting Evaluation Protocol of the UMP 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 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 its data and findings are closely aligned with the Evaluator's metering study margin of error, the Evaluator decided that the values established by NERHOU are still the most appropriate values for the LED lamps installed through Instant Savings. Again for 2018, the Evaluator used the average hours of operation value for efficient lamps without the snapback value, which is 2.9 hours per day.

In-service Rate

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 bulbs purchased in a recent 12-month period that are installed 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 using all bulbs regardless of the time of purchase."

The Evaluator conducted research and found that 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 percent, with four in-service rates being 95 percent or higher.

The UMP also mentions three main factors that cause in-service rates to be below 100 percent, namely (1) deeply discounted prices, (2) inclusion of LED multipacks, and (3) consumers waiting for bulbs to burn out before replacing them. Despite the rebate offered and the large majority (95%) of LED lamps purchased through Instant Savings in 2018 being in packs of two or more, the Evaluator considers unlikely that most of the LED lamps purchased are left unused since more than half of the participants (53%) interviewed during the fall campaign intercept survey mentioned that they purchased lamps to replace lamps that still work. The Evaluator also believes that it would not be accurate to use an in-service rate from a program that has different conditions than Instant Savings.

²⁷ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

²⁸ The snapback effect is an increase in usage following the installation of an efficient product because the operating cost is lower.

Moreover, first-year in-service rates mean that the LED lamps will be installed later, not that they will not be installed at all. Therefore, if an in-service rate is applied to LED lamp savings, a discount rate should also be applied on the savings removed by the in-service rate to claim the savings that will occur in the future. The Evaluator believes that the deduction of savings is too small to be considered.

For the above-mentioned reasons, the Evaluator decided not to apply an in-service rate to LED lamps and to claim all savings in the year during which the LED lamps were purchased.

Unitary Savings

The unitary savings values were revised according to the displaced wattage of 26.3 W for LED A-type lamps, 41.8 W for R, BR and decorative lamps, and 44.7 W for other LED Non-A-type lamps. The estimated hours of operation remained at 2.9 hours per day. Using the general lighting equation, the unitary savings values for LED A-type lamps, LED R, BR and decorative lamps, and other LED Non-A-type lamps were established at 27.8 kWh, 44.2 kWh and 47.3 kWh respectively.

LED Recessed Downlight Fixtures

The unitary savings value for recessed downlight fixtures sold through Instant Savings is obtained from the general lighting equation (Equation 1).

Displaced Wattage

To establish the displaced wattage of each category of lighting fixture offered under Instant Savings, the Evaluator identified the 10 best-selling models in the 2018 tracking sheet. Wattage value data of these models, as well as their incandescent or halogen wattage equivalents, were then gathered from the participating retailers' websites (as recommended by manufacturers). These values were then converted into wattage values that meet the current Canadian energy efficiency regulation for general service lamps.

The 10 best-selling models of LED recessed downlight fixtures represent over 82 percent of all recessed LED lamps sold. Most fixtures house reflector lamps for which the baseline is a halogen lamp. Some LED downlight fixtures house E27 type lamps; since this type is not covered by the Canadian energy efficiency regulation, the baseline used was the recommended equivalent incandescent wattage.

The analysis indicated that the average wattage value for these fixtures is 10.3 W and the average equivalent wattage for the replaced halogen and incandescent lamps is 61.5 W. As a result, the displaced wattage was established at 51.2 W.

Hours of Operation

Similar to LED lamps, the Evaluator concluded that the hours of operation value of LED lamps from the 2014 NERHOU Study (2.9 h/day) is still valid for LED recessed downlight fixtures and all other types of LED fixtures sold through Instant Savings, with the exception of those equipped with motion sensors (which are covered in the next subsection).

Unitary Savings

Using the general lighting equation with the displaced wattage of 51.2 W and the hours of operation value of 2.9 hours per day, the unitary savings value for LED recessed downlight fixtures was revised at 54.2 kWh per year.

ENERGY STAR Certified LED Fixtures Without a Motion Sensor

The unitary savings value associated with ENERGY STAR certified LED fixtures without a motion sensor is obtained from the general lighting equation (Equation 1).

Displaced Wattage

The Evaluator selected the 10 most popular models, which represent 70 percent of all 2018 ENERGY STAR certified LED fixtures without motion sensor sales. Some of those fixtures were used to replace fluorescent lamps. In these cases, a ballast factor of 0.88 was applied to the fluorescent wattage equivalent found on participating retailers' websites. The other selected fixtures replaced general-use lamps. For some fixtures using general-use lamps, information concerning the equivalent wattage was not available. The Evaluator therefore used the light output measured in lumens found on ENERGY STAR or manufacturer websites and used a table from the ENERGY STAR website to establish the equivalent incandescent wattage (see Table 36 below). Then, the equivalent incandescent wattage was converted by using the current energy efficiency regulation requirements for general service lamps.

Table 36: ENERGY STAR Certified Lamp Light Output Equivalency to Incandescent Lamp Wattage²⁹

Old Incandescent Lamps (W)	ENERGY STAR Certified Lamp Light Output (Lumens)
40	450
60	800
75	1,100
100	1,600
150	2,600

For fixtures replacing halogen lamps, which is the case for one of the ten selected models, information on equivalent wattage was available in manufacturer product descriptions.

²⁹ ENERGY STAR, *Learn About Brightness*, https://www.energystar.gov/products/lighting_fans/light_bulbs/learn_about_brightness (Last accessed December 21, 2018).

This analysis indicated that, for new LED fixtures without a motion sensor, the average wattage value is 19.3 W and the average equivalent wattage is 82.1 W. Thus, the displaced wattage was established at 62.8 W.

Unitary Savings

Using the displaced wattage of 62.8 W and hours of use of 2.9 h/day, the unitary savings value for ENERGY STAR certified LED fixtures not equipped with a motion sensor was revised at 66.5 kWh per year.

ENERGY STAR Certified LED Fixtures Equipped With a Motion Sensor

The unitary savings value associated with ENERGY STAR certified LED fixtures equipped with a motion sensor was determined by using the general lighting equation (Equation 1).

Displaced Wattage

The Evaluator analyzed all eight models of ENERGY STAR certified LED fixtures equipped with a motion sensor sold through Instant Savings. The Evaluator found that 79 percent of these fixtures housed lamps that replaced halogen lamps, while 21 percent of them replaced incandescent lamps. The methodology used for determining equivalent wattages of LED fixtures equipped with a motion sensor is the same as for those not equipped with such sensors.

The analysis concluded that the average wattage value for new LED fixtures is 29.7 W and the average equivalent wattage is 151.5 W. Using these values, the displaced wattage was established at 121.8 W.

Hours of Operation

The Evaluator did not identify any new metering study that reported the hours of use associated with motion sensors in residential settings for outdoor or indoor usage. Hence, the Evaluator again applied the hours of use values recommended for the Indoor Motion Sensors and Outdoor Motion Sensors products listed below.

For 2018, the Evaluator found that 84 percent of LED fixtures equipped with a motion sensor are designed for outdoor usage and the remaining 16 percent for indoor usage. Since indoor and outdoor motions sensors do not have the same hours of use values, the Evaluator calculated a weighted average for the old and new hours of operation values.

For LED fixtures installed outdoors, the old and new hours of operation used are 4.75 and 2.95 hours per day respectively. For indoor LED fixtures, the values for the old and new operating times are 2.7 and 1.24 hours per day respectively.

By using the percentage of indoor and outdoor LED fixtures, the values of 4.43 and 2.68 hours per day were established for the old and new hours of operation respectively.

Unitary Savings

To establish the unitary savings for ENERGY STAR certified LED fixtures equipped with a motion sensor, the following formula (Equation 2) was used:

$$\text{Annual Unitary Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{\left(\text{Wattage}_{old} [W] \times \text{HOU}_{old} \left[\frac{\text{hrs}}{\text{day}} \right] - \text{Wattage}_{new} [W] \times \text{HOU}_{new} \left[\frac{\text{hrs}}{\text{day}} \right] \right) \times 365 \left[\frac{\text{day}}{\text{yr}} \right]}{1,000 \left[\frac{W}{kW} \right]} \quad (2)$$

Using the aforementioned wattage and hours of operation values, the unitary savings for ENERGY STAR certified LED fixtures equipped with a motion sensor was established at 216 kWh.

Dimmer Switches

The unitary savings value for dimmer switches is based on the general lighting equation. The daily HOU are based on the NEHROU metered value of 2.7 hours per day for all types of bulbs. The baseline fixture wattage value is equal to two 43 W lamps, based on the Canadian regulation that came into effect on January 1, 2015, according to which the wattage of general-service lamps with a luminous flux in the range of 750 and 1,050 lumens must not exceed 43 W. This wattage value is used for the replacement of 60 W incandescent lamps because these lamps have a light output of about 800 lumens.³⁰ The Evaluator considers this value more representative of the various bulb types that are controlled by dimmers and installed in Nova Scotian houses in 2018.

The dimmed wattage is calculated by reducing the wattage value by 20 percent based on the OPA 2011 Prescriptive Measures and Assumptions.³¹ A unitary savings value of 17.0 kWh was thereby established for dimmer switches.

Indoor Motion Sensors

As for dimmer switches, the controlled wattage is considered equal to two 43 W bulbs. For all types of bulbs, the old operating time is 2.7 hours per day in conformity with the NEHROU Study.³² Using a 54 percent reduction in operating time due to the motion sensor, based on the 2010 OPA Prescriptive Measures and Assumptions list,³³ the new operating time is set at 1.24 hours per day. Therefore, the unitary savings value was established at 45.8 kWh for indoor motion sensors.

³⁰ U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, *Lumens and the Lighting Facts Label*, <http://energy.gov/energysaver/lumens-and-lighting-facts-label> (Last accessed December 8, 2015).

³¹ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

³² NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

³³ Ontario Power Authority (OPA), *2010 Prescriptive Measures and Assumptions*, released on January 1, 2010.

Indoor Motion Sensor with Dimmer Switches

The calculation of the unitary savings value for indoor motion sensors with dimmer switches is based on the combined savings associated with the installation of both a dimmer switch and motion sensor. As established previously, the dimmer reduces the lamp wattage by 20 percent and the motion sensor reduces the daily HOU by 54 percent. Considering a baseline fixture wattage equal to two 43 W bulbs and a baseline daily HOU value of 2.7 hours per day, the unitary savings value was established at 53.6 kWh.

Outdoor Motion Sensors

The unitary savings value of 159 kWh for outdoor motion sensors is based on the OPA 2011 Prescriptive Measures and Assumptions,³⁴ which assumes that the old operating time is 4.75 hours per day and the new operating time is 2.95 hours. The displaced wattage is calculated with the following assumptions: 85 percent of outdoor lighting is for security spotlights with an average wattage of 275.6 W³⁵ and the remaining 15 percent is for porch lighting, which has an average wattage of 55.5 W. Therefore, the average displaced wattage was estimated at 242.6 W.

Power Bars With Integrated Timers

Table 37 below presents the parameters used to calculate the annual 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,³⁶ with a minor adjustment to the number of days used per year, namely the total 12-month period was set at 365 days instead of 12 times 30 days (360 days). Therefore, the unitary savings value for power bars with integrated timers was estimated at 53.7 kWh, as indicated in the table below.

³⁴ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

³⁵ Representative lamp mix: $(85\% \times 2 \times 150 \text{ W incandescent}) + (10\% \times 2 \times 90 \text{ W halogen}) + (5\% \times 2 \times 26 \text{ W CFL}) = 275.6 \text{ W}$.

³⁶ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

Table 37: Unitary Savings Calculations 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 h/day	14 h/day	6 h/day	11 h/day
New Operating Time – with Timer	5 h/day	8 h/day	3 h/day	4 h/day
Operating Season	12 months	12 months	8.5 months	8.6 months
Number of Days	365	365	259	262
Calculated Unitary Savings (kWh/year)	55.6	61.3	46.5	51.3
Weighted Unitary Savings	53.7 kWh			

Load Sensing Power Bars (Smart Strips)

The annual unitary savings value for load sensing power bars sold through Instant Savings is based on the information provided in the 2016 Pennsylvania Public Utility Commission Technical Reference Manual (TRM),³⁷ which cites documents produced by the New York State Energy Research and Development Authority (NYSERDA) and Energy Center of Wisconsin.³⁸

The unitary savings values presented in the 2016 Pennsylvania TRM version are respectively 48.9 and 58.7 kWh for five-plug and seven-plug power bars purchased for unspecified use. According to the 2018 Instant Savings spring campaign tracking sheet, 98 percent of power bars sold had seven plugs or more. Therefore, the annual unitary savings value for load sensing power bars was determined to be 58.7 kWh.

Heavy-Duty Outdoor Timers

For heavy-duty outdoor timers, the unitary savings value of 122 kWh is based on the results of the OPA 2012 Consumer Program Evaluation.³⁹ The survey conducted for this 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.

³⁷ Pennsylvania Public Utility Commission, *Technical Reference Manual*, February 2017.

³⁸ 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.

³⁹ Research into Action, *Final Report: 2012 Consumer Program Evaluation*, Report presented to OPA, October 11, 2013, p. 154.

Programmable Thermostats

The results from the Hydro-Québec 2009 program evaluation of electronic thermostats in residential new construction⁴⁰ were used to establish the annual unitary savings value for programmable thermostats. This study obtained the most accurate savings since a billing analysis was conducted. In this study, the values include energy savings generated by the thermostat's accuracy performance and temperature setback for three types of dwellings (single-detached units, duplex/triplex/townhouses, and apartments). The unitary savings value was calculated through a weighted average based on the proportion of each dwelling type in Nova Scotia's residential market, as defined in the 2011 Efficiency Nova Scotia Corporation (ENSC) Socket Study.

As outlined in Table 38, a unitary savings value of 221 kWh per year was established.

Table 38: Unitary Savings Calculations for Programmable Thermostats

Calculation Parameters	Housing Type		
	Single-detached	Duplex/Triplex/Townhouse	Apartment
Proportion of Each Dwelling Type ⁴¹	70.4%	10.6%	19.0%
Gross Energy Savings per Thermostat			
Unitary Savings for Electronic Thermostat Accuracy	121 kWh	94 kWh	61 kWh
Unitary Savings for Temperature Setback	100 kWh	201 kWh	118 kWh
Total Savings per Dwelling Type	221 kWh	295 kWh	179 kWh
Average Weighted Value	221 kWh		

Clotheslines and Outdoor Drying Racks

The following equation is used to establish the unitary savings associated with clotheslines and outdoor drying racks offered through Instant Savings:

$$\begin{aligned}
 \Delta kWh \left[\frac{kWh}{year} \right] &= Annual \text{ Laundry Loads } \left[\frac{load}{year} \right] \\
 &\quad \times Proportion \text{ of Loads Dried on Clothesline or Outdoor Drying Racks } [\%] \\
 &\quad \times Energy \text{ Consumption per Load } \left[\frac{kWh}{load} \right]
 \end{aligned}$$

⁴⁰ Econoler, *Évaluation du programme thermostats électroniques – Volet nouvelle construction au marché résidentiel*, Final Report presented to Hydro-Québec, February 9, 2009.

⁴¹ Statistics Canada, 2011 Nova Scotia census data.

The Evaluator conducted a literature review to establish the average annual number of loads of laundry per household and Table 39 below summarizes the findings. The Hydro-Québec study is the most appropriate, due to its large sample size, to estimate the laundry habits of consumers who purchased clotheslines or outdoor drying racks through Instant Savings. Therefore, the value for annual loads of laundry per household is 290 for all types of participants.

Table 39: Literature Review Findings Summary for Average Annual Loads of Laundry per Household

Source	Study Sample Size	Annual Number of Loads
OPA, 2011 ⁴²	N/A	416
Hydro-Québec, 2011 ⁴³	255,709	290
Natural Resources Canada, 2011 ⁴⁴	6,000	213
2014 Residential Direct Install Evaluation Report ⁴⁵	500	233

Furthermore, pursuant to the literature review, the Evaluator based the proportion of displaced loads and the energy savings per load on the values found in the OPA 2011 Measures List and Assumptions.⁴⁶ Therefore, the unitary savings value is 104 kWh for clotheslines and outdoor drying racks offered through Instant Savings.

Efficient Refrigerators

For efficient refrigerators, the unitary savings value is determined by comparing the standard and efficient refrigerator energy consumption values.

As part of the 2018 evaluation, the Evaluator selected the 10 most popular models of refrigerators sold through Instant Savings for 2018; these models constitute 65 percent of all 2018 Instant Savings refrigerator sales.

The annual energy consumption of each model was retrieved from the ENERGY STAR website.⁴⁷ Using this data, the weighted average energy consumption value of efficient refrigerators was established at 394 kWh.

⁴² Ibid.

⁴³ Ad Hoc Recherche. *Marché résidentiel: Rapport d'évaluation. Programme: Produits Mieux Consommer – Électroménagers Energy Star*. September 2011.

⁴⁴ Calculated by the Evaluator based on data presented in: Natural Resources Canada, *2011 Survey of Household Energy Use Data Tables*, <http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=SH&sector=aaa&juris=ca&rn=35&page=1> (Last accessed November 21, 2018).

⁴⁵ Econoler, *Residential Direct Install 2014 DSM Evaluation*, February 2015.

⁴⁶ Ontario Power Authority (OPA), *OPA Prescriptive Measures and Assumptions List*, December 2010.

⁴⁷ ENERGY STAR, *ENERGY STAR Certified Residential Refrigerators*, <https://www.energystar.gov/productfinder/product/certified-residential-refrigerators/> (Last accessed December 6, 2018).

To determine the standard refrigerator energy consumption, the average maximum annual energy consumption based on the type of refrigerator and the adjusted volume calculated for the 10 most popular models were considered and an average energy consumption value of 439 kWh was established.

Therefore, the unitary savings value for efficient refrigerators was estimated at 45 kWh per year.

Efficient Clothes Washers

For efficient clothes washers, the unitary savings value was determined by comparing the standard and efficient clothes washer annual energy consumption values. These energy consumption values were determined by using the following equation:

$$\text{Clothes Washer Consumption} = \frac{\frac{\text{Loads}}{\text{Year}} * \text{Capacity}}{\text{IMEF}}$$

As part of the 2018 evaluation, the Evaluator identified the 10 most popular models sold through Instant Savings in the tracking sheet. These models constitute 92 percent of all 2018 Instant Savings clothes washer sales. For each of the selected models, the Evaluator established the Integrated Modified Energy Factor (IMEF)⁴⁸ and capacity by consulting the ENERGY STAR Certified Clothes Washers database.⁴⁹

In the above equation, capacity is the volume of clothes washers in litres and the number of loads per year is assumed to be 290, which is based on a survey conducted to evaluate Hydro-Québec's ENERGY STAR certified appliances program. For efficient washers, the weighted average based on the frequency of each model yielded an IMEF value of 83.4 L/kWh/cycle and a capacity of 127 L. Therefore, the annual consumption value for efficient models was established at 442 kWh.

To estimate the baseline consumption of standard clothes washers, the Evaluator used the same capacity as for efficient clothes washers and established the average IMEF values of non-ENERGY STAR Most Efficient 2017 clothes washers (excluding compact models) using the Natural Resources Canada Energy Efficiency Ratings directory from January 2019.⁵⁰ Using the IMEF value of 56, the number of loads per year of 290 and the capacity of 127 L, the annual consumption for standard clothes washers was established at 658 kWh.

⁴⁸ The new Canadian regulations now use IMEF as a measure of energy efficiency instead of MEF.

⁴⁹ ENERGY STAR, *ENERGY STAR Certified Residential Clothes Washers*, <https://www.energystar.gov/productfinder/product/certified-clothes-washers/> (Last accessed December 21, 2018).

⁵⁰ 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 December 21, 2018).

Both energy consumption values take into account neither 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 was broken down for each stage of the washing process, as presented in Table 40, to apply correction factors separately at each stage.

Table 40: Energy Consumption Breakdown for Standard and Efficient Clothes Washers

Energy Consumption Breakdown for Clothes Washers	Proportion of Overall Consumption ⁵¹	Standard Clothes Washer Electricity Consumption (kWh)	Efficient Clothes Washer Electricity Consumption (kWh)
Water Heating System	24.8%	163	110
Clothes Dryer	68.1%	448	301
Clothes Washer Drum	7.1%	47	31
Total	100.0%	658	442

To estimate the savings attributable to water heating system energy consumption, the Evaluator calculated the percentage of electrically heated water, as presented in Table 41 below. First, the percentage of non-ENERGY STAR Most Efficient 2017 clothes washers with an internal electrical heater was obtained from the Energy Efficiency Ratings directory. This same percentage was applied to efficient clothes washers. Where an internal heater was present, it was assumed that 100 percent of the water heating savings were to be claimed.

For clothes washers using a domestic hot water (DHW) tank as heating source, the proportion of electrical DHW tanks in Nova Scotia was 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 was established by using data (not yet published) provided by NRCan.

Table 41: 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	35%	-	-	35.0%
DHW Tank	65%	Electrical	67%	43.6%
		Non-electrical	33%	21.4%

By adding the proportion of internal electrical heaters to the proportion of electrical DHW tanks, the proportion of electrical water heating was established at 78.6 percent of total water heating energy consumption by clothes washers.

⁵¹ Ad Hoc Recherche, *Rapport d'évaluation, Programme : Produits Mieux Consommer – Électroménagers Energy Star (Années 2008 et 2009)*, p. 18.

For water heating consumption, an adjustment factor for cold water washing was applied. Thus, to account for the usage of cold water for washing, the water heating energy consumption value was multiplied by a factor of 0.67 (1-33% = 67%), which is based on a survey conducted by Hydro-Québec.⁵²

Table 42 and Table 43 present the calculations of the total electricity consumption for both standard and efficient clothes washers.

Table 42: Electricity Consumption for Standard Clothes Washers

Energy Consumption Component	Energy Consumption	Electricity Consumption (kWh)	Adjustment Factor	Adjusted Electricity Consumption (kWh)
Water Heating System	163	128	0.67	86
Internal Clothes Dryer	448	448	-	448
Washing Machine Drum	47	47	-	47
Total	658	623	-	581

Table 43: Electricity Consumption for Efficient Clothes Washers

Energy Consumption Component	Energy Consumption (kWh)	Electricity Consumption (kWh)	Adjustment Factor	Adjusted Electricity Consumption (kWh)
Water Heating System	110	86	0.67	58
Internal Clothes Dryer	301	301	-	301
Washing Machine Drum	31	31	-	31
Total	442	418	-	390

Therefore, the average electricity consumption value was established at 581 kWh for a standard clothes washer and 390 kWh for an efficient clothes washer. As a result, the unitary savings were established at 191 kWh.

ENERGY STAR Certified Room Air Purifiers

For ENERGY STAR certified room air purifiers, the unitary savings value is determined by using the following equation:

$$\begin{aligned}
 \text{Unitary Savings } \left[\frac{\text{kWh}}{\text{year}} \right] &= \left[\text{CADR} \left[\text{CADR} \right] \times \left(\frac{1}{\text{EF}_{\text{base}}} - \frac{1}{\text{EF}_{\text{eff}}} \right) \left[\frac{\text{W}}{\text{CADR}} \right] \times \text{Hours} \left[\frac{\text{hours}}{\text{year}} \right] \right. \\
 &\quad \left. + (\text{SBP}_{\text{base}} - \text{SBP}_{\text{eff}}) [\text{W}] \times (8,760 - \text{Hours}) \left[\frac{\text{hours}}{\text{year}} \right] \right] \times \frac{1 \text{ kW}}{1,000 \text{ W}}
 \end{aligned}$$

⁵² Ad Hoc Recherche, *Rapport d'évaluation, Programme : Produits Mieux Consommer – Électroménagers Energy Star (Années 2008 et 2009)*, p. 19.

Where:

- › CADR: Clean Air Delivery Rate (CADR)⁵³
- › EFbase: Efficiency for baseline unit (CADR/W)
- › EFeff: Efficiency for efficient unit (CADR/W)
- › Hours: Annual operating hours (hours/year)
- › SBPbase: Standby power for baseline unit (W)
- › SBPeff: Standby power for efficient unit (W)

The value for annual operating hours is 5,840 hours per year (16 hours per day all year long), a value drawn from the Savings Calculator for ENERGY STAR Qualified Appliances.

Currently, the Canadian government has no minimum requirements for room air purifiers. Efficiency and standby power values of one clean air delivery rate (CADR) per watt and one watt respectively are used for the baseline units, which are values based on the Savings Calculator for ENERGY STAR Qualified Appliances commonly used by other jurisdictions.

As part of the 2018 evaluation, the Evaluator calculated a weighted average CADR efficiency and standby power based on all models sold through Instant Savings by using the ENERGY STAR list of compliant models⁵⁴ (which provides the energy data of these products) and the December tracking sheet. The efficient case average CADR, efficiency, and standby power were established at 135 CADR, 2.9 CADR per watt, and 0.33 W respectively. With annual operating hours of 5,480 hours per year, the annual consumption of an ENERGY STAR certified air purifier was established at 273 kWh.

Using a 135 CADR, an efficiency of 1 CADR per watt, a standby power of 1 W, and annual operating hours of 5,840 hours per year, the annual consumption of a standard air purifier was established at 791 kWh.

The Evaluator therefore used unitary savings of 518 kWh per year for the room air purifiers sold.

⁵³ CADR is a widely used measure for room air purifier performance. This metric was developed by the Association of Home Appliance Manufacturers (AHAM) and is measured according to the ANSI/AHAM AC-1 test protocol. It is the rate of particulate contaminant reduction in the test chamber when the room air purifier is turned on, minus the rate of natural decay when the unit is not running, times the volume of the test chamber.

⁵⁴ ENERGY STAR, *Certified Products – Find and Compare Products – Room Air Cleaners*, <https://www.energystar.gov/productfinder/product/certified-room-air-cleaners/> (Last accessed December 20, 2018).

ENERGY STAR Certified Dehumidifiers

For ENERGY STAR certified dehumidifiers, the unitary savings value is determined by using the following equation:

$$\begin{aligned}
 \text{Unitary Savings } \left[\frac{\text{kWh}}{\text{year}} \right] &= \left(\text{Average Water Removal Volume } \left[\frac{\text{L}}{\text{day}} \right] \times \text{Average Operating Days } \left[\frac{\text{days}}{\text{year}} \right] \right) \\
 &\times \left(\frac{1}{\text{Energy Factor Standard Dehumidifier}} - \frac{1}{\text{Energy Factor ENERGY STAR Dehumidifier}} \right) \left[\frac{\text{kWh}}{\text{L}} \right]
 \end{aligned}$$

An average water removal volume of 3.87 L/day and an average of 168 operating days per year were used for the savings calculation, based on the 2011 OPA Prescriptive Measures and Assumptions report.⁵⁵

As part of the 2018 evaluation, the Evaluator used the December tracking sheet and the list of products displaying the ENERGY STAR label⁵⁶ (which provides the energy factor of these products) to establish a weighted average water removal capacity⁵⁷ of 24.8 L/day based on all dehumidifier models purchased through Instant Savings.

Since October 2012, Canadian regulations⁵⁸ have required a minimum energy factor of 1.6 L/kWh for dehumidifiers with a rated water removal capacity between 21.3 and 25.5 L/day. Therefore, the Evaluator used 1.6 L/kWh for the standard unit energy factor.

ENERGY STAR certified dehumidifiers on the Canadian market with a water removal capacity of less than 35.5 L/day has an energy factor of 2.00 L/kWh or higher, as indicated in the ENERGY STAR guidelines for dehumidifiers.⁵⁹ All the models sold through Instant Savings had an energy factor of 2.00 L/kWh. Therefore, the Evaluator used 2.00 L/kWh for the efficient unit energy factor.

Then, a unitary savings of 81.3 kWh per year was established for dehumidifiers sold through Instant Savings.

⁵⁵ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions, Released Version 1*, March 2011.

⁵⁶ ENERGY STAR, *Certified Products – Find and Compare Products – Dehumidifiers*, <https://www.energystar.gov/productfinder/product/certified-dehumidifiers/> (Last accessed December 20, 2018).

⁵⁷ The average water removal capacity refers to the amount of water that can be removed from the air during a day if a dehumidifier worked at full capacity with infinite water available in the air, while the average water removal volume is the actual amount of water removed during an average day, which was obtained from metering activities conducted for the Ontario Power Authority.

⁵⁸ Natural Resources Canada, *Regulations and Standards – Dehumidifiers*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6889> (Last accessed December 20, 2018).

⁵⁹ ENERGY STAR, *ENERGY STAR® Program Requirements Product Specification for Dehumidifiers – Eligibility Criteria 4.0*, https://www.energystar.gov/sites/default/files/ENERGY%20STAR_DeHumidifiers_V4%200_Specification_Final_1.pdf (Last accessed December 20, 2018).

APPENDIX XI

IS: DETAILED CALCULATIONS OF EQUIVALENT EFFECTIVE USEFUL LIFE FOR LED LAMPS AND FIXTURES

This appendix presents the details on how the equivalent effective useful life (EUL) values of LED lamps and fixtures were calculated, with the updated duration until the changes in Canadian regulations come into effect for general-service lamps. As described in the Instant Savings Evaluation Report, the equivalent EUL values are multiplied by the first-year savings to obtain lifetime energy savings. This is necessary because the regulation changes will cause the baseline to increase over the lifetime of LED lamps, which in turn will reduce the equivalent EUL values applied to the first-year savings to obtain the lifetime energy savings.

The Evaluator applied the same methodology as in the 2017 DSM Evaluation Report to consider increased baselines over the lifetime of LED lamps and fixtures. This analysis was based on current and projected Canadian regulations for LED lamps and fixtures. The Evaluator conserved the same years as the effective dates of each regulation; the only change made to the calculation is that the first year is now 2018 instead of 2017.

The Evaluator maintains the conclusion presented in the 2017 DSM Evaluation Report, which anticipates a baseline change in 2024. This regulation will affect the baselines of all LED lamps and fixtures offered through Instant Savings, for all of which a minimum efficiency of 45 lumens/W is expected.

The Evaluator used the average rated lifetime hours established as part of the 2017 evaluation by consulting the specification sheets of the most popular products rebated for each type of lighting product. These are listed in Table 44 below. Since these lamp types have lifetimes of 15 years or more, their baseline wattages will once again be affected by the regulation change occurring in 2024.

Table 44: Equipment Life Values per Lighting Product

Measure	Average Rated Lifetime Hours (Hours) ⁶⁰	Annual HOU (Hours/Year) ⁶¹	Equipment Life (Years)
LED A-type Lamps	18,916	1,059	18
LED Non-A-type Lamps (R, BR and Decorative)	16,861	1,059	16
LED Non-A-type Lamps (Excluding R, BR and Decorative)	25,000	1,059	24
LED Recessed Downlight Fixtures	39,906	1,059	38
LED Fixtures Without Motion Sensors	35,010	1,059	33
LED Fixtures With Motion Sensors	43,555	1,077	40

⁶⁰ Based on manufacturer specification sheets for the most popular models installed under Instant Savings in 2017.

⁶¹ Based on the unitary savings review.

LED A-type Lamps

For LED A-type lamps, the lifetime energy savings values for early replacement and replace-on-burnout scenarios were established, as well as for the different types of lamps replaced. The Evaluator also considered that the replaced incandescent light lamps under the early replacement scenario have an estimated remaining useful life of one year. Incandescent light bulbs have a typical rated life expectancy of 1,000 to 2,000 hours.⁶² The remaining useful life of replaced functional incandescent light bulbs is assumed to be half the rated life expectancy. By applying a remaining useful life of 1,000 hours and 2.9 hours of use per day, the period over which savings can be calculated with an incandescent baseline was established at one year. After the first year over which incandescent lamps remain the baseline, the baseline is increased to halogen incandescent lamps to match the current Canadian regulation. As mentioned previously, the subsequent changes in Canadian regulations are expected to impact the market in 2024, which will increase the baseline to a CFL equivalent.

The displaced wattage values used to obtain the lifetime energy savings of each scenario are summarized in Table 45 and Table 46 below.

Table 45: Baseline Evolution During the EUL of LED A-type Lamps Replaced Early

Type of Lamp Replaced	Incandescent Baseline		Halogen Incandescent Baseline – Canadian Legislation ^{63,64}		CFL Equivalent Baseline – American Legislation ⁶⁵		Lifetime Energy Savings (kWh)	% of Lamps Replaced	Average Lifetime Energy Savings (kWh)
	1 Year (2018)		5 Years (2019-2023)		12 Years (2024-2035)				
	Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage			
Standard Incandescent	60.4	51.2	43.3	34.1	18.1	8.9	348	33%	167
Efficient Incandescent	43.3	34.1	43.3	34.1	18.1	8.9	330	8%	
CFL	13.1	3.9	13.1	3.9	13.1	3.9	74	33%	
LED	9.2	0.0	9.2	0.0	9.2	0.0	0	25%	

For replaced lamps that are already CFLs or LEDs, the changing energy efficiency regulation has no impact on the baseline that remains the same throughout the entire EUL of the measure.

⁶² Lighting Research Center. *Rensselaer Polytechnic Institute. Lighting Patterns for Homes. Light Bulb Features*, www.lrc.rpi.edu/patternbook/resources/lamp_features.asp. (Last accessed January 24, 2018).

⁶³ Natural Resources Canada. *Energy Efficiency Regulations. General Service Lamps and Modified Spectrum Incandescent Lamps*, www.nrcan.gc.ca/energy/regulationscodes-standards/products/6869 (Last accessed January 20, 2018).

⁶⁴ Also equivalent to Incandescent Equivalent 1st Tier EISA 2007.

⁶⁵ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

Table 46: Baseline Evolution During the EUL of LED A-type Lamps Replaced on Burn-out

Halogen Incandescent Baseline – Canadian Legislation		CFL Equivalent Baseline – American Legislation		Lifetime Energy Savings (kWh)
6 Years (2018-2023)		12 Years (2024-2035)		
Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
43.3	34.1	18.1	8.9	330

The lifetime energy savings values in Table 45 and Table 46 were weighted by the proportion of each scenario (59% early replacement and 41% replaced on burn-out) to obtain an average lifetime energy savings value for A-type lamps (233 kWh). The result was then divided by the average first-year energy savings for LED A-type lamps (27.9 kWh/yr) to obtain an equivalent EUL of 8.4 years.

LED Non-A-type Lamps

A similar analysis was conducted for LED non-A-type lamps, a product category that mostly includes reflector and decorative lamps (R, BR, GU, PAR, MR and decorative lamps). Reflector and decorative lamps are not impacted by the current Canadian regulation, but they will be affected by the requirements of EISA 2020. Starting in 2024, the baseline wattage is therefore increased to match the minimum efficiency level of 45 lumen/W. As outlined in Table 47 below, an equivalent EUL of 7.1 years was established for R, BR and decorative lamps, while an equivalent EUL of 7.7 years was established for the other LED non-A-types, as outlined in Table 48.

Table 47: Equivalent Effective Useful Life Calculation Summary for LED Non-A-type Lamps (R, BR and Decorative Lamps)

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline – Canadian Legislation 6 Years (2018-2023)		CFL Equivalent Baseline – American Legislation ⁶⁶ 10 Years (2024-2033)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage		
48.0	6.2	48.0	41.8	10.6	4.4	312	7.1

⁶⁶ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

**Table 48: Equivalent Effective Useful Life Calculation Summary for LED Non-A-type Lamps
(Excluding R, BR and Decorative Lamps)**

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline – Canadian Legislation 6 Years (2018-2023)		CFL Equivalent Baseline – American Legislation ⁶⁷ 18 Years (2024-2041)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage		
51.5	6.8	51.5	44.7	11.0	4.2	364	7.7

LED Fixtures

As for LED fixtures, the Evaluator analyzed their equivalent EUL in the same manner as for replaced-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. However, the Evaluator decided to cap the EUL of LED fixtures at 25 years because it is very unlikely that these products produce savings throughout their entire equipment life considering factors such as early replacement.

The rated life of products sold under the LED Recessed Downlight Fixtures category was used to establish an equipment life of 38 years. However, for the same reason as for LED fixtures, the EUL was capped at 25 years and the equivalent EUL for LED recessed downlight fixtures was set to 7.6 years, as outlined in Table 49.

**Table 49: Equivalent Effective Useful Life Calculation Summary
for LED Recessed Downlight Fixtures**

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline – Canadian Legislation 6 Years (2018-2023)		CFL Equivalent Baseline – American Legislation ⁶⁸ 19 Years (2024-2042)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage		
61.5	10.3	61.5	51.2	14.7	4.4	414	7.6

For LED fixtures without motion sensors, the baseline for 81 percent of the 10 most popular models is mostly one, two or three general-service halogen incandescent lamps. Therefore, the same methodology as for A-type lamps was used, as presented in Table 50 below. The equivalent EUL for LED fixtures without motion sensors was thus established at 9.8 years.

⁶⁷ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

⁶⁸ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

**Table 50: Equivalent Effective Useful Life Calculation Summary
for LED Fixtures Without Motion Sensors**

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline – Canadian Legislation 6 Years (2018-2023)		CFL Equivalent Baseline – American Legislation ⁶⁹ 19 Years (2024-2042)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage		
82.1	19.3	82.1	62.8	32.0	12.7	654	9.8

For LED fixtures with motion sensors, the Evaluator calculated lifetime energy savings by considering the reduced wattage first, 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 of the units sold (60%). Therefore, the Evaluator applied the same methodology as for reflectors and used the average hours of operation of 2.34 hours per day, as presented in Table 51.

For the second step, the difference of hours of operation generated by the motion sensors was taken into account, as presented in Table 52.

Table 51: 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 6 Years (2018-2023)		CFL Equivalent Baseline – American Legislation ⁷⁰ 19 Years (2024-2042)		Lifetime Energy Savings (kWh)
		Baseline Wattage	Displaced Wattage	Baseline Wattage ⁷¹	Displaced Wattage	
151.5	29.7	151.5	121.8	47.6	17.9	1,731

Table 52: Lifetime Energy Savings for LED Fixtures with Motion Sensors – Reduced Hours of Use

Average Old Hours of Use (hours per day)	Average New Hours of Use (hours per day)	Average Wattage of Efficient Lamp	Measure Life (years)	Lifetime Energy Savings (kWh)
4.43	2.68	29.7	10.0	189

The total lifetime energy savings of 1,921 kWh were divided by the first-year savings of 216 kWh to obtain an equivalent EUL of 8.9 years.

⁶⁹ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

⁷⁰ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

⁷¹ Baseline wattage values were established based on the minimum efficiency level of 45 lumen/W, as dictated by the EISA.

APPENDIX XII

IS: ALGORITHM FOR FREE-RIDERSHIP CALCULATION

The figure below presents the algorithm for calculating free-ridership levels. The participant survey questionnaire included questions designed to assess the planning, quantity, efficiency, period, cost and influence of the program component. Each group of questions was transposed into a level of program component attribution that was used to calculate the free-ridership level associated with each participant. Free-ridership levels are calculated separately for the early replacement and replace on burn-out baselines to take into account the different ways of calculating savings for each type of baseline. Participants who replaced LED lamps that were still in working condition with other LED lamps, thereby generating no energy savings, were excluded from the free-ridership calculation to avoid double penalties.

Section 1 – Free-ridership level for those who were unaware of discount before paying	
FR0a. Before paying at the cash register, were you aware that a discount was offered on the purchase of L-E-Ds?	IF Yes : GO TO Section 2 IF No OR REF: Ask FR0b
FR0b. [ASK IF FR0a=2, DK, REF)] I just want to make sure I understand - You did not know about the discount on specific packages of L-E-Ds before paying at the register?	IF Yes: : GO TO Section 2 IF No OR REF: FR0b = 100%
PA1 Score:	FR0b
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	
FR0c. Before the beginning of the campaign on September 28 th , were you already aware that discounts on L-E-Ds would be offered this fall?	IF Yes : GO TO FR0d IF No OR REF: GO TO Section 3
FR0d. [ASK IF FR0c=1] Did you postpone your purchase of LEDs to take advantage of the discount?	IF Yes: : FR0d = GO TO FR4 IF No OR REF: FR0d = Empty
FR4. If the discount had NOT been offered, when would you have purchased the L-E-Ds that you purchased today? Would it have been...? 1. [ASK IF FR0d=1] Earlier 2. Definitely today 3. Probably today 4. Probably at a later date 5. Definitely at a later date 6. (Would not have purchased them at all) 99. (Don't know / Refused)	IF 1: FR4 = 100% OTHERWISE: Go to Path 3
PA2 Score:	FR4
FR5. Without the discount, would you have definitely purchased the same number of L-E-Ds? 1. Definitely the same number 2. Probably the same number 3. Probably fewer 4. Definitely fewer 99. (Don't know / Refused)	IF 1: FR5 = 100% IF 2: FR5 = 50% IF 3: FR5 = 25% IF 4. : FR5 = 0% IF 99. : FR5 = 0%
PA3 Score:	FR5
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)	
FR3. How likely would you have been to buy the L-E-Ds that you purchased today if You had to pay the full price? (Scale 0 to 10)	FR3 = Answer x 10% IF 99. FR3 = EMPTY
FR2a. If the discount on L-E-Ds had NOT been offered today, what would you have bought today? 1. L-E-Ds 2. Another type of bulbs 3. No bulbs 99. (Don't know / Refused)	IF 1: FR2a = 100% IF 2: FR2a = Use FR2b IF 3: FR2a = 0% IF 99: FR2a = EMPTY
FR2b. [ASK IF FR2a=2 AND I1a=1] Which type of bulb would you have purchased instead today? 1. Incandescent 2. Halogen 3. CFLs 99. (Don't know / Refused)	IF 1 OR 2: FR2b = 0% IF 3: FR2b = 50% IF 99: FR2b = EMPTY
PA4 Score:	MEAN VALUE OF (FR3;FR2a-B)
FR4. If you had to pay the full price, when would you have purchased the L-E-Ds that you purchased today? 2. Definitely today 3. Probably today 4. Probably at a later date 5. Definitely at a later date 6. (Would not have purchased them at all) – SKIP TO FR5 99. (Don't know / Refused)	IF 2: FR4 = 100% IF 3: FR4 = 50% IF 4: FR4 = 25% IF 5. : FR4 = 0% IF 6. : FR4 = 0% IF 99. : FR4 = 0%
PA5 Score:	FR4
FR5. Without the discount, would you have purchased the same number of L-E-Ds? 1. Definitely the same number 2. Probably the same number 3. Probably fewer 4. Definitely fewer 99. (Don't know / Refused)	IF 1: FR5 = 100% IF 2: FR5 = 50% IF 3: FR5 = 25% IF 4. : FR5 = 0% IF 99. : FR5 = 0%
PA6 Score:	FR5
Inconsistency Test #1	IF FR3 ≥ 70% AND FR2a-b = 0%: PA4 = EMPTY
Inconsistency Test #2	IF FR3 ≤ 30% AND FR5 ≥ 50% PA6 = EMPTY
Free-Ridership Level (after inconsistency tests) for regular participants	MEAN VALUE OF: (PA4 ; PA5 ; PA6)

APPENDIX XIII

IS: SPILLOVER METHODOLOGY

Retailer interviews were used to estimate the level of spillover by measuring the market effects attributable to the program component for LED lamps. Market effects were measured by estimating the number of LED lamps sold without receiving a rebate during one of the campaigns and the proportion of those sales that can be attributed to Instant Savings. When providing their sales numbers, retailers were asked to consider all LED lamp models, not only the models selected for rebate. For the retailers who provided an estimate of their LED lamp sales data from January to June 2018, the Evaluator used this data and the answers provided during the interviews to estimate the annual sales of LED lamps, while for other retailers the number of LED lamps sold throughout the year was established directly using their interview answers.

The figure below illustrates the methodology used to calculate the spillover level.

Total LED Sales	
Option A – For retailers who have total LED sales available	
All LED Sales for the first half of the year (Jan. to June) (from uplift data)	#LED _{Jan-Jun}
L1A/N1A. Of all the LED bulbs you anticipate selling in 2018, roughly what percentage of bulbs will have been sold during the first half of the year?	%LED _{Jan-Jun}
L1A/N1A. IF DOES NOT COVER ALL LED SALES. Roughly what percentage of your sales of LED bulbs is missing?	%LED _{Not covered} Or EMPTY
Total LED Sales (#LED _{Jan-Dec})	$\#LED_{Jan-Dec} = \frac{\#LED_{Jan-Jun}}{\%LED_{Jan-Jun} \times (1 - \%LED_{Not\ covered})}$
Option B – For retailers who do not have total LED sales available	
How many LED bulbs did you sell during the first six months of 2018?	#LED _{Jan-Jun}
L1B/N1B. Of all the LED bulbs you anticipate selling in 2018, roughly what percentage of bulbs will have been sold during the first half of the year?	%LED _{Jan-Jun}
Total LED Sales (#LED _{Jan-Dec})	$\#LED_{Jan-Dec} = \frac{\#LED_{Jan-Jun}}{\%LED_{Jan-Jun}}$
Option C – For retailers who had difficulty to answer Option B and only have rebate eligible LED sales	
All rebate eligible LED Sales for the first half of the year (Jan. to June) (from uplift data)	#LED _{Jan-Jun}
L1C/N1C. What percentage of all your sales of LED bulbs do you think these sales of rebate eligible LED bulbs represent?	%LED _{Rebate}
L1C/N1C. Of all the rebate eligible LED bulbs you anticipate selling in 2018, roughly what percentage of bulbs will have been sold during the first half of the year?	%LED _{Jan-Jun}
Total LED Sales (#LED _{Jan-Dec})	$\#LED_{Jan-Dec} = \frac{\#LED_{Jan-Jun}}{\%LED_{Jan-Jun} \times \%LED_{Rebate}}$

LED Sales During Instant Savings' Campaigns

LED Sales during Instant Savings' Spring and Fall Campaigns
(from the tracking system)

#LED_{IS}

Program Influence

I3. About what percentage of the total number of LED bulbs you sold, outside of those that received a rebate, can you directly or indirectly attribute to Efficiency Nova Scotia's programs and promotion – in essence, sales you would not have had during the months of January through March, mid-May through September, and mid-November through December, if the program had never existed, as well as sales of non-rebate eligible LED bulbs throughout the year?

%influence

$$\text{Final Market Effects (LEDs)} = ((\#LED_{\text{Jan-Dec}} - \#LED_{\text{IS}}) \times \%influence) / \#LED_{\text{IS}}$$

APPENDIX XIV

IS: 2018 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2018 evaluation of the Instant Savings program component. There were no incomplete 2017 recommendations at the time of evaluation.

Sections	2018 Recommendations
Executive Summary	1 Perform a socket study through on-site visits to document energy savings potential related to lighting. Market data point to increasingly high penetration rates of LED lamps and fixtures in Nova Scotia homes. To document the remaining energy savings potential related to lighting in existing homes, the Evaluator recommends conducting a socket study in Nova Scotia homes. The socket study, conducted through on-site visits, should serve to collect information such as the number and type of lamps installed in homes. This study would be helpful for all program components that offer residential lighting measures by providing insights on the current state of lighting market.
	2 Continue monitoring LED market indicators. Despite the removal of A-type lamps from the Instant Savings offering as of 2019, the Evaluator recommends continuing to monitor the evolution of all LED lamps. Market indicators such as the market shares and prices of lighting technologies should still be collected to understand the changes occurring in the market after A-type lamps are removed. Monitoring market indicators would also help with remaining current on the overall state of the lighting market, which is in a period of change.
Unitary Savings Values	3 The quantity of smart devices remains minimal, representing less than 1 percent of all products sold through Instant Savings in 2018. The Evaluator could not find publicly available studies presenting relevant savings data for these products. Therefore, the Evaluator recommends both continuing to apply the unitary savings value associated with the standard product and starting to track smart devices in different product categories to more easily follow their evolution since these products are expected to become more popular.



ECONOLER

EXISTING RESIDENTIAL PROGRAM

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Final Report

March 15, 2019



ABBREVIATIONS

ASHP	Air-source heat pump
AWHP	Air-to-water heat pump
CFL	Compact fluorescent lamp
COP	Coefficient of performance
CRA	Corporate Research Associates
DA	Delivery agent
DCF	Data-collection form
DHW	Domestic hot water
DSM	Demand-side management
DWHR	Drain water heat recovery
EA	Energy advisor
ENS	Efficiency Nova Scotia
EPI	Efficient Product Installation
ESHEC	Electrical space heating energy consumption
EUL	Effective useful life
GHG	Greenhouse gas
GSHP	Ground-source heat pump
HEA	Home Energy Assessment
HPWH	Heat pump water heater
HRV	Heat recovery ventilator
HSPF	Heating seasonal performance factor
HVAC	Heating ventilation and air conditioning
LCEF	Low Carbon Economy Fund
LED	Light-emitting diode
MSHP	Mini-split heat pump
MURB	Multi-unit Residential Building
NEEP	Northeast Energy Efficiency Partnerships

NERHOU	Northeast Residential Lighting Hours-of-Use
NRCan	Natural Resources Canada
NSP	Nova Scotia Power
NTGR	Net-to-gross ratio
OR	Overestimation ratio
PNS	Province of Nova Scotia
RDI	Residential Direct Install
RP&C	Rental Properties & Condos
RUR	Renovation Upgrade Report
SEER	Seasonal energy efficiency ratio
TRM	Technical reference manual

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

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

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

TABLE OF CONTENTS

EXECUTIVE SUMMARY	XII
INTRODUCTION	1
1 HEA OVERVIEW.....	3
1.1 Description	3
1.2 Follow-up on the 2017 Evaluation Report Recommendations	4
1.3 Participation History	5
2 HEA EVALUATION OBJECTIVE AND METHODOLOGY	7
3 HEA IMPACT EVALUATION	10
3.1 On-site Visits and Simulation Reviews	10
3.2 Gross Savings	13
3.2.1 Overview of the Measures	14
3.2.2 Building Envelope and Space Heating Savings Calculated in HOT2000	15
3.2.3 Wood, Pellet and Solar Air Equipment Savings.....	17
3.2.4 Domestic Hot Water Savings.....	18
3.2.5 Peak Demand Savings	20
3.2.6 Interactive Effects	21
3.2.7 Effective Useful Life	21
3.2.8 Revised Gross Savings	22
3.3 Net-to-gross Ratio.....	24
3.3.1 Free-ridership	24
3.3.2 Participant Spillover.....	24
3.3.3 Net-to-gross Ratio Calculation.....	24
3.4 Unconverted D Assessment Spillover	25
3.5 Green Heat Savings Deductions.....	26
3.6 Net Savings.....	26
4 HEA RECOMMENDATIONS.....	29
5 GREEN HEAT OVERVIEW.....	30
5.1 Description	30
5.2 Follow-up on 2017 Evaluation Report Recommendations.....	31
5.3 Participation History	32
6 GREEN HEAT EVALUATION OBJECTIVES AND METHODOLOGY	34
7 GREEN HEAT MARKET EVALUATION	37
8 GREEN HEAT IMPACT EVALUATION	39

8.1	Gross Savings	39
8.1.1	On-site Visits	39
8.1.2	Summary of Savings Values.....	41
8.1.3	Interactive Effects	43
8.1.4	Effective Useful Life	43
8.1.5	Revised Gross Savings	44
8.2	Net-to-gross Ratio.....	47
8.2.1	Free-ridership	47
8.2.2	Net-to-gross Ratio Calculation.....	49
8.3	Net Savings.....	49
9	GREEN HEAT MARKET EVOLUTION.....	53
9.1	Background	53
9.1.1	Efficiency Nova Scotia.....	53
9.1.2	Nova Scotia Power	53
9.2	Market Indicators	54
9.2.1	Market Share of Heat Pumps	54
9.2.2	ENS Incented Mini-split Heat Pumps.....	56
9.2.3	Green Heat Eligible Mini-split Heat Pumps.....	58
9.2.4	Mini-split Heat Pump Prices.....	59
9.2.5	Mini-split Heat Pump Market Outlook and Trends	59
9.2.6	Codes and Standards	60
9.2.7	Measured Free-ridership	61
9.3	Market Evolution Summary.....	61
9.4	Green Heat Recommendations.....	63
10	EPI OVERVIEW.....	64
10.1	Description	64
10.2	Follow-up on 2017 Evaluation Report Recommendations.....	65
10.3	Participation History	65
11	EPI EVALUATION OBJECTIVES AND METHODOLOGY	68
12	EPI MARKET EVALUATION	71
13	EPI IMPACT EVALUATION.....	74
13.1	Gross Savings	74
13.1.1	Unitary Savings Values.....	74
13.1.2	Installation Rates	76
13.1.3	Peak Demand Savings	77
13.1.4	Interactive Effects	79

13.1.5 Effective Useful Life	83
13.1.6 Revised Gross Savings	85
13.2 Net-to-gross Ratio.....	96
13.2.1 Free-ridership	96
13.2.2 Participant Spillover.....	97
13.3 Net Savings.....	98
14 EPI RECOMMENDATIONS	105
15 OVERALL SAVINGS FOR THE EXISTING RESIDENTIAL PROGRAM	106
CONCLUSION.....	107

LIST OF TABLES

Table 1: Overall Participation and Savings for Existing Residential	xii
Table 2: HEA Net-to-gross Ratio	xv
Table 3: Comparison of HEA Tracked and Evaluated Savings at the Generator	xvi
Table 4: Green Heat Net-to-gross Ratio	xxi
Table 5: Comparison of Green Heat Tracked and Evaluated Savings at the Generator	xxi
Table 6: EPI Net-to-gross Ratios	xxvii
Table 7: Comparison of EPI Tracked and Evaluated Savings at the Generator	xxvii
Table 8: Types of Evaluations Conducted for Each Program Component	2
Table 9: Implementation Status of 2017 Recommendations for HEA.....	4
Table 10: Results of On-site Visits and Simulation Reviews for HEA.....	11
Table 11: HEA Eligible Energy Efficiency Upgrades.....	14
Table 12: Overestimation Ratio Values for HEA.....	17
Table 13: Tracked and Revised Unitary Savings for Wood, Pellet and Solar Air Equipment	17
Table 14: Tracked and Revised Unitary Savings for Domestic Hot Water Heating Equipment.....	20
Table 15: HEA Equivalent Effective Useful Life Values	21
Table 16: Revised Gross Energy and Peak Demand Savings for HEA.....	23
Table 17: Average Free-ridership Level for HEA	24
Table 18: Average Participant Spillover Level for HEA.....	24
Table 19: Unconverted D Assessment Spillover.....	26
Table 20: Evaluated Net Energy and Peak Demand Savings for HEA.....	27
Table 21: Comparison of Tracked and Evaluated HEA Savings at the Generator	28
Table 22: Green Heat Incentives	31
Table 23: Implementation Status of 2017 Recommendations for Green Heat	32
Table 24: Survey Sample Sizes and Margin of Error.....	36
Table 25: Green Heat On-site Visits by Measure Category.....	39
Table 26: Tracked and Revised Unitary Savings Values for Biomass and DHW Measures.....	42
Table 27: Tracked and Revised Unitary Savings Values by Heat Pump Measure Type	42
Table 28: Green Heat Equivalent Effective Useful Life Values	44
Table 29: Revised Gross Energy and Peak Demand Savings for Green Heat.....	45
Table 30: Average Free-ridership Level by Measure Category for Green Heat.....	48
Table 31: Evaluated Net Energy and Peak Demand Savings for Green Heat.....	50
Table 32: Comparison of Tracked and Evaluated Green Heat Savings at the Generator	52
Table 33: Green Heat Incented High-efficiency Mini-split Heat Pump Systems	57
Table 34: HEA Incented High-efficiency Mini-split Heat Pump Systems	57
Table 35: Average Costs and Incentives of Program Component Units.....	59
Table 36: Analysis of Key Factors in Program Component Planning	61
Table 37: Implementation Status of 2017 Recommendations for EPI	65
Table 38: Summary of EPI Tracked and Revised Unitary Savings Values.....	75
Table 39: EPI Product Installation Rates	77
Table 40: EPI Peak Demand-to-energy Ratios by Product Type.....	79
Table 41: EPI Interactive Effects Calculation Results for LED Products Installed Indoors	80
Table 42: EPI Interactive Effects Factors by Lighting Product Type.....	81
Table 43: EPI Adjusted Peak Demand-to-energy Ratios by Lighting Product Type	81
Table 44: EPI Interactive Effects Factors for Pipe Insulation and Hot Water Tank Wraps	82
Table 45: EPI Equivalent Effective Useful Life Values.....	84

Table 46: Revised Gross Energy and Peak Demand Savings by Product Category for EPI Single-family Homes	86
Table 47: Revised Gross Energy and Peak Demand Savings by Product Category for EPI Apartments.....	91
Table 48: Average Free-ridership Level by Product Category for EPI Non-low-income Participants ...	97
Table 49: Average Participant Spillover Level for EPI Non-low-income Participants	98
Table 50: Evaluated Net Energy and Peak Demand Savings by Product Category for EPI.....	99
Table 51: Comparison of Tracked and Evaluated EPI Savings at the Generator	104
Table 52: Overall Savings for Existing Residential	106

LIST OF FIGURES

Figure 1: HEA Performance Overview, 2012-2018.....	xiv
Figure 2: Overview of Green Heat Performance, 2012-2018	xix
Figure 3: Overview of EPI Performance (Previously RDI and RP&C)	xxiv
Figure 4: Overview of Participation in HEA, 2012-2018.....	5
Figure 5: Evolution of HEA Gross Savings, 2012-2018	6
Figure 6: HEA Methodological Model	7
Figure 7: Summary of Participation in Green Heat, 2012-2018	33
Figure 8: Summary of Gross Savings for Green Heat, 2012-2018	33
Figure 9: Green Heat Methodological Model	34
Figure 10: Participant Satisfaction with Green Heat (10-point Scale)	38
Figure 11: Barriers to the Installation of Energy Efficient Heating Equipment	38
Figure 12: Incremental Homes with Heat Pump Systems Installed in Nova Scotia	55
Figure 13: Homes with Heat Pump Systems (Cumulative)	56
Figure 14: Comparison of Incremental Existing Homes with Mini-split Heat Pump Systems to ENS Incented Systems.....	58
Figure 15: Residential Market Evolution of Mini-split Heat Pumps	62
Figure 16: Summary of Participation in RDI, RP&C and EPI	66
Figure 17: Summary of Gross Savings in RDI, RP&C and EPI	67
Figure 18: EPI Methodological Model	68
Figure 19: Barriers to Energy Efficient Upgrades	72
Figure 20: Participant Satisfaction with EPI (Ratings on a 10-point Scale).....	73

EXECUTIVE SUMMARY

This report presents the 2018 demand-side management (DSM) evaluation results of the Existing Residential program operated by Efficiency Nova Scotia (ENS). This program is comprised of four components: (1) Home Energy Assessment (HEA); (2) Green Heat; (3) Efficient Product Installation (EPI), and (4) First Nations Home Energy Efficiency Pilot¹.

Table 1 presents the participation levels, net-to-gross ratios (NTGR), as well as evaluated gross and net savings for each program component and for the program as a whole.

Table 1: Overall Participation and Savings for Existing Residential

	Participation Level	Gross Savings	NTGR	Net Savings
HEA				
Energy Savings	791 participants	6.366 GWh	0.90	5.724 GWh
Lifetime Energy Savings ²		127.258 GWh	0.90	114.488 GWh
Peak Demand Savings		1.800 MW	0.89	1.600 MW
Green Heat				
Energy Savings	3,055 measures installed	9.078 GWh	0.47	4.227 GWh
Lifetime Energy Savings		163.749 GWh	0.47	76.292 GWh
Peak Demand Savings		8.647 MW	0.47	4.042 MW
EPI				
Energy Savings	10,813 participants	13.997 GWh	0.91	12.777 GWh
Lifetime Energy Savings		117.760 GWh	0.91	107.988 GWh
Peak Demand Savings		1.614 MW	0.91	1.463 GWh
Energy Savings		29.440 GWh		22.728 GWh
Lifetime Energy Savings		408.766 GWh		298.768 GWh
Peak Demand Savings		12.062 MW		7.105 MW

¹ The First Nations Home Energy Efficiency pilot did not have any participants who achieved savings in 2018; therefore, no evaluation was conducted for 2018.

² Throughout this report, energy savings always refer to first-year energy savings rather than lifetime energy savings, unless specified otherwise.

Home Energy Assessment

HEA encourages homeowners to improve the energy efficiency and comfort of their homes by improving building envelopes, space heating systems, water heating systems, and mechanical ventilation systems. Eligible measures and resulting energy savings were identified by energy advisors (EAs) hired by delivery agents (DAs) to provide pre-retrofit and post-retrofit assessments (also called D and E assessments respectively). HEA underwent significant changes in the last three years. Provincial funding ceased in April 2015, thus limiting participation to electrically heated households only. In October 2015, HEA began supporting measures beyond insulation, namely space heating equipment such as wood or pellet stoves and heat pumps, as well as water heating equipment such as solar domestic water heaters and heat pump water heaters (HPWHs). In July 2018, the HEA incentive structure was simplified by removing the tiered rebates. Additionally, on July 10, 2018, HEA received new funding from the federal government Low Carbon Economy Fund (LCEF) via the Government of Nova Scotia to support non-electrically heated households. The savings associated with measures installed after July 10, 2018, which displace non-electrical energy consumption, will be reported in the Province of Nova Scotia (PNS) Evaluation Report and were therefore not included in this report.

The 2018 HEA evaluation consisted of a program component documentation review, interviews with the program manager, a billing analysis to establish new overestimation ratios (ORs) used to adjust the modelled consumption values, and a review of 10 projects that included both an on-site visit and a simulation verification were carried out.

HEA Key Findings

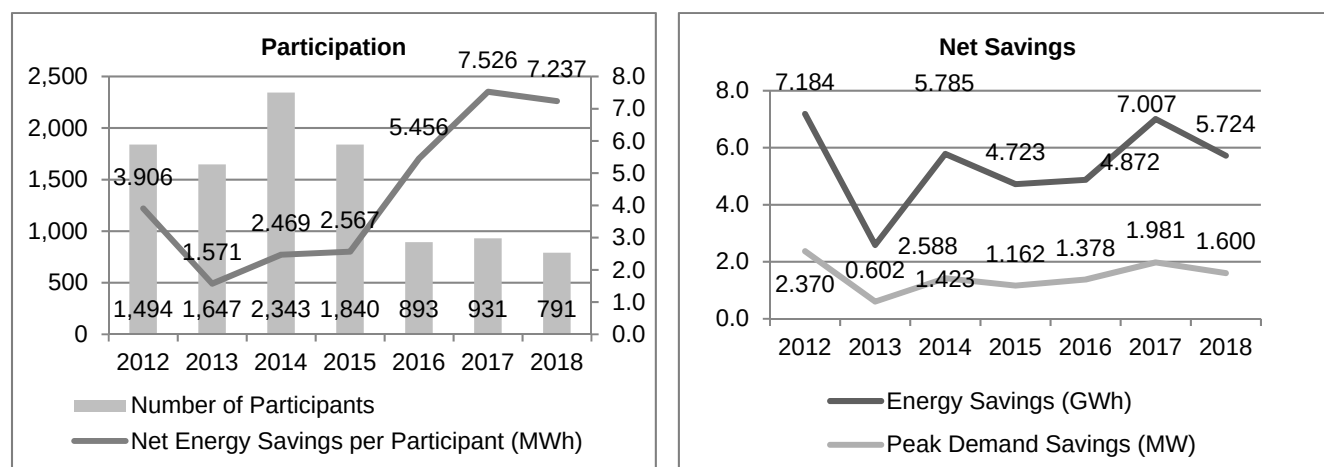
HEA Performance

HEA aimed to achieve 7.5 GWh in net electrical energy savings and 2.1 MW in net peak demand savings at the generator in 2018. The Evaluator determined that HEA achieved 5.724 GWh in net electrical energy savings and 1.600 MW in net peak demand savings at the generator with 791 participants in 2018. These savings represent 3,507 tonnes of CO₂ eq in terms of annual avoided greenhouse gas (GHG) emissions. HEA's net lifetime energy savings were established at 114.488 GWh, which yields an average effective useful life (EUL) value of 20.0 years.

Figure 1 illustrates the evolution of HEA in terms of participation and net energy and peak demand savings from 2012 to 2018. The 2018 participation level was only slightly lower than 2017 and 2016, although it represents a significant decrease compared to 2015 levels and previous years. The significant participation decreases in years 2016, 2017, and 2018, compared to participation in 2015 and previous years, are attributable to the removal of provincial funding in April 2015 for non-electrically heated households. Between April 2015 and July 2018, only participants who used an electrical main heat source could participate in HEA, resulting in a lower number of completed projects. The Nova Scotia housing stock is comprised of roughly one-third electrically heated homes, and two-thirds non-electrically heated homes,³ thereby significantly decreasing the percentage of the population with access to HEA due to the removal of provincial funding. Non-electrically heated households were recently reintroduced as eligible in July 2018 as a result of new federal funding, although no impacts could yet be observed since the majority of these new participants will complete program component participation in future years.

Although the participation levels in 2016, 2017, and 2018 were lower than in 2015, the net electrical energy savings per participant has increased since 2015 due to the removal of provincial funding. When provincial funding was available for non-electrical main heating sources, the proportion of electrical savings accounted for by such participants was lower since the majority of their savings were generated by their non-electrical heating system. The removal of non-electrical main heating sources and the increase in eligible measures (in October 2015) contributed to increasing the net electrical energy savings per participant. In 2018, the net electrical energy savings per participant decreased compared to 2017. The 2018 decrease in per participant savings is explained by the revised ORs resulting from the new billing analysis conducted as part of this evaluation.

Figure 1: HEA Performance Overview, 2012-2018



³ Natural Resources Canada, *Residential Sector – Nova Scotia - Heating System Stock by Building Type and Heating System Type*, <http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=ns&rn=21&page=4> (Last accessed February 07, 2019).

HEA Energy Savings

The objective of the 2018 HEA impact evaluation was to determine net energy and peak demand savings. To calculate gross savings, the Evaluator reviewed the contents of the 2018 tracking sheet. The Evaluator employed the same method as that used by ENS to calculate energy savings generated by building envelope upgrades and space heating equipment. This method used the space heating consumption values determined by HOT2000 simulations for the D and E assessments, and ORs established from a billing analysis that compared participant modelled consumption with actual consumption values. In 2018, the OR used since the 2015 evaluation was revised and new ORs are now applied depending on the heating system in place. Such a distinction was not possible for the billing analysis conducted for the 2015 evaluation because only 1 percent of participants installed a heat pump through HEA in 2015, compared to more than half the participants in 2018. The Evaluator also revised the unitary savings values used to calculate the savings associated with certain space heating equipment and with domestic hot water (DHW) measures, which are not modelled in HOT2000.

No data-collection activities aimed at updating the free-ridership or spillover levels were conducted in 2018 because the changes made to HEA in the second half of 2018 were too recent for their impacts to be observed in the 2018 evaluation. Therefore, 2017 levels were used for the 2018 evaluation. Based on the 2017 free-ridership level of 25 percent and participant spillover of 1 percent, a NTGR of 0.76 was used, as listed in Table 2.

Table 2: HEA Net-to-gross Ratio

	2017
Free-ridership Level	25%
Spillover Level	1%
Net-to-gross Ratio	0.76

Another spillover effect, associated with unconverted D assessment savings, was also considered in the net energy and peak demand savings calculations. This spillover effect corresponds to the savings generated through the measures implemented by those participants who did not complete their E assessments by the end of the allocated 12-month period. The total spillover-induced energy and peak demand savings from unconverted D assessment participants were 0.836 GWh and 0.236 MW at the meter respectively.

Several measures offered under HEA are also offered under Green Heat. To ensure that energy savings are not claimed twice for the same upgrade, savings already claimed in Green Heat are deducted from HEA net electrical savings.

For HEA, net savings are calculated by deducting Green Heat savings, applying the aforementioned NTGR value to evaluated gross savings, and adding the unconverted D assessment spillover savings. In 2018, HEA achieved 5.724 GWh in net electrical energy savings and 1.600 MW in net peak demand savings at the generator, as summarized in Table 3.

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

	Initial Gross Savings	Adjusted Gross Savings	NTGR*	Net Savings
Energy Savings				
Tracked Savings from ENS	8.607 GWh	7.279 GWh	0.88	6.429 GWh
Evaluation Results	8.599 GWh	6.366 GWh	0.90	5.724 GWh
Peak Demand Savings				
Tracked Savings from ENS	2.436 MW	2.060 MW	0.88	1.819 MW
Evaluation Results	2.433 MW	1.800 MW	0.89	1.600 MW
**The average NTGR values correspond to the ratio of net savings to gross savings and includes unconverted D assessment spillover and Green Heat savings deductions.				

Both the gross energy and peak demand savings calculated as part of the 2018 evaluation were very similar to the initial gross savings tracked by ENS. The slight difference was due to the revised unitary savings values for solar DHW systems and HPWH equipment, as well as the weighted average line loss factor of 1.099 (instead of the 1.000 used for tracked savings calculations). As for adjusted gross savings, the values calculated for energy and peak demand savings were both 13 percent lower than those tracked by ENS. The difference was mainly explained by the updated ORs used to adjust the modelled space heating consumption values generated by the HOT2000 software. Ultimately, the evaluated net energy and peak demand savings were also lower than those tracked by ENS due to both the aforementioned reasons and the adjustment in the number of unconverted D assessment participants.

HEA Recommendations

The 2018 evaluation revealed that HEA succeeded in achieving significant net and peak demand energy savings, although at lower levels than in previous years. Significant changes to HEA occurred in the second half of 2018, notably a reinstatement of funding for non-electrically heated households and a revision of the incentive structure. While these changes were too recent for their impacts to be observed in the 2018 evaluation, their impacts on participant satisfaction and savings will be evaluated in the next evaluation year.

In addition to the general recommendations presented for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator made recommendations for improving each Existing Residential component. What follows are the recommendations specifically made for HEA. The recommendations for improving Green Heat and EPI are presented further below in the Executive Summary. The following recommendations are also outlined in Appendix III.

2018 HEA-R1. Conduct a billing analysis to review the overestimation ratio when a sufficient participant sample becomes available. The billing analysis conducted in 2018 was initially aimed at estimating a new OR for the new version of HOT2000, although it revealed that the space heating systems in place, particularly heat pumps, had a much more significant impact on the overestimation than the difference between the versions of HOT2000 that are used. The Evaluator believes that further analyses should be conducted to evaluate the impact of the different HOT2000 versions on the ORs and confirm whether there is no significant difference in the ORs established for the D and E assessment periods. Version 11 of HOT2000 will progressively be used more in upcoming years and will enable conducting a billing analysis on a sample of participants large enough to consider: (1) D assessments and E assessments; (2) the various versions of HOT2000 (i.e. versions 11.3, 11.4, 11.5); and (3) evaluate the impact of the different heating systems in place, including the presence of wood or pellet stoves. Since overestimations significantly impact HEA net energy and peak demand savings, the Evaluator recommends conducting a billing analysis when a large enough participant sample becomes available.

2018 HEA-R2. Share evaluation findings with the EAs to ensure sustained quality simulations. As part of the 10 HEA on-site visits and HOT2000 simulation reviews, the Evaluator noted that significant improvements have been achieved in both the quantity of measurements and the accuracy of collected data since the last review in 2016. In 2018, the Evaluator found that EAs performed well in recording household energy component data and complied with the new EnerGuide requirements. While reviewing project files, the Evaluator noted some recurrent mistakes in the HOT2000 simulations (see Subsection 3.1). The Evaluator recommends sharing feedback on the improved accuracy of data collection and aspects of the project review process that could be improved with EAs to continue working toward higher quality simulations.

Green Heat

Green Heat provides financial incentives to homeowners and encourages them to reduce heating electricity consumption by either installing high-efficiency electrical systems or replacing existing electrical heating systems with systems that use a Green Heat qualified energy source. The heating system categories rebated under Green Heat are heat pumps, biomass, and solar thermal.

As of August 2017, Green Heat is delivered through an after-purchase mail-in rebate structure. This change is aimed at removing entry barriers for applicants, most notably by eliminating the pre-approval requirement prior to purchasing eligible heating equipment. Other changes to Green Heat as of August 2017 included new equipment eligibility criteria for cold climate mini-split heat pumps (MSHPs) and modifications to the rebate structure for heat pump equipment. Moreover, applicants interested in financing equipment are now referred to HEA, except for those seeking to finance MSHPs. The latter are referred to Nova Scotia Power (NSP).

Additionally, as of July 10, 2018, all Green Heat qualified equipment is offered to both electrically and non-electrically heated homes thanks to new funding from the federal government LCEF via the Government of Nova Scotia. The savings associated with measures installed after July 10, 2018, which reduce non-electrical energy consumption, will be reported in the PNS Evaluation Report and were therefore not included in this report.

The 2018 Green Heat evaluation is based on a program component documentation review, interviews with the program manager and six distributors, a telephone survey with 90 participants, 25 on-site visits, a savings review, and billing analyses.

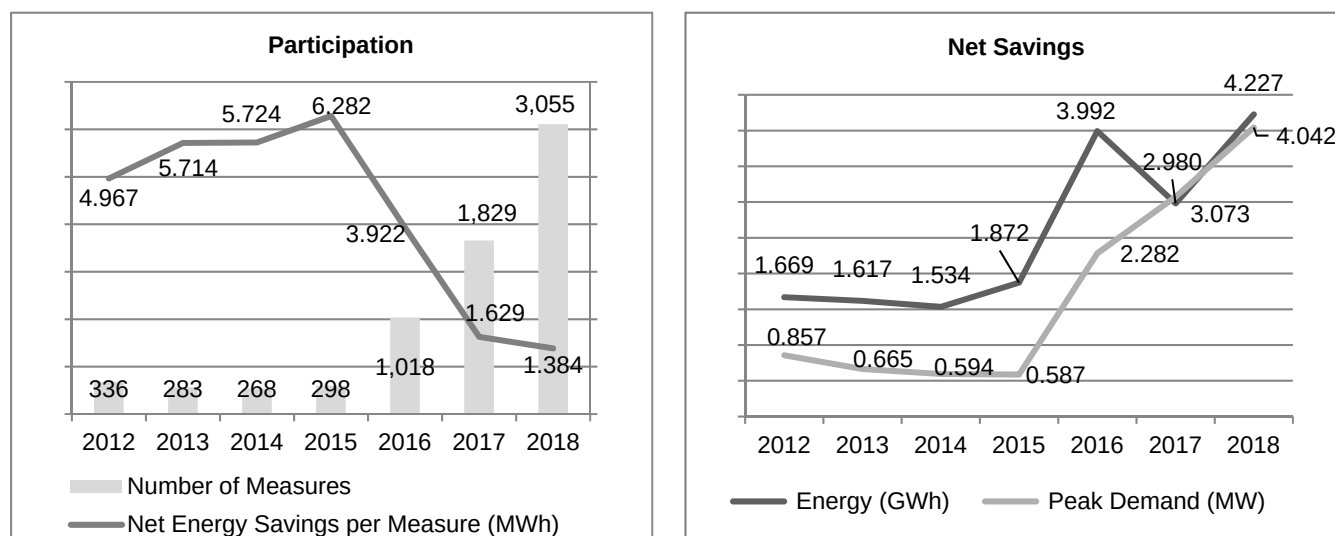
Green Heat Key Findings

Green Heat Performance

Green Heat aimed to achieve 3.7 GWh in net electrical energy savings and 3.8 MW in net peak demand savings at the generator in 2018. The Evaluator determined that Green Heat achieved 4.227 GWh in net electrical energy savings and 4.042 MW in net peak demand savings at the generator in 2018. These savings represent 2,589 tonnes of CO₂ eq in terms of annual avoided GHG emissions. Green Heat's net lifetime energy savings were established at 76.292 GWh, which yields a weighted average EUL value of 18.05 years.

Figure 2 below provides an overview of the evolution of Green Heat participation levels, as well as net energy and peak demand savings, from 2012 to 2018. The 2018 participation level was much higher than in previous years with 3,055 measures installed. MSHPs are still the most popular measure, accounting for 92 percent of the measures installed through Green Heat in 2018. Many factors likely contributed to higher participation, namely the removal of the pre-approval process, ENS marketing efforts and the particularly warm 2018 summer in Nova Scotia, which led to increased demand for MSHPs.

Net energy savings also increased in 2018, although to a lesser extent than participation. The lower NTGR calculated for Green Heat in 2018 somewhat limits the increase in net energy savings.

Figure 2: Overview of Green Heat Performance, 2012-2018


Green Heat Market Evaluation Highlights

The 2018 evaluation revealed that awareness about Green Heat was largely driven by contractors, retailers, and distributors (39%), or by word-of-mouth via a friend, acquaintance, or family member (23%). Participants were very satisfied with various aspects of Green Heat. They particularly appreciated the quality of the equipment installed in their home, the program component application processes, and the clarity of program component requirements.

When first considering installing energy efficient home heating equipment, concerns expressed by participants related mainly to equipment reliability, equipment capacity to produce enough heat, and selecting the right unit.

The main reason for participating in Green Heat was to save on energy costs (49%) followed by the desire for air conditioning in the home. Among participants who installed a heat pump, only one in three (34%) previously had air conditioning in their home, yet nearly all (94%) now use their heat pump to provide cooling.

Green Heat Energy Savings

To calculate Green Heat gross energy savings, the Evaluator reviewed the unitary savings values used for each type of equipment category based on the information in the tracking sheet, site visit results, literature reviews, and a billing analysis.

The site visits served to confirm the adequate operation of heating systems in all visited sites and led to the identification of a few discrepancies in the information tracked, mostly concerning existing primary and secondary heating systems.

The savings review resulted in minor changes for HPWHs and no changes for biomass measures. For MSHPs, the results of the billing analysis presented in the 2017 Evaluation Report were applied to obtain 2018 evaluation results. This resulted in MSHP unitary savings that were slightly different than those tracked by ENS. The main reason for the differences between tracked and revised savings for MSHPs stems from the use of old values from the 2016 Evaluation Report in the 2018 ENS tracking sheet. The Evaluator also noted some discrepancies in the heating capacities reported in the tracking sheet when comparing them to the values found in the reference measures list (which contains all technical specifications for approved MSHPs).

The Evaluator performed a billing analysis as part of the 2018 evaluation to more accurately estimate ducted air-source heat pump (ASHP) energy savings. Preliminary results indicated that ducted ASHP savings were much lower than those resulting from the 2017 billing analysis. The Evaluator investigated the reasons for this change and found that the tracking sheets contained incorrect information about existing heating systems for a large number of participating households. This was due to a combination of incorrectly filled-out participation forms and errors in data entry. Since the 2018 billing analysis was inconclusive, the Evaluator applied the savings value obtained from the 2017 billing analysis to ducted ASHPs installed in 2018.

The NTGR values listed in Table 4 below were established for each category of measures by using the free-ridership levels obtained through the participant survey. For MSHPs, which constitute by far the most popular Green Heat measure, the Evaluator found that 71 percent of participants already made the decision to install such equipment before hearing about Green Heat. The free-ridership calculations also took into account program component influence on participants' decision to install a high-efficiency heat pump rather than a regular heat pump, as well as the influence of previous participation in one of ENS's program components or ENS promotion about energy efficiency. When including in these factors, the free-ridership level was established at 54 percent. Although these results demonstrate the popularity of MSHPs in the Nova Scotia market, they also highlight the influence of ENS on the type of equipment purchased.

Overall, free-ridership levels increased significantly compared to 2017, in large part because of the new delivery mechanism that was rolled out in 2017. This new mechanism no longer requires participants to obtain approval from ENS prior to purchasing a system; while the objective was to simplify the participation process, it also enabled participants who hear about the program component after their purchase to obtain the rebate. The 2017 evaluation measured free-ridership among participants who installed MSHPs and revealed that free-ridership was 16 percent higher for participants who took part in the new delivery mechanism than in the previous one. In 2018, free-ridership was measured for the new mechanism delivery for all measures. Results are outlined in Table 4.

Table 4: Green Heat Net-to-gross Ratio

Measure Category	Free-ridership Level	Net-to-gross Ratio
Biomass and Solar Measures	58%	0.42
Central Heat Pumps	29%	0.71
MSHPs	54%	0.46
Heat Pump Water Heaters	0%	1.00

As presented in Table 5, applying the NTGRs to gross savings yields 4.227 GWh and 4.042 MW in net electrical energy and peak demand savings respectively at the generator for 2018.

Table 5: Comparison of Green Heat Tracked and Evaluated Savings at the Generator

	Initial Gross Savings	Adjusted Gross Savings	NTGR	Net Savings
Energy Savings				
ENS Tracked Savings	8.826 GWh	8.826 GWh	0.60	5.294 GWh
Evaluation Results	8.826 GWh	9.078 GWh	0.47	4.227 GWh
Peak Demand Savings				
ENS Tracked Savings	8.361 MW	8.361 MW	0.59	4.954 MW
Evaluation Results	8.361 MW	8.647 MW	0.47	4.042 MW
*Different NTGRs were established for MSHP, central heat pump, as well as biomass and solar measures. The average NTGR values presented in this table correspond to the ratio of net savings to gross savings for all measure categories combined.				

The evaluated gross energy savings are 3 percent above the tracked gross energy savings. This is mainly due to the adjustments made by the Evaluator for the unitary savings of MSHPs installed in fully electrically heated households, which accounted for 73 percent of the total savings. The evaluated net energy savings are 20 percent below the tracked value. This difference is due to the significant decrease in the NTGR compared to the value tracked by ENS. ENS used the 2017 average NTGR to track net savings in 2018 which was based on a majority of participants that took part in a previous version of Green Heat that required pre-approval, and this participation process was known to result in lower free-ridership.

The evaluated gross peak demand savings were slightly adjusted upward, by 3 percent because of minor adjustments made to the tracked values of heat pumps measures since some participants had nil tracked values. The evaluated net peak demand savings are 18 percent below the tracked value, also because of the decrease in the NTGR.

Green Heat Market Evolution

For a second year, the Evaluator completed a market evolution assessment by analyzing key market indicators for MSHPs. The Evaluator gathered additional information in 2018 to draw conclusions on the state of the market for MSHPs and present a technology diffusion curve illustrating the market adoption of MSHPs in Nova Scotia. A key source of information for this analysis was heat pump data and assumptions from the 2018 Nova Scotia Power load forecast. In addition, the evaluator completed in-depth interviews with seven MSHP distributors in Nova Scotia.

In 2017, an estimated 24 percent of all Nova Scotians had a heat pump as either a primary or secondary heating source. Distributors indicated that MSHP sales had to grown considerably in 2018, in part driven by hot, humid weather in Nova Scotia. The distributors expect growth in 2019, although they predict the rate of MSHP sales growth to be decreasing, with a larger portion of market demand being driven by new constructions and the replacement market.

Distributors reported that MSHPs have become an increasingly attractive option for Nova Scotians due to factors such as the proven technology, increased reliability at colder temperatures, the air-conditioning option, and longer warranties than older models. In addition, distributors reported that Green Heat eligible MSHPs are becoming more and more the norm, with lower efficiency MSHPs being more common for new constructions and for air-conditioning applications only.

Participating distributors reported that Green Heat qualified MSHPs constituted nearly 80 percent of 2017 MSHPs sales. The Evaluator estimated that about a quarter of MSHPs sold in Nova Scotia received an incentive from ENS through either Green Heat or HEA.

The analysis of market evolution suggests that the MSHP market is transforming from a steady growth phase to a product maturity phase as more and more Nova Scotians adopt MSHPs.

Green Heat Recommendations

The Evaluator noted that Green Heat participation increased significantly in 2018 (by 67%), likely due to changes to the application process and ENS promotional efforts. Changes in free-ridership levels and the MSHP market were also observed and will need to be considered in future planning. In addition to the general recommendations made for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator makes the following recommendations on how to improve Green Heat. These recommendations are also listed in Appendix X.

2018 GH-R1. Improve the accuracy of the information in the tracking sheet. While reviewing the data for the ducted ASHP billing analysis, the Evaluator noticed that the information on primary and secondary heating systems found in the tracking sheet was unreliable. Two reasons were identified for this issue: 2017 participants considered in the billing analysis used a previous version of the application form, which did not clearly identify which system (new or old) was being described. There were also numerous data entry errors between the application form and the tracking sheet. The information on heating systems is essential to the billing analysis. The Evaluator found that the technical characteristics (such as heating capacity) of some heat pumps were not consistent with the values found in the reference measures list. The Evaluator therefore recommends improving the quality assurance processes for the Green Heat tracking sheet.

2018 GH-R2. Continue monitoring barriers to the adoption of high-efficiency MSHPs to adapt the program component offer or plan for an exit strategy. The market indicators presented in the Market Evolution section of this report reveal the growing popularity of MSHPs in Nova Scotia. Results also indicate that the rebate is less and less important in fostering the development of the MSHPs market and that the latter is growing due to factors external to Green Heat.

Evaluation results also highlight that Green Heat still had some influence on how efficient the MSHPs purchased were in 2018. In this context, the Evaluator suggests that ENS continue incenting high-efficiency MSHP models in the short term, while monitoring barriers to high-efficiency MSHPs to understand if interventions in the market are still useful or if the measure needs to be removed or limited to those segments with lower high-efficiency MSHPs penetration rates, such as new constructions and multi-unit buildings.

Efficient Product Installation

Available to all Nova Scotia residents, EPI provides homeowners and tenants with free-of-charge direct installation of energy efficient products such as light-emitting diode (LED) lamps and nightlights, low-flow showerheads, pipe insulation, and smart power controllers for audiovisual equipment. EPI also encourages participants to consider other ENS residential program components. EPI debuted in 2017, with the merger of Rental Properties & Condos (RP&C) and Residential Direct Install (RDI).

The 2018 evaluation of EPI was based on a program component documentation review, an interview with the program manager, a telephone survey of 100 participants, and a unitary savings review.

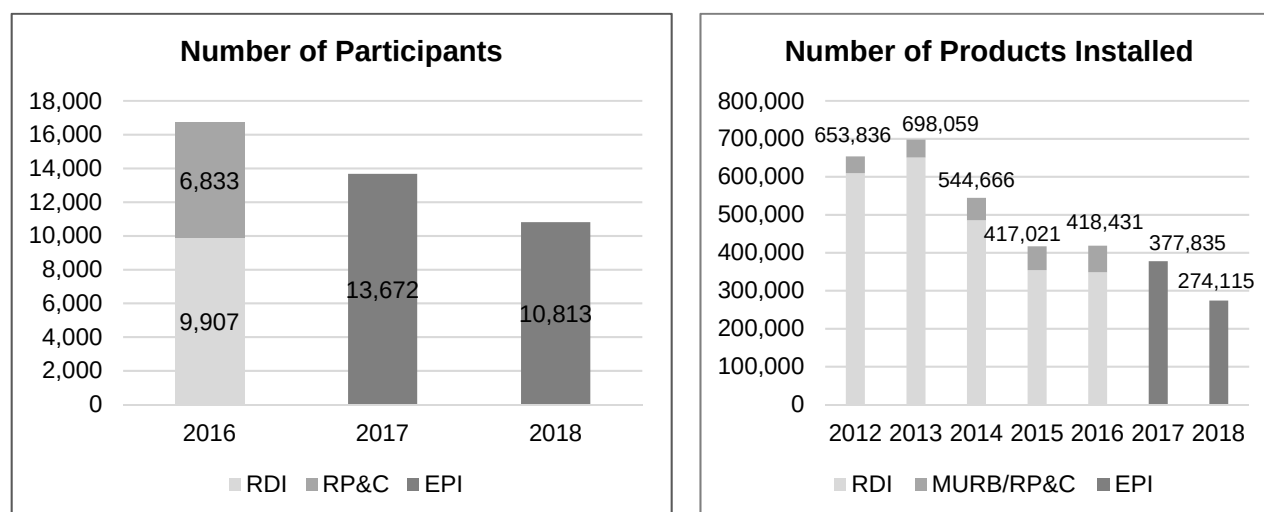
EPI Key Findings

EPI Performance

EPI aimed to achieve 17.1 GWh in net electrical energy savings and 2.0 MW in net peak demand savings at the generator in 2018. The Evaluator determined that EPI achieved 12.777 GWh in net electrical energy savings and 1.463 MW in net peak demand savings at the generator in 2018. These savings represent 7,827 tonnes of CO₂e in terms of annual avoided GHG emissions. EPI's net lifetime energy savings were established at 107.988 GWh, which yields a weighted average EUL value of 8.45 years.

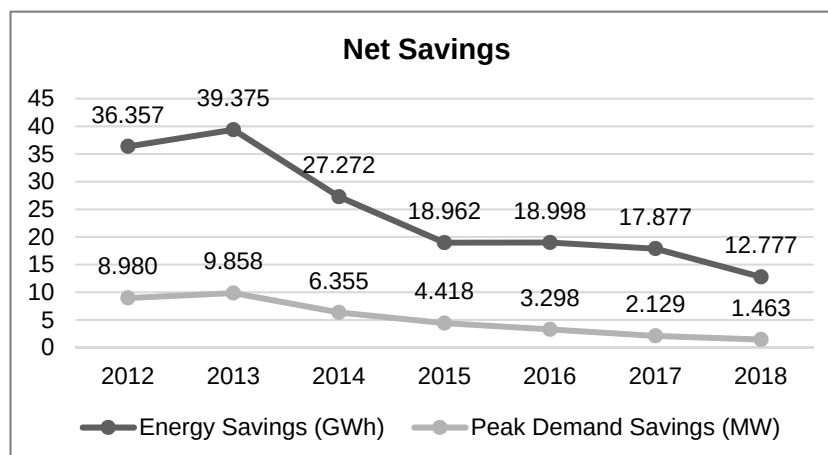
As highlighted in Figure 3 below, 10,813 households participated in EPI in 2018, through which a total of 274,115 efficient products were installed. The decline in participation level over the years is mainly due to the decreasing pool of potential participants. The number of installed products per household remains high due to the large proportion of participants living in single-family homes, which typically have many installation opportunities due to not only the size of the dwellings, but also broader needs for varied product types. In efforts to stimulate the participation level, ENS issued a free clothesline to all participants who participated in EPI between July and November 2018, with 3,246 clotheslines being distributed. In 2018, ENS also diversified its product offering to include additional non-A-type lamps⁴ and non-lighting products such as thermostatic shower valves. Importantly, A-type LED lamps remain the most popular product type, representing 64 percent of products installed and accounting for 53 percent of EPI gross savings.

Figure 3: Overview of EPI Performance (Previously RDI and RP&C)⁵



⁴ PAR20 and PAR38.

⁵ The Multi-Unit Residential Building (MURB) program component became the RP&C program component in 2014.



EPI Market Evaluation Highlights

EPI achieved a very high level of satisfaction among participants, who rated the component an average of 9.3 on a 10-point scale. Similar to past evaluations, the main reason provided for this high level of satisfaction was interactions with installers. Other aspects of EPI, such as the quality of work completed, the time required to complete the work, and the information received about energy efficient products, also received strong satisfaction ratings ranging from 9.3 to 9.5 on a 10-point scale. Although installed products received a high satisfaction rating of 8.9 overall, the thermostatic shower valve received a somewhat lower rating with an average of 7.3 on a 10-point scale.

Most survey respondents (62%) reported receiving information from the installer about energy efficient products. The majority of those who did not (68%) said they would be interested in receiving information about such products.

Participants reported that a lack of funds is the greatest barrier to energy efficiency upgrades in the home. By offering free-of-charge installation of energy efficient products, EPI addresses the main barrier to energy efficient upgrades.

The Evaluator probed respondents about their interest in having specific products installed in their home. Of the products suggested, interest was highest in a door sweep to seal any gaps at the bottom of exterior doors and lighting controls for porch lights (respectively 81% and 74% of respondents said they were interested).

EPI Energy Savings

To calculate EPI gross energy savings, the Evaluator performed a literature review of the unitary savings values of each category of product tracked and installed through EPI.

The Evaluator found that the values used to track the energy savings of lighting products were valid and required no adjustments. The Evaluator updated the unitary savings values for DHW consumption products, namely faucet aerators, low-flow showerheads, and thermostatic shower valves. For these products, the Evaluator updated the average number of people per household and the percentage of hot water used in showers, which resulted in lower unitary savings values. Following a literature review, the unitary savings value used for retractable clotheslines was also revised downward by updating the average annual number of laundry loads per household and the number of displaced loads.

The installation rates used in 2018 are based on the 2017 evaluation site-visit results, except for products that were introduced in 2018. The Evaluator based the new product installation rates, established at 87 percent for thermostatic shower valves and at 86 percent for retractable clotheslines, on participant surveys conducted in 2018. In contrast to other products offered in EPI, clotheslines were not installed by the service provider. Participants received clotheslines upon participation, between July and November 2018, and due to the timeline of the giveaway some survey respondents had not had the chance to install and use their clothesline when the survey was conducted. The Evaluator therefore included participants who reported planning on installing their retractable clothesline in the installation rate in addition to those who reported already having installed it. If ENS continues the clothesline giveaway in 2019, the Evaluator suggests that clotheslines be distributed earlier in the season and that the installation rate calculation be adjusted to better reflect the actual rate of participants who installed this product.

Net energy savings were estimated using a NTGR that represents the proportion of gross savings that can be reliably attributed to EPI. The NTGR was separately established for non-low-income owners and tenants because the Evaluator expected different results for each group. For low-income participants, the NTGR was assumed to be 1.

To estimate the NTGR, the Evaluator measured free-ridership for the two major products, LED lamps and low-flow showerheads, and considered free-ridership nil for the other products. The free-ridership level was established at 23 percent for LED lamps and 8 percent for low-flow showerheads. The Evaluator established a participant spillover level at 3 percent. Overall, the weighted average NTGR for low-income and non-low-income participants combined was established at 0.91, as shown in Table 6.

Table 6: EPI Net-to-gross Ratios

	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	0.80	1.00	0.95	1.00	1.03	1.00
Proportion of Gross Savings	69%	31%	68%	32%	69%	31%
NTGR for All Participants	0.86		0.97		1.02	
Overall NTGR	0.91					

In 2018, EPI generated 12.777 GWh in net energy savings and 1.463 MW in net peak demand savings at the generator. Net lifetime savings were estimated at 107.988 GWh. Table 7 below compares the tracked and the evaluated savings at the generator.

Table 7: Comparison of EPI Tracked and Evaluated Savings at the Generator

	Initial Gross Savings	Adjusted Gross Savings	NTGR*	Net Savings
Energy Savings				
ENS Tracked Savings	16.093 GWh	14.468 GWh	0.93	13.480 GWh
Evaluation Results	15.914 GWh	13.997 GWh	0.91	12.777 GWh
Peak Demand Savings				
ENS Tracked Savings	1.721 MW	1.650 MW	0.93	1.536 MW
Evaluation Results	1.676 MW	1.614 MW	0.91	1.463 MW
*The average NTGR values listed in this table correspond to the ratio of net savings to gross savings for all product categories combined.				

The evaluated net energy savings are 5 percent lower than the tracked net energy savings. The small decreases in both the overall installation rate (from 0.90 to 0.88) and the overall NTGR value (from 0.93 to 0.91), as well as the unitary savings adjustments, contributed to the slight difference between tracked and evaluated energy savings.

The evaluated net peak demand savings are 5 percent lower than those tracked by ENS. This difference is mainly due to unitary savings values adjustments for low-flow showerheads, faucet aerators, and thermostatic shower valves, which together account for 24 percent of gross peak demand savings. The impact of the unitary savings adjustments is greater on peak demand savings than on energy savings because DHW products account for a larger proportion of peak demand savings. Furthermore, the change in the overall NTGR value (from 0.93 to 0.91) also contributed to the difference between tracked and evaluated peak demand savings.

EPI Recommendations

Having operated in the market for several years, EPI still succeeds in achieving high levels of participation and savings. Moreover, participant satisfaction remains very high. The biggest challenges for EPI in the coming years will relate to the diminishing opportunities to recruit participants due to market saturation. Furthermore, opportunities to install A-type LED lamps in participating households will continue to decline. ENS has already taken actions to diversify the type of products offered through EPI, which contributed to maintaining a high number of products installed per household.

In addition to the general recommendations made for all ENS program components in the Overall Evaluation Executive Summary of the 2018 DSM Programs, the Evaluator provides one main recommendation on how to improve EPI, which is presented here and in Appendix XVII.

2018 EPI-R1. Better inform participants about thermostatic shower valves. In 2018, ENS expanded EPI product offerings by including thermostatic shower valves. The evaluation revealed a moderate satisfaction level with this new product. Due to the novelty of this product, the Evaluator recommends that ENS continue working with service providers to deliver high-quality information to participants regarding thermostatic shower valves. The information can be shared verbally upon installation or a pamphlet can be left behind. Experience demonstrates that improving product information can help lower product removal. It can also improve satisfaction levels since participants value receiving information about the products installed.

INTRODUCTION

Efficiency Nova Scotia (ENS) is operated by EfficiencyOne, an independent, non-profit organization. ENS 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 various segments of the population. ENS has a demand-side management (DSM) portfolio of three residential programs and three business, non-profit and institutional (BNI) programs. Each program has one or more program components that ENS markets to Nova Scotians. ENS receives funding for its activities from Nova Scotia Power (NSP) and the Province of Nova Scotia (PNS). The funds received from NSP cover the costs of activities designed to help reduce electricity consumption, whereas funds from the PNS are primarily used for activities designed to help reduce the use of other fuels.

Econoler was commissioned to evaluate ENS's 2018 DSM program portfolio comprised of six electricity efficiency programs and assess the impacts of energy efficiency codes and standards introduced in Nova Scotia. To carry out this assignment, Econoler collaborated with Research Into Action, Equilibrium Engineering and Corporate Research Associates (CRA). 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 impact evaluation calculations, as well as preparing and reviewing evaluation reports. Research Into Action carried out the process evaluations, while Equilibrium Engineering conducted the on-site visits and contributed to some impact evaluation analyses. CRA conducted interviews and surveys with participants and partners, as well as analyzed and reported on the data collected from these activities. Throughout this report, this team is referred to as the Evaluator.

Table 8 below lists the various programs assessed as part of the 2018 evaluation and indicates their respective components and the types of evaluations conducted. In this table, "C" means a complete evaluation and "R" indicates that reduced evaluation activities were performed. Moreover, Section 1 of the DSM Programs Evaluation Executive Summary presents the scope of work in further detail, along with the rationale for the types of evaluations performed for each program component.

Table 8: Types of Evaluations Conducted for Each Program Component

Program	Program Component	2017			2018		
		Process	Market	Impact	Process	Market	Impact
Residential Efficient Product Rebates Program	Appliance Retirement			R		C	C
	Instant Savings		R	R		C	C
Existing Residential Program	Home Energy Assessment		C	C			R
	Green Heat	C	C	C		C	C
	Efficient Product Installation		C	C		C	R
New Residential Program	New Home Construction		C	C	C		C
Efficient Product Rebates Program	Business Energy Rebates		C	R	C	C	C
Custom Incentives Program	Custom	C*	C	R	C**	C	C
	Energy Management Information Systems		C	C		C	C
	Strategic Energy Management***					C	C
Direct Installation Program	Small Business Energy Solutions		C	C		R	R
* The process evaluation specifically targets the Retrofit service of the Custom program component. ** The process evaluation specifically targets the New Construction service of the Custom program component. *** Due to the start date of the latest Strategic Energy Management (SEM) cohort, SEM did not have any participants who achieved savings in 2017; therefore, no evaluation was conducted for 2017.							

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

This evaluation report is for the Existing Residential program, which is comprised of three components: Home Energy Assessment (HEA), Green Heat, and Efficient Product Installation (EPI). In 2017, all program components underwent complete market and impact evaluations. In 2018, Green Heat underwent complete market and impact evaluations, while the evaluation scopes of HEA and EPI were reduced because key parameters evaluated in previous years were steady and no recent changes were made to the program components. Each program component description, evaluation methodology and main evaluation findings are presented in the following sections.

1 HEA OVERVIEW

This evaluation report first focuses on the HEA evaluation results, and then presents the results of the Green Heat and EPI program components.

This section describes the HEA program component, follows up on the 2017 evaluation recommendations and provides an overview of participation history.

1.1 Description

HEA is an energy efficiency evaluation-based service that encourages homeowners to improve the energy efficiency and comfort of their home while reducing energy consumption. HEA uses the EnerGuide home evaluation framework and is administered in collaboration with Natural Resources Canada (NRCAN). HEA is supported by seven delivery agents (DAs) across Nova Scotia, who provide pre and post-retrofit assessments (also referred to as a D assessment and E assessment respectively). HEA also provides educational activities and financial incentives to homeowners in the form of rebates or low-interest financing for the implementation of energy efficiency upgrades.

Participating homeowners initiate the HEA process by contacting one of the DAs serving their area to schedule a pre-retrofit assessment with an energy advisor (EA). EAs are hired by DAs to perform comprehensive energy assessments. The pre-retrofit assessment serves to examine the house, complete a blower door test, and collect information such as insulation levels (attic, exterior walls, etc.), the number and types of doors and windows, as well as the types of ventilation, heating, and hot water systems. The EA also educates and informs participants about their house as a system and discusses possible effective upgrades for achieving energy savings. These assessments provide an opportunity to educate as many potential participants as possible across Nova Scotia about the benefits of renovating their homes to improve energy efficiency and comfort levels. Once the pre-retrofit assessment is completed, a home energy assessment report (entitled the Renovation Upgrade Report) is sent to the homeowner within a few weeks. This report includes a set of upgrade recommendations and an EnerGuide rating of the home. The EnerGuide rating, along with the efficiency levels of the proposed upgrades, is calculated using HOT2000, a simulation tool developed by NRCAN. Since September 2017, a new version of HOT2000 and of the rating system have been put in place; with these new versions, a rating in GJ reflects the modelled consumption of a home and 0 GJ is the best rating a home can achieve.

Homeowners have 12 months to complete the upgrades they decide to undertake and schedule a post-retrofit assessment. Upgrades can be completed by a contractor or the homeowner. During the post-retrofit assessment, the EA verifies the upgrades and performs another blower door test. Based on the results of the post-retrofit assessment, a final EnerGuide rating is established. The cost of the pre-retrofit assessment to homeowners is \$99, and the post-retrofit assessment is provided to participants as a no-cost service.

HEA provides rebates or low-interest financing to perform eligible energy efficiency upgrades. Eligible measures include building envelope measures such as draft proofing, installing ENERGY STAR® certified windows, doors, or skylights, as well as insulation to exterior walls, exposed floors, attics, basements, and crawlspaces. Eligible measures also include space heating, water heating, and ventilation measures, such as heat pumps, wood stoves, heat pump water heaters (HPWHs), heat recovery ventilators (HRVs), etc. Participants receive a maximum incentive of up to \$5,000. In July 2018, HEA updated the incentive structure by removing the tiered rebates to simplify the program component. The rebate amount for each measure was only slightly adjusted, with the exception of HPWHs for which the rebate was increased substantially (previously ranging from \$250 to \$350 depending on the rebate tier, now a flat rebate of \$400). Also, rebates for heat pumps are now estimated in dollars per tonne of installed capacity instead of a fixed rebate based on a list of specific criteria.

On July 10, 2018, HEA received funding from the federal government Low Carbon Economy Fund (LCEF) via the Government of Nova Scotia to allow HEA to provide the same service to non-electrically heated homes since they did not qualify for participation under the previous funding structure. The rebate amounts and criteria remain unchanged whether the home is electrically or non-electrically heated. The savings associated with measures installed after July 10, 2018, which displace non-electrical energy consumption, will be reported in the PNS Evaluation Report and are therefore not included herein.

HEA aimed to achieve 7.5 GWh in net electrical energy savings and 2.1 MW in net peak demand savings at the generator for 2018.

1.2 Follow-up on the 2017 Evaluation Report Recommendations

HEA was evaluated in 2017 and improvement recommendations were made by the Evaluator. Table 9 below provides a summary of the implementation status of each recommendation presented in the Executive Summary section of the 2017 Evaluation Report.

Table 9: Implementation Status of 2017 Recommendations for HEA

2017 Recommendation	Status
2017 HEA-R1. Review the current incentive structure to look for possible ways to simplify it.	Implemented
2017 HEA-R2. Conduct a billing analysis to review the overestimation ratio (OR).	Implemented

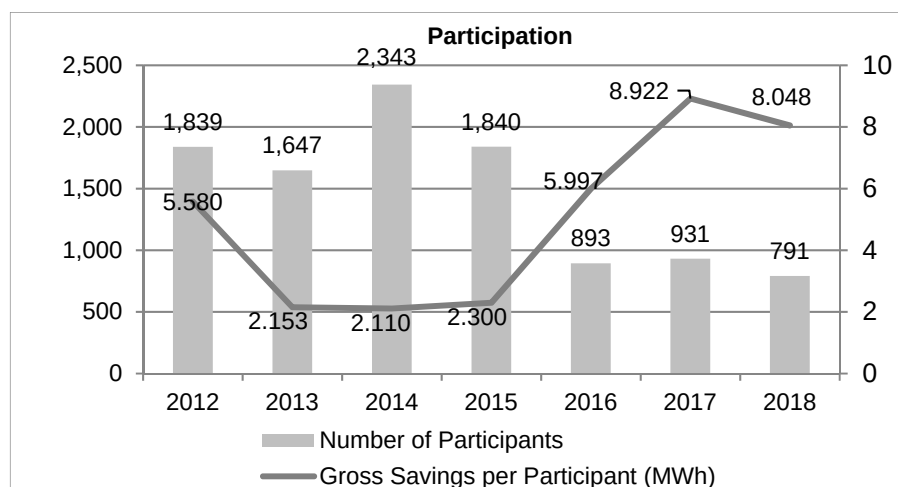
Both 2017 recommendations were implemented. Pursuant to recommendation 2017 HEA-R1, ENS reviewed the rebate guide and updated the incentive structure. The bundling and tiered structure was discontinued to simplify the program component for participants. The new incentive structure was launched in July 2018. As for recommendation 2017-HEA-R2, a HOT2000 billing analysis was conducted to estimate the ORs applied to the simulation models using the new version of HOT2000. The results of this analysis are presented in the Impact Evaluation section of this report.

1.3 Participation History

As presented in Figure 4 below, 791 participants completed an E assessment under HEA in 2018, representing a 15 percent decrease in participation level compared to 2017. The number of participants refers to those participants whose projects generated electrical savings, regardless of whether their homes were primarily electrically heated. In 2018, insulation measures as well as heat pump installations remain attractive measures under HEA: 57 percent of participants installed windows, doors, or skylights; 53 percent installed mini-split heat pumps (MSHPs); and 51 percent air sealed their homes. On average, participants implemented two individual measures in their home under HEA.

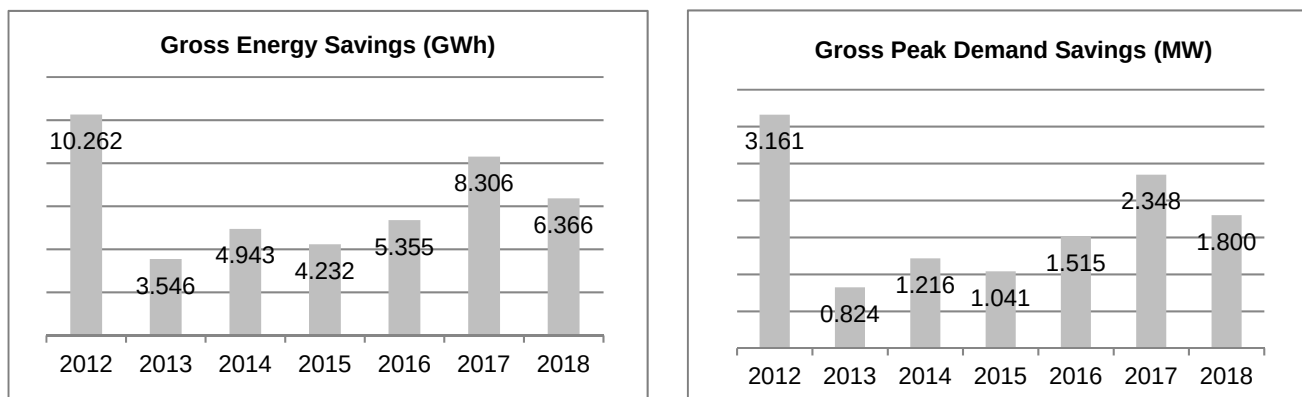
Figure 4 illustrates a decrease in the gross savings per participant compared to 2017. This lower value is mainly explained by an adjustment to the OR through the application of a specific value depending on the installed heating system (see Subsection 3.2.2 for more details). In upcoming years, the recent addition of funding for non-electrically homes may also have a downward impact on electrical savings per participant because space heating is the main source of savings under this program component and HEA participants will have a bigger portion of their savings claimed as non-electrical.

Figure 4: Overview of Participation in HEA, 2012-2018



As a consequence of the lower participation level and the above-mentioned reduction in savings per participant, HEA total gross energy and peak demand savings were also lower than 2017 levels. In 2018, HEA achieved 6.366 GWh in gross electrical energy savings and 1.800 MW in gross peak demand savings. Figure 5 below provides an overview of the evolution of HEA gross savings from 2012 to 2018.

Figure 5: Evolution of HEA Gross Savings, 2012-2018



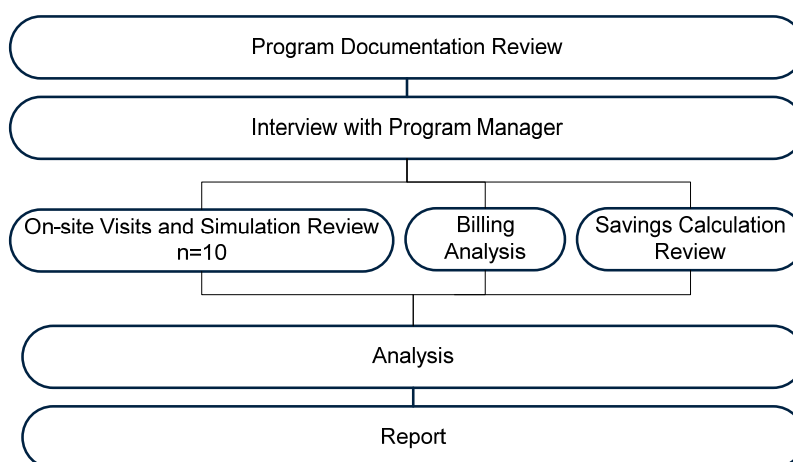
2 HEA EVALUATION OBJECTIVE AND METHODOLOGY

The main objective of the HEA evaluation is as follows:

- › Calculating program results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions

This section presents the methodology used to achieve the aforementioned objective. Figure 6 illustrates the research strategy employed and the data-collection activities carried out in the 2018 HEA evaluation.

Figure 6: HEA Methodological Model



The Evaluator first reviewed program component documentation and then met with the program manager in September 2018 to verify the implementation status of the previous evaluation recommendations and learn about recent program component changes. Based on the information obtained from this interview, a list of questions and topics to be included in the data-collection instruments was prepared.

Once the meeting with the program manager and the program component documentation review were completed, specific evaluation activities were undertaken as described in the following subsections.

For evaluation activities that yield quantitative results based on a sample, the Evaluator aimed to achieve a maximum margin of error of 10 percent at a confidence level of 90 percent. 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 percent of the time. Thus, the margin of error indicates the relative level of precision⁶ of the measurement, while its associated confidence level indicates the probability of a measure falling within this margin of error.⁷

As part of the HEA evaluation, the Evaluator calculated the margins of error for free-ridership and spillover levels, and ORs. The margins of error are presented alongside the results in the applicable sections. Examples of calculations used to establish margins of error are provided in Appendix II of the 2018 DSM Programs Evaluation Executive Summary.

On-site Visits and Simulation Review

As part of the evaluation, 10 HEA projects were reviewed. The project reviews consisted of: (1) an on-site visit at participating houses after the completion of the post-retrofit assessment (or E assessment); and (2) an assessment of the HOT2000 simulations used for the D and E assessments for the 10 houses. The main purposes of the on-site visits and simulation file verifications were to validate the on-site information collected by EAs in their data-collection forms (DCFs), input data, sketch drawings, assumptions used in the simulation files, and any additional information provided to the Evaluator by the DAs. The assumptions were reviewed to ensure that they were all within realistic ranges and reflected the actual energy performance of the houses assessed. The visits also served to visually confirm the changes made to the houses further to the D assessment. The on-site visits and simulation reviews were conducted by EcoPlus.

More information on the on-site visits is presented in the Impact Evaluation section of this report. The on-site visit and HOT2000 simulation review protocol is presented in Appendix I.

Billing Analysis

As part of the 2018 evaluation, a billing analysis was conducted to revise the OR used since the last billing analysis conducted as part of the 2015 evaluation. The new billing analysis served to compare each participant's electricity billing consumption to the electricity consumption obtained from the HOT2000 simulation models. Further explanations on the methodology used for this analysis are presented in the Impact Evaluation section of this report and in Appendix II.

⁶ 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.

⁷ 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.

Savings Calculation Review

For HEA, energy savings are calculated using the space heating consumption values obtained from the HOT2000 simulation models and by applying the ORs obtained from the billing analysis. For the few space heating and water heating measures whose savings are not calculated in HOT2000, unitary savings values are used. Savings deductions are also applied for those participants who participated in both HEA and Green Heat. The Evaluator reviewed the different steps used in the tracking sheet to calculate savings.

Comparison with 2017 Evaluation Scope

No market evaluation was carried out for HEA in 2018; hence, no participant survey was conducted. The impact evaluation scope was considered reduced since net-to-gross ratios (NTGRs) were not measured in 2018. The rationale behind these choices is based on analysis of 2018 evaluation objectives, key results of previous evaluations, and recent changes made to each program in the ENS portfolio. Further explanations are provided in Section 1 of the DSM Programs Evaluation Executive Summary.

3 HEA IMPACT EVALUATION

The objective of the 2018 HEA impact evaluation is to determine gross and net electrical energy and peak demand savings.

3.1 On-site Visits and Simulation Reviews

As part of the 2018 evaluation, the Evaluator conducted on-site visits and reviewed the simulation files of ten projects selected among those that generated electrical savings and completed both a D assessment and an E assessment. As in 2016, a stratified sampling methodology based on project sizes was adopted to select a sample that is representative of the program component population.

The purpose of these reviews was to determine the completeness and accuracy of the information in the simulation files and DCFs by comparing it with the information collected during the on-site visits. A qualitative review was conducted to gain insights on EA assessment documentation and processes; it was not aimed at calculating any adjustments to savings. The protocol used to gather information during the site visits was based on the EnerGuide home evaluation framework on how to conduct home assessments provided by NRCan to the EAs. The protocol was more complete than the one used in 2016 due to the new version of the EnerGuide Rating System (version 15), which requires more data to be collected and more detailed measurements to be conducted on-site by the EAs.

Overall, the information provided in the DCFs on the implemented energy efficiency upgrades were found to be comprehensive. Since the last review in 2016, significant improvements have been made in both the quantity of measurements as well as the accuracy of the data collected. The simulation file reviews confirmed that the EAs adapted their analyses to comply with the new EnerGuide requirements. The Renovation Upgrade Reports (RURs) were more uniform and of higher quality. Importantly, it appeared that most RURs contained fewer recommendations than in those for the projects reviewed in 2016. Only one or two recommendations were provided for each participant. Installing a high-efficiency heat pump was systematically recommended in the reports. Attention should be paid to recommending more upgrades when possible to leverage the opportunities offered by HEA and avoid focusing only on the heat pump measure.

For the DCFs, some information was missing in seven of the 10 reviewed files and, on average, four discrepancies were recorded per file. More particularly, the drawings and sketches included in the DCFs were found to be incomplete or unclear in several files. Since the DCFs serve to confirm that the data are correctly recorded in the HOT2000 simulations, this document needs to be complete and clear. Improvements could be easily made to the DCFs in accordance with certain good practices, more specifically: distinguishing interior from exterior dimensions; clearly identifying unheated areas; and providing a single drawing for each floor to facilitate reading information.

As for the simulation files, either the D or the E assessment energy consumption value was adjusted in all ten projects (i.e. 35 adjustments to the D assessment files and one adjustment to an E assessment file) to align them with the NRCan protocol. According to NRCan, HOT2000 simulations are considered accurate as long as the errors impact the total annual energy consumption value by less than 5 percent. Of the projects reviewed, three contained errors affecting energy consumption by more than 5 percent, while the seven others were within the acceptable range defined by NRCan. The global adjustment for the ten projects was less than 1 percent for the reviewed D assessment and E assessment files. This demonstrates the assessment process conducted by the EAs has significantly been improved since both the last on-site visits and simulation reviews conducted by the Evaluator in 2016.

Table 10 below summarizes the results of the reviews on both the D assessment and the E assessment. The percentages are only presented to provide an order of magnitude of the adjustments made, which are minimal overall and are not meant to be applied to the gross savings results. More specific observations are described in the following subsections on the specific house features considered in the HOT2000 simulations, namely: building envelope constituents; heating ventilation and air conditioning (HVAC) equipment; and water heating equipment.

Table 10: Results of On-site Visits and Simulation Reviews for HEA

	D Assessment		E Assessment	
	Positive Adjustment	Negative Adjustment	Positive Adjustment	Negative Adjustment
Building Envelope Constituents	2.5%	-1.6%	2.5%	-1.6%
HVAC Equipment	2.1%	-1.0%	2.5%	-1.6%
Water Heating Equipment	0.1%	-0.1%	0.1%	-0.1%
TOTAL	0.6%		0.4%	

Building Envelope Constituents

The review of HOT2000 simulations confirmed that building envelope constituents were generally recorded and transcribed accurately by EAs; the discrepancies found had an impact of less than 2 percent on the energy consumption of reviewed households. That being said, the review highlighted common mistakes made by EAs, which mainly related to the geometry, assumptions, and transcriptions of results.

The house dimensions (e.g. volume, area, length, height or perimeters of the ceilings, attics, walls, floors, basements, windows, and doors) were considered accurate since the project with the greatest geometry error impacted total household energy consumption by less than 2 percent. For this project, the EA recorded a total ceiling area (635 sq. ft) that greatly exceeded the floor area (260 sq. ft) surface. The specific dimensions recorded for each window were more precisely identified since this measurement was one of the significant differences included in the new version of the EnerGuide system.

While on-site measurements were precise, several assumption errors were identified in the HOT2000 simulations regarding building envelope constituents. None of these assumptions affected energy consumption by more than 5 percent. The most common mistake related to the basement configuration in the wall/floor section of HOT2000, for which the wrong configuration was used to model the foundation. This was the case in four projects. The EA gathered the information correctly but did not record it correctly in the simulation file. This was caused by the EA's incomplete knowledge of one or several guidelines contained in the HOT2000 User Manual. Another inconsistency related to window orientation; windows were sometimes modelled using the wrong orientation. While being negligible for a single window, the impact of this mistake on overall energy consumption is significant when it affects all windows. This was the case in one project that had a downward impact of 3 percent on total household consumption. Some specific mistakes regarding thermopane window assumptions more significantly affected energy consumption results. In one case, this had an upward impact on the energy consumption of the house by more than 4 percent. Generally, there were no indications on the thermopane window that specify if it is filled with argon or air. In such cases, it is the responsibility of the EA to make assumptions. Unless there is proof to support that the glass is indeed filled with argon and unless said proof is provided with the advisor file, it is advisable that the EA consider windows dating from the late 80s as being filled with air. This would provide more conservative results when the information is unavailable on-site.

In four of the reviewed files, the data recorded in the DCFs were not correctly transcribed in the HOT2000 simulations. In one of these cases, the EA recorded no insulation for the basement slab in the DCF, although R12.5 insulation was recorded in the HOT2000 simulation. This error downwardly impacted the energy consumption of the house by 3 percent. Therefore, the Evaluator recommends that EAs double-check their measurements and make sure they correctly record all details related to the assessed house.

HVAC Equipment

The EnerGuide Rating System (version 15) includes enhanced specifications for HVAC equipment. The protocol describes in greater detail which data must be collected to provide a more standardized home assessment, especially when specification sheets are not available. The specifications provided by the new EnerGuide version enabled EAs to successfully collect the specifications for the new equipment recorded during the post-retrofit evaluation. The review also revealed that the values recorded for equipment efficiency were investigated by EAs and corresponded to the data provided in manufacturer technical datasheets. Supplementary heating was also recorded properly.

Overall, in the ten reviewed files, 16 errors related to HVAC equipment were identified, three of which had an impact greater than 5 percent on energy consumption. In one file, the Evaluator noted that a broken wall-unit heat pump was not recorded since the equipment was not in working condition. Since the guidelines specify that any heating equipment installed in a house should be recorded, whether it works or not and whether it is used or not, this unit should have been modelled because it is part of the baseline equipment. This omission had an upward impact of 6 percent on household energy consumption. Typing errors related to HVAC equipment were also found to have a significant impact on the overall energy consumption of households in two files. In one file, the heat pump seasonal energy efficiency ratio (SEER) was recorded as 29.3 in the house, although it was selected as two in the simulation file. This divergence had an upward impact of 7 percent on the total energy consumption of the house. In another file, the main heating system was radiant floor heating connected to an electrical boiler. The boiler was modelled correctly whereas the radiant heating screen was not completed, which reduced the overall energy consumption of the household by 14 percent.

Additionally, errors in the HRV flow rate were identified in several files. Generally, once an HRV flow rate is calibrated, the corresponding efficiency of the system is not available. In this case, EAs must evaluate efficiency based on the data listed on the nameplates on-site. The NRCan protocol describes how the flow rate should be determined in this situation. For seven reviewed projects, the right procedure was not followed by the EA. This had an overall limited impact of 1 percent in absolute value on energy consumption.

Water Heating Equipment

The characteristics associated to domestic hot water (DHW) equipment were also reviewed. Only standard water heater tanks were recorded for the ten sites reviewed. In general, the information provided for this equipment was accurate and comprehensive, except for tank volume. The unit of measurement used to express water heater tank volume is in US gallons, imperial gallons, or liters. Therefore, EAs should ensure that they record the appropriate unit when collecting this information.

3.2 Gross Savings

Gross savings correspond to the change in energy consumption resulting from the building envelope measures, space heating measures as well as DHW measures implemented by HEA participants, regardless of why they participated.⁸ The Evaluator revised the gross savings tracked by ENS by reviewing the savings calculations for each eligible measure category. The Evaluator made small adjustments to the tracked savings in the number of solar DHWs and HPWHs to ensure that tracked and revised savings were compared on the same basis.

⁸ Definition adapted from: National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

3.2.1 Overview of the Measures

No new energy efficiency measures were made available to participants in 2018. Table 11 below lists the upgrades currently eligible under HEA and identifies the measures for which savings are calculated using HOT2000 energy consumption modelling. Table 11 also presents an implementation rate, which represents the proportion of projects having implemented a given upgrade.

Table 11: HEA Eligible Energy Efficiency Upgrades

Eligible HEA Upgrade Measures	HOT2000 Energy Consumption Modelling Used to Calculate Savings		Implementation Rate (%)
	Yes	No	
Building Envelope Measures			
Attic Insulation	x		23.6
Cathedral Ceiling Insulation	x		
Flat Roof Insulation	x		
Basement Foundation Wall Insulation	x		18.0
Crawlspace Exterior Wall Insulation	x		
Floor Above Crawlspace Insulation	x		
Basement Header Insulation	x		8.7
Exposed Floor Insulation	x		0.4
Basement Slab Insulation	x		0.3
Exterior Wall Insulation	x		15.5
Air Sealing	x		51.2
Windows, Doors and Skylights	x		57.4
Space Heating Equipment			
Ductless Mini-split Heat Pumps	x		53.1
Centrally Ducted Air Source Heat Pumps	x		4.6
Air-to-water Heat Pumps (AWHPs)	x		0.0
Geothermal Heat Pumps	x		0.1
Heat Recovery Ventilators	x		5.1
Wood or Pellet Stoves		x	5.6
Wood or Pellet Furnaces/Boilers		x	0.0
Solar Air		x	0.0
Domestic Water Heating Equipment			
Drain Water Heat Recovery (DWHR)		x	0.0
Solar Domestic Hot Water (DHW)		x	0.1
Heat Pump Water Heaters (HPWHs)		x	0.5

For impact evaluation purposes, the savings calculation was divided into two categories: space heating savings (including building envelope and space heating measures) and DHW savings.

3.2.2 Building Envelope and Space Heating Savings Calculated in HOT2000

Savings for the building envelope and space heating measures were calculated using the following equation:

$$\text{Gross Space Heating Savings (kWh)} = \frac{[(ESHEC_D(MJ) \times (1 - OR_D)) - (ESHEC_E(MJ) \times (1 - OR_E))]}{3.6 \text{ MJ/kWh}}$$

Where:

- › Electrical space heating energy consumption (ESHEC) is obtained from HOT2000 (for the D and E assessments)
- › OR is used to adjust the modelled energy consumption (according to the space heating system in place during the D and E assessments)

The savings calculation is based on the difference (reduction) between D and E assessment ESHEC levels, both of which were adjusted with an OR. In 2017, the Evaluator used an OR of 16 percent for all projects completed under HEA. As part of the 2018 evaluation, a billing analysis was conducted to review the OR used in the calculation of energy savings. The Evaluator suggests using distinct ORs depending on the main heating system in place, as detailed in the OR subsection.

The equation presented above was used in the tracking sheet for all participants who implemented building envelope measures and installed new space heating equipment that influenced the modeled consumption in HOT2000. Developed by ENS, this formula was updated from the 2017 evaluation equation to better reflect both the energy savings associated to fuel switching (i.e. from fossil fuel space heating energy sources to electric heat pump, wood or pellet stoves, or furnaces) and the distribution of savings between DSM funded and PNS funded programs for households that use multiple energy sources.

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 Overestimation Ratio

As illustrated in the space heating savings equation, ORs are used to adjust the modelled space heating consumption values generated by HOT2000 because it tends to overestimate savings. The ORs are obtained by comparing participants' space heating consumption modelled in HOT2000 with their actual space heating consumption obtained from their billing data.

In 2015, a billing analysis was performed with 887 HEA participants whose homes were simulated using prior versions of HOT2000. As part of the 2018 evaluation, a new billing analysis was performed with participants whose homes were simulated using the new version of HOT2000 (version 11). The 2018 billing analysis distinguished participants who had heat pumps installed from participants whose homes were equipped with other electrical heating systems. The billing analysis conducted in 2015 did not allow this distinction to be made because only 1 percent of participants installed a heat pump through HEA in 2015. Whereas in 2018, almost half of HEA participants installed a heat pump. The analysis revealed that the presence of heat pumps had a more significant impact than the version of HOT2000 on the ORs. Also, while both the D and E assessments were analyzed for participants selected for the billing analysis conducted in 2015, only the D assessment period was analyzed for the participants selected for the 2018 billing analysis. Only D assessment periods were analyzed because of the small number of participants using HOT2000 Version 11 who had enough electricity bills after the E assessment. The billing analysis conducted during the 2015 HEA evaluation demonstrated that there were no significant differences between the ORs established for each assessment period.

The Evaluator combined the results of the billing analysis conducted during the 2015 and 2018 HEA evaluation and calculated a distinct OR for three scenarios:

- › A participant who registered **with** a heat pump
- › A participant who registered **without** a heat pump and who did not install one
- › A participant who registered **without** a heat pump and then installed one

The heating system in place during the D and E assessment determines which OR is used to adjust the space heating consumption of each assessment period. No distinction is made in the ORs for the version of HOT2000. Similarly, no division is made in the ORs based on the presence of wood or pellet stoves as secondary heating systems because the sample reflects the mix of space heating systems in place in both scenarios, including the distribution of wood and pellet stoves.

Table 12 presents the ORs established for each scenario. By comparison, the OR used for the tracked savings calculation was 16 percent for all scenarios (the percent calculated during the 2015 billing analysis).

Table 12: Overestimation Ratio Values for HEA

Scenario	OR _D Assessment		OR _E Assessment	
	Tracked	Revised	Tracked	Revised
A participant who registered with a heat pump	16%	0%	16%	0%
A participant who registered without a heat pump and who did not install one		19%		19%
A participant who registered without a heat pump and then installed one		19%		0%

The billing analysis conducted in 2018 was initially aimed at estimating a new OR for the new version of HOT2000, although it revealed that the space heating system in place, particularly heat pumps, has a much more significant impact on the ORs than the difference between versions of HOT2000. Moreover, the Evaluator believes that further analyses should be conducted to evaluate the impacts of the different HOT2000 versions and to confirm that there is still no significant difference between the D and E assessment periods. HOT2000 version 11 will progressively be used more in upcoming years and will enable conducting a billing analysis on a sample of participants large enough to consider both the D assessment and E assessment as well as the various sub-versions of HOT2000 and evaluate the impact of the different heating systems in place, including the presence of wood or pellet stoves.

3.2.3 Wood, Pellet and Solar Air Equipment Savings

Wood, pellet, and solar air space heating equipment is not simulated in HOT2000. Since these types of equipment are also offered under Green Heat, the Evaluator relied on the results of the unitary savings review conducted for the 2018 Green Heat evaluation to establish the savings values for the wood, pellet and solar air space heating equipment installed through HEA in 2018.

Table 13 below lists the tracked and revised savings values for each type of equipment. Solar air equipment was installed under neither HEA, nor Green Heat in 2018. Therefore, no unitary savings value was established for this equipment category.

Table 13: Tracked and Revised Unitary Savings for Wood, Pellet and Solar Air Equipment

Category of Equipment	Tracked Savings Value (kWh)	Revised Savings Value (kWh)
Wood Stove – With Electrical Baseboard Baseline	10,443	No change
Wood Stove – With Heat Pump Baseline	10,443 / Heat Pump Annual COP	No change
Pellet Stove – With Electrical Baseboard Baseline	8,959	No change
Pellet Stove – With Heat Pump Baseline	8,959 / Heat Pump Annual COP	No change
Wood or Pellet Furnace/Boiler	13,765*	No change
Solar Air Equipment	-	-

*For Green Heat, the unitary savings value is 13,804 kWh for wood furnaces or boilers and 13,765 kWh for pellet furnaces or boilers. Considering minor differences in the two unitary savings values and the fact that there are no differentiations in the HEA tracking sheet for wood or pellet, ENS applies the smallest value to both types of equipment. Considering the lack of installations under HEA for these types of equipment (no installation occurred in 2018), the Evaluator considers this approach acceptable for future tracking.

The unitary savings values for wood and pellet stoves depend on the baseline heating system. The baseline for wood or pellets stoves installed under HEA corresponds to the main heating system in place at the E assessment. In the case of electrical baseboards, no adjustment is made to the unitary savings value. In the case of heat pumps,⁹ the unitary savings value is divided by the average coefficient of performance (COP). For Green Heat, a standard heat pump COP of 2.1 is used because no information is available on the heat pump in place. For HEA, the annual COP specific to the installed heat pump is used since this information is available in the tracking sheet. This value is estimated by converting the COP at 47 °F to an annual average COP.¹⁰ The Evaluator considers this approach more accurate and conservative since the heat pump systems installed under HEA are energy efficient units.

To distribute the wood and pellet stove savings between electrical and non-electrical savings, their unitary savings values are multiplied by the percentage of space heating energy from electrical sources during the E assessment.

3.2.4 Domestic Hot Water Savings

Savings for DHW measures are calculated using a unitary savings value specific to each type of measure implemented. The Evaluator established unitary savings for the small number of DHW measures implemented by 2018 participants. 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. Subsection 3.1 discusses the analysis conducted by the Evaluator to review the unitary savings values used by ENS.

⁹ Heat pumps include: ductless mini-split heat pumps; central-ducted air source heat pumps; ground source heat pumps; and water source heat pumps.

¹⁰ The formula used to evaluate the annual average COP is provided by NRCan. The annual average COP is calculated as follows: Annual average COP = (Heat Pump Annual COP - 0.78) / 0.376 / 3.412.

Drain Water Heat Recovery

ENS uses a unitary savings value of 805 kWh per year for DWHR. This value was determined in the 2017 evaluation using the online calculator from the Centre for Energy Advancement through Technology Innovation,¹¹ which takes into account the number of showers per household per day, average shower duration, shower flow, and Halifax groundwater temperature. It was assumed that two showers per day were taken per household and each shower lasted approximately eight minutes. The number of showers per household per day was determined by multiplying the average number of persons per household from the 2016 HEA participant survey (2.4 persons) and the number of showers per person per day (0.67 showers) from the Residential End Uses of Water Study.¹² The average shower duration was also established using the Residential End Uses of Water Study.¹³ The estimated shower flow rate is 9.5 liters per minute, which is based on the maximum rated flow for showerheads in the building code. The shower temperature was set at 41 °C.

The calculation assumed a DWHR system configuration that preheats cold water between the hot water tank and shower and an R3-60 model unit, which meets the HEA minimum efficiency requirement and is included in the list of NRCan eligible models.

The Evaluator considered that the online calculator is still appropriate for estimating the savings generated by an installed DWHR system. No participant survey was conducted in 2018. Based on the 2017 HEA participant survey, the average number of persons per household was revised to 2.4 persons. By multiplying this value by 0.67 showers per day, the number of showers per household per day remains two considering that the online calculator rounds the number to the nearest digit. The other parameters remain unchanged. Therefore, the unitary savings value for DWHR systems remained at 805 kWh. For 2018, no DWHR systems were installed under HEA, although this unitary savings value could be used for future tracking.

Solar Domestic Hot Water

The design details of the solar DHW systems installed through HEA are not included in the tracking sheet. Therefore, the unitary savings value for this equipment is determined based on the average value of DHW systems installed through Green Heat. For solar DHW systems, ENS uses a tracked unitary savings value of 2,803 kWh, which corresponds to the average savings value of the solar DHW systems installed through Green Heat between 2015 and 2017.

¹¹ Centre for Energy Advancement through Technology Innovation (CEATI), *Drain Water Heat Recovery Energy Savings Calculator*, <http://www.ceati.com/calculator/> (Last accessed November 15, 2017).

¹² Mayer, P. W., W. B. Oreo et al., *Residential End Uses of Water*, AWWA Research Foundation, 1999, pp. 99-102.

¹³ Mayer, P. W., W. B. Oreo et al., *Residential End Uses of Water*, AWWA Research Foundation, 1999, pp. 99-102.

The Evaluator updated the unitary savings value for HEA. The new average savings value includes the solar DHW systems installed through Green Heat over the past three years, i.e. between 2016 and 2018, for a total of 40 solar DHW systems.

The unitary savings value was established at 2,945 kWh per year for the solar DHW systems installed through HEA in 2018.

Heat Pump Water Heaters

The annual unitary savings values used by ENS for the HPWHs installed through HEA is the same as the tracked unitary savings values established for the HPWHs installed through Green Heat.

The values were revised as part of the 2018 Green Heat evaluation. The Evaluator still considers the Green Heat savings calculation methodology and values applicable for HEA.

The annual unitary savings for a HPWH installed through HEA was established at 1,312 kWh per year for those participants who had a heat pump prior to the implementation of the measure, and 790 kWh per year for participants who had electrical baseboards as the baseline.

Summary

Table 14 lists the tracked and revised savings values for each type of DHW heating equipment.

Table 14: Tracked and Revised Unitary Savings for Domestic Hot Water Heating Equipment

Category of Equipment	Tracked Savings Value (kWh)	Revised Savings Value (kWh)
Drain Water Heat Recovery	805	No change
Solar Domestic Hot Water	2,803	2,945
Heat Pump Water Heater – With Electrical Baseboard Baseline	771	790
Heat Pump Water Heater – With Heat Pump Baseline	1,257	1,312

3.2.5 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. in the months of December to February on non-holiday weekdays.

For HEA, peak demand savings were calculated using the peak demand-to-energy ratio of 0.283 MW/GWh for space heating savings and 0.162 MW/GWh for DHW savings set by Navigant in the 2016-2018 DSM Plan. These ratios were 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 was therefore used to estimate peak demand savings.

3.2.6 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 the house. In the case of wood and pellet equipment not modelled in HOT2000, it does not have an interactive effect on the heating or cooling loads needed to maintain the desired indoor comfort conditions.

As for DHW measures, interactive effects are considered to be nil with the exception of HPWHs. For HPWH measure, interactive effects are already included in the engineering equation used to calculate the unitary savings value. Therefore, no additional interactive effects factor was applied to the savings.

3.2.7 Effective Useful Life

For the 2018 evaluation, the Evaluator relied on equivalent effective useful life (EUL) values established through a thorough literature review conducted as part of the 2017 evaluation. These values remained valid in 2018.

Table 15 presents the equivalent EUL values for each measure category, as well as the lifetime gross energy savings per unit. In summary, all tracked equivalent EUL values were adequate and no changes were applied by the Evaluator. Only the lifetime savings per unit were recalculated using the 2018 unitary savings values.

Table 15: HEA Equivalent Effective Useful Life Values

Measure	Tracked Equivalent EUL (Years)	Revised Equivalent EUL (Years)	Revised Lifetime Gross Energy Savings per Unit (kWh)
Space Heating Equipment			
Building Envelope	20.0*	No change	-
Space heating Equipment			
Domestic Hot Water Equipment			
Drain Water Heat Recovery Equipment	20.0	No change	16,100
Solar Domestic Hot Water System	20.0	No change	58,900
Heat Pump Water Heater	10.0	No change	13,120
*The EUL value of 20.0 years for building envelope measures and space heating equipment simulated in HOT2000 was established as part of the 2018 HEA evaluation. It corresponds to a weighted average of EUL values associated with building envelopes; space heating measures simulated in HOT2000; wood or pellet stoves; wood or pellet furnaces/boilers; and solar air equipment. The distribution of implemented measures remained stable in 2018, so the average EUL value of 20.0 years was still valid for that year.			

3.2.8 Revised Gross Savings

The annual gross savings at the generator are presented in Table 16 further below. Overall, the annual gross energy and peak demand savings at the generator amounted to 6.366 GWh and 1.800 MW respectively, which represents 127.258 GWh in lifetime energy savings. As a result, the weighted average EUL value for gross energy savings is 20.0 years.

The gross savings at the generator were estimated by using a line loss factor of 1.099 between the meter and the generator. This value was established by calculating a weighted average of the line loss factors of HEA participants according to their rate codes. The residential code has a line loss factor of 10 percent while the municipal rate code, which only accounts for 1 percent of participants, has a line loss factor of 4.6 percent.

Table 16: Revised Gross Energy and Peak Demand Savings for HEA

	Space Heating*	DWHRs	Solar DHW	HPWHs	Total
Number of Participants/Units	791	0	1	4	791
Evaluated Energy Savings					
Unitary Savings Value (kWh/unit)	-	805	2,945	-	-
Gross Energy Savings without OR – at the Meter (GWh)	7.816	-	0.003	0.008	7.825
Revised Gross Energy Savings with OR– at the Meter (GWh)	5.784	0.000	0.003	0.005	5.792
Line Loss Factor	1.099	1.099	1.099	1.099	1.099
Revised Gross Energy Savings with OR – at the Generator (GWh)	6.357	0.000	0.003	0.006	6.366
Effective Useful Life (years)	20.0	20.0	20.0	10.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	127.135	0.000	0.065	0.058	127.258
Peak Demand Savings					
Peak Demand-to-energy Ratio (MW/GWh)	0.283	0.162	0.162	0.162	-
Revised Gross Peak Demand Savings – at the Meter (MW)	1.637	0.000	0.000	0.001	1.638
Line Loss Factor	1.099	1.099	1.099	1.099	1.099
Revised Gross Peak Demand Savings – at the Generator (MW)	1.799	0.000	0.001	0.001	1.800
*Space heating includes building envelopes and space heating measures simulated in HOT2000; wood or pellet stoves; wood or pellet furnaces/boilers; and solar air equipment.					

3.3 Net-to-gross Ratio

The NTGR serves to determine net savings, i.e. the energy savings that can be reliably attributed to a program component. More precisely, the NTGR represents the positive or negative impact of market effects on gross savings. For HEA, two such effects are considered, namely free-ridership and participant spillover.

3.3.1 Free-ridership

Free-ridership occurs when participants would have still implemented energy efficiency measures in the absence of the program component. Free-ridership was assessed in 2017 through a participant survey with HEA participants. No data-collection activities aimed at updating the free-ridership level were conducted in 2018 because the changes made to HEA in the second half of 2018 were too recent for their impacts to be observed in the 2018 evaluation. Therefore, the 2017 level was used for the 2018 evaluation. Table 17 below outlines the measured free-ridership level obtained in 2017.

Table 17: Average Free-ridership Level for HEA

Average Free-ridership Level	Sample Size	Population Size	Margin of Error
25%	61	931	5.2%

3.3.2 Participant Spillover

In 2017, a participant survey was used to assess participant spillover, which occurs when participants implement additional energy efficiency measures recommended in their initial energy assessments after their participation in the program component, i.e. after having completed their final energy assessment. Similar to free-ridership, no data collection aimed at updating the 2017 participant spillover level was conducted in 2018. Therefore, the 2017 level was used as part of this evaluation. Table 18 outlines the measured participant spillover level obtained in 2017.

Table 18: Average Participant Spillover Level for HEA

Average Participant Spillover Level	Sample Size	Population Size	Margin of Error
1%	69	931	4.1%

3.3.3 Net-to-gross Ratio Calculation

The NTGR is calculated using the following equation:

$$NTGR = (1 - \% \text{ free-ridership} + \% \text{ participant spillover})$$

By applying the free-ridership and spillover levels discussed above, a NTGR value of 0.76 was estimated for HEA.

3.4 Unconverted D Assessment Spillover

Since the 2014 evaluation, another spillover effect associated with unconverted D assessment savings has been considered. This effect corresponds to the savings associated with those measures implemented by participants who did not complete an E assessment by the end of the allocated 12-month period (expired participants or unconverted D assessment participants). These savings are added to gross savings as a form of spillover. Since the unconverted D assessment spillover savings do not depend on the number of regular HEA participants, they are accounted for in measurement units instead of a percentage without being included in the NTGR.

In 2016, a survey conducted by ENS with 232 expired participants demonstrated that 54 percent of respondents declared having installed at least one upgrade. An average electrical savings per participant of 2,283 kWh was used for the 2016 evaluation. This value was obtained by averaging the sum of 2,207 kWh and 2,359 kWh, which were the average electrical energy savings with influence from ENS generated by 2014 and 2015 expired participants respectively. E assessments were not conducted for any unconverted D households in either 2017 or 2018. The methodology and the parameters used in the 2016 evaluation were considered still appropriate for determining the total unconverted D assessment spillover savings. Therefore, the value of 54 percent and the average value of 2,283 kWh were also used for the 2018 evaluation.

The total unconverted D assessment spillover savings were calculated using the following equation:

$$\begin{aligned}
 &\textit{Unconverted D Assessment Spillover Energy Savings} \\
 &= (\textit{Total number of unconverted D participants}) \\
 &\times (\% \textit{ who declared having implemented measures after their D assessment}) \\
 &\times \left(\textit{average electrical savings per house visited and weighted} \right) \\
 &\quad \textit{with \% of influence from ENS}
 \end{aligned}$$

Peak demand savings were established by applying the same peak demand-to-energy ratio as that used for space heating measures installed by regular HEA participants because the majority of measures installed by unconverted D participants were building envelope upgrades.

With a total of 679 unconverted D assessment participants, the 2018 unconverted D assessment spillover energy and peak demand savings for HEA were estimated at 0.836 GWh and 0.236 MW at the meter respectively. The number of unconverted D assessment participants initially tracked by ENS was 701. The Evaluator subtracted 22 participants from this number to avoid claiming unconverted D assessment spillover savings for participants who were already in the 2017 unconverted D assessment participant list or who participated in HEA in 2018. Detailed results are outlined in Table 19.

Table 19: Unconverted D Assessment Spillover

2018 Results	
Total Number of Unconverted D Assessment Participants	679
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	366
Average Electrical Savings per Participant in kWh (with influence from ENS)	2,283
Total Unconverted D Assessment Spillover Energy Savings – at the Meter (GWh)	0.836
Peak Demand-to-energy Ratio (MW/GWh)	0.283
Total Unconverted D Assessment Spillover Peak Demand Savings – at the Meter (MW)	0.236

3.5 Green Heat Savings Deductions

Several measures are offered under both HEA and Green Heat. Energy savings cannot be double-counted in the two program components. To ensure that energy savings are not claimed twice for the same upgrade, ENS deducts the net electrical savings that were already claimed in Green Heat from the HEA net electrical savings for those participants who participated in both HEA and Green Heat.

For HEA participants who applied to Green Heat in 2018, the 2018 Green Heat revised savings were deducted from the HEA revised savings (rather than the 2017 savings as tracked by ENS). For HEA participants who applied to Green Heat in 2017, the 2017 Green Heat revised savings were used.

3.6 Net Savings

Net savings represent the savings that can be reliably attributed to a program component. For HEA, net savings are calculated by deducting the Green Heat savings, applying the aforementioned NTGR value to the evaluated gross savings, and adding the unconverted D assessment spillover savings, as illustrated in the following equation:

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

The 2018 net energy and peak demand savings for HEA were estimated at 5.724 GWh and 1.600 MW at the generator respectively, as outlined in Table 20 below. Using the Nova Scotia-specific factor¹⁴ for GHG emissions generated by electricity production, 0.6126 kg CO₂ eq/kWh at the generator, it was estimated that the net energy savings resulted in 3,507 tonnes of avoided CO₂ eq annually. The net lifetime energy savings were established at 114.488 GWh, which yields a weighted average EUL of 20.0 years for net energy savings.

Table 20: Evaluated Net Energy and Peak Demand Savings for HEA

Savings	Total
Energy Savings	
Revised Gross Energy Savings – at the Meter (GWh)	5.792
NTGR	0.76
Unconverted D Assessment Spillover Energy Savings – at the Meter (GWh)	0.836
Net Energy Savings without Savings Deductions – at the Meter (GWh)	5.238
Green Heat Net Energy Savings Deductions (GWh)	0.029
Net Energy Savings with Savings Deductions – at the Meter (GWh)	5.209
Line Loss Factor	1.099
Net Energy Savings – at the Generator (GWh)	5.724
Effective Useful Life (years)	20.0
Net Lifetime Energy Savings – at the Generator (GWh)	114.488
Peak Demand Savings	
Revised Gross Peak Demand Savings – at the Meter (MW)	1.638
NTGR	0.76
Unconverted D Assessment Spillover Peak Demand Savings – at the Meter (MW)	0.236
Net Peak Demand Savings without Savings Deductions – at the Meter (MW)	1.482
Green Heat Net Peak Demand Savings Deductions (MW)	0.026
Net Peak Demand Savings with Savings Deductions – at the Meter (MW)	1.456
Line Loss Factor	1.099
Net Peak Demand Savings – at the Generator (MW)	1.600

¹⁴ At the time of writing, 2018 data was not available. The Nova Scotia-specific factor was obtained from NSP's 2017 total system emissions data (6,725,126 CO₂ eq tonnes), and total electricity generation (10,978 GWh) from the following two sources:

Nova Scotia Power, *Total System Emissions*, <http://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 26, 2018).

Emera Inc., *Management's Discussion & Analysis as at February 9, 2018*, <http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 26, 2018).

Table 21 below compares the energy and peak demand savings established through the 2018 evaluation and those calculated in the tracking sheet.

Table 21: Comparison of Tracked and Evaluated HEA Savings at the Generator

	Initial Gross Savings	Adjusted Gross Savings	NTGR*	Net Savings
Energy Savings				
Tracked Savings from ENS	8.607 GWh	7.279 GWh	0.88	6.429 GWh
Evaluation Results	8.599 GWh	6.366 GWh	0.90	5.724 GWh
Peak Demand Savings				
Tracked Savings from ENS	2.436 MW	2.060 MW	0.88	1.819 MW
Evaluation Results	2.433 MW	1.800 MW	0.89	1.600 MW
**The average NTGR values correspond to the ratio of net savings to gross savings and includes unconverted D assessment spillover and Green Heat savings deductions.				

Both the gross energy and peak demand savings calculated as part of the 2018 evaluation were very similar to the initial gross savings tracked by ENS. The slight difference was due to the revised unitary savings values for solar DHW systems and HPWH equipment, as well as the weighted average line loss factor of 1.099 (instead of the 1.000 used for tracked savings calculations). As for adjusted gross savings, the values calculated for energy and peak demand savings were both 13 percent lower than those tracked by ENS. The difference was mainly explained by the updated ORs used to adjust the modelled space heating consumption values generated by the HOT2000 software. Ultimately, the evaluated net energy and peak demand savings were also lower than those tracked by ENS due to both the aforementioned reasons and the adjustment in the number of unconverted D assessment participants.

4 HEA RECOMMENDATIONS

The 2018 evaluation revealed that HEA succeeded in achieving significant net and peak demand energy savings, although at lower levels than in previous years. Significant changes to HEA occurred in the second half of 2018, notably a reinstatement of funding for non-electrically heated households and a revision of the incentive structure. While these changes were too recent for their impacts to be observed in the 2018 evaluation, their impacts on participant satisfaction and savings will be evaluated in the next evaluation year.

In addition to the general recommendations presented for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator made recommendations for improving each Existing Residential component. What follows are the recommendations specifically made for HEA. The recommendations for improving Green Heat and EPI are presented further below in the Executive Summary. The following recommendations are also outlined in Appendix III.

2018 HEA-R1. Conduct a billing analysis to review the overestimation ratio when a sufficient participant sample becomes available. The billing analysis conducted in 2018 was initially aimed at estimating a new OR for the new version of HOT2000, although it revealed that the space heating systems in place, particularly heat pumps, had a much more significant impact on the overestimation than the difference between the versions of HOT2000 that are used. The Evaluator believes that further analyses should be conducted to evaluate the impact of the different HOT2000 versions on the ORs and confirm whether there is no significant difference in the ORs established for the D and E assessment periods. The Evaluator believes that version 11 of HOT2000 will progressively be used more in upcoming years and will enable conducting a billing analysis on a sample of participants large enough to consider: (1) D assessments and E assessments; (2) the various versions of HOT2000 (i.e. versions 11.3, 11.4, 11.5); and (3) evaluate the impact of the different heating systems in place, including the presence of wood or pellet stoves. Since overestimations significantly impact HEA net energy and peak demand savings, the Evaluator recommends conducting a billing analysis when a large enough participant sample becomes available.

2018 HEA-R2. Share evaluation findings with the EAs to ensure sustained quality simulations. As part of the 10 HEA on-site visits and HOT2000 simulation reviews, the Evaluator noted that significant improvements have been achieved in both the quantity of measurements and the accuracy of collected data since the last review in 2016. In 2018, the Evaluator found that EAs performed well in recording household energy component data and complied with the new EnerGuide requirements. While reviewing project files, the Evaluator noted some recurrent mistakes in the HOT2000 simulations (see Subsection 3.1). The Evaluator recommends sharing feedback on the improved accuracy of data collection and aspects of the project review process that could be improved with EAs to continue working toward higher quality simulations.

5 GREEN HEAT OVERVIEW

The following sections present the Green Heat evaluation results. The evaluation results of the EPI program component follow.

This section describes Green Heat, follows up on the 2017 evaluation recommendations and provides an overview of participation history.

5.1 Description

The goal of Green Heat is to encourage the installation of energy efficient heating systems that have a renewable component in Nova Scotia homes. More specifically, Green Heat provides financial incentives to homeowners for the following categories of heating systems:

- › Heat pumps: high-efficiency space heating systems and DHW heating systems
- › Biomass: high-efficiency wood and pellet stoves, and central heating systems
- › Solar thermal: solar hot water and solar space heating systems

ENS staff manage and administer Green Heat. Homeowners have 90 days after the purchase and installation of eligible equipment to submit the required documentation to receive incentives. The equipment must be installed by a certified installer. As of August 2017, Green Heat is delivered through an after-purchase mail-in rebate structure. Other changes to Green Heat as of August 2017 included new equipment eligibility criteria for cold climate mini-split heat pumps, modifications to the rebate structure for heat pumps, and the removal of entry barriers for applicants, most notably the removal of the pre-approval requirement. Moreover, applicants interested in financing for heating systems, with the exception of MSHPs, are now referred to HEA. Applicants interested in obtaining financing for the purchase of MSHPs are referred to NSP. More precisely, ENS works with NSP to cross-promote the on-bill financing option that NSP offers to customers interested in installing MSHPs. Table 22 summarizes current Green Heat incentives for each type of eligible systems.

Table 22: Green Heat Incentives

Heat Pump Systems	Incentive
Mini-split Heat Pumps	\$200/Refrigeration Tonne
Air-source Heat Pumps (Centrally-ducted)	\$400/Refrigeration Tonne
Air-to-water Heat Pumps	\$400/Refrigeration Tonne
Ground-source Heat Pumps	\$500/Refrigeration Tonne
Heat Pump Water Heaters	\$150/Unit
Biomass Systems	Incentive
Wood/Pellet Stoves or Fireplace Inserts	\$500/Unit
Wood/Pellet Boilers or Centrally-ducted Forced Air Furnaces	\$1,000/Unit
Solar Thermal Systems	Incentive
Solar Thermal: Air-to-air	\$400/Unit
Solar Thermal: Domestic Hot Water	\$1,000/System

From August 1 to November 20, 2017, Green Heat offered incentives for centrally-ducted air-source heat pumps (ASHPs), AWHPs and ground-source heat pumps (GSHPs) to non-electrically heated participants. Some of those participants completed their participation process in 2018, which led to a number of participants with heat pumps reporting non-electrical energy consumption to be included in this 2018 Evaluation Report. Moreover, Green Heat has offered incentives for MSHPs to both electrically and non-electrically heated homes since August 2017. Hence, MSHPs that save either electrical or non-electrical energy consumption are included in the 2018 evaluation report.

On July 10, 2018, Green Heat received funding from the federal government LCEF via the Government of Nova Scotia to allow Green Heat to expand eligibility criteria to include non-electrically heated homes. The rebate amounts and criteria remain unchanged whether the home is electrically or non-electrically heated. The savings associated with measures installed after July 10, 2018 that displace non-electrical energy consumption will be reported in the PNS Evaluation Report and are therefore not included herein.

Green Heat aimed to achieve net electrical energy savings of 3.7 GWh and net peak demand savings of 3.8 MW at the generator in 2018.

5.2 Follow-up on 2017 Evaluation Report Recommendations

Green Heat was evaluated in 2017, and improvement recommendations were made by the Evaluator. Table 23 below summarizes the implementation status of each recommendation presented in the Executive Summary of the 2017 Evaluation Report.

Table 23: Implementation Status of 2017 Recommendations for Green Heat

2017 Recommendations	Status
2017 GH-R1. Perform the ASHP billing analysis again in 2018.	Implemented
2017 GH-R2. Conduct a survey with a larger sample of participants who installed MSHPs in non-electrically heated households.	Implemented
2017 GH-R3. Improve the collection of technical information about ASHPs.	Implemented
2017 GH-R4. Gather additional information to further characterize the MSHP market.	Implemented
2017 GH-R5. Develop a way for potential participants to better understand which ASHP equipment is eligible.	Being implemented

All 2017 Green Heat recommendations were implemented by ENS, except for recommendation GH-R5, which is still in progress. Recommendations 2017 GH-R1, R2 and R4 all pertain to evaluation activities, so ENS mandated the Evaluator to implement those recommendations. The results of the ASHP billing analysis are presented in Subsection 8.1.2 of this report, while the in-depth market evolution analysis is presented in Section 9. Because MSHP measures installed in non-electrically heated homes are funded by the federal government rather than by DSM funds, the evaluation of these measures and the results of the expanded participant survey are included in the PNS Evaluation Report.

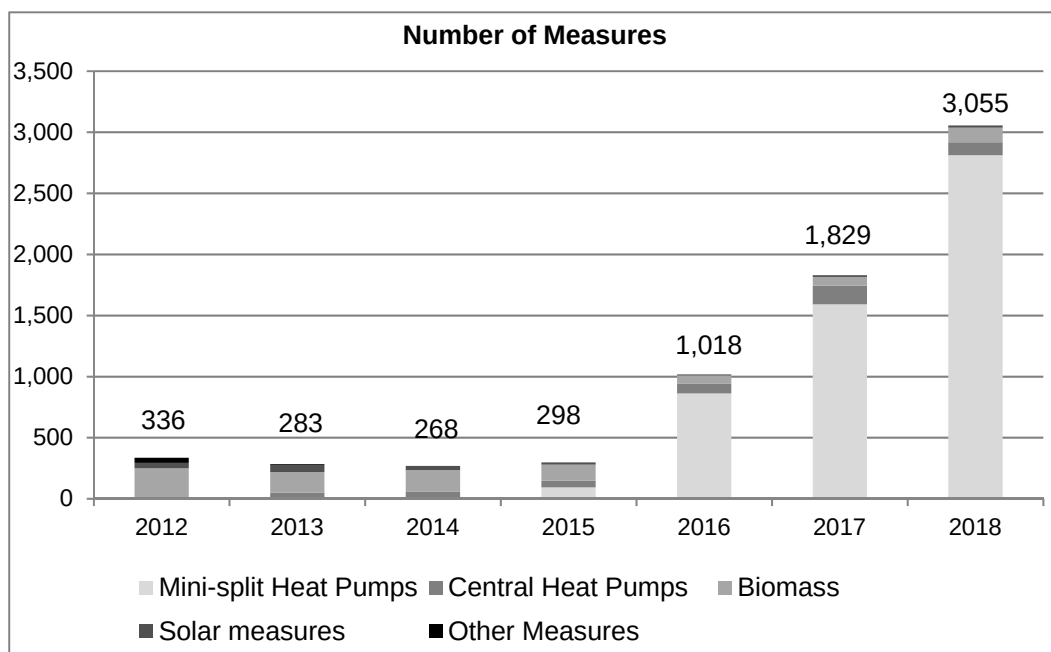
To address recommendation 2017 GH-R5, ENS decided to align their eligibility criteria with those of the Northeast Energy Efficiency Partnerships (NEEP), which has developed an exhaustive list of eligible ASHP models. The use of this list addresses recommendation 2017 GH-R3 because it includes performance data of ASHPs at -15 °C. However, the publication of this list has been delayed and the currently available list only covers a small proportion of the ASHPs installed through Green Heat. Moving forward, ENS will use this data to track peak demand savings specific to each model.

5.3 Participation History

In 2018, 3,055 measures were installed through Green Heat, which represented a significant increase of 67 percent over 2017 levels. As illustrated in Figure 7 below, MSHPs are the most commonly installed measure again this year with 2,812 units. Since August 2017, participants no longer need to obtain approval from ENS prior to purchasing equipment, which explains the significant increase of participation in Green Heat. The weather experienced in the 2018 summer was also mentioned by retailers as a significant driver for MSHP sales (see Subsection 9.2.5).

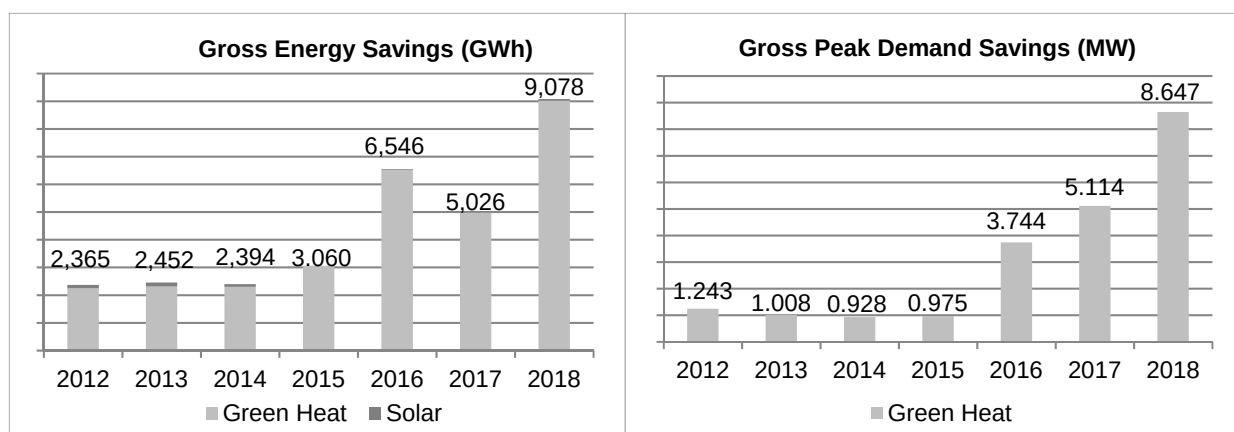
During the fall of 2018, ENS increased marketing efforts for wood stoves by providing retailers and contractors with in-store promotion materials and advertising in flyers. Radio ads were also used to reach out to potential participants. Besides removing the pre-approval requirement, the abovementioned efforts may also have contributed to achieving higher participation levels for wood stoves in 2018.

Figure 7: Summary of Participation in Green Heat, 2012-2018



As indicated in Figure 8, Green Heat achieved the highest savings levels since 2012 with 9.078 GWh in gross energy savings and 8.647 MW in peak demand savings. This is due to the higher number of units installed in 2018.

Figure 8: Summary of Gross Savings for Green Heat, 2012-2018



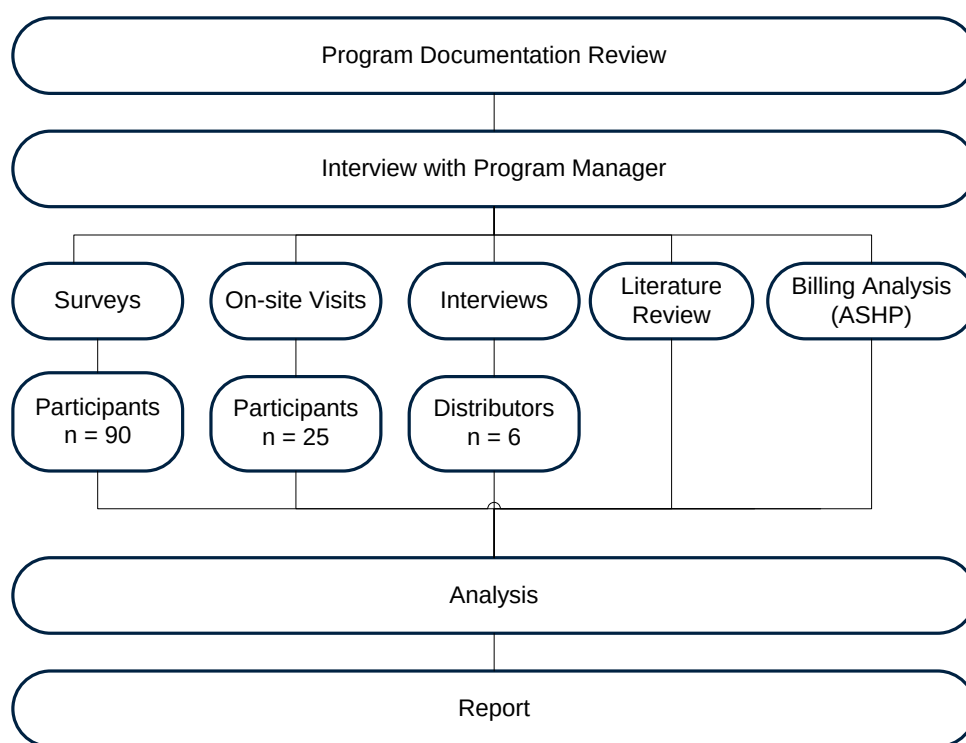
6 GREEN HEAT EVALUATION OBJECTIVES AND METHODOLOGY

The main objectives of the Green Heat evaluation are as follows:

- › Reporting on participant perspectives
- › Calculating program results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions
- › Analyzing the market evolution of MSHPs

This section presents the methodology used and the activities carried out for the 2018 Green Heat evaluation to achieve the aforementioned objectives. As illustrated in Figure 9, various data-collection activities were carried out throughout the evaluation.

Figure 9: Green Heat Methodological Model



The Evaluator first reviewed program component documentation and then met the program manager in September 2018 to verify the implementation status of the previous evaluation recommendations and learn about the changes implemented in 2017. Based on the information obtained from this meeting, a list of questions and topics to be included in the data-collection instruments was prepared.

After the meeting with the program manager and the documentation review, specific evaluation activities were undertaken as described in the following subsections.

For evaluation activities that yield quantitative results based on a sample, the Evaluator aimed to achieve a maximum margin of error of 10 percent at a confidence level of 90 percent. 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 percent of the time. Thus, the margin of error indicates the relative level of precision¹⁵ of the measurement, while its associated confidence level indicates the probability of a measure falling within this margin of error.¹⁶

As part of the Green Heat evaluation, the Evaluator calculated the margins of error for survey samples, metered results, and free-ridership levels. The margins of error are presented alongside the results in the relevant sections further below. An example of the calculation used to establish the margin of error for survey samples is also presented in Appendix II of the 2018 DSM Programs Evaluation Executive Summary.

Participant Survey

In October and November 2018, CRA conducted a telephone survey with 90 participants. The average length of the survey was 16 minutes. The questionnaire and complete survey results are presented in Appendices IV and V.

The participant survey was meant to collect feedback on the following aspects of Green Heat:

- › Program component awareness
- › Participation motivations
- › Usage of the old unit and new equipment installed
- › Free-ridership (including the cross-influence from ENS promotion and other program components)
- › Satisfaction with Green Heat and its aspects
- › Barriers to the installation of equipment
- › Recommendations for program component improvements
- › Demographics

Table 24 below presents the total number of Green Heat participants and sample sizes, as well as the corresponding margins of error at a 90 percent confidence level for the 2018 telephone survey.

¹⁵ 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 refers to accuracy.

¹⁶ 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.

Table 24: Survey Sample Sizes and Margin of Error

Type of Equipment	Population	Sample Sizes (n)	Sampling Margins of Error at 90% Confidence Level
Mini-split Heat Pumps	2,373	45	±12.3%
Air-source or Ground-source Heat Pumps	105	22	±16.0%
Solar or Biomass Systems	136	23	±16.0%
Total	2,608¹⁷	90	±8.6%

On-site Visits

In October and November 2018, 25 on-site visits were conducted by Equilibrium Engineering at participating homes, including two visits for solar thermal measures, two visits for biomass measures, and 21 visits for heat pump measures. These visits served to confirm whether the new equipment had been installed and was working properly, collect information on the old space heating and hot water systems, gather data on the use of the different energy sources available in homes, and ensure that information concerning the new and old systems was tracked properly. The visits for MSHPs were also focused on understanding why savings obtained through the billing analysis performed during the 2017 evaluation were lower than expected. The on-site visit sampling methodology and the protocol used to collect information are presented in Appendix VI.

Interviews with Distributors

In November 2018, Econoler conducted six interviews with distributors who sell and install HVAC products in Nova Scotia to gain deeper understanding of high-efficiency and standard MSHP sales and trends in the market. The guide used for the distributor interviews is presented in Appendix VII.

Literature Review

The Evaluator performed a literature review to update the savings values presented in the tracking sheet for biomass, solar thermal, and heat pump measures, with the exception of ASHPs for which a billing analysis was used, as described below.

Billing Analysis

A billing analysis was conducted for participants who had an ASHP (centrally-ducted) installed in previous years to establish the average energy savings achieved. The billing analysis compared energy consumption as a function of heating degree days for a one-year period prior to the new heat pump installation and for one heating season immediately following installation.

¹⁷ As part of Green Heat, 2,608 participants (based on unique phone numbers) installed 3,055 measures.

7 GREEN HEAT MARKET EVALUATION

A survey of 90 participating households was conducted as part of the Green Heat evaluation. In addition to the questions designed for impact evaluation purposes, survey participants were asked questions regarding the source of awareness, reasons for participating, satisfaction, potential barriers to the installation of heating equipment, and recommendations for improvement. One half of respondents had a mini-split heat pump system (n=45) installed, while the remaining half of respondents were divided into two groups: those who had either an air-source or ground source heat pump installed (n=22) and those who had a solar or biomass system installed, such as a solar water heater, wood stove, pellet stove, or wood boiler (n=23).

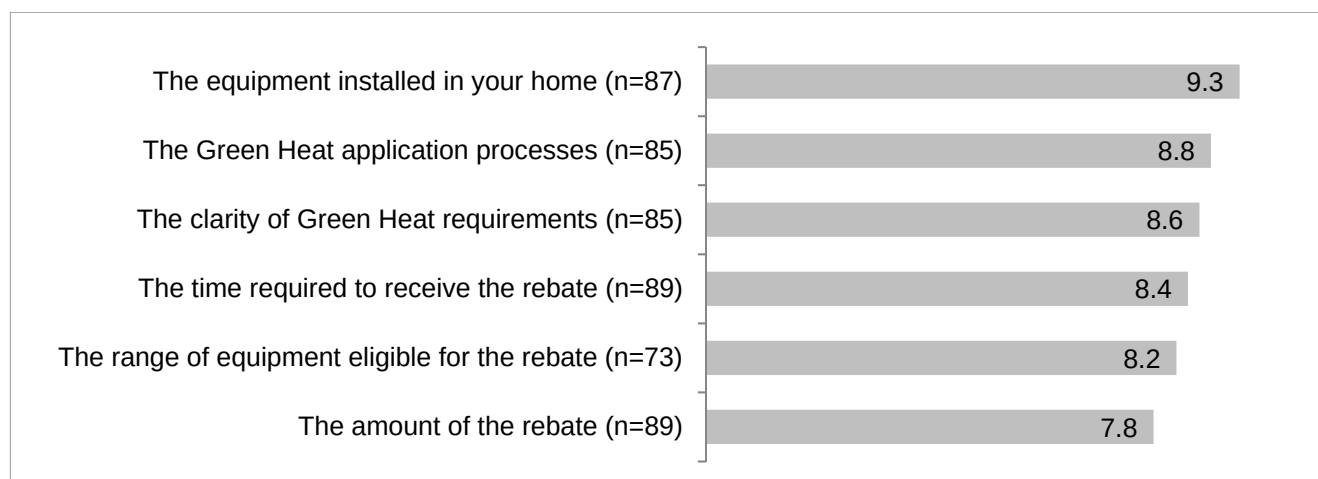
Awareness about Green Heat was driven largely by contractors, retailers, and distributors (39%), or by word-of-mouth via a friend, acquaintance, or family member (23%). The main reason for participating in Green Heat was to save on energy costs (49%) followed by, in smaller proportions, the need to replace the current heating system because it did not work properly (11%) and for better comfort (10%). Another reason mentioned by respondents was the desire for air conditioning in their home (17%). Among participants who installed a heat pump, only one in three (34%) previously had air conditioning in their home, yet nearly all (94%) now use their heat pump to provide cooling.

Four in ten participating households (39%) had previously taken part in another ENS program component, while three in four (74%) had seen ENS promotional materials. Both past participation and promotional materials were said to have influenced many to discuss energy efficient heating systems with a contractor and to take into account energy bill savings when evaluating different heating systems.

Satisfaction with Green Heat was very high overall, with participating households providing an average score of 9.0 on a 10-point scale, where 0 means “not at all satisfied” and 10 means “completely satisfied.” This satisfaction score is the same as in 2017. Among the small number of participants who were less satisfied, the main reasons reported were the amount of the rebate and the length of time to receive the rebate.

As indicated in Figure 10 below, participants also provided high ratings for the equipment installed, program component application processes, and clarity of program component requirements. There was somewhat less satisfaction with the rebate amount offered. Despite this dissatisfaction, almost half of participants (47%) found that the rebate offered is the most helpful aspect of Green Heat.

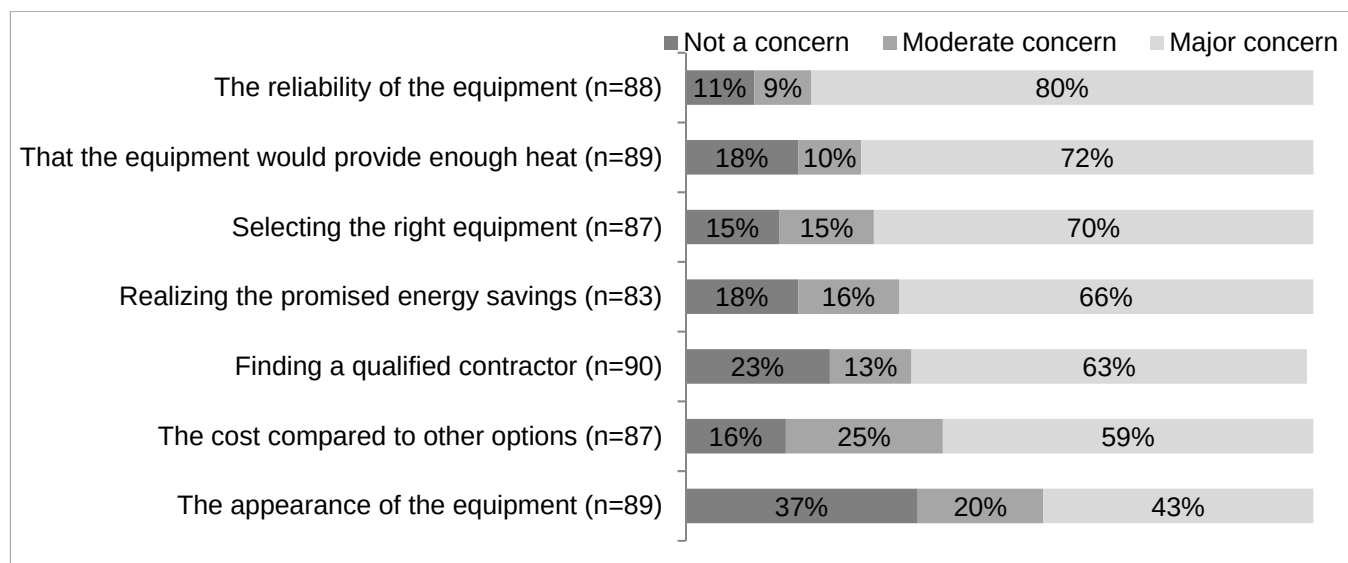
Figure 10: Participant Satisfaction with Green Heat (10-point Scale)



Note: Mean score of ratings on a scale of 0 to 10 where 0 means “not at all satisfied” and 10 means “completely satisfied”.

As indicated in Figure 11, when first considering installing energy-efficient home heating equipment, participants expressed more concerns with issues related to equipment, such as reliability, capacity to produce enough heat, and selecting the right unit rather than concerns about appearance.

Figure 11: Barriers to the Installation of Energy Efficient Heating Equipment



Note: Ratings on a scale of 0-10. “A major concern” and “moderate concern” are based on the top three and middle three scale options. “Not a concern” is based on the bottom four scale options.

While many participants (49%) did not offer any recommendation on how to improve Green Heat, some respondents suggested more or better advertisements (14%), more information on recommended equipment (9%), more eligible products for rebates (8%), or a simplified application process (6%).

8 GREEN HEAT IMPACT EVALUATION

The objective of the 2018 Green Heat impact evaluation is to determine the gross and net electrical energy and peak demand savings achieved.

8.1 Gross Savings

Gross savings correspond to the change in energy consumption that results from actions taken by participants regardless of their reasons for participating.¹⁸ For Green Heat, the Evaluator reviewed the unitary savings values, peak demand-to-energy ratios, and interactive effects factors. The EUL values established during the 2017 evaluation were used again for the 2018 evaluation to calculate lifetime energy savings.

8.1.1 On-site Visits

The Evaluator conducted 25 on-site visits as part of the 2018 Green Heat impact evaluation, as summarized in Table 25 below. The methodology to establish the visit sample and the protocol followed during the visits are presented in Appendix VI.

Table 25: Green Heat On-site Visits by Measure Category

Measure Category	Measure	Number of On-site Visits
Biomass	Wood stove	1
	Pellet stove	1
	Wood furnace or boiler	0
Solar	DHW solar system	2
	Solar-air-space heating system	0
Heat Pump	Air-source heat pump	6
	Ground-source heat pump	1
	Mini-split heat pump	14
	Heat pump water heater	0

¹⁸ Definition adapted from National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

The site visits were aimed at confirming that the information contained in the tracking sheet was accurate (notably the old and new heating system descriptions). Overall, the tracked data for old and newly installed equipment were reasonably representative of what was verified on site. The main variations identified between the tracked and verified information included the following:

- › Nine participants in the sample were tracked as not having air conditioning prior to participation, yet they were verified as having some form of air conditioning prior to installing new equipment. However, this error did not impact savings because it was not a variable taken into account in the savings calculations for a vast majority of measures.
- › Two tracked primary systems did not match what was verified on site. One system was tracked as an ASHP although it was a GSHP, and the second system was tracked as electrical baseboard although it was an electrical boiler with a radiant slab.
- › Two participants were tracked as not having a secondary heating system, yet the Evaluator identified that one had electrical baseboards, and another had a wood stove.

The Evaluator considers that these discrepancies are similar to what was encountered in previous evaluations and have a limited impact on savings calculations.

The site visits were also aimed at confirming that the equipment was installed properly and its usage actually offsets electrical consumption, which was the case for all measures verified. Observations from the Evaluator for each type of equipment measure are as follows:

Biomass Measures

The two site visits served to determine that the biomass measures were installed correctly, operating as intended and tracked correctly in the Green Heat tracking sheet. In each case, the new biomass equipment offset electrical consumption because the previous heat source was an MSHP. In one case, a pellet stove was installed to heat an area previously heated by an MSHP, while in the other case a wood stove was used to heat during the night instead of an MSHP, although that unit still operated during the day. These installations were carried out by Wood Energy Technology Transfer certified professionals, as required by Green Heat, and participants indicated no issues with the new biomass heating systems.

Solar Thermal Measures

The two solar thermal visits served to verify that the equipment was installed correctly. Roof-mounted flat-plate collector systems were indeed installed at each home, with suitable collector orientation and no obstructions from nearby trees or buildings. The installations were carried out by qualified professionals, as evidenced by the overall installation quality and participants' comments. Proper client education was provided on proper system operation and maintenance, with no issues or concerns reported. Electrical DHW heaters served as the baseline equipment in each household. The solar thermal systems therefore offset electricity consumption.

Heat Pump Measures

For these site visits, the Evaluator confirmed that the new heat pumps were used as a primary or major heat source in 19 of 21 homes. For the other two homes, an electrical boiler provided in-floor heat for the whole building and served as the primary system, and the MSHPs were installed in frequently occupied spaces. The on-site visits revealed that all new products were installed and operating correctly. In previous years, the Evaluator had noticed that ASHPs were more likely than other products to encounter installation issues due to higher installation complexity. The 2018 evaluation did not discover any installation issues with ASHPs.

The 2017 Evaluation Report identified significant impacts of non-electrical secondary heating systems on measured heat pump savings. The 2018 data-collection protocol included additional investigation items to better describe the heating systems for each participant to allow further investigation on the reasons behind these large impacts.

Half of the six participants with non-electrical secondary heat systems described using the secondary system less frequently after installing the heat pump, indicating that a portion of the previously non-electrical building heat load was shifted to electrical heat. The site visits served to determine that the most common secondary system was a wood or pellet stove that is manually loaded and not thermostatically controlled. Wood and pellet stoves typically have high output capacities and are commonly operated near full capacity for both ambiance and comfort. The Evaluator determined that the heat pump thermostats were located either directly within or near the area where the secondary heating system was installed in all cases. Thus, heat pumps might be turned off by the thermostat when the non-electrical secondary system is in use.

8.1.2 Summary of Savings Values

To review Green Heat unitary savings, the Evaluator conducted on-site visits for biomass, heat pump, and solar measures, performed a billing analysis for ASHPs and a literature review for all other measures, except for MSHPs installed in electrically heated homes. The detailed savings review is presented in Appendix VIII. Table 26 and Table 27 below list the tracked and revised unitary savings values for each measure installed under Green Heat. Solar DHW and solar air heating measures are not listed in the table as their savings are based on simulations rather than calculations. For those two measures, the Evaluator made no change to tracked savings.

Both the energy savings and peak demand savings calculations were reviewed. The peak demand savings period for 2018 is defined as the coldest days (with an on-peak temperature estimated at -15 °C) on non-holiday weekdays between 5 p.m. and 7 p.m. from December to February.

Table 26: Tracked and Revised Unitary Savings Values for Biomass and DHW Measures

Measure	Unitary Energy Savings (kWh)		Unitary Peak Demand Savings (kW)	
	Tracked	Revised	Tracked	Revised
Wood Stove with Electrical Resistance Baseline	10,443	No change	4.0	No change
Pellet Stove with Electrical Resistance Baseline	8,959	No change	4.0	No change
Wood Stove with ASHP Baseline	4,973	No change	4.0	No change
Pellet Stove with ASHP Baseline	4,266	No change	4.0	No change
Wood Furnace/Boiler	13,804	No change	7.66	No change
Pellet Furnace/Boiler	13,765	No change	7.75	No change
HPWH with Electrical Resistance Heating	771	790	0.304	0.128
HPWH with HP Heating	1,257	1,312	0.496	0.213

Table 27: Tracked and Revised Unitary Savings Values by Heat Pump Measure Type

Measure	Energy Savings per Capacity (kWh/Btu/h)		Average Unitary Energy Savings (kWh)		Average Unitary Peak Demand Savings (kW)	
	Tracked	Revised	Tracked	Revised	Tracked	Revised
MSHP – Fully Electrically Heated	0.169	0.179	3,166	3,362	2.41	2.47
MSHP – Mainly Electrically Heated	0.068	0.060	1,373	1,204	2.71	2.76
MSHP – Non-electrically Heated	N/A	N/A	626	418	2.34	2.52
ASHP and AWHP – Electrically Heated	0.100	0.101	3,702	3,744	3.00	3.04
ASHP and AWHP – Non-electrically Heated	N/A	N/A	840	352	0.04	0.24
GSHP	N/A	N/A	16,429	No change	0.30	No change

As presented in Table 26 above, the literature review conducted to update the unitary savings values for biomass measures and HPWHs only resulted in a change for HPWHs. For MSHPs, the results of the billing analysis presented in the 2017 Evaluation Report were applied to obtain 2018 evaluated results. The main reason for the differences between the tracked and revised savings is due to the use of old values from the 2016 Evaluation Report in the ENS 2018 tracking sheet. The Evaluator also noted some discrepancies in the heating capacities reported in the tracked sheet when comparing them to the values found in the reference measures list.

For ducted ASHPs, the Evaluator performed a billing analysis as part of the 2018 evaluation to estimate their energy savings more accurately. Preliminary results indicated that savings were much lower than those identified in the 2017 analysis. The Evaluator investigated the reasons for this change and found that the tracking sheet contained incorrect information about existing heating systems for a large number of participating households. This was due to a combination of incorrectly filled-out participation forms and errors in data entry. Since the 2018 billing analysis was inconclusive, the Evaluator applied the savings value obtained from the 2017 billing analysis to the ASHPs installed in 2018. The overall impact of changes made to tracked savings, as described in this subsection, is captured under the lines “Adjustment Ratio for Energy Savings” and “Adjustment Ratio for Peak Demand Savings” in the revised gross savings table presented in Subsection 8.1.5.

8.1.3 Interactive Effects

Interactive effects occur in a home when the implementation of energy efficiency measures has an impact on the energy consumption of other elements such as heating and cooling. In the case of Green Heat, the energy efficiency measures implemented are high-efficiency heating measures that do not result in an increase or decrease in the heating or cooling loads needed to maintain the desired indoor comfort conditions. The only exception is HPWHs; interactive effects are already included in the engineering equation for this measure. Therefore, no additional interactive effects factor was applied to the savings.

8.1.4 Effective Useful Life

For the 2018 evaluation, the Evaluator relied on equivalent EUL values established through a thorough literature review conducted as part of the 2017 evaluation. The Evaluator also validated that ENS correctly applied the 2017 EUL values to calculate lifetime energy savings.

Table 28 summarizes the tracked and revised equivalent EUL values used by ENS and the Evaluator respectively. The revised equivalent EUL values were applied to each product's gross and net first-year energy savings to obtain gross and net lifetime energy savings. As a result, the weighted average EUL values of gross and net savings differed (see Subsections 8.1.5 and 8.3).

Table 28: Green Heat Equivalent Effective Useful Life Values

Measure	Tracked Equivalent EUL (Years)	Revised Equivalent EUL (Years)	Revised Lifetime Gross Energy Savings per Unit (kWh)
Wood and Pellet Stoves	18.0	No change	187,974*
Wood and Pellet Furnace/Boilers	18.0	No change	-
Solar DHW and Solar Air Space Heating	20.0	No change	-
HPWH	10.0	No change	7,900*
MSHPs	18.0	No change	-
ASHPs and AWHPs	18.0	No change	-
GSHPs	25.0	No change	-
*Values calculated with the unitary savings value associated with the most popular scenario (e.g. for the Wood and Pellet Stove category, the unitary lifetime gross energy savings value was calculated for wood stove with an electrical resistance baseline).			

8.1.5 Revised Gross Savings

The annual gross savings for each category of equipment installed through Green Heat in 2018 are listed below in Table 29. Overall, the total gross electrical energy and peak demand savings amounted to 9.078 GWh and 8.647 MW respectively at the generator, which represents 163.749 GWh in lifetime electrical energy savings. As a result, the weighted average EUL value for gross energy savings is 18.04 years.

Table 29 below also includes the estimated gross savings at the generator using a residential line loss factor of 1.100 between the meter and the generator.

Table 29: Revised Gross Energy and Peak Demand Savings for Green Heat

Measure Category	Wood Stove	Pellet Stove	Wood Furnace/ Boiler	Pellet Furnace/ Boiler	Solar DHW	HPWH
Energy Savings						
Number of Units	88	31	0	0	18	2
Tracked Energy Savings (GWh)	0.772	0.245	0.000	0.000	0.052	0.002
Adjustment Ratio for Energy Savings	1.120	1.077	N/A	N/A	1.000	1.037
Revised Unitary Energy Savings (kWh)	9,511 ¹⁹	8,353 ²⁰	13,804	13,765	N/A	N/A
Gross Energy Savings – at the Meter (GWh)	0.837	0.259	0.000	0.000	0.052	0.002
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100
Gross Energy Savings – at the Generator (GWh)	0.921	0.285	0.000	0.000	0.057	0.002
Effective Useful Life (years)	18.0	18.0	18.0	18.0	20.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	16.571	5.127	0.000	0.000	1.144	0.023
Peak Demand Savings						
Tracked Peak Demand Savings (MW)	0.348	0.124	0.000	0.000	0.000	0.001
Adjustment Ratio for Peak Demand Savings	1.011	1.000	N/A	N/A	1.000	0.426
Revised Unitary Peak Demand Savings (kW)	4	4	4	4	0	N/A
Gross Peak Demand Savings – at the Meter (MW)	0.352	0.124	0.000	0.000	0.000	0.000
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100
Gross Peak Demand Savings – at the Generator (MW)	0.387	0.136	0.000	0.000	0.000	0.000

¹⁹ This value represents the average unitary savings value, accounting for a combination of wood stoves with electrical resistance baseline and ASHP baseline.

²⁰ This value represents the average unitary savings value, accounting for a combination of pellet stoves with electrical resistance baseline and ASHP baseline.

Revised Gross Energy and Peak Demand Savings for Green Heat (Continued)

Measure Category	MSHP – Fully Electrical	MSHP – Mainly Electrical	MSHP – Non-electrical	ASHP and AWHP – Electrical	ASHP and AWHP – Non-electrical	GSHP	Total
Energy Savings							
Number of Units	1,791	386	635	83	19	2	3,055
Tracked Energy Savings (GWh)	5.670	0.530	0.398	0.307	0.016	0.033	8.024
Adjustment Ratio for Energy Savings	1.062	0.877	0.668	1.011	0.419	1.000	-
Revised Unitary Energy Savings (kWh)	N/A	N/A	N/A	N/A	352	N/A	-
Gross Energy Savings – at the Meter (GWh)	6.022	0.465	0.266	0.311	0.007	0.033	8.253
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100	-
Gross Energy Savings – at the Generator (GWh)	6.624	0.511	0.292	0.342	0.007	0.038	9.078
Effective Useful Life (years)	18.0	18.0	18.0	18.0	18.0	25.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	119.232	9.205	5.257	6.152	0.132	0.961	163.749
Peak Demand Savings							
Tracked Peak Demand Savings (MW)	4.321	1.046	1.485	0.249	0.003	0.025	7.602
Adjustment Ratio for Peak Demand Savings	1.024	1.018	1.076	1.012	6.625	1.000	-
Revised Unitary Peak Demand Savings (kW)	N/A	N/A	N/A	3.04	N/A	N/A	-
Gross Peak Demand Savings – at the Meter (MW)	4.425	1.064	1.599	0.252	0.020	0.025	7.861
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100	-
Gross Peak Demand Savings – at the Generator (MW)	4.867	1.171	1.758	0.278	0.022	0.027	8.647

8.2 Net-to-gross Ratio

The NTGR serves to determine net savings, i.e. the savings that can be reliably attributed to a program component. More precisely, the NTGR includes effects, such as free-ridership and spillover, that positively or negatively affect the energy savings generated by a program component. In the case of Green Heat, only one effect is considered, namely free-ridership.

8.2.1 Free-ridership

For Green Heat, free-ridership occurs when participants would still have installed a heating system in the absence of the program component. The free-ridership level was assessed using a self-reporting approach that involved asking sampled participants to respond to a set of questions during a telephone survey. Three different sets of questions were asked depending on the type of measures installed: (1) fuel-switching measure, i.e. biomass or solar heating systems; (2) central heat pumps (including AHSPs, AWHPs and GSHPs); and (3) MSHPs. The questionnaire considers all applicable variables in the decision-making process, including planning, efficiency, timing, and cost.

The feedback collected from this participant survey was converted into an overall free-ridership level using the algorithms presented in Appendix IX.

Fuel-switching Measure

For biomass or solar heating systems, the questionnaire assessed the likelihood of participants replacing their electrical system with a non-electrical system in the absence of the program component. Additional questions were used to determine whether participant decisions to install the measures had been influenced by previous participation in one of ENS's program components or ENS efforts to raise awareness about energy efficiency.

Using this approach, the free-ridership level was established at 58 percent for biomass and solar measures, which is a significant increase compared to 2017 results (36%). All the variables used to establish the free-ridership level followed the same trend. For instance, 74 percent of participants had already decided to install a biomass or solar heating system before hearing about Green Heat (63% in 2017). Moreover, the influence of both the rebate and information provided by ENS in the decision-making process was lower in 2018 (average score of 4.4 and 3.7 respectively on a 10-point scale, compared to 5.4 and 5.3 in 2017). The Evaluator believes that the free-ridership increase is largely due to the new delivery mechanism that no longer requires participants to obtain approval from ENS prior to purchasing a system, thereby enabling participants who hear about the program component after purchase to obtain the rebate. A similar variation was observed for MSHPs in 2017, where participants in the old path (requiring pre-approval) had a significantly lower free-ridership level than participants in the new path.

Central Heat Pump Measure

For centrally-ducted heat pump measures, the questionnaire assessed the likelihood of participants, in the absence of Green Heat, replacing their electrical heating system with a centrally-ducted heat pump of the same efficiency level. Additional questions were used to determine whether participant decisions to install the measures had been influenced by previous participation in one of ENS' program components or ENS efforts to raise awareness about energy efficiency.

Using this approach, the free-ridership level was established at 29 percent for centrally-ducted heat pumps, which represents a decrease compared to the 2017 free-ridership level of 44 percent. This downward shift in free-ridership level can notably be explained by a new question added in the 2018 survey that serves to capture the influence of the information provided by retailers or contractors. Information on the benefits of high efficiency heat pumps provided by retailers or contractors is considered as program component influence since ENS staff worked more closely with these market actors in 2018 to more significantly include them in the program component delivery process.

MSHP Measure

For MSHPs, which constitute by far the most popular Green Heat measure, the Evaluator assessed free-ridership by using two factors: (1) a first series of questions regarding participants' decision to install a heat pump instead of another type of heating system or simply keeping the existing system (type-of-system factor); and (2) a second series of questions regarding participants' decision to install a high-efficiency heat pump rather than a regular heat pump (high-efficiency factor).

Participants who installed MSHPs were also asked questions to determine whether their decision to install the measure had been influenced by previous participation in one of ENS' program components or ENS efforts to awareness about energy efficiency (cross-influence factor).

When analyzing survey results, the Evaluator found that 71 percent of participants had already made the decision to install a MSHP before hearing about Green Heat. When factoring in the high-efficiency and cross-influence factors, the free-ridership level was established at 54 percent. Although these results demonstrate the popularity of MSHPs in the Nova Scotia market, they also highlight the influence of ENS on the type of equipment purchased. By comparison, the 2017 free-ridership level was 51 percent (value for new path participants in the 2017 Evaluation Report).

Table 30 summarizes the average free-ridership level by measure category.

Table 30: Average Free-ridership Level by Measure Category for Green Heat

Measure Category	Average Free-ridership Level	Sample Size	Population Size	Margin of Error
Biomass and Solar Measures	58%	23	137	9.9%
Centrally-ducted Heat Pumps	29%	22	104	8.4%
MSHPs	54%	45	2,812	7.3%

Since no HPWHs were included in the survey sample and this product does not fall under any of the previously mentioned categories, the Evaluator applied a free-ridership level of nil to the two HPWHs installed in 2018. Importantly, HPWHs are costly and the technology was only recently introduced in the market.

8.2.2 Net-to-gross Ratio Calculation

The NTGR was calculated using the following equation:

$$NTGR = (1 - \% \text{ free-ridership})$$

Using the free-ridership levels established for each measure type, the NTGR value was established at 0.42 for biomass and solar measures, 0.72 for centrally-ducted heat pumps, 0.46 for MSHPs, and 1.00 for HPWHs.

8.3 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:

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

The total net electrical energy savings were established at 4.227 GWh at the generator, while the total net peak demand savings were established at 4.042 MW at the generator. Using the Nova Scotia-specific factor²¹ for GHG emissions generated by electricity production, 0.6126 kg CO₂ eq/kWh, the net electrical energy savings resulted in an estimated 2,589 tonnes of avoided CO₂ eq annually. The net lifetime electrical energy savings were established at 76.292 GWh, which yields a weighted average EUL of 18.05 years for net energy savings.

The detailed results are summarized in Table 31.

²¹ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes), while total electricity generation (10,978 GWh) was found in the following two sources:

Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018).

Emera Inc., *Management's Discussion & Analysis* as at February 9, 2018

<http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

Table 31: Evaluated Net Energy and Peak Demand Savings for Green Heat

Measure Category	Wood Stove	Pellet Stove	Wood Furnace/Boiler	Pellet Furnace/Boiler	Solar DHW	HPWH
Energy Savings						
Revised Gross Energy Savings – at the Meter (GWh)	0.837	0.259	0.000	0.000	0.052	0.002
NTGR	0.42	0.42	0.42	0.42	0.42	1.00
Net Energy Savings – at the Meter (GWh)	0.352	0.109	0.000	0.000	0.022	0.002
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100
Net Energy Savings – at the Generator (GWh)	0.387	0.120	0.000	0.000	0.024	0.002
Effective Useful Life (years)	18.0	18.0	18.0	18.0	20.0	10.0
Net Lifetime Energy Savings – at the Generator (GWh)	6.960	2.153	0.000	0.000	0.481	0.023
Peak Demand Savings						
Revised Gross Peak Demand Savings – at the Meter (MW)	0.352	0.124	0.000	0.000	0.000	0.000
NTGR	0.42	0.42	0.42	0.42	0.42	1.00
Net Peak Demand Savings – at the Meter (MW)	0.148	0.052	0.000	0.000	0.000	0.000
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100
Net Peak Demand Savings – at the Generator (MW)	0.163	0.057	0.000	0.000	0.000	0.000

Evaluated Net Energy and Peak Demand Savings for Green Heat (Continued)

Measure Category	MSHP – Fully Electrical	MSHP – Mainly Electrical	MSHP – Non-electrical	ASHP and AWHP – Electrical	ASHP and AWHP – Non-electrical	GSHP	Total
Energy Savings							
Revised Gross Energy Savings – at the Meter (GWh)	6.022	0.465	0.266	0.311	0.007	0.033	8.253
NTGR	0.46	0.46	0.46	0.72	0.72	0.72	-
Net Energy Savings – at the Meter (GWh)	2.770	0.214	0.122	0.224	0.005	0.024	3.842
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100	-
Net Energy Savings – at the Generator (GWh)	3.047	0.235	0.134	0.246	0.005	0.026	4.227
Effective Useful Life (years)	18.0	18.0	18.0	18.0	18.0	25.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	54.847	4.234	2.418	4.430	0.095	0.651	76.292
Peak Demand Savings							
Revised Gross Peak Demand Savings – at the Meter (MW)	4.425	1.064	1.599	0.252	0.020	0.025	7.861
NTGR	0.46	0.46	0.46	0.72	0.72	0.72	-
Net Peak Demand Savings – at the Meter (MW)	2.035	0.490	0.735	0.182	0.015	0.018	3.674
Line Loss Factor	1.100	1.100	1.100	1.100	1.100	1.100	-
Net Peak Demand Savings – at the Generator (MW)	2.239	0.539	0.809	0.200	0.016	0.020	4.042

Table 32 compares the energy and peak demand savings established through this evaluation to those calculated in the tracking sheet.

Table 32: Comparison of Tracked and Evaluated Green Heat Savings at the Generator

	Initial Gross Savings	Adjusted Gross Savings	NTGR	Net Savings
Energy Savings				
ENS Tracked Savings	8.826 GWh	8.826 GWh	0.60	5.294 GWh
Evaluation Results	8.826 GWh	9.078 GWh	0.47	4.227 GWh
Peak Demand Savings				
ENS Tracked Savings	8.361 MW	8.361 MW	0.59	4.954 MW
Evaluation Results	8.361 MW	8.647 MW	0.47	4.042 MW
*Different NTGRs were established for MSHP, central heat pump, biomass and solar measures. The average NTGR values presented in this table correspond to the ratio of net savings to gross savings for all measure categories combined.				

The evaluated gross energy savings are 3 percent above the tracked gross energy savings. This is mainly due to the adjustments made by the Evaluator for the unitary savings of MSHPs installed in fully electrically heated households, which accounted for 73 percent of the total savings. The evaluated net energy savings are 22 percent below the tracked value. This difference is due to the significant decrease in the NTGR compared to the value tracked by ENS. ENS used the 2017 average NTGR to track net savings in 2018, which was based on a majority of participants that took part in a previous version of Green Heat that required pre-approval, and this participation process was known to result in lower free-ridership.

The evaluated gross peak demand savings were slightly adjusted upward, by 3 percent because of minor adjustments made to the tracked values of heat pump measures since some participants had nil tracked values. The evaluated net peak demand savings are 18 percent below the tracked value, also because of the decrease in the NTGR.

9 GREEN HEAT MARKET EVOLUTION

Econoler analyzed the evolution of the MSHP market in the 2017 evaluation. Since certain key data points were unavailable or were drawn from information from participating contractors, a conclusion on the current state of the MSHP market in Nova Scotia could not be made. The aim of the following subsection is to build on the work in the 2017 evaluation, outline additionally gathered information to understand the current state of the MSHP market, and identify to what extent the market has evolved. The results of this analysis can be used to adapt program component offerings (eligible products and rebate amounts) to the evolving market.

9.1 Background

9.1.1 Efficiency Nova Scotia

Until 2012, ENS provided rebates for ductless MSHPs through EnerGuide for Existing Houses (currently known as HEA). In April 2012, ENS incentives on heating and cooling equipment were transferred to a new program component called Fuel Substitution, and ductless MSHPs were no longer eligible for incentives. ENS continued to recommend the implementation of MSHPs through some of its residential programs without a rebate.

In October 2015, Green Heat, the successor to Fuel Substitution, was expanded to include ductless MSHPs and hybrid water heaters. The addition of MSHPs boosted program component participation considerably, as MSHPs constituted 92 percent of all Green Heat installations as of 2018.

In 2017, Green Heat underwent a series of changes. Starting in August 2017, Green Heat eliminated the pre-approval process, updated the eligibility criteria for cold-climate MSHPs, and changed its incentive structure for four of the five types of heat pumps incented by the program component, including MSHPs. Whereas only electrically heated homes qualified for an incentive prior to August 2017, MSHP incentives were offered to both electrically and non-electrically heated homes from August 2017 onward. In July 2018, non-electrically heated homes were offered MSHP incentives under the federal government LCEF through the Government of Nova Scotia, and DSM funds have been exclusively used for electrically heated homes since then.

9.1.2 Nova Scotia Power

NSP has maintained initiatives that encourage the adoption of heat pumps in Nova Scotia for a number of years. NSP currently offers on-bill financing options for customers who purchase a heat pump, including MSHPs.²² There are no performance requirements for heat pumps eligible for NSP on-bill financing. Financing is available for both existing homes and new constructions.

²² Nova Scotia Power Heat Pump Financing. <https://www.nspower.ca/en/home/for-my-home/heating-solutions/heat-pumps/heat-pump-financing.aspx> (Last accessed December 4, 2018).

9.2 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 2018 NSP load forecast.²³ NSP uses a range of information, including NSP program data, NRCan data, residential consumer surveys, and heat pump distributor interviews to quantify heat pump use in Nova Scotia. The NSP load forecast provides historical data up to 2017 and a forecast from 2018 onward. For this reason, the analysis below primarily focuses on 2017 data.

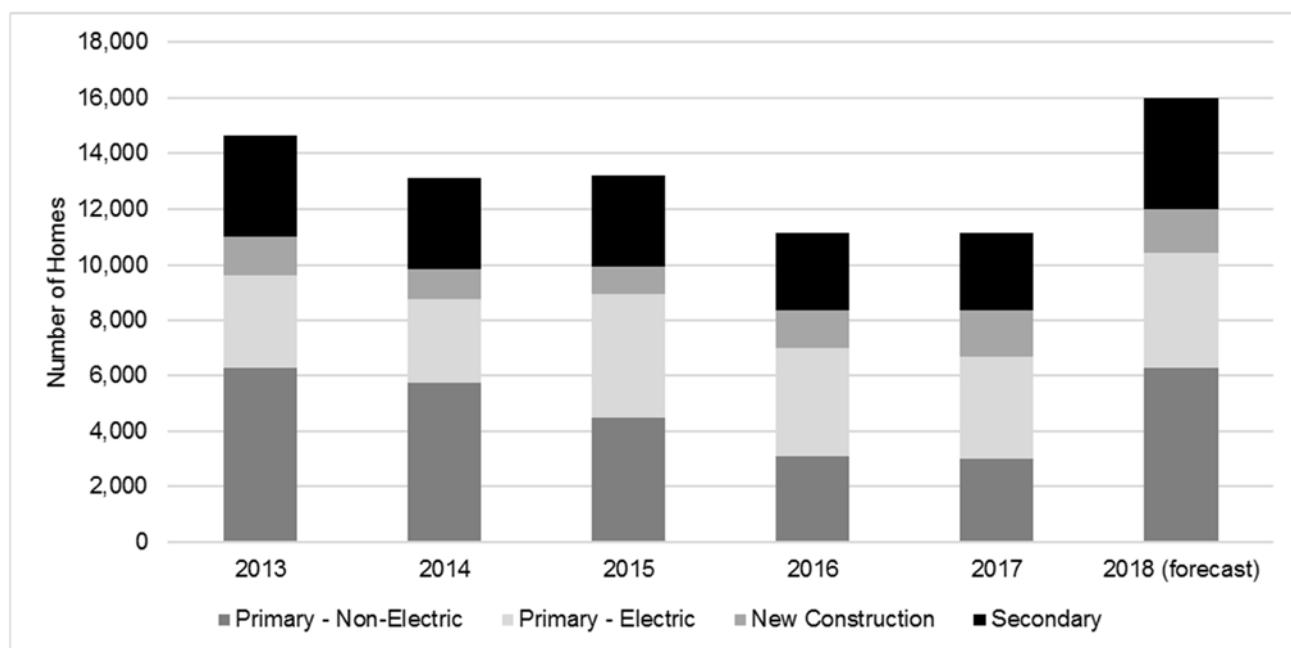
9.2.1 Market Share of Heat Pumps

Data presented in this subsection are for all heat pumps, not just MSHPs. NSP data indicates that, since 2013, over 90 percent of heat pumps installed through the NSP on-bill financing program are MSHPs.²⁴ This is echoed in Green Heat whereby 92 percent of incented heat pumps are MSHPs in 2018. Therefore, while this subsection presents information on heat pumps generally, the Evaluator concludes this information is representative of the MSHP market in Nova Scotia.

Figure 12 below depicts the number of incremental homes with heat pump systems installed annually in Nova Scotia since 2013, including new constructions. It was estimated that just over 11,000 homes had new heat pump systems installed in 2017, with the bulk of those installations in existing homes (85% of new heat pump systems). New heat pump installations decreased somewhat in 2016 and 2017, although the NSP load forecast predicts an increase in new heat pump system installations in 2018.

²³ Nova Scotia Utility and Review Board, Matter M08670. NSP Response to Synapse IR-05 Att 5 ELECTRONIC.

²⁴ Nova Scotia Utility and Review Board, Matter M08087. NSP Response to E1 IR-4 Att 1.

Figure 12: Incremental Homes with Heat Pump Systems Installed in Nova Scotia²⁵


Source: Nova Scotia Utility and Review Board, Matter M08670. NSP Response to Synapse IR-05 Att 5 ELECTRONIC

While Figure 12 above presents annual new heat pump installations, Figure 13 further below outlines the cumulative total number of homes with heat pumps in Nova Scotia. The number of homes with heat pumps has grown considerably since 2011. Note that the cumulative total number of secondary heat pumps is based on survey results that exhibit cause for some uncertainty and should be used with caution.²⁶

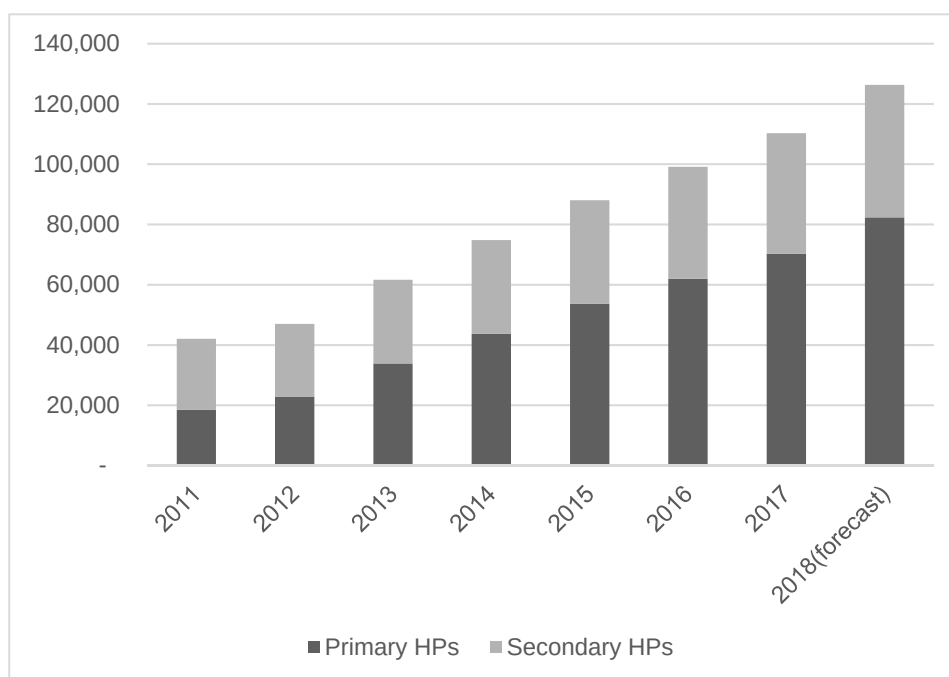
As indicated in Figure 13, 110,278 homes had either a primary or secondary heat pump system in 2017. Using the total number of Nova Scotia households estimated by NSP²⁷, this translates to approximately 27 percent of households having heat pumps in Nova Scotia for 2017, up from 11 percent in 2011. This growth was largely driven by an increase in primary heat pump systems, which more than doubled between 2011 and 2017.

The share of heat pumps used as a primary heating system increased to an estimated 17 percent in 2017, while the proportion of electrical furnaces, resistant heaters, and non-electrical heating systems has decreased.

²⁵ NSP assumes that 75% of new heat pump systems are primary systems, based on survey results.

²⁶ The number of primary systems is drawn directly in NSP Load Forecast data. The number of secondary systems presented herein were estimated, in part, using results from an NSP survey asking respondents to report their source of secondary heating (see Nova Scotia Utility and Review Board, Matter M08670, NSP Response to Synapse IR-5h). The survey found that 8 percent of secondary heating sources were MSHPs. Importantly, over a third of survey respondents responded "other/don't know", therefore the secondary pump estimates should be used with caution.

²⁷ Nova Scotia Utility and Review Board, Matter M08670. NSP Response to Synapse IR-05 Att 5 ELECTRONIC.

Figure 13: Homes with Heat Pump Systems (Cumulative)


Source: Nova Scotia Utility and Review Board, Matter M08670. NSP Response to Synapse IR-05 Att 5 ELECTRONIC

9.2.2 ENS Incented Mini-split Heat Pumps

Green Heat Mini-split Heat Pumps

Green Heat incents participants to purchase eligible high-efficiency MSHPs. Only single-zone systems with a heating seasonal performance factor (HSPF) greater than 9.565 in Region V and multi-zone systems with a HSPF greater than 8.696 are eligible for Green Heat.²⁸ By narrowing eligibility criteria, the program component targets a subset of high-efficiency MSHPs that provide the greatest energy savings.

Table 33 below provides the number of Green Heat incented systems since 2015. From August 2017 to July 2018, participants with non-electrically heated homes became eligible for the program component. The total number of incented systems has been increasing since 2015. The biggest growth in incented systems in 2018 came from participants with non-electrically heated homes (for which the LCEF now offers incentives for those participants).

²⁸ Systems with an HSPF below 9.565 may still be admitted to the program if equipped with a drain pan heater.

Table 33: Green Heat Incented High-efficiency Mini-split Heat Pump Systems

	2015**		2016		2017		2018	
	Electrical	Non-electrical	Electrical	Non-electrical	Electrical	Non-electrical	Electrical	Non-electrical
Number of MSHP Systems*	111	0	861	0	1,286	306	2,117	1,442***
Average HSPF of Units	10.86		10.48		10.27		10.27	
*In almost all cases, one MSHP system incented by Green Heat equates to one home. **In 2015, MSHPs were only offered in the last three months of the year. *** In 2018, non-electrical participants were tracked as DSM participants prior to July 2018, and after July 2018 as PNS participants. The 2018 non-electrical systems provided in Table 33 include both DSM and PNS participants.								

The efficiency of MSHP units has not increased since 2015, with the average HSPF rather decreasing from 10.86 in 2015 to 10.24 in 2018. The maximum efficiency MSHP sold through Green Heat in 2018 was unchanged from 2017, with an HSPF of 13.04.

HEA Mini-split Heat Pumps

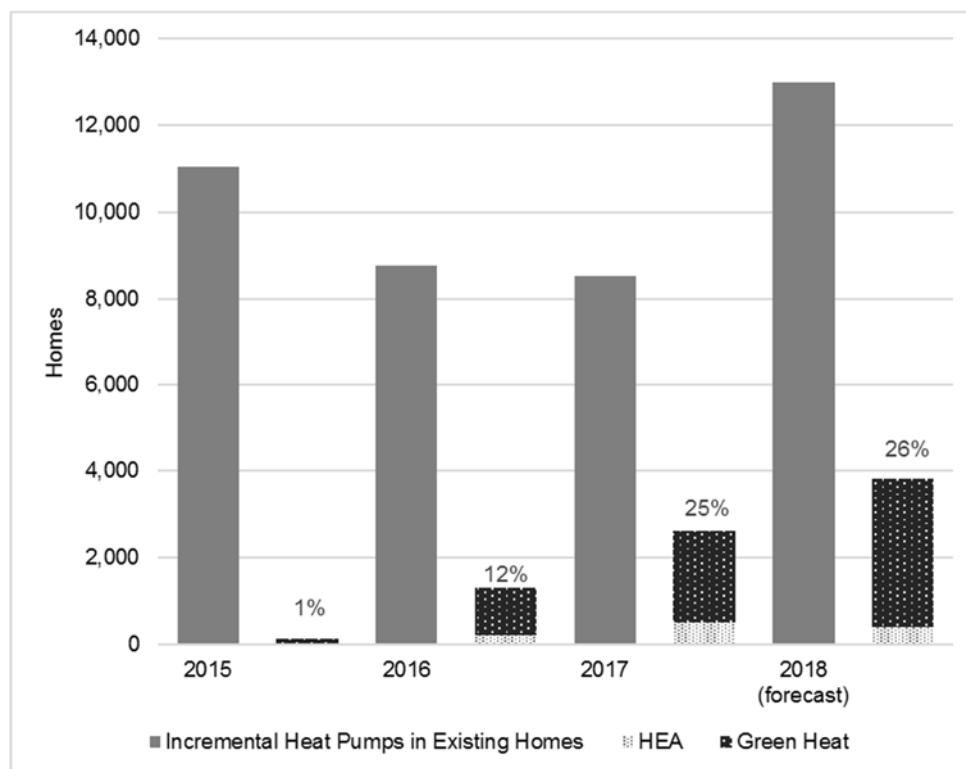
HEA also provides incentives for participants installing high-performing cold-climate MSHPs (i.e. same criteria as Green Heat) as part of a retrofit. As indicated in Table 34, HEA had 402 MSHP systems installed in 2018.

Table 34: HEA Incented High-efficiency Mini-split Heat Pump Systems

	2015	2016	2017	2018
Number of MSHP systems	16	220	516	402

Figure 14 further below presents the number of MSHP systems incented through Green Heat and HEA compared to an estimate of the incremental MSHP systems installed in existing homes in Nova Scotia through the years, assuming that 90 percent of heat pump systems are MSHPs as per NSP program data. Incented MSHPs made up a relatively small number of the incremental MSHP systems installed annually. In 2017, an estimated 25 percent (with 19 percent coming from Green Heat) of total MSHPs installed in existing homes were incented by ENS. Based on the NSP forecast, the relative percentage of installed incremental MSHPs incented by ENS was 26 percent in 2018.

Figure 14: Comparison of Incremental Existing Homes with Mini-split Heat Pump Systems to ENS Incented Systems



9.2.3 Green Heat Eligible Mini-split Heat Pumps

The Evaluator interviewed seven distributors who sell HVAC products 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 developed through internet research, referrals from Equilibrium Engineering, and interviewed distributors who were asked to name the key players in the Nova Scotia MSHP market. All interviewed distributors sell MSHPs wholesale to contractors and do not sell directly to homeowners. The interviewees had an average 10 years of experience in the MSHP market.

All interviewed distributors carry Green Heat eligible MSHPs and reported that the vast majority (90-100%) of the contractors with whom they work install Green Heat eligible MSHPs. The distributors reported they carry MSHPs that do not qualify for Green Heat for various reasons:

- › Cost of high-performing units versus lower performing units: “not everyone can afford a Cadillac” (3 responses)
- › Different applications, such as new constructions in multi-family apartments or condos and commercial buildings, whereby units are largely used for air conditioning or used for fewer hours, thus rendering energy efficiency less critical in the decision-making process (2 responses)
- › Not all the models of brands they carry qualify (1 response)

The distributors were asked to provide a best estimate of the portion of their MSHP sales that were eligible for Green Heat as of 2017. The median of the responses provided was 80 percent, with one distributor reporting 50 percent of sales, one reporting 90 percent, and the remainder ranging from 60 to 90 percent. Given that ENS incented an estimated one-quarter of newly purchased heat pump systems, if this trend exists across all distributors and retailers, then a sizable portion of Green Heat eligible MSHPs are sold without going through the program component.

9.2.4 Mini-split Heat Pump Prices

Table 35 provides the average cost of incented systems (not including incentives) and the average incentive across nominal capacities based on the Green Heat tracking sheets. This information indicates the general trend over time; the average cost figures should be used with caution since large variations in the costs of systems were observed in the tracking sheet and costs data combine systems with differing numbers of indoor heads. On average, the price of MSHPs has decreased slightly since 2016 for nominal capacities of 12,100 to 24,000 BTU/hr and above 24,000 BTU/hr. Average incentives have decreased across the range of units, reflecting changes to incentive levels made in 2017.

Table 35: Average Costs and Incentives of Program Component Units

Nominal Capacity (BTU/hr)	2016		2017		2018	
	Average Cost	Average Incentive	Average Cost	Average Incentive	Average Cost	Average Incentive
12,000 and below	\$4,462	\$335	\$5,028	\$256	\$4,693	\$216
12,100-24,000	\$6,510	\$428	\$6,335	\$351	\$6,124	\$302
Above 24,000	\$10,216	\$596	\$9,095	\$517	\$9,116	\$498

Distributors were asked about the price differential between a 12,000 BTU/hr standard MSHP and a Green Heat eligible MSHP. Of the four distributors who responded, the reported average price differential was approximately \$450, or 10 percent of the total cost. As described in the following subsection, distributors reported that other drivers, aside from cost, influence demand for MSHPs.

9.2.5 Mini-split Heat Pump Market Outlook and Trends

MSHP sales increased from 2017 to 2018. All interviewed distributors, except one, reported an increase in MSHP sales over the period, with an average increase of 28 percent. The growth reported by the distributors aligns with the NSP forecast for 2018 presented in Figure 12 above, which predicted that heat pump sales would grow by 30 percent from 2017 to 2018. Three distributors mentioned Nova Scotia's hot and humid summer, experienced in 2018, as a significant driver for MSHP sales for that year. Other mentioned growth drivers are the replacement market (people with existing MSHP systems who upgrade their old systems), the attractiveness of the technology that is now proven in the market, longer warranties, and greater reliability at colder temperatures.

The outlook reported for 2019 generally calls for more growth. Five distributors expect an increase in MSHP sales, while one expected a decrease, and another was unable to predict future sales. The distributor who expected a decrease in sales stated that the market was becoming saturated and sales are weather-dependent, reporting that their high 2018 sales were largely driven by the hot and humid summer experienced in Nova Scotia.

The interviewed distributors were asked to describe the changes they had seen in the MSHP market over the past several years. They reported the following changes:

- › Improved higher-efficiency products (5 mentions)
- › More educated consumers looking for higher-quality products (3 mentions)
- › More qualified contractors (2 mentions)
- › Longer product warranties (2 mentions)
- › More players in the market (1 mention)
- › Increased demand for air conditioning (1 mention)

Distributors were also asked where on the product adoption curve, depicted in Figure 15 below, they would place MSHPs. A product adoption curve indicates that when a new product is first introduced into the market, its sales are relatively low. Then product sales grow over time, reach a point of maturity, and sales peak. Sales then level off, taper, and eventually phase out.

Four of the seven interviewed distributors believe the MSHP market to be between sustained growth and nearing product maturity; sales are still increasing, yet at a slower rate. Two distributors believe the MSHP market to be in sustained growth and predict more growth to come. One distributor sees the market as levelling off and believes MSHPs are reaching saturation. In sum, the majority of distributors believe the market to be growing although nearing product maturity. Distributors reported that a strong driver for short-term heat pump demand was summer weather, a pattern observed in 2018 (see Figure 12 above). In addition, distributors expect that future growth in MSHP sales will largely come from new constructions, as well as the replacement market since existing systems require upgrades.

9.2.6 Codes and Standards

The ultimate indicator of market transformation is the adoption of more stringent codes and standards. The 2017 evaluation found that electrical resistance heating remains the minimal efficiency level as per building codes for small residential buildings. There are no major updates to requirements for heat pumps in the latest federal energy efficiency regulations and no known plans to render heat pumps mandatory. There has been no change in the codes and standards impacting heat pumps since the 2017 evaluation. The next regulatory update related to heat pumps is expected to be included in Amendment 17, which is planned for pre-publication in the fall of 2019 and should therefore not come into effect before at least 2021.

9.2.7 Measured Free-ridership

The MSHP free-ridership level was established at 54 percent in 2018, compared to 51 percent in 2017.²⁹ As discussed in Subsection 8.2.1, one factor contributing to the high overall free-ridership rate was that over 70 percent of 2018 participants had already made the decision to install a MSHP before hearing about Green Heat. This finding was echoed by one distributor who reported that factors (e.g. weather and demand for air conditioning, reliability of equipment) other than incentives influenced consumers' decision to install heat pumps.

9.3 Market Evolution Summary

In their recommendations on market transformation program planning, Rosenberg and Hoefgen (2009) identify a number of factors, presented in Table 36 below, to be analyzed to identify whether program component support should be withdrawn or reduced in light of changes observed in the market.³⁰

Table 36: Analysis of Key Factors in Program Component Planning

Factor	Results
Market share of heat pumps and efficient MSHPs	In 2017, an estimated 24% of Nova Scotians operated a heat pump either as a primary or secondary heating source. Heat pump sales were reported to grow considerably in 2018, in part driven by hot, humid weather experienced in 2018 in Nova Scotia. Distributors reported a 28% increase in sales in 2018 and expect further growth in 2019. Distributors predict the rate of future growth to be slowing down, with a larger portion of market demand coming from new constructions and the replacement market. Participating distributors reported that Green Heat qualified MSHPs comprised approximately 80% of their 2017 MSHP sales. An estimated 25% of total MSHPs sold in Nova Scotia received an incentive from ENS through either Green Heat or HEA. Therefore, the majority of Green Heat qualified MSHPs sold in 2017 did not receive an ENS incentive.
Recent trends in prices and availability	High-efficiency MSHPs are accessible to consumers. All of the 10 interviewed distributors carry Green Heat eligible MSHPs, and they reported that almost all contractors with whom they work install Green Heat eligible MSHPs. The average price of high-efficiency MSHPs sold through Green Heat has decreased slightly since 2016. Distributors reported that the average price differential between a 12,000 BTU/hr standard and Green Heat eligible MSHP was about \$450. Distributors reported that consumers have become more educated about high-efficiency MSHPs and that there are more, better-qualified contractors in the market.
Likelihood of inclusion in a near-term code or standard	Electrical resistance heating remains the minimal efficiency level as per building codes for small residential buildings. There are no major updates to requirements for heat pumps in the latest federal energy efficiency regulations and no known plans to make heat pumps mandatory.
Market readiness of more efficient substitute technology	Not applicable

²⁹ Free-ridership established for electrically heated households under the new path in 2017.

³⁰ 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.

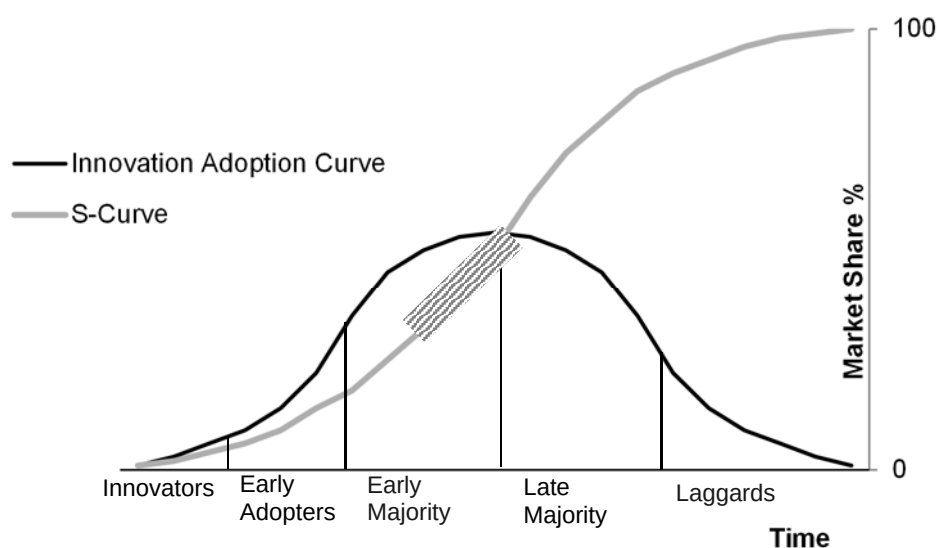
The above-listed market indicators demonstrate that the barriers to MSHP adoption continue to weaken. Distributors reported that MSHPs have become an increasingly attractive option for Nova Scotians thanks to the proven technology, increased reliability at colder temperatures, the air-conditioning option, and longer warranties. In addition, high-performing or Green Heat eligible MSHPs are becoming more and more the norm for the ten interviewed distributors. These distributors reported that about 80 percent of their sales are Green Heat eligible MSHPs and that lower efficiency MSHPs are often sold for new constructions and multi-unit buildings.

Figure 15 below provides a qualitative indication of the adoption stages of MSHPs in Nova Scotia. This figure illustrates how, with successive groups of consumers adopting the new technology (depicted by the innovation adoption curve in black),³¹ MSHP market share (depicted by the S-curve in grey) will eventually reach saturation.

This data, combined with the other market indicators discussed above, were used to provide an indication of the market phase of MSHPs in Nova Scotia, as illustrated by the hatched area of the S-curve illustrated in Figure 15. Figure 15 below gives a qualitative assessment of the MSHP market only. As such, it does not aim to represent the exact market share of MSHPs in Nova Scotia. Figure 15 uses a typical S-curve shape since more detailed analysis would be required to determine the slope and shape of the MSHP diffusion curve. Therefore, the intersection between market share and rate of adoption depicted in the chart should be interpreted with caution.

The data suggest that the MSHP market is moving from a steady growth phase to nearing product maturity given the fewer adoption barriers and increased MSHP adoption among residents.

Figure 15: Residential Market Evolution of Mini-split Heat Pumps



³¹ Everett Rogers, *Diffusion of Innovations*, 1983.

9.4 Green Heat Recommendations

The Evaluator noted that Green Heat participation increased significantly in 2018 (by 67%), likely due to changes to the application process and ENS promotional efforts. Changes in free-ridership levels and the MSHP market were also observed and will need to be considered in future planning. In addition to the general recommendations made for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator makes the following recommendations on how to improve Green Heat. These recommendations are also listed in Appendix X.

2018 GH-R1. Improve the accuracy of the information in the tracking sheet. While reviewing the data for the ducted ASHP billing analysis, the Evaluator noticed that the information on primary and secondary heating systems found in the tracking sheet was unreliable. Two reasons were identified for this issue: 2017 participants considered in the billing analysis used a previous version of the application form, which did not clearly identify which system (new or old) was being described. There were also numerous data entry errors between the application form and the tracking sheet. The information on heating systems is essential to the billing analysis. The Evaluator found that the technical characteristics (such as heating capacity) of some heat pumps were not consistent with the values found in the reference measures list. The Evaluator therefore recommends improving the quality assurance processes for the Green Heat tracking sheet.

2018 GH-R2. Continue monitoring barriers to the adoption of high-efficiency MSHPs to adapt the program component offer or plan for an exit strategy. The market indicators presented in the Market Evolution section of this report reveal the growing popularity of MSHPs in Nova Scotia. Results also indicate that the rebate is less and less important in fostering the development of the MSHPs market and that the latter is growing due to factors external to Green Heat.

Evaluation results also highlight that Green Heat still had some influence on how efficient the MSHPs purchased were in 2018. In this context, the Evaluator suggests that ENS continue incenting high-efficiency MSHP models in the short term, while monitoring barriers to high-efficiency MSHPs to understand if interventions in the market are still useful or if the measure needs to be removed or limited to those segments with lower high-efficiency MSHPs penetration rates, such as new constructions and multi-unit buildings.

10 EPI OVERVIEW

This section describes the EPI program component, follows up on the 2017 evaluation recommendations and provides an overview of EPI participation history.

10.1 Description

EPI provides participants with free-of-charge direct installations of energy efficient products. ENS contracts service providers to provide this service across the province. EPI encourages participants to also consider other ENS residential program components. EPI is available to both homeowners and renters. To diversify its product offering in 2018, ENS added thermostatic shower valves to the list of eligible products and offered free clotheslines to everyone who participated in EPI between July and November of 2018.

Products available for installation through EPI in 2018 were:

- › Light-emitting diode (LED) lamps, including A-type, reflector, and chandelier lamps
- › LED nightlights
- › Faucet aerators*
- › Low-flow showerheads*
- › Pipe insulation*
- › Hot water tank wraps *
- › Smart power controllers for audiovisual equipment
- › Programmable thermostats
- › Nest thermostats (for non-electrically heated low-income households)
- › Thermostatic shower valves*
- › Clotheslines
- › LED holiday lights (offered in exchange for incandescent holiday lights during February, as well as from October to December 2018 only)

EPI funding comes from two sources: (1) electricity ratepayer funding is used for upgrades that reduce electricity consumption; and (2) funding from the Government of Nova Scotia (using, in part, funds from the federal government LCEF) for upgrades that reduce the use of other fuels. Nest thermostats, which are offered to non-electrically heated low-income households, are funded by PNS. Previously, upgrades that reduce non-electrical energy consumption were only offered to low-income homes, although the addition of funds from the LCEF in July 2018 allowed EPI to start offering DHW products to non-low-income homes with non-electrically heated hot water. DHW products are identified in the list above with an asterisk (*). As for Nest thermostats, they remain only offered to non-electrically heated low-income households. This report only presents the evaluation results for the electricity ratepayer portion of EPI.

EPI aimed to achieve 17.1 GWh in net electrical energy savings and 2.0 MW in net peak demand savings at the generator for 2018.

10.2 Follow-up on 2017 Evaluation Report Recommendations

EPI was evaluated in 2017 and one recommendation was made by the Evaluator. Table 37 below summarizes the implementation status of the recommendation presented in the Executive Summary section of the 2017 Evaluation Report.

Table 37: Implementation Status of 2017 Recommendations for EPI

2017 Recommendation	Status
2017 EPI-R1. Document the energy savings potential related to halogen incandescent and compact fluorescent lamp (CFL) replacements.	Being implemented

To implement 2017 EPI-R1, starting in September 2018, ENS asked service providers to track halogen incandescent lamps that are already installed in participants' homes and to replace them with LED lamps to document the potential energy savings of these replacements for a certain period. The service providers reported finding no halogen incandescent lamps in participant homes. ENS and the Evaluator agree that this finding is inconsistent with other data sources.^{32,33} ENS therefore continues working with the service providers to document the energy savings potential related to halogen incandescent lamp replacements. As for CFL lamp replacements, ENS did not further investigate the potential of this measure since the cost was too high and the unitary savings were too low.

10.3 Participation History

Since 2012, EPI has contributed significantly to the growth of energy efficient lighting product penetration in the Nova Scotia market by providing direct installation of such products to over 100,000 households. In 2018, the overall participation level declined mainly due to the decreasing pool of potential participants each year.

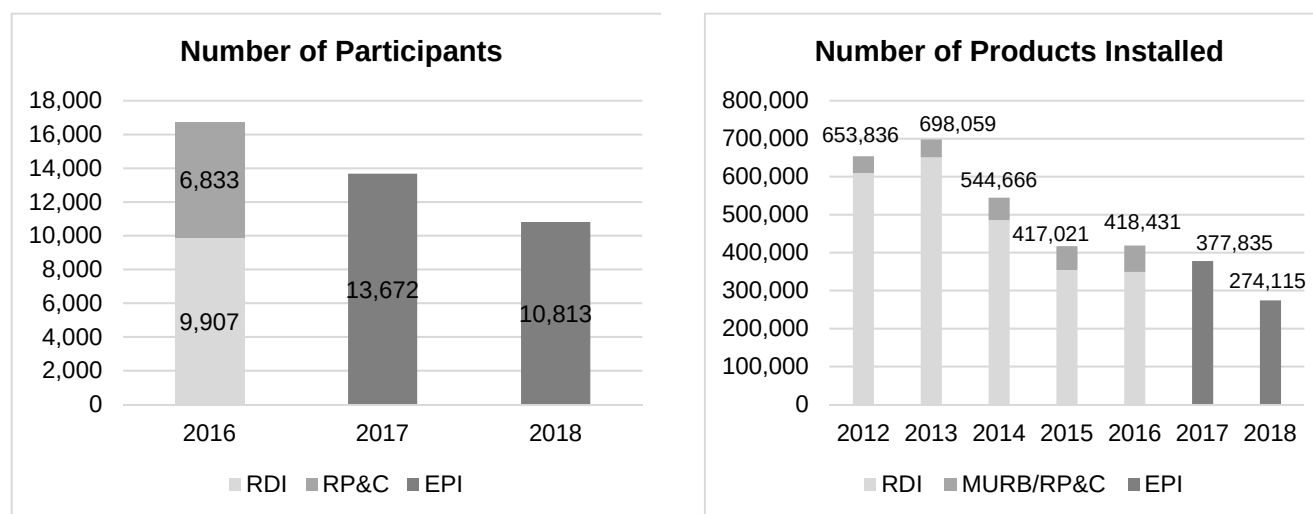
As presented in Figure 16 further below, there were a total of 10,813 EPI participants in 2018, representing a 21 percent decrease in participation compared to 2017. A total of 274,115 efficient products were installed in 2018, representing a 27 percent decline compared to 2017.

³² Electro-Federation Canada, Lamp Data - Consumer Channel and C&I Channel, 2004-2017.

³³ Corporate Research Associates Inc., *2016 Socket Study*, Final Report prepared for Efficiency Nova Scotia, December 2016.

The higher drop in total installed products than in total participants can be explained by the lower number of products installed per household. In 2018, an average of 25.3 products were installed per household. Although less than in 2017 (with an average of 27.6 products/household), this level is similar to 2016 (with an average of 25.2 products/household). Overall, the number of installed products per household remains high from one year to another and can be explained by a high proportion of participants living in single-family homes (91%); these typically offer many installation opportunities due to the size of such dwellings.

Figure 16: Summary of Participation in RDI,³⁴ RP&C³⁵ and EPI



In efforts to increase the participation level, ENS provided a free clothesline to those who participated in EPI between July and November 2018, totalling 3,246 clotheslines. In 2018, ENS also diversified its product offerings to include thermostatic shower valves and non-A-type lamps.³⁶

As highlighted in the 2017 evaluation report, the number of A-type lamp replacements in single-family homes has continued to decrease. More precisely, the average number of A-type lamps installed per single-family home decreased from 21 in 2017 to 17 in 2018. In contrast, the average number of non-A-type lamp replacements per single-family home increased from 4.0 in 2017 to 4.6 in 2018. A-type LED lamps remain the most popular product type, representing 64 percent of products installed in EPI and accounting for 53 percent of EPI gross savings.

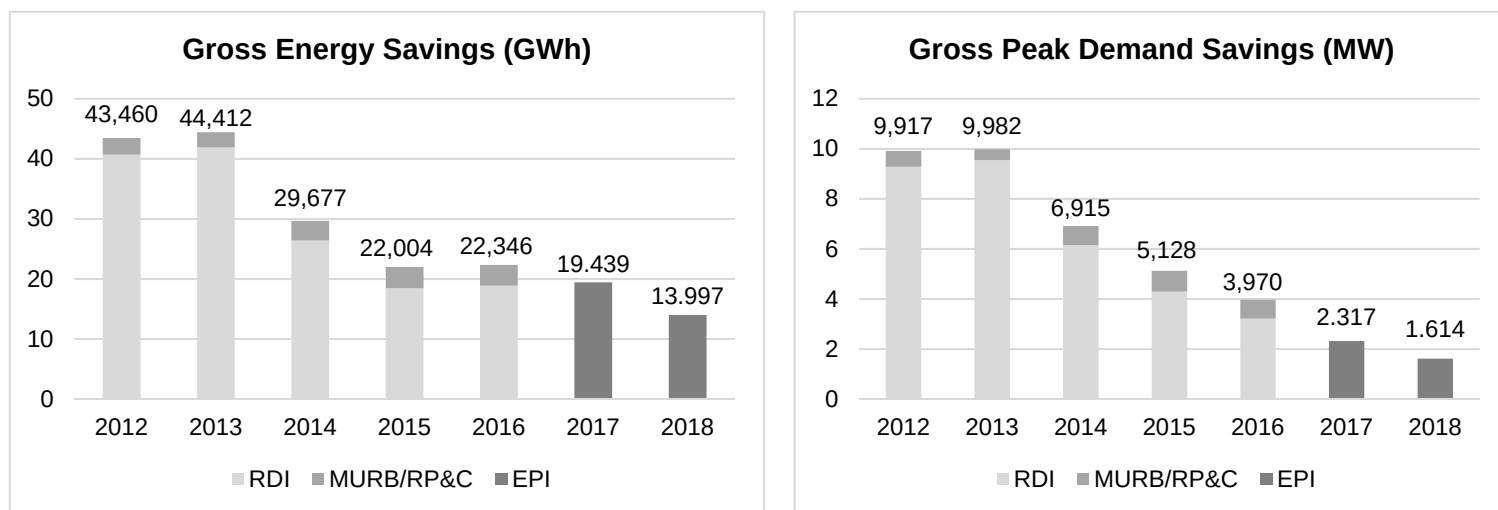
³⁴ The number of participants in RDI in 2016 was revised to 9,907 to correct a transcription error made in the RDI 2016 Evaluation Report.

³⁵ The Multi-unit Residential Building (MURB) program component became the RP&C program component in 2014.

³⁶ PAR20 and PAR38.

As illustrated in Figure 17 below, gross energy and peak demand savings generated in 2018 were lower than those generated in 2017, mainly due to decreasing participation. In 2018, EPI achieved 13.997 GWh in gross electrical savings and 1.614 MW in gross peak demand savings.

Figure 17: Summary of Gross Savings in RDI, RP&C and EPI



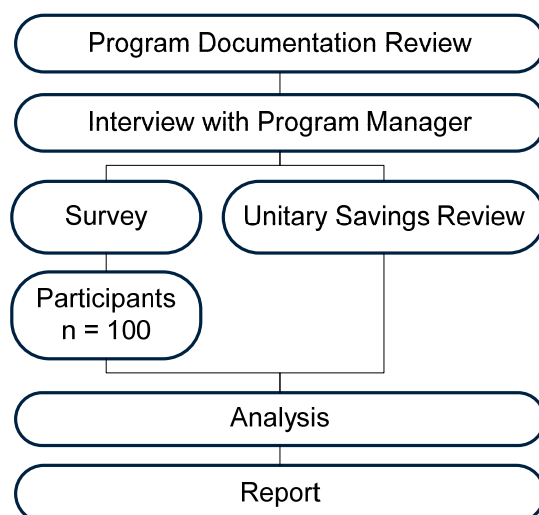
11 EPI EVALUATION OBJECTIVES AND METHODOLOGY

The main objectives of the EPI evaluation are as follows:

- › Reporting on participant perspectives
- › Calculating program results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions

This section describes the methodology used and the activities carried out for the EPI 2018 evaluation to achieve the aforementioned objectives. Figure 18 presents the data-collection activities carried out for the evaluation.

Figure 18: EPI Methodological Model



The Evaluator first reviewed EPI documentation and then held a meeting with the program manager in September 2018 to verify the implementation status of the previous evaluation recommendation and understand the program component changes made for that year. Based on the information obtained from this interview, a list of questions and topics to be included in the data-collection instruments was prepared.

Once the meeting with the program manager and the EPI documentation review were completed, specific evaluation activities were undertaken, as described in the following subsections.

For evaluation activities that yield quantitative results based on a sample, the Evaluator aimed to achieve a maximum margin of error of 10 percent at a confidence level of 90 percent. This means that if measurement were conducted many times with different samples, the data would be within 10 percentage points above or below the percentage reported 90 percent of the time. Thus, the margin of error indicates the relative level of precision³⁷ of the measurement, while its associated confidence level indicates the probability of a product falling within this margin of error.³⁸

As part of the EPI evaluation, the Evaluator calculated the margins of error for survey samples, free-ridership and spillover levels, and installation rates. The margins of error are presented along with results in the applicable sections. Examples of calculations used to establish margins of error are presented in Appendix II of the 2018 DSM Programs Evaluation Executive Summary.

Participant Survey

In October 2018, CRA conducted a telephone survey with a total of 100 non-low-income participants³⁹ comprising 70 owners and 30 tenants. The average length of the survey was 18 minutes. The questionnaire and complete survey results are presented in Appendix XI and Appendix XII, respectively. All the appendices are presented in the Existing Residential Program – Appendices document.

The participant survey collected feedback about the following aspects of EPI:

- › Installation of thermostatic shower valves and satisfaction with the devices
- › Installation of clotheslines
- › Reasons for participation
- › Information received as part of EPI
- › Satisfaction with EPI
- › Barriers to the installation of energy efficiency upgrades in homes
- › Recommendations for improvement
- › Potential for additional energy efficiency products
- › Free-ridership (including the cross-influence from ENS promotion and other program components)
- › Spillover
- › Demographics

³⁷ 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.

³⁸ 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.

³⁹ Low-income participants are usually assigned an NTGR of 1. All low-income participants were removed from the EPI survey sample so that free-ridership and spillover levels could be determined using the survey results.

The total number of EPI non-low-income participants was 7,600 for 2018. Drawing a random sample of 100 from a population of 7,600 yields a margin of error of 8.3 percent at a 90 percent confidence level.

Unitary Savings Review

The Evaluator conducted a thorough literature review, performed engineering calculations, and used program component data to review the unitary savings values used in the tracking sheet for each product type installed through EPI. Unitary savings for single-family homes and apartments were reviewed separately.

Technical reference manuals (TRMs) and public evaluation reports from jurisdictions similar to ENS were consulted and the most recent and relevant sources were selected as the basis of the unitary savings review.

Comparison with 2017 Evaluation Scope

The impact evaluation scope is defined as reduced in 2018 since the Evaluator did not conduct any on-site visits. This is justified because the products offered were very similar to previous years and the delivery method and service providers remained the same as in 2017. In addition, the results of on-site visits have been consistent over the past few years since EPI has reached high maturity. Further explanation is provided in Section 1 of the DSM Programs Evaluation Executive Summary.

12 EPI MARKET EVALUATION

A survey with 100 participating households was conducted as part of the EPI evaluation. In addition to questions designed for impact evaluation purposes, survey respondents were asked questions regarding reasons for participation, barriers to participation, satisfaction, potential for additional energy efficient products, and recommendations for improvement.

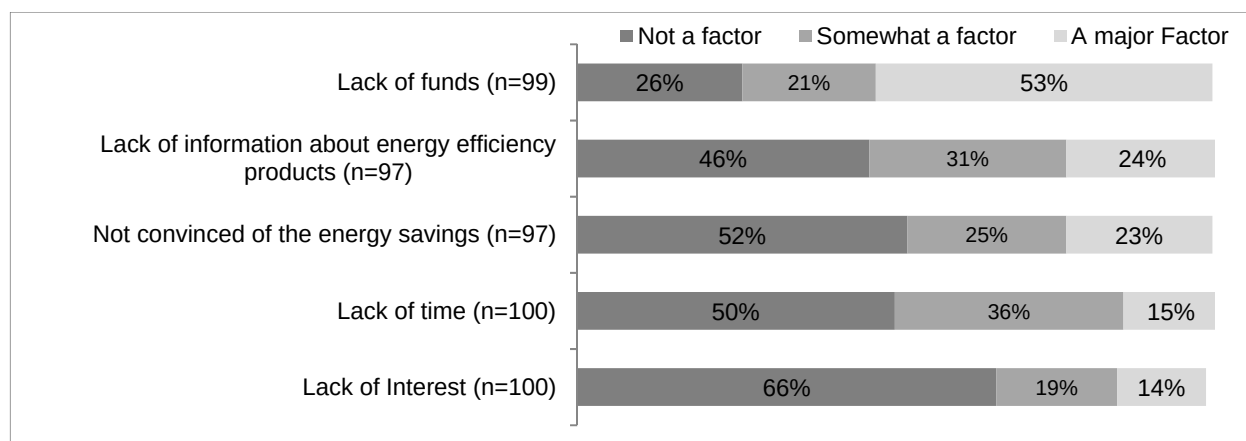
Survey results demonstrate that a little over one-third of participants (35%) had previously participated in other ENS programs or services before taking part in EPI. The Evaluator concluded that these previous experiences influenced participants' decision to have energy efficient products installed in the home (average rating of 7.9 out of 10).⁴⁰

The main reason for participating in EPI was to save on energy or energy costs (77%). In a smaller proportion, participants were interested in receiving LED bulbs (13%). When considering participating in EPI, nearly all participating households (96%) had no concerns about taking part in the program component.

Participants were asked to rate the importance of five predetermined factors in preventing their household from making energy efficiency upgrades in their home. As outlined in Figure 19 below, a lack of funds is the greatest barrier to energy efficient upgrades in homes, which is said to be a major factor by more than one-half of participating households (53%). A lack of information, skepticism toward energy savings or a lack of time each represents a barrier to roughly one-half of households, while a lack of interest is the least likely to be a factor. By offering free-of-charge installations of energy efficient products, EPI addresses the main barrier to energy efficient upgrades.

⁴⁰ Wording of the question: For the following statement, please indicate whether you agree or disagree. Your previous participation in an Efficiency Nova Scotia program or service and what you learned by participating in this service greatly influenced your decision to have energy efficient products installed in your home. Please use a scale of 0-10 where 0 indicates "completely disagree" and 10 "completely agree."

Figure 19: Barriers to Energy Efficient Upgrades



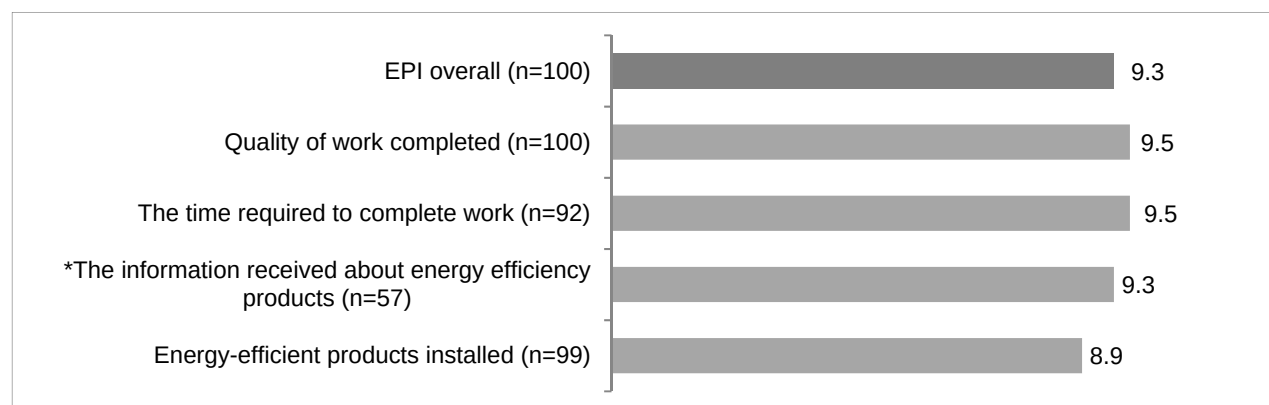
Note: Ratings based on a 10-point scale. "A major factor" and "Somewhat a factor" based on top 3 and middle 3 scale options. "Not a factor" based on the bottom 4 scale options.

Most survey respondents were home when the installer went to install the energy efficient products. Of these, 62 percent report receiving information from the installer about energy efficient products. The majority of those who did not receive information (68%) noted they would be interested in receiving information about such products.

Overall, participants were pleased with their experience with the program component. Satisfaction with EPI was very high, as indicated by the average rating of 9.3 on a 10-point scale where 1 indicates "not at all satisfied" and 10 "completely satisfied." Participants provided several reasons for their satisfaction with EPI, including that they liked the installer who visited the home, the service was good, the service was completed in a reasonable amount of time, or they found it informative.

"The installer was very professional, knowledgeable, and quick."

As presented in Figure 20 below, satisfaction was also very high with various aspects of EPI, including the quality of work completed, the time required to complete the work, the information received about energy efficient products, and the products installed.

Figure 20: Participant Satisfaction with EPI (Ratings on a 10-point Scale)


*Base: Respondents who received information during the visit from the installer about energy efficient products.

As for specific products, nine in 10 participants (89%)⁴¹ who had a thermostatic shower valve installed still had the product in place and satisfaction was moderately high, as indicated by an average rating of 7.3 on a 10-point scale. The four participants who removed the thermostatic shower valves mentioned issues related to inconvenience, poor water pressure, or not working as anticipated. Only a small proportion of households that received a clothesline installed it (29%), although two in three (68%) intend to do so. Overall, 82 percent⁴² have installed the clothesline or plan on installing it.

Less than two in 10 (18%) participating households had products recommended that they chose not to install, with the most often declined products being hot water tank wraps, smart power controllers, or showerheads. The main reason cited for not having installed the recommended products is that they did not need it, or it would not provide many benefits (6 mentions).

Two in 10 participants (20%) reported problems with the products installed through the program component, mostly with LED bulbs, faucet aerators, showerheads, and smart power controllers. According to participants, the main problems were that the LED bulbs burned out and the other products were not user-friendly.

While many participants were unable to offer any recommendations on how to improve EPI (67%), a small number mentioned offering greater diversity and choice in the product(s) offered (12%), or the need for more information on the product(s) installed (8%). For expanded product offerings, participating households provided several suggestions including different light bulbs (11%), heat pumps/geothermal (10%), and smart thermostats (7%). The Evaluator also probed respondents about their interest in having specific products installed in their home. Of the products suggested, interest is highest in a door sweep to seal any gaps at the bottom of exterior doors and lighting controls for porch lights (respectively 81% and 74% of respondents said they were interested).

⁴¹ When combining DSM and PNS survey results, the installation rate for thermostatic shower valves is 87 percent.

⁴² When combining DSM and PNS survey results, the installation rate for retractable clotheslines is 86 percent.

13 EPI IMPACT EVALUATION

The objective of the 2018 EPI impact evaluation is to determine the gross and net electrical energy and peak demand savings.

13.1 Gross Savings

For EPI, gross savings correspond to the change in energy consumption resulting from installing the energy efficient products in participants' homes, regardless of why they participated.⁴³ The Evaluator revised the gross savings tracked by ENS by reviewing the unitary savings values, peak demand-to-energy ratios, and interactive effects factors. The EUL values established during the 2017 evaluation were used again for the 2018 evaluation to calculate lifetime energy savings, with an adjustment to the equivalent EUL calculation for LED lamps and fixtures.

13.1.1 Unitary Savings Values

The Evaluator reviewed the unitary savings values used in the tracking sheet for each product installed through EPI in 2018. For this program component, ENS establishes separate unitary savings values for single-family homes and apartments. Using a combination of program data, engineering algorithms, and adapted unitary savings from studies, the Evaluator validated the tracked savings values and revised them where necessary. Appendix XIII provides a detailed description of inputs, references, and unitary savings calculations for all product types.

For products that were included in EPI prior to 2018, the Evaluator only made changes to the unitary savings values of DHW products, namely faucet aerators, and low-flow showerheads. The Evaluator updated the average number of people per household that participated in EPI based on the preliminary tracking sheet submitted by ENS in October. Furthermore, the Evaluator updated the average DHW consumption and percentage of hot water used in showers to match a more recent and large-scale study.⁴⁴ Other parameter values have remained stable over the last year and no more recent or accurate sources were found in the literature. The Evaluator found that the values used to track the energy savings of lighting products were valid and required no adjustments.

⁴³ Definition adapted from: National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

⁴⁴ 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).

In 2018, ENS introduced retractable clotheslines, reflector PAR20 7 W and PAR38 15 W LED lamps, as well as thermostatic shower valves. For retractable clotheslines, ENS used the unitary savings value presented in the 2017 Instant Savings Evaluation Report. Following a literature review, the Evaluator revised this value by changing the average annual number of laundry loads per household and the number of displaced loads. As for the two new reflector LED lamps, the Evaluator reviewed the tracked unitary savings values for these products and found they were adequate. For thermostatic shower valves, ENS tracked the unitary savings values presented in the 2017/18 PNS Evaluation Report.⁴⁵ The Evaluator updated the average DHW consumption and percentage of hot water used in showers to be consistent with the changes made to the unitary savings of low-flow showerheads.

Table 38 below summarizes the tracked and revised energy savings values for each product installed through EPI in 2018.

Table 38: Summary of EPI Tracked and Revised Unitary Savings Values

Products	EPI – Single-family Homes		EPI – Apartments	
	Tracked Savings (kWh/yr)	Revised Savings (kWh/yr)	Tracked Savings (kWh/yr)	Revised Savings (kWh/yr)
LED Lamps				
9 W Replacing 40 W	30.6	No change	30.6	No change
9 W Replacing 60 W	50.3	No change	50.3	No change
9 W Replacing 100 W	89.7	No change	89.7	No change
9.5 W Replacing 40 W	30.1	No change	30.1	No change
9.5 W Replacing 60 W	49.8	No change	49.8	No change
9.5 W Replacing 100 W	89.2	No change	89.2	No change
10 W Replacing 40 W ⁴⁶	29.6	No change	29.6	No change
10 W Replacing 60 W ⁴⁷	49.3	No change	49.3	No change
18 W Replacing 75 W	56.2	No change	56.2	No change
18 W Replacing 100 W	80.8	No change	80.8	No change
PAR20 7 W Replacing 50 W ⁴⁸	42.4	No change	42.4	No change
PAR38 15 W Replacing 90 W ⁴⁹	73.9	No change	73.9	No change
PAR38 15 W Replacing 120 W ⁵⁰	103	No change	103	No change
PAR38 15 W Replacing 150 W ⁵¹	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	32.5	No change	32.5	No change
5 W Chandelier E12	34.5	No change	34.5	No change

⁴⁵ Econoler, *Low Income 2017/18 Province of Nova Scotia Evaluation*, June 4, 2018.

⁴⁶ The Evaluator rounded the tracked values to include three significant figures.

⁴⁷ Ibid.

⁴⁸ Ibid.

⁴⁹ Ibid.

⁵⁰ Ibid.

⁵¹ Ibid.

Summary of EPI Tracked and Revised Unitary Savings Values (Continued)

Products	EPI – Single-family Homes		EPI – Apartments	
	Tracked Savings (kWh/yr)	Revised Savings (kWh/yr)	Tracked Savings (kWh/yr)	Revised Savings (kWh/yr)
Other Products				
LED Nightlights	28.5	No change	28.5	No change
LED Holiday Lights	43.6	No change	43.6	No change
Faucet Aerators	98	148	95	120
Low-flow Showerheads (0.5 gpm)	236	168	207	204
Low-flow Showerheads (0.75 gpm)	354	252	310	305
Low-flow Showerheads (1.0 gpm)	472	335	413	407
Thermostatic Shower Valves (1.5 gpm)	84	63	73	51
Thermostatic Shower Valves (2.0 gpm)	112	84	N/A	68
Thermostatic Shower Valves (2.25 gpm)	125	95	N/A	77
Thermostatic Shower Valves (2.5 gpm)	139	105	112	85
Pipe Insulation (per ft)	12.7	No change	12.7	No change
Hot Water Tank Wraps	159	No change	118	No change
Smart Power Controllers for Audiovisual Equipment	411	No change	411	No change
Retractable Clotheslines	150	104	150	104

13.1.2 Installation Rates

Installation rates represent the proportion of products recorded in the tracking sheet that remain installed in participants' homes. For products that were included in the 2017 evaluation, the Evaluator applied the installation rates established during the 110 on-site visits conducted as part of 2017 evaluation activities. This value was obtained by comparing the recorded numbers of installed products and the actual numbers verified on-site.

For thermostatic shower valves and retractable clotheslines, which ENS introduced to the program component in 2018, the Evaluator based the installation rates on the 2018 DSM participant survey and the 2018/19 PNS participant survey. By combining the results, the Evaluator established the installation rates at 87 percent for thermostatic shower valves and at 86 percent for retractable clotheslines. Section 12 above provides details about reasons why participants decided not to use these products.

In contrast to other products offered in EPI, clotheslines were not installed by service providers and were rather given away to participants upon registration. Due to the timeline of the giveaway, which took place from July to November 2018, some respondents of the 2018 survey did not have the chance to install their clothesline at the time the survey was conducted. The Evaluator therefore included participants who reported planning on installing their retractable clothesline in the installation rate, in addition to those who reported already having installed it. If ENS continues the clothesline giveaway in 2019, the Evaluator suggests that clotheslines be distributed earlier in the season and that the installation rate calculation be adjusted to better reflect the actual rate of participants who installed this product.

For LED holiday lights, it is assumed that all lights were installed. Therefore, the Evaluator established the installation rate at 100 percent for this product type.

Table 39 lists the installation rates that the Evaluator applied to the gross savings.

Table 39: EPI Product Installation Rates

Type of Product	Installation Rate Applied to Gross Savings	Margin of Error	Source
LED Lamps	98%	1.3%	2017 On-site Visits
LED Nightlights	97%	4.8%	2017 On-site Visits
LED Holiday Lights	100%	N/A	Assumption
Faucet Aerators	93%	3.9%	2017 On-site Visits
Low-flow Showerheads	89%	5.1%	2017 On-site Visits
Thermostatic Shower Valves	87%	9.5%	2018 DSM and 2018/19 PNS Surveys
Pipe Insulation (per ft)	106%	9.0%	2017 On-site Visits
Hot Water Tank Wraps	97%	4.2%	2017 On-site Visits
Smart Power Controllers	57%	10.6%	2017 On-site Visits
Retractable Clotheslines	86%	8.1%	2018 DSM and 2018/19 PNS Surveys

13.1.3 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 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.

For DHW products and smart power controllers, the peak demand savings were calculated using the on-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 the 2016-2018 period.

For lighting products, the Evaluator finds that the recommendation formulated in the 2017 Evaluation Report is still valid and thus recommends applying the Northeast Residential Lighting Hours-of-Use Study (NERHOU) ratio of 0.162 W/kWh to all indoor and outdoor lamps. As a reminder, the Evaluator conducted a lighting metering study, the Residential Lighting Metering Study,⁵² in 2017 among 75 EPI participating homes and compared the results to other studies found in the literature. The Evaluator chose to recommend using the NERHOU ratio because it is very close to the value of 0.161 W/kWh established by the Residential Lighting Metering Study. In addition, the margin of error in the NERHOU study was 1 percent, which is lower than the 10 percent in the Residential Metering study. Without specific data about LED nightlights, the Evaluator also applied the 0.162 W/kWh value to this product category.

For LED holiday lights, the Evaluator applied the ratio calculated in 2017. Based on NSP's peak load data⁵³ for 2014 and assuming that LED holiday lights are used between 5 p.m. and 7 p.m. during the month of December and the first nine days of January (40 days), the Evaluator obtained a peak coincidence factor of 35 percent and the peak demand-to-energy ratio was established at 1.509 W/kWh.

The Evaluator assumed a ratio of zero for retractable clotheslines since this product is likely not used during the winter. Consequently, the on-peak demand-to-energy ratio was set at zero.

Table 40 lists the peak demand-to-energy ratios established for each product category. These ratios are applicable to both single-family homes and apartments.

⁵² Econoler, *Residential Lighting Metering Study*, report presented to Efficiency Nova Scotia, 2017.

⁵³ Nova Scotia Power, Open Access Same-Time Information System, *Hourly Total Net Nova Scotia Load*, available at <http://oasis.nspower.ca/en/home/oasis/monthly-reports/hourly-total-net-nova-scotia-load.aspx> (Last accessed January 18, 2016).

Table 40: EPI Peak Demand-to-energy Ratios by Product Type

Type of Product	Peak Demand-to-energy Ratio	Source
Lighting Products (LEDs and LED Nightlights)	0.162	Northeast Residential Lighting Hours-of-Use Study
LED Holiday Lights	1.509	Calculated by the Evaluator
Faucet Aerators	0.162	RES-Water Heat, Navigant 2016-2018 DSM Plan
Low-flow Showerheads	0.162	RES-Water Heat, Navigant 2016-2018 DSM Plan
Thermostatic Shower Valves	0.162	RES-Water Heat, Navigant 2016-2018 DSM Plan
Pipe Insulation (ft)	0.162	RES-Water Heat, Navigant 2016-2018 DSM Plan
Hot Water Tank Wraps	0.162	RES-Water Heat, Navigant 2016-2018 DSM Plan
Smart Power Controllers	0.000	RES-Plug Load Controls, Navigant 2016-2018 DSM Plan
Retractable Clotheslines	0.000	Calculated by the Evaluator

13.1.4 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.

Lighting Products

The interactive effects factors used by ENS for energy savings are based on a methodology developed by the Evaluator in 2015 and are still valid for 2018. As for peak demand savings, the Evaluator adjusted the methodology in 2017 to apply interactive effects factors only to products whose peak demand-to-energy ratios do not already account for interactive effects. This methodology remains valid for the 2018 evaluation and, therefore, the Evaluator adjusted peak demand-to-energy ratios for A-type and reflector LED lamps, LED nightlights, and LED holiday lights to include interactive effects. The approach used to adjust peak demand-to-energy ratios for lighting products is further described below.

Based on the information in the tracking sheet, the Evaluator updated the percentages of LED products installed in homes that use electrical heating, heat pump heating, and air conditioning. The interactive effects calculation is based on a heating system efficiency of 100 percent. Therefore, the Evaluator made some adjustments for participants who use a heat pump as a primary heating system since the efficiency of this system is superior to 100 percent. It was found that 15 percent of participants who heated their homes primarily with electricity had an electrical heat pump. The Evaluator divided the interactive effects factor for heating (-58.0%) by the COP of a heat pump. This COP was estimated based on a HSPF Region V of 7.1, which is the value for a standard split heat pump as defined by the Federal Energy Efficiency Regulations.⁵⁴ The HSPF of a split system was used for heat pumps since the vast majority of participants use a ductless mini-split unit as their electrical heat pump. As a result, the interactive effects factor for heating was first divided by a COP of 2.1, the result of which was then added to the cooling-only interactive effects factor of +3.6 percent, yielding an overall interactive effects factor of -24.0 percent for buildings that are electrically heated with a heat pump.

Table 41 lists the interactive effects factor calculation results for LED products installed indoors.

Table 41: EPI Interactive Effects Calculation Results for LED Products Installed Indoors

Parameter	% of LED Products ⁵⁵	Energy Interactive Effects Factor ⁵⁶	Peak Demand Interactive Effects Factor
Heat Pump Heating and Air Conditioning	15%	-24.0%	-90.0%
Electrical Heating with Air Conditioning	3%	-54.4%	-90.0%
Electrical Heating Without Air Conditioning	29%	-58.0%	-90.0%
No Electrical Heating with Air Conditioning	5%	3.6%	0%
With Neither Electrical Heating nor Air Conditioning	47%	0%	0%
Weighted Interactive Effects Factor	100%	-22.2%	-43.0%

⁵⁴ Minister of Justice, Canada, *Energy Efficiency Regulations, 2016*, <http://laws-lois.justice.gc.ca/PDF/SOR-2016-311.pdf> (Last accessed December 6, 2018).

⁵⁵ The proportions of heating types and participants who use a heat pump or air conditioner are drawn from the 2018 EPI tracking sheet.

⁵⁶ ADS ASSOCIÉS, *Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale*, report presented to Hydro-Québec, 1992.

These interactive effects occur only when the products are installed inside buildings. For reflector and decorative LED lamps and LED nightlights, the Evaluator assumed they are all installed indoors. Their interactive effects factors therefore remain -22.2 percent for energy savings and -43.0 percent for peak demand savings. Since LED A-type lamps and LED holiday lights installed through the program component are used for both indoor and outdoor lighting, their interactive effects factors were adjusted to take this into account, as presented in Table 42 below. The proportion for each category of lamp type installed indoors or outdoors was determined based on data from the 2017 tracking sheet. For LED holiday lights, the Evaluator used the assumption that all sets replacing large incandescent sets are installed outdoors and that 25 percent of the sets replacing mini incandescent sets are installed outdoors.

Table 42: EPI Interactive Effects Factors by Lighting Product Type

Type of Product	% Indoor	% Outdoor	Energy Interactive Effects Factor	Peak Demand Interactive Effects Factor
A-type LED Lamps ⁵⁷	96%	4%	-21.3%	-41.3%
Reflector and Decorative LED Lamps ⁵⁸	100%	0%	-22.2%	-43.0%
LED Nightlights	100%	0%	-22.2%	-43.0%
LED Holiday Lights	47%	53%	-10.4%	-20.2%

The interactive effects factors were then applied to the peak demand-to-energy ratios for lighting products, as outlined in Table 43.⁵⁹

Table 43: EPI Adjusted Peak Demand-to-energy Ratios by Lighting Product Type

Type of Product	Peak Demand-to-energy Ratio	Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings	Adjusted Peak Demand-to-energy Ratio
A19 and A21 LED Lamps	0.162	-21.3%	-41.3%	0.121
Reflector and Decorative LED Lamps	0.162	-22.2%	-43.0%	0.119
LED Nightlights	0.162	-22.2%	-43.0%	0.119
LED Holiday Lights	1.509	-10.4%	-20.2%	1.344

⁵⁷ Including 9 W, 9.5 W, 10 W, and 18 W LED lamps.

⁵⁸ Including 7 W GU10, 7 W G25, and 5 W chandelier E12 LED lamps.

⁵⁹ Adjusted peak demand-to-energy ratio = peak demand-to-energy ratio × (1 + interactive effects factor for peak demand savings) / (1 + interactive effects factor for energy savings).

Hot Water Insulation Products

In the 2015 Rental Properties & Condos (RP&C) evaluation and for the hot water insulation interactive effects factors, the Evaluator used 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. The methodology and the assumptions used in the 2015 evaluation are still considered appropriate for determining the energy interactive effects factors generated by the hot water insulation products.

Unlike lighting interactive effects, the interactive effects calculations for hot water insulation products are different for apartments and single-family homes. The reason for this is that the locations of hot water tanks vary by dwelling type. It is assumed that about half of hot water tanks are located in the basement or semi-conditioned spaces in single-family homes, whereas hot water tanks in apartments are more likely to be in air-conditioned living spaces. Consequently, interactive effects during the cooling period are only considered for apartments and interactive effects during the heating period vary by dwelling type.

Table 44 below lists the updated interactive effects factors for hot water insulation products based on the new proportions of heating and cooling systems among participants that had pipe insulation and hot water tank wraps installed, as indicated in the 2018 tracking sheet.

Table 44: EPI Interactive Effects Factors for Pipe Insulation and Hot Water Tank Wraps

Parameter	% of Hot Water Insulation Products	Energy Interactive Effects During Heating Period	Energy Interactive Effects During Cooling Period
Single-family Homes, Heat Pump Heating	16%	$-90\% \times 3.8/12/2.1 = -13.6\%$	$0\% \times 2/12/2.1 = 0.0\%$
Single-family Homes, Electrical Heating	27%	$-90\% \times 3.8/12 = -28.5\%$	$0\% \times 2/12 = 0.0\%$
Single-family Homes, no Electrical Heating	54%	$0\% \times 3.8/12 = 0.0\%$	$0\% \times 2/12 = 0.0\%$
Apartments, Heat Pump Heating with Air Conditioning	0%	$-90\% \times 8/12/2.1 = 28.6\%$	$40\% \times 2/12 = 6.7\%$
Apartments, Electrical Heating with Air Conditioning	0%	$-90\% \times 8/12 = -60.0\%$	$40\% \times 2/12 = 6.7\%$
Apartments, Electrical Heating Without Air Conditioning	1%	$-90\% \times 8/12 = -60.0\%$	$0\% \times 2/12 = 0.0\%$
Apartments, no Electrical Heating with Air Conditioning	0%	$0\% \times 8/12 = 0.0\%$	$40\% \times 2/12 = 6.7\%$
Apartments with Neither Electrical Heating nor Air Conditioning	1%	$0\% \times 8/12 = 0.0\%$	$0\% \times 2/12 = 0.0\%$
Weighted Interactive Effects Factor	100%	-10.79%	0.01%
		-10.80%	

13.1.5 Effective Useful Life

As part of the 2018 evaluation, the Evaluator reviewed the EUL values used by ENS in the calculation of energy savings that are expected to persist over time. These EUL values were consistent with those established as part of the 2017 evaluation through a literature review and remain valid for the 2018 evaluation.

For LED A19, reflector and decorative lamps, equivalent EUL values need to be updated since these lamp types are expected to experience increased baselines during their lifetimes, which reduce their EULs. Using the same EULs and calculation methodology as in 2017, updated equivalent EUL values were calculated for 2018. The Evaluator also calculated the equivalent EUL for the two reflector lamps introduced to EPI in 2018⁶⁰ using this methodology. Additional details on how equivalent EUL values were established are provided in Appendix XIV.

For the two product types introduced to EPI in 2018 (other than reflector lamps), namely thermostatic shower valves and retractable clotheslines, the Evaluator reviewed the EUL values tracked by ENS. For thermostatic shower valves, ENS tracks an EUL value of 10 years, which the Evaluator found to be the most common value cited in TRMs from other jurisdictions. As for clotheslines, ENS sets the EUL at 10 years based on the value recommended in the 2017 Instant Savings Evaluation Report. Therefore, the Evaluator did not revise the values tracked by ENS.

Table 45 below summarizes the tracked and revised equivalent EUL values used by ENS and the Evaluator. The revised equivalent EUL values are applied to each product's gross and net first-year energy savings to obtain the gross and net lifetime energy savings. As a result, the weighted average EUL values of gross and net savings differ (see Subsections 13.1.6 and 11).

⁶⁰ PAR20 and PAR38 lamps.

Table 45: EPI Equivalent Effective Useful Life Values

Products	Tracked Equivalent EUL (Years)	Revised Equivalent EUL (Years)	Revised Gross Lifetime Unitary Savings (kWh)	
			Single- family	Apartments
LED A19 Lamps				
9 W Replacing 40 W	6.1	No change	187	
9 W Replacing 60 W	8.4	No change	423	
9 W Replacing 100 W	9.9	No change	888	
9.5 W Replacing 40 W	6.1	No change	184	
9.5 W Replacing 60 W	8.4	No change	418	
9.5 W Replacing 100 W	9.9	No change	883	
10 W Replacing 40 W	6.1	No change	181	
10 W Replacing 60 W	8.4	No change	414	
18 W Replacing 75 W	8.4	No change	472	
18 W Replacing 100 W	9.9	No change	800	
LED Reflector Lamps				
PAR20 7 W Replacing 50 W	6.0	No change	254	
PAR38 15 W Replacing 90 W	6.0	No change	443	
PAR38 15 W Replacing 120 W	6.0	No change	618	
PAR38 15 W Replacing 150 W	6.0	No change	798	
GU10 7 W Replacing 35 W	6.0	No change	166	
GU10 7 W Replacing 50 W	6.0	No change	254	
LED Decorative Lamps				
7 W G25	6.0	No change	166	
5 W Chandelier E12	7.0	6.0	254	
Other Products				
LED Nightlights	23.0	No change	656	
LED Holiday Lights	25.0	No change	1,090	
Faucet Aerators	10.0	No change	1,480	1,200
Low-flow Showerheads (0.5 gpm)	10.0	No change	1,680	2,040
Low-flow Showerheads (0.75 gpm)	10.0	No change	2,520	3,050
Low-flow Showerheads (1.0 gpm)	10.0	No change	3,350	4,070
Thermostatic Shower Valves (1.5 gpm)	10.0	No change	630	510
Thermostatic Shower Valves (2.0 gpm)	10.0	No change	840	680
Thermostatic Shower Valves (2.25 gpm)	10.0	No change	950	770
Thermostatic Shower Valves (2.5 gpm)	10.0	No change	1,050	850
Pipe Insulation (per ft)	15.0	No change	191	
Hot Water Tank Wraps	7.0	No change	1,113	826
Smart Power Controllers for Audiovisual Equipment	4.0	No change	1,644	
Retractable Clotheslines	10.0	No change	1,040	

13.1.6 Revised Gross Savings

The annual gross savings for each category of products installed in 2018 through EPI are listed below. Table 46 presents the results for single-family homes and Table 47 for apartments. Overall, the total gross energy and peak demand savings amounted to 13.997 GWh and 1.614 MW at the generator, which represents 117.760 GWh in lifetime energy savings. As a result, the weighted average EUL value for gross energy savings is 8.41 years.

Table 46 and Table 47 below also include the estimated gross savings at the generator using a line loss factor of 1.099 between the meter and the generator. This value is based on a weighted average of the line loss factors of EPI participants according to their rate code (the residential rate code has a line loss factor of 10.0% and the municipal rate code 4.6%).

Table 46: Revised Gross Energy and Peak Demand Savings by Product Category for EPI Single-family Homes

Category of Product	LED Lamps					
	9 W Replacing 40 W	9 W Replacing 60 W	9 W Replacing 100 W	9.5 W Replacing 40 W	9.5 W Replacing 60 W	9.5 W Replacing 100 W
Energy Savings						
Total Number of Units	2,412	151,865	684	1,686	6,080	358
Installation Rate (%)	98%	98%	98%	98%	98%	98%
Total Number of Units Installed	2,364	148,828	670	1,652	5,958	351
Unitary Savings Value (kWh)	30.6	50.3	89.7	30.1	49.8	89.2
Interactive Effects Factor	-21.30%	-21.30%	-21.30%	-21.30%	-21.30%	-21.30%
Total Gross Energy Savings – at the Meter (GWh)	0.057	5.892	0.047	0.039	0.234	0.025
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Energy Savings – at the Generator (GWh)	0.063	6.475	0.052	0.043	0.257	0.027
Effective Useful Life (years)	6.1	8.4	9.9	6.1	8.4	9.9
Gross Lifetime Energy Savings – at the Generator (GWh)	0.382	54.389	0.515	0.262	2.156	0.268
Peak Demand-to-energy Ratio	0.121	0.121	0.121	0.121	0.121	0.121
Total Gross Peak Demand Savings – at the Meter (MW)	0.007	0.713	0.006	0.005	0.028	0.003
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Peak Demand Savings – at the Generator (MW)	0.008	0.783	0.006	0.005	0.031	0.003

Revised Gross Energy and Peak Demand Savings by Product Category for EPI Single-family Homes (Continued)

Category of Product	LED Lamps					
	10 W Replacing 40 W	10 W Replacing 60 W	18 W Replacing 75 W	18 W Replacing 100 W	PAR20 7 W Replacing 50 W	PAR38 15 W Replacing 90 W
Energy Savings						
Total Number of Units	2	42	12	1,646	2,426	3
Installation Rate (%)	98%	98%	98%	98%	98%	98%
Total Number of Units Installed	2	41	12	1,613	2,377	3
Unitary Savings Value (kWh)	29.6	49.3	56.2	80.8	42.4	73.9
Interactive Effects Factor	-21.30%	-21.30%	-21.30%	-21.30%	-22.20%	-22.20%
Total Gross Energy Savings – at the Meter (GWh)	0.000	0.002	0.001	0.103	0.078	0.000
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Energy Savings – at the Generator (GWh)	0.000	0.002	0.001	0.113	0.086	0.000
Effective Useful Life (years)	6.1	8.4	8.4	9.9	6.0	6.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.000	0.015	0.005	1.116	0.517	0.001
Peak Demand Savings						
Peak Demand-to-energy Ratio	0.121	0.121	0.121	0.121	0.119	0.119
Total Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.012	0.009	0.000
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.014	0.010	0.000

Revised Gross Energy and Peak Demand Savings by Product Category for EPI Single-family Homes (Continued)

Category of Product	LED Lamps					
	PAR38 15 W Replacing 120 W	PAR38 15 W Replacing 150 W	GU10 7 W Replacing 35 W	GU10 7 W Replacing 50 W	G25 7 W	5 W Chandelier E12
Energy Savings						
Total Number of Units	4	1,120	1,057	8,972	7,853	24,230
Installation Rate (%)	98%	98%	98%	98%	98%	98%
Total Number of Units Installed	4	1,098	1,036	8,793	7,696	23,745
Unitary Savings Value (kWh)	103	133	27.6	42.4	32.5	34.5
Interactive Effects Factor	-22.20%	-22.20%	-22.20%	-22.20%	-22.20%	-22.20%
Total Gross Energy Savings – at the Meter (GWh)	0.000	0.114	0.022	0.290	0.195	0.637
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Energy Savings – at the Generator (GWh)	0.000	0.125	0.024	0.319	0.214	0.700
Effective Useful Life (years)	6.0	6.0	6.0	6.0	6.0	6.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.002	0.749	0.147	1.913	1.283	4.203
Peak Demand Savings						
Peak Demand-to-energy Ratio	0.119	0.119	0.119	0.119	0.119	0.119
Total Gross Peak Demand Savings – at the Meter (MW)	0.000	0.014	0.003	0.035	0.023	0.076
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Peak Demand Savings – at the Generator (MW)	0.000	0.015	0.003	0.038	0.025	0.083

Revised Gross Energy and Peak Demand Savings by Product Category for EPI Single-family Homes (Continued)

Category of Product	LED Nightlights	LED Holiday Lights	Faucet Aerators	Low-flow Showerheads		
				0.5 gpm Reduction	0.75 gpm Reduction	1.0 gpm Reduction
Energy Savings						
Total Number of Units	14280	636	4,807	71	898	3,026
Installation Rate (%)	97%	100%	93%	89%	89%	89%
Total Number of Units Installed	13,852	636	4,471	63	799	2,693
Unitary Savings Value (kWh)	28.5	43.6	148	168	252	335
Interactive Effects Factor	-22.20%	-10.40%	0%	0%	0%	0%
Total Gross Energy Savings – at the Meter (GWh)	0.307	0.025	0.662	0.011	0.201	0.902
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Energy Savings – at the Generator (GWh)	0.338	0.027	0.727	0.012	0.221	0.992
Effective Useful Life (years)	23.0	25.0	10.0	10.0	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	7.764	0.683	7.272	0.117	2.213	9.915
Peak Demand Savings						
Peak Demand-to-energy Ratio	0.119	1.344	0.162	0.162	0.162	0.162
Total Gross Peak Demand Savings – at the Meter (MW)	0.037	0.033	0.107	0.002	0.033	0.146
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Peak Demand Savings – at the Generator (MW)	0.040	0.037	0.118	0.002	0.036	0.161

Revised Gross Energy and Peak Demand Savings by Product Category for EPI Single-family Homes (Continued)

Category of Product	Thermostatic Shower Valves				Pipe Insulation	Hot Water Tank Wraps	Smart Power Controllers	Retractable Clotheslines	Total for Single-family Homes
	1.5 gpm	2.0 gpm	2.25 gpm	2.5 gpm					
Energy Savings									
Total Number of Units	167	2	3	287	13,497	2,605	5,605	3162	259,498
Installation Rate (%)	87%	87%	87%	87%	106%	97%	57%	86%	-
Total Number of Units Installed	145	2	3	250	14,307	2,527	3,195	2,719	251,904
Unitary Savings Value (kWh)	63	84	95	105	12.7	159	411	104	-
Interactive Effects Factor	0%	0%	0%	0%	-10.80%	-10.80%	0.00%	0.00%	-
Total Gross Energy Savings – at the Meter (GWh)	0.009	0.000	0.000	0.026	0.162	0.358	1.313	0.283	11.994
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099	1.099	1.099	-
Total Gross Energy Savings – at the Generator (GWh)	0.010	0.000	0.000	0.029	0.178	0.394	1.443	0.311	13.182
Effective Useful Life (years)	10.0	10.0	10.0	10.0	15.0	7.0	4.0	10.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	0.101	0.002	0.003	0.288	2.672	2.757	5.772	3.108	110.588
Peak Demand Savings									
Peak Demand-to-energy Ratio	0.162	0.162	0.162	0.162	0.162	0.162	0	0	-
Total Gross Peak Demand Savings – at the Meter (MW)	0.001	0.000	0.000	0.004	0.026	0.058	0.000	0.000	1.381
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099	1.099	1.099	-
Total Gross Peak Demand Savings – at the Generator (MW)	0.002	0.000	0.000	0.005	0.029	0.064	0.000	0.000	1.518

Table 47: Revised Gross Energy and Peak Demand Savings by Product Category for EPI Apartments

Category of Product	LED Lamps					
	9 W Replacing 40 W	9 W Replacing 60 W	9 W Replacing 100 W	9.5 W Replacing 40 W	9.5 W Replacing 60 W	9.5 W Replacing 100 W
Energy Savings						
Total Number of Units	127	9,239	21	69	47	6
Installation Rate (%)	98%	98%	98%	98%	98%	98%
Total Number of Units Installed	124	9,054	21	68	46	6
Unitary Savings Value (kWh)	30.6	50.3	89.7	30.1	49.8	89.2
Interactive Effects Factor	-21.30%	-21.30%	-21.30%	-21.30%	-21.30%	-21.30%
Total Gross Energy Savings – at the Meter (GWh)	0.003	0.358	0.001	0.002	0.002	0.000
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Energy Savings – at the Generator (GWh)	0.003	0.394	0.002	0.002	0.002	0.000
Effective Useful Life (years)	6.1	8.4	9.9	6.1	8.4	9.9
Gross Lifetime Energy Savings – at the Generator (GWh)	0.020	3.309	0.016	0.011	0.017	0.004
Peak Demand Savings						
Peak Demand-to-energy Ratio	0.121	0.121	0.121	0.121	0.121	0.121
Total Gross Peak Demand Savings – at the Meter (MW)	0.000	0.043	0.000	0.000	0.000	0.000
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Peak Demand Savings – at the Generator (MW)	0.000	0.048	0.000	0.000	0.000	0.000

Revised Gross Energy and Peak Demand Savings by Product Category for EPI Apartments (Continued)

Category of Product	LED Lamps					
	10 W Replacing 40 W	10 W Replacing 60 W	18 W Replacing 75 W	18 W Replacing 100 W	PAR20 7 W Replacing 50 W	PAR38 15 W Replacing 90 W
Energy Savings						
Total Number of Units	0	6	0	15	14	0
Installation Rate (%)	98%	98%	98%	98%	98%	98%
Total Number of Units Installed	0	6	0	15	14	0
Unitary Savings Value (kWh)	29.6	49.3	56.2	80.8	42.4	73.9
Interactive Effects Factor	-21.30%	-21.30%	-21.30%	-21.30%	-22.20%	-22.20%
Total Gross Energy Savings – at the Meter (GWh)	0.000	0.000	0.000	0.001	0.000	0.000
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Energy Savings – at the Generator (GWh)	0.000	0.000	0.000	0.001	0.000	0.000
Effective Useful Life (years)	6.1	8.4	8.4	9.9	6.0	6.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.000	0.002	0.000	0.010	0.003	0.000
Peak Demand Savings						
Peak Demand-to-energy Ratio	0.121	0.121	0.121	0.121	0.119	0.119
Total Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.000	0.000
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.000	0.000	0.000

Revised Gross Energy and Peak Demand Savings by Product Category for EPI Apartments (Continued)

Category of Product	LED Lamps					
	PAR20 15 W Replacing 120 W	PAR20 15 W Replacing 150 W	GU10 7 W Replacing 35 W	GU10 7 W Replacing 50 W	G25 7 W	5 W Chandelier E12
Energy Savings						
Total Number of Units	0	5	9	379	793	586
Installation Rate (%)	98%	98%	98%	98%	98%	98%
Total Number of Units Installed	0	5	9	371	777	574
Unitary Savings Value (kWh)	103	133	27.6	42.4	32.5	34.5
Interactive Effects Factor	-22.20%	-22.20%	-22.20%	-22.20%	22.20%	-22.20%
Total Gross Energy Savings – at the Meter (GWh)	0.000	0.001	0.000	0.012	0.020	0.015
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Energy Savings – at the Generator (GWh)	0.000	0.001	0.000	0.013	0.022	0.017
Effective Useful Life (years)	6.0	6.0	6.0	6.0	6.0	6.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.000	0.003	0.001	0.081	0.130	0.102
Peak Demand Savings						
Peak Demand-to-energy Ratio	0.119	0.119	0.119	0.119	0.119	0.119
Total Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.001	0.002	0.002
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.002	0.003	0.002

Revised Gross Energy and Peak Demand Savings by Product Category for EPI Apartments (Continued)

Category of Product	LED Nightlights	LED Holiday Lights	Faucet Aerators	Low-flow Showerheads		
				0.5 gpm Reduction	0.75 gpm Reduction	1.0 gpm Reduction
Energy Savings						
Total Number of Units	1440	21	664	3	38	278
Installation Rate (%)	97%	100%	93%	89%	89%	89%
Total Number of Units Installed	1,397	21	618	3	34	247
Unitary Savings Value (kWh)	28.5	43.6	120	204	305	407
Interactive Effects Factor	-22.20%	-10.40%	0%	0%	0%	0%
Total Gross Energy Savings – at the Meter (GWh)	0.031	0.001	0.074	0.001	0.010	0.101
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Energy Savings – at the Generator (GWh)	0.034	0.001	0.081	0.001	0.011	0.111
Effective Useful Life (years)	23.0	25.0	10.0	10.0	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	0.783	0.023	0.815	0.006	0.113	1.107
Peak Demand Savings						
Peak Demand-to-energy Ratio	0.119	1.344	0.162	0.162	0.162	0.162
Total Gross Peak Demand Savings – at the Meter (MW)	0.004	0.001	0.012	0.000	0.002	0.016
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Gross Peak Demand Savings – at the Generator (MW)	0.004	0.001	0.013	0.000	0.002	0.018

Revised Gross Energy and Peak Demand Savings by Product Category for EPI Apartments (Continued)

Category of Product	Thermostatic Shower Valves				Pipe Insulation	Hot Water Tank Wraps	Smart Power Controllers	Retractable Clotheslines	Total for Apartments
	1.5 gpm	2.0 gpm	2.25 gpm	2.5 gpm					
Energy Savings									
Total Number of Units	17	0	0	6	262	142	346	84	14,617
Installation Rate (%)	87%	87%	87%	87%	106%	97%	57%	86%	-
Total Number of Units Installed	15	0	0	5	278	138	197	72	14,114
Unitary Savings Value (kWh)	51	68	77	85	12.7	118	411	104	-
Interactive Effects Factor	0%	0%	0%	0%	-10.80%	-10.80%	0.00%	0.00%	-
Total Gross Energy Savings – at the Meter (GWh)	0.001	0.000	0.000	0.000	0.003	0.014	0.081	0.008	0.741
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099	1.099	1.099	-
Total Gross Energy Savings – at the Generator (GWh)	0.001	0.000	0.000	0.000	0.003	0.016	0.089	0.008	0.815
Effective Useful Life (years)	10.0	10.0	10.0	10.0	15.0	7.0	4.0	10.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	0.008	0.000	0.000	0.005	0.052	0.112	0.356	0.083	7.171
Peak Demand Savings									
Peak Demand-to-energy Ratio	0.162	0.162	0.162	0.162	0.162	0.162	0	0	-
Total Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.000	0.088
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099	1.099	1.099	-
Total Gross Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.000	0.001	0.003	0.000	0.000	0.097

13.2 Net-to-gross Ratio

The NTGR serves to determine net energy savings, i.e. the energy savings that can be reliably attributed to a program component. More precisely, the NTGR represents the positive or negative impacts of interactive effects on gross savings. In the case of EPI, two effects were considered, namely free-ridership and participant spillover.

13.2.1 Free-ridership

For EPI, free-ridership occurs when participants would have installed the energy efficient products in the absence of the program component. The free-ridership level was assessed using a self-report approach that involved asking non-low-income participants a set of questions during a telephone survey.

The questions were designed to assess the likelihood that participants would have purchased and installed the energy efficient products in the absence of the program component. The questions consider all applicable variables related to the decision-making process including planning, efficiency, quantity, timing, and cost. Additional questions were asked to determine the extent to which participants' decisions on whether to have products installed had been influenced by previous participation in one of ENS' program components or by ENS efforts to raise awareness about energy efficiency.

The Evaluator used the participant survey to assess free-ridership for LED lamps and low-flow showerheads. While the free-ridership level for low-flow showerheads was not measured in the 2017 evaluation, the Evaluator opted to measure it for 2018 since this product generated approximately 14 percent of tracked energy savings. The Evaluator assumes that the free-ridership level of low-flow showerheads is nil for tenants. As for LED lamps, separate free-ridership levels were established for owners and tenants since the Evaluator expected their decision-making processes would differ.

The feedback collected from participants who had LED lamps or low-flow showerheads installed was converted into an overall free-ridership level for each participant and each product. Furthermore, different free-ridership levels for LED lamps were established for owners and tenants. The algorithm underlying this calculation is presented in Appendix XV.

Using this approach to analyze the survey results, free-ridership levels of 23 percent for owners and 26 percent for tenants were established for LED lamps. The overall free-ridership level for all non-low-income participants was established at 23 percent for LED lamps. In 2017, the free-ridership level for LED lamps was 25 percent.

For low-flow showerheads, the free-ridership level for owners was established at 9 percent. By comparison, in 2016 the free-ridership level for DHW products in the Residential Direct Install (RDI) program component, which also targeted owners, was measured at 8 percent. With the assumption that free-ridership is nil for tenants, the Evaluator calculated that the overall free-ridership level for all non-low-income participants is 8 percent for low-flow showerheads in 2018.

As for all other types of products installed through EPI, the Evaluator considered the free-ridership value for those products to be nil.

As a result, an overall free-ridership level of 16 percent was established for all non-low-income participants. Table 48 summarizes the free-ridership levels.

**Table 48: Average Free-ridership Level by Product Category for
EPI Non-low-income Participants**

Product Category	Average Free-ridership Level	Sample Size	Population Size ⁶¹	Margin of Error	Percentage of Gross Energy Savings
LED Lighting					
Owners	23%	67	5,833	3.3%	59%
Tenants	26%	28	568	4.7%	5%
All Participants	23%	N/A	N/A	N/A	64%
Low-flow Showerheads					
Owners	9%	45	2,430	5.30%	9%
Tenants	0%	N/A	N/A	N/A	1%
All Participants	8%	N/A	N/A	N/A	10%
Other Products					
All Participants	0%	N/A	N/A	N/A	26%
All Products					
All Participants	16%	N/A	N/A	N/A	100%

13.2.2 Participant Spillover

For EPI, participant spillover occurs when participants purchase and install additional energy efficient products, due to the influence of having previously participated in the program component, without receiving any additional support from the program component.

The participant survey results were used to assess participant spillover. The methodology used to calculate the level of participant spillover is presented in Appendix XVI. As with the free-ridership levels, spillover levels were separately established for owners and tenants.

Based on the 2018 survey results, a participant spillover level was established at 3 percent for non-low-income owners and 4 percent for non-low-income tenants. For all non-low-income participants, a participant spillover level was established at 3 percent, as outlined in Table 49. By comparison, the average spillover level in 2017 was 6 percent.

⁶¹ Population size is based on the number of unique reference numbers.

Table 49: Average Participant Spillover Level for EPI Non-low-income Participants

Product Category	Average Participant Spillover Level	Sample Size	Population Size ⁶²	Margin of Error	Percentage of Gross Energy Savings
All Products					
Owners	3%	70	6,979	3.9%	92%
Tenants	4%	30	676	2.3%	8%
All Participants	3%	N/A	N/A	N/A	100%

13.3 Net Savings

Net savings are defined as the energy-use reductions that are specifically attributable to EPI. Net savings were estimated by applying the above overall NTGR to the 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 savings and peak demand savings.

The net energy savings for EPI in 2018 were estimated at 12.777 GWh at the generator and the peak demand savings at 1.463 MW at the generator. By applying 0.6126 kg CO₂ eq/kWh, which is Nova Scotia's specific factor⁶³ for GHG emissions generated by electricity production, it was estimated that the net energy savings resulted in 7,827 tonnes of avoided CO₂ eq annually. The net lifetime energy savings were established at 107.988 GWh, which yielded a weighted average EUL value of 8.45 years for net energy savings.

The detailed results for all building types combined are presented in Table 50 below.

⁶² Population size is based on the number of unique reference numbers.

⁶³ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes) and total electricity generation (10,978 GWh) was found in the following two sources:

Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018).

Emera Inc., *Management's Discussion & Analysis* as at February 9, 2018, <http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

Table 50: Evaluated Net Energy and Peak Demand Savings by Product Category for EPI

Category of Product	LED Lamps					
	9 W Replacing 40 W	9 W Replacing 60 W	9 W Replacing 100 W	9.5 W Replacing 40 W	9.5 W Replacing 60 W	9.5 W Replacing 100 W
Energy Savings						
Total Gross Energy Savings – at the Meter (GWh)	0.060	6.250	0.049	0.041	0.235	0.025
NTGR	0.86	0.86	0.86	0.86	0.86	0.86
Total Net Energy Savings – at the Meter (GWh)	0.052	5.375	0.042	0.035	0.202	0.022
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Net Energy Savings – at the Generator (GWh)	0.057	5.908	0.046	0.039	0.222	0.024
Effective Useful Life (years)	6.1	8.4	9.9	6.1	8.4	9.9
Net Lifetime Energy Savings – at the Generator (GWh)	0.346	49.624	0.456	0.235	1.869	0.234
Peak Demand Savings						
Total Gross Peak Demand Savings – at the Meter (MW)	0.007	0.756	0.006	0.005	0.028	0.003
NTGR	0.86	0.86	0.86	0.86	0.86	0.86
Total Net Peak Demand Savings – at the Meter (MW)	0.006	0.650	0.005	0.004	0.024	0.003
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Net Peak Demand Savings – at the Generator (MW)	0.007	0.715	0.006	0.005	0.027	0.003

Evaluated Net Energy and Peak Demand Savings by Product Category for EPI (Continued)

Category of Product	LED Lamps					
	10 W Replacing 40 W	10 W Replacing 60 W	18 W Replacing 75 W	18 W Replacing 100 W	PAR20 7 W Replacing 50 W	PAR38 15 W Replacing 90 W
Energy Savings						
Total Gross Energy Savings – at the Meter (GWh)	0.000	0.002	0.001	0.104	0.079	0.000
NTGR	0.86	0.86	0.86	0.86	0.86	0.86
Total Net Energy Savings – at the Meter (GWh)	0.000	0.002	0.000	0.089	0.068	0.000
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Net Energy Savings – at the Generator (GWh)	0.000	0.002	0.000	0.098	0.075	0.000
Effective Useful Life (years)	6.1	8.4	8.4	9.9	6.0	6.0
Net Lifetime Energy Savings – at the Generator (GWh)	0.000	0.014	0.004	0.969	0.447	0.001
Peak Demand Savings						
Total Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.013	0.009	0.000
NTGR	0.86	0.86	0.86	0.86	0.86	0.86
Total Net Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.011	0.008	0.000
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Net Peak Demand Savings – at the Generator (MW)	0.000	0.000	0.000	0.012	0.009	0.000

Evaluated Net Energy and Peak Demand Savings by Product Category for EPI (Continued)

Category of Product	LED Lamps					
	PAR38 15 W Replacing 120 W	PAR38 15 W Replacing 150 W	GU10 7 W Replacing 35 W	GU10 7 W Replacing 50 W	G25 7 W	5 W Chandelier E12
Energy Savings						
Total Gross Energy Savings – at the Meter (GWh)	0.000	0.114	0.022	0.302	0.214	0.653
NTGR	0.86	0.86	0.86	0.86	0.86	0.86
Total Net Energy Savings – at the Meter (GWh)	0.000	0.098	0.019	0.260	0.184	0.561
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Net Energy Savings – at the Generator (GWh)	0.000	0.108	0.021	0.286	0.203	0.617
Effective Useful Life (years)	6.0	6.0	6.0	6.0	6.0	6.0
Net Lifetime Energy Savings – at the Generator (GWh)	0.002	0.647	0.127	1.714	1.215	3.702
Peak Demand Savings						
Total Gross Peak Demand Savings – at the Meter (MW)	0.000	0.014	0.003	0.036	0.025	0.078
NTGR	0.86	0.86	0.86	0.86	0.86	0.86
Total Net Peak Demand Savings – at the Meter (MW)	0.000	0.012	0.002	0.031	0.022	0.067
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Net Peak Demand Savings – at the Generator (MW)	0.000	0.013	0.003	0.034	0.024	0.073

Evaluated Net Energy and Peak Demand Savings by Product Category for EPI (Continued)

Category of Product	LED Nightlights	LED Holiday Lights	Faucet Aerators	Low-flow Showerheads		
				0.5 gpm Reduction	0.75 gpm Reduction	1.0 gpm Reduction
Energy Savings						
Total Gross Energy Savings – at the Meter (GWh)	0.338	0.026	0.736	0.011	0.212	1.003
NTGR	1.02	1.02	1.02	0.97	0.97	0.97
Total Net Energy Savings – at the Meter (GWh)	0.345	0.026	0.750	0.011	0.205	0.973
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Net Energy Savings – at the Generator (GWh)	0.379	0.029	0.825	0.012	0.226	1.069
Effective Useful Life (years)	23.0	25.0	10.0	10.0	10.0	10.0
Net Lifetime Energy Savings – at the Generator (GWh)	8.718	0.719	8.248	0.119	2.257	10.692
Peak Demand Savings						
Total Gross Peak Demand Savings – at the Meter (MW)	0.040	0.034	0.119	0.002	0.034	0.162
NTGR	1.02	1.02	1.02	0.97	0.97	0.97
Total Net Peak Demand Savings – at the Meter (MW)	0.041	0.035	0.122	0.002	0.033	0.158
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099
Total Net Peak Demand Savings – at the Generator (MW)	0.045	0.039	0.134	0.002	0.037	0.173

Evaluated Net Energy and Peak Demand Savings by Product Category for EPI (Continued)

Category of Product	Thermostatic Shower Valves				Pipe Insulation	Hot Water Tank Wraps	Smart Power Controllers	Retractable Clotheslines	Total for All Products
	1.5 gpm	2.0 gpm	2.25 gpm	2.5 gpm					
Energy Savings									
Total Gross Energy Savings – at the Meter (GWh)	0.010	0.000	0.000	0.027	0.165	0.373	1.394	0.290	12.736
NTGR	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	-
Total Net Energy Savings – at the Meter (GWh)	0.010	0.000	0.000	0.027	0.169	0.380	1.422	0.296	11.625
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099	1.099	1.099	-
Total Net Energy Savings – at the Generator (GWh)	0.011	0.000	0.000	0.030	0.185	0.418	1.563	0.325	12.777
Effective Useful Life (years)	10.0	10.0	10.0	10.0	15.0	7.0	4.0	10.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	0.111	0.002	0.003	0.299	2.778	2.926	6.252	3.255	107.988
Peak Demand Savings									
Total Gross Peak Demand Savings – at the Meter (MW)	0.002	0.000	0.000	0.004	0.027	0.060	0.000	0.000	1.469
NTGR	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	
Total Net Peak Demand Savings – at the Meter (MW)	0.002	0.000	0.000	0.004	0.027	0.062	0.000	0.000	1.331
Line Loss Factor	1.099	1.099	1.099	1.099	1.099	1.099	1.099	1.099	-
Total Net Peak Demand Savings – at the Generator (MW)	0.002	0.000	0.000	0.005	0.030	0.068	0.000	0.000	1.463

Table 51 compares the energy and peak demand savings established through this evaluation to those tracked in the 2018 tracking sheet.

Table 51: Comparison of Tracked and Evaluated EPI Savings at the Generator

	Initial Gross Savings	Adjusted Gross Savings	NTGR*	Net Savings
Energy Savings				
ENS Tracked Savings	16.093 GWh	14.468 GWh	0.93	13.480 GWh
Evaluation Results	15.914 GWh	13.997 GWh	0.91	12.777 GWh
Peak Demand Savings				
ENS Tracked Savings	1.721 MW	1.650 MW	0.93	1.536 MW
Evaluation Results	1.676 MW	1.614 MW	0.91	1.463 MW
*The average NTGR values listed in this table correspond to the ratio of net savings to gross savings for all product categories combined.				

The evaluated net energy savings are 5 percent lower than the tracked net energy savings. The small decreases in both the overall installation rate (from 0.90 to 0.88) and the overall NTGR value (from 0.93 to 0.91), as well as the unitary savings adjustments, contributed to the slight difference between tracked and evaluated energy savings.

The evaluated net peak demand savings are 5 percent lower than those tracked by ENS. This difference is mainly due to unitary savings values adjustments for low-flow showerheads, faucet aerators and thermostatic shower valves, which together account for 24 percent of peak demand savings. The impact of the unitary savings adjustments is greater on peak demand savings than on energy savings because DHW products account for a larger proportion of peak demand savings. Furthermore, the change in the overall NTGR value (from 0.93 to 0.91) also contributed to the difference between tracked and evaluated peak demand savings.

14 EPI RECOMMENDATIONS

Having operated in the market for several years, EPI still succeeds in achieving high levels of participation and savings. Moreover, participant satisfaction remains very high. The biggest challenges for EPI in the coming years will relate to the diminishing opportunities to recruit participants due to market saturation. Furthermore, opportunities to install A-type LED lamps in participating households will continue to decline. ENS has already taken actions to diversify the type of products offered through EPI, which contributed to maintaining a high number of products installed per household.

In addition to the general recommendations made for all ENS program components in the Overall Evaluation Executive Summary of the 2018 DSM Programs, the Evaluator provides one main recommendation on how to improve EPI, which is presented here and in Appendix XVII.

2018 EPI-R2. Better inform participants about thermostatic shower valves. In 2018, ENS expanded EPI product offerings by including thermostatic shower valves. The evaluation revealed a moderate satisfaction level with this new product. Due to the novelty of this product, the Evaluator recommends that ENS continue working with service providers to deliver high-quality information to participants regarding thermostatic shower valves. The information can be shared verbally upon installation or a pamphlet can be left behind. Experience demonstrates that improving product information can help lower product removal. It can also improve satisfaction levels since participants value receiving information about the products installed.

15 OVERALL SAVINGS FOR THE EXISTING RESIDENTIAL PROGRAM

Table 52 below summarizes the participation level, as well as the gross and net savings for each Existing Residential program component and for the program as a whole.

Table 52: Overall Savings for Existing Residential

	Participation Level	Gross Savings	NTGR	Net Savings
HEA				
Energy Savings	791 participants	6.366 GWh	0.90	5.724 GWh
Lifetime Energy Savings		127.258 GWh	0.90	114.488 GWh
Peak Demand Savings		1.800 MW	0.89	1.600 MW
Green Heat				
Energy Savings	3,055 measures installed	9.078 GWh	0.47	4.227 GWh
Lifetime Energy Savings		163.749 GWh	0.47	76.292 GWh
Peak Demand Savings		8.647 MW	0.47	4.042 MW
EPI				
Energy Savings	10,813 participants	13.997 GWh	0.91	12.777 GWh
Lifetime Energy Savings		117.760 GWh	0.91	107.988 GWh
Peak Demand Savings		1.614 MW	0.91	1.463 GWh
Energy Savings		29.440 GWh		22.728 GWh
Lifetime Energy Savings		408.766 GWh		298.768 GWh
Peak Demand Savings		12.062 MW		7.105 MW

CONCLUSION

The Existing Residential program is comprised of four program components, namely HEA, Green Heat, EPI, and First Nations Home Energy Efficiency pilot. Existing Residential aimed to achieve 28.518 GWh in net electrical energy savings and 8.0 MW in peak demand savings at the generator for 2018. It achieved 22.728 GWh in net electrical energy savings and 7.105 MW in net peak demand savings at the generator, in 2018. Therefore, the program fell short of achieving planned energy and peak demand savings. EPI was the largest contributor to total program net energy savings, while Green Heat was the greatest contributor to total net peak demand savings. EPI achieved 4.323 GWh fewer than planned energy savings, which explains the bulk of the 5.572 GWh difference between program planned energy savings and program evaluated results for 2018. The First Nations Home Energy Efficiency pilot was launched in 2018 and seeks to deliver electrical energy savings to on-reserve, band-owned homes. Energy savings resulting from upgrades recommended in energy assessments that took place in 2018 are expected to be evaluated in the 2019 DSM Evaluation Report.

The following subsections summarize the main evaluation findings for each of the evaluated Existing Residential program components.

Home Energy Assessment

HEA achieved 5.724 GWh in net electrical energy savings and 1.600 MW in net peak demand savings at the generator in 2018, thus falling short of planned energy savings by 7.5 GWh in net electrical energy savings and 2.1 MW in net peak demand savings. With 791 participants, the 2018 participation level was only slightly lower than in 2017 and 2016, although it represents a significant decrease compared to 2015 levels and previous years when non-electrically homes were eligible to participate thanks to provincial funding. Non-electrically heated households were recently reintroduced as eligible, in July 2018, as a result of new federal funding, although no impacts could yet be observed since the majority of these new participants will complete the program component in future years.

The net electrical energy savings per participant decreased in 2018 compared to 2017. This decrease is explained by the revised ORs obtained from the combined results of the billing analysis conducted during the 2015 and 2018 evaluations. Results from the 2018 billing analysis on the new version of HOT2000 revealed that the type of space heating systems in place, particularly heat pumps, had a larger impact on the overestimation than the difference between the versions of HOT2000. Therefore, the results of the billing analyses conducted as part of the 2015 and 2018 evaluations were merged to obtain ORs specific to the space heating systems in place. The Evaluator still believes that further analyses should be conducted to evaluate the impact of the different HOT2000 versions on the OR and confirm whether there is no significant difference on the OR established for the D and E assessment periods.

Green Heat

Green Heat achieved 4.227 GWh in net electrical energy savings and 4.042 MW in net peak demand savings in 2018, thus surpassing both the planned 3.7 GWh in electrical energy savings and the planned 3.8 MW in peak demand savings. The 2018 participation level was much higher than in previous years with 3,055 measures installed, which contributed to achieving and surpassing planned energy savings. MSHPs were still the most popular measure, accounting for 92 percent of the measures installed through Green Heat.

Many factors likely contributed to higher participation, notably the removal of the pre-approval process, ENS marketing efforts, and the particularly warm 2018 Nova Scotia summer that led to increased demand for MSHPs. Participation increased significantly since the introduction of MSHPs to Green Heat in late 2015. Net energy savings also increased in 2018, although to a lesser extent than compared to participation. The new delivery mechanism was designed to eliminate the pre-approval process, which has had a positive impact on participation levels, but also led to significant increases in free-ridership levels. While no longer requiring participants to obtain approval from ENS prior to purchasing a system simplifies the participation process, it also enables participants who hear about the program component after their purchase to obtain the rebate up to 90 days after purchase and installation.

The 2018 evaluation revealed that awareness about Green Heat was largely driven by contractors, retailers and distributors. Participants were very satisfied with various aspects of Green Heat. They particularly appreciated the quality of the equipment installed in their home, the application processes, and the clarity of program component requirements.

Over the past three years, the methodology used to establish energy savings has involved performing billing analyses, which has resulted in improved accuracy. For MSHPs, the results of the billing analysis presented in the 2017 Evaluation Report were applied to obtain 2018 evaluation results. The Evaluator performed a billing analysis as part of the 2018 evaluation to estimate more accurately ducted ASHP energy savings; unfortunately, the analysis was inconclusive likely due to a combination of incorrectly filled out participation forms and errors in data entry. Therefore, the Evaluator applied the savings value obtained from the 2017 billing analysis to ducted ASHPs installed in 2018 and recommends improving the accuracy of the information in the tracking sheet going forward.

Furthermore, the Evaluator completed a market evolution assessment by analyzing key market indicators for MSHPs and found that the MSHP market is transforming from a steady growth phase to a product maturity phase as more and more Nova Scotians adopt the technology.

Efficient Product Installation

EPI achieved 12.777 GWh in net electrical energy savings and 1.463 MW in net peak demand savings at the generator in 2018, thus not attaining the planned savings of 17.1 GWh and 2.0 MW respectively. The 2018 EPI planned savings were aligned with the results achieved in 2017, although participation levels continued to decline since that year. Savings and participation levels have declined in recent

years mainly due to the decreasing pool of potential participants. Nonetheless, the program component contributed significantly to the growth of energy-efficient lighting product penetration in the Nova Scotia market by providing direct installations for 10,813 participants in 2018 and over 100,000 participants since 2012.

In 2017, the Evaluator found that the bulk of energy savings were generated by LED A-type lamps, although opportunities for incandescent A-type lamp replacements were declining, thus creating a risk for diminished savings in the future. To address this trend, ENS diversified its product offering in 2018 by including thermostatic shower valves and additional non-A-type lamps to the list of eligible products. Free clotheslines were also offered to everyone who participated in EPI between July and November of 2018.

Again for 2018, A-type LED lamps accounted for the bulk of EPI gross savings, representing 53 percent of energy savings and 56 percent of peak demand savings. The average number of A-type lamps installed per single-family home decreased from 21 in 2017 to 17 in 2018, indicating that opportunities for incandescent A-type lamp replacements continue to decline. On the other hand, efforts made by ENS to diversify LED product offerings have produced positive results since the average number of non-A-type lamp replacements per single-family home increased from 4.0 in 2017 to 4.6 in 2018.

Consistently with previous years, participant satisfaction with EPI was very high in 2018. Interactions with installers (including work quality and the information they provided to participants), the time required to complete the work, and the installed energy efficient products were all cited as reasons for this high level of satisfaction. Thermostatic shower valves, newly introduced in 2018, received a moderate satisfaction rating.

LIST OF APPENDICES

The following are presented in the Existing Residential Program – Appendices document.

Home Energy Assessment

Appendix I HEA: On-site Visits and HOT2000 Simulation Review Protocol

Appendix II HEA: Billing Analysis Details

Appendix III HEA: 2018 Recommendations

Green Heat

Appendix IV GH: Participant Survey Questionnaire

Appendix V GH: Participant Survey Results

Appendix VI GH: On-site Visit Sampling Methodology and Protocol

Appendix VII GH: Distributors Interview Guide

Appendix VIII GH: Savings Review Results

Appendix IX GH: Algorithm for Free-ridership Calculation

Appendix X GH: 2018 Recommendations

Efficient Product Installation

Appendix XI EPI: Participant Survey Questionnaire

Appendix XII EPI: Participant Survey Results

Appendix XIII EPI: Detailed Calculations of Unitary Savings Values

Appendix XIV EPI: Detailed Calculations of Equivalent EUL of LED Lamps

Appendix XV EPI: Algorithm for Free-ridership Calculation

Appendix XVI EPI: Participant Spillover Methodology

Appendix XVII EPI: 2018 Recommendations



ECONOLER

EXISTING RESIDENTIAL PROGRAM

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Appendix Report

March 15, 2019



TABLE OF CONTENTS

APPENDIX I HEA: ON-SITE VISITS AND HOT2000 SIMULATION REVIEW PROTOCOL.....	1
APPENDIX II HEA: BILLING ANALYSIS DETAILS	10
APPENDIX III HEA: 2018 RECOMMENDATIONS	12
APPENDIX IV GH: PARTICIPANT SURVEY QUESTIONNAIRE.....	13
APPENDIX V GH: PARTICIPANT SURVEY RESULTS	27
APPENDIX VI GH: ON-SITE VISIT SAMPLING METHODOLOGY AND PROTOCOL	44
APPENDIX VII GH: DISTRIBUTORS INTERVIEW GUIDE	53
APPENDIX VIII GH: SAVINGS REVIEW RESULTS.....	57
APPENDIX IX GH: ALGORITHM FOR FREE-RIDERSHIP CALCULATION	69
APPENDIX X GH: 2018 RECOMMENDATIONS	73
APPENDIX XI EPI: PARTICIPANT SURVEY QUESTIONNAIRE	74
APPENDIX XII EPI: PARTICIPANT SURVEY RESULTS.....	91
APPENDIX XIII EPI: DETAILED CALCULATIONS OF UNITARY SAVINGS VALUES	113
APPENDIX XIV EPI: DETAILED CALCULATIONS OF EQUIVALENT EUL OF LED LAMPS	127
APPENDIX XV EPI: ALGORITHM FOR FREE-RIDERSHIP CALCULATION	131
APPENDIX XVI EPI: PARTICIPANT SPILLOVER METHODOLOGY.....	133
APPENDIX XVII EPI: 2018 RECOMMENDATIONS	134

**APPENDIX I
HEA: ON-SITE VISITS AND HOT2000 SIMULATION
REVIEW PROTOCOL**

The following sets out the criteria that each evaluated house file must meet:

1. Each question must be answered with a 'Yes', 'No', or 'N/A' (if not applicable to the type of service) via the drop-down list.
2. If a section is not applicable, enter N/A in the section heading and the section will be greyed out.
3. Provide details in the "additional information/comments" section to help support your response.
4. Where a line asks whether the section was a significant error, score it as 1 (Low significance), 2 (Medium significance), 3 (High Significance).
5. Upon completion of the File Assessment and Modeling Verification, enter your name and date in the form (top of form).

Quality assurance auditor / Quality Assurance Specialist:	File number (D)	File number (E)																								
Date of quality assurance audit (YYYY/MM/DD):	D Energy advisor name:	E Energy advisor name:																								
	House evaluation date (YYYY/MM/DD):	House evaluation date (YYYY/MM/DD):																								
	Building type:	Building type:																								
	Type of service:	Type of service:																								
		Post Retrofit ("E")																								
Overall Consumption Difference (%)	<table border="1"> <thead> <tr> <th>0</th> <th>Impact of the error on the energy consumption (in %) only if the difference is > 0.1%</th> <th>Additional Information/Comments</th> </tr> </thead> <tbody> <tr> <td>1</td> <td></td> <td></td> </tr> <tr> <td>1</td> <td></td> <td></td> </tr> <tr> <td>0%</td> <td></td> <td></td> </tr> </tbody> </table>	0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/Comments	1			1			0%			<table border="1"> <thead> <tr> <th>0</th> <th>Impact of the error on the energy consumption (in %) only if the difference is > 0.1%</th> <th>Additional Information/Comments</th> </tr> </thead> <tbody> <tr> <td>1</td> <td></td> <td></td> </tr> <tr> <td>1</td> <td></td> <td></td> </tr> <tr> <td>0%</td> <td></td> <td></td> </tr> </tbody> </table>	0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/Comments	1			1			0%		
0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/Comments																								
1																										
1																										
0%																										
0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/Comments																								
1																										
1																										
0%																										
Data Collection Was sufficient information provided in order to model or verify the modeling of the following?	<table border="1"> <thead> <tr> <th>0</th> <th>Impact of the error on the energy consumption (in %) only if the difference is > 0.1%</th> <th>Additional Information/Comments</th> </tr> </thead> <tbody> <tr> <td>Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings</td> <td></td> <td></td> </tr> </tbody> </table>	0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/Comments	Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings			<table border="1"> <thead> <tr> <th>0</th> <th>Impact of the error on the energy consumption (in %) only if the difference is > 0.1%</th> <th>Additional Information/Comments</th> </tr> </thead> <tbody> <tr> <td>Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings</td> <td></td> <td></td> </tr> </tbody> </table>	0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/Comments	Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings														
0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/Comments																								
Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings																										
0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/Comments																								
Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings																										
General information and geometry																										
Type of Service (Basic, Upgrade)																										
General house information/specification																										
Blower door info (data collection form or 3rd party software printout)																										
Sketches/measurements/calculations - for each floor level																										
Sketches - gable profile/dimensions for sloped ceilings																										
Risk assessment of mixed-use buildings																										
Heated floor area																										

Mechanicals					
Primary heating system					
MURBS - Multiple heating systems					
Supplementary heating system					
Type 2 Systems (Heat pumps/Cooling systems)					
Domestic hot water					
Whole house ventilation					
Supplemental ventilation					
Drain water heat recovery					
Renewables	N/A			Yes	
Solar DHW	N/A				
Photovoltaic	N/A				
Wind turbine	N/A				
Program specific					
Low-flush toilets					
Household operating conditions	N/A				
Atypical energy loads	N/A				
Reduced operating conditions					
Program specific					
Dwelling units and Non-Res units					
Multi-unit: one unit identified as basement only					
Other					

	0			0	
Photographic Requirements <i>Follows criteria as per data collection purposes</i>	Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings	Impact of the error on the energy consumption (in) only if the difference is > 0.1%	Additional Information/ Comments	Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%
Exterior building components					
Front of building					
All exterior elevations					
Mechanical equipment					
Primary heating system					
Domestic hot water heater					
Air source heat pump and central air conditioner					
Supplementary heating system					
HRV/ERV					
Drain water heat recovery system					
Renewables	Yes			Yes	
Solar domestic hot water (SDHW)					
Photovoltaic panels					
Wind turbines					
Building Envelope					
Attic (gable, hip, scissor)					
Basement wall					
Pony wall (can be included in basement wall photo)					
Crawl space					
Header					
Exposed floor					
Half storey					
Other				Yes	
Blower door					
Additions					
Photos date stamped or indicated in photo properties					
MURB Specific					
Non residential units					
For Multi-unit: one unit, front of unit					

Modelling Verification Criteria <i>Reflect DCFs, photos, notes & sketches</i>	0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/Comments	0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/Comments
	Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings			Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings		
General information and house specifications						
Was a HOT2000 file (.h2k) that corresponds to the evaluated house provided?						
File naming convention						
Weather region and location						
Heated floor area (above and below grade)						
Front orientation						
House type						
Number of storeys						
Program specific						
Presence of vermiculite						
Toilets						
Default Values						
Were default values left as-is in the Specifications screen: Effective Mass Fraction, Foundation Soil Condition, Water Table Level, Wall Colour, Roof Colour, and Default Roof Cavity Inputs?						
Basement unit checked on Temperature screen						
Ceiling and roof assemblies	Yes			Yes		
Construction details structure type (e.g. truss, framing, etc.)						
Insulation (layers, type, thickness, RSI/R-value)						
Geometry (i.e. flat/sloped ceiling areas)						
Ceiling /roof areas containing different construction details modelled separately						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Wall assemblies						
Wall construction details (structure type, framing, interior/exterior finishes)						
Insulation (type, thickness, RSI/R-value)						
Buffering effect						
Geometry (height/perimeter)						
Wall area (avg. Wall height) for gable walls						
If attached house, wall perimeters correctly modelled						
Wall areas containing different construction details modelled separately						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Main wall Floor headers	Yes			Yes		
Header construction details						
Geometry (height/perimeter)						
Insulation (layers, type, thickness, RSI/R-value)						
Buffering effect						
Floor header sections containing different construction details modelled separately						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						



Exposed floors	Yes			Yes		
Geometry (length/area)						
Construction details (structure type, framing, interior/exterior finishes)						
Insulation (type, thickness, RSI/R-value)						
Buffering effect						
Crawl space modelled as exposed floor						
Exposed floor areas containing different construction details modelled separately						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Windows						
Window construction details						
Window assemblies with differing in construction details modelled separately						
Have different window types (casement, picture, slider) been modelled separately?						
Number of windows						
Wall section/location						
Orientation						
Dimensions (width and height)						
Significant overhang, header height						
Was the buffering effect added appropriately?						
Have skylights been modelled correctly?						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Doors	Yes			Yes		
Type						
Number of <i>single</i> doors						
Have the doors been placed in the correct wall section/location?						
Windows in doors (orientation, type)?						
Double doors or door assemblies (rough opening measurements)?						
Was the buffering effect added appropriately?						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Foundation						
Upgrade foundation modelling same configuration as base case						
Did the EA model a "walkout" basement without the "walkout" configuration						
Basement	Yes			Yes		
If the foundation had concrete walls, was the configuration used to model the walls BCCB_4 or BCCB_8						
Geometry (composites, wall height, perimeter/area)						
Depth below grade (basement wall height below grade)						
Attached or multiple foundations exposed surfaces perimeter						
Wall construction details						
Composite values and percentages modelled correctly?						
Insulation (layers, type, thickness, RSI/R-value)						
Slab construction details						
Has the location of the foundation floor been identified as "heated floor", "above" or "below" frost line?						
Floors above foundation construction details						
Header construction details						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Pony wall	Yes			Yes		
Pony wall construction details						
Pony wall geometry (height, perimeter, equivalent wall height)						
Composite values and percentages modelled correctly?						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						

Crawlspace	Yes			Yes		
Geometry (composites, wall height, perimeter/area)						
Depth below grade (basement wall height below grade)						
Attached or multiple foundations exposed surfaces perimeter						
Wall construction details						
Insulation (layers, type, thickness, RSI/R-value)						
Composite values and percentages modelled correctly?						
Slab construction details						
Has the location of the foundation floor been identified as "heated floor", "above" or "below" frost line?						
Header construction details						
Floors above foundation construction details						
Crawl space "heated" indicated						
Heated crawl space volume included in total volume						
Open crawl space with more than one foundation type present modelled as exposed floor						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Slab-On Grade	Yes			Yes		
Slab insulation and integral footings noted?						
Slab insulation details (above/below)						
Has the location of the foundation floor been identified as "heated floor", "above" or "below" frost line?						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Primary Heating System						
Equipment type (furnace, boiler, etc.)						
Manufacturer name and model number						
Dual fuel system and switchover temperature						
Efficiency (AFUE or steady state)						
Motorized vent damper						
Combustion air supply duct						
Energy-efficient motor						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Heat pumps	Yes			Yes		
Type (GSHP, ASHP, WSHP)						
Manufacturer name and model number						
Function (heating/cooling)						
Temp. Cut-off type and Cut-off Temp.						
Heating/cooling efficiency (COP/HSPF, SEER)						
Output capacity						
Model numbers of both condenser and evaporator coil						
GSHP GeoExchange Coalition certified						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Cooling system	Yes			Yes		
Manufacturer name and model number - both condenser and evaporator						
Duct to basement?						
Number of heads						
Efficiency (SEER or COP)						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						



Supplementary heating system	Yes			Yes		
Type (fireplace, sealed, airtight)						
Energy source						
Pilot light						
Combustion air supply duct						
Usage						
If usage is "always" complete fields below						
Manufacturer name and model number						
Efficiency						
Location heated						
Floor area heated						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Domestic hot water heater						
Energy source						
Type						
Presence of pilot identified with type						
Location (main floor/basement)						
Manufacturer name and model number						
Efficiency/performance						
Insulating blanket						
Combustion air supply						
DHW flue combined with furnace/boiler flue						
Integrated heat pump, EF, COP (standby, if applicable)						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Ventilation (HRV/ERV)	Yes			Yes		
Manufacturer name and model number						
Supply and exhaust flow rates						
Sensible efficiency (at 0°C and -25°C)						
Number of bathroom fan(s) and range hood(s)						
Flow rates of supplemental exhaust adjusted without justification						
If bathroom or other fan for whole-house, make/model/exhaust flow rate						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Drain water heat recovery	Yes			Yes		
Manufacturer name and model number						
Destination of preheated water - to hot water tank or hot water + shower						
Efficiency if modelled as generic						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						
Blower Door Test / Natural Air Infiltration						
$r \geq 0.99$						
$0.5 < n < 1.0$						
Data points < 6% error						
ELA < 7% error?						
Where combustion devices are subject to depressurization, is there evidence of an exhaust devices depressurization test performed?						
Is there a minimum eight (8) blower door test points recorded?						
Are there a minimum of five (5) valid blower door test points present?						
Above-grade height of highest ceiling						
Total house volume						
Other						
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high						

EnerGuide Rating System Outputs: <i>Homeowner Information Sheet Renovation Upgrade Report</i> <i>Follows criteria as per data collection and modelling procedures</i>	0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/Comments	0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/Comments
	Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings			Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings		
Homeowner Information Sheet (HOIS)						
Homeowner Information Sheet (HOIS) provided?						
Renovation Upgrade Report (RUR)	Yes			N/A		
Renovation Upgrade Report (RUR) provided?						
Were a minimum of two upgrades recommended?						
Were custom comments entered for each upgrade?						
Is the Energy Action Roadmap logical and accurately prioritized based on the information provided?						
Were the written air sealing recommendations appropriate based on the blower door test results (sufficient house-specific air leakage)?						
HRV recommended for airtight houses or potential indoor air quality issues?						
Are the recommendations provided in the RUR consistent with the information/data collected by the EA?						
Were under-insulated components modelled with upgrades that reflect the appropriate insulation levels for the specific climate zone (i.e. based on degree days, energy codes, etc.)?						
Based on the house conditions and components present in the home at the time of the evaluation, are the recommended upgrades and results reasonable?						
Were there any upgrade recommendations that were missing in the RUR (i.e. low-flush toilets, components or mechanicals)?						
Was the customized report text in the RUR house specific and address the concerns of the homeowner (i.e. indicative of a long-term energy plan)?						
Were the house-specific or custom information sections of the report free of grammatical, formatting and spelling errors?						

Evaluation Authorization Form Blower Door Test Waiver Criteria	0 Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings	Impact of the error on the energy consumption (in) only if the difference is > 0.1%	Additional Information/ Comments	0 Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/ Comments
Was the EnerGuide Rating System-Evaluation Authorization Form provided?						
Was the EnerGuide Rating System-Evaluation Authorization Form signed by the client?						
If a blower door test was not performed due to the presence of vermiculite, has a signed copy of the EnerGuide Rating System-Blower Door Test Waiver been provided?						
Additional comments (D)			Additional comments (E)			

APPENDIX II

HEA: BILLING ANALYSIS DETAILS

The overestimation ratios (ORs) are used to adjust the heating consumption values resulting from the HOT2000 simulations, which tend to slightly overestimate houses' space heating consumption. This appendix presents the details of the billing analyses conducted to establish the ORs for the 2018 HEA evaluation.

In 2018, 300 HEA participants who had their house modelled using HOT2000 version 11 were randomly selected for a billing analysis. Only the D assessment period was analyzed for this sample because of the small number of participants using HOT2000 Version 11 who had enough electricity bills after the E assessment.

The 2018 sample was combined with the sample of 887 HEA participants who were selected in the billing analysis conducted for the 2015 HEA evaluation using the prior versions of HOT2000. These participants had both the D and E assessments analyzed.

For each participant, a regression model was built to express the energy consumption as the sum of a constant and a coefficient multiplied by an independent variable representing the outdoor temperature. The coefficient of the energy consumption model was then multiplied by the normal heating degree days (HDDs)¹ and compared to the heating consumption obtained in the HOT2000 software to calculate the ORs.

Table 1 below details the main steps and criteria used for each billing analysis.

¹ The normal HDDs were calculated over a 30-year period, from 1971 to 2000 for the participants selected in 2015 and from 1981 to 2010 for the participants selected in 2018. These HDDs figures correspond to the most up-to-date data at the time of the analysis. The typical weather year data were also updated in version 11.

Table 1: Details of the 2018 and 2015 HEA Billing Analyses

HEA Evaluation Year	2018	2015
Version of HOT2000	Version 11	Prior to Version 11
Assessment Period Analyzed	D only	Both D and E
Initial Sample	300	887
Minimum Period	6 months	12 months
Regression-ready Sample²	207	559 for the D assessment 423 for the E assessment
Regression Model Criteria	Statistically significant constant Statistically significant and positive coefficient(s) Highest coefficient of determination among models with various HDD and CDD balance temperatures No participation in Green Heat during the period analyzed (indicating a change in their heating systems)	Statistically significant and positive constant Statistically significant and positive coefficient
Final Sample	161	305 for the D assessment 208 for the E assessment

The two billing analysis samples were combined to establish an OR for the cases where heat pumps were in place and the cases where there was no heat pump. The Evaluator thinks that although the billing analysis methodology was slightly improved for the 2018 evaluation, the changes were not significant enough to prevent the Evaluator from combining the two billing analysis samples.

Table 2 presents the ORs established for each installed heating system scenario.

Table 2: Overestimation Ratio Values for HEA

Scenario	Number of Participants in the Billing Analysis	Difference Between the Modelled and Actual Space Heating Consumption	Margin of Error	Revised OR
With a heat pump	53	-2%	13%	0%
Without a heat pump	618	19%	3%	19%

The average difference between the modelled and actual space heating consumption in the with-a-heat-pump scenario is -2 percent. Due to the margin of error being higher than the percentage of difference in this scenario, the Evaluator considers the OR negligible in this scenario.

² These were the sample sizes after (1) the raw data sets were cleaned to remove the overlapping bills, longer billing cycles, etc. and (2) only those participants with enough billing data available were kept to cover the minimum analysis period.

APPENDIX III

HEA: 2018 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2018 evaluation of the Home Energy Assessment (HEA) program component. There were no incomplete 2017 recommendations at the time of evaluation.

Sections	Recommendations
Executive Summary	1. Conduct a billing analysis to review the overestimation ratio when a sufficient participant sample becomes available. The billing analysis conducted in 2018 was initially aimed at estimating a new overestimation ratio (OR) for the new version of HOT2000, although it revealed that the space heating systems in place, particularly heat pumps, had a much more significant impact on the overestimation than the difference between the versions of HOT2000 that are used. The Evaluator believes that further analyses should be conducted to evaluate the impact of the different HOT2000 versions on the ORs and confirm whether there is no significant difference in the ORs established for the D and E assessment periods. The Evaluator believes that version 11 of HOT2000 will progressively be used more in upcoming years and will enable conducting a billing analysis on a sample of participants large enough to consider: (1) D assessments and E assessments; (2) the various versions of HOT2000 (i.e. versions 11.3; 11.4; 11.5); and (3) evaluate the impact of the different heating systems in place, including the presence of wood or pellet stoves. Since overestimations significantly impact HEA net energy and peak demand savings, the Evaluator recommends conducting a billing analysis when a large enough participant sample becomes available.
	2. Share evaluation findings with the EAs to ensure sustained quality simulations. As part of the 10 HEA on-site visits and HOT2000 simulation reviews, the Evaluator noted that significant improvements have been achieved in both the quantity of measurements and the accuracy of collected data since the last review in 2016. In 2018, the Evaluator found that EAs performed well in recording household energy component data and complied with the new EnerGuide requirements. While reviewing project files, the Evaluator noted some recurrent mistakes in the HOT2000 simulations (see Subsection 3.1). The Evaluator recommends sharing feedback on the improved accuracy of data collection and aspects of the project review process that could be improved with EAs to continue working toward higher quality simulations.

APPENDIX IV

GH: PARTICIPANT SURVEY QUESTIONNAIRE

Type of Equipment	Quota	Sample
Mini-split heat pump	40	1,010
Air-source heat pump Ground source heat pump	22	44
Wood or pellet furnace / boiler Wood or pellet stove Solar water heating	28	59
Total	90	1,113

Could I speak with [INSERT NAME]?

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

INTRODUCTION

Hello, my name is _____ from Corporate Research Associates, a Halifax-based survey research company. We are performing an evaluation of energy efficiency services provided by Efficiency Nova Scotia. Our records indicate that you or your household recently participated in the Green Heat program.

We would appreciate your help in answering questions about this program. The information you provide will be used to help Efficiency Nova Scotia improve the program. Is this a good time for you?

(IF NEEDED: The program provides a rebate for the installation of solar systems or home heating equipment, such as heat pumps, furnaces, and boilers.)

(IF NEEDED: You may have recently been contacted by Corporate Research Associates 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.)

[READ IF ONE EQUIPMENT IN THE DATABASE]

V1. Our records indicate that your household installed a [EQUIPMENT 1] through the Green Heat program. Is this correct?

1. Yes [CONTINUE]
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]
9. Don't know/Refused [PROBE: "Is there someone else in your household who would know about having participated in the Green Heat program?"] [IF NO, ASK TO SPEAK TO THE APPROPRIATE PERSON AND RESTART AT INTRODUCTION. IF PERSISTS AS NO, THANK, TERMINATE, RECORD AND KEEP DATA.]

[IF REFUSED, ASK "Can we schedule a more convenient time for you to conduct this survey?"]

[SCHEDULED, IF NECESSARY, FOR: _____]

[READ IF MORE THAN ONE EQUIPMENT IN THE DATABASE]

V2a. Our records indicate that your household installed a [EQUIPMENT 1] and a [EQUIPMENT 2] through the Green Heat program. Is this correct?

1. Yes [CONTINUE TO V2b]
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 V2b. IF PERSIST AS NO, THANK, TERMINATE, RECORD AND KEEP DATA]
3. No, I only installed a [EQUIPMENT 1]
4. No, I only installed a [EQUIPMENT 2]
9. Don't know/Refused [PROBE: "Is there someone else in your household who would know about having participated in the Green Heat program?"] [IF NO, ASK TO SPEAK TO THE APPROPRIATE PERSON AND RESTART AT INTRODUCTION. IF PERSISTS AS NO, THANK, TERMINATE, RECORD AND KEEP DATA.]

[IF REFUSED, ASK "Can we schedule a more convenient time for you to conduct this survey?"]

[SCHEDULED, IF NECESSARY, FOR: _____]

[IF V2a = 1 or 2]

V2b. For purposes of this survey, keep only the [EQUIPMENT 1] clearly in your mind as you answer the next few questions.

Participation [P Series]

P1. How did you first become aware of the Green Heat program? [DO NOT READ. SINGLE RESPONSE]

- 1 (Radio ads)
- 2 (In-store signage)
- 3 (Retailer flyer)
- 4 (Through a contractor, retailer, or distributor)
- 5 (Via a friend, acquaintance, or family member)
- 6 (Saw an advertisement - general)
- 7 (Online)
- 96. (Other) [SPECIFY_____]
- 98 Don't know
- 99 Refused

P2. First, I'm going to ask you to think back to when you decided to install a [EQUIPMENT]. What was the SINGLE most important reason you were interested in installing a [EQUIPMENT]? [DO NOT READ – CODE ONE ONLY]

- 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)
- 96. (Other) [SPECIFY_____]
- 98. (Don't know) [GO TO U1]
- 99. (Refused) [GO TO U1]

P3. Were there any other reasons? [SAME LIST AS IN P2] [DO NOT READ. ACCEPT MULTIPLE RESPONSES]

- 97 None/no other reasons

**Usage [IF EQUIPMENT TYPE = MINI-SPLIT HEAT PUMP OR AIR-SOURCE HEAT PUMP OR
GROUND-SOURCE HEAT PUMP] [U Series]**

U1. Before participating in the Green Heat Program, what did you use as your main heating system?
Was it...? [READ AND ACCEPT ONE RESPONSE ONLY]

1. Electric baseboards or electric furnace
2. Heat pump
3. Geothermal system
4. Heating stove (wood or pellet)
5. Gas or oil-fired furnace
96. Or something else (**SPECIFY:** _____)
98. (Don't know) [SKIP TO B5a]
99. (Refused) [SKIP TO B5a]

U2. **[DO NOT ASK IF DON'T KNOW/REFUSED IN U1]** When you decided to participate in the Green Heat Program, in what state was this heating system? Was it...?

1. In good working condition
2. Not working well
3. Not working at all
98. (Don't know)
99. (Refused)

U3. Before participating in the Green Heat Program, did you use an air conditioner at home?

1. Yes
2. No
98. (Don't know)
99. (Refused)

U4. Now that you have a heat pump, do you use it to provide cooling for your home?

1. Yes
2. No
98. (Don't know)
99. (Refused)

**Free-Ridership – Mini-split Heat Pumps [IF EQUIPMENT TYPE = MINI-SPLIT HEAT PUMPS
(MSHP)] [FRM Series]**

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

FRM1. Had you already decided to install a heat pump before you heard about the Green Heat program?

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

FRM1a. [IF FRM1=1] I just want to make sure I understand – before you learned about the Green Heat program, you had already made the decision to install a heat pump?

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

FRM2. [IF FRM1=2, 98, 99 or FRM1a=2, 98, 99] If the program rebate had not been offered, which of the following actions would you have taken? [READ IN ORDER, CODE ONE ONLY]

- 1. Kept your existing heating system [GO TO S SERIES]
- 2. Purchased a new electric heating system [GO TO S SERIES]
- 3. Purchased a new non-electric heating system (e.g. oil or gas system) [GO TO S SERIES]
- 4. Purchased a heat pump
- 98. (Don't know)
- 99. (Refused)

FRM3. [IF FRM1a=1 OR FRM2=4] If the program rebate had not been offered, 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, with a 0 indicating that it is “Very unlikely” and 10, “Very likely.” [PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]

___ Response ___98 Don't Know ___99 Refused

Series B: Questions on the decision to install a high-efficiency heat pump

Only high-efficiency heat pump models are eligible for a rebate under the Green Heat program, so the heat pump you have installed is much more efficient than the standard heat pump models on the market, especially at low temperatures of -15°C or less. Now, we will discuss your decision to install a high-efficiency heat pump model rather than a less efficient and less expensive model.

FRM4. Were you aware of the availability of high efficiency heat pumps that operate at temperatures below -15°C before you heard about the Green Heat program?

1. Yes
2. No
98. (Don't know)
99. (Refused)

FRM4a. [IF FRM4=1] Before you heard about the Green Heat program, had you already made the decision to install a **high-efficiency** heat pump model?

1. Yes
2. No
98. (Don't know)
99. (Refused)

FRM5. 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, with a 0 indicating that you “Definitely **Would Not** Have Paid” and a 10 indicating that you “Definitely **Would Have** Paid.” [PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]

___ Response ___98 Don't Know ___99 Refused

FRM6. Next, I'm going to ask you to rate the importance of factors that might have influenced your decision to install high-efficiency heat pump. Using a scale from 0 to 10, where 0 means “No influence” and 10 means “Great influence,” please rate the influence of each of the following in your decision to install a high-efficiency heat pump.

Factor (READ AND RANDOMIZE)	Responses – DO NOT ACCEPT A RANGE
a. The program rebate	___ Response ___98 Don't Know ___99 Refused
b. Information on the benefits of high efficiency heat pumps provided by Efficiency Nova Scotia	___ Response ___98 Don't Know ___99 Refused
c. Information on the benefits of high efficiency heat pumps provided by the retailers or contractors	___ Response ___98 Don't Know ___99 Refused

**Free-Ridership – Heat Pumps [IF EQUIPMENT TYPE = AIR-SOURCE HEAT PUMPS OR
GROUND SOURCE HEAT PUMP] [FRH Series]**

FRH1. Moving along to another topic... Had you **already** decided to install a high efficiency [EQUIPMENT] **before** you heard about the Green Heat program?

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

FRH1a. [IF FRH1=1] I just want to make sure I understand – **before** you decided to participate in the Green Heat program, you had already made the decision to install a high efficiency [EQUIPMENT]?

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

FRH2. 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, with a 0 indicating that you “Definitely **Would Not** Have Paid” and a 10 indicating that you “Definitely **Would Have** Paid.” [PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]

___ Response ___ 98 Don't Know ___ 99 Refused

[READ FIRST TIME THROUGH ONLY] Now I would like to ask you to consider what actions you would have taken if the Green Heat program had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is “Very Unlikely” and a 10 indicating that it is “Very Likely.”

[DO NOT ACCEPT A RANGE – ASK FRH3 a-c SEQUENCE IN ORDER/DO NOT RANDOMIZE]

FRH3a. If the program rebate had not been offered, what is the likelihood that you would have installed a less efficient and less expensive heat pump?

___ Response ___ 98 Don't Know ___ 99 Refused

FRH3b. If the program rebate had not been offered, what is the likelihood that you would have kept your old heating system instead of installing a new one?

___ Response ___ 98 Don't Know ___ 99 Refused

FRH3c. If the program rebate had not been offered, what is the likelihood that you would have postponed installing the [EQUIPMENT] by at least one year?

___ Response ___98 Don't Know ___99 Refused

FRH4. Next, I'm going to ask you to rate the importance of factors that might have influenced your decision to install [a/an] [EQUIPMENT]. Using a scale from 0 to 10, where 0 means "No influence" and 10 means "Great influence," please rate the influence of each of the following in your decision to install a [EQUIPMENT].

Factor (READ AND RANDOMIZE)	Responses – DO NOT ACCEPT A RANGE
a. The program rebate	___ Response ___98 Don't Know ___99 Refused
b. Information provided by Efficiency Nova Scotia	___ Response ___98 Don't Know ___99 Refused
c. Information on the benefits of high efficiency equipment provided by the retailers or contractors	___ Response ___98 Don't Know ___99 Refused

Free-Ridership – Solar and Biomass [IF EQUIPMENT TYPE = Solar water heating, Wood Stove, Pellet Stove or Wood Boiler/ Furnace] [FRS Series]

FRS1. Moving along to another topic... Had you **already** decided to install a [EQUIPMENT] **before** you heard about the Green Heat program?

1. Yes
2. No
98. (Don't know)
99. (Refused)

FRS1a. [IF FRS1=1] I just want to make sure I understand – **before** you decided to participate in the Green Heat program, you had already made the decision to install a [EQUIPMENT]?

1. Yes
2. No
98. (Don't know)
99. (Refused)

FRS2. 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, with a 0 indicating that you "Definitely **Would Not** Have Paid" and a 10 indicating that you "Definitely **Would Have** Paid." [PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]

___Response ___98 Don't Know ___99 Refused

[READ FIRST TIME THROUGH ONLY] Now I would like to ask you to consider what actions you would have taken if the Green Heat program had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is “Very Unlikely” and a 10 indicating that it is “Very Likely.”

[DO NOT ACCEPT A RANGE – ASK FRS3 a-c SEQUENCE IN ORDER/DO NOT RANDOMIZE]

FRS3a. If the program rebate had not been offered, what is the likelihood that you would have installed an electrical heating system instead of the [EQUIPMENT] you installed through the program?

___ Response ___ 98 Don't Know ___ 99 Refused

FRS3b. If the program rebate had not been offered, what is the likelihood that you would have kept your old heating system instead of installing a new one?

___ Response ___ 98 Don't Know ___ 99 Refused

FRS3c. If the program rebate had not been offered, what is the likelihood that you would have postponed installing the [EQUIPMENT] by at least one year?

___ Response ___ 98 Don't Know ___ 99 Refused

FRS4. Next, I'm going to ask you to rate the importance of factors that might have influenced your decision to install a [EQUIPMENT]. Using a scale from 0 to 10, where 0 means “No influence” and 10 means “Great influence,” please rate the influence of each of the following in your decision to install a [EQUIPMENT].

Factor (READ AND RANDOMIZE)	Responses – DO NOT ACCEPT A RANGE
a. The program rebate	___ Response ___ 98 Don't Know ___ 99 Refused
b. Information provided by Efficiency Nova Scotia	___ Response ___ 98 Don't Know ___ 99 Refused

Cross-Influence [CI Series]

READ AND ROTATE (CI1 + CI2a-c) AND (CI3 + CI4a-c) SEQUENCES

CI1. Before participating in the Green Heat program in 2018, had you at any time in the past already participated in another 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.

CI2a. [IF CI1=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
- 98. (Don't know)
- 99. (Refused)

CI2b. [IF CI1=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
- 98. (Don't know)
- 99. Refused)

CI2c. [IF CI1=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
- 98. (Don't know)
- 99. (Refused)

CI3. Before participating in the Green Heat program in 2018, had you at any time in the past already seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

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

CI4a. [IF CI3=1] The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in your decision to install [a/an] [EQUIPMENT] in your home.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

CI4b. [IF CI3=1] The energy efficiency promotional materials distributed 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
- 98. (Don't know)
- 99. (Refused)

CI4c. [IF CI3=1] The energy efficiency promotional materials distributed 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
- 98. (Don't know)
- 99. (Refused)

Satisfaction [S Series]

S1. 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? [RECORD NUMBER, 98=Don't know, 99 Refused] DO NOT ACCEPT A RANGE.

S2. [IF S1<8] What was the most important reason you were not more satisfied with the program overall? [PROBE FOR SPECIFIC REASON. ACCEPT MULTIPLE RESPONSE]

- 96. (RECORD VERBATIM: _____)
- 98. (Don't know)

S3. On a scale of 0 to 10, where 0 = “not at all satisfied” and 10 = “completely satisfied,” how satisfied were you with each of the following aspects of the Green Heat program? Please indicate if any are not applicable to you. [DO NOT RANDOMIZE] [97 = Not Applicable, 98 = Don't know/Don't recall, 99 = Refused]

- a. The clarity of program requirements
- b. The program application processes
- c. The amount of the rebate
- d. Time required to receive rebate
- e. The equipment installed in your home
- f. The range of equipment eligible for the rebate

Barriers [B Series]

B1. For the next few statements, I'd like you to think back to the point when you started to consider installing [a/an] [EQUIPMENT]. On a scale of 0 to 10 where 0 equals "not at all a concern" and 10 equals "a major concern," how much of a concern was... [CODE ONLY ONE 0-10, 98=DK, 99=REFUSED] ROTATE ORDER

- a. Selecting the right equipment
- b. The appearance of the equipment
- c. Finding a qualified contractor
- d. The reliability of the equipment
- e. That the equipment would provide enough heat
- f. Realizing the promised energy savings
- g. The overall purchase and installation cost of the equipment compared to other heating options

B2. What other concerns, if any, did you have with installing [a/an] [EQUIPMENT]?
RECORD VERBATIM

- 97 None/no concerns
- 98 (Don't know)
- 99 (Refused)

Recommendations for Program Improvements [R Series]

R1. What was the most helpful aspect of the Green Heat program? [RANDOMIZE, SINGLE RESPONSE, DO NOT READ]

- 1 (Rebate/Lowering the cost of the installation)
- 2 (Assistance in finding an installer)
- 3 (Providing energy savings/efficient equipment)
- 4 (Providing information about efficient equipment)
- 5 (Easy application process)
- 6 (Good/knowledgeable representatives)
- 96 (Other [SPECIFY _____])
- 98 (Don't know)
- 99 (Refused)

R2. Other than increase the rebate, how could Efficiency Nova Scotia improve the Green Heat program? PROBE: Anything else? [DO NOT READ. ACCEPT MULTIPLE]

1. (Offer additional equipment eligible for rebates)
2. (Offer more information on the equipment recommended)
3. (Simplify program application, forms, and associated paperwork)
4. (Speed up the process)
5. (Increase the time given to complete the upgrades)
6. (Advertise the program more or in a better way)
7. (No recommendation)
- 96 (Other [SPECIFY _____])
- 98 (Don't know)
- 99 (Refused)

Demographics [D Series]

These final questions are asked for statistical purposes only. The information collected is strictly confidential.

D1. 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)

D2. How many bedrooms are in your home? [98=DK; Enter zero for a studio apartment with no bedrooms]

D3. Including yourself, how many people live in this residence on a full-time basis?

Number of people: _____ [NOTE: DON'T ALLOW ZERO FOR A RESPONSE]

98. (Nobody lives in the house on a full-time basis)
99. (Refused)

D4. What is your age group? Are you... [READ]

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)

D5. What is the highest level of education you have completed? [DO NOT READ]

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)
99. (Refused)

D6. Which of the following income categories best describes your total annual household income before taxes in 2017? Stop me when I reach the right category. [READ LIST; SELECT ONE RESPONSE]

1. Less than \$15,000
2. \$15,000 - \$24,999
3. \$25,000 - \$34,999
4. \$35,000 - \$49,999
5. \$50,000 - \$69,999
6. \$70,000 - \$79,999
7. \$80,000 or more
99. (Refused)

D7. [DO NOT READ] Gender:

1. Male
2. Female

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

GH: PARTICIPANT SURVEY RESULTS

P1. How did you first become aware of the Green Heat program?

Source of Awareness	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
Through a contractor, retailer or distributor	39%	29%	59%	39%
Via a friend, acquaintance, or family member	23%	40%	-	13%
Online	12%	7%	14%	22%
Saw an advertisement - general	9%	9%	5%	13%
Radio ads	3%	7%	-	-
Newspaper	2%	2%	5%	-
Had a heat pump before	2%	-	9%	-
Retailer flyer	2%	2%	-	4%
Other	4%	2%	9%	4%
Don't know	2%	2%	-	4%

P2. First, I'm going to ask you to think back to when you decided to install a [EQUIPMENT]. What was the SINGLE most important reason you were interested in installing a [EQUIPMENT]?

Most Important Reason for Participating	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
Save on energy/energy costs	49%	62%	36%	35%
Old system wasn't working properly	11%	2%	32%	9%
For better comfort	10%	11%	9%	9%
To make home more energy efficient	7%	4%	9%	9%
Wanted wood stove/like wood heat	6%	-	9%	13%
To have a backup heating source	6%	4%	-	13%
Wanted air conditioning	3%	7%	-	-
To heat the basement	2%	4%	-	-
Convenience/ease of use/maintenance	2%	4%	-	-
To replace another heating source	1%	-	5%	-
To help the environment	1%	-	-	4%
Other	2%	-	-	9%

P3. Were there any other reasons?

Other Important Reasons for Participating	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
Save on energy/energy costs	23%	22%	36%	13%
Wanted air conditioning	17%	27%	14%	-
To make home more energy efficient	10%	7%	9%	17%
Wanted wood stove/like wood heat	8%	-	-	30%
For better comfort	8%	7%	9%	9%
To have a backup heating source	6%	9%	5%	-
To help the environment	4%	2%	9%	4%
Convenience/ease of use/maintenance	4%	9%	-	-
To replace another heating source	3%	-	14%	-
Old system wasn't working properly	3%	2%	5%	4%
Other	6%	7%	9%	-
None/No other reasons	21%	22%	9%	30%
Don't know	3%	4%	5%	-
Multiple Responses				

Usage [IF EQUIPMENT TYPE = MINI-SPLIT HEAT PUMP OR AIR-SOURCE HEAT PUMP OR GROUND-SOURCE HEAT PUMP] [U Series]

U1. Before participating in the Green Heat Program, what did you use as your main heating system?
Was it...?

Main Heating System Before Participating in Green Heat	2018		
	Total	MSHP	Heat Pump
Sample Size	67	45	22
Electric baseboards or electric furnace	55%	67%	32%
Heat pump	15%	-	45%
Gas or oil-fired furnace	13%	13%	14%
Heating stove (wood or pellet)	12%	16%	5%
Electric thermal storage	1%	2%	-
Others	3%	2%	5%
Base: Respondents who purchased a mini-split heat pump, air-source heat pump or ground-source heat pump Responses do not sum to 100% due to rounding			

U2. When you decided to participate in the Green Heat Program, in what state was this heating system? Was it...?

Condition of Old Heating System	2018		
	Total	MSHP	Heat Pump
Sample Size	67	45	22
In good working condition	70%	89%	32%
Not working well	18%	9%	36%
Not working at all	10%	-	32%
Don't know	1%	2%	-
Base: Respondents who purchased a mini-split heat pump, air-source heat pump or ground-source heat pump Responses do not sum to 100% due to rounding			

U3. Before participating in the Green Heat Program, did you use an air conditioner at home?

Previous Use of Air Conditioner at Home	2018		
	Total	MSHP	Heat Pump
Sample Size	67	45	22
Yes	34%	38%	27%
No	64%	60%	73%
Don't know	1%	2%	-
Base: Respondents who purchased a mini-split heat pump, air-source heat pump or ground-source heat pump Responses do not sum to 100% due to rounding			

U4. Now that you have a heat pump, do you use it to provide cooling for your home?

Use of Heat Pump to Provide Cooling	2018		
	Total	MSHP	Heat Pump
Sample Size	67	45	22
Yes	93%	91%	95%
No	7%	9%	5%
Base: Respondents who purchased a mini-split heat pump, air-source heat pump or ground-source heat pump			

Free-Ridership – Mini-split Heat Pumps [IF EQUIPMENT TYPE = MINI-SPLIT HEAT PUMPS (MSHP)] [FRM Series]

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

FRM1. Had you already decided to install a heat pump before you heard about the Green Heat Program?

FRM1a. I just want to make sure I understand – before you learned about the Green Heat Program, you had already made the decision to install a heat pump?

Already Made Decision to Install Heat Pump Prior to Green Heat	2018
Sample Size	45
Yes	71%
No	27%
Don't know	2%
Base: Respondents who had previously decided to install a mini-split heat pump prior to the program component	

FRM2. If the program rebate had not been offered, which of the following actions would you have taken?

Actions Taken in Absence of Green Heat	2018
Sample Size	13 (#)
Purchased a heat pump	11
Kept your existing heating system	1
Don't know	1
Base: Respondents who had not previously decided to install a mini-split heat pump prior to the program component	

FRM3. If the program rebate had not been offered, 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, with a 0 indicating that it is "Very unlikely" and 10 "Very likely."

Actions Taken in Absence of Green Heat	2018	
	Sample Size	Mean
Postponed the purchase of a heat pump by at least one year	43	2.5
Don't know/refused excluded from calculation		
Base: Respondents who previously decided to install a mini-split heat pump prior to hearing about Green Heat, or were likely to purchase a heat pump without the program component		

Series B: Questions on the decision to install a high-efficiency heat pump

FRM4. Were you aware of the availability of high efficiency heat pumps that operate at temperatures below -15°C before you heard about the Green Heat Program?

Aware of High Efficiency Heat Pumps	2018
Sample Size	44
Yes	59%
No	41%
Base: Respondents who previously decided to install a mini-split heat pump prior to hearing about Green Heat, or were likely to purchase a heat pump without the program component	

FRM4a. Before you heard about the Green Heat Program, had you already made the decision to install a high-efficiency heat pump model?

Previously Decided to Install High Efficiency Heat Pump	2018
Sample Size	26
Yes	81%
No	15%
Don't know	4%
Base: Respondents who were aware of high efficiency heat pumps prior to participating in the program component	

FRM5. Efficiency Nova Scotia gave you 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, with a 0 indicating that you “Definitely Would Not Have Paid” and a 10 indicating that you “Definitely Would Have Paid.”

Would Have Paid Full Cost of High Efficiency Heat Pump	2018	
	Sample Size	Mean
Would have paid/financed full cost of heat pump	44	9.0
Don't know/Refused excluded from calculations Base: Respondents who previously decided to install a mini-split heat pump prior to hearing about Green Heat, or were likely to purchase a heat pump without the program component		

FRM6. Next, I'm going to ask you to rate the importance of factors that might have influenced your decision to install a high-efficiency heat pump. Using a scale from 0 to 10, where 0 means "No influence" and 10 means "Great influence," please rate the influence of each of the following in your decision to install a high-efficiency heat pump.

Influence of Factors on Decision to Have High Efficiency Heat Pump Installed	2018	
	Sample Size	Mean
Information on the benefits of high efficiency heat pumps provided by the retailers or contractors	44	8.4
Information on the benefits of high efficiency heat pumps provided by ENS	43	5.7
The program component rebate	44	4.9
Don't know/Refused excluded from calculations Base: Respondents who previously decided to install a mini-split heat pump prior to hearing about Green Heat, or were likely to purchase a heat pump without the program component		

Free-Ridership – Heat Pumps [IF EQUIPMENT TYPE = AIR-SOURCE HEAT PUMPS OR GROUND SOURCE HEAT PUMP] [FRH Series]

FRH1. Moving along to another topic... Had you already decided to install a high efficiency [EQUIPMENT] before you heard about the Green Heat program?

FRH1a. I just want to make sure I understand – before you decided to participate in the Green Heat program, you had already made the decision to install a high efficiency [EQUIPMENT]?

Already Made Decision to Install Equipment Prior to Green Heat	2018
Sample Size	22
Yes	64%
No	32%
Don't know	5%
Base: Respondents who had previously decided to install an air-source heat pump or ground-source heat pump prior to the program component	

FRH2. 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, with a 0 indicating that you "Definitely Would Not Have Paid" and a 10 indicating that you "Definitely Would Have Paid."

Would Have Paid Full Cost of Heat Pump	2018	
	Sample Size	Mean
Would have paid/financed full cost of air-source heat pump or ground-source heat pump	20	8.1
Don't know/Refused excluded from calculations Base: Respondents who had previously decided to install an air-source heat pump or ground-source heat pump prior to the program component		

- FRH3. Now I would like to ask you to consider what actions you would have taken if the Green Heat program had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is “Very Unlikely” and a 10 indicating that it is “Very Likely.”

Likelihood of Actions If Program Not Available	2018	
	Sample Size	Mean
Installed a less efficient and less expensive heat pump	22	5.1
Postponed installing equipment by at least one year	22	3.7
Kept your old heating system instead of installing a new one	21	3.0
Don't know/Refused excluded from calculations Base: Respondents who had previously decided to install an air-source heat pump or ground-source heat pump prior to the program component		

- FRH4. Next, I'm going to ask you to rate the importance of factors that might have influenced your decision to install [a/an] [EQUIPMENT]. Using a scale from 0 to 10, where 0 means “No influence” and 10 means “Great influence,” please rate the influence of each of the following in your decision to install a [EQUIPMENT].

Influence of Factors on Decision to Have Heat Pump Installed	2018	
	Sample Size	Mean
b. Information on the benefits of high efficiency heat pumps provided by the retailers or contractors	22	7.9
a. The program component rebate	21	5.2
c. Information on the benefits of high efficiency heat pumps provided by ENS	21	5.0
Don't know/Refused excluded from calculations Base: Respondents who had previously decided to install an air-source heat pump or ground-source heat pump prior to the program component		

Free-Ridership - Solar and Biomass [IF EQUIPMENT TYPE = Solar water heating, Wood Stove, Pellet Stove or Wood Boiler/ Furnace] [FRS Series]

- FRS1. Moving along to another topic... Had you already decided to install a high efficiency [EQUIPMENT] before you heard about the Green Heat program?
- FRS1a. I just want to make sure I understand – before you decided to participate in the Green Heat program, you had already made the decision to install a [EQUIPMENT]?

Already Made Decision to Install Equipment Prior to Green Heat	2018
Sample Size	23
Yes	87%
No	9%
Don't know	4%
Base: Respondents who had previously decided to install a Wood/Pellet Stove/Solar Heating System prior to the program component	

- FRS2. 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, with a 0 indicating that you “Definitely Would Not Have Paid” and a 10 indicating that you “Definitely Would Have Paid.”

Would Have Paid Full Cost of Equipment	2018	
	Sample Size	Mean
Would have paid/financed full cost of solar water heating, wood stove, pellet stove or wood boiler/ furnace	23	8.8
Don't know/Refused excluded from calculations Base: Respondents who had previously decided to install a Wood/Pellet Stove/Solar Heating System prior to the program component		

- FRS3. Now I would like to ask you to consider what actions you would have taken if the Green Heat program had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is “Very Unlikely” and a 10 indicating that it is “Very Likely.”

Likelihood of Actions If Program Not Available	2018	
	Sample Size	Mean
c. Postponed installing by at least one year	22	3.6
b. Kept your old heating system instead of installing a new one	20	3.0
a. Installed an electrical heating system instead of the equipment installed through the program	21	1.8
Don't know/Refused excluded from calculations Base: Respondents who had previously decided to install a Wood/Pellet Stove/Solar Heating System prior to the program component		

- FRS4. Next, I'm going to ask you to rate the importance of factors that might have influenced your decision to install a [EQUIPMENT]. Using a scale from 0 to 10, where 0 means “No influence” and 10 means “Great influence,” please rate the influence of each of the following in your decision to install a [EQUIPMENT].

Influence of Factors on Decision to Solar or Biomass Equipment Installed	2018	
	Sample Size	Mean
The program component rebate	23	4.4
Information provided by ENS	23	3.7
Don't know/Refused excluded from calculations Base: Respondents who had previously decided to install a Wood/Pellet Stove/Solar Heating System prior to the program component		

CI1. Before participating in the Green Heat program in 2018, had you at any time in the past already participated in another Efficiency Nova Scotia program?

Previous Participation in Another ENS Program Component	2018			
	Total	MSHP	Heat Pump	Solar/Biomass
Sample Size	89	44	22	23
Yes	39%	39%	45%	35%
No	61%	61%	55%	65%
Base: Respondents who would not have kept their existing heating system if program component rebate had not been offered				

CI2a. Your previous participation in an Efficiency Nova Scotia program was a major factor in your decision to install [equipment] in your home.

Previous Participation in Another ENS Program Component was Factor in Decision to Install	2018			
	Total	MSHP	Heat Pump	Solar/Biomass
Sample Size	35	17 (#)	10 (#)	8 (#)
Agree	43%	6	6	3
Disagree	54%	10	4	5
Don't know	3%	1	-	-
Base: Respondents who previously participated in another ENS program component				

CI2b. Because of your previous participation in an Efficiency Nova Scotia program and what you learned by participating in this program, you asked a contractor or a distributor about energy efficient heating systems for your home.

Previous Participation in Another ENS Program Component Influenced Decision to Ask About Energy Efficient Heating Systems	2018			
	Total	MSHP	Heat Pump	Solar/Biomass
Sample Size	35	17 (#)	10 (#)	8 (#)
Agree	69%	11	9	4
Disagree	31%	6	1	4
Base: Respondents who previously participated in another ENS program component				

CI2c. 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.

Previous Participation in Another ENS Program Influenced Decision to Account for Energy Bill Savings When Evaluating Heating Systems	2018			
	Total	MSHP	Heat Pump	Solar/Biomass
Sample Size	35	17 (#)	10 (#)	8 (#)
Agree	89%	16	9	6
Disagree	9%	-	1	2
Don't know	3%	1	-	-
Base: Respondents who previously participated in another ENS program component				

CI3. Before participating in the Green Heat program in 2018, had you at any time in the past already seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?

Previously Saw Energy Efficiency Promotional Materials Distributed by ENS	2018			
	Total	MSHP	Heat Pump	Solar/Biomass
Sample Size	89	44	22	23
Yes	74%	80%	73%	65%
No	25%	18%	27%	35%
Don't know	1%	2%	-	-
Base: Respondents who would not have kept their existing heating system if program rebate had not been offered				

CI4a. The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in your decision to install [equipment] in your home.

Promotional Materials Distributed by ENS Were a Factor in Decision to Install	2018			
	Total	MSHP	Heat Pump	Solar/Biomass
Sample Size	66	35	16 (#)	15 (#)
Agree	44%	49%	7	5
Disagree	53%	49%	8	10
Don't know/	3%	3%	1	-
Base: Respondents who had previously seen ENS promotional materials				

Cl4b. The energy efficiency promotional materials distributed by Efficiency Nova Scotia prompted you to ask a contractor or a distributor about energy efficient heating systems for your home.

Promotional Materials Distributed by ENS Were a Factor in Decision to Install	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	66	35	16 (#)	15 (#)
Agree	59%	60%	10	8
Disagree	41%	40%	6	7
Base: Respondents who had previously seen ENS promotional materials				

Cl4c. The energy efficiency promotional materials distributed by Efficiency Nova Scotia prompted you to take into account the savings on your energy bill when evaluating different heating systems for your home.

Promotional Materials Distributed by ENS Were a Factor in Decision to Install	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	66	35	16 (#)	15 (#)
Agree	70%	69%	11	11
Disagree	30%	31%	5	4
Base: Respondents who had previously seen ENS promotional materials				

S1. 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?

Satisfaction with Green Heat Overall	2018							
	Total		MSHP		Heat Pump		Solar/ Biomass	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Overall satisfaction	89	9.0	45	9.0	21	9.3	23	9.0
Don't know/Refused excluded from calculations								

S2. What was the most important reason you were not more satisfied with the program overall?

Most Important Reason Not More Satisfied with Green Heat Overall	2018			
	Total	MSHP	Heat Pump	Solar/Biomass
Sample Size	10 (#)	5 (#)	2 (#)	3 (#)
It is too long to receive the rebate amount	2	1	-	1
The rebate amount is too small	2	2	-	-
They didn't do anything the first time they came	1	1	-	-
Never received paperwork/report	1	-	-	1
Energy efficient equipment didn't qualify	1	-	1	-
Poor communication	1	1	-	-
Program too hard to understand	1	-	-	-
Other	1	-	-	1
Base: Respondents who provided an overall satisfaction score of 7 or lower				

S3. On a scale of 0 to 10, where 0 = “not at all satisfied” and 10 = “completely satisfied,” how satisfied were you with each of the following aspects of the Green Heat program?

Satisfaction with Green Heat Overall	2018							
	Total		MSHP		Heat Pump		Solar/ Biomass	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
The equipment installed in your home	87	9.3	44	9.4	20	8.9	23	9.4
The program application processes	85	8.8	43	8.9	21	8.6	21	8.6
The clarity of program component requirements	85	8.6	42	8.6	21	8.3	22	8.6
The time required to receive the rebate	89	8.4	44	8.6	22	7.9	23	8.3
The range of equipment eligible for the rebate	73	8.2	35	8.1	21	8.3	17	8.4
The amount of the rebate	89	7.8	44	7.3	22	8.3	23	8.2
Don't know/Refused excluded from calculations								

- B1. For the next few statements, I'd like you to think back to the point when you started to consider installing [a/an] [EQUIPMENT]. On a scale of 0 to 10 where 0 equals "not at all a concern" and 10 equals "a major concern," how much of a concern was...

Concerns When Considering Installation of New Equipment	2018							
	Total		MSHP		Heat Pump		Solar/ Biomass	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
The reliability of the equipment	88	8.4	44	8.6	21	8.7	23	7.7
Selecting the right equipment	87	7.7	43	8.3	21	7.1	23	6.9
That the equipment would provide enough heat	89	7.6	44	8.3	22	7.2	23	6.5
Finding a qualified contractor	90	7.3	45	7.4	22	7.0	23	6.0
Realizing the promised energy savings	83	7.3	41	8.0	20	7.4	22	6.0
The overall purchase and installation cost of the equipment compared to other heating options	87	6.9	44	6.8	20	7.6	23	6.6
The appearance of the equipment	89	5.6	45	5.6	21	5.6	23	5.3
Don't know/Refused excluded from calculations								

B2. What other concerns, if any, did you have with installing [a/an] [EQUIPMENT]?

Other Concerns with Installation of Equipment	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
It wouldn't provide enough heat	10%	20%	-	-
The reliability of the equipment and how to properly use it	8%	7%	14%	4%
Quality of contractor/Having equipment installed properly	4%	4%	5%	4%
It would increase home insurance	2%	-	-	9%%
Safety of the equipment/Fire safety	2%	-	-	9%
Whether it will save money	2%	2%	-	4%
The location of the installed unit or space limitation	2%	4%	-	-
The appearance of the unit	1%	2%	-	-
It wouldn't work the way it was supposed to	1%	-	5%	-
Other	11%	11%	14%	9%
Don't know	1%	-	5%	-
None/No concerns	59%	58%	59%	61%
Multiple responses				

R1. What was the most helpful aspect of the Green Heat program?

Helpful Aspects of Green Heat	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
The rebate	47%	33%	50%	70%
Good/knowledgeable representatives	10%	7%	14%	13%
Providing information about efficient equipment	8%	11%	5%	4%
Providing energy savings/efficient equipment	7%	9%	5%	4%
Easy application process	6%	7%	9%	-
Information provided	3%	7%	-	-
Assistance in finding an installer	2%	2%	5%	-
More environmentally friendly	1%	2%	-	-
Financing option	1%	2%	-	-
Providing a better heating system than previous system	1%	2%	-	-
Others	7%	2%	-	-
Don't know/Refused	8%	11%	5%	-

R2. Other than increase incentives, how could Efficiency Nova Scotia improve the Green Heat program? PROBE: Anything else?

Recommendations to Improve Green Heat	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
Advertise the program more or in a better way	14%	11%	18%	17%
Offer more information on the equipment recommended	9%	11%	5%	9%
Offer additional equipment eligible for rebates	8%	4%	9%	13%
Simplify application, forms, and associated paperwork	6%	4%	5%	9%
Information on qualified contractors	3%	2%	9%	-
Increase the rebates	2%	2%	-	4%
Speed up process	2%	2%	-	4%
Increase the time given to complete the upgrades	1%	-	-	4%
Others	9%	11%	-	13%
Don't know	19%	16%	36%	9%
No recommendations	30%	38%	18%	26%
Multiple responses				

D1. What type of residence do you live in?

Type of Residence	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
Detached single-family home	80%	78%	82%	83%
Mobile home or house trailer	10%	16%	-	9%
Semi-detached house	3%	4%	5%	-
Townhouse or duplex which share adjacent walls	1%	-	5%	-
Another type	6%	2%	9%	9%

D2. How many bedrooms are in your home?

Number of Bedrooms	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
1	4%	4%	-	9%
2	9%	7%	5%	17%
3	59%	58%	68%	52%
4+	28%	31%	28%	22%

D3. Including yourself, how many people live in this residence on a full-time basis?

Number of People in Household	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
1	14%	11%	18%	17%
2	56%	58%	59%	48%
3	12%	13%	14%	9%
4+	17%	18%	9%	26%

D4. What is your age group?

Age	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
25-34	9%	9%	-	17%
35-44	9%	9%	-	17%
45-54	14%	11%	14%	22%
55-64	38%	40%	36%	35%
65+	30%	31%	50%	9%

D5. What is the highest level of education you have completed?

Education	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
Less than high school graduation certificate	3%	-	5%	9%
High school graduation certificate and/or some post-secondary	28%	27%	27%	30%
Trades certificate or diploma	11%	9%	14%	13%
College certificate or diploma	13%	16%	5%	17%
University certificate or diploma	44%	49%	50%	30%

D6. Which of the following income categories best describes your total annual household income before taxes in 2017?

Income	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
Less than \$25,000	3%	4%	-	4%
\$25,000-\$34,999	10%	11%	9%	9%
\$35,000-\$49,999	16%	13%	14%	22%
\$50,000-\$69,999	12%	11%	18%	9%
\$70,000-\$79,999	6%	4%	9%	4%
\$80,000 or more	44%	44%	36%	52%
Refused	9%	11%	14%	-

D7. Gender?

Gender	2018			
	Total	MSHP	Heat Pump	Solar/ Biomass
Sample Size	90	45	22	23
Male	62%	58%	73%	61%
Female	38%	42%	27%	39%

APPENDIX VI

GH: ON-SITE VISIT SAMPLING METHODOLOGY AND PROTOCOL

For 2018, a total of 25 site visits were conducted to evaluate the implemented Green Heat measures.

Sampling Methodology

As presented in Table 3, to establish the on-site visit sample, the Evaluator considered the distribution of projects and savings among measure categories, as well as the objectives of the 2018 evaluation.

At the moment of completing the project sample, at the end of September 2018, MSHPs accounted for 80 percent of Green Heat savings. This explains why a majority of visits were performed for this measure category. To investigate the cause of the lower-than-expected savings and especially the role of secondary non-electrical heating systems in this issue, two sub-categories were created for MSHPs with and without such secondary systems. The Evaluator also increased the size of the ASHP sample to address the issue of lower savings. The rest of the sample was divided among other measure categories so that at least one visit was conducted to verify each category, with the exception of wood furnaces or boilers for which no projects were completed as of September 2018.

Table 3: Sample Distribution

Measure Category	Count of Measures ³	Net Tracked Savings (kWh) ⁴	% of Savings	Sample Size
MSHP With Non-electrical Secondary System	237	275,243	9%	7
MSHP Without Non-electrical Secondary System	1,128	2,275,431	71%	7
ASHP	89	186,655	6%	6
Wood Stove	47	288,123	9%	1
Pellet Stove	17	103,617	3%	1
Ground-source heat pump (GSHP)	2	20,240	1%	1
Wood Furnace or Boiler	0	0	0%	0
Solar	17	33,734	1%	2
Grand Total	1,537	3,183,044	100%	25

The projects were randomly chosen from each of the equipment categories to prevent selection bias.

³ As of September 2018.

⁴ Idem.

On-site Visit Protocols

The Evaluator prepared a standardized site-visit protocol to collect relevant information. The site-visit protocol was intended to confirm the tracked information and identify those patterns that could impact tracked savings. For heat pump visits, the objective was to understand why the savings obtained through the billing analysis performed in the 2017 evaluation were lower than expected.

The protocol involved verifying the primary and secondary heat sources prior to the installation of biomass measures or heat pumps, including their contribution levels to total heat loads. Participants' declarations about the new system usage patterns were also documented to allow confirming whether the new heating system was functioning as the primary heat source and displacing previous electrical heating.

The section of the protocol specific to solar measures involved collecting information about the old heating systems (primary, secondary, and water heating), validating the number of system components, their types, applications, manufacturers, model numbers, as well as documenting the panel angles and any apparent obstructions. The Evaluator also documented how the new systems were integrated into the old systems and confirmed the usage patterns reported in the tracking sheet, such as the number of occupants.

On-site Visit Data Collection Form

The data-collection forms used by the Evaluator during the on-site visits are presented here below.

1. General Information

Date of Visit:	_____
Project Name:	_____
Project Tracking Sheet #:	_____
Contact Name:	_____
Address:	_____
City:	_____
Telephone:	_____
Name of Contact Met with:	_____
Number of Full-time Occupants:	_____

2. Biomass

Home Information

Building Type:	_____
Approximate Age of Home (Years):	_____
Number of Storeys Above Grade:	_____
Estimated Insulation Value AG:	_____
Number of Storeys Below Grade:	_____
Estimated Insulation Value BG:	_____
Roof Type:	_____
Roof Insulation Value:	_____
Approximate Size (ft ²):	_____
Does the Home Have A Heated Garage?	_____
Primary Window Types:	_____
Estimated Age of Windows (Years):	_____
Photos Taken of All Four Sides of Home? (Y/N):	_____

Primary Heating System
**In the Tracking
Sheet**
Validated On Site

Primary Heating Source:

Primary Heating System Type:

Primary Heating System Capacity:

% Total Heating from Primary Source
(Participant Declaration):

Is the Equipment Still in Place? (Y/N):

Does the Primary System Serve the Whole
House?

If Not What Areas Does it Still Serve? List All
Zones Below.

Secondary Heating System
**In the Tracking
Sheet**
Validated On Site

Secondary Heating Source:

Secondary Heating System Type:

Secondary Heating System Capacity:

% Total Heating from Secondary Source
(Participant Declaration):

Is the Equipment Still in Place? (Y/N):

Does the Secondary System Serve the Whole
House?

If Not What Areas Does it Still Serve? List All
Zones Below.

New Heating System
**In the Tracking
Sheet**
Validated On Site

New Heating Source:

New Heating System

Model Name:

Model Number:

New Heating System Capacity:

% Total Heating from New Heating System
(Participant Declaration):

Is the Equipment ENERGY STAR® Canada
Certified? (Y/N):

New System Usage Patterns

Location of the New Equipment:

Does the New System Serve All Living Space? (Y/N):

If not, what % does the system serve?

Method of Heat Distribution:

Is the New System Used when the Home is NOT occupied?

Is the New System Used as the Primary Heat Source?

Describe the Supplementary System Used:

Notes:

Existing Cooling System

Existing A/C Prior to Biomass Measure
installation? (Y/N):

Cooling System Type (i.e., Window A/C,
Stand-alone A/C, etc.):

3. Solar

Site Information

	In the Tracking Sheet	Validated On Site
Primary Heating Source:	_____	_____
Secondary Heating Source:	_____	_____
DHW Heating Source:	_____	_____

Solar System Information

	In the Tracking Sheet	Validated On Site
Number of Collectors:	_____	_____
Solar System Usage (DHW or Air):	_____	_____
Collector Manufacturer:	_____	_____
Collector Model Number:	_____	_____
Does the System Have a Heat Exchanger?	_____	_____
Is the Pump Run by PV?	_____	_____
Explain How the System Is Tied into the Space Heating System.	_____	_____
Collector Type - On-site	_____	_____
Collector Orientation	_____	_____
Collector Angle (approx.)	_____	_____
Roof or Ground-mounted?	_____	_____
Are the Collectors Obstructed by Trees or Adjacent Buildings, etc.?	_____	_____
NOTES on Installation Issues or Client Training	_____	_____

4. HVAC

Home Information

Building Type: _____

Approximate Age of Home (Years): _____

Number of Storeys Above Grade: _____

Estimated Insulation Value AG: _____

Number of Storeys Below Grade: _____

Estimated Insulation Value BG: _____

Roof Type: _____

Roof Insulation Value: _____

Approximate Size (ft²): _____

Does the Home Have A Heated Garage? _____

Primary Window Types: _____

Estimated Age of Windows (Years): _____

Photos Taken of All Four Sides of Home?
(Y/N): _____

Operating Information

What is the Normal Heating Set-point? (°C) _____

What is the Normal Cooling Set-point? (°C) _____

Are the Heating/Cooling Systems Set Back
During Unoccupied Times? _____

How Many Degrees is the Set-back? (°C) _____

Primary Heating System

	In the Tracking Sheet	Validated On Site
Primary Heating Source:	_____	_____
Primary Heating System Type:	_____	_____
Primary Heating System Capacity:	_____	_____
% Total Heating from Primary Source (Participant Declaration):	_____	_____
Is the Equipment Still in Place? (Y/N):	_____	_____
Does the Primary System Serve the Whole House?	_____	_____
If Not What Areas Does it Still Serve? List All Zones Below.	_____	_____

Secondary Heating System

	In the Tracking Sheet	Validated On Site
Secondary Heating Source:	_____	_____
Secondary Heating System Type:	_____	_____
Secondary Heating System Capacity:	_____	_____
% Total Heating from Secondary Source (Participant Declaration):	_____	_____
Is the Equipment Still in Place? (Y/N):	_____	_____
Does the Secondary System Serve the Whole House?	_____	_____
If Not What Areas Does it Still Serve? List All Zones Below.	_____	_____

New System Usage Patterns

Location of Indoor Unit(s):	_____
Does Heat Pump Serve All Living Space? (Y/N):	_____
If not, What % does the system serve?	_____
Is the Heat Pump Used when the Home is NOT Occupied?	_____
Describe the Heat Pump Usage Patterns:	_____
Notes:	_____

Existing Cooling System

Existing A/C Prior to Heat Pump installation? (Y/N):	_____
Cooling System Type (i.e., Window A/C, Stand-alone A/C, etc.):	_____

Site Information

	In the Tracking Sheet	Validated On Site
Heat Pump Type:	_____	_____
Was This a Replacement for a Malfunctioning Unit?	_____	_____
Heat Pump Manufacturer:	_____	_____
Outdoor Model Number:	_____	_____
Indoor Model Number:	_____	_____

	In the Tracking Sheet	In the Spec. Sheet
SEER:	_____	_____
EER:	_____	_____
HSPF Region V:	_____	_____
Quantity:	_____	_____
Explanation if Quantity Different:	_____	_____
Rated Heating Capacity (BTU/h):	_____	_____
Rated Cooling Capacity (BTU/h):	_____	_____
Low Temp Heating Capacity (BTU/h):	_____	_____
COP at -15°C:	_____	_____
Heating Temperature Set-point (°C)	_____	_____
Cooling Temperature Set-point (°C)	_____	_____
Closed or Open Loop? (GSHP only):	_____	_____
Has a Correct Combination of Indoor and Outdoor Units Been Used?	_____	_____

APPENDIX VII

GH: DISTRIBUTORS INTERVIEW GUIDE

Introduction

Thank you for taking the time to speak with me. As part of the 2018 evaluation of their Green Heat program, which provides financial incentives for the purchase of high-efficiency mini-split heat pumps (MSHPs), Efficiency Nova Scotia wants to understand the state of the province-wide MSHP market. I very much appreciate your taking the time to participate in this interview.

As someone involved in the MSHP market, your input is very important to help Efficiency Nova Scotia better understand the evolution of this market. Your comments will be summarized and combined with the answers from other people who participate in the interview. Neither your name nor your organization will be identified with your answers.

Our discussion should last approximately 15 minutes.

Do you have any questions before we begin?

Part A: Role

First, I would like to get a little background information about you.

A1a. [IF DISTRIBUTOR/MANUFACTURER] My understanding is that your company is a [DISTRIBUTOR/MANUFACTURER] of heating and cooling equipment, such as MSHPs. Is this correct? [Go to A2]

A1b. [IF PROFESSIONAL ASSOCIATION] My understanding is that your organization is a professional association comprising of distributors and manufacturers of heating and cooling equipment. Is this correct [Go to A3]

A2. Do you sell MSHPs to contractors or directly to homeowners?

A3. For how many years have you worked in or had contact with the MSHP market?

Part B: Efficiency of MSHPs

First, I want to discuss with you the characteristics of MSHPs that you sell.

B1. What is the minimum efficiency level in Region IV of MSHPs that you sell? [PROBE HEATING SEASONAL PERFORMANCE FACTOR (HSPF), COP at -15 degrees C]

RECORD HSPF:

RECORD COP at -15 degrees C:

B3. [IF HSPF LESS THAN 7.1] We understand that regulation requires an HSPF of 7.1 or greater, can you confirm that you sell heat pumps with HSPF of [INSERT HSPF FROM B1] for Region IV?

EfficiencyOne's Green Heat program provides incentives to high-performance cold climate MSHPs; that is ENERGY -STAR certified MSHPs that have a HSPF (high seasonal performance factor) of over 11 in Region IV as well as a COP (coefficient of performance) at -15 degrees Celsius that is greater than 1.75. For the purposes of the interview, I will refer to Green Heat eligible MSHPs as **high-performing cold climate MSHPs**. Please keep in mind that Green Heat eligible MSHPs are higher performing and more energy-efficient than most ENERGY STAR certified MSHPs.

B2. Do you sell high-performing cold climate MSHPs?

B3. Why do you sell standard efficiency MSHPs in addition to selling high-performing cold climate MSHPs? [PROBE FOR OTHER REASONS ASIDE FROM COST, E.G. CONTRACTOR FAMILIARITY, CUSTOMER ACCEPTANCE OF TECHNOLOGY]

B4. What is the average price differential between a standard efficiency MSHP and a high-performing cold climate MSHP with a 12,000 BTU/hour cooling capacity?

B5. What percentage of the contractors that you sell MSHPs to carry high-performing cold climate MSHPs?

Part C: Market Size of Mini-Split Heat Pumps – Part 1

Now, I would like to specifically discuss your sales of MSHPs.

C1. What is the approximate number of mini-split units sold by your company in 2017, for Nova Scotia only? **RANGES OF MAGNITUDE ARE SUFFICIENT.**

PRODUCT CATEGORY	Units sold in 2017	Value in 2017 (thousands of \$)
Mini-Split Heat Pumps		

C1a. [ASK IF VALUE AND NOT UNITS IS PROVIDED FOR C1] What is your average sales price of a MSHP?

C2. What is your best estimate of the portion (%) of your MSHPs sales that were high-performing cold climate MSHPs in 2017?

RECORD (%):

C3. So, to confirm your company sold around [C1 UNITS * C2 PERCENT] high-performing cold climate MSHPs in 2017. Does that sound correct?

C4. [IF C3 = NO] How many high-performing cold climate MSHPs did you sell in 2017?

C5. Please answer the following questions based on your best estimate of all your MSHP sales in 2018.

To the best of your knowledge, what was the change in your sales of MSHPs in 2018 from 2017?	☐	☐	☐ %

C6. Do you expect your sales of MSHPs to increase, decrease or stay the same in 2019?

C6a. Why do you say that?

Part E: Product Adoption Curve

Now, I am interested in hearing your thoughts on how the market for MSHPs has changed over the last few years.

E1a. What changes in the MSHP market, if any, have you seen over the past several years in Nova Scotia?

[If needed, probe for changes or trends related to the efficiency, materials, or prices of MSHP installed in Nova Scotia homes.]

E1b. In your opinion, what explains these changes or trends?

E2. Figure 1 (Product Adoption Curve) illustrates the typical lifecycle for a product in the market.
[SEND GRAPH AHEAD OF INTERVIEW]

When a new product is first introduced into the market, its sales are relatively low. Moving from left to right, the graph illustrates how product sales grow over time, reach a point of maturity and peak sales, level off, then taper and eventually phase out.

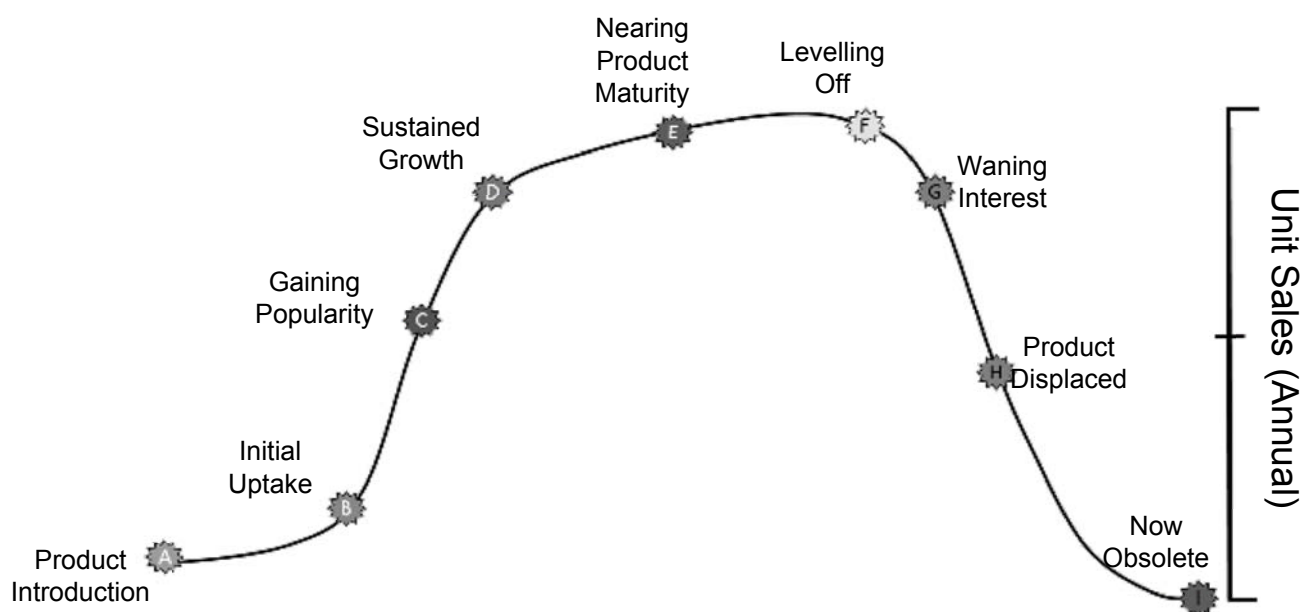


Figure 1: Product Adoption Curve

Thinking of the Nova Scotia MSHP market, where on the product adoption curve would you place the MSHPs?

	Letter on the Curve	Why do you think that?
Mini Split Heat Pumps		

Part F: Closing

F1. We will analyze interview responses to establish an overview of the MSHP market. Would you consider participating in a brief follow-up call to explore our findings?

END: 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 VIII

GH: SAVINGS REVIEW RESULTS

This appendix presents the results of the savings review for each measure under Green Heat.

Savings Review of Biomass Measures, Solar Measures and Hybrid Heat Pump Water Heaters

The Evaluator reviewed the savings methodologies and calculation values for all biomass and solar measures, as well as hybrid heat pump water heaters (HPWHs) installed under Green Heat in 2018.

Wood and Pellet Stoves

Tracked Savings

ENS uses unitary savings values to track the energy and peak demand savings associated with wood and pellet stoves. The unitary savings values are based on HOT2000 energy models created for the 2013 evaluation. The baseline of the models used electrical resistance heating as the primary heat source and was calibrated to account for historical electrical consumption.

For participants who have ASHPs as their primary heating system, tracked unitary savings values are calculated by dividing the unitary savings value by a coefficient of performance (COP) of 2.1 based on the Technical reference manual (TRM)⁵ of the Pennsylvania Public Utility Commission (PUC).

With respect to peak demand savings, it was assumed that existing ASHPs operated exclusively on the electrical resistance backup in the air handler, and thus the peak demand savings for wood and pellet stove measures with an ASHP baseline were identical to the peak demand savings with an electrical resistance baseline. Therefore, the unitary peak demand savings value is the same for participants who replaced ASHPs with wood or pellet stoves.

The tracked unitary savings values are listed in Table 4.

Table 4: Tracked Unitary Savings Values for Wood and Pellet Stoves

Category of Equipment	Tracked Energy Savings Value (kWh/year)	Tracked Peak Demand Savings Value (kW)
Wood Stove with Electrical Resistance Baseline	10,443	4.0
Pellet Stove with Electrical Resistance Baseline	8,959	4.0
Wood Stove with ASHP Baseline	4,973	4.0
Pellet Stove with ASHP Baseline	4,266	4.0

⁵ Pennsylvania Public Utility Commission (PUC), *Technical Reference Manual*, June 2015, Subsection 2.2 – HVAC.

Revised Savings

As in previous years, the Evaluator performed a literature review in search of updated or recently released technical references and metering studies that could be used to refine the unitary savings methodologies for wood and pellet stoves. The literature review did not identify any additional resources based on metered studies or billing analyses in comparable climates. Therefore, the calibrated energy simulations remain the most representative source for the unitary savings values.

Wood and Pellet Boilers and Furnaces

Tracked Savings

The tracked unitary savings values for wood and pellet boilers and furnaces are based on the 2010 Residential Fuel Substitution Program review carried out by Dunskey Energy Consulting.⁶

The energy savings values were adjusted using a billing analysis and HOT2000 energy modelling to reflect the typical annual heating consumption values of actual 2012 program component participants. These values, listed in Table 5, have been used since 2013.

Table 5: Tracked Unitary Savings Values for Wood and Pellet Furnaces and Boilers

Category of Equipment	Tracked Energy Savings Value (kWh/year)	Tracked Peak Demand Savings Value (kW)
Wood Furnace or Boiler	13,804	7.66
Pellet Furnace or Boiler	13,765	7.75

Revised Savings

A literature review focused on identifying updated technical references, metering studies and/or comparable billing analyses was carried out for wood and pellet boilers and furnaces in 2018. The Evaluator found no updated references or studies that were more representative and therefore recommends that the current unitary savings values be maintained. This is further supported by the fact that only four Green Heat participants installed wood and pellet furnaces and boilers in 2016 and 2017 combined, and zero participants in 2018. The unitary savings values listed in Table 5 were thus maintained.

⁶ Dunskey Energy Consulting, *Residential Fuel Substitution Pilot Program*, Final Report, December 2010.

Solar Domestic Hot Water and Solar Air Heaters

Tracked Savings

Currently, the tracked energy savings values for solar domestic hot water (DHW) and solar air heaters are based on RETScreen energy models. ENS creates the energy models for each participant using manufacturer technical specifications for the given equipment and a set of defined operating variables. The modelling variables are based on recommendations from the 2012 evaluation.

Peak demand savings for both solar domestic water and solar air heaters are tracked as zero because the sun has set during the peak demand period. Hence, the solar equipment is unable to generate heat.

Revised Savings

The Evaluator carried out a literature review to determine if any recent studies supported adopting another approach than energy modelling and found none that would improve the accuracy of the calculated energy savings values. Therefore, the Evaluator recommends that ENS continue using the RETScreen energy models to determine unitary savings.

Heat Pump Water Heaters

Tracked Savings

In 2018, ENS revised their savings calculation methodology for heat pump water heaters to align with the 2015 Efficiency Vermont TRM, which uses the following equation.

$$Savings = Q_{DHW} \times \left(\frac{1}{EF_{Base}} - \frac{1}{EF_{HPWH}} \right) \times (1 - PF_{Elect\ Heat})$$

$$PF_{Elect\ Heat} = WHHF / COP$$

Table 6 lists the parameters and corresponding values used in the equation above for heat pump water heaters installed through Green Heat in 2018 and the resulting unitary savings values.

Table 6: Unitary Savings Values for Heat Pump Water Heaters

Parameter	Symbol	Value for Electrical Resistance Space Heating	Value for HP Space Heating	Source
Heat Delivered to Water in HPWH Tank Annually	Q_{DHW}	2,618		Efficiency Vermont
Energy Factor of Electrical Water Heater (Base Case)	EF_{Base}	0.91		Efficiency Vermont
Energy Factor of Heat Pump Water Heater	EF_{HPWH}	2.31		Lowest Performance Bin Average from Efficiency Vermont
Heating Penalty Factor from Conversion of Home Electrical Heat to Water Heat	$PF_{Elect\ heat}$	0.558	0.279	Calculated
Portion of Reduced Waste Heat that Results in Increased Heating	WHHF	0.558		Efficiency Vermont
Coefficient of Performance of Space Heating	COP	1	2	Convention
Unitary Savings [kWh/year]	-	771	1,257	Calculation

To obtain peak demand savings, ENS divided the energy savings by an equivalent full-load hour (EFLH) value of 2,533 hours, which yielded results of 0.304 kW and 0.496 kW respectively for homes heated with electrical resistance systems and those heated with heat pumps.

Revised Savings

To review the new unitary savings calculations, the Evaluator first assessed the reasonableness of each variable.

- › Q_{DHW} : This value is drawn from Efficiency Vermont, but the source of the calculation is not publicly available. The Evaluator recreated this calculation using an increase in water temperature of 79 °F (which is consistent with the assumption used in other ENS residential program components) and average daily DHW usage per household from HOT2000 assumptions (41.8 gallons per day). This resulted in an increased revised value of 2,948 kWh for this variable.
- › EF_{Base} : The EF for basecase water heaters is not defined by federal regulations. The Evaluator therefore relied on a literature review of EF used for basecases in other water heater programs. A review of 12 American jurisdictions (no Canadian programs share publicly available information on the EF of water heaters) revealed that all values were between 0.904 and 0.945; the 0.91 value used by ENS was therefore considered reasonable.

- › EF_{HPWH} : The Evaluator was able to retrieve the EF of participants who installed HPWH through Green Heat since 2016 to establish the typical efficiency of those units. Importantly in 2017, the U.S. Department of Energy changed their testing procedures, so water heater efficiency is expressed in Uniform Energy Factor (UEF), which differs from the previously used EF metric. The UEF can be significantly higher than EF, especially for large water heater volumes, so it cannot be used as is in the engineering equation presented above. Therefore, the Evaluator recommends using a COP of 2.35 established by a performance study for HPWHs,⁷ which is used by the Maine⁸ and Massachusetts⁹ TRMs.
- › WHHF: The current value of 0.558 is equivalent to saying that the heat is useful during slightly less than seven months out of twelve, which is considered reasonable for Nova Scotia.
- › COP for heat pump space heating: A COP of two is reasonable, although the Evaluator modified it to 2.1 to be consistent with adjustments made to the heating energy consumption baseline made to other Green Heat measures.

By adjusting the EF_{HPWH} to 2.35 and the COP for heat pump space heating to 2.1, the revised savings were set to 790 kWh for homes with electrical resistance space heating and 1,312 kWh for homes with heat pump space heating.

The current calculation for peak demand savings is based on an undocumented EFLH value of 2,553 hours. This calculation assumes that all peak hours are hours during which the water heater is on since no peak coincidence factor is applied. Thus, the Evaluator recommends using the on-peak demand-to-energy ratio developed by Navigant in the 2016-2018 demand-side management (DSM) Plan to calculate peak demand savings. Navigant used local data to establish a DHW ratio of 0.162 W in demand reduction for every kWh of energy saved. This results in peak demand savings of 0.128 kW for homes with electrical resistance space heating and 0.213 for homes with heat pump space heating.

Savings Review of Heat Pump Measures

The Evaluator reviewed the savings methodologies and calculation values for MSHPs, central air-source and air-to-water heat pumps (AWHPs), as well as GSHPs installed under Green Heat in 2018.

Mini-split Heat Pumps

Tracked Savings

ENS applied different unitary savings values depending on the energy source used for space heating by each participant prior to installing a MSHP, as detailed in Table 7.

⁷ Steven Winter Associates Inc., Heat Pump Water Heaters, Evaluation of Field Installed Performance, June 26, 2012, Table 1.

⁸ Efficiency Maine, *Technical Reference Manual, Version 2019.1*, Effective July 1, 2018, p.62.

⁹ Mass Save, *Massachusetts Technical Reference Manual for Estimation Savings for Energy Efficiency Measures, 2016-2018 Program Years – Plan Version*, October 2015, p.194.

Table 7: Tracked Unitary Savings Values for MSHPs

Existing Heating System Type	Average Tracked Energy Savings	Average Tracked Peak Demand Savings
Fully Electrically Heated Households	0.169 kWh/BTU/h	2.41 kW
Mainly Electrically Heated Households	0.068 kWh/BTU/h	2.71 kW
Non-electrically Heated Households	626 kWh	2.34 kW

Energy savings for previously fully or mainly electrically heated homes are applied to the heating capacity of each heat pump. The average tracked values do not correspond to values outlined in the 2017 Evaluation Report because a mix of unitary savings values from the 2016 and the 2017 Evaluation Reports were used by ENS. The tracked energy savings and peak demand savings for non-electrically heated households were not obtained from a unitary savings value, but rather calculated for each MSHP based on its performance data. Since equations are not visible in the tracking sheet, the Evaluator could not confirm the source of the tracked values; when recreating the calculations to establish revised savings, only minor discrepancies were observed.

Revised Savings

To establish revised savings, the Evaluator first validated the performance data (heating capacity, HSPF, heating capacity and COP at -15 °C) of each heat pump by extracting data from the measure list. This was especially important for heating capacities since they were missing for 324 MSHPs and incorrect for 10 MSHPs.

As part of the 2017 evaluation, the Evaluator conducted a billing analysis on a significant sample of past MSHP participants, which included all previous MSHP participants for which enough billing data was available. This analysis yielded savings per units of capacity that differed for households that were fully electrically heated versus those that were only partially electrically heated (e.g. that had secondary non-electrical heating systems such as wood stoves). The Evaluator recommended that these savings values (0.179 kWh/BTU/h for fully electrically heated households and 0.060 kWh/BTU/h for partially electrically heated households) be used to track savings in 2018. Therefore, no new billing analysis was conducted as part of the 2018 evaluation and the Evaluator only validated that energy savings were tracked in accordance with the 2017 evaluation recommendation. For non-electrically heated households, savings were calculated using the performance data of each MSHP and the equation defined below and in Table 8.

$$Energy\ Savings_{kWh} = \left(HC * \left[\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{ee}} \right] * EFLH_h \right)$$

Table 8: Definition of Parameters – Energy Savings for MSHPs in Non-electrically Heated Households

Acronym	Unit	Variable	Value/Source
HC	BTU/h	Rated heating capacity of the new heat pump	Specification data for each installed system (AHRI certified value)
$HSPF_{base}$	BTU/W·h	Heating seasonal performance factor (Region V) for the baseline equipment	7.1 (Energy efficiency regulation for split system heat pumps) ¹⁰
$HSPF_{ee}$	BTU/W·h	Rated heating seasonal performance factor (Region V) for the new heat pump	Specification data for each installed system (AHRI certified value)
$EFLH_{heat}$	h/year	Full heating load hours	528 (MSHP billing analysis in the 2017 evaluation)

The tracked peak demand unitary savings were calculated for each MSHP using the variables defined and listed in the equation and Table 9 below.

$$Peak\ Demand\ Savings_{kW} = \left(\frac{HC_{min}}{3.412} \right) * \left[\frac{1}{COP_{base\_min}} - \frac{1}{COP_{ee\_min}} \right]$$

Table 9: Definition of Parameters – Peak Demand Savings for MSHPs in Non-electrically Heated Households

Acronym	Unit	Variable	Value/Source
HC_{min}	kBTU/h	Rated heating capacity of the new heat pump at outdoor air temperature of -15 °C	Specification data for each installed system
COP_{base_min}	kW/kW	COP for the assumed base case (electrical resistance)	Resistance heater has a COP of 1
COP_{ee_min}	kW/kW	COP for the new heat pump at -15 °C	Specification data for each installed system

Central Air-source and Air-to-water Heat Pumps

The central air-source heat pump category under Green Heat currently includes centrally ducted (air-to-air) ASHPs and AWHPs. In accordance with the 2017 evaluation, both ASHP and AWHP savings were calculated using the same average savings values per nominal installed heating capacity. Since the Green Heat Program Manual defines AWHPs as a subcategory of central heat pumps and they are not commonly installed, they are referred to as ASHPs throughout the remainder of this report.

¹⁰ Natural Resources Canada, *Single-Phase and Three-Phase Split-System Central Air Conditioners and Heat Pumps*. <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6895> (Last accessed January 17, 2019).

Tracked Savings

Electrically Heated Households

For each ASHP installed in electrically heated households, ENS uses an average annual savings value of 0.101 kWh per BTU/h of nominal installed heating capacity. This value is the result of a billing analysis carried out in the 2017 evaluation.

ASHP peak demand savings are calculated using a unitary peak demand savings value of 3.04 kW, a value drawn from 2015 evaluation results, using a sample of 15 ASHPs and the equation below.

$$Demand\ Savings_{kW} = \left(\frac{HC_{min}}{1,000 * 3.412} \right) * \left[\frac{1}{COP_{base}} - \frac{1}{COP_{ee\_min}} \right]$$

Table 10 further defines the variables used in determining tracked energy and peak demand savings.

Table 10: Definition of the Parameters - Peak Demand Savings for ASHPs

Acronym	Unit	Variable	Value/Source
HC_{min}	BTU/h	Rated heating capacity of the new heat pump at an outdoor air temperature of -15 °C	Specification data for each installed system
COP_{base}	kW/kW	COP for the baseline equipment	Electrical resistance: 1
COP_{ee_min}	kW/kW	COP for the new heat pump at an outdoor temperature of -15 °C	Specification data for each installed system

Non-electrically Heated Households

For participants who installed ASHPs in non-electrically heated households, the tracked energy savings ranged from -147 kWh to 6,770 kWh. The values did not match the unitary savings value recommended in last year's evaluation of 325 kWh.

For peak demand savings, ENS uses a value of 0 kW for all ASHPs installed in non-electrically homes.

Revised Savings

Electrically Heated Households

A billing analysis was performed again in the 2018 evaluation to more accurately estimate ASHP energy savings. All participants from 2013 to 2017 who installed ASHPs that did not replace existing heat pumps were included in the analysis, resulting in an initial sample size of 147 participants. The billing data of each selected participant were analyzed to adjust or remove any unusual bills (including longer billing cycles or overlapping bills), remove participants who had moved during the analyzed period, and remove participants who had an insufficient number of bills for either the pre or post-installation period. Thirty (30) participants were thus removed from the analysis at this stage.

Similar to the analysis performed in 2017, the objective of the billing analysis was to compare the electrical energy consumption of sampled participants before and after ASHP installation. To do so, a regression model based on the Princeton Scorekeeping Method was used. This standard statistical method calculates a regression specific to each participant instead of analyzing the data as a whole. The linear regression model is expressed in the following equation:

$$CONS = A + B \times HDD + C \times CDD$$

Where:

- › CONS is the average daily consumption
- › A is the daily base consumption constant
- › B is the unitary consumption coefficient per heating degree day (HDD)
- › C is the unitary consumption coefficient per cooling degree day (CDD)

For each participant, the energy consumption regression was built for six sets of independent variables, i.e. HDDs calculated for three different balance temperatures (12, 15, and 18°C) with and without CDDs calculated at the same balance temperature. The Evaluator selected the best model for each participant based on the following criteria:

- › Highest R²
- › Statistically significant constant
- › Statistically significant coefficient(s)

The analysis was focused on the variable electricity consumption linked to heating. This consumption level was obtained by multiplying the Coefficient B by normalized annual HDDs¹¹ to establish ASHP energy savings.

The Evaluator first analyzed the results specifically for previously fully electrically heated households since this group includes the largest number of households and was expected to exhibit less variability in results. A total of 31 households fit this criterion and had valid energy consumption models. The Evaluator noticed that savings were negative for 12 of those 31 households. Once two outlying results were removed, the average savings was calculated at 0.016 kWh/BTU/h with a margin of error of ±0.055 kWh/BTU/h. This result indicates that the savings are not statistically significant at a confidence level of 90 percent. It is also significantly different from the 2017 billing analysis results, which established savings of 0.140 kWh/BTU/h with a margin of error of ± 0.078 kWh/BTU/h.

¹¹ Government of Canada, *Station Results - 1981-2010 Climate Normals and Averages*, <http://climate.weather.gc.ca>. These data are updated every 10 years.

The Evaluator therefore investigated the reasons for this large variation in results. A sample of 17 participating households that obtained negative or low savings was selected. With the help of Efficiency Nova Scotia (ENS), participants were contacted to verify the information found in the tracking sheet about previous heating systems, and they were asked about changes to their homes that might explain lower than expected savings. This research revealed that many participants either used their ASHP to replace either an existing heat pump (10 cases) or an oil-fired heating system (5 cases). These participants should have been removed from the billing analysis since the comparison of their pre and post-installation electricity bills cannot be used to establish electricity savings.

Further investigation revealed that the incorrect information on heating systems was explained by data entry errors in 10 cases wherein the information in the application form was not correctly entered in the tracking sheet. In five other cases, participants had not entered correct information in the application forms. This is explained by the fact that fields requiring a description of existing heating systems in the 2017 application forms were somewhat unclear; ENS has since then improved the form to ensure that participants accurately describe the heating systems that they are intended to be replaced.

In summary, the billing analysis conducted for ASHPs as part of the 2018 evaluation was inconclusive due to the poor quality of data on existing heating systems. For this reason, the Evaluator applied the savings value of 0.101 kWh/Btu/h obtained from the 2017 billing analysis to the ASHPs installed in electrically heated households.

As for peak demand savings, the Evaluator used the Northeast Energy Efficiency Partnerships (NEEP) Cold Climate Air Source Heat Pump Listing v3.0¹² to retrieve specifications at -15 °C on the models installed through Green Heat and calculate the peak demand savings as per the following equation.

$$Demand\ Savings_{kW} = \left(\frac{HC_{min}}{1000 * 3.412} \right) * \left[\frac{1}{COP_{base}} - \frac{1}{COP_{ee,min}} \right]$$

Importantly, this list is not yet complete and the models it includes covered only 16 of the 128 participants who installed an ASHP in 2018. Since it was not possible to estimate a new unitary peak demand savings value with adequate accuracy, the Evaluator maintained the peak demand savings of 3.04 kW as per 2017 evaluation.

¹² Northeast Efficiency Partnerships, *NEEP Cold Climate Air Source Heat Pump Listing v3.0*, available at <https://neep.org/ccashp-product-listing-download> (Version updated January 1, 2019).

Non-electrically Heated Households

Since ASHPs installed in non-electrically heated households are no longer eligible for the DSM portion of Green Heat and only 19 participants claimed savings in 2018, the Evaluator relied on the unitary savings values established as part of the 2017 evaluation. The Evaluator applied an average unitary energy savings value of 352 kWh and an average unitary peak demand value of 1.06 kW. These values are based on an analysis of three potential replacement scenarios: whether participants intended to either purchase a standard efficiency heat pump, purchase an electrical resistance system, or keep their non-electrical heating system in the absence of the program component.

Ground-source Heat Pumps

GSHPs installed under Green Heat are required to be Canadian GeoExchange Coalition certified.

Tracked Savings

The tracked energy and peak demand savings for GSHP measures installed in 2018 were established using the standardized engineering algorithms defined further below. These algorithms are based on the 2016 Pennsylvania PUC TRM.¹³ The heating EFLH was revised in the 2017 Evaluation Report to 1,384 hours, which corresponds to the number of hours a three-tonne geothermal heat pump would need to run to produce the average annual space heating load determined from a billing analysis of previous Green Heat participants. The cooling EFLHs were maintained at 213 hours per year and are based on the values for Northern Minnesota, obtained through energy modelling and retrieved by the Evaluator from the 2017 State of Minnesota TRM.¹⁴ The variables used in the equations below are defined in Table 11.

$$\begin{aligned}
 \text{Energy Savings}_{kWh} &= \text{Heating Savings} + \text{Cooling Savings or Penalty} \\
 &= \left(\frac{HC}{1,000} \times \left(\frac{1}{HSPF_{base}} - \frac{1}{COP_{ee} \times DRF \times GSOP} \right) \times FLH_{heat} \right) \\
 &\quad + \left(\frac{CC}{1,000} \times \left(\frac{1}{SEER_{base}} \times AC - \frac{1}{EER_{ee} \times DRF \times GSER} \right) \times FLH_{cool} \right) \\
 \text{Demand Savings}_{kW} &= \left(\frac{HC}{3412 \frac{Btu/hr}{kW}} \times \left(\frac{1}{COP_{base}} - \frac{1}{COP_{ee} \times DRF} \right) \right)
 \end{aligned}$$

¹³ Pennsylvania Public Utility Commission (PUC), *Technical Reference Manual*, June 2015, Subsection 2.2 – HVAC.

¹⁴ Minnesota Department of Commerce – Division of Energy Resources, *State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs – Version 2*, Effective January 1, 2017.

Table 11: Definition of the Parameters and Corresponding Numerical Values - GSHPs

Acronym	Unit	Variable	Value/Source
HC	BTU/h	Heating capacity of installed system	Specification data for each installed system
CC	BTU/h	Cooling capacity of installed system	Specification data for each installed system
$HSPF_{base}$	BTU/W·h	Heating seasonal performance factor of the baseline equipment	Electrical resistance: 3.412 Functioning ASHP: 7.13 (PUC TRM) Non-electrical system: 7.13 (PUC TRM)
COP_{base}	kW/kW	Coefficient of performance of the baseline equipment	Electrical resistance: 1
COP_{ee}	kW/kW	Coefficient of performance of the new heat pump	Specification data for each installed system
DRF	Unitless	Derating factor from PUC TRM	0.885
$GSOP$	BTU/W·h	Factor to determine the HSPF of a GSHP based on its COP	3.412
$GSER$	Unitless	Factor used to determine the SEER of a GSHP based on its EER	1.02
$SEER_{base}$	BTU/W·h	Energy efficiency ratio for existing AC system	PUC TRM MSHP/ASHP: 14 Central AC: 13 Room AC: 11.3
EER_{ee}	BTU/W·h	Energy efficiency ratio for the new heat pump	Specification data for each installed system
FLH_{heat}	h/year	Full heating load hours	1,384 (As per 2017 evaluation recommendation)
FLH_{cool}	h/year	Full cooling load hours	213 (Minnesota TRM)
AC	Unitless	Cooling penalty modifier	AC in baseline = 1 No AC in baseline = 0

Revised Savings

No new studies have become available for GSHPs since the 2017 evaluation. The Evaluator therefore made no change to the methodology applied by ENS.

APPENDIX IX

GH: ALGORITHM FOR FREE-RIDERSHIP CALCULATION

The figures below show the algorithm for calculating the free-ridership level for each type of measure. The participant survey questionnaire included questions designed to assess the planning, quantity, efficiency, period, cost, and influence of the program component. A set of questions was also asked to assess cross-influence, which refers to the level of influence that participants' previous participation in one of ENS' program components or energy efficiency awareness campaigns had on their decisions to implement energy efficiency measures. A participant's responses to each group of questions were converted into a value indicating the level of program component attribution and this value was used to calculate the free-ridership level associated with each participant.

For those participants who installed an MSHP, the algorithm consisted of two portions. The first portion assessed a participant's decision to install a heat pump. The second assessed a participant's decision to purchase a high-efficiency heat pump. The portion for assessing the decision to install a heat pump was given a weight of 75 percent, since the savings associated with the efficiency increase brought by an electric resistance system (with an HSPF of 3.412) to a standard heat pump (usually with an HSPF of 7.1, according to federal energy efficiency regulations) represent about 75 percent of the total savings attributable to a high-efficiency MSHP. Also, the portion of the free-ridership linked to the decision to purchase a high-efficiency heat pump (the remaining 25%) was considered only if the free-ridership level of the first portion was higher than 50 percent. It was assumed that if the probability of purchasing a heat pump was lower than or equal to 50 percent, the probability of purchasing a high-efficiency heat pump was close to nil.

Algorithm – Stoves and Solar

FRS2. If you had not received the rebate from ENS, would you have paid the entire cost of your [EQUIPMENT]? (Scale 0 to 10)	FRS2 = Answer x 10% IF DK OR REF. FRS2 = EMPTY
FRS3a. If the program rebate had <u>not been</u> offered, 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)	FRS3a = (10 – Answer) x 10% IF 98 OR 99. FRS3a = EMPTY
FRS3b. If the program rebate had <u>not been</u> offered, what is the likelihood that you would have kept your old heating system instead of installing a new one? (Scale 0 to 10)	FRS3b = (10 – Answer) x 10% IF 98 OR 99. FRS3b = EMPTY
PA1 Score:	MEAN VALUE OF: (FRS2 ; MIN(FRS3a ; FRS3b))
FRS1. Had you <i>already</i> decided To install a [EQUIPMENT] <i>before</i> you heard about Green Heat?	IF 1. Yes: Use FRS1a IF 2. No OR DK OR REF: FRS1a = 0%
FRS1a. [IF FRS1=YES] I just want to make sure - <i>before</i> you decided to participate in Green Heat, you had already made the decision to install a [EQUIPMENT]?	IF 1. Yes: FRS1a = 100% IF 2. No OR DK OR REF : FRS1a = 0%
PA2 Score:	FRS1a
FRS4. Level of influence (Scale 0 to 10)	FRS4 = MAX(FRS4a ; FRS4b)
PA3 Score:	(10 – FRS4) x 10%
FRS3c. If Green Heat rebate had not been offered, what is the likelihood that you would have postponed installing the [EQUIPMENT] by at least one year?	(10 – Answer) x 10% IF 2. DK OR REF: FRS3c = EMPTY
PA4 Score:	FRS3c
Inconsistency Test PA1	IF ABS (FRS2 – MIN (FRS3a; FRS3b)) ≥ 50% PA1 = MIN (FRS2 ; FRS3a; FRS3b)
Inconsistency Test PA2	IF FRS1a = 100% and FRS2 < 70% PA2 = EMPTY
Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)
CI2/4a. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] was a major factor in your decision to install a [EQUIPMENT] in your home. CI2/4b. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted you to ask a contractor or a distributor about energy efficient heating systems for your home. CI2/4c. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted you to take into account the savings on your energy bill when evaluating different heating systems for your home. (Agree or Disagree)	CI = IF(CI2a OR CI4a=Agree) + IF(CI2b OR CI4b=Agree) + IF(CI2c OR CI4c=Agree)
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

Algorithm – Central Heat Pump

FRH2. If you had not received the rebate from ENS, would you have paid the entire cost of your [EQUIPMENT]? (Scale 0 to 10)	FRH2 = Answer x 10% IF DK OR REF: FR2 = EMPTY
FRH3a. If Green Heat rebate had not been offered, what is the likelihood that you would have installed a less efficient and less expensive heat pump (Scale 0 to 10)	FRH3a = (10 – Answer) x 10% IF DK OR REF: FRH3a = EMPTY
FRH3b. If Green Heat rebate had not been offered, what is the likelihood that you would have kept your old heating system instead of installing a new one? (Scale 0 to 10)	FRH3b = (10 – Answer) x 10% IF DK OR REF: FRH3b = EMPTY
PA1 Score:	MEAN VALUE OF: (FRH2 ; MIN(FRH3a ; FRH3b))
FRH1. Had you <i>already</i> decided to install a high efficiency [EQUIPMENT] <i>before</i> you heard about Green Heat?	IF 1. Yes: Use FRH1a IF 2. No OR DK OR REF: FRH1a = 0%
FRH1a. [IF FRH1=1] I just want to make sure - <i>before</i> you decided to participate in Green Heat, had you already made the decision to install a high efficiency [EQUIPMENT]?	IF 1. Yes: FRH1a = 100% IF 2. No OR DK OR REF: FRH1a = 0%
PA2 Score:	FRH1a
FRH4. Level of influence (Scale 0 to 10)	FRH4 = MAX(a; b)
PA3 Score:	(10 - FRH4) x 10%
FRH3c. If Green Heat rebate had not been offered, what is the likelihood that you would have postponed installing the [EQUIPMENT] <i>by at least one year</i> ? (Scale 0 to 10)	FRH3c = (10 – Answer) x 10% IF DK OR REF: FRH3c = EMPTY
PA4 Score:	FRH3c
Inconsistency Test PA1	IF ABS (FRH2 – MIN (FRH3a; FRH3b)) ≥ 50% PA1 = MIN (FRH2 ; FRH3a; FRH3b)
Inconsistency Test PA2	IF FRH1a = 100% AND FRH2 < 70% PA2 = EMPTY
Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)
CI2/4a. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] was a major factor in your decision to install a [EQUIPMENT] in your home. CI2/4b. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted you to ask a contractor or a distributor about energy efficient heating systems for your home. CI2/4c. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted you to take into account the savings on your energy bill when evaluating different heating systems for your home. (Agree or Disagree)	CI = IF(CI2a OR CI4a=Agree) + IF(CI2b OR CI4b=Agree) + IF(CI2c OR CI4c=Agree)
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

Algorithm – Mini-split Heat Pump in Electrically Heated Households

Series A: Decision to install a HP	
FRM1. Had you already decided to install a heat pump before you heard about the Green Heat Program?	IF 1. Yes: Use FRM1a IF 2. No OR DK OR REF: FRM1a = 0%
FRM1a. I just want to make sure - <i>before</i> you learned about the Green Heat Program, had you already made the decision to install a heat pump?	IF 1. Yes: FRM1a = 100% IF 2. No OR DK OR REF: FRM1a = 0%
FRM2. [ASK IF FRM1<>1 OR FRM1a<>1] If the program had not been offered, which of the following actions would you have taken? 1. Kept your existing heating system 2. Purchased a new electric heating system 3. Purchased a new non-electric heating system (e.g. oil or gas system) 4. Purchased a heat pump	IF 1, 2 or 3: END IF 4: ASK FRM3
FRM3. [ASK IF FRM1a=1 OR FRM2=4] If the program had not been offered, what is the likelihood that you would have postponed the purchase of a heat pump by at least one year? (Scale 0 to 10)	FRM3 = (10 – Answer) x 10% IF DK OR REF: FRM3 = EMPTY
PA1 Score (Series A)	MEAN VALUE OF: (FRM1a ; FRM3)
Series B: Decision to install a high-efficiency HP	
FRM4. Were you aware of the availability of high efficiency heat pumps that operate at temperatures below -15°C before you heard about Green Heat?	IF 1. Yes: Use FRM4a IF 2. No, DK OR REF: FRM4a = 0% and END
FRM4a. [ASK IF FRM4=1] Before you heard about the Green Heat Program, had you already made the decision to install a high-efficiency heat pump model?	IF 1. Yes: FRM4a=100% IF 2. No, DK OR REF: FRM4a = 0%
FRM5. [ASK IF FRM4=1] 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)	FRM5 = Answer x 10% IF DK OR REF: FRM5 = EMPTY
FRM6. Level of influence (Scale 0 to 10)	FRM6 = (10 - MAX(a;b;c))*10%
PA2 Score (Series B)	IF PA1<=50% OR FRM4<>1 PA2 = 0%, OTHERWISE MEAN VALUE OF: (FRM4a;FRM5;FRM6)
Inconsistency Test #1	IF FRM4a = 100% and FRM5 < 70% FRM4a = EMPTY
Free-Ridership	0.75xPA1+0.25xPA2
C12/4a. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] was a major factor in your decision to install a [EQUIPMENT] in your home. C12/4b. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted you to ask a contractor or a distributor about energy efficient heating systems for your home. C12/4c. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted you to take into account the savings on your energy bill when evaluating different heating systems for your home. (Agree or Disagree)	CI = IF(CI2a OR CI4a=Agree) + IF(CI2b OR CI4b=Agree) + IF(CI2c OR CI4c=Agree)
Revised Free-Ridership	IF CI=0 OR 1, Revised FR = FR IF CI=2, Revised FR = FR*.75 IF CI=3, Revised FR = FR*.50

APPENDIX X

GH: 2018 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2018 evaluation of the Green Heat program component, as well as all 2017 evaluation recommendations that were not fully implemented.

Section	Recommendations
Executive Summary	1. Improve the accuracy of the information in the tracking sheet. While reviewing the data for the ducted air-source heat pump (ASHP) billing analysis, the Evaluator noticed that the information on primary and secondary heating systems found in the tracking sheet was unreliable. Two reasons were identified for this issue: 2017 participants considered in the billing analysis used a previous version of the application form, which did not clearly identify which system (new or old) was being described. There were also numerous data entry errors between the application form and the tracking sheet. The information on heating systems is essential to the billing analysis. The Evaluator found that the technical characteristics (such as heating capacity) of some heat pumps were not consistent with the values found in the reference measures list. The Evaluator therefore recommends improving the quality assurance processes for the Green Heat tracking sheet.
	2. Continue monitoring barriers to the adoption of high-efficiency MSHPs to adapt the program component offer or plan for an exit strategy. The market indicators presented in the Market Evolution section of this report reveal the growing popularity of mini-split heat pumps (MSHPs) in Nova Scotia. Results also indicate that the rebate is less and less important in fostering the development of the MSHPs market and that the latter is growing due to factors external to Green Heat. Evaluation results also highlight that Green Heat still had some influence on how efficient the MSHPs purchased were in 2018. In this context, the Evaluator suggests that ENS continue incenting high-efficiency MSHP models in the short term, while monitoring barriers to high-efficiency MSHPs to understand if interventions in the market are still useful or if the measure needs to be removed or limited to those segments with lower high-efficiency MSHPs penetration rates, such as new constructions and multi-unit buildings.
2017 Recommendations (Not fully implemented at the time of evaluation)	3. Develop a way for potential participants to better understand which ASHP equipment is eligible. Non-MSHP participants do not have a simple list of rebated equipment to choose from and therefore must rely on contractors to determine if equipment is eligible. To drive interest in non-MSHP measures, such as ASHPs, and prevent dissatisfied participants who purchased equipment thinking it was eligible for a rebate, ENS should develop a list of eligible equipment, similar to the list established for MSHPs. Contractors could be asked to develop and update this list.

APPENDIX XI EPI: PARTICIPANT SURVEY QUESTIONNAIRE

Efficient Product Installation

October 2018

Hello, may I please speak with [INSERT NAME]?

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

INTRODUCTION

Hello, my name is _____, I am with Corporate Research Associates and we are performing an evaluation of energy efficiency services provided by Efficiency Nova Scotia. Our records indicate that you or your household recently participated in the Efficient Product Installation Service. Are you the person who was most involved with this installation service?

(IF NEEDED: As part of this service, someone would have come to your house and installed new lighting or product to use hot water more efficiently, such as LED light bulbs and faucet aerators, at no charge, as well as offered advice on ways your house can save energy).

[IF NO, ASK TO SPEAK TO THE APPROPRIATE PERSON]: “May I please speak to the person who knows the most about this installation service?”]

We would appreciate your help in answering questions related to your participation in this service. The information you provide will be used to help Efficiency Nova Scotia evaluate and improve the service. Is this a good time for you?

(IF NEEDED: You may have recently been contacted by Corporate Research Associates or by an Efficiency Nova Scotia representative about your experience with the service. This survey is different as it focuses on other aspects of your participation in the service.)

(IF NEEDED: The survey will take about fifteen minutes.)

1. Yes [CONTINUE]
2. No, I don’t remember the service / Don’t know [PROMPT: “Are you sure? Someone would have come to your house and installed energy efficient products, at no charge, for you to save energy and money?” RECODE AS “YES” IF THE PROMPT WORKS; IF RESPONDENT STILL SAYS NO: Is there someone else in the household who would know about having participated in this Efficiency Nova Scotia service?
3. Yes [ASK TO SPEAK TO THEM AND REPEAT INTRODUCTION]
4. No, but they came to my previous home [CONTINUE]
5. 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: _____]

EPI: Non-Low-Income Participants	QUOTA
Owners	n=70
Tenants	n=30
TOTAL	n=100

Verification and Recall [V Series]

V1. I am going to read you a list of energy efficient products that, according to our records, were installed in your home by the Efficient Product Installation Service. For each one, can you please confirm that this product was in fact installed through the service? [READ WHAT IS ON RECORD (MEASURE#0 IN THE DATABASE)] [1=YES, INSTALLED, 2=NO, NOT INSTALLED, 98=DON'T KNOW, 99=REFUSED]

[NOTE FOR PROGRAMMER: DO NOT PUT THE NUMBER OF EACH MEASURE]

- a) LED bulbs
- b) LED nightlights
- c) Pipe insulation
- d) Hot water tank wrap
- e) Low-flow showerheads or showerwands
- f) Thermostatic shower valve for shower [IF NEEDED: This valve shuts off the water once hot water is flowing. You then have to open the valve to begin showering.]
- g) Bathroom and/or kitchen faucet aerators
- h) Programmable thermostats
- i) Smart power strips

[THANK, TERMINATE, RECORD AND KEEP DATA IF RESPONDENT SAYS “NO,” “DK,” OR “REF” TO ALL QUESTIONS FROM V1]

Installation of Thermostatic Shower Valves [T Series]

[ASK PARTICIPANTS WHO HAD THERMOSTATIC SHOWER VALVE INSTALLED: **IF V1f=YES**]

T1. You just mentioned that a thermostatic shower valve was installed in your shower as part of the service. Do you still have this thermostatic shower valve installed in your shower?

[IF NEEDED: Once the water is heated and flowing, the valve shuts off and water flow is reduced to a trickle. You then have to open the valve to begin showering.]

- 1. Yes
- 2. No
- 98. (Don't Know) [GO TO CL SERIES]
- 99. (Refused) [GO TO CL SERIES]

- T2. [ASK IF T1=2 (NO)] Why did you choose to remove this thermostatic shower valve from your shower? [DO NOT READ, CODE ALL THAT APPLY]
1. (Shut water off too quickly)
 2. (Did not believe any changes would result in lower energy bills)
 96. (Other [SPECIFY: _____])
 98. (Don't know)
 99. (Refused)
- T3. Using a scale from 1 to 10, where 1 means "not at all satisfied" and 10 means "completely satisfied," please tell me how satisfied you are with the thermostatic shower valve that was installed under the program. [98 = Don't know/Don't recall, 99 = Refused] [DO NOT ACCEPT A RANGE]

Clotheslines [CL Series]

[ASK PARTICIPANTS WHO HAD RECEIVED CLOTHESLINES: IF CLOTHESLINE="YES" IN THE DATABASE]

- CL1. As part of your participation in the Efficient Product Installation Service, did you receive a free clothesline?
- 1 Yes
 - 2 No
 98. (Don't know / don't remember)
 99. (Refused)
- CL2. [ASK IF CL1 =1] Have you installed it?
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)
- CL3. [ASK IF CL2 = 2, 98 or 99] Do you plan to install it?
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)

CL4. [ASK IF CL3=2, 98 or 99] Why don't you plan to install the clothesline? [ACCEPT ONE RESPONSE ONLY]

1. (Too complicated to install)
2. (I don't use a clothesline to dry my clothes)
3. (I gave it to someone else)
4. (I already have a clothesline)
96. (Other [SPECIFY: _____])
98. (Don't know)
99. (Refused)

Participation [P Series]

P1. What was the SINGLE most important reason you agreed to participate in the Efficient Product Installation Service? [ACCEPT ONE RESPONSE] [DO NOT READ]

1. (To save on energy/to save on energy costs)
2. (For better comfort)
3. (To receive LED bulbs)
4. (To help protect the environment)
5. (No cost for services/service was free-of-charge)
6. (To reduce my water consumption)
7. (Wanted energy efficient upgrades)
96. (Other) [SPECIFY: _____]
98. (Don't know) [GO TO P3]
99. (Refused) [GO TO P3]

P2. Were there any other reasons? [DO NOT READ. ACCEPT MULTIPLE. SAME LIST AS P1]

97. None/no other reasons

P3. Were you home when the installer came to your home to install energy efficient products?

1. Yes
2. No
98. (Don't know)
99. (Refused)

P4. [ASK IF YES IN P3] Did your household receive information about energy efficient products during the visit from the installer? **DO NOT READ, CODE ONE ONLY**

1. Yes, I received some information
2. No, I did not receive any information
98. (Don't recall)

- P5. [ASK IF NO OR DON'T RECALL IN P4] Would you have been interested in receiving information about energy efficient products from the installer?
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)

Satisfaction with the Service [S Series]

- S1. 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 Efficient Product Installation Service overall? [RECORD NUMBER, 98=Don't know, 99 Refused]. DO NOT ACCEPT A RANGE.
- S2. [IF S1 < 8, DO NOT ASK IF DK OR REFUSED IN S1] What was the most important reason you were not more satisfied with the service overall? [PROBE FOR SPECIFIC REASON. ACCEPT MULTIPLE RESPONSES]
1. (I expected more)
 2. (Did not like the products installed)
 3. (I did not like the installer who came to my home)
 4. (I did not notice any savings on my energy bill)
 5. (The process was complicated)
 97. (Other: Please specify: _____)
 98. (Don't know)
 99. (Refused)

- S3. [IF S1 ≥ 8] What was the most important reason you were satisfied with the service overall?
[PROBE FOR SPECIFIC REASON. DO NOT READ – ACCEPT MULTIPLE RESPONSES]
1. (Lowered energy bill)
 2. (Good service)
 3. (Saves energy)
 4. (Better lights/lighting)
 5. (Informative/Information received)
 6. (I like the installer who visited the home)
 7. (Program was free)
 8. (Everything went smooth)
 9. (Reasonable time frame)
 10. (Products/services offered through program)
 97. (Other: Please specify: _____)
 98. (Don't know)
 99. (Refused)
- S4. Using a scale from 1 to 10, where 1 means “not at all satisfied” and 10 means “completely satisfied,” please tell me how satisfied you are with your experience with each of the following aspects of the Efficient Product Installation Service. [DO NOT RANDOMIZE] [97 = Not Applicable, 98 = Don't know/Don't recall, 99 = Refused] [DO NOT ACCEPT A RANGE]
- a) [ASK IF YES IN P3] The time required to complete work
 - b) The energy efficient products installed
 - c) The quality of the work completed
 - d) [ASK IF YES IN P4] The information you received about energy efficient products
- S5. Have you had any problems with the products installed in your home through the Efficient Product Installation Service?
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)
- S6. [ASK IF YES IN S5] Which products led to problems?
96. (RECORD ANSWER: _____)
 98. (Don't know)
 99. (Refused)

S7. [ASK IF YES IN S5] What problems did you have with the products installed in your home?

96. (RECORD VERBATIM: _____)

98. (Don't know)

99. (Refused)

Barriers to Action [B Series]

B1. [ASK IF YES IN P3] Were there any energy efficient products recommended through the Efficient Product Installation Service that you chose not to have installed in your home?

1. Yes

2. No

98. (Don't recall)

B2. [ASK IF YES IN B1] Which products did you choose not to have installed?

96. (RECORD ANSWER: _____)

98. (Don't know)

99. (Refused)

B3. [ASK IF YES IN B1] Why did you choose not to have these products installed in your home?

96. (RECORD VERBATIM: _____)

98. (Don't know)

99. (Refused)

[ASK TO ALL]

B4. Now, I would like you think about when you began to consider participating in the Efficient Product Installation Service? Did you have any concerns about participating in the service? (NOTE THE RESPONSE)

Specify: _____

97. (No concerns)

98. (Don't know)

99. (Refused)

Recommendations and Potential for Additional Measures [R Series]

- R1. Do you have any recommendations that you think would help improve the Efficient Product Installation Service? PROBE: Anything else? [ACCEPT MULTIPLE]
- 96. NOTE VERBATIM: _____
 - 97. (NO RECOMMENDATION)
 - 98. (Don't know)
 - 99. (Refused)
- R2. Which other energy efficient products would you like to have had installed through the Efficient Product Installation Service? [DO NOT READ. ACCEPT MULTIPLE]
- 1. (Dishwasher)
 - 2. (Washing machine)
 - 3. (Dryer)
 - 4. (Windows)
 - 5. (Envelope/Insulation)
 - 6. (Refrigerator)
 - 7. (Freezer)
 - 8. (Air sealing/Weather stripping)
 - 9. (Outdoor timer)
 - 10. (Power bars)
 - 11. (Smart thermostats)
 - 96. Other [SPECIFY: _____])
 - 97. None
 - 98. (Don't know)
 - 99. (Refused)
- R3. Can you tell me whether you use the following equipment for your home? [READ] [1=YES, I USED IT, 2=NO, NOT USED, 98=DON'T KNOW, 99=REFUSED]
- a. Pool pump
 - b. Block heater for your car

R4. [ASK FOR EACH 'YES' in R3] Efficiency Nova Scotia is looking at expanding the products offered as part of the Efficient Service Installation Service. For each of the following products, please tell me how interested you would be in having these products installed in your home.

How interested would you have been in having ... [READ - RANDOMIZE]

- a. [IF R3a=1] A timer for your pool pump
- b. [IF R3b=1] A timer for your block heater
- c. Lighting control for your porch lights, such as a timer or motion sensor
- d. Weather stripping or air sealing for your windows
- e. A door sweep to seal any gaps at the bottom of an exterior door

IF NEEDED: Timers switch equipment on and off at a preset time.

- 1. Very interested
- 2. Somewhat interested
- 3. Not very interested
- 4. Not at all interested
- 97. (I already have this product)
- 98. (Don't know)
- 99. (Refused)

Free-Ridership [FR Series]

INSTRUCTION: FR SERIES SHOULD BE ASKED ONLY TO RESPONDENTS WHO INDICATED:

- **"YES" IN V1a** (LED Bulbs)

OR

- **"YES" IN V1e** (low-flow showerheads) **AND IF Own/Rent = "OWN" IN DATABASE**

OTHERWISE, SKIP TO SO SERIES.

FR - LED Bulbs [ASK IF YES IN V1a]

The next questions will be about the **LED bulbs**, excluding night lights, that you had installed through the service.

FR1. Did you or anyone in your household have specific plans to purchase and install LED bulbs prior to learning about the Efficient Product Installation Service? [CODE ONE ONLY]

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

FR1a. **IF FR1=YES, THEN ASK:** I just want to make sure I understand – before you learned about the Efficient Product Installation Service, you had already made the decision to purchase and install LED bulbs in your home?

- 1. Yes, I had already made the decision to purchase and install LED bulbs
- 2. No, I had not already made the decision
- 98. (Don't know)
- 99. (Refused)

FR2. If Efficiency Nova Scotia had not installed these LED bulbs at no-charge as part of the Efficient Product Installation Service, would you have paid the full cost of the LED bulbs, which is approximately \$4 per bulb?

Please use a scale of 0-10, where 0="DEFINITELY **WOULD NOT** HAVE PAID" and 10 ="DEFINITELY **WOULD HAVE** PAID."

0-10 SCALE – RECORD NUMBER - 98 DON'T KNOW - 99 PREFER NOT TO SAY

[READ FIRST TIME THROUGH ONLY] Now I would like to ask you to consider what actions you would have taken if the Efficient Product Installation Service had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is "Very Unlikely," and a 10 indicating that it is "Very Likely."

[DO NOT ACCEPT A RANGE – ASK FR3 SEQUENCE IN ORDER/DO NOT RANDOMIZE]

FR3a. If the service had not been offered, what is the likelihood that you would have taken the initiative to purchase LED bulbs at a store and then install them yourself in your home?

FR3b. [IF FR3a>=5] If the service had not been offered, what is the likelihood that you would have postponed replacing your bulbs with LEDs by at least one-year?

FR3c. [ASK IF LED bulbs QUANTITY>1] If the service had not been offered, what is the likelihood that you would have purchased and installed all [QUANTITY] LED bulbs that were installed through the Efficient Product Installation Service?

[IF ONLY LED BULBS, GO TO FR4. OTHERWISE GO TO FR1M2]

FR - Low-flow showerheads [ASK IF YES IN V1e AND IF “OWN” IN DATABASE]

The next questions will be about the **Low-flow showerheads** you had installed through the service.

FR1M2. Did you or anyone in your household have specific plans to purchase and install low-flow showerheads prior to learning about the Efficient Product Installation Service? [CODE ONE ONLY]

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

FR1aM2. **IF FR1M2=YES, THEN ASK:** I just want to make sure I understand – before you learned about the Efficient Product Installation Service, you had already made the decision to purchase and install low-flow showerheads?

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

FR2M2. If Efficiency Nova Scotia had not installed these low-flow showerheads at no-charge as part of the Efficient Product Installation Service, would you have paid the full cost of the low-flow showerheads, which is approximately \$30?

Please use a scale of 0-10, where 0 = “DEFINITELY **WOULD NOT** HAVE PAID” and 10 = “DEFINITELY **WOULD HAVE** PAID.”

0-10 SCALE– RECORD NUMBER - 98 DON'T KNOW - 99 PREFER NOT TO SAY

[READ FIRST TIME THROUGH ONLY] Now I would like to ask you to consider what actions you would have taken if the Efficient Product Installation Service had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is “Very Unlikely” and a 10 indicating that it is “Very Likely.”

[DO NOT ACCEPT A RANGE – ASK FR3 SEQUENCE IN ORDER/DO NOT RANDOMIZE]

- FR3aM2. If the service had not been offered, what is the likelihood that you would have taken the initiative to purchase low-flow showerheads at a store and then install them yourself?
- FR3bM2. [IF FR3a>=5] If the service had not been offered, what is the likelihood that you would have postponed replacing your showerheads by at least one-year?
- FR3cM2. [ASK IF low-flow showerheads and/or showerwands QUANTITY>1] If the service had not been offered, what is the likelihood that you would have purchased and installed all [QUANTITY] low-flow showerheads that were installed through the Efficient Product Installation Service?

[ASK FR4 ONCE, NOT FOR EACH MEASURE (V1a or V1e)]

- FR4. Next, I'm going to ask you to rate the importance of factors that might have influenced your decision to have energy efficient products installed in your home. Using a scale from 0 to 10, where 0 means "No influence" and 10 means "Great influence," please rate the influence of each of the following in your decision to have the energy efficient products installed in your home. **[DO NOT ACCEPT A RANGE]**

Factor (READ AND RANDOMIZE)	Responses
a. The installation of energy efficient products, at no-charge, offered by the service	___ Response ___98 Don't Know ___99 Refused ___ 97 Not applicable
b. Information or advice provided by the service staff	___ Response ___98 Don't Know ___99 Refused ___ 97 Not applicable

Cross-Influence [CI Series]

INSTRUCTION: CI SERIES SHOULD BE ASKED ONLY TO RESPONDENTS WHO INDICATED "YES" IN V1a (LED Bulbs) OR "YES" IN V1e (low flow showerheads), AND IF Own/Rent = "OWN" IN DATABASE. OTHERWISE, SKIP TO SO SERIES.

READ AND ROTATE (CI1 + CI2) AND (CI3 + CI4) SEQUENCES

- CI1. Before participating in the Efficient Product Installation Service in [MONTH/YEAR], had you at any time in the past already participated in another Efficiency Nova Scotia program or service?
1. Yes
 2. No
 98. Don't know
 99. Prefer not to say

- CI2. [IF CI1=1] For the following statement, please indicate whether you agree or disagree. Your previous participation in an Efficiency Nova Scotia program or service, and what you learned by participating in this service, greatly influenced your decision to have energy efficient products installed in your home. Please use a scale of 0-10, where 0 = “COMPLETELY DISAGREE” and 10 = “COMPLETELY AGREE.”

[0-10 SCALE, WHERE 0 = “COMPLETELY DISAGREE” AND 10 = “COMPLETELY AGREE”]
RECORD NUMBER - 98 DON'T KNOW 99 PREFER NOT TO SAY

- CI3. Before participating in the Efficient Product Installation Service in [MONTH/YEAR], had you at any time in the past already seen energy efficiency promotional materials distributed by Efficiency Nova Scotia?

1. Yes
2. No
98. Don't know
99. Prefer not to say

- CI4. [IF CI3=1] For the following statement, please indicate whether you agree or disagree. The energy efficiency promotional materials distributed by Efficiency Nova Scotia greatly influenced your decision to have energy efficient products installed in your home. Please use a scale of 0-10, where 0= “COMPLETELY DISAGREE” and 10 = “COMPLETELY AGREE.”

[0-10 SCALE, WHERE 0 = “COMPLETELY DISAGREE” AND 10 = “COMPLETELY AGREE.”]
RECORD NUMBER - 98 DON'T KNOW 99 PREFER NOT TO SAY

Spillover [SO Series]

- SO1. Now I'd like you to think of the time since you participated in the Efficient Product Installation Service. Have you installed any additional energy efficient products or retired any old appliances on your own?

1. Yes
2. No [GO TO B SERIES]
98. (Don't know/Don't recall) [GO TO B SERIES]
99. (Refused) [GO TO B SERIES]

- SO2. [IF SO1= YES, THEN ASK] I just want to make sure I understand – after you participated in the Efficient Product Installation Service, you installed additional energy efficient products or retired old appliances on your own, that is, without a rebate or assistance from an Efficiency Nova Scotia program. Is that correct?

1. Yes, I installed additional products or retired appliances on my own
2. No [GO TO B SERIES]
98. (Don't know) [Go TO B SERIES]
99. (Refused) [GO TO B SERIES]

SO4a. What, if any, additional energy efficient products have you installed on your own after participating in the Efficient Product Installation Service? [DO NOT READ, ALLOW MULTIPLE]
Probe: Any others?

1. (LED bulbs)
2. (Low flow showerheads)
3. (Faucet aerators)
4. (Pipe insulation/tank wrap)
5. (Smart power strip/smart power bar)
6. (ENERGY STAR refrigerator)
7. (ENERGY STAR clothes washer)
8. (LED fixtures)
9. (NEST or other smart thermostats)
10. (Programmable thermostats)
11. (Dehumidifiers)
12. (Thermostatic shower valves)
13. (Air purifiers)
14. (Clothesline)
96. (Other [SPECIFY: _____])
97. (None)
98. (Don't know)

SO4b. [ASK FOR EACH RESPONSE IN S04a] How many [INSERT RESPONSE IN SO4a FOR ALL SO4a RESPONSES, EXCEPT SAY "feet of pipe insulation" IF CODE 4] have you purchased and installed on your own? [RECORD NUMBER IN QUANTITY OR NUMBER OF FEET OF PIPE INSULATION. 98=DK, 99=REFUSED]

SO4c. [IF SO4a = 1, 5, 6, 7, 8, 9, 10, 11, 13, 14] Did you receive an instant rebate at the cashier on the [INSERT ANSWER FROM SO4a] you purchased? [REPEAT FOR EACH ANSWER TO SO4a]

1. Yes
2. No
98. (Don't know)
99. (Refused)

SO4d. What appliances, if any, have you retired on your own, that is, outside of a rebate or other assistance from a program, after participating in the Efficient Product Installation Service? [DO NOT READ, ALLOW MULTIPLE] Probe: Any others?

1. (Refrigerators)
2. (Freezers)
3. (Room air-conditioning units)
4. (Dehumidifiers)
96. (Other [SPECIFY: _____])
97. None
98. (Don't know)

SO4e. [ASK FOR EACH RESPONSE IN SO4d] How many [INSERT RESPONSE IN SO4d] have you retired on your own? [RECORD NUMBER. 98=DK, 99=REFUSED]

SO5. How influential was your experience with the Efficient Product Installation Service on your decision to install these additional energy efficient products or retire these appliances on your own? Please give your answer on a scale of 0 to 10, where 0 indicates that the Efficient Product Installation Service “had no influence at all on your decision” and 10 indicates that the service was “extremely influential to your decision.” [RECORD RESPONSE 0-10, 98 = Don't know, 99 = REFUSED] [DO NOT ACCEPT A RANGE]

Barriers to Action #2 [B Series]

[ASK ALL]

B5. We would like to understand what the biggest challenges are when it comes to making energy efficiency upgrades in the home. Please tell me how much of a factor, if any, are each of the following in preventing your household from making energy efficiency upgrades? Please answer on a scale of 1 to 10, where 1 means “not at all a factor” and 10 means “a major factor.” [ROTATE. RECORD RESPONSE BETWEEN 1 AND 10. 98=DON'T KNOW, 99=REFUSED]

- a. Lack of funds
- b. Lack of time
- c. Lack of information about energy efficient products
- d. Lack of interest
- e. Not convinced of the energy savings

Demographic Characteristics (D Series)

[ASK ALL] These final questions are asked for statistical purposes only. The information collected is strictly confidential.

- D1. What type of residence do you live in? [READ RESPONSES 1-7, THEN 96; SELECT ONE RESPONSE]
1. Apartment building that has fewer than five stories
 2. Apartment building that has five or more stories
 3. Rowhouse (Single story apartment building)
 4. Detached single-family home
 5. Semi-detached house
 6. Mobile home or house trailer
 7. Townhouse or duplex with shared adjacent walls
 96. Or some other type [SPECIFY: _____]
 98. (Don't know)
 99. (Refused)
- D2. How many bedrooms are in your home? [98=DK; Enter zero for a studio apartment with no bedrooms]
- D3. How many showers are in your home? [98=DK; Record number of showers]
RECORD NUMBER: _____ 98=DK
- D5. Do you pay the electric bills for your home?
1. Yes
 2. No
 96. (Other Specify: _____)
 98. (Don't Know)
 99. (Refused)
- D6. Including yourself, how many people live in this residence on a full-time basis?
Number of people: _____ [NOTE: DON'T ALLOW ZERO FOR A RESPONSE]
99. (Refused)
- D7. What is your age group? Are you.... [READ]
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)

- D8. What is the highest grade of schooling completed by the head of your household? [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)
 97. (Other [SPECIFY: _____])
 98. (Don't know)
 99. (Refused)
- D9. 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. SELECT ONE RESPONSE]
1. Less than \$15,000
 2. \$15,000 - \$24,999
 3. \$25,000 - \$34,999
 4. \$35,000 - \$49,999
 5. \$50,000 - \$69,999
 6. \$70,000 - \$79,999
 8. \$80,000 or more
 98. (Don't know)
 99. (Refused)
- D10. [DO NOT READ] Gender:
1. Male
 2. Female

END: THAT IS ALL THE QUESTIONS I HAVE FOR YOU. THANK YOU FOR TAKING THE TIME TO RESPOND TO THIS SURVEY.

APPENDIX XII

EPI: PARTICIPANT SURVEY RESULTS

The participant survey results are presented in the following tables. In total, 70 interviews were completed with homeowners and 30 interviews with tenants. The total columns in the tables below have been weighted to match the actual proportion of tenants and homeowners in the program component tracking sheet. Meanwhile, results for tenants and homeowners shown in the tables below are unweighted results. This means that the number of respondents and the survey results presented in the tenant and homeowner columns do not correspond to the total columns.

- T1. You just mentioned that a thermostatic shower valve was installed in your shower as part of the service. Do you still have this thermostatic shower valve installed in your shower?

Thermostatic Shower Valve Installed	2018		
	Tenants (#)	Homeowners (%)	Total (%)
Sample Size	1	29	39
Yes	-	90%	89%
No	1	10%	11%
Base: Respondents who had thermostatic shut-off valve for shower installed through EPI			

- T2. Why did you choose to remove this thermostatic shower valve from your shower?

Reason Thermostatic Shower Valve No Longer Installed	2018		
	Tenants (#)	Homeowners (#)	Total (#)
Sample Size	1	3	4
It was inconvenient	-	1	1
Poor water pressure	-	1	1
It ran all the time	-	1	1
Did not work like I thought it would	1	-	1
Base: Respondents who removed thermostatic shower valve			

- T3. Using a scale from 1 to 10, where 1 means “not at all satisfied” and 10 means “completely satisfied,” please tell me how satisfied you are with the thermostatic shower valve that was installed under the program.

Satisfaction with Thermostatic Shower Valve	2018		
	Tenants	Homeowners	Total
Sample Size	1	27	36
Mean	6.0	7.3	7.3
Base: Respondents who still have thermostatic shower valve installed Don't know/Refused excluded from calculations			

CL1. As part of your participation in the Efficient Product Installation Service, did you receive a free clothesline?

Received a Free Clothesline	2018		
	Tenants (%)	Homeowners (%)	Total (%)
Sample Size	23	22	35
Yes	78%	100%	97%
No	22%	-	3%
Base: Respondents who participated in EPI at the time of the clothesline promotion			

CL2. Have you installed it?

Installed Clothesline	2018		
	Tenants (#)	Homeowners (%)	Total (%)
Sample Size	18	22	33
Yes	7	27%	29%
No	11	73%	71%
Base: Respondents who received clothesline through EPI			

CL3. Do you plan to install it?

Intention to Install Clothesline	2018		
	Tenants (#)	Homeowners (#)	Total (%)
Sample Size	11	16	24
Yes	7	11	68%
No	2	4	24%
Don't know/Refused	2	1	8%
Base: Respondents who received clothesline through EPI but have not installed			

CL4. Why don't you plan to install the clothesline?

Reason for not Planning on Installing Clothesline	2018	
	Tenants (#)	Homeowners (#)
Sample Size	4	5
Need a spot to install it	2	1
I already have a clothesline	1	1
Not a real clothesline	-	1
Wait until summer	1	-
Too complicated to install	-	1
Others	-	1
Base: Respondents who do not plan on installing clothesline Multiple responses		

P1. What was the single most important reason you agreed to participate in the Efficient Product Installation Service?

P2. Were there any other reasons?

Reasons for Participating	2018					
	Most Important Motivation			Other Important Motivations*		
	Tenants	Home-owners	Total	Tenants	Home-owners	Total
Sample Size	30	70	100	30	70	100
To save on energy/energy costs	50%	79%	77%	33%	14%	16%
Wanted energy efficient upgrades	17%	3%	4%	-	11%	11%
To help protect the environment	7%	3%	3%	7%	10%	10%
No cost for services/service was free-of-charge	3%	1%	2%	13%	10%	10%
To receive LED bulbs	10%	13%	13%	-	4%	4%
To reduce my water consumption	3%	-	-	-	1%	1%
For better comfort	3%	-	-	-	-	-
Others	7%	1%	2%	10%	-	1%
None/no other reasons	-	-	-	50%	56%	55%
*Multiple Responses						

P3. Were you home when the installer came to your home to install energy efficient products?

Was Home During Installation	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
Yes	93%	91%	92%
No	7%	9%	8%

P4. Did your household receive information about energy efficient products during the visit from the installer?

Received Information	2018		
	Tenants	Homeowners	Total
Sample Size	28	64	92
Yes	82%	61%	62%
No	11%	17%	17%
Don't recall	7%	22%	21%
Base: Respondents who were home during the installation			

P5. Would you have been interested in receiving information about energy efficient products from the installer?

Interested in Receiving Information	2018		
	Tenants (#)	Homeowners (%)	Total (%)
Sample Size	5	25	34
Yes	3	68%	68%
No	2	28%	28%
Don't recall	-	4%	4%
Base: Respondents who did not receive information during the visit			

CI1. Before participating in the Efficient Product Installation Service in [MONTH/YEAR], had you at any time in the past already participated in another Efficiency Nova Scotia program or service?

Previous Participation in another ENS program or service	2018		
	Tenants	Homeowners	Total
Sample Size	28	68	97
Yes	32%	35%	35%
No	68%	65%	65%
Base: Respondents who had LED bulbs or low flow showerheads installed through EPI			

- CI2. For the following statement, please indicate whether you agree or disagree. Your previous participation in an Efficiency Nova Scotia program or service and what you learned by participating in this service greatly influenced your decision to have energy efficient products installed in your home. Please use a scale of 0-10, where 0 equals “completely disagree” and 10 equals “completely agree.”

Participation in Previous Programs or Services Influenced Decision to Install Energy Efficient Products	2018		
	Tenants	Homeowners	Total
Sample Size	9	24	34
Mean	10.0	7.8	7.9
Base: Respondents who participated in another ENS service, and who had LED bulbs or low flow showerheads installed through EPI Don't know/Refused excluded from calculations			

- CI3. Before participating in the Efficient Product Installation Service in [MONTH/YEAR], had you at any time in the past already seen energy efficiency promotional materials distributed by Efficiency Nova Scotia?

Recall of ENS Energy Efficiency Promotional Materials	2018		
	Tenants	Homeowners	Total
Sample Size	28	68	97
Yes	71%	76%	76%
No	29%	65%	65%
Don't know	-	1%	1%
Base: Respondents who had LED bulbs or low flow showerheads installed through EPI, and who own home			

- CI4. For the following statement, please indicate whether you agree or disagree. The energy efficiency promotional materials distributed by Efficiency Nova Scotia greatly influenced your decision to have energy-efficient products installed in your home. Please use a scale of 0-10, where 0 equals “completely disagree” and 10 equals “completely agree.”

ENS Energy Efficiency Promotional Materials Influenced Decision to Install Energy Efficient Products	2018		
	Tenants	Homeowners	Total
Sample Size	20	52	74
Mean	7.9	8.0	8.0
Base: Respondents who previously saw ENS energy efficiency promotional materials, and who had LED bulbs or low flow showerheads installed through EPI Don't know/Refused excluded from calculations			

- S1. 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 Efficient Product Installation Service overall?

Satisfaction with EPI Overall	2018		
	Tenants	Homeowners	Total
Sample Size	29	70	100
Mean	9.2	9.3	9.3
Don't know/Refused excluded from calculations			

- S2. What was the most important reason you were not more satisfied with the service overall?

Key Reasons Not More Satisfied with EPI Overall	2018	
	Tenants (#)	Homeowners (#)
Sample Size	1	4
I expected more	1	2
I did not like the products installed	-	2
Base: Respondents who were not satisfied with the service (as indicated by a rating of 'less than 8')		
Multiple responses		

- S3. What was the most important reason you were satisfied with the service overall?

Key Reasons Satisfied with EPI Overall	2018		
	Tenants	Homeowners	Total
Sample Size	28	66	94
I like the installer who visited the home	21%	39%	38%
Good service	25%	24%	24%
Reasonable time frame	21%	24%	24%
Informative/Information received	14%	20%	19%
Everything went smooth	18%	14%	14%
Products/services offered through service	14%	12%	12%
Saves energy	-	9%	8%
Lowered energy bill	11%	6%	6%
Service was free	7%	5%	5%
Better lights/lighting	-	5%	4%
Service met my expectations	11%	-	1%
Others	4%	5%	4%
Don't know/Refused	4%	5%	4%
Base: Respondents who were satisfied with the service (as indicated by a rating of '8 or more')			
Multiple response			

- S4. Using a scale from 1 to 10, where 1 means “not at all satisfied” and 10 means “completely satisfied,” please tell me how satisfied you are with your experience with each of the following aspects of the Efficient Product Installation Service.

Satisfaction with Aspects of EPI	2018					
	Tenants		Homeowners		Total	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
*The time required to complete work	28	9.8	64	9.5	92	9.5
The quality of the work completed	30	9.7	70	9.5	100	9.5
**The information you received about energy efficient products	23	9.2	39	9.3	57	9.3
Energy efficient products installed	30	9.4	69	8.9	99	8.9
Not applicable, Don't know/Don't recall and Refused excluded from calculations						
*Base: Respondents who were home during the installation						
**Base: Respondents who received information during the visit from the installer about energy efficient products						

- S5. Have you had any problems with the products installed in your home through the Efficient Product Installation Service?

Any Problems with Products Installed	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
Yes	13%	20%	20%
No	87%	80%	80%

- S6. Which products led to problems?

Products That Led to Problems	2018	
	Tenants (#)	Homeowners (#)
Sample Size	4	14
LED bulbs	1	4
Showerhead	1	3
Faucet aerator	-	4
Smart power strip	1	3
Hot water tank wrap	1	2
Thermostatic shower valve	-	1
Base: Respondents who had problems with products installed Multiple responses		

S7. What problems did you have with the products installed in your home?

Specific Problems with Products Installed	2018	
	Tenants (#)	Homeowners (#)
Sample Size	4	14
Not user-friendly/difficult to use	1	4
Bulb burnt out	1	4
Caused a leak/issue with water dripping	-	2
It broke/filter came out	-	2
Hot water wrap started to come off/became un-taped	1	1
Issue with temperature regulation	1	1
Issues with water flow	-	1
Power strip kept turning TV off	-	1
Others	-	1
Base: Respondents who had problems with products installed		

B1. Were there any energy efficiency products recommended through the Efficient Product Installation Service that you chose not to have installed in your home?

Products Recommended but Not Installed	2018		
	Tenants	Homeowners	Total
Sample Size	28	64	92
Yes	14%	19%	18%
No	71%	78%	78%
Don't recall	14%	3%	4%
Base: Respondents who were home during the installation			

B2. Which products did you choose not to have installed?

Products Chosen Not to be Installed	2018	
	Tenants (#)	Homeowners (#)
Sample Size	4	12
Hot water tank wrap	-	4
Showerhead	2	2
Smart power strip	-	3
Faucet aerator	1	1
Light bulbs	1	1
Heat pump	-	1
Clotheslines	1	-
Base: Respondents who had products recommended but chose not to install		

B3. Why did you choose not to have these products installed in your home?

Reasons for Not Installing Recommended Products	2018	
	Tenants (#)	Homeowners (#)
Sample Size	4	12
Didn't need it/wouldn't provide much benefit	-	6
Don't like it/like the one I have	2	3
Water tank needed to be replaced	-	2
Already have one	2	-
Cost	-	1
Base: Respondents who had products recommended but chose not to install Multiple responses		

B4. Now I would like you think about when you began thinking about participating in the Efficient Product Installation Service? Did you have any concerns about participating in the service?

Concerns about the Service	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
Wouldn't like the products installed	-	3%	3%
If it was free who would be paying for it	3%	1%	2%
No concerns	97%	96%	96%
Multiple responses			

R1. Do you have any recommendations that you think would help improve the Efficient Product Installation Service? Anything else?

Participant Suggestions to Improve EPI	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
Offer more products to be installed	13%	11%	12%
Offer more information on the products installed	7%	9%	8%
Improve communication	7%	3%	3%
Better advertising/more awareness of service	-	3%	3%
Improve quality of work	3%	1%	2%
Complete work faster	3%	1%	2%
Replace a higher number of light bulbs	-	1%	1%
Issues with faucet aerator	-	1%	1%
Others	-	4%	4%
None/no recommendations	70%	67%	67%
Multiple responses			

R2. Which other energy efficient products would you like to have had installed through the Efficient Product Installation Service?

Energy Efficient Products that Respondents Would Have Liked Installed	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
Different light bulbs	3%	11%	11%
Heat pump/geothermal	10%	10%	10%
Smart thermostats	-	7%	7%
Solar panels	7%	4%	4%
Windows	7%	4%	4%
Refrigerator	3%	4%	4%
Air sealing/weather stripping	7%	3%	3%
Power bars	3%	3%	3%
Outdoor lights	-	3%	3%
Dryer	-	3%	3%
Washing machine	-	3%	3%
Hot water heater	7%	1%	2%
Envelope/insulation	3%	1%	2%
Dishwasher	-	1%	1%
Faucet aerator	7%	-	-
Toilets	3%	-	-
Others	7%	4%	4%
Don't know/refused	20%	14%	15%
None	37%	33%	33%
Multiple responses			

R3a-b. Can you tell me whether you use the following equipment for your home?

Used Equipment in Home	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
Pool pump (% saying yes)	13%	4%	5%
Block heater for your car (% saying yes)	7%	3%	3%

- R4. Efficiency Nova Scotia is looking at expanding the products offered as part of the Efficient Service Installation Service. For each of the following products, please tell me how interested you would be in having these products installed in your home. (Scale: very interested, somewhat interested, not very interested, or not at all interested.)

Level of Interest	2018					
	Tenants		Homeowners		Total	
	Sample Size	Very/ somewhat Interested	Sample Size	Very/ somewhat Interested	Sample Size	Very/ somewhat Interested
A timer for pool pump*	4	1	3	1	7	2
A timer for block heater*	2	1	2	2	4	3
Lighting control for porch lights	30	83%	70	73%	100	74%
Weather stripping or air sealing for your windows	30	70%	70	69%	100	69%
A door sweep to seal any gaps at the bottom of an exterior door	30	90%	70	80%	100	81%
*Base: Respondents who have equipment in home						

- FR1. Did you or anyone in your household have specific plans to purchase and install LED bulbs prior to learning about the Efficient Product Installation Service?
- FR1a. I just want to make sure I understand – before you learned about the Efficient Product Installation Service, you had already made the decision to purchase and install LED bulbs in your home?

Already Made Decision to Install LEDs Prior to EPI	2018		
	Tenants	Homeowners	Total
Sample Size	28	67	96
Yes	54%	60%	59%
No	43%	37%	38%
Don't know/Refused	4%	3%	3%
Base: Respondents who had LED bulbs installed through EPI			

FR2. If Efficiency Nova Scotia had not installed these LED bulbs at no charge as part of the Efficient Product Installation Service, would you have paid the full cost of the LED bulbs, which is approximately \$4 per bulb?

Would Have Paid for Full LED Cost in Absence of EPI	2018					
	Tenants		Homeowners		Total	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Would have paid full cost	26	5.8	67	5.9	95	5.9
Base: Participants who had LED bulbs installed through EPI Don't know/Prefer not to say excluded from calculations						

FR3. Now I would like to ask you to consider what actions you would have taken if the Efficient Product Installation Service had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is “Very Unlikely” and a 10 indicating that it is “Very Likely.”

Actions Taken in Absence of EPI	2018					
	Tenants		Homeowners		Total	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Postponed replacing your bulbs with LEDs by at least one year*	24	7.0	52	6.8	75	6.8
Taken the initiative to purchase LED bulbs at a store and then install them yourself in your home	28	6.9	67	6.4	96	6.5
Purchased and installed all [QUANTITY] LED bulbs that were installed through the Efficient Product Installation Service**	27	5.0	67	4.9	95	4.9
Don't know/Prefer excluded from calculations Base: Participants that had LED bulbs installed through EPI *Base: Participants who gave rating of 5 or higher for FR3a **Base: Participants that had a quantity of more than one LED bulb						

FR1M2. Did you or anyone in your household have specific plans to purchase and install low-flow showerheads prior to learning about the Efficient Product Installation Service?

FR1aM2. I just want to make sure I understand – before you learned about the Efficient Product Installation Service, you had already made the decision to purchase and install low-flow showerheads?

Already Made Decision to Install Low-Flow Showerheads	2018
	Homeowners
Sample Size	45
Yes	4%
No	96%
Base: Respondents who had low flow showerheads installed through EPI and own home	

FR2M2. If Efficiency Nova Scotia had not installed these low-flow showerheads at no-charge as part of the Efficient Product Installation Service, would you have paid the full cost of the low-flow showerheads, which is approximately \$30?

Would Have Paid Full Cost for Low-Flow Showerhead in Absence of EPI	2018	
	Homeowners	
	Sample Size	Mean
Would have paid full cost	45	2.6
Base: Participants who had low flow showerhead installed through EPI, and own home Don't know/Prefer not to say excluded from calculations		

FR3M. Now I would like to ask you to consider what actions you would have taken if the Efficient Product Installation Service had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is “Very Unlikely” and a 10 indicating that it is “Very Likely.”

Actions Taken in Absence of EPI	2018	
	Homeowners	
	Sample Size	Mean
Postponed replacing your showerhead by at least one year*	6	5.2
Purchased and installed all [QUANTITY] low-flow showerheads that were installed through the Efficient Product Installation Service**	17	2.6
Taken the initiative to purchase low-flow showerheads at a store and then install them yourself	45	2.4
Don't know/Prefer excluded from calculations Base: Participants that had low flow showerheads installed through EPI *Base: Participants who gave rating of 5 or higher for FR3aM2 **Base: Participants that had a quantity of more than one showerhead		

FR4. Next, I'm going to ask you to rate the importance of factors that might have influenced your decision to have LED bulbs installed in your home. Using a scale from 0 to 10, where 0 means "No influence" and 10 means "Great influence," please rate the influence of each of the following in your decision to have the energy efficient products installed in your home.

Influence of Factors on Decision to Have Products Installed	2018					
	Tenants		Homeowners		Total	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
The installation of energy efficient products, at no-charge, offered by the service	28	9.4	68	9.0	97	9.1
Information or advice provided by the service staff	28	5.8	63	7.5	90	7.3
Base: Participants who had LED bulbs installed through EPI Don't know/Refused/Not applicable excluded from calculations						

SO1. Now I'd like you to think of the time **since you participated** in the Efficient Product Installation Service. Have you installed any additional energy efficient products or retired any old appliances **on your own**?

SO2. I just want to make sure I understand – **after** you participated in the Efficient Product Installation Service, you installed additional energy efficient products or retired old appliances on your own. Is that correct?

Installed Additional Products or Retired Appliances After Participation	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
Yes	23%	26%	26%
No	77%	73%	73%
Don't know/Don't recall	-	1%	1%

SO4a. What, if any, additional energy efficient products have you installed on your own after participating in the Efficient Product Installation Service?

Other Products Installed After Participating	2018		
	Tenants (#)	Homeowners (#)	Total (%)
Sample Size	7	18	26
LED bulbs	3	4	24%
Stove	-	4	21%
Heat pump	1	2	11%
ENERGY STAR refrigerator	1	2	11%
Small appliances/toaster	-	2	10%
Windows/doors	-	2	10%
ENERGY STAR clothes washer	-	2	10%
Air sealing/weather stripping	-	1	5%
Dishwasher	-	1	5%
Freezer	-	1	5%
Air purifiers	-	1	5%
Dehumidifiers	-	1	5%
LED fixtures	-	1	5%
Faucet aerators	1	-	1%
TV	-	1	1%
Furnace	-	1	1%
Motion sensor	1	-	-
None	1	2	11%
Multiple responses			

SO4b. How many [INSERT RESPONSE IN SO4a FOR ALL SO4a RESPONSES, EXCEPT SAY “feet of pipe insulation” IF CODE 4] have you purchased and installed on your own?

No respondents

SO4c. Did you receive an instant rebate at the cashier on the [INSERT ANSWER FROM SO4a] you purchased?

Other Products Installed After Participating	2018			
	Total			
	SO4b. Sample Size	Mean Number Purchased and Installed	SO4c. Sample Size	Received an Instant Rebate (# saying yes)
LED bulbs	6	6.1	6	1
Faucet aerators	0*	1.0	n/a	n/a
ENERGY STAR refrigerator	0*	1.0	1	-
ENERGY STAR clothes washer	3	1.0	2	-
Dehumidifier	1	2.0	1	-
Base: Respondents who installed products after participating in EPI and did not receive financing or rebates from other ENS services				
*Weighted sample size is zero, however unweighted sample size is 1 respondent.				

SO4d. What appliances, if any, have you retired on your own, that is, outside of a rebate or other assistance from a program, after participating in the Efficient Product Installation Service?

Appliances Retired Outside of a Rebate or Assistance from Other Service, after Participating in EPI	2018		
	Tenants (#)	Homeowners (#)	Total (%)
Sample Size	7	18	26
Stove	-	4	21%
Dishwasher	-	3	16%
Small kitchen appliances/toaster/coffee maker	-	2	10%
Freezers	-	2	10%
Refrigerators	-	2	10%
Laundry machines/washer/dryer	-	1	5%
Others	1	2	11%
None	6	10	57%
Base: Respondents who installed additional products or retired appliances after participating in EPI and did not receive financing or rebates from other ENS services			
Multiple Responses			

SO4e. How many [INSERT RESPONSE IN SO4d] have you retired on your own?

Number of Appliances Retired Outside of a Rebate or Assistance from Other Service, after Participating in EPI	2018	
	Homeowners	
	Sample Size	Mean
Refrigerators	2	1.5
Freezers	1	1.0
Base: Respondents who installed additional products or retired appliances after participating in EPI and did not receive financing or rebates from other ENS services Don't know/Refused excluded from calculations		

SO5. How influential was your experience with the Efficient Product Installation Service on your decision to install these additional energy efficient products or retire these appliances on your own? Please, give your answer on a scale of 0 to 10, where 0 indicates that the Efficient Product Installation Service “had no influence at all on your decision” and 10 indicates that the service was “extremely influential to your decision.”

Influence of EPI on Decision to Install Other Products	2018					
	Tenants		Homeowners		Total	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Influence EPI had on decision to install energy efficient products or retire products after participating in EPI	7	3.6	18	5.7	26	5.6
Base: Respondents who installed additional products or retired appliances after participating in EPI and did not receive financing or rebates from other ENS services Don't know/Refused excluded from calculations						

- B5. We would like to understand what the biggest challenges are when it comes to making energy efficiency upgrades in the home. Please tell me how much of a factor, if any, are each of the following in preventing your household from making energy efficiency upgrades? Please answer on a scale of 1 to 10, where 1 means “not at all a factor” and 10 means “a major factor.”

Challenges to Making Energy Efficiency Upgrades	2018					
	Tenants		Homeowners		Total	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Lack of funds	30	7.3	69	6.5	99	6.5
Lack of information about energy efficient products	30	4.5	68	4.9	97	4.9
Not convinced of the energy savings	29	3.5	68	4.4	97	4.3
Lack of time	30	4.0	70	4.2	100	4.2
Lack of interest	29	3.4	70	3.4	100	3.4
Don't know/Refused excluded from calculations						

- D1. What type of residence do you live in?

Type of Home	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
Detached single-family home	63%	77%	76%
Semi-detached house	7%	10%	10%
Townhouse or duplex with shared adjacent walls	13%	6%	6%
Mobile home or house trailer	3%	6%	6%
Apartment building that has five or more stories	-	1%	1%
Apartment building that has fewer than five stories	7%	-	-
Rowhouse/single story apartment building	3%	-	-
Others	3%	-	-

D2. How many bedrooms are in your home?

Number of Bedrooms	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
1	3%	1%	2%
2	17%	10%	10%
3	47%	57%	56%
4 or more	33%	30%	30%
Don't know	-	1%	1%

D3. How many showers are in your home?

Number of Showers	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
1	40%	40%	40%
2	47%	46%	46%
3 or more	13%	13%	13%
Don't know	-	1%	1%

D5. Do you pay the electric bills for your home?

You Pay Electricity Bills	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
Yes	93%	100%	100%
No	7%	-	-

D6. Including yourself, how many people live in this residence on a full-time basis?

People in Household	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
1	37%	17%	18%
2	33%	49%	48%
3	7%	13%	12%
4+	23%	20%	20%
Refused	-	1%	1%

D7. What is your age group?

Age of Respondent	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
18 to 24	-	1%	1%
25 to 34	10%	10%	10%
35 to 44	23%	14%	15%
45 to 54	17%	19%	18%
55 to 64	23%	21%	22%
65 or over	23%	34%	34%
Refused	3%	-	-

D8. What is the highest grade of schooling completed by the head of your household?

Level of Education	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
Less than high school graduation diploma	7%	4%	4%
High school graduate diploma and/or some post-secondary education	3%	19%	18%
Trades certificate/diploma	3%	1%	2%
College certificate/diploma	33%	21%	22%
University degree, certificate, or diploma	50%	51%	51%
Others	3%	-	-
Don't know/Refused	-	3%	3%

D9. Which of the following income categories best describes your total annual household income before taxes last year?

Household Income	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
Less than \$15,000	3%	-	-
\$15,000 - \$24,999	10%	3%	3%
\$25,000 - \$34,999	7%	10%	10%
\$35,000 - \$49,999	7%	11%	11%
\$50,000 - \$69,999	10%	14%	14%
\$70,000 - \$79,999	-	11%	11%
\$80,000 or more	37%	34%	34%
Don't know/Refused	26%	15%	17%

D10. Gender?

Gender	2018		
	Tenants	Homeowners	Total
Sample Size	30	70	100
Male	43%	49%	48%
Female	57%	51%	52%

APPENDIX XIII

EPI: DETAILED CALCULATIONS OF UNITARY SAVINGS VALUES

This appendix presents the detailed calculations and assumptions used to establish the unitary savings.

LED Lamps

Table 12 lists the parameters and corresponding values used in Equation 1 below for light-emitting diode (LED) lamps installed through EPI in 2018 and the resulting unitary savings values for each pairing of the old and the new lamp wattages. The parameters are identical for single-family homes and apartments.

$$\text{Annual Unitary Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{(\text{Old Wattage} - \text{New Wattage})[\text{W}] \times \text{HOU} \left[\frac{\text{h}}{\text{day}} \right] \times 365 \left[\frac{\text{day}}{\text{yr}} \right]}{1,000 \left[\frac{\text{W}}{\text{kW}} \right]} \quad (1)$$

Table 12: Unitary Savings Values by LED Category

Type of LED	Old Wattage (W)	New Wattage (W)	Displaced Wattage (W)	Operating Hours (hrs/day)	Unitary Savings Value for Single-family Homes (kWh/year)	Unitary Savings Value for Apartments (kWh/year)
9 W replacing 40 W	40	9	31	2.7	30.6	30.6
9 W replacing 60 W	60	9	51	2.7	50.3	50.3
9 W replacing 100 W	100	9	91	2.7	89.7	89.7
9.5 W replacing 40 W	40	9.5	30.5	2.7	30.1	30.1
9.5 W replacing 60 W	60	9.5	50.5	2.7	49.8	49.8
9.5 W replacing 100 W	100	9.5	90.5	2.7	89.2	89.2
10 W replacing 40 W	40	10	30	2.7	29.6	29.6
10 W replacing 60 W	60	10	50	2.7	49.3	49.3
18 W replacing 75 W	75	18	57	2.7	56.2	56.2
18 W replacing 100 W	100	18	82	2.7	80.8	80.8
PAR20 7 W Replacing 50 W	50	7	43	2.7	42.4	42.4
PAR38 15 W Replacing 90 W	90	15	75	2.7	73.9	73.9
PAR38 15 W Replacing 120 W	120	15	105	2.7	103	103
PAR38 15 W Replacing 150 W	150	15	135	2.7	133	133
7 W GU10 replacing 35 W	35	7	28	2.7	27.6	27.6
7 W GU10 replacing 50 W	50	7	43	2.7	42.4	42.4
7 W G25	40	7	33	2.7	32.5	32.5
5 W Chandelier E12	40	5	35	2.7	34.5	34.5

Displaced Wattage

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 tracking sheet. In 2018, installed LED lamps had a light output wattage equivalent to that of the replaced lamps for almost all replacements (97%). In other cases, the savings calculations are still based on the difference in the real wattage values.

Hours of Operation

The value for the daily hours of operation applied by ENS is based on the Northeast Residential Lighting Hours-of-Use Study (NERHOU)¹⁵ study, which found that the average runtime is 2.7 hours/day for all types of bulbs.

The Residential Lighting Evaluation Protocol of the UMP¹⁶ recommends that each jurisdiction conduct a metering study to determine their specific hours of use. In 2016 and 2017, the Evaluator conducted a metering study among 75 households to assess the daily hours of operation. The overall average daily hours of use (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 its data and findings fall within the Evaluator's metering study's margin of error, the Evaluator decided that the value of 2.7 hours/day established by NERHOU for all types of bulbs is still the most appropriate value for the LED lamps installed through EPI.

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 types of dwellings in EPI are identical.

LED Nightlights

Table 13 below lists the parameters and corresponding values applied in Equation 1 above for LED nightlights installed through EPI in 2018 and the resulting unitary savings values. The values for displaced wattage and hours of operation are consistent with the values used by other jurisdictions.¹⁷¹⁸

¹⁵ NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.

¹⁶ NREL, *Uniform Methods Protocol Chapter 6: Residential Lighting Evaluation Protocol*, February 2014, p. 6-20.

¹⁷ Pennsylvania Public Utility Commission, *Technical Reference Manual – State of Pennsylvania*, June 2016 Errata Update February 2017.

¹⁸ Tennessee Valley Authority, *Technical Resource Manual Version 6.0*. October 1, 2017.

Table 13: Unitary Savings Values for LED Nightlights

Parameter	Value for Single-family Homes	Value for Apartments
Old Wattage [W]	7.0	7.0
New Wattage [W]	0.5	0.5
Average Displaced Wattage [W]	6.5	6.5
Hours of Operation [hrs/day]	12	12
Unitary Savings [kWh/year]	28.5	28.5

LED Holiday Lights

Equations 2 and 3 are used to calculate the annual unitary savings value for LED Holiday Lights installed through EPI.

$$\text{Annual Unitary Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \frac{(\text{Displaced Wattage})[W] \times \text{HOU} \left[\frac{\text{h}}{\text{day}} \right] \times \text{Days} \left[\frac{\text{day}}{\text{yr}} \right] \times \text{Number of Sets Replaced}}{1,000 \left[\frac{\text{W}}{\text{kW}} \right]} \quad (2)$$

$$\text{Displaced Wattage} [W] = (\text{Average Old Wattage} - \text{New Wattage})[W] \quad (3)$$

Table 14 below lists the parameters and corresponding values applied to calculate the unitary savings value for LED holiday lights installed through EPI in 2018.

Table 14: Unitary Savings Values for LED Holiday Lights

Parameter	Value for Single-family Homes	Value for Apartments	Source
Average Old Wattage [W]	99.6	99.6	Calculation
New Wattage [W]	0.08 W/lamp × 70 lamps/set = 5.6	0.08 W/lamp × 70 lamps/set = 5.6	ENS
Displaced Wattage [W]	94.0	94.0	Calculation
Daily Hours of Operation	5.8	5.8	2013 Participant Survey
Days of Use per Year	40	40	2015 Literature Review
Number of Sets Replaced per Unit of LED Holiday Lights	2	2	Program Requirement
Unitary Savings [kWh/year]	43.6	43.6	Calculation

Table 15 below details how the average old wattage was obtained.

Table 15: Average Old Wattage for LED Holiday Lights

Parameter	Value for Single-family Homes	Value for Apartments	Source
Proportion of Old Large Incandescent Sets Returned (35 lamps per set)	37%	37%	2017 Tracking Sheet
Proportion of Old Mini Incandescent Sets Returned (50 lamps per set)	32%	32%	2017 Tracking Sheet
Proportion of Old Mini Incandescent Sets Returned (20 lamps per set)	31%	31%	2017 Tracking Sheet
Wattage of Old Large Incandescent Sets (35 lamps per set) [W]	7 W/lamp × 35 lamps/set = 245 W/set	7 W/lamp × 35 lamps/set = 245 W/set	2014 Literature Review
Wattage of Old Mini Incandescent Sets (50 lamps per set) [W]	0.4 W/lamp × 50 lamps/set = 20 W/set	0.4 W/lamp × 50 lamps/set = 20 W/set	2014 Literature Review
Wattage of Old Mini Incandescent Sets (20 lamps per set) [W]	0.4 W/lamp × 20 lamps/set = 8 W/set	0.4 W/lamp × 20 lamps/set = 8 W/set	2014 Literature Review
Average Old Wattage (incandescent sets) [W]	(37% × 245 W) + (32% × 20 W) + (31% × 8 W) = 99.6 W/set	(37% × 245 W) + (32% × 20 W) + (31% × 8 W) = 99.6 W/set	Calculation

Faucet Aerators

Equation 4 below is used to calculate the annual unitary savings value for the faucet aerators installed through EPI.

$$\begin{aligned}
 & \text{Annual Unitary Savings} \left[\frac{kWh}{yr} \right] \\
 &= \frac{(DHW_{base} - DHW_{efficient}) \left[\frac{gal}{day} \right] \times Cp_{H_2O} \left[\frac{BTU}{lb^{\circ}F} \right] \times \rho_{H_2O} \left[\frac{lb}{ft^3} \right] \times \Delta T_{H_2O} [^{\circ}F] \times 365 \left[\frac{days}{yr} \right] \times \frac{1}{3412} \left[\frac{kWh}{BTU} \right] \times 0.1337 \left[\frac{ft^3}{gal} \right]}{\eta} \quad (4)
 \end{aligned}$$

The base domestic hot water consumption value (DHW_{base}) reference in Equation 5 is calculated by dividing the product of the consumption of domestic hot water per person (DHW_{person}) and the number of people per single-family home or apartment (n_{people}) by the number of faucets per single-family home or apartment ($n_{faucets}$), as illustrated in Equation 6 below:

$$DHW_{base} \left[\frac{gal}{day} \right] = \frac{DHW_{person} \left[\frac{gal}{day \cdot person} \right] \times n_{people} [person]}{n_{faucets}} \quad (5)$$

The efficient domestic hot water consumption value ($DHW_{\text{efficient}}$) is calculated by using the baseline flow rate (q_{base}), the low-flow rate (q_{low}), and the base domestic hot water consumption value, as illustrated in the following equation:

$$DHW_{\text{efficient}} \left[\frac{\text{gal}}{\text{day}} \right] = DHW_{\text{base}} \left[\frac{\text{gal}}{\text{day}} \right] \times \left(1 - \frac{q_{\text{base}} - q_{\text{low}}}{q_{\text{base}}} \right) \quad (6)$$

Table 16 below lists the parameters and values applied in Equations (4), (5), and (6) for faucet aerators installed through EPI in 2018 and the resulting unitary savings values.

Table 16: 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) ¹⁹
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) ^{20,21}
Number of People per Household [person]	n_{people}	2.1	1.7	2018 EPI October Tracking Sheet
DHW Used per Person for Total Number of Faucets [gpd]	DHW_{person}	9.9	9.9	DeOreo et al. ²²
Number of Faucets per Household	n_{faucets}	3.3	2	Single-family homes: EPI 2017 site visits Apartments: assumption
Specific Heat of Water [BTU/lb°F]	$C_{p\text{H}_2\text{O}}$	1	1	Convention
Density of Water [lb/ft ³]	$\rho_{\text{H}_2\text{O}}$	62.43	62.43	Convention
Temperature Rise in Electric Water Heater [°F]	$\Delta T_{\text{H}_2\text{O}}$	79	79	2011 OPA
Electric Water Heater Efficiency	η	97%	97%	Pennsylvania TRM ²³
Unitary Savings [kWh/year]	-	148	120	Calculation

¹⁹ Illinois Commerce Commission (2016). *Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 5.0 – Volume 3: Residential Measures*, p. 175.

²⁰ Illinois Commerce Commission (2016). *Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 5.0 – Volume 3: Residential Measures*, p. 175.

²¹ *Ibid.*

²² 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.

²³ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

Low-flow Showerheads

The equation below is used to determine the annual unitary savings values for the low-flow showerheads installed through EPI. The difference between the base and efficient domestic hot water consumption levels is established by using the following parameters: the baseline flow rate (q_{base}), the low-flow rate (q_{low}), the number of people per household (n_{people}), the percentage of hot water used in showers ($\%_{DHW}$), the showering time (t_{shower}), the number of showers per day per person (n_{shower}), and the number of showerheads in the household ($n_{showerheads}$).

$$\begin{aligned}
 & \text{Reduction in DHW Consumption } (DHW_{base} - DHW_{efficient}) \left[\frac{gal}{day} \right] \\
 &= (q_{base} - q_{low}) [gpm] \times n_{people} [person] \times \%_{DHW} \times t_{shower} \left[\frac{min}{shower} \right] \times n_{shower} \left[\frac{shower}{day \cdot person} \right] \\
 &\quad \times \frac{1}{n_{showerheads}}
 \end{aligned} \tag{7}$$

Table 17 below lists the parameters and corresponding values applied in Equation (7) for low-flow showerheads installed through EPI in 2018 and the resulting unitary savings values.

Table 17: Unitary Savings Values for Low-flow Showerheads²⁴

Parameter	Symbol	Value for Single-family Homes	Value for Apartments	Source
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)	2018 EPI Tracking Sheet
Low-flow Rate [gpm]	Q_{low}	1.5	1.5	2017 EPI On-site visits
Number of People per Household [person]	n_{people}	2.1	1.7	2018 EPI October Tracking Sheet
Average Number of Showers per Day per Person [shower/day/person]	n_{shower}	0.67	0.67	Mayer and Oreo ²⁵
Number of Showerheads per Household [showers]	$n_{\text{showerheads}}$	1.5	1	Single-family homes: 2017 EPI site visits Apartments: assumption
Average Shower Time per Person [min/shower]	t_{shower}	7.8	7.8	DeOreo et al. ²⁶
Percentage of Hot Water Used in Showers	$\%_{\text{DHW}}$	63%	63%	DeOreo et al. ²⁷
Specific Heat of Water [BTU/lb°F]	$C_{p\text{H}_2\text{O}}$	1	1	Convention
Density of Water [lb/ft ³]	$\rho_{\text{H}_2\text{O}}$	62.43	62.43	Convention
Temperature Rise in Electric Water Heater [°F]	$\Delta T_{\text{H}_2\text{O}}$	79	79	2011 OPA
Electric Water Heater Efficiency	η	97%	97%	Pennsylvania Public Utility Commission TRM ²⁸
Unitary Savings [kWh/year]	Flow rate reduction of 0.5 gpm	168	204	Calculation
	Flow rate reduction of 0.75 gpm	252	305	Calculation
	Flow rate reduction of 1 gpm	335	407	Calculation

²⁴ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, pp. 45-48.

²⁵ Mayer, P. W., W. B. Oreo et al., *Residential End Uses of Water*, published by the AWWA Research Foundation, 1999, pp. 99-102.

²⁶ 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.

²⁷ 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.

²⁸ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

Thermostatic Shower Valves

To estimate the unitary savings of thermostatic shower valves, TRMs usually present equations for calculating the unitary savings of low-flow showerheads with modifications to two parameters, namely flow rates and shower duration. The Evaluator used the same approach.

Equations 8 and 9 are used to determine the annual unitary savings values for thermostatic shower valves installed through EPI. The energy savings are established by calculating the reduction in domestic hot water usage by using the showerhead flow rate (q), the number of people per household (n_{people}), the percentage of hot water used in showers ($\%_{DHW}$), the behavioural waste seconds avoided (t_{shower}), the number of showers per day per person (n_{shower}), and the number of showerheads per household ($n_{showerhead}$) to the equation.

The only part of these equations that differ from the low-flow showerhead equation, above, is the domestic hot water usage calculation. As opposed to low-flow showerheads, there is no variation in flow rate. Furthermore, the time component of the equation corresponds to shower time saved by the shut-off valve as opposed to the entire duration of the shower. The domestic hot water usage equation is as follows for thermostatic shower valves:

$$\begin{aligned}
 DHW \text{ Reduction } \left[\frac{gal}{year} \right] &= q \left[\frac{gal}{min} \right] \times n_{people} [person] \times \%_{DHW} \times t_w \left[\frac{min}{shower} \right] \\
 &\times n_{shower} \left[\frac{shower}{day \cdot person} \right] \times \frac{1}{n_{showerhead}} \times n_{days} \left[\frac{days}{year} \right]
 \end{aligned} \tag{8}$$

Equation 9 below is used to calculate the unitary energy savings value for thermostatic shower valves. This equation corresponds to the equation used for low-flow showerheads and the equation presented in the evaluation reports since 2014.

$$\begin{aligned}
 \Delta kWh \left[\frac{kWh}{year} \right] &= \frac{DHW \text{ Reduction } \left[\frac{gal}{year} \right] \times C_{p_{H2O}} \left[\frac{Btu}{lb \cdot ^\circ F} \right] \times \rho_{H2O} \left[\frac{lb}{ft^3} \right] \times \Delta T_{H2O} [^\circ F] \times UC1 \left[\frac{kWh}{Btu} \right] \times UC2 \left[\frac{ft^3}{gal} \right]}{\eta}
 \end{aligned} \tag{9}$$

Table 18 below lists the parameters and corresponding values applied in Equation 7 for thermostatic shower valves installed through EPI in 2018 and the resulting unitary savings values. Most parameters are identical to those used by ENS for low-flow showerheads. As for behavioural waste time, the Evaluator conducted a literature review in 2018 and established the value at 0.98 minutes based on a one-month metering study of 22 showers.²⁹ This study is referenced by two jurisdictions, namely Maine and Pennsylvania.

²⁹ Wood, A. and D'Acquisto, J., *Pilot Study for a Thermostatic Shower Restriction Valve*. <http://thinkevolve.com/wp-content/uploads/2016/09/PPL-ShowerStart-TSV-Field-Study.pdf>, (Last accessed December 6, 2018).

Table 18: Revised Unitary Savings Values of Thermostatic Shower Valves

Parameter	Symbol	Value for Single-family Homes	Value for Apartments	Source
Flow Rate [gal/min or 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)	2018 EPI Tracking Sheet
Number of People per Household [person]	η_{people}	2.1	1.7	2018 EPI October Tracking Sheet
Average Number of Showers per Day per Person [shower/day/person]	η_{shower}	0.67	0.67	Mayer and Oreo ³⁰
Average Number of Showerheads per Household [showerhead]	$\eta_{\text{showerheads}}$	1.5	1	Single-family: 2017 EPI on-site visit results Apartments: assumption
Behavioural Waste Time [min/shower]	t_w	0.98	0.98	Pennsylvania Public Utility Commission TRM ³¹ Maine TRM ³²
Percentage of Hot Water Used in Showers	%DHW	63%	63%	DeOreo et al. ³³
Number of Days per Year [days/year]	n_{days}	365	365	Convention
Specific Heat of Water [BTU/lb·°F]	$C_{p\text{H}_2\text{O}}$	1	1	Convention
Density of Water [lb/ft ³]	$\rho_{\text{H}_2\text{O}}$	62.43	62.43	Convention
Temperature Rise in Electric Water Heater [°F]	$\Delta T_{\text{H}_2\text{O}}$	79	79	2011 OPA
Unit Conversion #1 [kWh/BTU]	UC1	1 / 3,412	1 / 3,412	Convention
Unit Conversion #2 [ft ³ /gal]	UC2	0.1337	0.1337	Convention
Electric Water Heater Efficiency	η	97%	97%	Pennsylvania Public Utility Commission TRM ³⁴

³⁰ Mayer, P. W., W. B. Oreo et al., *Residential End Uses of Water*, published by the AWWA Research Foundation, 1999, pp. 99-102.

³¹ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 133.

³² Efficiency Maine, *Retail/Residential Technical Reference Manual Version 2019.1*, July 2018.

³³ 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.

³⁴ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

Parameter	Symbol	Value for Single-family Homes	Value for Apartments	Source
Unitary Savings [kWh/year]	Flow rate of 1.5 gpm	63	51	Calculation
	Flow rate of 2.0 gpm	84	68	Calculation
	Flow rate of 2.25 gpm	95	77	Calculation
	Flow rate of 2.5 gpm	105	85	Calculation

Pipe Insulation

The annual unitary savings value for the pipe insulation installed through EPI in single-family homes and apartments was identified through Ontario Power Authority (OPA) 2011³⁵ values and amounts to 12.7 kWh per linear foot.

Hot Water Tank Wrap

The following equations are used to determine the annual unitary savings associated with the hot water tank wrap installed through EPI. The algorithm was developed in the 2014 RDI and the 2013 Multi-unit Residential Building (MURB) evaluations. 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:

$$R_{\text{layer}} = \frac{\ln(r_e/r_i)}{2\pi k} \quad (10)$$

$$R_{\text{cyl}} = R_{\text{layer1}} + R_{\text{layer2}} \quad (11)$$

$$Q_{\text{cyl}} = \frac{T_i - T_e}{R_{\text{cyl}}} L \quad (12)$$

$$Q_{\text{top}} = \frac{A_{\text{top}} \times (T_i - T_e)}{R_{\text{top}}} \quad (13)$$

$$Q_{\text{total}} = Q_{\text{cyl}} + Q_{\text{top}} \quad (14)$$

³⁵ Ontario Power Authority (OPA), *OPA Prescriptive Measures and Assumptions List*, December 2010.

$$\text{Annual Energy Consumption} = \frac{(Q_{\text{total}}) \cdot \text{HOU}}{\eta_{\text{heater}}} \quad (15)$$

A typical tank is an entry-level domestic water heater with a capacity of 60 imperial gallons. This tank capacity was established based on the on-site visits conducted by the Evaluator; the majority of visited participants had a tank of this capacity. Furthermore, the hot water tank wraps installed through EPI have a thermal resistance of 1.21 m²·°C/W.

Table 19 lists the values applied in Equations (10), (11), (12), (13), (14), and (15) presented above to obtain the unitary savings for the tank wraps installed in 2018.

Table 19: Revised 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 ³⁶
Internal Radius of the Layer [m]	r_i	0.249	0.229	Idem
Thermal Conductivity of the Layer [W/m·°C]	k	0.024	0.024	Idem
Thermal Resistance of a 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	2.113	Giant
Layer 2: Tank Wrap				
External Radius of the Layer [m]	r_e	0.351	0.331	Estimated from Frost King Insulation Blanket Specifications ³⁷
Internal Radius of the Layer [m]	r_i	0.300	0.280	Giant
Thermal Conductivity of the Layer [W/m·°C]	k	0.042	0.042	Estimated from Frost King Insulation Blanket Specifications
Thermal Resistance of a Layer of Material Inside the Cylinder (e.g. insulation inside the tank and tank wrap) [m·°C/W]	R_{layer}	1.821	1.967	Calculation
Thermal Resistance of the Top of the Tank [m·°C/W]	R_{Top}	3.323	3.323	Calculation

³⁶ Giant Inc., *Engineering Submittal Data Sheet 172ETE Models*, <http://www.giantinc.com/tech-data/FT-172E-An.pdf> (Last accessed February 18, 2015).

³⁷ Frost King Weatherization Products, *Water Heater Insulation Blanket*, <http://www.frostking.com/water-heater-insulation-blanket/> (Last accessed January 4, 2014).

Parameter	Symbol	Value for Single-family Homes	Value for Apartments	Source
Heat Transfer				
Length of the Cylinder [m]	L	1.52	1.22	Giant
Area of the Top of the Tank [m ²]	A _{top}	0.283	0.246	Calculated from Giant's data
Temperature at the External Radius of the Cylinder [°C]	T _e	21	21	Assumption for standard ambient temperature indoors
Temperature at the Internal Radius of the Cylinder [°C]	T _i	60	60	OPA Prescriptive Measures and Assumptions 2011
Hours of Use [h/year]	HOU	8,760	8,760	Assumption
Thermal Efficiency of Heating Element	η _{heater}	97%	97%	Pennsylvania Public Utility Commission ³⁸
Heat Transfer Through the Tank [W]	Q _{tank}	53.5	40.2	Calculation
Heat Transfer Through the Insulated Tank [W]	Q _{tank}	35.9	27.1	Calculation
Unitary Savings for Tank Wrap [kWh/year]	-	159	118	Calculation

Smart Power Controllers for Audiovisual Equipment

Based on a literature review conducted in 2015, the unitary savings value associated with the use of smart power controllers was established at 411 kWh per year and drawn from a study of 15 South African households.³⁹

The studies covered in the literature review did not include homes with more than two smart power controllers installed. The Evaluator believes that the savings generated by the smart power controllers could decrease in houses with more than two controllers installed, though the Evaluator does not have sufficient data to estimate the level of such a decrease.

Retractable Clotheslines

Equation 16 is used to establish the unitary savings associated with the retractable clotheslines installed through EPI.

³⁸ Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

³⁹ Karebo Systems, *Audiovisual Standby Power Controller: Energy Savings Field Trial, South Africa - June-August 2012*, Field Trial Data Analysis, March 6, 2013.

$$\Delta kWh \left[\frac{kWh}{year} \right] = \text{Annual Laundry Loads} \left[\frac{load}{year} \right] \times \text{Proportion of Loads Dried on Clothesline} [\%] \times \text{Energy Consumption per Load} \left[\frac{kWh}{load} \right] \quad (16)$$

Table 20 below lists the parameters and corresponding values applied in the equation above for retractable clotheslines installed through EPI in 2018 and the resulting unitary savings values. The rationale behind the Evaluator's choice of value for each parameter is presented below the table.

Table 20: Unitary Savings Values for Retractable Clotheslines

Parameter	Value for Single-family Homes	Value for Apartments	Source
Number of Laundry Loads per Year [loads/year]	290	290	Hydro-Québec ⁴⁰
Proportion of Loads Dried on a Clothesline [%]	16.3%	16.3%	OPA 2011 ⁴¹
Energy Consumption per Load [kWh/load]	2.2	2.2	OPA 2011 ⁴²
Unitary Savings [kWh/year]	104	104	Calculation

The Evaluator conducted a literature review to establish the average annual number of loads of laundry per household and Table 21 below summarizes the findings. The Evaluator concluded that the Hydro-Québec study is the most appropriate to estimate the laundry habits of EPI participants due to its large sample size. Since the referenced study makes no distinction between single-family homes and apartments, the value for annual loads of laundry per household is 290 for all types of participants.

⁴⁰ Ad Hoc Recherche. *Marché résidentiel: Rapport d'évaluation. Programme: Produits Mieux Consommer – Électroménagers ENERGY STAR*. September 2011.

⁴¹ Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.

⁴² Ibid.

Table 21: Literature Review Findings for Average Annual Loads of Laundry per Household

Source	Study Sample Size	Annual Number of Loads
OPA ⁴³	N/A	416
Hydro-Québec ⁴⁴	255,709	290
Natural Resources Canada ⁴⁵	6,000	213
2014 Residential Direct Install Evaluation Report ⁴⁶	500	233

Furthermore, pursuant to a literature review, the Evaluator based the proportion of displaced loads and the energy savings per load on the values found in the OPA 2011 Measures List and Assumptions.⁴⁷

⁴³ Ibid.

⁴⁴ Ad Hoc Recherche. *Marché résidentiel: Rapport d'évaluation. Programme: Produits Mieux Consommer – Électroménagers ENERGY STAR*. September 2011.

⁴⁵ Calculated by the Evaluator based on data presented the *2011 Survey of Household Energy Use Data Tables* by Natural Resources Canada.

<http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=SH&sector=aaa&juris=ca&rn=35&page=1> (Last accessed on November 21, 2018).

⁴⁶ Econoler, *Residential Direct Install 2014 DSM Evaluation*, February 2015.

⁴⁷ Ontario Power Authority (OPA), OPA Prescriptive Measures and Assumptions List, December 2010.

APPENDIX XIV

EPI: DETAILED CALCULATIONS OF EQUIVALENT EUL OF LED LAMPS

This appendix presents the details on how the equivalent effective useful life (EUL) of LED lamps were calculated with an updated duration pending the changes in Canadian regulations for general-service lamps. As described in the report, the equivalent EUL value is multiplied by the first-year savings to obtain the lifetime energy savings. This is necessary because the regulation changes will cause the baseline to increase over the lifetime of LED lamps, which in turn reduces the equivalent EUL value that is applied to the first-year savings to obtain the lifetime energy savings.

The Evaluator applied the same methodology as in the 2017 DSM Evaluation Report to consider increased baselines over the lifetime of general-use, decorative, and reflector lamps. This analysis was based on current and projected Canadian regulations for general-service lamps. The Evaluator conserved the same years as the effective dates of each regulation; the only change made to the calculation is that the first year is now 2018 instead of 2017.

The Evaluator maintains the conclusion presented in 2017 DSM Evaluation Report, which anticipates a baseline change in 2024. This regulation change will affect the baselines of general-use, decorative, and reflector lamps, for all of which a minimum efficiency of 45 lumens/watt is expected. For comparison, 60 W lamps typically replaced in the program component have an efficiency level of 13 lumens/watt. In the 2017 evaluation, the Evaluator established that this will affect EPI A19 lamps, reflector lamps, and decorative lamps.

The Evaluator used the lamp type lifetimes established through a literature review conducted as part of the 2017 evaluation. These are listed below in Table 22. Since these lamp types have lifetimes of 15-years and above, the baseline wattages will be affected by the regulation change anticipated to occur in 2024.

Table 22: Equipment Life Value per LED Lamp Type

LED Lamp Type	Average Rated Lifetime Hours (hours)⁴⁸	Annual HOU (hours/year)⁴⁹	Equipment Life (years)
LED A19 Lamps	25,000	986	25
LED Reflector Lamps	25,000	986	25
LED Decorative Lamps	15,000	986	15

⁴⁸ Based on manufacturer specifications sheets for the most popular models installed through EPI in 2017.

⁴⁹ Based on the unitary savings review.

LED A19 Lamps

For A19 type lamps, the existing incandescent light bulbs have an estimated remaining useful life of one-year. Incandescent light bulbs have a typical rated life expectancy of 1,000 to 2,000 hours.⁵⁰ The remaining useful life of replaced functional incandescent light bulbs is assumed to be half the rated life expectancy. By applying a remaining useful life of 1,000 hours and 2.7 hours of use per day, the period over which savings can be calculated with an incandescent baseline was established at one-year. After the first year, over which incandescent lamps remain the baseline, the baseline is increased to halogen incandescent lamps to match current Canadian regulations. As mentioned previously, the forthcoming changes in Canadian regulations are expected to impact the market in 2024, which will increase the baseline to a CFL-equivalent minimum efficacy requirement. The equivalent EUL calculation for A19 type lamps is based on 9 W lamps being the most common A19 type lamps installed through EPI in 2018. With the information presented in Table 23, equation 17 was used to establish the equivalent EUL to be applied to first-year savings to determine lifetime energy savings. The resulting equivalent EUL values for LED A19 type lamps typically replacing 40 W, 60 W, and 100 W incandescent lamps are six, eight, and ten years, respectively.

Equivalent EUL

$$= \frac{\Delta W_{\text{Incandescent}} \times 1 \text{ year} + \Delta W_{\text{Halogen}} \times 5 \text{ years} + \Delta W_{\text{CFL}} \times 19 \text{ years}}{\Delta W_{\text{Incandescent}}} \quad (17)$$

Table 23: Baseline Evolution During the EUL of LED A19 Lamps and Resulting Equivalent EUL

Replaced Lamp (W)	Typical Efficient Lamp (W)	Incandescent Baseline 1 Year (2018)		Halogen Incandescent Baseline – Canadian Legislation ^{51,52} 5 Years (2019-2023)		CFL Equivalent Baseline – American Legislation ⁵³ 19 Years (2024-2042)		Equivalent EUL (years)
		Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)	Baseline (W) ⁵⁴	Displaced Wattage (W)	
40	9	40	31	29	20	12	3	6.1
60	9	60	51	43	34	20	11	8.4
100	9	100	91	72	63	35	26	9.9

⁵⁰ Lighting Research Center, Rensselaer Polytechnic Institute. *Lighting Patterns for Homes. Light Bulb Features*, www.lrc.rpi.edu/patternbook/resources/lamp_features.asp (Last accessed January 24, 2018).

⁵¹ 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).

⁵² Also equivalent to Incandescent Equivalent 1st Tier EISA 2007.

⁵³ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

⁵⁴ Baseline wattage values were established based on the minimum efficiency level of 45 lumen/watt dictated by the EISA regulation and on the assumed lumen levels of 550 lumens for 40-watt lamps, 800 lumens for 60-watt lamps and 1,600 lumens for 100-watt lamps.

Reflector Lamps

A similar analysis was conducted for reflector lamps (GU10, PAR20 and PAR38 lamps), the results of which are outlined in Table 24. While reflector lamps are not impacted by current Canadian regulations, they will be affected by the requirements of the upcoming regulation (Amendment 17). Starting in 2024, the baseline wattage is therefore increased to match the minimum efficiency level of 45 lumens/watt. Using an approximate level of 350 lumens and 430 lumens for 35 W and 50 W lamps, respectively, the baseline wattage values are found to be essentially at the level of LED lamps currently installed. Since there is no current intermediate technology between halogen and LED reflector lamps, it is recommended that the equivalent EUL of reflector lamps be capped before they reach the year 2024. Therefore, for the 2018 evaluation, the equivalent EUL of LED reflector lamps was set at six-years.

Table 24: Baseline Evolution During the Effective Useful Life of LED Reflector Lamps and Resulting Equivalent EUL

Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Baseline 6 Years (2018-2023)		CFL Equivalent Baseline – American Legislation ⁵⁵ 19 Years (2024-2042)		Equivalent EUL (years)	Recommended Equivalent EUL (years)
		Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)		
35	7	35	28	8	1	6.7	6.0
50	7	50	43	10	3	7.3	6.0
90	15	90	75	28	13	9.3	6.0
120	15	120	105	28	13	8.4	6.0
150	15	150	135	28	13	7.8	6.0

Decorative Lamps

As for decorative lamps (G25 and chandelier lamps), compact fluorescent lamp (CFL) replacements are not widely available in the market. Using an approximate level of 300 lumens for G25 lamps and E12 chandelier lamps, the baseline wattage values are found to be very close to the efficient LED lamp wattage. As presented in Table 25, the Evaluator has applied the same approach as for reflector lamps and has capped the savings before the year 2024, since decorative lamps will also be affected by the requirements of EISA 2020. This means that, for the 2018 evaluation, the equivalent EUL of LED decorative lamps is set at six-years.

⁵⁵ As imposed by US federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

Table 25: Baseline Evolution During the Effective Useful Life of LED Decorative Lamps and Resulting Equivalent EUL

Lamp Type	Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Baseline 6 Years (2016-2023)		CFL Equivalent Baseline – American Legislation ⁵⁶ 9 Years (2024-2032)		Equivalent EUL (years)	Recommended Equivalent EUL (years)
			Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)		
G25	40	7	40	33	7	0	6.0	6.0
E12 Chandelier	40	5	40	35	7	2	6.5	6.0

⁵⁶ As imposed by US federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

APPENDIX XV

EPI: ALGORITHM FOR FREE-RIDERSHIP CALCULATION

The figure below presents the algorithm for calculating the free-ridership level. The participant survey questionnaire included questions designed to assess the planning, quantity, efficiency, period, cost, and influence of the program component. Questions were also asked to quantify cross-influence. This corresponds to the level of influence that previous participation in one of ENS' energy efficiency program components or ENS' efforts to raise energy efficiency awareness had on the decision to implement the energy efficient product. Each group of questions was transposed into a level of program component attribution, which was used to calculate the free-ridership level associated with each participant.

FR2. If ENS had not installed these [LED bulbs/low flow showerheads] at no charge as part of the EPI Service, would you have paid the full cost of the LED bulbs, which is approximately \$4 per bulb? (Scale 0 to 10)	FR2 = Answer x 10% IF DK OR REF: FR2 = EMPTY
FR3a. If the service had <u>not been</u> offered, what is the likelihood that you would have taken the initiative to purchase [LED bulbs/low flow showerheads] at a store and then install them yourself in your home? (Scale 0 to 10)	FR3a = Answer x 10% IF DK OR REF: FR3a = EMPTY
PA1 Score:	MEAN VALUE OF (FR2 ; FR3a)
FR1. Did you or anyone in your household have specific plans to purchase and install [LED bulbs/low flow showerheads] prior to learning about the EPI Service?	IF 1. Yes: Use FR1a IF 2. No OR DK OR REF: FR1a = 0%
FR1a. I just want to make sure I understand - Before you learned about the EPI Service, you had already made the decision to purchase and install [LED bulbs/low flow showerheads] in your home?	IF 1. Yes: FR1a = 100% IF 2. No OR DK OR REF: FR1a = 0%
PA2 Score:	FR1a
FR4. Level of influence (Scale 0 to 10)	FR4 = MAX(a ; b)
PA3 Score:	(10 – FR4) x 10%
FR3b. [IF FR3a ≥ 5] If the service had <u>not been</u> offered, what is the likelihood that you would have postponed replacing [your bulbs with LEDs / your Showerheads] by at least one year ? (Scale 0 to 10)	FR3b = (10 – Answer) x 10% IF DK OR REF: EMPTY
PA4 Score:	FR3b
FR3c. [ASK IF (LED bulbs / low flow showerheads and/or showerwands QUANTITY>1] If the service had not been offered, what is the likelihood that you would have purchased and installed all [QUANTITY] [LED bulbs/ your Showerheads] that were installed through EPI? (Scale 0 to 10)	FR3c = Answer x 10% IF DK OR REF: EMPTY
PA5 Score:	FR3c
Inconsistency Test PA1	IF ABS(FR2 – FR3a) ≥ 50%: PA1 = MIN (FR2 ; FR3a)
Inconsistency Test PA2	IF FR1a = 100% AND IF FR2< 70% OR FR3a < 70%: PA2 = EMPTY
Free-Ridership	MEAN VALUE OF: (PA1 ; PA2 ; PA3 ; PA4; PA5)
CI2/CI4. [Your previous participation in an ENS program or service and what you learned by participating in this program]/[The energy efficiency promotional materials distributed by ENS] greatly influenced your decision to have energy-efficient products installed in your home (Scale 0 to 10)	CI = MAX (CI2 ; CI4)
Revised Free-Ridership	IF CI ≥ 7 AND CI < 9, Revised FR*75% IF CI ≥ 9, Revised FR*50%

APPENDIX XVI

EPI: PARTICIPANT SPILLOVER METHODOLOGY

Participant spillover was measured using a participant survey. Participants were asked whether, following their participation in the program component, they bought and implemented any additional energy efficient products, without benefitting from rebates offered through ENS program components. If a participant admitted to having implemented additional products, they were asked a set of questions designed to identify the additional energy efficient products implemented in order to quantify their associated savings. Subsequently, another question was asked to quantify the level of influence the program component had on the participant's decision to implement these additional products. The value established regarding this level of influence was used to determine the portion of the additional savings attributable to the program component.

Then, the level of participant spillover was established by dividing the total quantity of the additional savings attributable to the program component by the total quantity of savings achieved by the program component for all the survey respondents.

The figure below illustrates the methodology used to calculate the participant spillover level.

SO1. Since the time that you participated in EPI Service, have you installed any additional energy-efficient products or retired any old appliances on your own ?	IF 1. Yes: CONTINUE IF 2. No OR DK OR REF : END
SO2. I just want to make sure I understand - After you participated in the EPI Service, you installed additional energy-efficient products or retired old appliances on your own, that is, without a rebate or assistance from an ENS program. Is that correct?	IF 1. Yes: CONTINUE IF 2. No OR DK OR REF: END
SO4. Which additional energy-efficient products or retired old appliances have you installed on your own after participating in EPI Service?	SO4 = SUM (kWh associated with each upgrade)
Additional Products and Retirement Savings:	SO4
SO5. How influential was your experience with EPI Service on your decision to install these additional energy-efficient products or retire these appliances on your own? (Scale 0 to 10)	SO5 = Answer x 10% IF DK or REF: SO5 = EMPTY
Attribution Level:	SO5
Spillover Savings:	SO4 x SO5
Final Spillover Level = $\frac{\text{SUM of (SO4 x SO5) for All Respondents}}{\text{SUM of Program Savings for All Respondents}}$	

APPENDIX XVII

EPI: 2018 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2018 evaluation of the Efficient Product Installation (EPI) program component, as well as all 2017 evaluation recommendations that were not fully implemented.

Section	Recommendations
Executive Summary	1. Better inform participants about thermostatic shower valves. In 2018, ENS expanded EPI product offerings by including thermostatic shower valves. The evaluation revealed a moderate satisfaction level with this new product. Due to the novelty of this product, the Evaluator recommends that ENS continue working with service providers to deliver high-quality information to participants regarding thermostatic shower valves. The information can be shared verbally upon installation or a pamphlet can be left behind. Experience demonstrates that improving product information can help lower product removal. It can also improve satisfaction levels since participants value receiving information about the products installed.
Impact Evaluation	2. Distribute clotheslines earlier in the season and improve the installation rate calculation for this product. Participants received clotheslines upon registration, between July and November 2018, and due to the timeline of the giveaway some survey respondents had not had the chance to install and use their clothesline when the survey was conducted. The Evaluator therefore included participants who reported planning on installing their retractable clothesline in the installation rate in addition to those who reported already having installed it. If ENS continues the clothesline giveaway in 2019, the Evaluator suggests that clotheslines be distributed earlier in the season and that the installation rate calculation be adjusted to better reflect the actual rate of participants who installed this product.
2017 Recommendations (Not fully implemented at the time of evaluation)	3. Document the energy-saving potential related to halogen incandescents and CFL lamp replacements. The tracking report indicated that the average number of A-type LED lamps installed per household significantly decreased among participating single-family homes. Although EPI achieved high savings in 2017, this trend suggests that fewer incandescents are present in homes and will consequently provide fewer opportunities for LED replacements in the future. The Evaluator recommends that ENS start gathering information about the types of lamps installed in EPI participants' homes to analyze the savings potential that can be tapped if general-service lamp types other than incandescents are made eligible for replacement.



ECONOLER

NEW RESIDENTIAL PROGRAM

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Final Report

March 15, 2019



ECONOLER

research>into>action^{inc}

ABBREVIATIONS

AIA	American Institute of Architects
BNI	Business, non-profit and institutional
CRA	Corporate Research Associates
DA	Delivery agent
DCF	Data-collection form
DHW	Domestic hot water
DOE	Department of Energy
DSM	Demand-side management
EA	Energy advisor
ENS	Efficiency Nova Scotia
EUL	Effective useful life
GHG	Greenhouse gas
HEA	Home Energy Assessment
HERs	Home Energy Rating System
HPHP	High Performance Home Plan
HRBA	Home Builders and Remodelers Association
HRV	Heat recovery ventilator
HVAC	Heating, ventilation and air conditioning
LED	Light-emitting diode
NBC	National Building Code
NHC	New Home Construction
NRCan	Natural Resources Canada
NSP	Nova Scotia Power
NTGR	Net-to-gross ratio
OR	Overestimation ratio
PHPP	Passive House Planning Package
RESNET	Residential Energy Services Network
SEER	Seasonal energy efficiency factor

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

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

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

TABLE OF CONTENTS

EXECUTIVE SUMMARY	VIII
INTRODUCTION	1
1 NHC OVERVIEW.....	3
1.1 Description	3
1.2 Follow-up on 2017 Evaluation Report Recommendations	4
1.3 Participation History	5
2 NHC EVALUATION OBJECTIVES AND METHODOLOGY	7
3 NHC PROCESS EVALUATION.....	10
3.1 The Builder Journeys.....	10
3.1.1 Program Outreach and Recruitment.....	12
3.1.2 DA Selection	13
3.1.3 Project Registration.....	14
3.1.4 Project Application Review.....	15
3.1.5 Construction and Inspections	16
3.2 Incentives and Home Labels	17
3.3 Training.....	20
3.4 Process Evaluation Summary	20
4 NHC IMPACT EVALUATION	21
4.1 On-site Visits and Simulation Review.....	21
4.2 Gross Savings	24
4.2.1 Gross Energy Savings Calculations for NHC	25
4.2.2 Gross Energy Savings Calculation for Passive House Pilot.....	27
4.2.3 Interactive Effects	28
4.2.4 Peak Demand Savings.....	29
4.2.5 Effective Useful Life	29
4.2.6 Revised Gross Savings.....	29
4.3 Net-to-gross Ratio	30
4.3.1 Free-ridership.....	30
4.3.2 Spillover (Market Effects)	31
4.3.3 NTGR Calculation	32
4.4 Net Savings.....	32
5 NHC RECOMMENDATIONS.....	35
CONCLUSION.....	37

LIST OF TABLES

Table 1: Overall Participation and Savings for New Residential	viii
Table 2: Net-to-gross Ratios	xiii
Table 3: Overall Comparison of Tracked and Evaluated Savings at the Generator	xiii
Table 4: Types of Evaluations Conducted for Each Program Component	2
Table 5: Implementation Status of 2017 Recommendations for NHC.....	4
Table 6: Regulatory Oversight of Reviewed Programs	10
Table 7: Outreach and Recruitment Activities	12
Table 8: Type of DA by Program	13
Table 9: Project Registration Overview	14
Table 10: Construction and Inspection Overview	16
Table 11: Incentive Amounts and Basis for Incentive by Program	18
Table 12: Results of On-site Visits and Simulation Reviews for NHC	22
Table 13: Overestimation Ratio Values for NHC	26
Table 14: Summary of EUL Values for NHC	29
Table 15: Revised Gross Energy and Peak Demand Savings.....	30
Table 16: Average Free-ridership Levels for NHC.....	31
Table 17: Evaluated Net Energy and Peak Demand Savings.....	33
Table 18: Comparison of Tracked and Evaluated Savings at the Generator	33
Table 19: Overall Participation and Savings for New Residential	34

LIST OF FIGURES

Figure 1: Performance Overview of NHC (2012-2018)	x
Figure 2: Summary of Participation in NHC (2012-2018).....	6
Figure 3: Summary of Gross Savings for NHC (2012-2018).....	6
Figure 4: Methodological Model for NHC	7
Figure 5: The Builder Journeys	11

EXECUTIVE SUMMARY

This report presents the demand-side management (DSM) results of the 2018 evaluation of the New Residential program. This program is comprised of one component, New Home Construction (NHC).

Table 1 below lists the number of participants, net-to-gross ratios (NTGRs), as well as gross savings and net savings for New Residential.

Table 1: Overall Participation and Savings for New Residential

	Participation Level	Gross Savings	NTGR	Net Savings
NHC				
Energy Savings	652 participants	4.806 GWh	0.94	4.515 GWh
Lifetime Energy Savings		144.705 GWh	0.94	135.671 GWh
Peak Demand Savings		1.360 MW	0.94	1.278 MW

NHC Overview

Administered by Efficiency Nova Scotia (ENS), NHC encourages homeowners and builders to exceed energy efficiency building code requirements for new homes. Participation in NHC involves completing the following steps: (1) reviewing the new home plans using the HOT2000 simulation software; (2) providing the builder or homeowner with a report that contains simulation results and energy efficiency recommendations on how to make the home meet NHC eligibility requirements; and (3) once the home is built, having an energy advisor (EA), hired by an NHC delivery agent (DA), conduct a final inspection and an air-tightness (blower door) test to verify the energy efficiency level of the new home.

Changes were made to NHC and its incentive structure in the last few years. On 1 October 2017, NHC adopted a new EnerGuide rating system to estimate the annual energy use in gigajoules.¹ The NHC incentive structure was adapted to accommodate this change, although the rebate amounts remained the same. The following incentives were available to NHC participants during most of 2018:²

- › An incentive of \$2,000 is provided for homes that achieve: (1) ENERGY STAR® certification; or (2) an energy use level 30 percent better than required by the code for homes no larger than 1,200 ft²; or (3) an energy use level 45 percent better than required by the code for homes larger than 1,200 ft².
- › An incentive of \$5,000 is provided for homes that achieve: (1) R2000 certification; or (2) an energy use level 45 percent better than required by the code for homes no larger than 1,200 ft²; or (3) an energy use level 60 percent better than required by the code for homes larger than 1,200 ft².

¹ Projects that obtain incentives by achieving ENERGY STAR certification are still assessed using the 0-100 EnerGuide rating system.

² ENS changed the NHC incentive levels on 3 December 2018.

In October 2016, ENS launched a Passive House pilot to encourage builders and homeowners to build or buy homes that are even more energy efficient; the savings from this pilot were evaluated separately from the savings of traditional 2018 NHC participants.

The 2018 evaluation was conducted based on:

- › A NHC documentation review
- › An in-depth interview with the program manager
- › A jurisdictional review that involved collecting information on five other new home construction programs in North America and interviewing key staff working on these programs
- › A review of 10 NHC projects consisting of an on-site visit at participating houses after the completion of the as-built assessment (or N assessment) and an assessment of the HOT2000 simulations
- › A savings calculation review

Key Findings

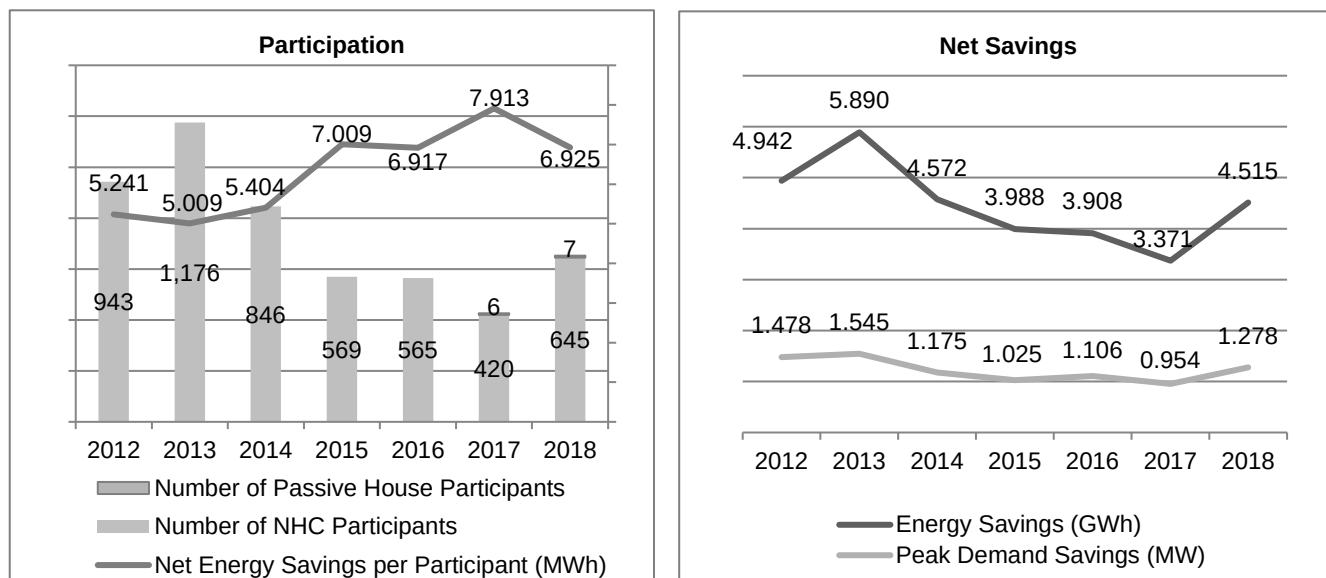
NHC Performance

NHC aimed to achieve 4.6 GWh in net electrical energy savings and 1.3 MW in net peak demand savings at the generator in 2018. The Evaluator found that NHC achieved 4.515 GWh in net electrical energy savings and 1.278 MW in net peak demand savings at the generator in 2018. These savings represent 2,766 tonnes of CO₂ eq in terms of annual avoided greenhouse gas emissions. NHC net lifetime energy savings were established at 135.671 GWh, which yields a weighted average effective useful life value of 30.0 years.

A total of 652 participants completed projects and generated electrical savings under NHC in 2018, including seven participants who completed a project through the Passive House pilot. Figure 1 further below illustrates the evolution in participation levels, as well as net energy and peak demand savings from 2012 to 2018. The 2017 and 2018 figures also include the Passive House pilot. In 2018, participation in NHC was higher than the previous three years.

The net energy and peak demand savings achieved in 2018 were also higher than the previous three years, while the per-participant net energy savings result remained fairly stable over the past four years.

Figure 1: Performance Overview of NHC (2012-2018)³



NHC Process Evaluation Highlights

The main evaluation activity of the 2018 NHC process evaluation was a jurisdictional review of new home construction programs in North America. The following five utilities were included in the review: New Brunswick Power; Energize Connecticut; Efficiency Vermont; Rhode Island National Grid; and Fortis BC. Topics investigated during this review included outreach and recruitment, program participation processes, incentive levels, and solutions to overcoming challenges encountered through residential new home construction programs.

Outreach and Recruitment

ENS uses most of the same activities as other program administrators to conduct outreach and recruit builders to use their programs. Evidence from the interviews revealed that ENS uses at least seven different activities to market and promote NHC, whereas other jurisdictions reported using between three and six different activities. The use of building permit offices to identify and target builders was seen as a particularly helpful step in outreach efforts, and several program administrators noted that EAs can also be successful at recruiting builders.

DA Selection

Most programs, including ENS, rely on third-party vetted DAs to educate and guide builders as they undergo program processes. Education and guidance activities include providing builders with technical assistance and training, as well as marketing and program paperwork support.

³ The number of participants indicated in the figures refer to participants who generated electrical savings and, if they registered before October 2015, were electrically heated.

Project Registration

Most programs require applications, and they require these be submitted and approved before construction. Respondents reported that having a DA register projects with the program takes the burden off builders and leads to higher satisfaction among the latter.

Most jurisdictions do not require builders to register with the program within 30 days of receiving a building permit, and there is evidence that builders – especially custom builders – find this requirement problematic when it exists.

Project Application Review

Interviews revealed that all programs have similar project application review processes and approval phases – typically no longer than four weeks – and none reported noticeable complaints from builders about this timeline.

Construction and Inspections

DAs provide value to builders both in terms of assisting with program participation and keeping builders abreast of code and technology changes. Four of the five reviewed jurisdictions reported that EAs conduct at least two of the three following site visits: a pre-construction visit to collect data for their energy model; a pre-drywall inspection; and a final inspection. These four programs reported that builders like having multiple site visits because the EA or DA staff that visit on site can act as a consultant to help solve problems and the visits establish rapport between the builders and DAs, which contribute to future successful projects.

New home projects generally take from six to 24 months, with spec-built homes taking less time and custom homes taking longer. ENS and one other jurisdiction require projects to be completed within 12 months, and if builders need more time, they need to re-apply. The other four jurisdictions do not have this 12-month requirement, which makes it slightly easier for builders to complete their projects within their timeline. Having this flexibility may be particularly helpful for custom home builders.

Incentives and Home Labels

Jurisdictions use a range of incentive amounts and base their incentives on different benchmarks depending on their location, program delivery history, market research, and home label certifications. Offering a range of incentives helps attract a range of builder types – from those committed to high efficiency construction to code-based builders. Builders can take small steps and become increasingly more efficient over time. Furthermore, associating programs with home certification labels like ENERGY STAR allows builders to stand apart from their competition in the eyes of their customers.

Training

Partnering with other agencies to pool funds and deliver training to builders throughout a state or province helps develop relationships between programs, builders, and other market actors. All organizations that reported offering training noted that their partnerships with industry organizations such as local home builder association chapters were key to offering successful training.

NHC On-site Visits and Simulation Review Highlights

On-site visits and simulation file reviews were conducted for 10 NHC projects to determine the completeness and accuracy of the information in the as-built simulation files and data-collection forms. Overall, the Evaluator found some limitation in the documentation provided to support the data recorded in the simulation files. Of the 10 reviewed projects, eight had missing documents, that is building plans for six of the projects and as-built reports for two of the projects. In these eight files, each layer of the building component was detailed in the initial report, whereas only the total R-value of the components was given in the as-built report, without detailing the type of insulation and the exact wall assembly. The lack of technical documents that records the characteristics of each house component in the participant files was also observed in 2016 when the last NHC simulations review was performed.

The Evaluator made adjustments to the N assessment energy consumption values in all 10 projects, for a total of 44 adjustments, by following the Natural Resources Canada (NRCAN) protocol minimum precision requirements. That said, of the 10 reviewed projects, only two contained errors affecting energy consumption by more than 5 percent, while the eight others were in the acceptable range defined by NRCAN. In total, the global adjustment for the 10 projects was 0.3 percent, compared with 3 percent in 2016, thereby demonstrating considerable improvement in the accuracy of the simulations.

NHC Energy Savings

The objective of the 2018 NHC impact evaluation was to establish net energy and peak demand savings. Prior to reviewing the gross savings calculations, the Evaluator reviewed the contents of the 2018 tracking sheet to ensure all formulas were accurate and consistent. For NHC, participants' gross energy savings were calculated by determining the difference between the to-code and the as-built modelled energy consumption values. Each value was adjusted with an overestimation ratio (OR), depending on the heating system in place. The ORs were established as part of this evaluation based on a billing analysis conducted on HEA participants since the number of NHC participants with sufficient available billing data and who used the new version of HOT2000 did not allow for such an analysis.

To calculate the Passive House pilot gross energy savings, the Evaluator used the same methodology and parameters as those developed during the 2017 evaluation.

NHC net savings were determined using the NTGR, which considers free-ridership and spillover (the latter being in the form of market effects). No data-collection activities aimed at updating the free-ridership or spillover levels were conducted in 2018. Therefore, the 2017 free-ridership level was used for the 2018 evaluation (29%). For market effects, the 2017 methodology and attribution level were used, although the number of non-participating houses was updated, resulting in a market effects factor of 24 percent compared to 35 percent in 2017. The Passive House pilot free-ridership level was established at 61 percent in 2017 and this assumption was maintained in 2018.

Based on these free-ridership and market effects levels, the NTGRs for NHC and the Passive House pilot were established at 0.95 and 0.39 respectively, as outlined in Table 2 below. These values were used to determine the net savings.

Table 2: Net-to-gross Ratios

	NHC	Passive House Pilot
Free-ridership Level	29%	61%
Market Effects Level	24%	-
NTGR	0.95	0.39

The net energy and peak demand savings were established at 4.481 GWh and 1.268 MW at the generator respectively for NHC, and at 0.035 GWh and 0.010 MW at the generator respectively for the Passive House pilot. Table 3 below compares overall tracked and evaluated savings at the generator.

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

	Initial Gross Savings	Adjusted Gross Savings	NTGR*	Net Savings
Energy Savings				
ENS Tracked Savings	5.901 GWh	4.946 GWh	0.90	4.451 GWh
Evaluation Results	5.901 GWh	4.806 GWh	0.94	4.515 GWh
Peak Demand Savings				
ENS Tracked Savings	1.670 MW	1.400 MW	0.90	1.260 MW
Evaluation Results	1.670 MW	1.360 MW	0.94	1.278 MW
*The average NTGR values correspond to the ratio of net savings to gross savings for NHC and Passive House combined.				

Both the gross energy and peak demand savings calculated as part of the 2018 evaluation are equal to the initial gross savings tracked by ENS. As for the adjusted gross savings, the evaluated savings are 3 percent lower than the tracked values. This difference is mainly explained by the updated ORs used to adjust the modelled space heating consumption values generated by the HOT2000 software for NHC. On the other hand, the evaluated net energy and peak demand savings are higher than those tracked by ENS due to the increase in the NTGR value for NHC (0.95) compared to the tracked value (0.90). For Passive House, the NTGR used by ENS for tracking was also 0.90 and was revised to 0.39 according to the NTGR value established specifically for this pilot in the 2017 evaluation.

NHC Recommendations

One of the main goals of the 2018 evaluation was to identify ways of improving NHC since past evaluations revealed dissatisfaction with the process and a decrease in both participation levels and savings. From a participation standpoint, the 2018 evaluation demonstrated an increase in the number of completed projects. While they did not reach targets, 2018 net energy savings are also higher than in 2017. In addition to the general recommendations presented for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator makes the following recommendations for NHC. These recommendations are intended to serve various purposes, from increased collaboration between builders and DAs/EAs, greater builder satisfaction, to improved savings accuracy and tracking processes, with the goal of generating more completed projects. These recommendations are also outlined in Appendix III. No specific recommendation was made for the Passive House pilot.

2018 NHC-R1. Increase support and guidance to builders by exploring ways to further involve DAs and EAs in the NHC participation process. As evidenced by the process evaluation, DAs and EAs are valuable partners in new home construction programs and their involvement in projects can be a key factor in project success and builder satisfaction. They have the knowledge and expertise to, among other things, assist builders with registration and offer technical assistance during construction, such as measure suggestions and on-site verifications of measure installations. ENS should review the NHC participation process and identify areas where DAs and EAs can be further involved. While the Evaluator believes that EAs and DAs are also key allies in the recruitment of new builders, achieving the goal of generating more projects under NHC must first involve an assessment of current processes to ensure they are in line with builder expectations and needs.

2018 NHC-R2. Be flexible, as much as possible, with timeline requirements that may be difficult for builders to meet. Interviews with other program administrators revealed that flexibility with builders is key to program success. For example, providing exceptions to the requirement to register within 30 days of receiving a building permit and offering extensions to builders that need more than 12 months to complete a project without having to re-register are important aspects to builders and can be a deal breaker for certain builders.

- 2018 NHC-R3. Share evaluation findings with the EAs to ensure sustained quality simulations and that all required documentation is included in participant files.** As part of the 10 NHC on-site visits and HOT2000 simulation reviews, the Evaluator noted that improvements had been achieved in the accuracy of simulations since the last review in 2016. Conversely, the Evaluator identified errors affecting the energy consumption in each file reviewed. Moreover, the Evaluator noted that building plans or as-built reports, containing the characteristics of each house component, were still missing for the majority of the files reviewed despite the recommendation made in the 2016 Evaluation Report to ensure that all required documentation be included in participant files. These findings should be shared with the EAs to continue working toward higher-quality simulations, and particular effort should be invested in investigating concrete solutions on how all the required documentation could be included in the participant files.
- 2018 NHC-R4. Conduct a billing analysis to review ORs when a sufficient NHC participant sample becomes available.** The current ORs used for NHC were obtained from a billing analysis of Home Energy Assessment (HEA) participant data. In past years, no billing analyses were conducted with NHC participants since only a few participants had their as-built energy consumption value available. The HEA billing analysis conducted in 2018 was initially aimed at estimating an OR for the new version of HOT2000, although it revealed that the space heating systems in place, particularly heat pumps, had a much more significant impact on the OR than the difference between the versions of HOT2000 that are used. Since more NHC projects will be completed under the HOT2000 version 11 rating system in upcoming years, the Evaluator recommends conducting a billing analysis specific to NHC participants when a large enough sample becomes available to both consider the various versions of HOT2000 (i.e. versions 11.3; 11.4; 11.5) and evaluate the impact of the different heating systems in place.
- 2018 NHC-R5. Ensure the tracked savings are accurate.** Prior to reviewing the gross savings calculations, the Evaluator identified several issues in the 2018 tracking sheet, including with values that had been entered manually. The Evaluator reviewed all the formulas used for the tracked savings calculations and when revisions were required, the Evaluator shared the revisions with ENS. For future years, the Evaluator recommends that ENS apply these formulas to track NHC savings and ensure they are consistently applied to all participants in the tracking sheet.

INTRODUCTION

Efficiency Nova Scotia (ENS) is operated by EfficiencyOne, an independent, non-profit organization. ENS 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 various segments of the population. ENS has a demand-side management (DSM) portfolio of three residential programs and three business, non-profit and institutional (BNI) programs. Each program has one or more program components that ENS markets to Nova Scotians. ENS receives funding for its activities from Nova Scotia Power (NSP) and the Province of Nova Scotia. The funds received from NSP cover the costs of activities designed to help reduce electricity consumption, whereas funds from the Province of Nova Scotia are primarily used for activities designed to help reduce the use of other fuels.

Econoler was commissioned to evaluate ENS's 2018 DSM program portfolio comprised of six electricity efficiency programs and assess the impacts of energy efficiency codes and standards introduced in Nova Scotia. To carry out this assignment, Econoler collaborated with Research Into Action, Equilibrium Engineering and Corporate Research Associates (CRA). 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 impact evaluation calculations, as well as preparing and reviewing evaluation reports. Research Into Action carried out the process evaluations, while Equilibrium Engineering conducted the on-site visits and contributed to some impact evaluation analyses. CRA conducted interviews and surveys with participants and partners, as well as analyzed and reported on the data collected from these activities. Throughout this report, this team is referred to as the Evaluator.

Table 4 below lists the various programs assessed as part of the 2018 evaluation and indicates their respective components and the types of evaluations conducted. In this table, "C" means a complete evaluation and "R" indicates that reduced evaluation activities were performed. Moreover, Section 1 of the DSM Programs Evaluation Executive Summary presents the scope of work in further detail, along with the rationale for the types of evaluations performed for each program component.

Table 4: Types of Evaluations Conducted for Each Program Component

Program	Program Component	2017			2018		
		Process	Market	Impact	Process	Market	Impact
Residential Efficient Product Rebates Program	Appliance Retirement			R		C	C
	Instant Savings		R	R		C	C
Existing Residential Program	Home Energy Assessment		C	C			R
	Green Heat	C	C	C		C	C
	Efficient Product Installation		C	C		C	R
New Residential Program	New Home Construction		C	C	C		C
Efficient Product Rebates Program	Business Energy Rebates		C	R	C	C	C
Custom Incentives Program	Custom	C*	C	R	C**	C	C
	Energy Management Information Systems		C	C		C	C
	Strategic Energy Management***					C	C
Direct Installation Program	Small Business Energy Solutions		C	C		R	R
* The process evaluation specifically targets the Retrofit service of the Custom program component. ** The process evaluation specifically targets the New Construction service of the Custom program component. *** Due to the start date of the latest Strategic Energy Management (SEM) cohort, SEM did not have any participants who achieved savings in 2017; therefore, no evaluation was conducted for 2017.							

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

This evaluation report concerns the New Residential program, which is comprised only of the New Home Construction (NHC) program component. In 2017, NHC underwent market and impact evaluations. In 2018, an impact evaluation was maintained, but a process evaluation was also added to the NHC scope of work to provide insights into ways to increase participation and builder satisfaction. A description of the NHC program component, the evaluation methodology and main evaluation findings are presented in the following sections.

1 NHC OVERVIEW

This section describes the NHC program component, follows up on 2017 evaluation recommendations and presents participation history.

1.1 Description

NHC is meant to encourage homeowners and builders to exceed energy efficiency building code requirements in new homes, thus increasing the number of energy efficient dwellings in the province. Since October 2015, NHC has been fully funded through DSM funds. In the past, the Province of Nova Scotia funded measures implemented in non-electrically heated homes. Provincial funding came to an end on October 20, 2015, and any funding beyond that date was provided only to participants registered before the aforementioned date. Since then, only electrically heated households have been eligible.⁴

Once a new home is registered under NHC, a review of house plans is conducted to inform participants of the expected energy efficiency level of the home and provide recommendations to meet NHC requirements. House plans are evaluated by energy advisors (EAs) who work for delivery agents (DAs) hired by ENS to implement NHC across Nova Scotia. The HOT2000 software⁵ is used to model the energy efficiency of the home based on both the building code and house plans before construction begins. NHC energy efficiency requirements consist of a certification (ENERGY STAR® Canada or R2000) or an improvement beyond the National Building Code (NBC) minimum requirements. Once the home is built, a final assessment and a blower door test are completed by an EA to verify energy efficiency performance.

Changes were made to the NHC incentive structure over the last few years. On October 1, 2017, NHC transitioned to version 15 of the EnerGuide rating system to estimate annual energy use in gigajoules.⁶ The incentive structure was adapted to accommodate this change, although the rebate amounts remained the same. This new version of the rating system and HOT2000 are meant to provide homeowners with more useful information about their new homes' energy performance.

⁴ ENS 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.

⁵ This software was developed by the Housing, Buildings, Communities and Simulation Group at CanmetENERGY, a division of NRCan: http://198.103.48.154/eng/software_tools/hot2000.html (Last accessed October 31, 2016).

⁶ Projects that obtain incentives by reaching ENERGY STAR certification are still assessed using the 0-100 EnerGuide rating system.

The following incentives were available to NHC participants during most of 2018:⁷

- › An incentive of \$2,000 is provided for homes that achieve: (1) ENERGY STAR certification; or (2) an energy use level 30 percent better than required by the NBC for homes no bigger than 1,200 ft²; or (3) an energy use level 45 percent better than required by the NBC for homes bigger than 1,200 ft².
- › An incentive of \$5,000 is provided for homes that achieve: (1) R2000 certification; or (2) an energy use level 45 percent better than required by the NBC for homes no bigger than 1,200 ft²; or (3) an energy use level 60 percent better than required by the NBC for homes bigger than 1,200 ft².

ENS launched a Passive House pilot in October 2016 to encourage builders and homeowners to build or buy homes that are even more energy efficient. The pilot was continued through 2017 and 2018. Participants who meet Passive House requirements receive a \$10,000 incentive. To be eligible, a project must either be Passive House certified or meet a heating demand of 7.1 kBtu/ft²/yr or lower. Projects that do not meet these requirements are transferred to NHC.

A second pilot called High Performance Home Plan (HPHP) was launched by ENS on December 3, 2018. This pilot is designed to offset some of the initial consultation costs for high performance home plans and thereby further encourage the construction of high-efficiency homes in Nova Scotia. HPHP is funded by the Province of Nova Scotia. Although not included in the 2018 NHC evaluation due to its launch date, ENS does plan on integrating the HPHP pilot with NHC.

Combined, NHC and the Passive House pilot aimed to achieve 4.6 GWh in net electricity savings and 1.3 MW in net peak demand savings at the generator for 2018.

1.2 Follow-up on 2017 Evaluation Report Recommendations

The Evaluator evaluated NHC in 2017 and made improvement recommendations. Table 5 below provides a brief summary of the implementation status of each recommendation presented in the Executive Summary section of the 2017 Evaluation Report.

Table 5: Implementation Status of 2017 Recommendations for NHC

2017 Recommendations	Status
2017 NHC-R1. Conduct a process evaluation for NHC in 2018.	Implemented
2017 NHC-R2. Conduct a billing analysis to review the overestimation ratio (OR).	Not implemented

⁷ ENS changed the NHC incentive levels on 3 December 2018.

Recommendation 2017 NHC-R1 was made after the Evaluator had observed moderate levels of satisfaction with NHC and criticism of the incentive levels and participation process by participants and builders during past evaluations. Additionally, the number of completed houses has been decreasing since 2014 despite the number of registrations remaining high. In light of these findings and the changes made to NHC, the Evaluator recommended that a process evaluation be conducted in 2018. The recommendation was implemented and this NHC evaluation includes a process evaluation aimed at determining the most effective ways to generate more projects and increase program satisfaction.

Recommendation 2017 NHC-R2 has not been implemented due to too few NHC completions under the new HOT2000 rating system, thereby not providing a large enough sample for the recommended billing analysis. ENS and the Evaluator have determined that the OR obtained through the Home Energy Assessment (HEA) evaluation would be used for the NHC evaluation.

1.3 Participation History

Figure 2 below illustrates the evolution of NHC participation levels as well as in net energy and peak demand savings from 2012 to 2018. The 2017 and 2018 figures also include the results from the Passive House pilot evaluation. After increasing significantly from 2012 to 2013, then decreasing between 2013 and 2017, NHC participation is ramping up again in 2018; a total of 652 participants completed a project under NHC (and generated electrical savings), including seven participants who completed a project through the Passive House pilot.

A factor that allows assessing NHC performance in the province is the total number of new houses in the market. As highlighted in Figure 2 below, participation in NHC as a percentage of housing completions increased in 2018 compared to 2017.

In terms of gross energy and peak demand savings, 2018 results were higher than in previous years, due to the higher participation level for that year. In 2018, NHC achieved 4.806 GWh and 1.360 MW in gross energy and peak demand savings at the generator respectively, as illustrated in Figure 3 below. Regardless, the per-participant gross energy savings value decreased.

Figure 2: Summary of Participation in NHC (2012-2018)⁸

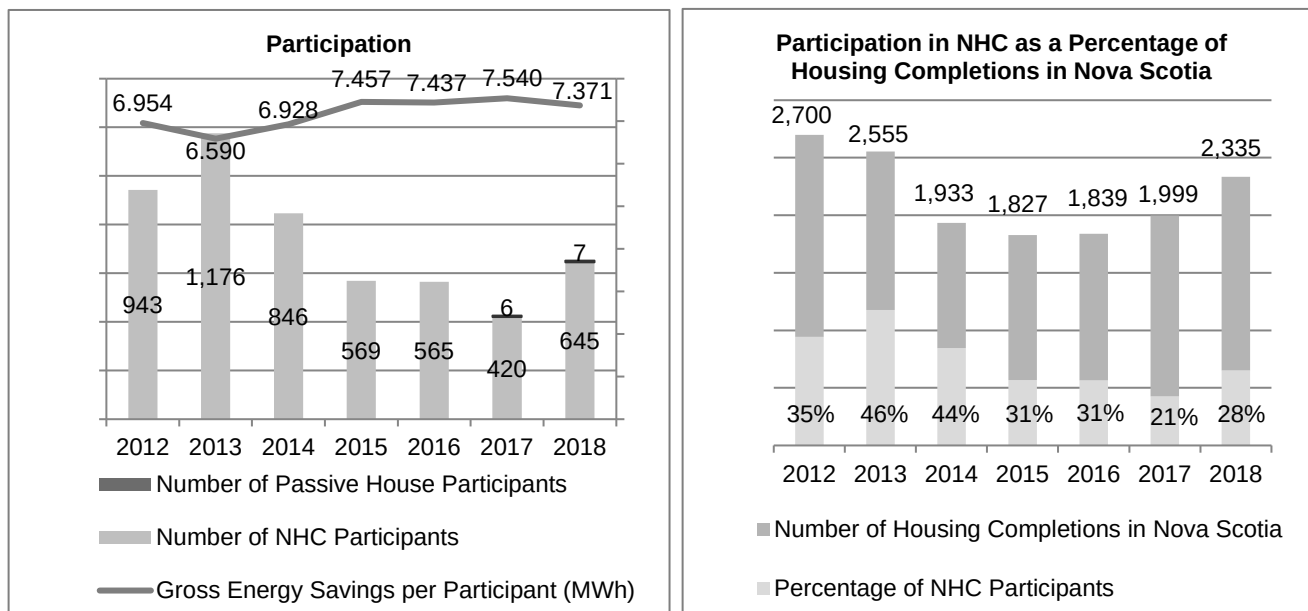
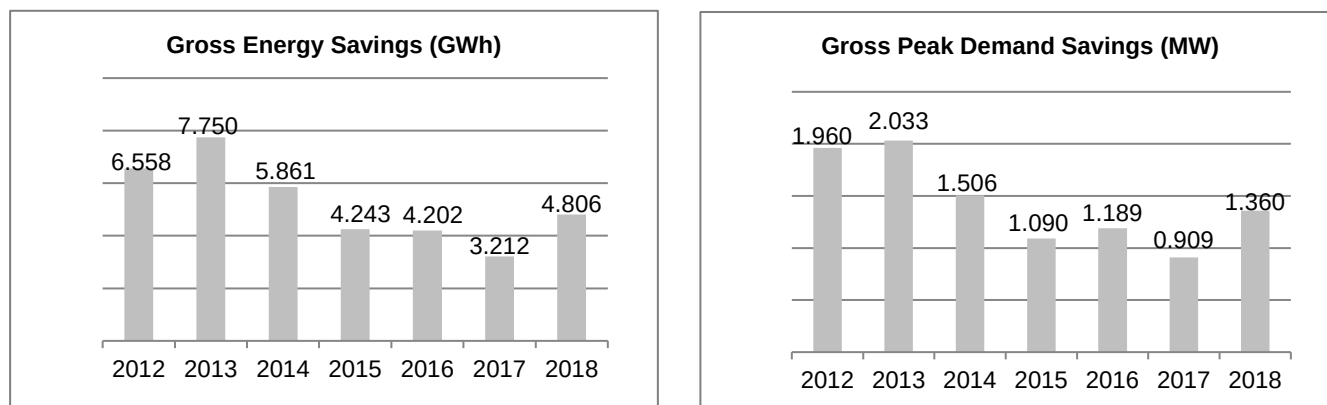


Figure 3: Summary of Gross Savings for NHC (2012-2018)



⁸ The numbers of participants indicated in the figures refer to participants who generated electrical savings and, if they registered before October 2015, were electrically heated. The housing completion numbers were drawn from the Canada Mortgage and Housing Corporation website using the Housing Market Information Portal at: <https://www03.cmhc-schl.gc.ca/hmportal/en/#Profile/12/2/Nova%20Scotia> (Consulted January 24, 2019).

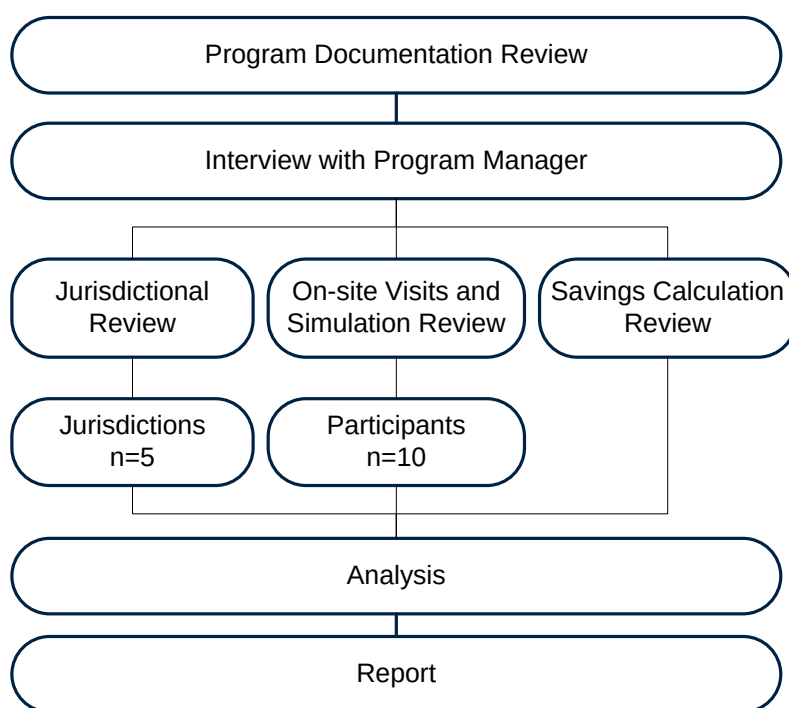
2 NHC EVALUATION OBJECTIVES AND METHODOLOGY

The main objectives of the NHC evaluation are as follows:

- › Assessing the effectiveness of NHC design and delivery
- › Calculating program results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions

This section presents the methodology used to achieve the aforementioned objectives. Figure 4 below illustrates the research strategy employed and the data-collection activities carried out in the 2018 NHC evaluation.

Figure 4: Methodological Model for NHC



The Evaluator first reviewed NHC documentation and then met the program manager in September 2018 to verify the implementation status of the previous evaluation recommendations and learn about the changes made to NHC in 2018. Based on the information obtained from this meeting, the Evaluator prepared a list of questions and topics to be included in the data-collection instruments.

Once the meeting with the program manager and the NHC documentation review were completed, specific evaluation activities were undertaken as described in the following subsections.

Jurisdictional Review

For the NHC process evaluation, Research Into Action conducted a jurisdictional review that involved collecting information on other new home construction programs in North America and interviewing key staff working on these programs. Topics investigated included incentive levels, program participation processes, and solutions to overcoming challenges encountered through residential new home construction programs.

A builder journey component was also included in the process evaluation scope of work, whereby Research Into Action assessed the process undertaken by builders to participate in each reviewed program to compare these journeys and highlight any sticking points or issues with NHC that could explain the moderate levels of satisfaction expressed by builders in past evaluations.

The following five utilities were included in the review:

- › New Brunswick Power
- › Energize Connecticut
- › Efficiency Vermont
- › Rhode Island National Grid
- › Fortis BC

A copy of the interview guide used for the interview portion of the jurisdictional review is provided in Appendix I.

On-site Visits and Simulation Review

As part of the evaluation, 10 NHC projects were reviewed. The project reviews consisted of: (1) an on-site visit at participating houses after the completion of the as-built assessment (or N assessment); and (2) an assessment of the per-plan and as-built HOT2000 simulations for these 10 houses. The main purposes of the on-site visits and simulation file verifications were to validate the on-site information collected by EAs in their data-collection forms (DCFs) as well as their input data, sketch drawings, assumptions used in the simulation files, and any additional information provided to the Evaluator by the DAs. The assumptions were reviewed to ensure that they were all within realistic ranges and reflected the actual energy performance of the houses assessed. The on-site visits also served to visually confirm the energy efficiency measures implemented in the new houses. The visits and simulation reviews were conducted by EcoPlus.

More information on the on-site visits is presented in the Impact Evaluation section of this report, while the on-site visit and HOT2000 simulation review protocols are presented in Appendix II.

Savings Calculation Review

For NHC, energy savings are calculated using the energy consumption values obtained from the HOT2000 simulation models and by applying ORs obtained from a billing analysis. The Evaluator reviewed the different steps used in the tracking sheet to calculate savings. New ORs were also established for NHC, based on the results of a billing analysis conducted with HEA participants. The savings calculation methodology was also reviewed for the Passive House pilot. The equations and parameters established as part of the 2017 evaluation were reused for the 2018 evaluation.

3 NHC PROCESS EVALUATION

This section provides a summary of key findings from a review of NHC documentation, including a recent report⁹ about builder satisfaction with NHC, interviews with program staff, as well as a review of new home construction programs in other jurisdictions and interviews with staff from said programs. Table 6 provides an overview of the reviewed organizations and lists the regulatory body that oversees each program.

Table 6: Regulatory Oversight of Reviewed Programs

Organization	Regulated	Regulatory Body
Efficiency Vermont	Yes	Vermont Department of Public Service
Energize Connecticut	Yes, via participating utilities*	Connecticut Public Utilities Regulatory Authority
National Grid Rhode Island	Yes	Rhode Island Public Utilities Commission
Fortis BC	Yes	British Columbia Utilities Commission
NB Power	Yes	New Brunswick Energy and Utilities Board
Efficiency Nova Scotia	Yes	Nova Scotia Utility and Review Board

*Eversource and United Illuminating.

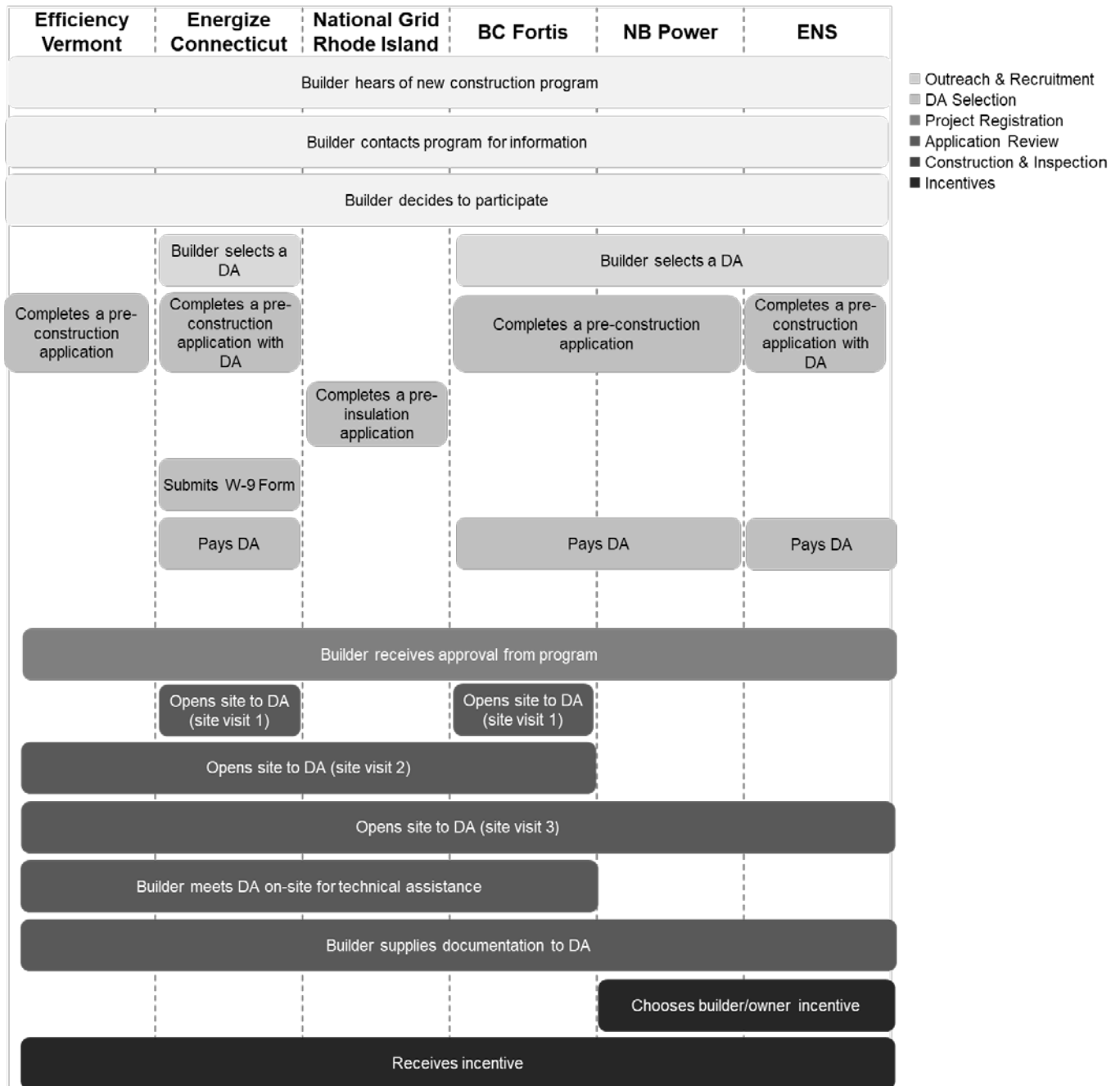
The key research issues identified by previous evaluations and ENS staff are how to increase both participation in NHC and builder satisfaction with the participation process. This section begins with an overview of the builder journeys through the reviewed programs from initial recruitment to program participation, project completion, and incentive payment. The subsequent subsections compare the incentives, home labels, and training offered. Each subsection provides a comparison of programs and lessons that respondents from the jurisdictional review learned during the administration of their programs.

3.1 The Builder Journeys

Builder participation through a new home construction program can be categorized into five distinct phases: (1) program outreach and recruitment; (2) DA selection (or having one assigned); (3) project registration; (4) project application review; and (5) construction and inspections. Figure 5 below provides a high-level summary of the builder journeys through these various phases.

⁹ ENS New Home Construction Program Qualitative Study. Draft Report. July 2018. Prepared by Corporate Research Associates.

Figure 5: The Builder Journeys



3.1.1 Program Outreach and Recruitment

Comparison

Staff from the reviewed programs noted a variety of ways they conduct outreach to builders and ENS already uses most of these outreach and recruitment approaches. All jurisdictions use their program website and relationships with municipality permit offices to target and enroll builders in programs. Lesser-cited outreach paths include working with trade associations and having service providers conduct recruitment. These results, presented in Table 7, might not represent an exhaustive list of all activities that programs carry out to conduct outreach.

Table 7: Outreach and Recruitment Activities

Outreach and Recruitment Activity	Efficiency Vermont	Energize Connecticut	National Grid Rhode Island	Fortis BC	NB Power	ENS	Total
Partner with permit offices	✓	✓	✓	✓	✓	✓	6
Website	✓	✓	✓	✓	✓	✓	6
Contact past builders	✓		✓			✓	3
Online ad tools		✓			✓	✓	3
Trade ally groups/trade associations		✓			✓	✓	3
Service providers recruit				✓	✓	✓	3
Home shows					✓	✓	2
Bill inserts and ads to homeowners				✓			1
Total	3	4	3	4	6	7	-

Lessons Learned by Respondents

All respondents placed noticeable value on working with municipal permit offices to identify builders to target with information about programs. In addition, municipalities can act as program advocates. For instance, one respondent reported that some permit offices actively inform builders and homeowners about programs and possible incentives.

Energy advisors can be successful recruiters for programs. For example, before a program was launched in New Brunswick, one energy advisor leveraged existing relationships with builders to inform them and recruit them into the program.

3.1.2 DA Selection

Comparison

Similarly to ENS, most jurisdictions use third parties such as DAs to deliver their new home construction programs. Specifically, three use independent service providers, as is the case for ENS, while one uses a third-party program implementer and another uses program administrator staff. Additionally, three utilities rely on individuals credentialed by the Residential Energy Services Network (RESNET) to deliver programs, and two rely on program-approved service organizations, as does ENS (see Table 8).

Table 8: Type of DA by Program

Program Delivery Strategy	Efficiency Vermont	Energize Connecticut	National Grid Rhode Island	Fortis BC	NB Power	ENS	Total
DAs							
Open-market service providers		✓		✓	✓	✓	4
Third-party program implementer			✓				1
Program administrator staff	✓						1
Credentials of DAs							
Home Energy Rating System (HERS) ¹⁰ Raters	✓	✓	✓				3
Program-approved service organizations				✓	✓	✓	3

Lessons Learned by Respondents

The DAs of these programs play an important role in educating and guiding builders through the programs. Specifically, the DAs offer builders:

- › Technical assistance (Subsection 3.1.5)
- › Training (Subsection 3.3)
- › Marketing support (Subsection 3.1.1)
- › Assistance with completing program paperwork such as applications and inspections (Subsections 3.1.3 and 3.1.5).

¹⁰ HERS raters are individuals certified to inspect and test a home to determine a Home Energy Rating according to RESNET standards.

3.1.3 Project Registration

Comparison

Most programs require applications be submitted before construction and the application be approved by the program, although not all programs require this. All except one of the reviewed programs require some form of initial application before construction begins. These programs have staff (or an implementer) review and approve initial applications, and then program staff enter project data into a program database. The one program that does not require an initial application, depending on which path the builder chooses, allows builder participants to submit a report mid-construction (pre-drywall) and/or upon project completion.

In most cases, DAs register projects with the program prior to construction and some programs require builders to pay at least part of a fee to a HERS rater or energy advisor to participate. Two programs do not require builders to pay a fee and, similarly to ENS NHC, three require builders to pay a HERS rater or energy advisor directly.¹¹ To register projects, builders typically contact program customer support or complete an online application. One program asks builders to submit applications and technical information in paper format, although the form can be emailed to program representatives (see Table 9).

Table 9: Project Registration Overview

Project Registration Processes	Efficiency Vermont	Energize Connecticut	National Grid Rhode Island	Fortis BC	NB Power	ENS	Total
Fees Builders Pay							
No fee	✓		✓				2
Fee paid to HERS rater or energy advisor directly		✓		✓	✓	✓	4
Method Available to Builders to Register Projects							
Call or email customer support	✓	✓	✓		✓	✓	5
Complete online application	✓	✓		✓	✓	✓	5
Complete paper application			✓				1
Complete worksheet with technical information			✓				1
Who Completes Project Registration							
DA		✓	✓	✓			3
Builder	✓				✓	✓	3
Registration Requirement							
Register within 30 days of receiving building permit					✓	✓	2

¹¹ Builders in ENS territory pay \$99 of the overall fee paid to DAs. The remaining portion, \$501, is paid by ENS directly to DAs.

Lessons Learned by Respondents

Having builders work with DAs to register projects with the program can alleviate some dissatisfaction among builders. As noted in Table 9, three jurisdictions reported having DAs complete and submit project registration paperwork on behalf of builders. Having the DA register projects allows the agent and the builder to meet early on in the project and build rapport with one another. Furthermore, one utility, representing a program that was launched in 2018 and that does not follow this process, noted that they have received negative feedback about their enrollment process from builders.

Requiring projects to be registered with the program within 30 days of receiving a building permit is problematic for some builders. The only utility, other than ENS, that requires projects to be registered within 30 days of receiving a building permit (NB Power) noted that builders complain about that requirement. Additionally, a study of builder participants in ENS's NHC noted that builders, especially custom home builders, were dissatisfied with the 30-day registration period.¹² None of the other reviewed programs requires registration timelines like ENS and NB Power do, and one noted that not having such a requirement is intentional because they want to meet builders "where they are" and accommodate custom builders.

3.1.4 Project Application Review

Comparison

The project application review and approval phase typically takes program administrators from three days to four weeks – ENS approvals being within this timeline – and none of the respondents reported any significant complaints from their builders about this timeline. In two cases, respondents reported that an automated process alerts builders about the receipt of their application, offers application status updates and indicates when the application is approved. These automatic alerts occur when the required data is inputted into the project tracking software.

Lessons Learned by Respondents

Some jurisdictions have found value in having an online application process that requires less work by the program administrator to approve project registrations. One respondent noted that their organization was in the process of implementing an automated process for approving and tracking projects and another organization has such a system in place.

¹² ENS New Home Construction Program Qualitative Study. Draft Report. July 2018. Prepared by Corporate Research Associates.

3.1.5 Construction and Inspections

Comparison

NB Power and ENS differ in their approach to the project construction and inspection phases compared to their peers. NB Power and ENS programs both include preparing a preliminary energy model and conducting a final inspection of the home to verify savings. Unlike several of the other programs, they do not conduct multiple site visits, and they do not offer on-site technical assistance during construction to the same degree as the other programs (see Table 10). For example, one program administrator reported that the builders like having a third party come on-site to conduct modelling tests and “act as a consultant” for their projects. Furthermore, according to this respondent, builders like having a third party that “helps the builder stay a step ahead” of code and technological changes.

Table 10: Construction and Inspection Overview

Construction and Inspection Processes		Efficiency Vermont	Energize Connecticut	National Grid Rhode Island	Fortis BC	NB Power	ENS	Total
Technicians prepare preliminary energy model			✓	✓	✓	✓	✓	5
Site visits	Site visit 1 - Collect data for energy model		✓		✓			2
	Site visit 2 - Pre-drywall inspection	✓	✓	✓	✓			4
	Site visit 3 - Final inspection	✓	✓	✓	✓	✓	✓	6
Receive technical assistance during construction		✓	✓	✓	✓			4

Program participation and construction typically take builders six to 24 months to complete, with spec-builds generally taking less time and custom builds taking longer. One utility explained that developers can “crank [homes] out very quickly,” whereas “the average custom-built home or homeowner-builder [may take] one and one-half to two years” to complete a home.

Two programs, NB Power and ENS, require all projects to be completed within 12 months, although these programs do allow extensions if builders reapply. The other four programs do not have a timeline associated with participation, although when there is a change in program requirements, projects issued under the old requirements will be given a “hard-stop” date by which time they must be completed. Otherwise, those projects are subject to the new requirements, which could cause difficulties if construction of that home is largely complete.

Lessons Learned by Respondents

All program representatives emphasized the value provided by the DA during the construction phase. For example, early and mid-construction site visits provide an opportunity to work with builders and offer advice, guidance, and recommendations beyond conducting the required verification inspections. This consultation typically includes suggestions for mechanical systems, recommendations on which appliances and lighting to install, and other tactics to improve home performance. These on-site visits also provide builders an opportunity to discuss any building plan issues or changes and ensure they meet program requirements. Furthermore, on-site inspections allow DAs and builders to build rapport with one another; they are thus more likely to work together on future projects. One example of the value programs place on the role of DAs is the communication training offered to DAs. One jurisdiction works to ensure DAs are “tactful” when offering critiques to builders and trains them to avoid being overly critical or assertive when providing guidance to builders.

3.2 Incentives and Home Labels

Comparison

There is no single incentive amount or incentive basis that works for all jurisdictions. Incentive amounts range from less than CAD 1,000¹³ for National Grid Rhode Island and Fortis BC, to CAD 10,000 for NB Power. The reviewed programs provide different incentive amounts, varying numbers of incentive options, and base their incentives on different metrics including third-party certification scores and calculating savings above code (see Table 11).

¹³ US Dollars (USD) were converted to Canadian Dollars (CAD) using an exchange rate of CAD 0.78 to USD 1.00.

Table 11: Incentive Amounts and Basis for Incentive by Program

Range (CAD)		Program					
Low	High	Efficiency Vermont*	Energize Connecticut	National Grid Rhode Island	Fortis BC [^]	NB Power	ENS ^{>}
Incentive Amounts Offered							
\$500	\$1,000			✓	✓		
\$1,001	\$2,000			✓	✓		✓
\$2,001	\$3,000			✓		✓	
\$3,001	\$4,000	✓			✓		
\$4,001	\$5,000	✓	✓				✓
\$5,001	\$6,000		✓	✓		✓	
\$6,001	\$7,000		✓				✓
\$7,001	\$8,000				✓		
\$8,001	\$9,000						
\$9,001	\$10,000					✓	
Total Options		2	3	4	4	3	3
Incentive Basis							
Efficiency Vermont Certification**		✓					
HERS Score			✓	✓			
British Columbia Step Code**					✓		
% Above Code						✓	✓
Extra Rebate for High Performance Label			✓ ⁺	✓		✓	
* Incentives are doubled for low-income homes. + Additionally, \$750 is offered to Zero Net Energy (ZNE) Homes and \$500 is offered to ENERGY STAR, LEED for homes, National Green Building Standard (NGBS), and Passive House homes. [^] In addition to builder incentives, \$400 is offered to energy advisors. ^{>} Total audit costs of \$600. Audit subsidy from ENS is \$501 and \$99 is paid by participant. ** Based on a list of requirements such as specifying appliances, insulation levels, air leakage, windows, etc. ⁺⁺ Based on a combination of building air-tightness and performance requirements for building equipment, systems and envelope.							

Long established programs have evolved how they structure incentives to meet code and market changes, and they will continue to learn and adapt. The three US-based programs have been in operation for over a decade, and each has made changes to incentives over that time. Changes were often based on feedback from builders and DAs. For example, one respondent noted their organization introduced program requirements that added to builder labour and material costs. To compensate for that additional cost, the organization interviewed builders and developers about the changes and structured an incentive that satisfied builders while ensuring program requirements were met.

All programs offer home labels or certifications for participating homes and most support ENERGY STAR, LEED for Homes, and Passive House certifications. Additionally, Efficiency Vermont offers their own home label and ENERGY STAR, both for free. For a fee, they certify homes as Passive House or LEED. NB Power and ENS offer the EnerGuide label.

Lessons Learned by Respondents

Offering several incentive tiers provides options for many different types of builders. All respondents noted offering multiple incentive tiers designed to provide differing efficiency levels so builders can take small steps and become increasingly efficient over time. For instance, one respondent noted that they had only one tier under a previous version of their program. Under the new version of their program, they decided to implement four tiers, one that was less stringent, one that was comparable to the previous version, and two that had higher efficiency levels than the previous standard. They decided to establish a lower tier to entice code builders to “try the program out” and they set higher tiers to assist high-efficiency builders to go even further – as far as Net Zero Energy construction.

Home labels and certifications can be important for builders that want to stand apart from their competition. For example, the National Grid Rhode Island respondent, representing a program that has been in operation for more than two decades, spoke about how important the ENERGY STAR brand has been to encouraging efficiency over time. According to this respondent, that brand has been instrumental for some builders to set themselves apart from their code-built competition. Furthermore, other labels such as the US Department of Energy (DOE) Zero Energy Ready are important for the same reason. The Fortis BC respondent noted they are planning to work with builders to help them market their high-efficiency homes and noted that the EnerGuide label might be especially useful in marketing support.

3.3 Training

Comparison

Four jurisdictions offer training opportunities to builders, which were reported as key successes for those programs. One administrator emphasized how training partnerships with industry organizations are important for both builder training and program outreach:

“The things that we have done really well in the last few years is partnering with organizations like HBRA [Home Builders and Remodelers Association] and AIA [American Institute of Architects] to deliver training to those folks, whether it’s code training or programmatic. We have a really good working relationship with a lot of different industry organizations that have helped us both push the word out about our program as well as to help their members stay well informed of what’s going on in the industry in terms of codes.”

Lessons Learned by Respondents

Partnering with other agencies to pool funds and deliver training to builders throughout the state or province helps develop relationships between programs, builders, and other market actors. For example, Fortis BC has developed partnerships with other utilities in the province, as well as housing organizations, to offer courses on building techniques for high-performance homes or training on air tightness. Energize Connecticut partners with trade associations, such as the HRBA of Central Connecticut, to deliver training on programmatic updates or upcoming code changes.

3.4 Process Evaluation Summary

NHC processes are in line with most reviewed program practices. The jurisdictional review indicated two phases of the participation process whereby improvements should be considered to increase builder satisfaction and the number of completed projects: project registration; and construction and inspections. These improvements focus around having the builders and DAs work together and offering flexibility in program timelines.

Three of the reviewed jurisdictions have DAs register houses with the program, whereas builders register houses in the two other jurisdictions and for ENS. According to some jurisdictions, having builders work with DAs to register projects with the program can alleviate some dissatisfaction among builders and build rapport between the two early in the participation process. Additionally, having DAs perform site visits during construction is viewed by other jurisdictions as a means of providing assistance and guidance to builders. Furthermore, being flexible with the required timelines to register houses and complete construction was also mentioned as a means of accommodating builders. Overall, the jurisdictional review highlighted how important it is for new home construction programs to adapt to not only the market, codes and regulations, but also builders whenever possible.

4 NHC IMPACT EVALUATION

The objective of the 2018 NHC impact evaluation is to determine NHC gross and net electrical energy and peak demand savings.

4.1 On-site Visits and Simulation Review

The Evaluator conducted on-site visits for and reviewed the simulation files of 10 NHC projects selected among those that generated electrical savings and completed the as-built assessment (or N assessment) within 12 months of the registration date. For the 2018 evaluation, the sample was not large enough to use the stratified sampling methodology used in 2016. The sample was established considering the participants for whom the simulation was conducted with HOT2000 version 11 and who were located in a radius of 50 km of Halifax. Also, attention was paid to selecting different project sizes to obtain a sample that was representative of the program component population.

The purpose of these reviews was to determine the completeness and accuracy of the information in the as-built simulation files and DCFs by comparing it with the information collected during the on-site visits. This qualitative review served to gain insights on EA assessment documentation and processes. The impact of inaccuracies on the energy consumption computed in HOT2000 for the N assessment was also calculated for improvement purposes, although this was not considered in the impact evaluation of the NHC savings results. The protocol used by the Evaluator to gather information during the site visits was based on the EnerGuide home evaluation framework provided by Natural Resources Canada (NRCan) to the EAs to conduct home assessments. The protocol was more complete than the one used in the 2016 evaluation due to the new version of the EnerGuide rating system (version 15), which requires more data to be collected and more detailed measurements to be conducted on-site by the EA.

Overall, the Evaluator found some limitation in the documentation provided to support the data recorded in the simulation files. Of the 10 reviewed projects, eight were missing documents, notably building plans for six of the projects reviewed and as-built reports for two of the projects reviewed. Building plans and as-built reports have to be provided because they include the characteristics of each house component. Indeed, the NRCan protocol specifies that the R-values of all layers and materials installed in a component, as well as the material type and thickness, should be reported along with the total R-value of each house component. In these eight files, each layer of the building component was detailed in the initial report, whereas only the total R-values of the components were presented in the as-built report without detailing the type of insulation and the exact wall assembly. For these projects, the Evaluator was therefore not able to validate the details recorded in HOT2000 and used the initial report to validate the layers of the building envelope.

As for the reviewed as-built simulation files, the N assessment energy consumption values were adjusted in all 10 projects, for a total of 44 adjustments, by following the NRCan protocol minimum precision requirements. According to NRCan, HOT2000 simulations are considered accurate as long as

the errors impact the total annual energy consumption value by less than 5 percent. Of the 10 projects reviewed, two contained errors affecting energy consumption by more than 5 percent, while the eight others were within the acceptable range defined by NRCan. In total, the global adjustment for the 10 projects was less than 1 percent for the reviewed N assessment files. This demonstrated the assessment process conducted by the EAs had been improved since the last on-site visits and simulation reviews conducted by the Evaluator in 2016 where the global adjustment was 3 percent in absolute value.

Table 12 below summarizes the results of the N assessment reviews. The percentages are only presented to provide an order of magnitude of the adjustments found, which are minimal overall, and are not meant to be applied to the gross savings results. More specific observations are described in the following subsections on the specific house features considered in the HOT2000 simulations, which are: building envelope constituents; heating, ventilation and air conditioning (HVAC) equipment; and water heating equipment.

Table 12: Results of On-site Visits and Simulation Reviews for NHC

House Feature	N Assessment	
	Positive Adjustment	Negative Adjustment
Building Envelope Constituents	1.3%	-3.3%
HVAC Equipment	0.5%	-0.7%
Water Heating Equipment	1.8%	0%
TOTAL	0.3%	

Building Envelope Constituents

The values related to building envelope constituents were adjusted in eight projects (23 adjustments), and only one contained a geometry error affecting energy consumption by more than 5 percent. Overall, the identified discrepancies had an impact of less than 2 percent on the energy consumption of evaluated households. The review of HOT2000 simulations confirmed that building envelope (e.g. ceiling, attic, wall, floor, basement, window, and door) characteristics and dimensions were recorded and transcribed accurately by EAs. Regardless, the review revealed that EAs made some common mistakes mainly related to the transcriptions of and assumptions in results.

In six of the reviewed files, the slab insulation values or the wall insulation values recorded in either the DCFs, building plans, or as-built reports were not correctly transcribed in the HOT2000 simulation. In one case, the EA recorded R29 insulation (2X6 walls with R24 batts and with 1" extruded polystyrene), although the section plan indicated an R24 insulation value. This downwardly impacted the energy consumption of that house by 4 percent. Another inconsistency related to the transcription of results. One project presented an inaccurate building envelope model. Three walls were modelled with a perimeter of 150 ft, instead of 120 ft, 30 ft and 20 ft respectively, which increased the total energy consumption of the simulation file by more than 20 percent.

Building components were also adjusted in three other projects, but those errors were also negligible since energy consumption was impacted by less than 3 percent. In addition, some specific assumptions regarding window orientation also impacted energy consumption results. In four files, windows were modelled using the wrong orientation. This error affected all windows in three of those files, and only one window for the fourth file. These errors were negligible given they impacted the energy consumption of the houses by less than 1 percent.

While on-site measurements were accurate, several errors were identified in the HOT2000 simulations. In two files, the wall component model was inaccurate because the thermal bridging impact on heat loss was not properly assessed. HOT2000 measures heat loss through material thermal bridging. To achieve this, the software provides for two insulation options: non-continuous (installed between framing members); and continuous (along a building without interruption). For the same nominal R-value, continuous insulation will typically have a higher effective R-value. According to the available data, the wall insulation was composed of non-continuous insulation in the two aforementioned files. Conversely, the EAs recorded two layers of insulation: one for non-continuous insulation, with an additional layer of continuous insulation. Although both models lead to the same R-value, the one with a continuous insulation layer is more efficient and affects modelled energy consumption. These thermal bridging effect modelling mistakes had a limited impact of 1 percent on house energy consumption for the two projects.

HVAC Equipment

Version 15 of EnerGuide includes enhanced specifications for HVAC equipment. The guidelines provided by the new EnerGuide version enabled EAs to successfully collect the specifications for the new equipment during the post-retrofit evaluation.

In the 10 reviewed files, 18 errors related to HVAC equipment were identified, none of which had an impact greater than 5 percent on energy consumption. Notwithstanding, the review highlighted common mistakes made by the EAs, which mainly related to recording additional ventilation, heat recovery ventilator (HRV) flow rates and heat pump efficiency values.

The most common mistake related to the number of recorded exhaust fans. This was the case in six projects. In four cases, the EA did not record any bathroom or kitchen fans. In another file, the EA recorded a higher number of exhaust fans than the maximum allowed by the guidelines. Another inconsistency related to HRV flow rates and the HRV sensible recovery percentage. Generally, once an HRV flow rate is calibrated, the corresponding efficiency of the system is not available. In such cases, EAs must evaluate efficiency based on the data listed on the nameplates on site. The NRCan protocol describes how the flow rate can be determined depending on the information available. In four of the 10 projects reviewed, the right procedure was not followed by the EA. Some specific mistakes regarding the Seasonal Energy Efficiency Ratio (SEER) also affected energy consumption results. In four projects, the EA recorded a SEER of 20 or 22 instead of 25. This error occurred several times as the EA probably used the same template file for these four houses that had similar dimensions and were located in the same area. Attention should be paid when using template files; if errors occur, they will be repeated many times.

Water Heating Equipment

The characteristics associated to domestic hot water (DHW) equipment were also reviewed. The information provided for DHW equipment was accurate and comprehensive, except for in the case of three sites. Errors in the tank volume were identified in two files. This had a limited impact of less than 1 percent on the energy consumption of each household. In the third file, the EA recorded a tankless DHW system, whereas the review indicated a 76 US gallon electrical tank was installed, which reduced the overall energy consumption of the household by 13 percent.

4.2 Gross Savings

Gross savings correspond to the change in energy consumption resulting from the energy efficiency levels achieved in the new homes under NHC. Prior to calculating gross savings, the Evaluator had to adjust the formula used in the tracking sheet since several manual entries and unclear formulas were found. It was therefore too difficult for the Evaluator to revise the gross savings that ENS tracked without ensuring that all formulas used in the tracked savings calculations were consistent for all participants.

The following subsections describe how gross savings were calculated for NHC, including those associated with the Passive House pilot.

4.2.1 Gross Energy Savings Calculations for NHC

The final 2018 tracking sheet provided by ENS contained data for a total of 645 NHC participants who generated electrical savings. To establish the modelled gross energy savings associated with each participant, two methods were used: (1) modelled energy consumption; and (2) savings per EnerGuide point. Since 2015, to-code and as-built modelled energy consumption values have been available for most participants and were used for the savings calculations. For participants who registered under NHC before 2015, to-code energy consumption values were not available; hence the previous savings calculation method was used. This method consisted of applying the average savings per EnerGuide point increase to the difference between the baseline EnerGuide rating (established at 78) and the as-built EnerGuide rating. For the 2018 evaluation, this method was used for two participants. One of the two participants registered after 2015 but had inconsistencies in their to-code and as-built modelled energy consumption values; therefore, the Evaluator decided to use the savings per EnerGuide point method. The two methods are further discussed here below.

Method 1: Modelled Energy Consumption

The modelled gross energy savings were calculated by comparing the to-code and as-built modelled energy consumption (EC) levels resulting from the HOT2000 simulations, minus the baseload consumption (BC), and adjusted with an OR (overestimation ratio). The baseline consumption is a fix value of 8,760 kWh for HOT2000 version 10.5 and of 7,118 kWh for HOT2000 version 11. Since it is not affected by the energy efficient upgrades, the baseline consumption is removed from the savings calculation. The to-code energy consumption represents the value of the baseline, i.e. the energy consumption of the house built according to the current building code. For this method, the modelled gross energy savings were calculated using the equation below. All consumption values are in kWh. The Evaluator considered this method appropriate and should be favoured whenever the as-built consumption value is available.

$$\text{Gross Energy Savings} = (EC_{\text{To-code}} - BC) \times (1 - OR_{\text{To-Code}}) - (EC_{\text{As-built}} - BC) \times (1 - OR_{\text{As-built}})$$

Overestimation Ratio

The OR is used to adjust the modelled energy consumption values generated by the HOT2000 software because it tends to slightly overestimate savings. The ORs established as part of the HEA evaluation were used to adjust the modelled energy consumption of NHC houses since no billing analysis was ever performed specifically for NHC because consumption data have been insufficient.

While the billing analysis conducted for HEA in 2018 was initially aimed at estimating a new OR for the new version of HOT2000, it revealed that the space heating system in place, particularly heat pumps, had a greater impact on the OR than expected. Consequently, distinct ORs were established for the 2018 HEA evaluation, depending on whether a heat pump was in place or not, but without distinguishing which version of HOT2000 was used. These ORs were used to adjust the as-built total energy consumption of NHC participants based on the heating system in place (with or without a heat pump).

For the to-code model, which corresponds to a house entirely heated with electrical baseboards, the Evaluator conducted additional analyses to calculate an OR for participants having neither a heat pump nor a wood/pellet stove in place, which is more representative of the to-code scenario.

Table 13 presents the OR established for each scenario. No distinction is made for the HOT2000 version. By comparison, the OR used for the tracked savings calculation was 16 percent for all scenarios (the percent calculated during the 2015 HEA billing analysis).

Table 13: Overestimation Ratio Values for NHC

Scenario	Number of Participants in the Billing Analysis	Difference Between Modelled and Actual Space Heating Consumption	Margin of Error	OR
To-code Model – With Neither Heat Pump Nor Wood/Pellet Stove	400	9%	2%	9%
As-built Model – With Heat Pump	53	-2%	13%	0%
As-built Model – Without Heat Pump	618	19%	3%	19%

The fact that the majority of the savings achieved through NHC are generated by measures affecting space heating consumption justifies the application of the space heating consumption ORs obtained from HEA participants to the total energy consumption of NHC houses minus the baseload consumption.

The Evaluator believes that HOT2000 version 11 will progressively be used more in upcoming years and will enable billing analysis on a sample of NHC participants large enough to consider the various versions of HOT2000 (i.e. versions 11.3; 11.4; 11.5) to evaluate the impacts of the different heating systems in place.

Non-electrical Heating System Used as Backup

In NHC, the baseline heating system modelled in the to-code simulation corresponds to 100 percent electrical baseboards. The total as-built modelled energy consumption is subtracted from this baseline scenario, even if a portion of energy consumption is non-electrical. This ensures a conservative estimate in the savings calculation and avoids accounting for fuel-switching savings. Only 11 percent of 2018 participating homes had a non-electrical backup heating system installed. Moreover, 2 percent of participating homes used only non-electrical heating systems yet had all their savings claimed as electrical.

Method 2: Savings per EnerGuide Point

For 2018, the savings per EnerGuide point method was used for one participant who registered before 2015 and who did not have a to-code energy consumption value. The method was also used for one participant who seemed to have inconsistent modelled energy consumption values with a final consumption higher than the to-code consumption even if the final EnerGuide rating (84) was above the baseline EnerGuide rating (78).

The savings per EnerGuide point method is based on the following equation:

$$\text{Gross Energy Savings (kWh)} = [\text{ER}_{\text{As-built}} - \text{ER}_{\text{Baseline}}] \times \text{Savings per EnerGuide Point (kWh)}$$

Where ER corresponds to the EnerGuide rating.

The average baseline EnerGuide rating is established at 78. This value is based on Revision 2012 of the NBC (Part 9) adopted in July 2013 by Nova Scotia.¹⁴ The requirements of the NBC Revision 2012 have been in effect in Nova Scotia since December 31, 2013; these requirements indicate that an average EnerGuide rating of 78 should be used when modelling using HOT2000 Version 10. In addition, the average value of the available to-code EnerGuide rating in the 2018 tracking sheet is 77.7. The Evaluator therefore considered an EnerGuide baseline of 78 as still valid for 2018 and appropriate to the current market.

ENS uses a savings per EnerGuide point value of 1,278 kWh. This value was calculated by multiplying the average savings per EnerGuide point (1,521 kWh) by the OR (1-0.16). The average savings per EnerGuide point was determined based on 2015 NHC participants for whom savings had been calculated using the modelled energy consumption values and whose final EnerGuide ratings were available. The OR value was established at 16 percent since only HOT2000 version 10 was used in 2015.

Given the small number of participants using the savings per EnerGuide point method, the Evaluator maintained the 2015 savings value of 1,278 kWh per EnerGuide point to calculate the savings of these participants.

4.2.2 Gross Energy Savings Calculation for Passive House Pilot

Savings for the Passive House pilot are calculated by comparing the baseline energy consumption and as-built energy consumption using the following formula:

$$\text{Gross Energy Savings (kWh)} = [\text{EC}_{\text{Baseline}}(\text{kWh}) - (\text{EC}_{\text{As-built}}(\text{kWh/ft}^2) * \text{TFA}(\text{ft}^2))]$$

Where:

- › $\text{EC}_{\text{Baseline}}$ is the baseline energy consumption (kWh)
- › $\text{EC}_{\text{As-built}}$ is the as-built energy consumption per square footage (kWh/ft²)
- › TFA is the treated floor area (ft²)

¹⁴ Nova Scotia, Building Code Regulation, "Nova Scotia Building Code Regulation – Users Version, 2014," pp. 88-89, available at: <https://novascotia.ca/dma/firesafety/buildingcode/docs/141020FINALUSERSNSBCR141231.pdf> (Last accessed December 11, 2017).

Baseline energy consumption values (EC_{Baseline}) are calculated using the following equation which was obtained from a linear regression analysis conducted as part of the 2017 evaluation. The linear regression was developed using the to-code energy consumption and the house area values of 2016 and 2017 NHC participants who used electricity as a primary heating source, and then corrected with the 16 percent OR.

$$EC_{\text{Baseline}} (\text{kWh}) = 5.0103 * \text{CFA}(\text{ft}^2) + 9,609.1$$

Where CFA is the common floor area (in ft^2).

These values were obtained from the building plans of Passive House pilot participant houses and represent interior floor areas of all heated space within the envelope. This floor area definition is also how HOT2000 defines a house floor area for modelling. The value is entered in the tracking sheet for all participants.

As-built energy consumption per square footage values ($EC_{\text{As-built}}$) are calculated using either the Passive House Planning Package (PHPP) or WUFI®, which are well-known software applications used by specialists in passive house modelling. All passive house projects must be modelled using either software to determine whether the project is eligible for the Passive House pilot or not. To be eligible, projects must meet a heating demand of 7.1 kBtu/ ft^2/yr or lower. PHPP and WUFI® use the treated floor area values, a practice that differs from the house floor area values used in HOT2000. For the treated floor area values, areas such as stairs with more than three steps, garages, chimneys, walls, and interior columns are excluded. Rooms must have a height of 6.6 ft or higher. Furthermore, only 50 percent of the floor area is considered for rooms with a height between 3.3 and 6.6 ft. Finally, 60 percent of the floor area of storage and mechanical rooms is included in the simulation. As-built energy consumption is established for each Passive House pilot participant by multiplying the treated floor area value and the as-built energy consumption per square footage value.

This method, based on the 2017 NHC evaluation, was used in the tracking sheet for all participants of the Passive House pilot and was considered still appropriate in 2018. Therefore, the Evaluator used that same approach to calculate savings for the seven participants who completed Passive House projects in 2018.

4.2.3 Interactive Effects

No interactive effects were added by the Evaluator savings calculation since they were already taken into account in the HOT2000 simulations.

For the Passive House pilot, the interactive effects were already considered in the savings calculation since the calculations are also based on simulation models.

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

For both NHC and the Passive House pilot, the tracked peak demand savings were calculated using the on-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 also used local data to establish this ratio. The Evaluator considered that the approach used by Navigant was valid and therefore used it to estimate peak demand savings for NHC and the Passive House pilot.

4.2.5 Effective Useful Life

For the 2018 evaluation, the Evaluator relied on equivalent effective useful life (EUL) values established through a literature review conducted as part of the 2017 evaluation. Table 14 below presents the equivalent EUL values established for NHC and the Passive House pilot. In summary, all tracked equivalent EUL values were adequate and no changes were applied by the Evaluator.

Table 14: Summary of EUL Values for NHC

	Tracked Equivalent EUL (Years)	Revised Equivalent EUL (Years)
NHC	30	No change
Passive House Pilot	36	No change

4.2.6 Revised Gross Savings

The gross savings at the generator were calculated using an NSP line loss factor of 1.100 between the meter and the generator. The revised gross energy and peak demand savings at the generator amount to 4.716 GWh and 1.335 MW for NHC respectively, and 0.089 GWh and 0.025 MW for the Passive House pilot respectively. Based on an average EUL value of 30 years for NHC and a value of 36 years for the Passive House pilot, the lifetime energy savings are 141.493 GWh and 3.212 GWh for NHC and the Passive House pilot respectively.

The revised annual gross savings for NHC and the Passive House pilot are presented in Table 15.

Table 15: Revised Gross Energy and Peak Demand Savings

	NHC	Passive House Pilot	Total
Number of Participants	645	7	652
Energy Savings			
Initial Gross Energy Savings (GWh)	5.256	0.109	5.365
Overestimation Ratio	_*	_**	-
Revised Gross Energy Savings – at the Meter (GWh)	4.288	0.081	4.369
Line Loss Factor	1.100	1.100	-
Revised Gross Energy Savings – at the Generator (GWh)	4.716	0.089	4.806
Effective Useful Life (years)	30	36	-
Gross Lifetime Energy Savings – at the Generator (GWh)	141.493	3.212	144.705
Peak Demand Savings			
Demand-to-energy Ratio (MW/GWh)	0.283	0.283	-
Revised Gross Peak Demand Savings – at the Meter (MW)	1.213	0.023	1.236
Line Loss Factor	1.100	1.100	-
Revised Gross Peak Demand Savings – at the Generator (MW)	1.335	0.025	1.360
*Distinct ORs were applied considering the scenario (to-code or as-built model) depending on whether a heat pump was in place or not. Please refer to the Overestimation Ratio subsection (4.2.1) for more detail. **An OR of 0.84 was applied only to the baseline energy consumption (none was applied to the to-code energy consumption).			

4.3 Net-to-gross Ratio

The net-to-gross ratio (NTGR) serves to determine net savings, i.e. the energy savings that can be reliably attributed to a program component. More precisely, the NTGR represents the positive or negative effects on gross savings. Two effects are considered for NHC: free-ridership; and spillover in the form of market effects.

4.3.1 Free-ridership

Free-ridership occurs when participants would have still implemented energy efficiency measures in the absence of the program component. Free-ridership was assessed in 2017 for both NHC and the Passive House pilot through participant surveys. No data collection aimed at updating the 2017 free-ridership levels was conducted in 2018 since no major changes were made to NHC and participation distribution between homeowners and builders remained similar for both years. Table 16 outlines the free-ridership levels obtained in 2017 and used for the 2018 evaluation.

Table 16: Average Free-ridership Levels for NHC

	Average Free-ridership Level	Sample Size	Population Size
NHC – Homeowner Participants	26%	12	57
NHC – Participating Builders	29%	40	363
NHC – Combined (Homeowners + Builders)	29%	52	420
Passive House Pilot – Participants	61%	4	6

4.3.2 Spillover (Market Effects)

Spillover occurs when participants decide to implement energy efficiency measures in new construction projects without participating in the program component. For NHC, this is measured in the form of market effects based on builder perspectives, housing market information, and data from the tracking sheet, as illustrated in the following equation:

$$\text{Spillover Level} = \frac{\text{Total \# of N – P Houses} \times \%N - P \text{ Houses}_{EE} \times \%Attrib \times \%Elect}{\text{Total \# of Participating Houses}}$$

The total number of non-participating houses (Total # of N-P Houses) was obtained by subtracting the number of new houses that participated in NHC (as per the 2018 tracking sheet) from the total number of houses built in Nova Scotia in 2018.¹⁵ The result was multiplied by the percentage of non-participating houses that would have met the NHC energy efficiency criteria (%N-P Houses_{EE}) and by the percentage of attribution (%Attrib) that corresponds to the influence of NHC on the residential new home construction market. These two percentages were obtained from the builder survey conducted as part of the 2017 evaluation. These two percentages were then multiplied by the percentage of new houses that are primarily electrically heated (%Elect). This value was established at 90 percent during the 2016 evaluation by calculating the average proportion of participants who used electricity as their main heating source and who participated in NHC between 2012 and 2015, a period when NHC was also offered to participants with non-electrical heating systems. Finally, the spillover level was obtained by dividing the resulting number by the total number of participating houses in 2018 (Total # of P Houses) obtained from the 2018 tracking sheet. The measured spillover level for 2018 was established at 24 percent, compared to 35 percent in 2017.

No spillover was considered for the Passive House pilot in 2017 since it was still fairly new in the market and had not yet been adopted by many builders.

¹⁵ Canada Mortgage and Housing Corporation data. *Housing Market Information Portal*. <https://www03.cmhc-schl.gc.ca> (Last accessed December 05, 2018).

4.3.3 NTGR Calculation

The NHC NTGR is calculated using the following equation:

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

By applying the free-ridership and spillover levels discussed in the previous subsections, the NTGR value for NHC was estimated at 0.95.

The NTGR of the Passive House pilot was calculated using the same equation as that for NHC without applying a spillover percentage. The Passive House pilot NTGR was established at 0.39.

4.4 Net Savings

Net savings represent the savings that can be reliably attributed to a program component. For NHC and the Passive House pilot, net savings are calculated by applying the NTGR value calculation above to the revised gross savings, as exemplified in the following equation:

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

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

The net energy and peak demand savings were respectively established at 4.481 GWh and 1.268 MW at the generator for NHC and respectively at 0.035 GWh and 0.010 MW at the generator for the Passive House pilot. Detailed results are presented in Table 17 below. Based on an EUL of 30 years for NHC and 36 years for the Passive House pilot, the net lifetime energy savings were established at 134.419 GWh and 1.253 GWh respectively. By applying 0.6126 kg CO₂ eq/kWh, which is Nova Scotia's specific factor¹⁶ for GHG emissions generated by electricity production, it was estimated that the net energy savings resulted in 2,745 tonnes and 21 tonnes of avoided annual CO₂ eq for NHC and the Passive House pilot respectively.

¹⁶ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes) and total electricity generation (10,978 GWh) was found in the following two sources:

Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018).

Emera Inc., *Management's Discussion & Analysis* as at February 9, 2018, <http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

Table 17: Evaluated Net Energy and Peak Demand Savings

Parameter	NHC	Passive House Pilot	Total
Energy Savings			
Revised Gross Energy Savings – at the Meter (GWh)	4.288	0.081	4.369
NTGR	0.95	0.39	-
Total Net Energy Savings – at the Meter (GWh)	4.073	0.032	4.105
Line Loss Factor	1.100	1.100	-
Total Net Energy Savings – at the Generator (GWh)	4.481	0.035	4.515
Effective Useful Life (years)	30	36	-
Net Lifetime Energy Savings – at the Generator (GWh)	134.419	1.253	135.671
Peak Demand Savings			
Revised Gross Peak Demand Savings – at the Meter (MW)	1.213	0.023	1.236
NTGR	0.95	0.39	-
Total Net Peak Demand Savings – at the Meter (MW)	1.153	0.009	1.162
Line Loss Factor	1.100	1.100	-
Total Net Peak Demand Savings – at the Generator (MW)	1.268	0.010	1.278

A comparison of the energy and peak demand savings values established through this evaluation and those calculated by ENS is presented in Table 18.

Table 18: Comparison of Tracked and Evaluated Savings at the Generator

	Initial Gross Savings	Adjusted Gross Savings	NTGR*	Net Savings
Energy Savings				
ENS Tracked Savings	5.901 GWh	4.946 GWh	0.90	4.451 GWh
Evaluation Results	5.901 GWh	4.806 GWh	0.94	4.515 GWh
Peak Demand Savings				
ENS Tracked Savings	1.670 MW	1.400 MW	0.90	1.260 MW
Evaluation Results	1.670 MW	1.360 MW	0.94	1.278 MW

*The average NTGR values correspond to the ratio of net savings to gross savings for NHC and Passive House combined.

The savings tracked by ENS were compared with the results established by the Evaluator for 2018. Both the gross energy and peak demand savings calculated as part of the 2018 evaluation are equal to the initial gross savings tracked by ENS. As for the adjusted gross savings, the evaluated savings are 3 percent lower than the tracked values. This difference is mainly explained by the updated ORs used to adjust the modelled space heating consumption values generated by the HOT2000 software for NHC. On the other hand, the evaluated net energy and peak demand savings are higher than those tracked by ENS due to the increase in the NTGR value for NHC (0.95) compared to the tracked value (0.90). For Passive House, the NTGR used by ENS for tracking was also 0.90 and was revised to 0.39 according to the NTGR value established specifically for this pilot in the 2017 evaluation.

Table 19 below summarizes the participation level, as well as gross savings and net savings for NHC, including the Passive House pilot.

Table 19: Overall Participation and Savings for New Residential

	Participation Level	Gross Savings	NTGR	Net Savings
NHC				
Energy Savings	652 participants	4.806 GWh	0.94	4.515 GWh
Lifetime Energy Savings		144.705 GWh	0.94	135.671 GWh
Peak Demand Savings		1.360 MW	0.94	1.278 MW

5 NHC RECOMMENDATIONS

One of the main goals of the 2018 evaluation was to identify ways of improving NHC since past evaluations revealed dissatisfaction with the process and a decrease in both participation levels and savings. From a participation standpoint, the 2018 evaluation demonstrated an increase in the number of completed projects. While they did not reach targets, 2018 net energy savings are also higher than in 2017. In addition to the general recommendations presented for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator makes the following recommendations for NHC. These recommendations are intended to serve various purposes, from increased collaboration between builders and DAs/EAs, greater builder satisfaction, to improved savings accuracy and tracking processes, with the goal of generating more completed projects. These recommendations are also outlined in Appendix III. No specific recommendation was made for the Passive House pilot.

2018 NHC-R1. Increase support and guidance to builders by exploring ways to further involve DAs and EAs in the NHC participation process. As evidenced by the process evaluation, DAs and EAs are valuable partners in new home construction programs and their involvement in projects can be a key factor in project success and builder satisfaction. They have the knowledge and expertise to, among other things, assist builders with registration and offer technical assistance during construction, such as measure suggestions and on-site verifications of measure installations. ENS should review the NHC participation process and identify areas where DAs and EAs can be further involved. While the Evaluator believes that EAs and DAs are also key allies in the recruitment of new builders, achieving the goal of generating more projects under NHC must first involve an assessment of current processes to ensure they are in line with builder expectations and needs.

2018 NHC-R2. Be flexible, as much as possible, with timeline requirements that may be difficult for builders to meet. Interviews with other program administrators revealed that flexibility with builders is key to program success. For example, providing exceptions to the requirement to register within 30 days of receiving a building permit and offering extensions to builders that need more than 12 months to complete a project without having to re-register are important aspects to builders and can be a deal breaker for certain builders.

- 2018 NHC-R3. Share evaluation findings with the EAs to ensure sustained quality simulations and that all required documentation is included in participant files.** As part of the 10 NHC on-site visits and HOT2000 simulation reviews, the Evaluator noted that improvements had been achieved in the accuracy of simulations since the last review in 2016. Conversely, the Evaluator identified errors affecting the energy consumption in each file reviewed. Moreover, the Evaluator noted that building plans or as-built reports, containing the characteristics of each house component, were still missing for the majority of the files reviewed despite the recommendation made in the 2016 Evaluation Report to ensure that all required documentation be included in participant files. These findings should be shared with the EAs to continue working toward higher-quality simulations, and particular effort should be invested in investigating concrete solutions on how all the required documentation could be included in the participant files.
- 2018 NHC-R4. Conduct a billing analysis to review ORs when a sufficient NHC participant sample becomes available.** The current ORs used for NHC were obtained from a billing analysis of Home Energy Assessment (HEA) participant data. In past years, no billing analyses were conducted with NHC participants since only a few participants had their as-built energy consumption value available. The HEA billing analysis conducted in 2018 was initially aimed at estimating an OR for the new version of HOT2000, although it revealed that the space heating systems in place, particularly heat pumps, had a much more significant impact on the OR than the difference between the versions of HOT2000 that are used. Since more NHC projects will be completed under the HOT2000 version 11 rating system in upcoming years, the Evaluator recommends conducting a billing analysis specific to NHC participants when a large enough sample becomes available to both consider the various versions of HOT2000 (i.e. versions 11.3; 11.4; 11.5) and evaluate the impact of the different heating systems in place.
- 2018 NHC-R5. Ensure the tracked savings are accurate.** Prior to reviewing the gross savings calculations, the Evaluator identified several issues in the 2018 tracking sheet, including with values that had been entered manually. The Evaluator reviewed all the formulas used for the tracked savings calculations and when revisions were required, the Evaluator shared the revisions with ENS. For future years, the Evaluator recommends that ENS apply these formulas to track NHC savings and ensure they are consistently applied to all participants in the tracking sheet.

CONCLUSION

The New Residential program, including NHC and the Passive House pilot, achieved 4.515 GWh in net energy savings and 1.278 MW in net peak demand savings at the generator, which resulted in 2,766 tonnes of CO₂ eq in avoided annual GHG emissions. These energy and peak demand savings are very close to the 2018 NHC targets of 4.6 GWh in net electrical energy savings and 1.3 MW in net peak demand savings at the generator. The net lifetime energy savings amounted to 135.671 GWh. A total of 652 participants, including seven Passive House pilot participants, completed a project that generated electricity savings in 2018. Participation and net energy and peak demand savings all increased compared to 2017 levels.

The main data-collection activity of the impact evaluation involved conducting on-site visits and simulation file reviews for 10 NHC projects to determine the completeness and accuracy of the information in the as-built simulation files and DCFs. Overall, the Evaluator found that documentation was missing in eight of the 10 reviewed projects. On the plus side, although the Evaluator made adjustments to the N assessment energy consumption values in all 10 projects, only two contained errors affecting energy consumption by more than 5 percent. In total, the global adjustment for the 10 projects was 0.3 percent, compared with 3 percent in 2016, thereby demonstrating considerable improvement in the accuracy of the simulations. Revised ORs were also established for NHC, based on the results of a billing analysis conducted with HEA participants, and used for energy savings calculations.

The 2018 evaluation scope of work included a process evaluation to identify ways of improving NHC since past evaluations revealed dissatisfaction with the process and a decrease in both participation levels and savings. The main evaluation activity of the 2018 NHC process evaluation was a jurisdictional review of new home construction programs in North America. The review served to assess (1) program outreach and recruitment, (2) DA selection, (3) project registration, (4) project application review, (5) construction and inspections, (6) incentive levels and home labels, and (7) training. Results revealed that NHC processes are in line with most reviewed program practices. The jurisdictional review indicated two phases of the participation process whereby improvements should be considered to increase builder satisfaction and the number of completed projects: project registration; and construction and inspections. These improvements focus around having the builders and DAs work together and offering flexibility in program timelines. According to some jurisdictions, having builders work with DAs to register projects under the program can alleviate some dissatisfaction among builders and build rapport between the two early on in the participation process. Additionally, having DAs perform site visits during construction is viewed by other jurisdictions as a means of providing assistance and guidance to builders. Furthermore, being flexible with the required timelines to register houses and complete construction was also mentioned as a means of accommodating builders. Overall, the jurisdictional review highlighted how important it is for new home construction programs to adapt to not only the market, codes and regulations, but also builders whenever possible.

LIST OF APPENDICES

The following are presented in the New Residential Program – Appendices.

NHC

Appendix I: Interview Guide with Jurisdictions

Appendix II: On-site Visits and HOT2000 Simulation Review Protocol

Appendix III: 2018 Recommendations



ECONOLER

NEW RESIDENTIAL PROGRAM

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Appendix Report

March 15, 2019



TABLE OF CONTENTS

APPENDIX I INTERVIEW GUIDE WITH JURISDICTIONS	1
APPENDIX II ON-SITE VISITS AND HOT2000 SIMULATION REVIEW PROTOCOL	8
APPENDIX III 2018 RECOMMENDATIONS	16

APPENDIX I

INTERVIEW GUIDE WITH JURISDICTIONS

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	In-depth interview
Estimated Time to Complete	30 minutes
Population Description	Program Managers of New Homes Programs in North America
Population Count	25+
Sampling Strata Definitions	None
Contact List Source and Date	Efficiency Nova Scotia Staff, Review of EE Program Literature
Fielding Firm	Research Into Action

Interviewer Information

Interviewer instructions are in *italics* or in brackets [].

Program Description: New Home Construction

NHC encourages homeowners and builders to exceed energy efficiency building code requirements for new homes. Participation in NHC involves completing the following steps: (1) reviewing a home's plans using the HOT2000 simulation software; (2) providing the builder or the homeowner with a report which contains the simulation results and some energy-efficiency recommendations on how to make the home meet NHC eligibility requirements; (3) once the home is built, having an energy advisor (EA) conduct a final inspection and an air-tightness (blower door) test to verify the new home's energy-efficiency level.

There were 420 participants in 2017 and the program saved 3.6 GWh. Additionally, in 2017 there was a Passive House pilot project that had six participants that generated 0.02 GWh of savings.

Instrument

Name:

Company:

Date:

Interviewer:

[Prior to scheduling interview, the interviewer will have reviewed program documents and data we could gather online.]

I work for Research Into Action, a subcontractor to Econoler, and we have been asked by Efficiency Nova Scotia to conduct a process evaluation for their New Home Construction program. As part of that, we are interviewing people representing other new home programs in North America.

We understand you are a program manager or other person knowledgeable about [PROGRAM NAME]. Is that correct?

[If yes, continue with script. If no, ask for an alternate contact person?]

Our talk will take about 30-45 minutes. Do you have time now or can we schedule a time to talk?

[Before administering the interview state the following]

Everything you say is confidential. We won't share our notes from the conversation unless we are legally required to, and we will not report findings in a way that would identify any individual respondent. I'll be taking notes as we talk, but I'd also like to record the call, just to help with my notetaking. Is that OK with you?

S1. If you would like, we will be happy to send you a copy of the report when completed. Would you like a copy of the report?

1. Yes, verify email address_____
2. No

Do you have any questions before we get started?

Roles and Experience

[ASK ALL]

Q1. Let's start with a bit about you. Can you please tell me your title and briefly describe your role with your organization?

[ASK ALL]

Q2. How long have you been in your role?

Document Review

[ASK ALL]

- Q3. I'd like to let you know that we did collect and review some information about your program in preparation for this call. We have [LIST DOCUMENTS HERE]. Are there any other documents you can refer us to that would help us understand your program processes?

Outreach and Recruitment

Let's switch gears and talk about how builders and homeowners are recruited into your program.

[ASK ALL]

- Q4. First, how do builders typically learn about your new construction program? How do you encourage them to participate?

[ASK ALL]

- Q5. What challenges, if any, have you had recruiting builders into the program? How have you addressed those challenges?

[ASK ALL]

- Q6. How do homeowners typically learn about your new construction program? What do you do to encourage them to participate?

[ASK ALL]

- Q7. What challenges, if any, have you had recruiting homeowners to participate? How have you addressed those challenges?

Program Delivery and Phases

Let's talk about program processes by starting with....

[ASK ALL]

- Q8. Who delivers the program to builders and homeowners? For example, ENS has four "service organizations" that register participants (builders or homeowners) in the program, then model each home's initial plans and conducts an audit when the home's construction is near complete. Does your program have a similar entity? Please describe?

Project Registration Phase

[ASK ALL]

- Q9. What does a builder or homeowner do to register a home in the program? How, if at all, does this differ between built to specification and custom homes? *[If needed: By spec or model home I mean a home constructed with the intention of selling the home upon completion. By custom, I mean a home being built specifically for a homeowner].*

[ASK ALL]

Q10. How long does it take a builder or homeowner to register a home in the program and what are the steps involved? How, if at all, does this differ between spec and custom homes?

[ASK ALL]

Q11. What feedback, if any, have you heard from builders or homeowners about registering homes? How, if at all, does this differ between spec and custom homes?

[ASK ALL]

Q12. What does the program staff do with the home registration? How, if at all, does this differ between spec and custom homes?

[ASK ALL]

Q13. How long does it take the staff, typically, to respond to the builder or homeowner? How, if at all, does this differ between spec and custom homes?

[ASK ALL]

Q14. What feedback, if any, have you heard from builders or homeowners about registering the home? *[If needed: Is the turn-around time for staff review a problem for builders?]* Are the registration applications a struggle for builders? How, if at all, does this differ between spec and custom homes?

Home Construction Phase

[ASK ALL]

Q15. During home construction, how often, if at all, does a program representative visit the home? At what stages of the construction do these on-site visits occur?

[ASK ALL]

Q16. *[If there are on-site visits]* What is the intent of each on-site visit(s)? What documents are collected or created at each visit?

[ASK ALL]

Q17. What feedback, if any, have you heard from builders or homeowners about these on-site visits? How, if at all, does this differ between spec and custom homes?

Project Completion Phase

[ASK ALL]

Q18. What steps does a builder or homeowner need to follow to receive their final incentive? Is there a difference between custom and spec homes?

[ASK ALL]

Q19. How long does it take the builder or incentive to receive their incentive once they have completed all required program steps?

[ASK ALL]

Q20. What feedback, if any, have you heard from builders or homeowners about the time it takes to receive the incentive?

[ASK ALL]

Q21. How long does it typically take from the time a builder or homeowner first registers a home, until they receive an incentive for the home at the end of the program?

[ASK IF NOT ADDRESSED ABOVE]

Q22. How, if at all, does participation in the program differ for custom home builders versus spec or model home builders?

Requirements of Builders

I have several questions about program requirements and eligibility. To start...

[ASK ALL]

Q23. What requirements do builders have to meet, if any, to build homes as part of your program? Do they have to be vetted somehow, have certain insurance, etc.? Do you know the rationale for these requirements? If the program requirements for builders have changed over time, how have they changed and why were the changes made?

[ASK ALL]

Q24. ENS requires that a home be registered with their program within 30 days of receiving a building permit. Do you have a similar requirement? *[If so]* what is the requirement? Have you heard any feedback from builders or homeowners about this requirement? Has this deadline changed since the program was first implemented? *[If so]* How has this requirement changed and why did you make these changes?

[ASK ALL]

Q25. ENS requires homes that are registered with the program be completed within 1 year of registration in order to receive incentives. Do you have a similar requirement, and if so, what is the requirement? What feedback, if any, have you heard from builders or homeowners about this requirement? Has this deadline changed since the program was first implemented? *[If so]* How has this requirement changed and why were the changes made?

Incentives

I think I have an understanding of your incentive structure from your program website and documents. However, could you please go over your incentives with me. Let's start with ...

[ASK ALL]

Q26. Who receives program incentives - builders, homeowners, or both? Why did you choose to give incentives to builders and/or homeowners?

[ASK ALL]

Q27. How did you choose the incentive amounts you offer?

[ASK ALL]

Q28. How have incentive amounts changed over the last few years, if at all? Why did you make these changes?

[ASK ALL]

Q29. What feedback have you heard from builders about the incentive amounts? I am sure everyone would want larger incentives, but in general, are the incentive amounts you offer sufficient to keep builders coming back to the program year after year? Why do you say that?

[ASK IF NOT ADDRESSED]

Q30. How, if at all, do the perceptions about incentives differ between spec and custom builders? *[If differences:]* What are those differences?

Home Labels

[ASK ALL]

Q31. Does your program provide home labels or certification to homes that go through the program? *[If needed: By home labels I am thinking of things like Energy Star, Earth Advantage, or LEED for homes].*

[ASK IF THEY USE LABELS]

Q32. How effective or useful is that label in encouraging program participation?

[ASK IF THEY USE LABELS]

Q33. What have you heard from spec builders about how effective or useful labels are in encouraging customers to purchase these homes?

Successes, Challenges, and Opportunities

To wrap-up I have a few general questions about the program's successes, challenges, and opportunities.

[ASK ALL]

Q34. What do you think builders and homeowners like best about your program?

[ASK ALL]

Q35. What do you think builders and homeowners dislike about your program?

[ASK ALL]

Q36. What changes, if any, are you planning to make to your program in the coming year or two? *[If making changes]* Why are you planning these changes?

[ASK ALL]

Q37. What are your program's key successes? Why do you say that?

[ASK ALL]

Q38. What are the key challenges your program will face over the next two years? How do you plan to overcome those challenges?

[ASK ALL]

Q39. How often, if at all, are process evaluations performed for your New Homes program?

[ASK ALL]

Q40. Is there anything else about the program that we have not discussed that you would like to mention?

Those are all the questions I have. Thanks for your time.

APPENDIX II

ON-SITE VISITS AND HOT2000 SIMULATION REVIEW PROTOCOL



File Assessment and Modeling Verification Form

To be used for: Level 3, Level 4 and Level 5 Quality Assurance Audits

The following sets out the criteria that each evaluated house file must meet:

1. Each question must be answered with a 'Yes', 'No', or 'N/A' (if not applicable to the type of service) via the drop-down list.
2. If a section is not applicable, enter N/A in the section heading and the section will be greyed out.
3. Provide details in the "additional information/comments" section to help support your response.
4. Where a line asks whether the section was a significant error, score it as 1 (Low significance), 2 (Medium significance), 3 (High Significance).
5. Upon completion of the File Assessment and Modeling Verification, enter your name and date in the form (top of form).

Quality assurance auditor / Quality Assurance Specialist:

Date of quality assurance audit (YYYY/MM/DD):

File number (N)

N Energy advisor name:

House evaluation date (YYYY/MM/DD):

Building type:

Type of service:

Overall Consumption Difference (%)

Energy Consumption (Net AEC-AEP) of Energy Advisor File

Energy Consumption (Net AEC-AEP) of re-modelled File

Difference in energy consumption between the energy advisor and the quality assurance auditor file?

0

Impact of the error
on the energy
consumption (in %)
only if the difference
is > 0.1%

Additional
Information/
Comments

1

1

0%

Data Collection

Was sufficient information provided in order to model or verify the modeling of the following?

General information and geometry

Type of Service (Basic, Upgrade)

General house information/specification

Blower door info (data collection form or 3rd party software printout)

Sketches/measurements/calculations - for each floor level

Sketches - gable profile/dimensions for sloped ceilings

Risk assessment of mixed-use buildings

Heated floor area

0

Yes No N/A
Information in
accordance with
the Data Collection
Forms, Pictures
and Drawings

Impact of the error
on the energy
consumption (in %)
only if the difference
is > 0.1%

Additional
Information/
Comments

Building Envelope			
Ceiling and roof assembly configurations			
Wall assemblies			
Floor header information			
Exposed floor information			
Windows			
Significant window overhangs			
Doors			
Foundation			
Foundation configuration (s)			
Basement information			
Crawlspace information			
Slab-on grade information			
Foundation header			
Pony wall			
Mechanicals			
Primary heating system			
MURBS - Multiple heating systems			
Supplementary heating system			
Type 2 Systems (Heat pumps/Cooling systems)			
Domestic hot water			
Whole house ventilation			
Supplemental ventilation			
Drain water heat recovery			
Renewables	N/A		
Solar DHW	N/A		
Photovoltaic	N/A		
Wind turbine	N/A		
Program specific			
Low-flush toilets			
Household operating conditions	N/A		
Atypical energy loads	N/A		
Reduced operating conditions			
Program specific			
Dwelling units and Non-Res units			
Multi-unit: one unit identified as basement only			
Other			

Photographic Requirements <i>Follows criteria as per data collection purposes</i>	0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/ Comments
	Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings		
Exterior building components			
Front of building			
All exterior elevations			
Mechanical equipment			
Primary heating system			
Domestic hot water heater			
Air source heat pump and central air conditioner			
Supplementary heating system			
HRV/ERV			
Drain water heat recovery system			

Renewables	N/A		
Solar domestic hot water (SDHW)	N/A		
Photovoltaic panels	N/A		
Wind turbines	N/A		
Building Envelope			
Attic (gable, hip, scissor)			
Basement wall			
Pony wall (can be included in basement wall photo)			
Crawl space			
Header			
Exposed floor			
Half storey			
Other			
Blower door			
Additions			
Photos date stamped or indicated in photo properties			
MURB Specific			
Non residential units			
For Multi-unit: one unit, front of unit			

	0	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/ Comments
Modelling Verification Criteria <i>Reflect DCFs, photos, notes & sketches</i>	Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings		
General information and house specifications			
Was a HOT2000 file (.h2k) that corresponds to the evaluated house provided?			
File naming convention			
Weather region and location			
Heated floor area (above and below grade)			
Front orientation			
House type			
Number of storeys			
Program specific			
Presence of vermiculite			
Toilets			
Default Values			
Were default values left as-is in the Specifications screen: Effective Mass Fraction, Foundation Soil Condition, Water Table Level, Wall Colour, Roof Colour, and Default Roof Cavity Inputs?			
Basement unit checked on Temperature screen			
Ceiling and roof assemblies (attic/flat/cathedral/scissor)	Yes		
Construction details structure type (e.g. truss, framing, etc.)			
Insulation (layers, type, thickness, RSI/R-value)			
Geometry (i.e. flat/sloped ceiling areas)			
Ceiling /roof areas containing different construction details modelled separately			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			

Wall assemblies			
Wall construction details (structure type, framing, interior/exterior finishes)			
Insulation (type, thickness, RSI/R-value)			
Buffering effect			
Geometry (height/perimeter)			
Wall area (avg. Wall height) for gable walls			
If attached house, wall perimeters correctly modelled			
Wall areas containing different construction details modelled separately			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			
Main wall Floor headers	Yes		
Header construction details			
Geometry (height/perimeter)			
Insulation (layers, type, thickness, RSI/R-value)			
Buffering effect			
Floor header sections containing different construction details modelled separately			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			
Exposed floors	Yes		
Geometry (length/area)			
Construction details (structure type, framing, interior/exterior finishes)			
Insulation (type, thickness, RSI/R-value)			
Buffering effect			
Crawl space modelled as exposed floor			
Exposed floor areas containing different construction details modelled separately			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			
Windows			
Window construction details			
Window assemblies with differing in construction details modelled separately			
Have different window types (casement, picture, slider) been modelled separately?			
Number of windows			
Wall section/location			
Orientation			
Dimensions (width and height)			
Significant overhang, header height			
Was the buffering effect added appropriately?			
Have skylights been modelled correctly?			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			

Doors	Yes		
Type			
Number of <i>single</i> doors			
Have the doors been placed in the correct wall section/location?			
Windows in doors (orientation, type)?			
Double doors or door assemblies (rough opening measurements)?			
Was the buffering effect added appropriately?			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			
Foundation			
Upgrade foundation modelling same configuration as base case			
Did the EA model a "walkout" basement without the "walkout" configuration			
Basement	Yes		
If the foundation had concrete walls, was the configuration used to model the walls BCCB_4 or BCCB_8			
Geometry (composites, wall height, perimeter/area)			
Depth below grade (basement wall height below grade)			
Attached or multiple foundations exposed surfaces perimeter			
Wall construction details			
Composite values and percentages modelled correctly?			
Insulation (layers, type, thickness, RSI/R-value)			
Slab construction details			
Has the location of the foundation floor been identified as "heated floor", "above" or "below" frost line?			
Floors above foundation construction details			
Header construction details			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			
Pony wall	Yes		
Pony wall construction details			
Pony wall geometry (height, perimeter, equivalent wall height)			
Composite values and percentages modelled correctly?			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			

Crawlspace	Yes		
Geometry (composites, wall height, perimeter/area)			
Depth below grade (basement wall height below grade)			
Attached or multiple foundations exposed surfaces perimeter			
Wall construction details			
Insulation (layers, type, thickness, RSI/R-value)			
Composite values and percentages modelled correctly?			
Slab construction details			
Has the location of the foundation floor been identified as "heated floor", "above" or "below" frost line?			
Header construction details			
Floors above foundation construction details			
Crawl space "heated" indicated			
Heated crawl space volume included in total volume			
Open crawl space with more than one foundation type present modelled as exposed floor			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			
Slab-On Grade	Yes		
Slab insulation and integral footings noted?			
Slab insulation details (above/below)			
Has the location of the foundation floor been identified as "heated floor", "above" or "below" frost line?			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			
Primary Heating System			
Equipment type (furnace, boiler, etc.)			
Manufacturer name and model number			
Dual fuel system and switchover temperature			
Efficiency (AFUE or steady state)			
Motorized vent damper			
Combustion air supply duct			
Energy-efficient motor			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			
Heat pumps	Yes		
Type (GSHP, ASHP, WSHP)			
Manufacturer name and model number			
Function (heating/cooling)			
Temp. Cut-off type and Cut-off Temp.			
Heating/cooling efficiency (COP/HSPF, SEER)			
Output capacity			
Model numbers of both condenser and evaporator coil			
GSHP GeoExchange Coalition certified			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			

Cooling system	Yes		
Manufacturer name and model number - both condenser and evaporator			
Duct to basement?			
Number of heads			
Efficiency (SEER or COP)			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			
Supplementary heating system	Yes		
Type (fireplace, sealed, airtight)			
Energy source			
Pilot light			
Combustion air supply duct			
Usage			
If usage is "always" complete fields below			
Manufacturer name and model number			
Efficiency			
Location heated			
Floor area heated			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			
Domestic hot water heater			
Energy source			
Type			
Presence of pilot identified with type			
Location (main floor/basement)			
Manufacturer name and model number			
Efficiency/performance			
Insulating blanket			
Combustion air supply			
DHW flue combined with furnace/boiler flue			
Integrated heat pump, EF, COP (standby, if applicable)			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			
Ventilation (HRV/ERV)	Yes		
Manufacturer name and model number			
Supply and exhaust flow rates			
Sensible efficiency (at 0°C and -25°C)			
Number of bathroom fan(s) and range hood(s)			
Flow rates of supplemental exhaust adjusted without justification			
If bathroom or other fan for whole-house, make/model/exhaust flow rate			
Other			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			
Drain water heat recovery	Yes		
Manufacturer name and model number			
Destination of preheated water - to hot water tank or hot water + shower			
Efficiency if modelled as generic			
How significant are these errors? 0 = not, 1 = low, 2 = medium, 3 = high			

Blower Door Test / Natural Air Infiltration		
$r \geq 0.99$		
$0.5 < n < 1.0$		
Data points < 6% error		
ELA < 7% error?		
Where combustion devices are subject to depressurization, is there evidence of an exhaust devices depressurization test performed?		
Is there a minimum eight (8) blower door test points recorded?		
Are there a minimum of five (5) valid blower door test points present?		
Above-grade height of highest ceiling		
Total house volume		
Other		
How significant are these errors?		
0 = not, 1 = low, 2 = medium, 3 = high		

EnerGuide Rating System Outputs: Homeowner Information Sheet Renovation Upgrade Report <i>Follows criteria as per data collection and modelling procedures</i>	0 Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/ Comments
Homeowner Information Sheet (HOIS)			
Homeowner Information Sheet (HOIS) provided?			

Evaluation Authorization Form Blower Door Test Waiver Criteria	0 Yes No N/A Information in accordance with the Data Collection Forms, Pictures and Drawings	Impact of the error on the energy consumption (in %) only if the difference is > 0.1%	Additional Information/ Comments
Was the EnerGuide Rating System-Evaluation Authorization Form provided?			
Was the EnerGuide Rating System-Evaluation Authorization Form signed by the client?			
If a blower door test was not performed due to the presence of vermiculite, has a signed copy of the EnerGuide Rating System-Blower Door Test Waiver been provided?			

Additional comments (N)

APPENDIX III

2018 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator throughout the report as well as the section from which the recommendations originated.

Sections	Recommendations
Executive Summary	1. Increase support and guidance to builders by exploring ways to further involve DAs and EAs in the NHC participation process. As evidenced by the process evaluation, DAs and EAs are valuable partners in new home construction programs and their involvement in projects can be a key factor in project success and builder satisfaction. They have the knowledge and expertise to, among other things, assist builders with registration and offer technical assistance during construction, such as measure suggestions and on-site verifications of measure installations. ENS should review the NHC participation process and identify areas where DAs and EAs can be further involved. While the Evaluator believes that EAs and DAs are also key allies in the recruitment of new builders, achieving the goal of generating more projects under NHC must first involve an assessment of current processes to ensure they are in line with builder expectations and needs.
	2. Be flexible, as much as possible, with timeline requirements that may be difficult for builders to meet. Interviews with other program administrators revealed that flexibility with builders is key to program success. For example, providing exceptions to the requirement to register within 30 days of receiving a building permit and offering extensions to builders that need more than 12 months to complete a project without having to re-register are important aspects to builders and can be a deal breaker for certain builders.
	3. Share evaluation findings with the EAs to ensure sustained quality simulations and that all required documentation is included in participant files. As part of the 10 NHC on site visits and HOT2000 simulation reviews, the Evaluator noted that improvements had been achieved in the accuracy of simulations since the last review in 2016. Conversely, the Evaluator identified errors affecting the energy consumption in each file reviewed. Moreover, the Evaluator noted that building plans or as-built reports, containing the characteristics of each house component, were still missing for the majority of the files reviewed despite the recommendation made in the 2016 Evaluation Report to ensure that all required documentation be included in participant files. These findings should be shared with the EAs to continue working toward higher quality simulations, and particular effort should be invested in investigating concrete solutions on how all the required documentation could be included in the participant files.
	4. Conduct a billing analysis to review overestimation ratios (ORs) when a sufficient NHC participant sample becomes available. The current ORs used for NHC were obtained from a billing analysis of Home Energy Assessment (HEA) participant data. In past years, no billing analyses were conducted with NHC participants since only a few participants had their as-built energy consumption value available. The HEA billing analysis conducted in 2018 was initially aimed at estimating an OR for the new version of HOT2000, although it revealed that the space heating systems in place, particularly heat pumps, had a much more significant impact on the OR than the difference between the versions of HOT2000 that are used. Since more NHC projects will be completed under the HOT2000 version 11 rating system in upcoming years, the Evaluator recommends conducting a billing analysis specific to NHC participants when a large enough sample becomes available to both consider the various versions of HOT2000 (i.e. versions 11.3; 11.4; 11.5) and evaluate the impact of the different heating systems in place.

Sections	Recommendations
	5. Ensure the tracked savings are accurate. Prior to reviewing the gross savings calculations, the Evaluator identified several issues in the 2018 tracking sheet, including with values that had been entered manually. The Evaluator reviewed all the formulas used for the tracked savings calculations and when revisions were required, the Evaluator shared the revisions with ENS. For future years, the Evaluator recommends that ENS apply these formulas to track NHC savings and ensure they are consistently applied to all participants in the tracking sheet.



ECONOLER

EFFICIENT PRODUCT REBATES PROGRAM

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Final Report

March 15, 2019



research>into>action^{inc}



ABBREVIATIONS

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BER	Business Energy Rebates
BNI	Business, non-profit and institutional
CFL	Compact fluorescent lamp
CRA	Corporate Research Associates
DLC	DesignLights Consortium
DSM	Demand-side management
ENS	Efficiency Nova Scotia
EUL	Effective useful life
GHG	Greenhouse gas
HOU	Hours of use
HVAC	Heating, ventilation and air conditioning
ISR	In-service rate
LED	Light-emitting diode
NSP	Nova Scotia Power
NTGR	Net-to-gross ratio
PCF	Peak coincidence factor
SBES	Small Business Energy Solutions
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.
Base case	To determine gross savings, a 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 base case may include such information as the hours of operation, wattage and the 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 the energy simulations and the actual energy consumption of the building or system.
Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
Displaced wattage	The displaced wattage is defined as the difference between the wattage values of the baseline equipment or product and the efficient equipment or product.
EnerGuide rating	An EnerGuide (official brand of Natural Resources Canada) rating is a standard measure of the home's energy performance. It is a measure of the efficiency of the building only and does not take into account occupant behaviour. It shows how energy efficient the home is through modelled heat losses of the home, based on several factors including building envelope characteristics, heated volume, heating systems and air leakage.
Effective useful life	The period a measure is expected to be in service and provide both energy and peak demand savings. This value combines the equipment life and the measure persistence, which includes factors such as business turnover or early retirement.
Equipment life	The number of years installed equipment will operate before it fails.
Equivalent CO ₂	A unit of measurement indicating the amount of carbon dioxide to which various kinds of emitted greenhouse gases are equivalent in terms of warming effects. In this report, the gases' global-warming potential is estimated over a timescale of 100 years.
Equivalent effective useful life	The number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. This value takes into account variations in annual energy savings throughout the effective useful life due to increased baselines.

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

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

TABLE OF CONTENTS

EXECUTIVE SUMMARY	IX
INTRODUCTION	1
1 BER OVERVIEW.....	3
1.1 Description	3
1.2 Follow-up on 2017 Evaluation Report Recommendations.....	4
1.3 Participation History.....	5
2 BER EVALUATION OBJECTIVES AND METHODOLOGY.....	9
2.1 Mail-in.....	10
2.2 Instant Rebates	11
3 BER PROCESS AND MARKET EVALUATION	13
3.1 Interrelations Between BER Services	13
3.1.1 BER Service Offers and Logic for Lighting Measures	13
3.1.2 Installation Contexts of BER Lighting Measures.....	14
3.1.3 Awareness and Use of BER Services	15
3.1.4 Jurisdictional Review	16
3.2 Interest and Participation in Non-lighting Measures	17
3.2.1 Actors and Factors Influencing Measure Choices	17
3.2.2 Intentions to Implement Measures.....	18
3.2.3 Barriers to Mail-in Participation and Non-lighting Measures.....	19
3.2.4 Suggestions to Generate Interest in Non-lighting Measures	20
3.3 Satisfaction with BER.....	21
3.3.1 Satisfaction with the Mail-in Participation Process	21
3.3.2 Satisfaction with Instant Rebates.....	22
3.3.3 Satisfaction with BER Incentives	23
3.3.4 Improvement Suggestions.....	24
4 IMPACT EVALUATION FOR BER MAIL-IN.....	26
4.1 Gross Savings.....	26
4.1.1 Summary of Adjustments to Gross Savings	26
4.1.2 Interactive Effects	29
4.1.3 Effective Useful Life	29
4.1.4 Revised Gross Savings	29
4.2 Net-to-gross Ratio.....	32
4.2.1 Free-ridership	32
4.2.2 Spillover.....	32
4.2.3 NTGR Calculation.....	33
4.3 Net Savings.....	33
5 IMPACT EVALUATION FOR BER INSTANT REBATES.....	37

5.1	Gross Savings.....	37
5.1.1	Summary of Adjustments to Gross Savings	37
5.1.2	In-service Rates.....	39
5.1.3	Peak Demand Savings	39
5.1.4	Interactive Effects	39
5.1.5	Effective Useful Life	40
5.1.6	Revised Gross Savings	42
5.2	Net-to-gross Ratio.....	45
5.2.1	Free-ridership	45
5.2.2	NTGR Calculation.....	47
5.3	Net Savings.....	48
6	OVERALL BER RESULTS	52
7	BER MARKET EVOLUTION.....	53
7.1	Market Indicators	53
7.1.1	Market Shares of Lighting Technologies	53
7.1.2	BER Instant Rebates Rebated Units	55
7.1.3	BER Participating Distributor Outlook.....	56
7.1.4	Retail LED Prices.....	57
7.2	Evaluation Results	59
7.2.1	Free-ridership Levels.....	59
7.3	Market Evolution Summary.....	60
CONCLUSION.....		65

LIST OF TABLES

Table 1: Overall Participation and Savings for BER	ix
Table 2: Net-to-gross Ratio for BER Mail-in.....	xiii
Table 3: 2018 Net-to-gross Ratio for BER Instant Rebates	xiii
Table 4: Overall Comparison of Tracked and Evaluated Savings at the Generator for BER.....	xiv
Table 5: Types of Evaluations Conducted for Each Program Component	2
Table 6: Implementation Status of 2017 Recommendations for BER.....	4
Table 7: Mail-in Surveyed Participant Planned Measures (n=47).....	18
Table 8: Mail-in Site-visit Participant Planned Measures (n=30)	19
Table 9: Participant Improvement Suggestions (n=70) for BER Mail-in.....	24
Table 10: Adjustment Ratios per BER Mail-in Measure Category	28
Table 11: Revised Gross Energy and Peak Demand Savings for BER Mail-in	30
Table 12: NTGR for BER Mail-in.....	33
Table 13: Revised Net Energy and Peak Demand Savings for BER Mail-in	34
Table 14: Comparison of Tracked and Evaluated Savings at the Generator – BER Mail-in.....	36
Table 15: Adjustment Ratios per BER Instant Rebates Measure Category	38
Table 16: Revised Equivalent Effective Useful Life Values by Instant Rebates Measure Category	41
Table 17: Revised Gross Energy and Peak Demand Savings for BER Instant Rebates.....	43

Table 18: Free-ridership for BER Instant Rebates	46
Table 19: NTGR for BER Instant Rebates	47
Table 20: Evaluated Net Energy and Peak Demand Savings for BER Instant Rebates.....	49
Table 21: Comparison of Tracked and Evaluated Savings at the Generator – BER Instant Rebates ..	51
Table 22: Comparison of Overall Tracked and Evaluated Savings at the Generator for BER.....	52
Table 23: Overall Participation and Savings for BER	52
Table 24: Average Rebate Values Under Instant Rebates for LED Measures, 2015-2018	58
Table 25: LED Free-ridership Levels for BER Instant Rebates	60
Table 26: Analysis of Key Factors in Program Planning.....	60

LIST OF FIGURES

Figure 1: Overview of BER Net Savings at the Generator, 2012-2018.....	x
Figure 2: Summary of Participation in BER Mail-in, 2012-2018.....	5
Figure 3: Distribution of BER Mail-in Gross Energy Savings by Measure Category.....	6
Figure 4: BER Instant Rebates Measures Sold, 2012-2018	6
Figure 5: Distribution of BER Instant Rebates Gross Savings by Measure Category.....	7
Figure 6: Summary of Gross Savings for BER, 2012-2018	8
Figure 7: BER Methodological Model	9
Figure 8: Who Completed Mail-in Application by Participant Type	20
Figure 9: Participant Satisfaction with BER Mail-in Measures	21
Figure 10: Participant Satisfaction with ENS Staff and BER Mail-in Processes	22
Figure 11: Participant Satisfaction with Incentives.....	23
Figure 12: Atlantic Canada Commercial and Industrial Lighting Shipments by Technology (%)	54
Figure 13: Atlantic Canada Commercial and Industrial LED Lighting Shipments by Type (%).....	54
Figure 14: BER Instant Rebates Incented LED Units, 2012-2018	55
Figure 15: Average Retail Prices of Rebated LED Measures, 2015-2018.....	57
Figure 16: Market Evolution for Commercial LED Lighting	62

EXECUTIVE SUMMARY

This report presents the demand-side management (DSM) results of the 2018 evaluation of the Efficient Product Rebates program comprised of the Business Energy Rebates (BER) program component. BER includes the Mail-in and Instant Rebates services. The 2018 evaluation was based on an interview with the program manager, telephone surveys of 70 Mail-in participants and 50 Instant Rebates participants (20 contractors and 30 end users), project reviews, on-site visits of 78 Mail-in projects, as well as interviews with 15 Mail-in contractors and 11 Instant Rebates distributors.

Table 1 presents the participation levels, net-to-gross ratios (NTGRs), as well as gross and net savings for BER Mail-in and Instant Rebates.

Table 1: Overall Participation and Savings for BER

	Participation Level	Gross Savings	NTGR	Net Savings
Mail-in				
Energy Savings	366 projects	24.596 GWh	0.83	20.414 GWh
Lifetime Energy Savings		379.986 GWh	0.83	315.388 GWh
Peak Demand Savings		3.702 MW	0.83	3.073 MW
Instant Rebates				
Energy Savings	506,533 products sold	76.053 GWh	0.72	54.884 GWh
Lifetime Energy Savings		716.364 GWh	0.75	536.729 GWh
Peak Demand Savings		11.144 MW	0.74	8.255 MW
TOTAL				
Energy Savings		100.648 GWh	0.75	75.298 GWh
Lifetime Energy Savings		1096.349 GWh	0.78	852.117 GWh
Peak Demand Savings		14.846 MW	0.76	11.327 MW

Business Energy Rebates

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. Instant Rebates is available through electrical distributors across the province of Nova Scotia, while Mail-in requires a project application to be submitted to Efficiency Nova Scotia (ENS).

The measures eligible under BER are divided into 13 categories:

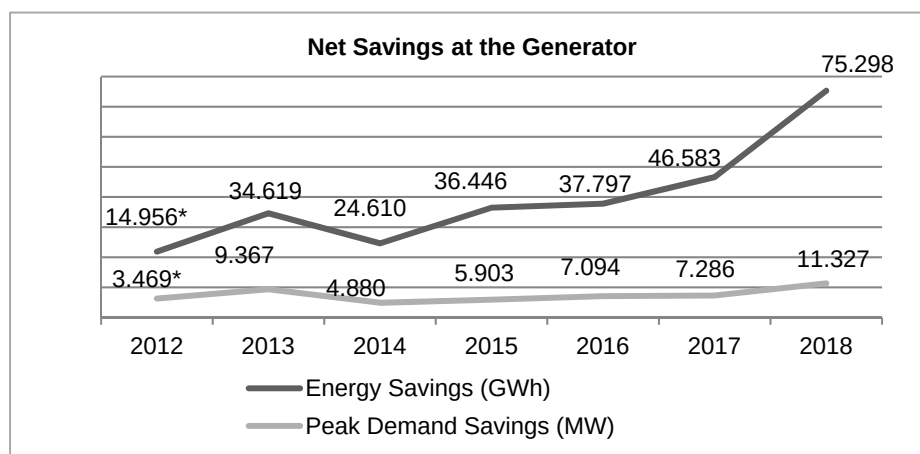
- › Agriculture
- › Lighting
- › Refrigeration
- › Laundry
- › Kitchen
- › Compressed Air
- › Heating
- › IT & Datacenters
- › Variable Frequency Drives (VFDs)
- › Water Heating
- › Solar Thermal
- › Pumping
- › Pool Equipment

BER Performance

BER aimed to achieve 50.6 GWh in net electrical energy savings and 7.9 MW in net peak demand savings at the generator in 2018. The Evaluator determined that BER achieved 75.298 GWh in net electrical energy savings and 11.327 MW in net peak demand savings at the generator in 2018. These savings represent 46,128 tonnes of CO₂ eq in terms of annual avoided greenhouse gas (GHG) emissions. BER's net lifetime energy savings were established at 852.117 GWh, which yields a weighted average effective useful life (EUL) value of 11.3 years.

Figure 1 below provides an overview of BER evolution in net energy and peak demand savings from 2012 to 2018. In 2018, BER achieved the highest savings level in its history. This result is due, in part, to the high participation in Instant Rebates, which achieved 54.884 GWh in 2018 compared to 30.805 GWh in 2017. Mail-in achieved 20.414 GWh in net energy savings, up from 16.068 GWh in 2017. Instant Rebates accounted for 73 percent of BER savings.

Figure 1: Overview of BER Net Savings at the Generator, 2012-2018



*2011 results include the sum of the savings for Mail-in Rebates from BER and Instant Rebates from Smart Lighting Choices.

In 2018, a total of 366 Mail-in projects were implemented by 257 unique participants, representing a 27 percent increase in projects over 2017. Lighting measures were the most popular measures installed by participants, representing 75 percent of Mail-in energy savings. As for Instant Rebates, 506,533 products were rebated through the service, a 60 percent increase over 2017. This increase is, in part, due to one participant who installed 67,311 measures through Instant Rebates. Similarly to 2017, downlight fixtures were the most popular measure category.

BER Key Findings

BER Process and Market Evaluation Highlights

Interrelations Between the BER Services

One of the objectives of the process and market evaluation was to draw a picture of the BER services and what differentiates them to verify whether using different sets of assumptions and calculation methodologies is justified and provide insights into the best approach to delivering BER. This objective was especially relevant in a context where Instant Rebates is an increasingly important contributor to overall BER savings, as presented in the BER Performance Section of this Executive Summary.

The Evaluator found that while a few specific Mail-in measures comprised a significant percentage of this service's savings, there was also a large proportion of the Mail-in offer that did not differ much from that of Instant Rebates. More specifically, half of 2018 Mail-in lighting savings were generated from lighting measures that were also available under Instant Rebates.

In addition to comparing the measures installed in each service, the Evaluator compared the context in which lighting measures were installed. Through the Mail-in site visits and Instant Rebates participant survey, the Evaluator found that both services serve retrofit and new construction projects. One third of Instant Rebates participants who purchased measures for retrofit projects reported purchasing them for early-replacement projects, while this figure reached 69 percent for Mail-in. Instant Rebates contractor participants mentioned purchasing lighting measures for residential projects or a mix of residential and commercial projects, whereas lighting projects in residential buildings are generally not eligible under Mail-in, except when they target common areas in multi-family buildings.

The Evaluator measured whether Mail-in participants know about Instant Rebates and vice versa, and why participants and contractors choose one service over the other. Mail-in participants who were aware of Instant Rebates reported choosing to participate in the former because the desired measures were not part of Instant Rebates offerings. As for Instant Rebates participants aware of Mail-in, over half chose Instant Rebates because it required less paperwork, and one-quarter stated it was because the rebate was provided immediately as opposed to Mail-in, which has a delay. The remaining 16 percent of participants either did not know why they chose one service over the other or reported using Instant Rebates for residential work – something they could not do through Mail-in.

Interest and Participation in Non-lighting Measures

ENS developed a long-term diversification strategy to encourage the implementation of non-lighting measures. The Evaluator assessed participants' interest in and intentions to implement non-lighting measures in the near future.

Among Mail-in participants, 53 percent of survey respondents and 41 percent of site-visit participants intended to implement energy efficiency measures in the ensuing two years, with the most common non-lighting measure category being heating, ventilation and air conditioning (HVAC). Approximately half (49%) of BER site-visit participants reported having specific contractors they use for replacing and maintaining equipment. Of those, three-quarters noted having specific lighting contractors they use. Fewer participants have a go-to contractor for non-lighting measures. About one-quarter of site-visit participants (28%) noted having an HVAC contractor, and even fewer participants noted having specific plumbing or refrigeration contractors.

According to non-lighting Mail-in contractors, there are no measures they avoid promoting, and they already promote a range of measure types. Mail-in contractors who sell non-lighting measures suggested that ENS add roof-top units, measures that improve sequencing when equipment starts in the morning, chillers, and measures applicable to automobile shops to the service offering. Some contractors indicated that higher incentives for heating and refrigeration measures would help drive interest.

Half of Mail-in participants reported that their organizations employ payback thresholds when deciding to make efficiency improvements and most of those require payback periods within five years. Of the 35 Mail-in participants who reported having payback thresholds when making upgrade decisions, 37 percent require payback periods of two years or less and 46 percent require three to five years. These results suggest that a considerable portion of participants would not implement measures with payback periods longer than five years, which is an implementation barrier for many non-lighting measures.

Satisfaction

Mail-in participants were very satisfied with BER staff, although slightly less satisfied with the project information required to be submitted and the process of completing the application forms. The most frequently mentioned improvement suggestion is to make the application forms more user-friendly. One-third of interviewed contractors expressed experiencing challenges, stating that the process was too time consuming and they have difficulties explaining the service to their customers.

Furthermore, interviewed distributors provided an overall satisfaction rating of 7.7 out of 10 when considering the Instant Rebates overall (using a scale from 0 to 10 where 0 means "not at all satisfied" and 10 means "completely satisfied"). The distributors who were not as satisfied with the service mentioned the time and work required to administer the rebates and keep track of which exact measures are eligible for rebates as the main reasons for dissatisfaction.

BER Impact Evaluation Highlights

BER Mail-In

The results of the site visits and project reviews revealed that only small adjustments were required to tracked energy savings, in large part due to the improvements made to the participant application forms, which allowed ENS to track accurate HOU's. Net savings were estimated using an NTGR that represents the proportion of gross savings that can be reliably attributed to the service. Using free-ridership and spillover effects measured as part of participant surveys and interviews, the NTGR value was established at 0.83, as presented in Table 2.

Table 2: Net-to-gross Ratio for BER Mail-in

	2018
Free-ridership Level	17%
Spillover Level	0%
NTGR	0.83

BER Instant Rebates

To establish the gross savings of Instant Rebates for 2018, the Evaluator reviewed the tracked savings to ensure that the recommended savings values from the 2016 evaluation were applied correctly and made only minor adjustments. Net savings were then calculated by applying the NTGRs listed in Table 3 below to the gross evaluation savings. The Evaluator measured the free-ridership level of Instant Rebates for 2018 by using both the participant survey and distributor interviews. The Evaluator calculated free-ridership levels for four light-emitting diode (LED) measure categories and applied a NTGR of 1.00 to the other measure categories, resulting in an overall NTGR of 0.72 for Instant Rebates energy savings.

Table 3: 2018 Net-to-gross Ratio for BER Instant Rebates

Measure Category	NTGR
LED Linear Fixtures	0.71
LED Downlight Fixtures	0.66
LED Linear Lamps	0.63
LED General-use and Decorative Lamps	0.68
Other Measures	1.00
Overall	
Energy Savings	0.72
Peak Demand Savings	0.74

BER Energy Savings

Table 4 compares the 2018 tracked and evaluated savings for Mail-in and Instant Rebates combined.

Table 4: Overall Comparison of Tracked and Evaluated Savings at the Generator for BER

	Initial Gross Savings	Adjusted Gross Savings	NTGR*	Net Savings
Energy Savings				
ENS Tracked Savings	101.271 GWh	101.271 GWh	0.76	77.208 GWh
Evaluation Results	101.271 GWh	100.648 GWh	0.75	75.298 GWh
Peak Demand Savings				
ENS Tracked Savings	17.751 GWh	17.751 GWh	0.78	13.762 GWh
Evaluation Results	17.751 GWh	14.846 GWh	0.76	11.327 GWh
*Different NTGRs were established for Mail-in and Instant Rebates. The average NTGR values presented in this table correspond to the ratio of net savings to gross savings for both services.				

Overall, the evaluated net energy savings are 2 percent lower than the tracked values as a result of both Mail-in and Instant Rebates being adjusted downward (6% and 1% respectively).

For Mail-in, some minor adjustments were made to gross savings, which affected some of the most popular measure categories in Mail-in, namely lighting, motors and VFDs. Along with the slight decrease in NTGR, this explains the difference between tracked and revised savings. For Instant Rebates, the slight downward adjustment was mostly due to both the decrease in NTGR, which went from 0.73 in 2017 to 0.72 in 2018, and minor downward adjustments to unitary savings and interactive effect factors.

Net peak demand savings were 18 percent lower than their corresponding tracked values. For Mail-in, the downward adjustment to net peak demand savings was 12 percent, which was the result of an adjustment ratio applied to the peak demand savings of lighting measures. As for Instant Rebates, the downward adjustment to net peak demand savings was 20 percent, mainly as a consequence of the downward adjustments to the peak coincidence factor for indoor measures.

BER Market Evolution Findings

ENS has been active in the LED market of the BNI sector through BER since 2010. For a second year, the Evaluator completed a market evolution assessment to establish the level of LED lamp market adoption in Nova Scotia.

The market share of LED technology continues to grow in the commercial and industrial sectors in Atlantic Canada, comprising 56 percent of all lighting shipments for that sector in 2018. In addition, prices continue to decline across all LED categories targeted by BER, with downlight and linear LED fixtures having the most significant decrease in price in 2018.

Distributors reported the market for LED linear lamps and general-use and decorative LEDs is nearing maturity, with continued price decreases, as well as increased accessibility of measures and customer awareness about the technology. Even so, distributors believe that there remains a large market for LED linear lamps because certain customers are not yet ready to replace fluorescent fixtures, although they wish to replace fluorescent lamps with LEDs.

In contrast, the market for downlight and linear fixtures is not as close to maturity as lamps. While prices are decreasing for downlight and linear fixtures, prices are still relatively high, and the market will continue to grow and evolve as more customers switch to integrated lamps.

The savings potential of general-use, decorative, and reflector lamps as well as downlight fixtures is negatively impacted by upcoming changes in regulations that will push the baseline efficiency for these technologies to LED levels within approximately five years. These regulatory changes and their effect on savings confirm ENS's decision to gradually remove decorative lamps, general-use lamps, reflector lamps, downlight fixtures, and LED wall sconces from the BER offering as of 2019.

The Evaluator concludes that LEDs remain in a growth phase, although they are approaching maturity, particularly LED linear, general-use, and decorative lamps. Upcoming changes to regulations will further push general-use and decorative lamps, reflector lamps, and downlight fixtures toward maturity. Of the LED technologies analyzed, the market for LED linear fixtures is the least evolved and has the most potential to grow and evolve. LED linear lamps and fixtures are not impacted by upcoming regulations.

BER Recommendations

The 2018 impact evaluation revealed that the accuracy of reported savings had improved, especially for Mail-in. In addition, ENS has been proactive in adapting their Instant Rebates offerings to the evolving market by removing products that are closer to market maturity. The recommendations formulated by the Evaluator therefore focus on the process evaluation findings, which concern the interrelations between Mail-in and Instant Rebates as well as the diversification of measures implemented through Mail-in. In addition to the general recommendations presented for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator makes the following recommendations for BER. These recommendations are also outlined in Appendix XVI.

- 2018 BER-R1. Review BER logic model and eligibility criteria to ensure that the intended projects and participants go through each service.** As evidenced by the process evaluation, no project types are exclusive to either service and many sold measures overlap the two services. Despite these similarities, the Evaluator also found that a significant proportion of Instant Rebates measures are installed in residential applications that would not be eligible for a Mail-in incentive. A review of the logic model and eligibility criteria would clarify the purpose of the similarities and differences between the two services and realign BER design in relation to its objectives. This review would result in a better definition of target participants and measures, which would in turn improve BER performance as well as the accuracy of the performance and savings assessment.
- 2018 BER-R2. Implement a system that enables connecting Instant Rebates sales data to participants.** While ENS implemented the Evaluator's past recommendations to improve Instant Rebates participant tracking, the information to fully capture the actual Instant Rebates market is still fairly limited, rendering it challenging to adjust savings assumptions to represent average conditions. One challenge, in particular, is clearly knowing whether Instant Rebates measures were purchased by contractors or end users and how many units were purchased by each of these types of participants. The Evaluator recommends that ENS implement a system that allows tracking sales and linking them to participating individuals. This would enable the Evaluator to collect more specific data from these individuals and gain a better sense of what their sales represent compared to overall service sales.
- 2018 BER-R3. Investigate ways to liaise more clients with non-lighting contractors.** Contractors are key players in achieving the goal of implementing more non-lighting measures through BER and ENS programs overall. Fewer interviewed participants have go-to non-lighting contractors than lighting contractors for potential projects. The Evaluator recommends findings ways to connect participants to non-lighting contractors and training the latter to further promote non-lighting projects.
- 2018 BER-R4. Analyze the incentive levels for non-lighting measures with a higher payback period.** Meeting company payback thresholds remains a key barrier to implementing non-lighting measures among participants. The Evaluator recommends that ENS assess possible ways of pushing more participants toward non-lighting measures that typically have longer payback periods. While actively promoting the energy and non-energy benefits of measures might be enough to push some participants to implement non-lighting measures, for other participants whose companies require specific payback thresholds before any energy efficiency project is approved, an ENS review of incentive levels for at least a few high-potential measures might be needed.

INTRODUCTION

Efficiency Nova Scotia (ENS) is operated by EfficiencyOne, an independent, non-profit organization. ENS 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 various segments of the population. ENS has a demand-side management (DSM) portfolio of three residential programs and three business, non-profit and institutional (BNI) programs. Each program has one or more program components that ENS markets to Nova Scotians. ENS receives funding for its activities from Nova Scotia Power (NSP) and the Province of Nova Scotia. The funds received from NSP cover the costs of activities designed to help reduce electricity consumption, whereas funds from the Province of Nova Scotia are primarily used for activities designed to help reduce the use of other fuels.

Econoler was commissioned to evaluate ENS's 2018 DSM program portfolio comprised of six electricity efficiency programs and assess the impacts of energy efficiency codes and standards introduced in Nova Scotia. To carry out this assignment, Econoler collaborated with Research Into Action, Equilibrium Engineering and Corporate Research Associates (CRA). 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 impact evaluation calculations, as well as preparing and reviewing evaluation reports. Research Into Action carried out the process evaluations, while Equilibrium Engineering conducted the on-site visits and contributed to some impact evaluation analyses. CRA conducted interviews and surveys with participants and partners, as well as analyzed and reported on the data collected from these activities. Throughout this report, this team is referred to as the Evaluator.

Table 5 below lists the various programs assessed as part of the 2018 evaluation and indicates their respective components and the types of evaluations conducted. In this table, "C" means a complete evaluation and "R" indicates that reduced evaluation activities were performed. Moreover, Section 1 of the DSM Programs Evaluation Executive Summary presents the scope of work in further detail, along with the rationale for the types of evaluations performed for each program component.

Table 5: Types of Evaluations Conducted for Each Program Component

Program	Program Component	2017			2018		
		Process	Market	Impact	Process	Market	Impact
Residential Efficient Product Rebates Program	Appliance Retirement			R		C	C
	Instant Savings		R	R		C	C
Existing Residential Program	Home Energy Assessment		C	C			R
	Green Heat	C	C	C		C	C
	Efficient Product Installation		C	C		C	R
New Residential Program	New Home Construction		C	C	C		C
Efficient Product Rebates Program	Business Energy Rebates		C	R	C	C	C
Custom Incentives Program	Custom	C*	C	R	C**	C	C
	Energy Management Information Systems		C	C		C	C
	Strategic Energy Management***					C	C
Direct Installation Program	Small Business Energy Solutions		C	C		R	R

* The process evaluation specifically targets the Retrofit service of the Custom program component.
 ** The process evaluation specifically targets the New Construction service of the Custom program component.
 *** Due to the start date of the latest Strategic Energy Management (SEM) cohort, SEM did not have any participants who achieved savings in 2017; therefore, no evaluation was conducted for 2017.

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

This evaluation report concerns the Efficient Product Rebates program, which is comprised only of the Business Energy Rebates (BER) component. In 2017, BER underwent market and impact evaluations as well as an assessment of the evolution of LED lighting in the Nova Scotian BNI market. In 2018, those same three evaluation types were maintained, except that a process evaluation was also added to the BER scope of work to provide insights into the reasons that prevent participants from implementing measures other than lighting, suggest solutions to maximize the diversification of measures, and better understand the two BER services as well as how and why participants use them. A description of BER program component, the evaluation methodology and main evaluation findings are presented in the following sections.

1 BER OVERVIEW

This section describes BER, follows up on 2017 evaluation recommendations and presents participation history.

1.1 Description

BER provides financial incentives in the form of prescriptive rebates or financing to BNI participants to foster reductions in electricity consumption and peak demand. All businesses, non-profits and institutions in Nova Scotia are eligible.

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 of said measure or technology.

In 2018, the measures offered under BER were divided into 13 categories:

› Agriculture	› IT & Datacenters
› Lighting	› Variable Frequency Drives (VFDs)
› Refrigeration	› Water Heating
› Laundry	› Solar Thermal
› Kitchen	› Pumping
› Compressed Air	› Pool Equipment
› Heating	

Any measure designed by any manufacturer can be offered through BER provided that it meets the specified criteria for that measure category. Specific criteria include minimum efficiency/efficacy values, as well as industry standards such as ENERGY STAR® performance levels or those established by the DesignLights Consortium (DLC) and the National Electrical Manufacturers Association.

Rebates offered through BER are delivered either through the Mail-in Rebates or Instant Rebates service. Instant Rebates aims to reach a greater volume of participants and offer them easier access to BER. Conversely, Mail-in allows for better project-level control and lower risk since more participant details are provided to ENS. While some technologies are only available through Mail-in, many are eligible to both services.

Instant Rebates is delivered through a network of participating distributors within the province of Nova Scotia. These distributors play a key role in not only promoting Instant Rebates to end users, but also providing customer service about measures in Mail-in in the form of measure expertise and assistance in completing Mail-in applications to purchase measures eligible only through the service.

In 2018, BER was advertised through presentations to relevant industry associations, marketing materials for specific segments of the population, trade show appearances, articles in trade association newsletters, and province-wide mail-outs to businesses. Information was also made available in distributor branches.

BER aimed to achieve 50.6 GWh in net electrical energy savings and 7.9 MW in net peak demand savings at the generator for 2018.

1.2 Follow-up on 2017 Evaluation Report Recommendations

BER was evaluated in 2017 and improvement recommendations were made by the Evaluator. Table 6 below provides a brief summary of the implementation status of each recommendation presented in the Executive Summary section of the 2017 Evaluation Report.

Table 6: Implementation Status of 2017 Recommendations for BER

2017 Recommendations	Status
2017 BER-R1. Continue to monitor the market evolution of LED lamps and adapt the BER offer when needed.	Implemented
2017 BER-R2. Identify opportunities to diversify the portfolio of projects completed through BER Mail-in.	Being Implemented
2017 BER-R3. Continue and improve tracking of Instant Rebates participants.	Implemented

To address recommendation 2017 BER-R1, ENS asked the Evaluator to continue the market analysis on light-emitting diode (LED) lighting since this market is transforming quickly. The results of this analysis are presented in the BER Market Evolution section of this report (Section 7).

Recommendation 2017 BER-R2 is being addressed in part by evaluation activities. The Evaluator used the on-site visits to collect information on the awareness and interest of participants in measures other than lighting as well as conducted interviews with contractors to discuss the rebate levels for non-lighting measures and their opinion on which technologies should be added to BER. In addition, ENS plans to promote technologies other than lighting measures to businesses, non-profits and institutions through both a technical series to be delivered on its website and email newsletters distributed to a list of BNI participants six times per year. Furthermore, a cross-cutting ENS committee is looking at measure diversification strategies for DSM programs where applicable. Some of these strategies are part of an ongoing transition, the full benefits of which will only be perceivable over time.

To address recommendation 2017 BER-R3, ENS has continued to track Instant Rebates participant information (e.g. names and phone numbers) and added a clause to participating distributor contracts that requires distributors to provide participant information. As a result, the Evaluator was able to sample survey respondents from a much larger list of participants than in 2017.

1.3 Participation History

BER Mail-in

In 2018, 366 Mail-in projects were implemented by 257 unique participants.¹ Figure 2 below illustrates how Mail-in participation has evolved since its inception in 2012. The number of participating businesses increased by 21 percent over 2017, which is the first time the service has benefited from an increase since 2015. The gross savings achieved per participant have continued to increase since 2016, reaching 95.702 MWh per participant in 2018.

Figure 2: Summary of Participation in BER Mail-in, 2012-2018

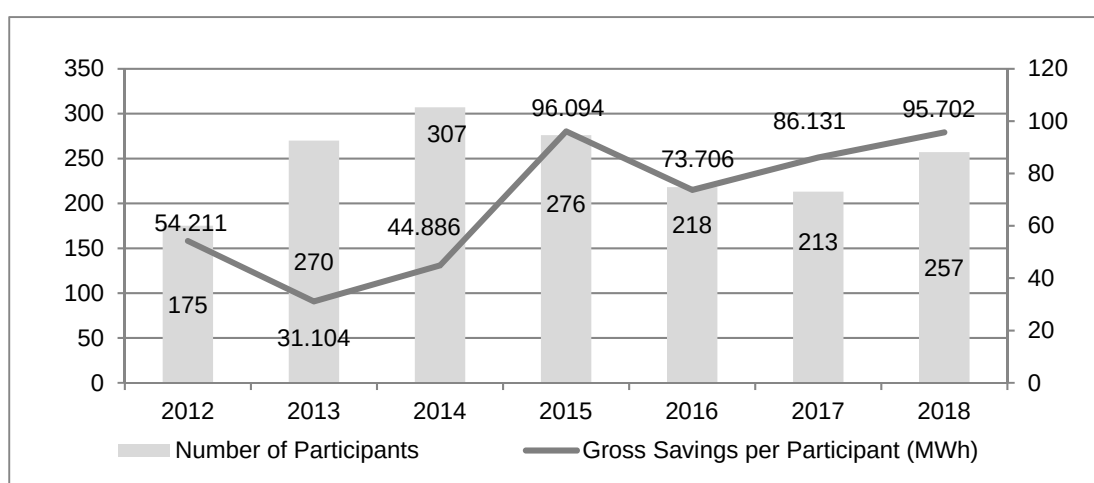
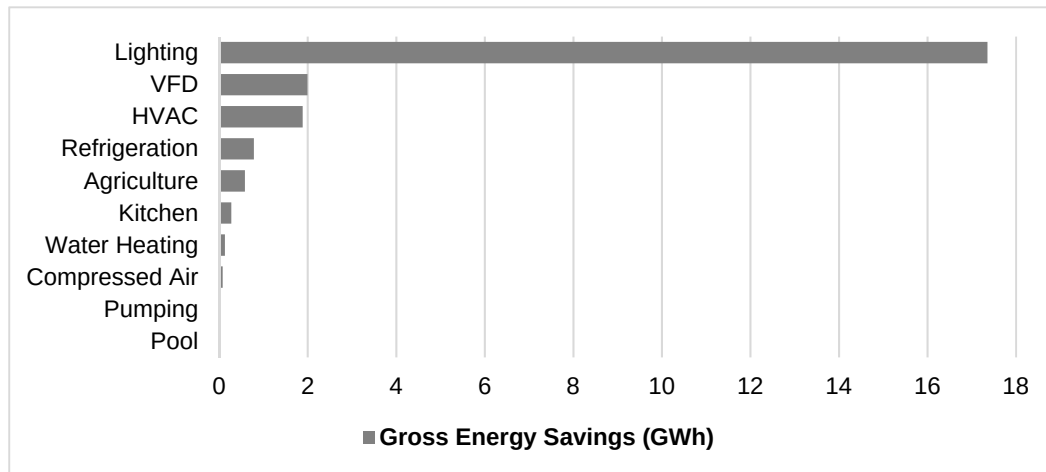


Figure 3 below illustrates the distribution of gross savings among the measure categories for Mail-in. With 75 percent of gross savings being generated by lighting measure categories and 9 percent of gross savings by VFDs, these two categories account for most Mail-in savings. The large proportion of savings generated by lighting measures is a consistent trend for BER; this proportion has varied between 58 percent and 78 percent since 2015.

¹ The number of unique participants in BER Mail-in corresponds to the number of businesses that participated in the program component.

Figure 3: Distribution of BER Mail-in Gross Energy Savings by Measure Category



BER Instant Rebates

Since participant information is not tracked systematically for Instant Rebates, the number of participants is unknown. Available information does indicate the number of rebated measures sold by distributors. Figure 4 below indicates that 506,533 measures were rebated through Instant Rebates in 2018, a 60 percent increase over 2017. The increase in participation is, in part, due to a single customer purchasing 67,311 LED measures.

Figure 4: BER Instant Rebates Measures Sold, 2012-2018

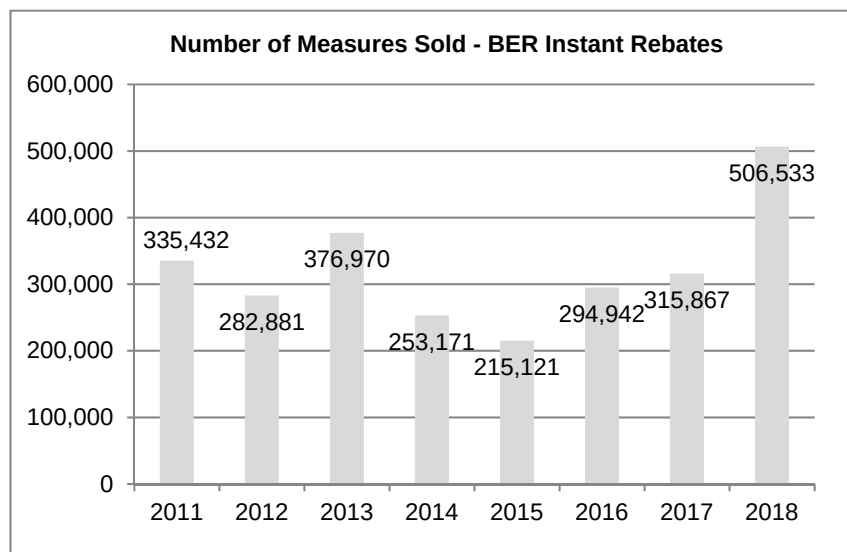
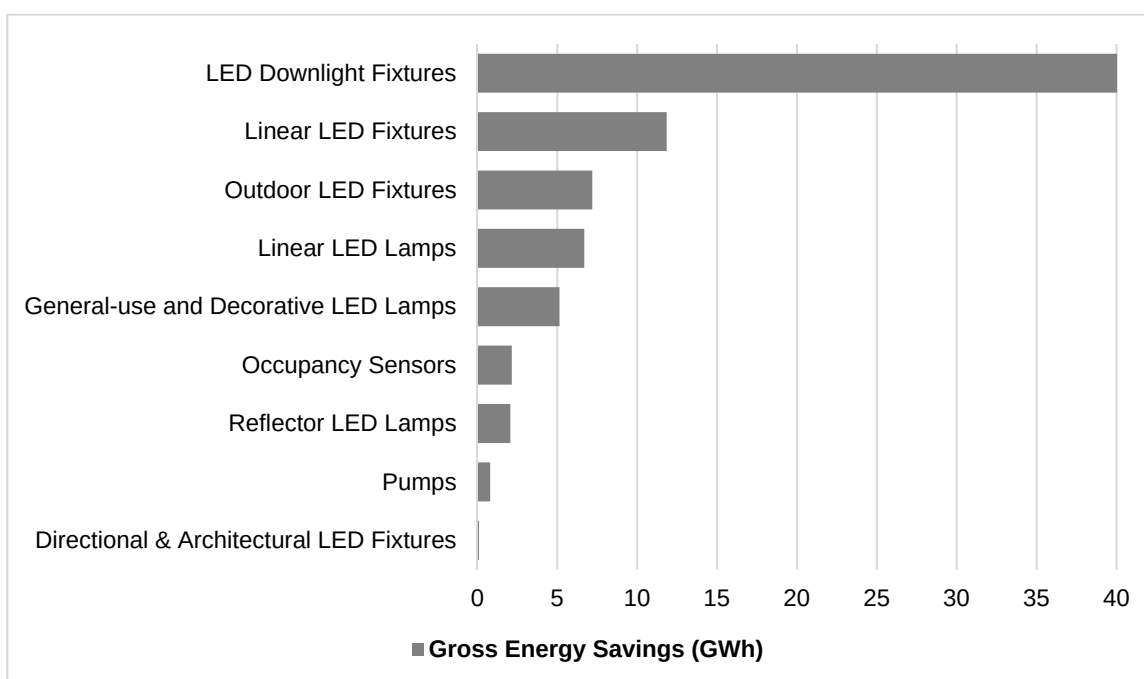


Figure 5 below provides an overview of the distribution of Instant Rebates gross savings among pumps and different lighting measures. In 2018, LED downlight lamps generated the largest share of gross savings (53%), followed by LED linear fixtures (16%) and outdoor LED fixtures (9%).

In 2017, LED downlight fixtures also generated the largest share of gross savings (56%) but were followed by LED linear lamps (9%) and LED linear fixtures (16%).

Figure 5: Distribution of BER Instant Rebates Gross Savings by Measure Category



The average unitary savings of rebated measures have continued to increase to 150 kWh in 2018, up from 108 kWh in 2016 and 133 kWh in 2017.

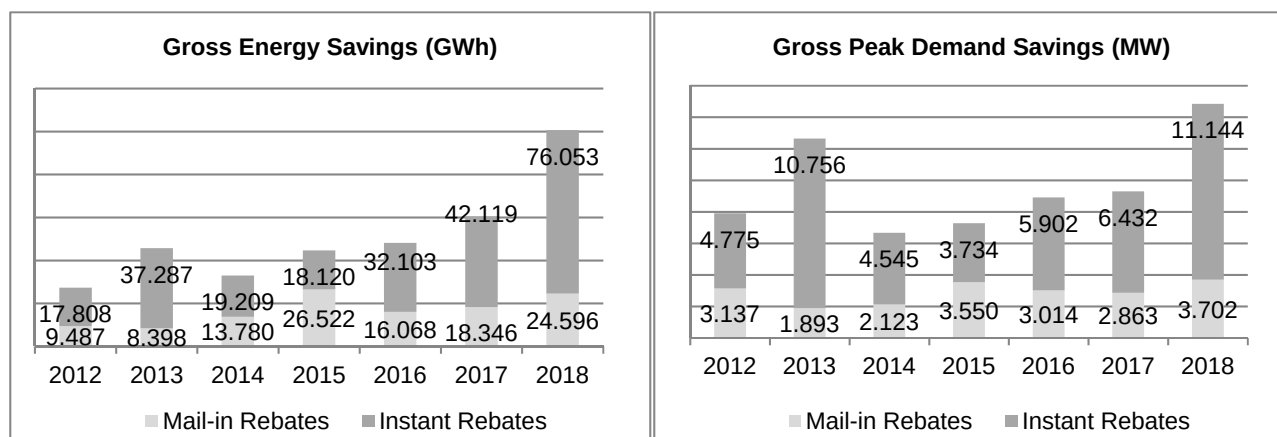
BER Overall

As presented in Figure 6 further below, BER generated a total of 100.648 GWh in gross energy savings at the generator, which is the highest result since inception. Mail-in accounted for 24 percent of savings, while Instant Rebates accounted for the remaining 76 percent.

The increase in overall gross savings is mostly due to Instant Rebates whose energy savings have grown by 81 percent since 2017. Moreover, participation levels also increased in Mail-in, with lighting measures playing a key role in generating gross savings in Mail-in.

In 2018, gross peak demand savings totalled 14.846 GWh for both Mail-In and Instant Rebates, up from 9.295 MW in 2017 and representing a 60 percent increase. Once again, the increase over 2017 is mostly due to the increase in participation levels in both services.

Figure 6: Summary of Gross Savings for BER, 2012-2018²



² 2011 results include the sum of savings for Mail-in Rebates from BER and Instant Rebates from Smart Lighting Choices.

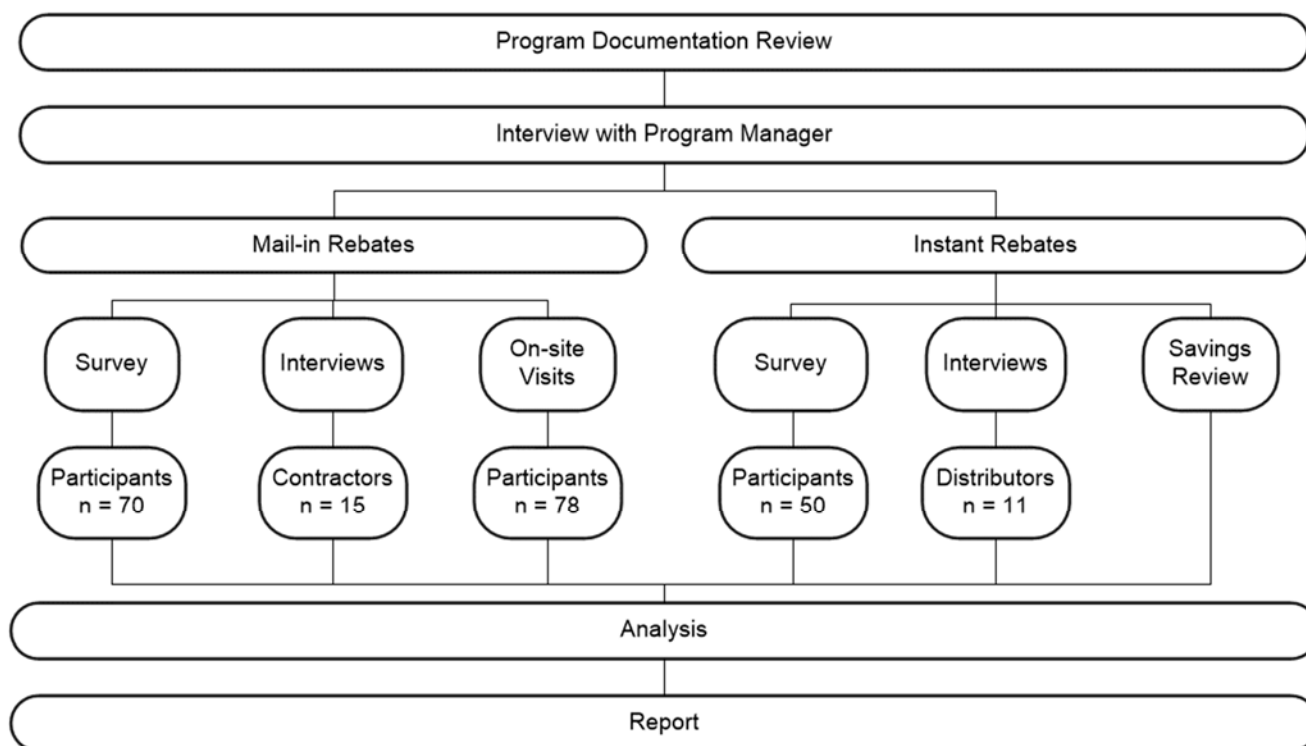
2 BER EVALUATION OBJECTIVES AND METHODOLOGY

The main objectives of the BER evaluation are as follows:

- › Assessing the effectiveness of BER design and delivery
- › Reporting on participant and partner perspectives
- › Calculating program results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions
- › Analyzing the market evolution of LED lamps

This section presents the methodology used and the activities carried out for the 2018 BER evaluation to achieve the aforementioned objectives. As illustrated in Figure 7, various data-collection activities were used throughout the evaluation.

Figure 7: BER Methodological Model



The Evaluator first reviewed BER documentation and then met the program manager in September 2018 to verify the implementation status of the previous evaluation recommendations and learn about recent BER changes. Based on the information obtained from this meeting, the Evaluator prepared a list of questions and topics to be included in the data-collection instruments.

Once the program manager meeting and the BER documentation review were completed, specific evaluation activities were undertaken, as described in the following subsections.

For evaluation activities that yield quantitative results based on a sample, the Evaluator aimed to achieve a maximum margin of error of 10 percent at a confidence level of 90 percent. 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 percent of the time. Thus, the margin of error indicates the relative level of precision³ of the measurement, while its associated confidence level indicates the probability of a measure falling within this margin of error.⁴

As part of this evaluation, the Evaluator calculated the margins of error for survey samples, free-ridership levels and savings adjustment ratios. The margins of error are presented alongside the results in the relevant sections. Examples of calculations used to establish margins of error are provided in Appendix II of the 2018 DSM Programs Evaluation Executive Summary.

2.1 Mail-in

Participant Survey

In October and November 2018, CRA conducted a telephone survey with a total of 70 BER Mail-in participants. The average length of the survey was 17 minutes. The questionnaire and complete survey results are presented in Appendix I and Appendix II respectively. All appendices are presented in the Efficient Product Rebates Program – Appendices document.

The survey was meant to generate feedback on the following aspects of Mail-in:

- › Awareness of other ENS program components or services, including Instant Rebates
- › Reasons for participation
- › Experience with the participation process
- › Free-ridership
- › Cross-influence of ENS promotional materials or past program component participation
- › Satisfaction with the service
- › Barriers to implementing energy efficient measures (including non-lighting measures)
- › Improvement recommendations
- › Firmographics

³ Precision refers to how reproducible a set of measurements is. However, it does not take into account how close the measured values are to the true values since this refers to accuracy.

⁴ 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.

The total number of unique Mail-in participants was 257 for the entire 2018 year. Drawing a random sample of 70 from a population of 257 yields a margin of error of 8.5 percent at a 90 percent confidence level.

Interviews with Contractors

As part of the process evaluation, Research Into Action conducted 15 interviews with Mail-in participating contractors in October and November 2018. These interviews mainly served to inform the Evaluator on three overarching issues with the service, notably:

- › How to generate more interest and participation in non-lighting measures
- › How Mail-in and Instant Rebates interrelate
- › Whether rebate levels should be adjusted and, if so, for which measures

The interview guide also included questions to understand the activities and types of projects completed by contractors, key successes and challenges related to Mail-in, along with ways to improve the service.

The guide used for the contractor interviews is presented in Appendix III.

On-site Visits

In the fall of 2018, Equilibrium Engineering conducted 78 on-site visits at the facilities of participants who received a rebate through Mail-in. The main purpose of the on-site visits was to validate whether the measures implemented were consistent with the information contained in the tracking sheet. Additionally, the Evaluator validated the hours of use (HOU), various operating conditions and, whenever possible, old and new equipment characteristics (power consumption in watts or horsepower, efficiency, etc.). These elements were used to revise gross savings by either adjusting savings on individual projects or applying an adjustment factor to all projects in a given category when the sample size was large enough. The Evaluator also interviewed participants to assess and quantify possible spillover and ask process-related questions about their interest in implementing non-lighting measures in the near future, the reasons for considering doing so, and the decision-making process that goes into such a decision. The on-site visit sampling methodology and protocol are presented in Appendix IV.

2.2 Instant Rebates

Participant Survey

In October and November 2018, CRA conducted a telephone survey with a total of 50 Instant Rebates participants. Of the 50 participants, 30 were end users who had purchased LED lighting measures for their own business and 20 were contractors who had purchased LED lighting measures to be implemented in client facilities.

The average length of the survey was 10 minutes. The questionnaire and complete survey results are presented in Appendix V and Appendix VI respectively.

The survey was meant to generate feedback on the following aspects of Instant Rebates:

- › Reasons for participation and for purchasing energy efficient measures instead of standard measures
- › Who, among end users, distributors, and contractors, is involved in the decision to purchase eligible measures
- › The type of project for which eligible measures were purchased (e.g. retrofit vs. new construction; commercial vs. residential)
- › Whether participants were aware of the ENS rebate at the time of purchase
- › Sources of awareness about Instant Rebates and Mail-in
- › Free-ridership
- › Cross-influence of ENS promotional materials or past program component participation

Since it is not possible to obtain a complete list of Instant Rebates participants due to the nature of this service, the margin of error is calculated using a conservative assumption that the service population is infinite. Drawing a random sample of 50 from an infinite population yields a margin of error of 11.8 percent at a 90 percent confidence level. Considering the small number of end users identified in 2017 and the varying quality of contact information, the Evaluator considered this sample size to be realistic.

Interviews with Distributors

In November 2018, CRA conducted 11 interviews with Instant Rebates participating distributors. These interviews mainly served to establish free-ridership levels for the highest-selling lighting measure categories by estimating how the market would have reacted without the existence of the service. Distributors were also asked about their satisfaction with the service and ways to improve the service.

Similar to the Mail-in contractor interviews, Instant Rebates distributors were also asked about interrelations between Mail-in and Instant Rebates and the level of awareness of these services among participants. Distributors also provided feedback on Instant Rebates incentive levels.

Finally, the distributor interview guide included questions to situate the lighting measure categories on a product adoption curve to inform the BER market evolution analysis.

The guide used for the distributor interviews is presented in Appendix VII.

Savings Review

Similarly to the 2017 evaluation, the savings review for the 2018 evaluation was limited to validating whether tracked savings were consistent with the recommended values from the 2016 evaluation.

3 BER PROCESS AND MARKET EVALUATION

This section provides a summary of the key findings from a review of BER documentation, participant interviews during site visits, participant surveys, as well as interviews with key ENS staff, Mail-in contractors and Instant Rebates distributors.

Three primary research questions were addressed in the process and market evaluation:

- › How do the two BER services (Mail-in and Instant Rebates) interrelate?
- › How can BER and ENS encourage the implementation of non-lighting measures?
- › What is the level of satisfaction with BER?

3.1 Interrelations Between BER Services

One of the main objectives of this portion of the process and market evaluation was to draw a picture of the two BER services to verify whether using different sets of assumptions and calculation methodologies is justified. Instant Rebates uses a set of assumptions that is the same for all products within each category, whereas Mail-in bases savings on real conditions for each individual project; it is therefore possible that a given project reports different savings depending on the service under which it is registered. Additionally, the Evaluator wanted to gain insights into the best approach to delivering BER by better understanding how and why each BER service is used. These evaluation objectives are especially relevant because Instant Rebates is an increasingly important contributor to overall BER savings, as highlighted in the Participation History subsection of this report (Subsection 1.3).

The following subsections explore the interrelations between the two BER services by assessing the Mail-in and Instant Rebates installation contexts, how aware participants, contractors, and distributors are of the two services, and the reasons for participating in one service over the other. This section ends with a brief review of programs similar to BER in other Canadian jurisdictions.

3.1.1 BER Service Offers and Logic for Lighting Measures

BER-eligible measures are offered through both Instant Rebates and Mail-in. Instant Rebates provides point-of-purchase rebates through participating distributors, whereas Mail-in requires participants to complete an application process before receiving rebates. All lighting measures eligible under Instant Rebates are also offered through Mail-in, yet the opposite is not permitted. Some measures are only available through Mail-in, most notably high-bay luminaires, stairway and passageway luminaires, refrigerated case luminaires, and most outdoor LED lighting (including parking lighting).

Instant Rebates was designed to facilitate the purchase of high-volume measures for which savings assumptions are assumed to be consistent. Given the limited participant information tracked through Instant Rebates due to its delivery approach, measures that require participant or site-specific information are administered through Mail-in.

What follows are observations related to certain lighting measures sold under BER in 2018 to illustrate the highest-selling measures in each service and how some of them overlap.

- › Fifty-two percent (52%) of 2018 Mail-in lighting savings were generated by lighting measures that were also available under Instant Rebates.
- › Half of 2018 Instant Rebates gross energy savings (53%) were generated by downlight luminaires, which also generated 5 percent of Mail-in lighting savings in 2018.
- › Linear replacement lamps are the lighting measure that generated the most savings under Mail-in in 2018 (39%); this measure was also a key contributor to Instant Rebates savings in 2018 (9%).
- › The two Mail-in-only lighting measures that generated the most savings in 2018 were: high-bay luminaires (32%) and pole/arm-mounted area luminaires (13%). When considering 2018 lighting savings, these two measures constitute the main differences between Mail-in and Instant Rebates.

In short, while a few Mail-in specific measures constitute a significant percentage of this service's savings, there is also a large proportion of the Mail-in offer that does not differ much from that of Instant Rebates.

3.1.2 Installation Contexts of BER Lighting Measures

In addition to comparing the measures installed in each service, the Evaluator also compared the context in which lighting measures are installed. This section discusses the types of projects for which BER lighting measures are purchased and installed, specifically: (1) whether they are for new construction or retrofit projects; (2) in the case of retrofit projects, whether the existing measures were at the end of their useful life or not; (3) and whether the measures are for residential or commercial use.

New Construction vs. Retrofit

The Instant Rebates participant survey sample included 30 end users who purchased eligible lighting measures for their own businesses and 20 contractors who purchased them for clients. For a majority of contractors (60%), most of the lighting measures they bought were for new construction projects, whereas only 17 percent of the lighting measures bought by end users through BER in 2018 were for new construction projects; 80 percent of end users mentioned retrofit projects.

Based on site visit findings, the Evaluator concluded that most Mail-in participants had purchased their lighting measures for retrofit projects (59%) compared to new construction projects (41%).

Although these findings should not be compared directly given the different methodologies used to obtain them, they reveal that Instant Rebates and Mail-in both serve retrofit and new construction projects.

Early vs. End of Life Replacement

Those Instant Rebates participants who mentioned purchasing their measures for retrofit projects were asked about the state of their existing equipment at the time of replacement. About one-third of participants (32%) indicated that their equipment was working and not close to end of useful life (early replacement). Most of the remaining participants replaced equipment at the end of useful life (45%) or a mix of working and non-working equipment (13%).

Based on Mail-in site visits, most of the lighting measures were purchased for early replacement (69%), while only 2 percent were for equipment at the end of useful life. The remainder were new measures that did not serve to replace existing equipment.

Again, although these findings should not be compared directly given the different methodologies used to obtain them, they demonstrate that participants use Instant Rebates and Mail-in for both early replacement and end-of-life scenarios, with end-of-life replacements being more frequent under Instant Rebates.

Residential vs. Commercial

Of the nine surveyed contractors who had purchased lighting measures suitable for both commercial and residential projects (i.e. LED downlight fixtures and/or general-use and decorative LED lamps), five mentioned that they had purchased them for both residential and commercial projects, while the other four had purchased them for residential projects only.

According to site visit results, almost all Mail-in lighting measures implemented in 2018 were for commercial use.

The information obtained from the Instant Rebates participant survey reveals that the Instant Rebates market is less homogenous than anticipated, which also implies that the variables used in savings calculations, such as the baseline and HOU, are not consistent among participants. While ENS has implemented the Evaluator's recommendations to improve Instant Rebates participant tracking, the information to fully capture the actual Instant Rebates market is still fairly limited, rendering it challenging to adjust savings assumptions to represent average conditions. While the baseline assumptions for Instant Rebates are new standard fixtures or lamps, a significant proportion of participants use this service for retrofit projects.

3.1.3 Awareness and Use of BER Services

This subsection discusses whether Mail-in participants know about Instant Rebates and vice versa, as well as why participants and contractors choose one service over the other.

During the survey, 70 Mail-in participants were asked about past participation in ENS program components. Those who said that they had participated in ENS program components were then asked about whether they had heard of or participated in Instant Rebates. Nearly one-quarter (24%) of surveyed Mail-in participants reported the use of or awareness about Instant Rebates. Among those participants who knew about Instant Rebates but had never taken part in it, the main reason for participating in Mail-in over Instant Rebates was that the desired measures were not part of Instant Rebates offerings (2 out of 5 participants).

As previously mentioned, a separate survey was conducted with 50 Instant Rebates participants. Forty-six percent (46%) of surveyed participants (end users and contractors) reported having heard of Mail-in. Over half of that group (57%) chose Instant Rebates over Mail-in because it was easier or required less paperwork, and 26 percent stated it was because the rebate was provided immediately, as opposed to Mail-in, which has a delay. The remaining 16 percent of participants either did not know why they chose one service over the other or reported using Instant Rebates for residential work – something they could not do via Mail-in.

An interview was completed with 11 Instant Rebates distributors, 10 of whom mentioned being aware of Mail-in and, of those, nine reported using both BER services. An interview with 15 Mail-in contractors revealed that 12 of them had knowledge of Instant Rebates. Contractors gravitate toward not only the BER service that best suits their business and how they operate, but also the process with which they are most comfortable. Some contractors with experience using both services used one more than the other, a decision generally dictated by the type of project, the customers they serve, and willingness to take part in the more demanding Mail-in process. For example, two Mail-in contractors noted never using Instant Rebates because they source their measures nationally and do not purchase from local distributors. Another Mail-in contractor reported using Mail-in instead of Instant Rebates because they liked being able to calculate an actual energy savings value. Conversely, a third contractor noted they avoid Mail-in whenever possible because it requires more work on their part than Instant Rebates.

3.1.4 Jurisdictional Review

The Evaluator performed a brief jurisdictional review of business programs elsewhere in Canada to determine how BER design compared. This review included the following utilities: BC Hydro, Energy Efficiency Alberta, Manitoba Hydro, the Independent Electricity System Operator, New Brunswick Power, and Newfoundland Power.

The six utilities all have a program similar to the ENS Mail-in service, whereby customers apply for rebates on lighting and/or non-lighting measures. Five of these six utilities require measures to be pre-approved under their mail-in program. None of the reviewed utilities have an instant rebates program for their business clients like ENS does.

3.2 Interest and Participation in Non-lighting Measures

ENS developed a long-term diversification strategy to encourage the implementation of non-lighting measures. To contribute to this strategy, the subsequent subsections discuss:

- › Who and what drive participants' measure choices
- › Participants' intentions to implement measures in the next two years
- › Barriers that inhibit participants from participating in BER and implementing non-lighting measures
- › Suggestions to generate interest in non-lighting measures, including possible new BER measures

3.2.1 Actors and Factors Influencing Measure Choices

The Evaluator asked Mail-in and Instant Rebates participants how they became aware of BER offerings and the role of distributors and contractors in their awareness and choice of measures.

Mail-in

While visiting with Mail-in participants on site, the Evaluator took the opportunity to ask a few process-related questions. Of the 74 site-visit participants who provided answers, most learned about BER offerings through a contact at ENS (39%) or via a contractor (36%). Of those who learned about BER via their contractor (n=27), most mentioned their lighting (16) or heating, ventilation and air conditioning (HVAC) (7) contractor.

About half (49%) of BER site-visit participants reported having specific contractors they use for replacing and maintaining equipment. Of those, three-quarters noted having specific lighting contractors they use. Fewer participants have a go-to contractor for non-lighting measures. Approximately one-quarter of site-visit participants (28%) noted having an HVAC contractor, and even fewer participants noted having specific plumbing or refrigeration contractors.

Instant Rebates

According to the Instant Rebates survey, distributors are the primary source of information about the rebate for end users (57%), followed by ENS through direct contact (10%).

Of the 20 contractors interviewed during the Instant Rebates survey, 65 percent believe that the contractor is usually the one who makes the decision to buy energy efficient measures rather than standard efficiency measures. The remaining contractors mentioned that clients who make the decision usually ask for their advice, overall making contractors key actors in the choice of lighting measures. Distributors are also a source of recommendations for half of participating contractors and end users (51%).

While the majority of Instant Rebates participants who answered the survey mentioned having purchased only energy efficient lighting measures in 2018, one-third also bought standard efficiency measures. Most of them did so because the measures were cheaper (44%) or because they wanted to match the existing equipment (31%). The main reason for choosing energy efficient measures over standard measures is quality, followed by improved energy efficiency and savings on energy costs.

3.2.2 Intentions to Implement Measures

Two-thirds of surveyed Mail-in participants intend to implement energy efficiency measures in the next two years and many participants plan on implementing non-lighting measures. The most common non-lighting measure category is HVAC (see Table 7 below).

Table 7: Mail-in Surveyed Participant Planned Measures (n=47)

Measure Type	Will Implement Measures in the Next Two Years
Lighting	66%
HVAC	43%
Building Shell	19%
Water Heating	17%
Industrial Equipment	15%
Appliances	4%
Kitchen Equipment	4%
Compressed Air	4%

Forty percent of site-visit participants indicated interest in implementing measures in the next two years and the range of measures being considered varied widely (see Table 8 below), which is similar to the range of measures noted by surveyed Mail-in participants in Table 7. Most of those intending to implement measures plan on implementing non-lighting measures.

Table 8: Mail-in Site-visit Participant Planned Measures (n=30)

Type	Will Implement Measures in the Next Two Years
HVAC	9%
Water Heating	8%
Lighting	5%
VFD	5%
Solar	5%
Compressed Air	3%
Kitchen	1%
Pumps	1%
Pool Equipment	1%

The principal reason for implementing these measures in the future would be to save money (83%). Other reasons included improving the performance or comfort of the facility (23%), such as providing better lighting for employees, and for environmental reasons (13%). To implement these measures, 60 percent of site-visit participants suggested they would contact a contractor first. Nearly one-quarter noted they would use internal staff and 13 percent suggested they would reach out to ENS first. Almost three-quarters of surveyed participants noted they would have to seek approval from a board or other decision makers before implementing any intended measures.

Some participants noted that ENS could offer support for their intended projects. About half (16 of 30) suggested support for the following:

- › Educating clients about ENS offerings and new technologies (9 mentions)
- › Assisting with feasibility studies/audits (5 mentions)
- › Providing information about how energy efficiency measures limit the environmental impacts of facilities (2 mentions)

3.2.3 Barriers to Mail-in Participation and Non-lighting Measures

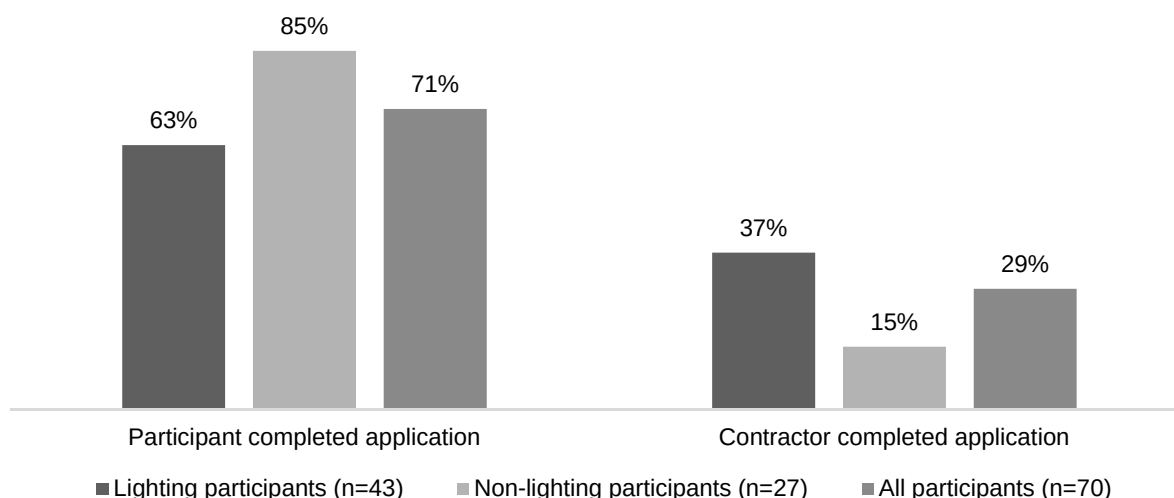
One-third of surveyed Mail-in participants implemented a building upgrade in the last two years without ENS support. Lighting and HVAC were the most popular upgrades reported by Mail-in participants. Approximately half (11 of 23) of those Mail-in participants who upgraded without ENS support did not know about ENS support opportunities. Forty percent (10 of 23) of Mail-in participants who upgraded without ENS support thought the service would have been “too much hassle” or the project too small to participate in the service. The remaining two Mail-in participants who upgraded without ENS support (12%) indicated that their project would not have qualified for rebates.

About one-quarter of Mail-in participants do not plan to make upgrades in the next two years because they perceive their equipment as already energy efficient (13%), or they only make upgrades upon equipment failure (11%). Smaller percentages of participants reported not having enough money to make replacements (9%), not being able to implement upgrades because they rent (4%), or other reasons (9%).

Half of Mail-in participants reported that their organizations employ payback thresholds when deciding to make efficiency improvements and most require payback periods within five years. Of the 35 Mail-in participants who reported having payback thresholds when making upgrade decisions, 37 percent require payback periods to be two years or less and 46 percent require three to five years. These results suggest that a considerable portion of participants would not implement measures with payback periods longer than five years, which is an implementation barrier for many non-lighting measures.

Non-lighting Mail-in participants often bear the burden of submitting Mail-in applications and collecting associated documentation. On average, non-lighting participants complete their own applications more often than lighting participants. Non-lighting participants are more likely than lighting participants to report that they (or their colleagues) completed the application (Figure 8).

Figure 8: Who Completed Mail-in Application by Participant Type



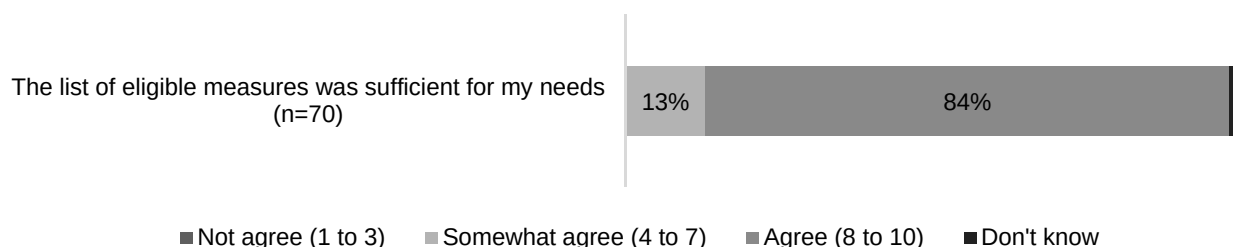
3.2.4 Suggestions to Generate Interest in Non-lighting Measures

According to non-lighting Mail-in contractors, there are no measures that they avoid promoting, and they already promote a range of measure types. Typically, contractors that use the BER services promote measures that they think align well with their own services and will motivate customers to complete projects. For example, two HVAC contractors reported widely promoting heat pumps, although one of them noted that the heat pump incentive is not high enough to motivate many clients to install those units.

Non-lighting contractors noted measures that ENS could offer and promote to generate interest in non-lighting measures and increase participation in Mail-in. Five of the 11 interviewed Mail-in contractors who sell non-lighting measures suggested roof-top units. According to those same non-lighting contractors, there are opportunities to improve the current list of controls by rebating measures that improve sequencing when equipment starts in the morning. Fewer contractors suggested chillers (1 mention), boilers (1 mention), and measures applicable to automobile shops (1 mention). The four contractors that solely implement lighting projects did not suggest additional measures.

Mail-in survey participants did not note any specific non-lighting measures they wished to see included in the service. Participants generally agreed that the Mail-in list of measures meets their needs (see Figure 9).

Figure 9: Participant Satisfaction with BER Mail-in Measures⁵



About three-quarters of surveyed Mail-in participants reported that past participation in an ENS program component or service heavily influenced their decision to participate again. Additionally, contractors recalled instances whereby participation in Mail-in influenced participants to participate in other ENS program components and services.

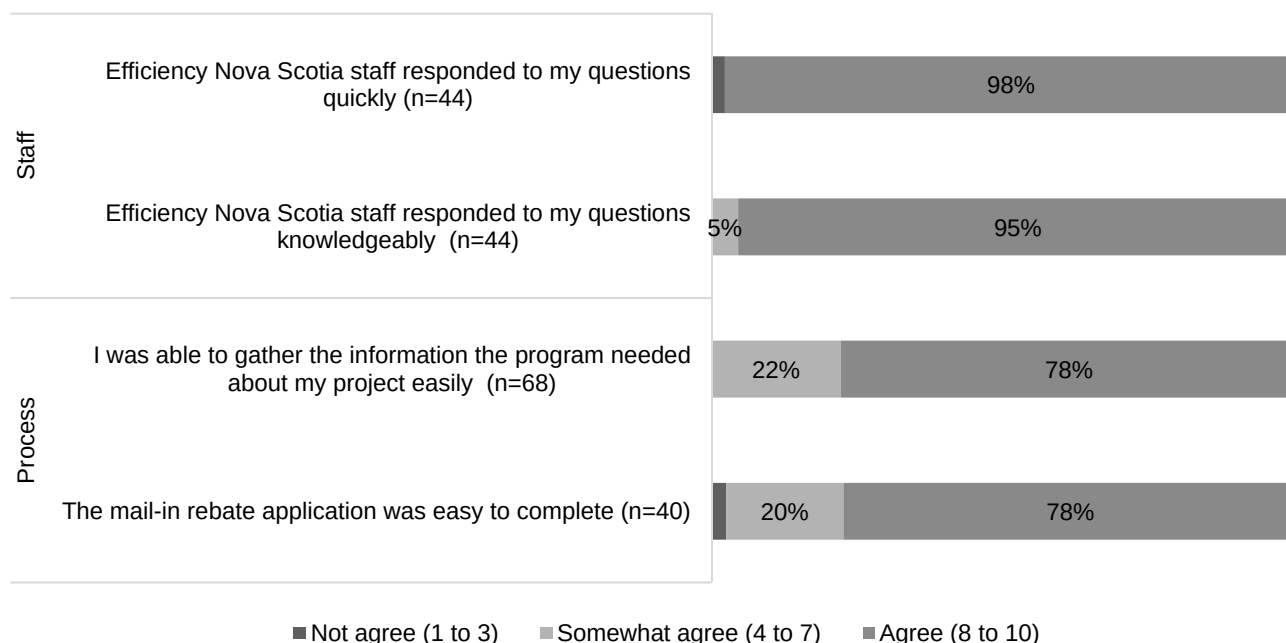
3.3 Satisfaction with BER

This subsection presents feedback from participants, contractors and distributors on the current state of BER and their relationship with ENS.

3.3.1 Satisfaction with the Mail-in Participation Process

Figure 10 below indicates that participants were very satisfied with BER staff and slightly less satisfied with service processes. No statistically significant differences in satisfaction were identified when examining satisfaction levels based on who completed the application, whether the participant or the contractor.

⁵ Participants were asked to rate their level of agreement with statements on a scale of 1 to 10 where one means “not at all agree” and 10 means “highly agree”.

Figure 10: Participant Satisfaction with ENS Staff and BER Mail-in Processes


Of the 15 interviewed Mail-in contractors, five expressed challenges using Mail-in with three reporting the process was too time consuming, but they did not offer specifics about process steps that should be removed or addressed. Two contractors expressed difficulties explaining the service to their customers and ensuring that customers understand the Mail-in participation process.

3.3.2 Satisfaction with Instant Rebates

The 11 interviewed Instant Rebates distributors provided an overall satisfaction rating of 7.7 out of 10 when considering the service overall (using a scale from 0 to 10 where 0 means “not at all satisfied” and 10 means “completely satisfied”). Those who provided ratings of seven or less mentioned the time and work required to administer the rebates and keep track of which exact measures are eligible for rebates. Another distributor mentioned a concern about contractors obtaining the rebates instead of end users.

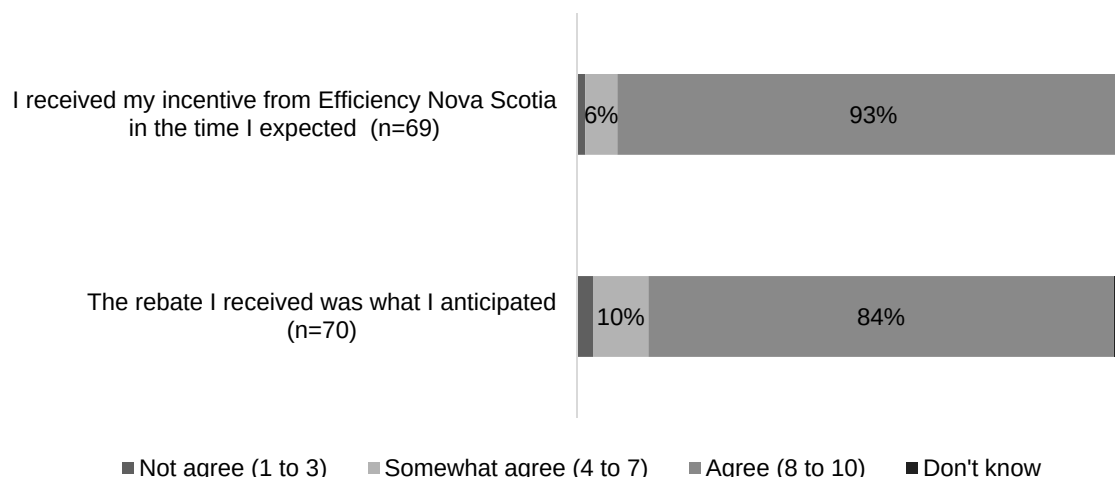
Satisfaction with support and communications provided by ENS staff obtained an average score of 7.9 out of 10 based on the above scale. The main reason for dissatisfaction was the difficulty in reaching staff to ask questions and receiving a quick response.

The rebate processing, tracking and reporting portion of the service obtained an average rating of seven out of 10 using the above scale. Some distributors indicated that the process to populate the spreadsheet with sales data was cumbersome and time consuming and that the format did not provide much flexibility.

3.3.3 Satisfaction with BER Incentives

Mail-in participants noted that, generally, received incentives were what they expected, and the time to receive the incentives was as anticipated (see Figure 11).

Figure 11: Participant Satisfaction with Incentives⁶



Instant Rebates distributors generally agreed that incentives were sufficient to motivate interest in LED fixtures and lamps. One distributor mentioned that the level of incentive could be increased for low-bay luminaires given the higher price point for these measures. Another distributor mentioned that a higher rebate should be offered on LED downlight fixtures over 3,000 lumens to further encourage measure adoption. When considering LED linear lamps, it was mentioned that there is a wide variation of price points within this measure category and that the incentive level should be increased for higher-end measures. Finally, the incentives for general-use and decorative LED lamps were considered adequate by all distributors. That being said, three of the distributors believe that the rebate is not always an important purchase consideration given that the measure price point has recently significantly decreased, leading to many occasions whereby the full incentive level (50% rebate) is not reached.

⁶ Participants were asked to rate their level of agreement with statements on a scale of 1 to 10 where one means “not at all agree” and 10 means “highly agree”.

In terms of non-lighting measures, Mail-in contractors had limited knowledge of the sufficiency of incentive amounts to foster interest in many measure types. No contractors had knowledge or experience with compressed air, kitchen, agricultural, or water heating equipment and therefore had no suggestions or feedback about these services or the sufficiency of corresponding incentives. Of the eight contractors with HVAC experience that could report about the sufficiency of heating incentives, more than half (5) indicated that higher incentives for heating measures would foster more interest. The remaining three contractors suggested existing incentives were sufficient. All three contractors with refrigeration experience suggested higher incentives would help drive interest in that measure. One indicated that higher incentives for strip curtains on coolers would drive interest in the measure, and another contractor reported that higher incentives for refrigeration controls like KE2 controls would generate interest in those measures.

3.3.4 Improvement Suggestions

In addition to the abovementioned recommendations aimed at generating more interest in non-lighting measures, Mail-in participants and contractors who were surveyed and/or interviewed provided the recommendations in Table 9 for Mail-in.

Table 9: Participant Improvement Suggestions (n=70) for BER Mail-in

Suggestions	Count	Percent
No Improvement Suggestions	42	60%
Improvement Suggestions	28	40%
Awareness	15	21%
Better marketing/awareness	7	10%
Provide more information/information sessions	5	7%
Provide information about rebates	2	3%
Improve quality of information about the service	2	3%
Inform and educate contractors about the service	1	1%
Process	14	20%
Make forms more user-friendly	10	14%
Speed up process/receive rebate more quickly	3	4%
ENS staff should be more knowledgeable about service	3	4%
Measures	4	6%
Offer additional measures through service	3	4%
Offer measure guarantees	1	1%
Rebates	4	6%
Increase/better rebates	4	6%

A total of 28 participants provided 11 improvement suggestions that fall under four categories: improving service awareness; improving processes; expanding the list of measures rebated; and increasing rebates (see Table 9 above). Participant improvement suggestions for Mail-in largely revolved around increasing service awareness and making the process as easy as possible.

Some contractors provided varied suggestions for ways to improve the service with no obvious trend emerging, as follows.

- › Offer a single point-of-contact to contractors who complete many projects across program components and services. According to them, it can be difficult to locate the correct person to speak with at ENS and determine which program component to use for a given project (1 mention).
- › Improve the website to make it easier to find incentive values by measure (1 mention).
- › Incent service providers participating in other ENS program components and services to direct projects to Mail-in (1 mention).

A few contractors reported types of facilities that they thought are underrepresented in BER:

- › An HVAC contractor implied that car dealerships and auto service facilities might be underrepresented, especially when it comes to implementing non-lighting measures such as compressed air equipment and controls.
- › An HVAC and integrated controls contractor noted that office buildings controlled by property managers are not easily convinced to participate because of the split incentive issue, tenants bear the cost of the utilities, not building owners.

4 IMPACT EVALUATION FOR BER MAIL-IN

The objective of the 2018 BER Mail-in impact evaluation is to determine the gross and net electrical energy and peak demand savings.

4.1 Gross Savings

Gross savings refer to changes in energy consumption resulting from actions taken by participants, regardless of their reasons for participating.⁷ For each Mail-in Rebates project, ENS tracks annual gross savings using the equations defined in the most up-to-date CIRx Screening Tool and the equipment parameters specific to each project.

In 2018, the Mail-in tracking sheet contained a total of 366 projects implemented by 257 unique participants across 10 different measure categories. The Evaluator reviewed ENS gross savings based on the equations found in the CIRx Screening Tool and the information collected from on-site visits. The visits covered 78 projects, with six projects being counted in more than one measure category. In this report, a measure is defined as one specific type of installation such as an air-source heat pump, an HVAC occupancy sensor, or one LED fixture type. The tracking sheet usually presents each measure on a separate line with a single project containing one or more unique measures.

To present revised savings, the Evaluator established an adjustment ratio for each category, which corresponds to the factor by which tracked savings are multiplied to obtain revised savings.

4.1.1 Summary of Adjustments to Gross Savings

Since lighting measures represent 75 percent of Mail-in savings, applying an adjustment factor to this measure category had the largest impact on gross savings. The most common adjustment was revising HOU's using data collected on site. Only 23 percent of measures required an adjustment greater than 5 percent, which represents an improvement compared to the 36 percent observed in the 2017 evaluation. This improvement aligns with the adjustments made to the participant application forms by ENS to better track HOU's. The efficient wattage values were also revised for 16 percent of measures. One measure was considered an outlier; the Evaluator therefore applied a one-time adjustment to this measure, which resulted in an overall adjustment ratio slightly lower than the extrapolated adjustment ratio.

⁷ Definition adapted from National Renewable Energy Laboratory, *The Uniform Methods Project Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

Three other measure categories were significantly adjusted, the results of which were extrapolated to other projects in the same categories, namely motors and drives, HVAC, and refrigeration. The adjustments made to motor, VFD, and HVAC measures also had considerable impacts on the overall savings since these measures represent a significant portion of tracked savings. The most common adjustments made to motor and VFD measures were to modify the energy savings factors and demand savings factors based on actual motor usage observed on site. For refrigeration measures, the savings were considerably increased since the Evaluator noted, during the site visits and project documentation review, that efficient wattages for multiple measures were higher than the values tracked. Appendix VIII presents additional details as to adjustments made to specific projects, while Appendix IX shows the detailed revised savings calculations for an example project.

Moreover, some agricultural measures were largely adjusted based mostly on different HOU values noted during site visits. This resulted in margins of error above 10 percent and the adjustment ratios for this measure category were therefore not extrapolated. The adjustment ratios for kitchen, pumping and water heating measures were also not extrapolated because the margins of error were too high, or the sample of reviewed measures were too small. For these measure categories, one-time adjustments were made to the corresponding savings to account for the differences in energy and demand savings that were confirmed during site visits.

Table 10 below lists the adjustment ratios calculated for each measure category and the corresponding margin of error at a confidence level of 90 percent. The table also indicates which adjustment ratios were extrapolated and the resulting overall adjustment ratios. The overall adjustment ratios represent the revised savings divided by the tracked savings after applying both the extrapolated adjustment ratios and the one-time adjustments for outliers.

Table 10: Adjustment Ratios per BER Mail-in Measure Category

Measure Category	Number of Measures		Energy Savings				Peak Demand Savings			
	Total	Sample	Calculated Adjustment Ratio	Margin of Error	Extrapolated	Overall Adjustment Ratio	Calculated Adjustment Ratio	Margin of Error	Extrapolated	Overall Adjustment Ratio
Commercial Lighting	725	140	0.984	4.5%	Yes	0.972	0.909	4.3%	Yes	0.902
HVAC	78	20	0.990	2.8%	Yes	0.990	0.955	3.5%	Yes	0.955
Motors and VFDs	80	70	0.821	2.9%	Yes	0.821	0.831	3.4%	Yes	0.831
Commercial Refrigeration	54	24	1.285	8.6%	Yes	1.285	1.200	8.1%	Yes	1.200
Compressed Air	9	2	1.000	0.0%	Yes	1.000	1.000	0.0%	Yes	1.000
Agriculture	17	13	1.451	26.3%	No	1.416	0.763	10.3%	No	0.785
Commercial Kitchen	22	9	0.818	24.4%	No	0.930	0.839	27.1%	No	0.945
Commercial Pumping	9	6	0.917	28.7%	No	0.966	0.917	28.8%	No	0.961
Water Heating	3	2	1.321	5.5%	No	1.218	1.321	5.5%	No	1.218
Pool	1	0	-	-	N/A	1.000	-	-	N/A	1.000

4.1.2 Interactive Effects

When a measure implemented as part of BER Mail-in is affected by interactive effects, this is taken into account by the gross savings standard equation presented in the CIRx Screening Tool. For BER, interactive effects only apply to lighting projects. Based on site-visit observations, the Evaluator ensured that ENS used the correct interactive effects factors for visited projects. When applicable, the Evaluator adjusted the interactive effects factor based on the CIRx Screening Tool value that most accurately corresponds to the situation observed on site. These adjustments are included in the adjustments presented in Subsection 4.1.1.

4.1.3 Effective Useful Life

As part of the 2018 evaluation, the Evaluator reviewed the effective useful life (EUL) values used by ENS to calculate the energy savings that are expected to persist over time. The EUL values of all measures were reviewed based on the results of the 2017 DSM Evaluation Report; the Evaluator ensured that the right value was applied to each measure in the tracking sheet. In addition, the Evaluator revised the EUL values of lighting measures that are expected to undergo baseline changes during their lifetime due to regulatory changes. The equivalent EUL values applied to each eligible measure are presented in Appendix X.

ENS accurately tracked the EUL values for the vast majority of non-lighting measures, with only three measures being incorrectly tracked, although this led to a negligible impact on the overall EUL of those three measures.

While the EUL values for most lighting measures were correctly tracked by ENS in the tracking sheet, some EUL values were not accurately tracked, notably for downlight fixtures, high-bay luminaires, troffers, and multiple outdoor LED fixtures. The Evaluator therefore applied the EUL values established in the 2017 evaluation, which resulted in higher revised equivalent EUL values.

4.1.4 Revised Gross Savings

The savings achieved by Mail-in measure category are presented in Table 11 further below. Both the energy and peak demand savings were revised by applying the adjustment ratios discussed in Subsection 4.1.1.

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 NSP for each rate code and the corresponding energy savings listed in the final 2018 tracking sheet.

Overall, the total gross energy and peak demand savings for BER Mail-in amounted to 24.596 GWh and 3.702 MW respectively at the generator. Lifetime energy savings were calculated at 379.986 GWh and the weighted average EUL value for gross energy savings is 15.4 years.

Table 11: Revised Gross Energy and Peak Demand Savings for BER Mail-in

Measure Category	HVAC	Lighting	Refrigeration	Motors and VFDs	Compressed Air	Agricultural
Energy Savings						
Tracked Gross Energy Savings (GWh)	1.905	17.848	0.611	2.429	0.080	0.412
Adjustment Ratio on Energy Savings	0.990	0.972	1.285	0.821	1.000	1.416
Gross Energy Savings – at the Meter (GWh)	1.886	17.354	0.786	1.994	0.080	0.584
Line Loss Factor	1.064	1.064	1.064	1.064	1.064	1.064
Gross Energy Savings – at the Generator (GWh)	2.006	18.463	0.836	2.122	0.085	0.621
Effective Useful Life (years)	16.9	15.5	13.3	15.0	14.9	15.0
Gross Lifetime Energy Savings – at the Generator (GWh)	33.996	286.585	11.107	31.829	1.261	9.314
Peak Demand Savings						
Tracked Gross Peak Demand Savings (MW)	0.191	3.045	0.116	0.262	0.012	0.113
Adjustment Ratio on Peak Demand Savings	0.955	0.902	1.200	0.831	1.000	0.785
Gross Peak Demand Savings – at the Meter (MW)	0.183	2.746	0.139	0.218	0.012	0.089
Line Loss Factor	1.064	1.064	1.064	1.064	1.064	1.064
Gross Peak Demand Savings – at the Generator (MW)	0.195	2.922	0.148	0.232	0.013	0.095

Revised Gross Energy and Peak Demand Savings for BER Mail-in (Continued)

Measure Category	Kitchen	Water Heating	Pumping	Solar	Total for All Categories
Energy Savings					
Tracked Gross Energy Savings (GWh)	0.297	0.107	0.022	0.007	23.718
Adjustment Ratio on Energy Savings	0.930	1.218	0.966	1.000	-
Gross Energy Savings – at the Meter (GWh)	0.276	0.131	0.021	0.007	23.117
Line Loss Factor	1.064	1.064	1.064	1.064	-
Gross Energy Savings – at the Generator (GWh)	0.294	0.139	0.022	0.007	24.596
Effective Useful Life (years)	13.9	10.0	15.0	10.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	4.095	1.392	0.335	0.072	379.986
Peak Demand Savings					
Tracked Gross Peak Demand Savings (MW)	0.058	0.026	0.004	0.001	3.830
Adjustment Ratio on Peak Demand Savings	0.945	1.218	0.961	1.000	-
Gross Peak Demand Savings – at the Meter (MW)	0.055	0.032	0.004	0.001	3.479
Line Loss Factor	1.064	1.064	1.064	1.064	-
Gross Peak Demand Savings – at the Generator (MW)	0.059	0.034	0.004	0.001	3.702

4.2 Net-to-gross Ratio

The net-to-gross ratio (NTGR) serves to determine net savings, i.e. the savings that can be reliably attributed to a service. More precisely, the NTGR is established by giving due consideration to the effects, namely free-ridership and spillover, that positively or negatively affect the energy savings generated by a service.

4.2.1 Free-ridership

In the case of Mail-in, free-ridership occurs when participants would have still implemented the energy efficiency upgrades and measures in the absence of the service. The assessment of the free-ridership level is based on a self-report approach that involves asking participants a set of questions during a telephone survey.

These questions were designed to assess the likelihood for participants to have deployed energy efficient technologies in the absence of the service. The questions consider all the applicable variables related to the decision-making process, including planning, efficiency, cost, timing and quantity. Additional questions were used to determine the extent to which participant decisions to have measures implemented had been influenced by previous participation in an ENS energy efficiency program component or ENS 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.

The feedback collected from the participant survey was converted into an overall free-ridership level using the algorithm presented in Appendix XI.

The overall free-ridership level obtained is a weighted average based on the revised energy savings for each project. No adjustments to the weight of each measure category were applied for two reasons: (1) the number of sampled participants for categories other than lighting and HVAC was too small to obtain a statistically significant result; and (2) the distribution of savings of the surveyed sample was approximately equivalent to that of the entire population, which eliminated the need for a weighted average based on measure categories. An overall free-ridership level of 17 percent was obtained, with a margin of error of 2.7 percent. By comparison, the overall free-ridership level was 14 percent in 2017.

A statistically significant individual result was obtained for the most important measure category (lighting) and is presented here for reference purposes. The free-ridership level for participants who implemented lighting measures was 12 percent. This value is higher in 2018 compared to 2017 (8%), which might partially be explained by the increasing popularity of efficient lighting.

4.2.2 Spillover

For Mail-in, spillover occurs when participants implement eligible energy efficiency measures due to previous participation in the service, without having received any kind of additional support.

The Evaluator conducted on-site visits to directly question participants about any potential spillover effects and found that the spillover level for 2018 was nil, the same as in 2017. The algorithm used to determine the level of spillover is presented in Appendix XII.

4.2.3 NTGR Calculation

The NTGR is calculated using the following equation:

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

Based on the free-ridership and spillover levels established for BER Mail-in, the NTGR value was estimated at 0.83, as presented in Table 12.

Table 12: NTGR for BER Mail-in

BER Mail-in	
Free-ridership	17%
Spillover	0%
NTGR	0.83

4.3 Net Savings

Net savings are defined as the changes in energy use attributable specifically to Mail-in Rebates. Net savings were estimated by applying the above NTGR to the revised gross savings, as illustrated in the following equation:

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

Overall, the total net energy and peak demand savings for BER Mail-in amounted to 20.414 GWh and 3.073 MW respectively at the generator. By applying Nova Scotia's specific factor⁸ for GHG emissions generated by electricity production, 0.6126 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 12,506 tonnes of avoided CO₂ eq annually.

The net lifetime energy savings for BER Mail-in were established at 315.388 GWh and, as a result, the weighted average EUL value for gross energy savings is 15.4 years. Detailed results are presented in Table 13.

⁸ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes), and total electricity generation (10,978 GWh) was found in the following two sources: Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018).
Emera Inc., *Management's Discussion & Analysis* as at February 9, 2018, <http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

Table 13: Revised Net Energy and Peak Demand Savings for BER Mail-in

Measure Category	HVAC	Lighting	Refrigeration	Motors and VFDs	Compressed Air	Agricultural
Energy Savings						
Revised Gross Energy Savings – at the Meter (GWh)	1.886	17.354	0.786	1.994	0.080	0.584
NTGR	0.83	0.83	0.83	0.83	0.83	0.83
Net Energy Savings – at the Meter (GWh)	1.565	14.404	0.652	1.655	0.066	0.484
Line Loss Factor	1.064	1.064	1.064	1.064	1.064	1.064
Net Energy Savings – at the Generator (GWh)	1.665	15.325	0.694	1.761	0.070	0.515
Effective Useful Life (years)	16.9	15.5	13.3	15.0	14.9	15.0
Net Lifetime Energy Savings – at the Generator (GWh)	28.217	237.865	9.219	26.418	1.047	7.731
Peak Demand Savings						
Revised Gross Peak Demand Savings – at the Meter (MW)	0.183	2.746	0.139	0.218	0.012	0.089
NTGR	0.83	0.83	0.83	0.83	0.83	0.83
Net Peak Demand Savings – at the Meter (MW)	0.152	2.279	0.116	0.181	0.010	0.074
Line Loss Factor	1.064	1.064	1.064	1.064	1.064	1.064
Net Peak Demand Savings – at the Generator (MW)	0.161	2.425	0.123	0.193	0.011	0.078

Revised Net Energy and Peak Demand Savings for BER Mail-in (Continued)

Measure Category	Kitchen	Water Heating	Pumping	Solar	Total for All Categories
Energy Savings					
Revised Gross Energy Savings – at the Meter (GWh)	0.276	0.131	0.021	0.007	23.117
NTGR	0.83	0.83	0.83	0.83	-
Net Energy Savings – at the Meter (GWh)	0.229	0.109	0.017	0.006	19.187
Line Loss Factor	1.064	1.064	1.064	1.064	-
Net Energy Savings – at the Generator (GWh)	0.244	0.116	0.019	0.006	20.414
Effective Useful Life (years)	13.9	10.0	15.0	10.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	3.399	1.155	0.278	0.059	315.388
Peak Demand Savings					
Revised Gross Peak Demand Savings – at the Meter (MW)	0.055	0.032	0.004	0.001	3.479
NTGR	0.83	0.83	0.83	0.83	-
Net Peak Demand Savings – at the Meter (MW)	0.046	0.027	0.003	0.001	2.888
Line Loss Factor	1.064	1.064	1.064	1.064	-
Net Peak Demand Savings – at the Generator (MW)	0.049	0.028	0.003	0.001	3.073

Table 14 compares the energy and peak demand savings established through the 2018 BER Mail-in evaluation to those calculated in the 2018 tracking sheet.

Table 14: Comparison of Tracked and Evaluated Savings at the Generator – BER Mail-in

	Initial Gross Savings	Adjusted Gross Savings	NTGR	Net Savings
Energy Savings				
ENS Tracked Savings	25.235 GWh	25.235 GWh	0.86	21.702 GWh
Evaluation Results	25.235 GWh	24.596 GWh	0.83	20.414 GWh
Peak Demand Savings				
ENS Tracked Savings	4.075 MW	4.075 MW	0.86	3.505 MW
Evaluation Results	4.075 MW	3.702 MW	0.83	3.073 MW

The gross evaluated energy savings are 3 percent lower than the tracked values. While the Evaluator applied only a small adjustment to the energy savings of most measure categories, the savings of the lighting and motor and VFD measure categories were reduced by nearly 3 percent and 18 percent respectively. Since these two measure categories respectively accounted for 75 percent and 9 percent of tracked gross savings, the downward adjustments made to their savings explain most of the difference between the tracked and evaluated gross savings. The slight decrease in the NTGR resulted in a slightly larger difference, 6 percent, between tracked and evaluated net energy savings.

The evaluated net peak demand savings are 12 percent below the tracked value. The difference between tracked and evaluated peak demand savings is larger than for energy savings mainly because of the lower adjustment ratio applied to the peak demand savings of lighting measures. Indeed, the lighting peak demand savings were reduced by 7 percent more than the energy savings.

5 IMPACT EVALUATION FOR BER INSTANT REBATES

The objective of the 2018 BER Instant Rebates impact evaluation is to determine gross and net electrical energy and peak demand savings.

5.1 Gross Savings

Gross savings refer to changes in energy consumption resulting from actions taken by participants regardless of their reasons for participating.⁹ Since eligible measures are tracked at the point of sale, ENS estimates savings based on a set of assumptions specific to each measure type rather than using the real operating conditions and old equipment of projects. Energy and peak demand savings are calculated for each data entry; the equation used includes baseline wattages, the actual wattages of the efficient measures, ballast factors when applicable, interactive effects factors, peak coincidence factors (PCFs), and in-service rates (ISRs).

In 2018, the Evaluator did not conduct a full literature review to update the savings values recommended in the 2016 evaluation. Instead, the contents of the 2018 tracking sheet were reviewed to ensure that the Evaluator's 2016 recommended savings values were applied correctly.

The following subsections present a summary of the adjustments made to measures rebated under Instant Rebates, along with the changes applied to ISRs, PCFs, interactive effects, and EULs.

5.1.1 Summary of Adjustments to Gross Savings

As mentioned above, the Evaluator reviewed the contents of the 2018 tracking sheet to ensure that the 2016 recommended savings values were applied correctly. Seven evaluation categories required adjustments, namely LED linear fixtures, LED linear lamps, LED general-use and decorative lamps, LED downlight fixtures, LED outdoor lamps, LED directional and architectural fixtures, and occupancy sensors. Table 15 below lists the resulting adjustment ratios for each evaluation category. Appendix XIII provides additional details about the recommended savings and the nature of the adjustments.

⁹ Definition adapted from National Renewable Energy Laboratory, *The Uniform Methods Project, Chapter 23: Estimating Net Savings: Common Practices*, September 2014, p. 3.

Table 15: Adjustment Ratios per BER Instant Rebates Measure Category

Measure Category	Energy Savings Adjustment Ratio	Demand Savings Adjustment Ratio
LED Linear Fixtures	1.000	1.000
LED Linear Lamps	1.009	1.009
LED General-use and Decorative Lamps	1.014	1.014
LED Reflector Lamps	1.003	1.003
LED Downlight Fixtures	0.999	0.999
LED Outdoor Fixtures	1.000	1.000
LED Directional and Architectural Fixtures	1.000	1.000
Occupancy Sensors	0.934	1.000
Pumps	1.000	1.000

ENS applied the recommended hours of use values to all measures in the tracking sheet, with the exception of occupancy sensors for which the Evaluator corrected the value. Furthermore, ENS applied the recommended baseline wattages to almost all measures. Among the data entries that required adjustments, the Evaluator corrected the baseline wattages of 23 LED general-use and decorative lamps, 10 LED linear lamps, as well as 480 LED downlight fixtures.

To assess whether the correct efficient wattage was tracked for rebated measures, the Evaluator consulted specification sheets for the five most popular measures of each evaluation category. Following this review, the Evaluator modified the rated wattages of 4,074 LED downlight fixtures (out of 8,333 verified fixtures), four LED outdoor fixtures (out of 1,561 verified fixtures), and one LED directional and architectural fixture (out of seven verified fixtures). The Evaluator found 11 data entry errors where the rated wattage was lower than the baseline wattage, resulting in negative savings. The Evaluator adjusted the rated wattage for each product after consulting the corresponding specification sheets.

5.1.2 In-service Rates

To establish ISRs, the Evaluator conducted a literature review in 2016 of other jurisdictions with an upstream commercial program service similar to Instant Rebates because research indicates that a percentage of purchased measures might be stored for later use. Based on a study conducted by DNV-GL for the Massachusetts Energy Efficiency Program Administrators,¹⁰ an ISR of 85 percent was applied to LED lamps, which corresponds to the proportion of in-service fluorescent and LED lighting technologies three years after their purchase through an Instant Rebates program. The Evaluator used the 85 percent third-year ISR only for lamps since, within a three-year period, there is little chance that spare lamps will be used to replace other efficient lamps given that the EUL of LEDs is nearly 10 years. The Evaluator maintained the ISR of 100 percent for fixtures, occupancy sensors, and pumps because their higher price points discourage stocking in large quantities.

Again in 2018, the Evaluator applied this methodology to all measure categories, the results of which largely corresponded to the values tracked by ENS.

5.1.3 Peak Demand Savings

Since no on-site visits were conducted for Instant Rebates in 2018, no PCF specific to the lighting measures sold through the service could be established. Hence, a PCF of 62.4 percent was applied to Instant Rebates. This percentage was obtained through the average results from 2018 BER Mail-in and Small Business Energy Solutions (SBES) on-site visits for indoor lighting measures, which is in line with the approach used for HOU's and interactive effects (as explained in Subsection 5.1.4). For outdoor measures (these lights are typically turned on between 5 p.m. and 7 p.m. throughout December, January and February) and measures that are used 24 hours per day, a PCF of 100 percent was applied.

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 percent was applied to this measure category.

5.1.4 Interactive Effects

When a measure is installed as part of Instant Rebates it is affected by interactive effects, this is taken into account in the gross savings unitary equation presented in the tracking sheet.

Since 2016, a standardized approach, based on a methodology published in the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Journal,¹¹ has been used to calculate the interactive effects for lighting projects on a per building-type basis.

¹⁰ DNV-GL, *Massachusetts Commercial and Industrial Upstream Lighting Program: "In Storage" Lamps Follow-up Study*, March 2015.

¹¹ Rundquist, Robert A. et al., "Calculating Lighting and HVAC Interactions," ASHRAE Journal, November 1993, pp. 28 to 37.

The interactive effects for Instant Rebates are based on the building types and associated heating and cooling systems verified during the SBES and BER Mail-in lighting project on-site visits conducted as part of the 2016 evaluation. In 2016, the SBES average peak demand savings interactive effects factor was -14.7 percent and the average energy savings interactive effects factor was -8.2 percent. For BER Mail-in, the peak demand savings interactive effects factor was -3.2 percent and the average energy savings interactive effects factor was 0.3 percent. When averaged, these values resulted in overall interactive effects factors of -8.9 percent and -4.0 percent respectively for peak demand savings and energy savings.

Additionally, the Evaluator applied a factor of 57 percent to interactive effects to take into account the limited contribution of recessed fixtures; this factor was consistently applied to BER lighting measure categories that included recessed fixtures. This factor impacted the interactive effects factors for LED linear fixtures, LED linear lamps and LED downlight fixtures. For each of these categories, the percentage of savings generated by recessed fixtures and lamps was estimated from the database and a recessed factor of 57 percent was applied to the interactive effect factor for this proportion of savings only.

5.1.5 Effective Useful Life

The EUL values attributed to each measure are used to calculate energy savings over the lifetime of measures. For Instant Rebates, the revised EUL values of all the measures eligible for the service were obtained based on the 2017 DSM Evaluation Report. To do so, the Evaluator consulted the specification sheets of the most popular measures rebated through the service to validate the rated life previously established for each evaluation category, as outlined in Table 16 further below.

The rated lives of two outdoor LED fixture subcategories were increased; the rated life of full-cutoffs was increased from 50,000 to 75,000 hours, while the rated lives of non-cutoffs and semi-cutoffs were increased from 80,000 to 100,000 hours. The revised EULs were then determined by dividing the rated life (in hours) by the annual HOU. Adjustments were made to account for increases in baselines through the life of the measures, leading to revised equivalent EULs. These equivalent EULs therefore correspond to the number of years by which the first-year savings estimates are multiplied to obtain lifetime energy savings. For Instant Rebates, this adjustment only modified the revised EUL value of LED downlight fixtures. The revised equivalent EUL values by subcategory are presented in Table 16.

The revised equivalent EUL values are applied to each measure's gross and net first-year energy savings to obtain the corresponding gross and net lifetime energy savings. As a result, the weighted average EUL values of gross and net savings differ (see Subsections 5.1.6 and 5.3). Appendix XIV provides additional details about the EUL values for Instant Rebates.

Table 16: Revised Equivalent Effective Useful Life Values by Instant Rebates Measure Category

Measure Category	Subcategory	Tracked Equivalent EUL (Years)	Rated Life (Hours)	Annual HOU	Revised EUL (Years)	Revised Equivalent EUL (Years)
Linear LED Fixtures	1 x 4 Luminaires	11.3 or 14	50,000	4,410	11.3	11.3
	2 x 2 Luminaires and Retrofit Kits					
	2 x 4 Luminaires and Retrofit Kits					
	Linear Ambient and Low-bay Luminaires					
Linear LED Lamps	4-foot Replacement Lamps	11.3 or 14	50,000	4,410	11.3	11.3
	2-foot Replacement Lamps					
General-use and Decorative LED Lamps	LED Decorative (chandeliers)	5.7 or 13.6	25,000	4,410	5.7	5.7
	LED Omnidirectional (A-lamps and globes)					
Reflector LED Lamps	Small LED Reflector Lamps - PAR, MR, MRX 16	5.7 or 13.6	25,000	4,410	5.7	5.7
	Small LED Reflector Lamps - PAR, R 20					
	Large LED Reflector Lamps - PAR, BR, R 30/30L					
	Large LED Reflector Lamps - PAR, BR, R 38/40					
LED Downlight Fixtures	LED Recessed	11.3 or 14.2	50,000	4,410	11.3	7.6
	LED Ceiling Mount, LED Surface Mount, LED Solid State Retrofit, LED Inseparable Solid State Luminaires, LED Wall Sconces, LED Wall Sconce Retrofit	11.3 or 14.2	50,000	4,410	11.3	7.7
Outdoor LED Fixtures	Outdoor Full-cutoff Wall-mounted Area Luminaires	11.4 or 18	75,000	4,380	17.1	17.1
	Outdoor Non-cutoff and Semi-cutoff Wall-mounted Area Luminaires	18	100,000	4,380	22.8	22.8
	Architectural Flood and Spot Luminaires	17.1 or 18	75,000	4,380	17.1	17.1
Directional and Architectural LED Fixtures	Track or Mono-point Directional Luminaires	11.3 or 14	50,000	4,410	11.3	11.3
Occupancy Sensors	Ceiling Remote-mounted	10.0	-	-	10.0	10.0
	Wall Remote-mounted					
	Fixture Mounted					
	Wall Switch					
	Exterior					
Pumps	Variable Speed ECM Circulatory Pumps	15.0	-	-	15.0	15.0

5.1.6 Revised Gross Savings

The energy and peak demand savings associated with Instant Rebates were calculated using the unitary savings values, ISRs, and interactive effects factors revised as part of this evaluation. The savings at the generator were also calculated using a weighted average line loss factor calculated according to the distribution of rate code spending of other BNI programs.

The total savings established for each measure type are presented in Table 17 below. For Instant Rebates, gross energy savings amounted to 76.053 GWh at the generator, which represents 716.364 GWh in lifetime energy savings and a resulting weighted average EUL value of 9.4 years. The total gross peak demand savings were estimated at 11.144 MW at the generator.

Table 17: Revised Gross Energy and Peak Demand Savings for BER Instant Rebates

Measure Category	Linear LED Fixtures	Linear LED Lamps	General-use and Decorative LED Lamps	Reflector LED Lamps	LED Downlight Fixtures	Outdoor LED Fixtures
Tracking Sheet						
Number of Units	57,900	131,720	39,638	14,634	247,311	8,150
Energy Savings						
Tracked Gross Energy Savings (GWh)	11.509	7.577	5.829	2.376	38.567	6.751
Adjustment Ratio on Energy Savings	1.000	1.009	1.014	1.003	0.999	1.000
In-service Rate	1.000	0.850	0.850	0.850	1.000	1.000
Interactive Effects Factor	0.967	0.967	0.960	0.960	0.975	1.000
Total Gross Energy Savings – at the Meter (GWh)	11.124	6.281	4.823	1.945	37.582	6.751
Line Loss Factor	1.065	1.065	1.065	1.065	1.065	1.065
Total Gross Energy Savings – at the Generator (GWh)	11.851	6.691	5.138	2.072	40.036	7.192
Effective Useful Life (years)	11.3	11.3	5.7	5.7	7.6	17.6
Gross Lifetime Energy Savings – at the Generator (GWh)	133.915	75.606	29.289	11.809	304.273	126.584
Peak Demand Savings						
Tracked Gross Non-peak Demand Savings (MW)	2.610	1.718	1.322	0.539	8.745	1.541
Adjustment Ratio on Demand Savings	1.000	1.009	1.014	1.003	0.999	1.000
In-service Rate	1.000	0.850	0.850	0.850	1.000	1.000
Peak Coincidence Factor	0.624	0.624	0.624	0.624	0.624	1.000
Interactive Effects Factor	0.927	0.927	0.911	0.911	0.945	1.000
Total Gross Peak Demand Savings – at the Meter (MW)	1.509	0.852	0.648	0.261	5.154	1.541
Line Loss Factor	1.065	1.065	1.065	1.065	1.065	1.065
Total Gross Peak Demand Savings – at the Generator (MW)	1.607	0.908	0.690	0.278	5.491	1.642

Revised Gross Energy and Peak Demand Savings for BER Instant Rebates (Continued)

Measure Category	Directional and Architectural LED Fixtures	Occupancy Sensors	Pumps	Total for All Measures
Tracking Sheet				
Number of Units	461	5,845	874	506,533
Energy Savings				
Tracked Gross Energy Savings (GWh)	0.099	2.264	0.755	75.727
Adjustment Ratio on Energy Savings	1.000	0.934	1.000	-
In-service Rate	1.000	1.000	1.000	-
Interactive Effects Factor	1.000	0.960	1.000	-
Total Gross Energy Savings – at the Meter (GWh)	0.099	2.030	0.755	71.391
Line Loss Factor	1.065	1.065	1.065	-
Total Gross Energy Savings – at the Generator (GWh)	0.106	2.163	0.804	76.053
Effective Useful Life (years)	11.3	10.0	15.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	1.197	21.627	12.065	716.364
Peak Demand Savings				
Tracked Gross Non-peak Demand Savings (MW)	0.023	0.557	0.157	17.211
Adjustment Ratio on Demand Savings	1.000	1.000	1.000	-
In-service Rate	1.000	1.000	1.000	-
Peak Coincidence Factor	1.000	0.624	1.000	-
Interactive Effects Factor	1.000	0.911	1.000	-
Total Gross Peak Demand Savings – at the Meter (MW)	0.023	0.316	0.157	10.461
Line Loss Factor	1.065	1.065	1.065	-
Total Gross Peak Demand Savings – at the Generator (MW)	0.024	0.337	0.167	11.144

5.2 Net-to-gross Ratio

As mentioned in Subsection 4.2, the NTGR serves to determine net savings, i.e. the savings that can be reliably attributed to a service. In the case of Instant Rebates, the NTGR is established by considering free-ridership.

5.2.1 Free-ridership

For Instant Rebates, free-ridership corresponds to the proportion of savings that is due to natural market trends. Thus, the free-ridership assessment aims to estimate what the sales of energy efficient measures would have been in a market that evolved naturally, i.e. without service influence.

The Evaluator conducted a survey with 50 Instant Rebates participants to assess free-ridership. Free-ridership was measured through in-depth interviews with 11 distributors, along with the participant survey. This approach allows incorporating the perspectives of both participants and distributors, the latter being especially important in program services such as Instant Rebates because they influence measure offerings. Using multiple methods to assess free-ridership serves to triangulate results and provides the most defensible NTGR estimate.¹²

The evaluation targeted the following four specific measures:

- › LED linear fixtures
- › LED downlight fixtures
- › LED linear lamps
- › LED general-use and decorative lamps

These measure categories represent 84 percent of all gross energy savings generated by Instant Rebates. They were selected because they are the best-selling categories in 2018 and they are more likely to attract a significant level of free-ridership (especially in the case of LED general-use and decorative lamps).

During interviews with distributors, the Evaluator used a set of questions to identify the influence that the service had on the market. The in-depth interviews with distributors included questions to estimate:

- › The percentage of their energy efficient measures that would not have been sold in the absence of the service
- › The service influence (on a scale of 0 to 10) on participant decisions to purchase the target energy efficient lighting measures
- › The service influence (on a scale of 0 to 10) on distributor decisions to carry DLC and ENERGY STAR certified measures

¹² TecMarket Works, *The California Evaluation Framework*, June 2004.

The participant survey sample included 30 end users and 20 contractors. The Evaluator used a set of questions to identify the influence of the service on their decision to purchase LED measures. The questions included in the questionnaire aimed to estimate:

- › The influence of the rebates on participant decisions to purchase the target energy efficient lighting measures
- › The cross-influence that previous exposure to ENS communication and programs had on participant decisions

The Evaluator calculated the level of free-ridership for each measure category using the results of the distributor interviews and participant survey, as presented in Table 18 below. Appendix XV provides the algorithm used to convert the participant survey results into free-ridership levels. The margins of error for the participant survey results are 6.5 percent for LED linear fixtures; 9.7 percent of LED downlight fixtures; 14.9 percent for LED linear lamps; and 6.2 percent for LED general-use and decorative lamps. The margins of error for the distributor interview results are 5.2 percent for LED linear fixtures; 5.3 percent of LED downlight fixtures; 4.7 percent for LED linear lamps; and 9.1 percent for LED general-use and decorative lamps.

The free-ridership levels obtained for each measure category vary between 29 and 37 percent, meaning that approximately two-thirds of sold LED measures would not have been sold in the absence of the service. The 2018 free-ridership levels are comparable to 2017 levels, with no measure seeing a change that is statistically significant.

Table 18: Free-ridership for BER Instant Rebates

Measure Category	Free-ridership Level (from distributor interviews)	Free-ridership Level (from participant survey)	Overall 2018 Free-ridership Level
LED Linear Fixtures	40%	18%	29%
LED Downlight Fixtures	42%	27%	34%
LED Linear Lamps	45%	29%	37%
LED General-use and Decorative Lamps	45%	18%	32%

The questionnaire answers provided by distributors were similar to those from 2017. Surveyed distributors explained that the prices for these LED measures continue to decrease and participants are more aware of LED technology, thus reducing the impact of the rebate on the sales of these measures. Regardless, various distributors recognized the important role played by the service in raising participant awareness and lowering the price closer to standard technologies. Furthermore, distributors attributed to the service a strong influence in their decision to carry DLC and ENERGY STAR certified measures.

The answers from participants were similar to those provided by distributors in some areas. Surveyed participants claimed to have been sufficiently aware of the benefits of LED measures that they would have purchased the same measures in the absence of the service, indicating high levels of free-ridership. Contrarily, they recognized the large influence of the rebate on their decision and noted their past exposure to ENS communication and programs (e.g. the cross-influence factor). This cross-influence factor mostly explains why the participant survey ranged from 15 to 27 percent lower than the levels obtained from the distributor interviews.

Participant survey results indicated that two-thirds of end users purchase lighting measures for new construction projects or to replace lighting measures on burnout, whereas this is true for close to all contractors (93%). In other words, end users undertake more early replacement-type projects than contractors. This suggests there are differences in the projects undertaken by these two participant profiles and, thus, that the decision to purchase efficient lighting measures could be affected. However, since the participant database does not provide information on whether participants are end users or contractors, the Evaluator could neither estimate the proportion of end users and contractors among the entire participant population, nor apply distinct free-ridership levels. Therefore, to establish participant free-ridership levels, the Evaluator calculated a simple mean of answers from end users and contractors.

5.2.2 NTGR Calculation

The NTGR is calculated using the following equation:

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

Using the free-ridership levels established in Subsection 5.2.1, NTGRs were established for the main measure categories. For the other measures sold through Instant Rebates, a NTGR of 1.00 was used. This resulted in a weighted overall NTGR of 0.72 for energy savings and 0.74 for peak demand savings, as presented in Table 19.

Table 19: NTGR for BER Instant Rebates

Measure	NTGR
LED Linear Fixtures	0.71
LED Downlight Fixtures	0.66
LED Linear Lamps	0.63
LED General-use and Decorative Lamps	0.68
Other Measures	1.00
Overall	
Energy Savings	0.72
Peak Demand Savings	0.74

5.3 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 the revised gross savings, as exemplified in the following equation:

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

Net energy savings were first calculated separately for each measure category because the NTGR differed from one measure category to another.

The total net energy and peak demand savings amounted to 54.884 GWh and 8.255 MW respectively at the generator. Using the 2017 Nova Scotia-specific factor¹³ of GHG generated by electricity production, 0.6126 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 35,622 tonnes of avoided CO₂ eq. annually. The net lifetime energy savings were established at 536.729 GWh, which yielded an average EUL of 9.8 years. Table 20 below presents the details of these calculations.

¹³ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes), and total electricity generation (10,978 GWh) was found in the following two sources: Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018).

Emera Inc., *Management's Discussion & Analysis* as at February 9, 2018, <http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

Table 20: Evaluated Net Energy and Peak Demand Savings for BER Instant Rebates

Measure Category	LED Linear Fixtures	LED Linear Lamps	LED General-use and Decorative Lamps	LED Reflector Lamps	LED Downlight Fixtures	LED Outdoor Fixtures
Energy Savings						
Revised Gross Energy Savings – at the Meter (GWh)	11.124	6.281	4.823	1.945	37.582	6.751
NTGR	0.71	0.63	0.68	1.00	0.66	1.00
Net Energy Savings – at the Meter (GWh)	7.898	3.957	3.280	1.945	24.804	6.751
Line Loss Factor	1.065	1.065	1.065	1.065	1.065	1.065
Net Energy Savings – at the Generator (GWh)	8.414	4.215	3.494	2.072	26.424	7.192
Effective Useful Life (years)	11.3	11.3	5.7	5.7	7.6	17.6
Net Lifetime Energy Savings – at the Generator (GWh)	95.079	47.632	19.916	11.809	200.820	126.584
Peak Demand Savings						
Revised Gross Peak Demand Savings – at the Meter (MW)	1.509	0.852	0.648	0.261	5.154	1.541
NTGR	0.71	0.63	0.68	1.00	0.66	1.00
Net Peak Demand Savings – at the Meter (MW)	1.071	0.537	0.440	0.261	3.402	1.541
Line Loss Factor	1.065	1.065	1.065	1.065	1.065	1.065
Net Peak Demand Savings – at the Generator (MW)	1.141	0.572	0.469	0.278	3.624	1.642

Evaluated Net Energy and Peak Demand Savings for BER Instant Rebates (Continued)

Measure Category	LED Directional and Architectural Fixtures	Occupancy Sensors	Pumps	Total for All Measures
Energy Savings				
Revised Gross Energy Savings – at the Meter (GWh)	0.099	2.030	0.755	71.391
NTGR	1.00	1.00	1.00	-
Net Energy Savings – at the Meter (GWh)	0.099	2.030	0.755	51.520
Line Loss Factor	1.065	1.065	1.065	-
Net Energy Savings – at the Generator (GWh)	0.106	2.163	0.804	54.884
Effective Useful Life (years)	11.3	10.0	15.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	1.197	21.627	12.065	536.729
Peak Demand Savings				
Revised Gross Peak Demand Savings – at the Meter (MW)	0.023	0.316	0.157	10.461
NTGR	1.00	1.00	1.00	-
Net Peak Demand Savings – at the Meter (MW)	0.023	0.316	0.157	7.749
Line Loss Factor	1.065	1.065	1.065	-
Net Peak Demand Savings – at the Generator (MW)	0.024	0.337	0.167	8.255

Table 21 below compares the savings tracked by ENS to the 2018 evaluated savings for Instant Rebates.

**Table 21: Comparison of Tracked and Evaluated Savings at the Generator –
BER Instant Rebates**

	Initial Gross Savings	Adjusted Gross Savings	NTGR	Net Savings
Energy Savings				
ENS Tracked Savings	76.036 GWh	76.036 GWh	0.73	55.506 GWh
Evaluation Results	76.036 GWh	76.053 GWh	0.72	54.884 GWh
Peak Demand Savings				
ENS Tracked Savings	13.676 MW	13.676 MW	0.75	10.257 MW
Evaluation Results	13.676 MW	11.144 MW	0.74	8.255 MW

Evaluated gross energy savings were less than 1 percent below tracked savings since adjustments to unitary savings values and interactive effects factors were minor. Evaluated net energy savings were established at 1 percent below the value tracked by ENS, which is explained by the decrease in the overall NTGR for energy savings, from 0.73 in 2017 to 0.72 in 2018.

As for peak demand savings, gross evaluated savings were 19 percent below tracked savings. This difference is mostly due to the downward adjustment of the PCF for indoor measures (from 0.790 to 0.624) as well as the minor downward adjustments to unitary savings values and interactive effects factors. Net evaluated peak demand savings were 20 percent below tracked savings. This difference is explained by the same factors that influence the change in gross peak demand savings along with the decrease in overall NTGR for peak demand savings, from 0.75 in 2017 to 0.74 in 2018.

6 OVERALL BER RESULTS

Table 22 below compares the savings tracked by ENS to the 2018 evaluated savings for BER.

Table 22: Comparison of Overall Tracked and Evaluated Savings at the Generator for BER

	Initial Gross Savings	Adjusted Gross Savings	NTGR*	Net Savings
Energy Savings				
ENS Tracked Savings	101.271 GWh	101.271 GWh	0.76	77.208 GWh
Evaluation Results	101.271 GWh	100.648 GWh	0.75	75.298 GWh
Peak Demand Savings				
ENS Tracked Savings	17.751 GWh	17.751 GWh	0.78	13.762 GWh
Evaluation Results	17.751 GWh	14.846 GWh	0.76	11.327 GWh
*Different NTGRs were established for Mail-in and Instant Rebates. The average NTGR values presented in this table correspond to the ratios of net savings to gross savings for both services.				

Table 23 summarizes the participation level as well as gross and net savings for Mail-in and Instant Rebates.

Table 23: Overall Participation and Savings for BER

	Participation Level	Gross Savings	NTGR	Net Savings
Mail-in Rebates				
Energy Savings	366 projects	24.596 GWh	0.83	20.414 GWh
Lifetime Energy Savings		379.986 GWh	0.83	315.388 GWh
Peak Demand Savings		3.702 MW	0.83	3.073 MW
Instant Rebates				
Energy Savings	506,533 measures sold	76.053 GWh	0.72	54.884 GWh
Lifetime Energy Savings		716.364 GWh	0.75	536.729 GWh
Peak Demand Savings		11.144 MW	0.74	8.255 MW
TOTAL				
Energy Savings		100.648 GWh	0.75	75.298 GWh
Lifetime Energy Savings		1096.349 GWh	0.78	852.117 GWh
Peak Demand Savings		14.846 MW	0.76	11.327 MW

7 BER MARKET EVOLUTION

ENS has been active in the LED market of the BNI sector through BER since 2010. The 2016 BER evaluation found that market barriers to LED adoption, such as the price of LEDs in the BNI sector, were declining. A market evolution assessment was completed as part of the 2017 evaluation, which served to analyze key market indicators and presented a technology diffusion curve illustrating the market adoption of LEDs in the Nova Scotia BNI sector. The aim of this section is to update the data collected as part of the 2017 evaluation and provide up-to-date insights regarding the market transformation of LED lamps in the Nova Scotia BNI sector, including a technology diffusion curve illustrating the market adoption of LEDs in the BNI market.

7.1 Market Indicators

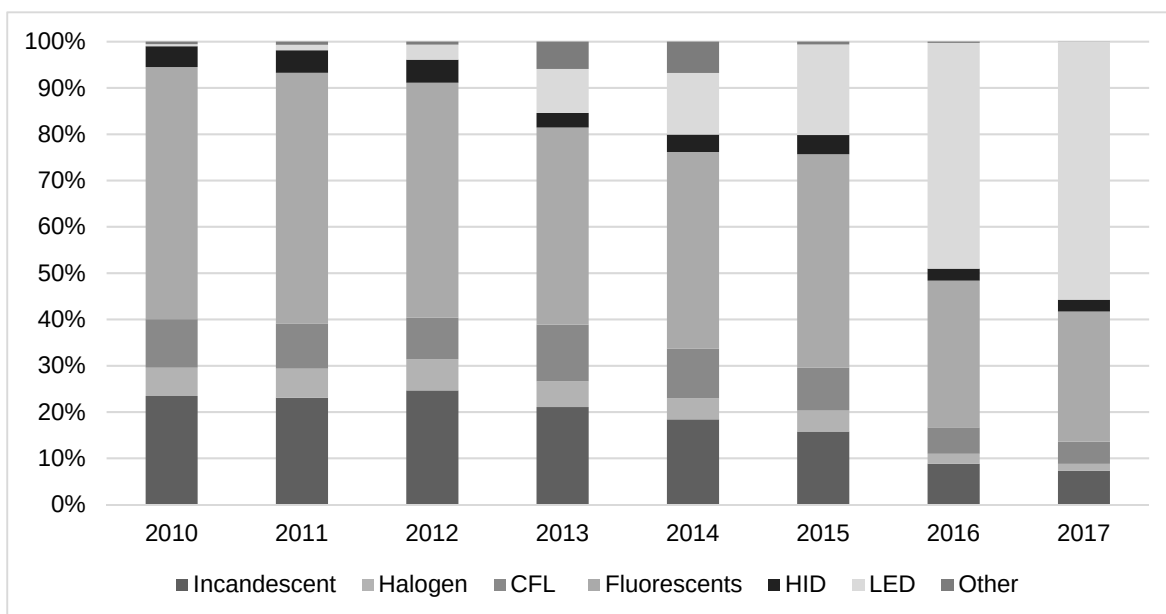
The Evaluator analyzed available market data and established key market indicators to understand the state of the Nova Scotia LED market. For this analysis, the Evaluator relied on data from Instant Rebates since sales quantities and prices are documented with a level of detail that is not available for Mail-in lighting category measures.

7.1.1 Market Shares of Lighting Technologies

The BNI lighting market is comprised of six main technologies: incandescent, halogen, compact fluorescent lamps (CFL), high-intensity discharge, LED, and fluorescent. Analyzing lighting shipments in the Atlantic region between 2010 and 2017 revealed that the share of LEDs rapidly grew in the commercial and industrial sectors, as illustrated in Figure 12 below.¹⁴ LEDs continued to have the highest share of sales in 2017, 56 percent, a 6 percent increase over 2016.

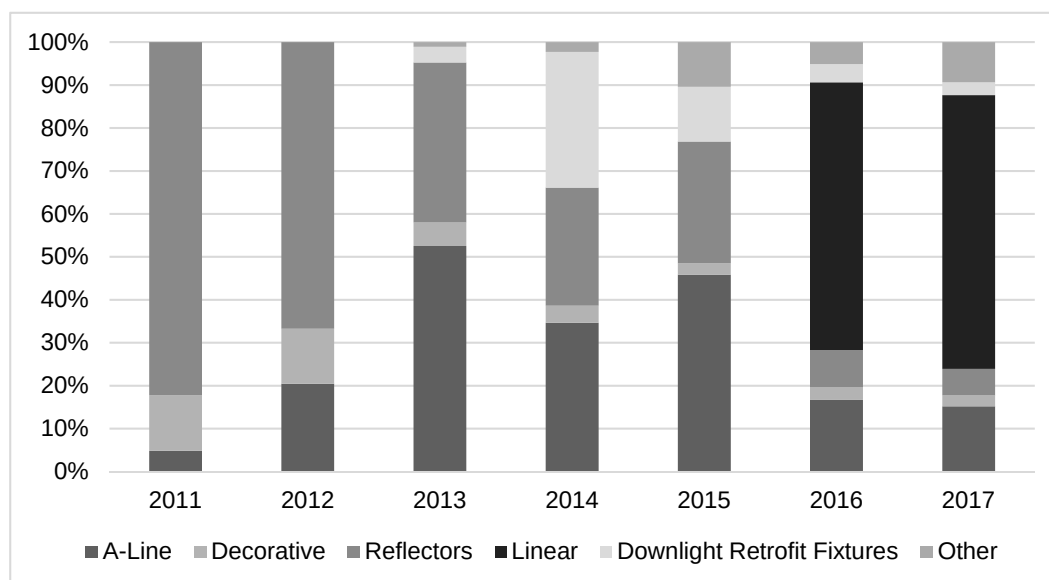
The share of fluorescents continued to decrease from 32 percent in 2016 to 28 percent in 2017. The market share of all other technologies also decreased marginally in 2017 over 2016, except high-intensity discharge lamps whose share remained flat at 3 percent.

¹⁴ Data was not available specifically for the BNI sector. Data was available for two groups: consumer, and commercial and industrial. The commercial and industrial sectors were selected as the most similar sectors to the BNI sector among available data.

Figure 12: Atlantic Canada Commercial and Industrial Lighting Shipments by Technology (%)


Source: Electro-Federation Canada, Lamp Data - Consumer Channel and C&I Channel 2004–2017, March 2017.

The breakdown of LED shipments in the Atlantic region by bulb type is presented in Figure 13 below. Data was unavailable for LED linear lamps before 2016. The share of LED lamp types remained relatively the same from 2016 to 2017, with linear lamps comprising over 60 percent of LED shipments.

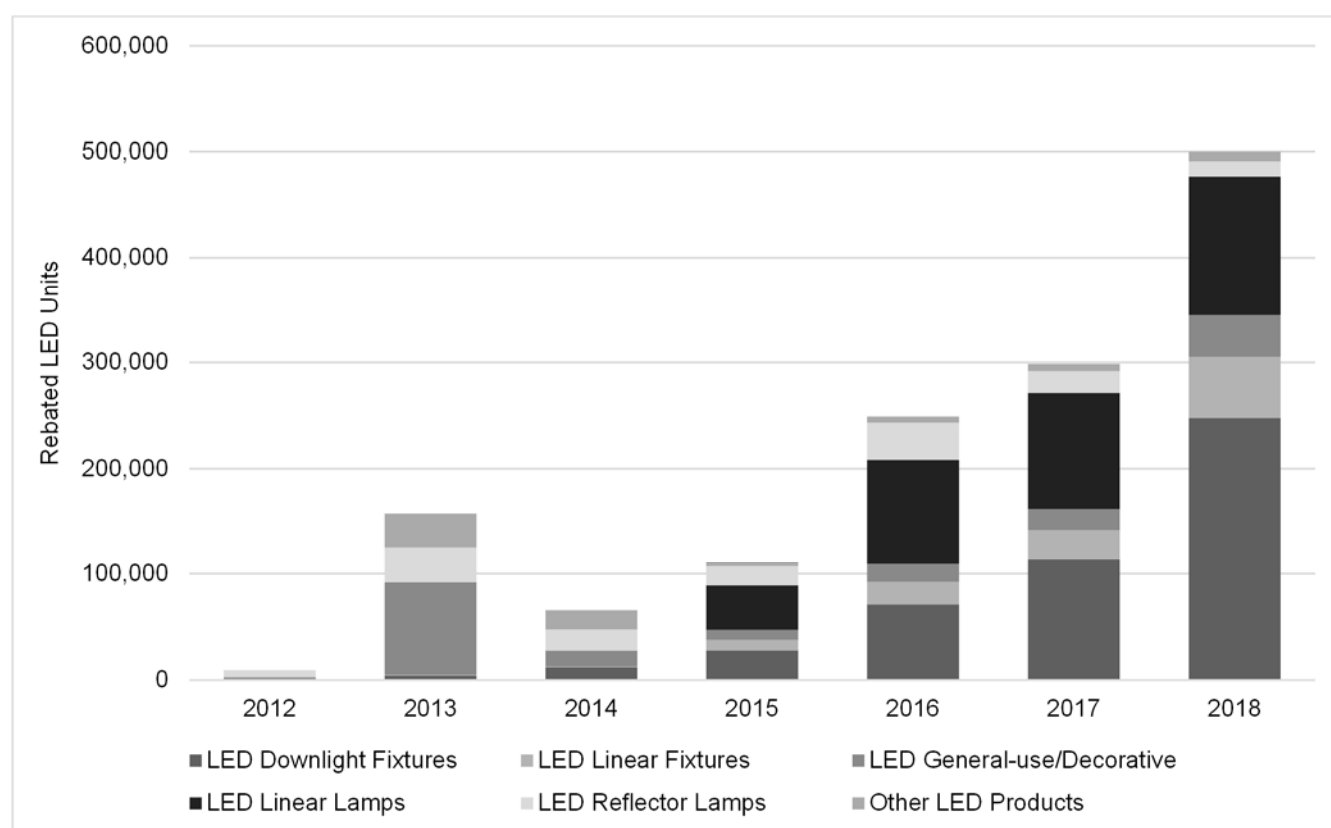
Figure 13: Atlantic Canada Commercial and Industrial LED Lighting Shipments by Type (%)


Source: Electro-Federation Canada, Lamp Data - Consumer Channel and C&I Channel 2004–2017, March 2017.

7.1.2 BER Instant Rebates Rebated Units

The total number of LED lamps and fixtures incented by BER Instant Rebates since 2012 is presented in Figure 14 below, along with the proportion of each LED measure type. The increase that occurred in 2013 is an outlier. As reported in the 2013 Evaluation Report, this increase is due to rebate and pricing changes made by two distributors, which led to abnormal sales. The number of LED units rebated by BER continued to grow in 2018 in all categories. In terms of LED types rebated, LED downlight fixtures saw a large increase in units in 2018 and comprised almost 50 percent of all rebated LED units. LED linear fixtures grew in share, while, for the first time since 2014, the share of LED linear lamps decreased.

Figure 14: BER Instant Rebates Incented LED Units, 2012-2018¹⁵



¹⁵ Data by type of LEDs before 2015 should be used with caution since measure descriptions found in the 2012-2014 tracking sheets were not as detailed as they have been since 2015.

7.1.3 BER Participating Distributor Outlook

BER Instant Rebates collaborates with distributors to provide rebates on lighting measures to BNI participants. The overall number of distributors reporting LED sales has varied slightly throughout the years. The lowest number was 12 distributors in 2012, and the maximum was 16 in 2015. In 2018, 15 distributors reported LED sales. ENS estimates that the majority of distributors operating in the province are included in BER, indicating that LED measures remain widely available in Nova Scotia.

As part of the interviews discussed in Section 3, distributors were asked where on a product adoption curve they would place each measure category (LED downlight fixtures, LED linear fixtures, LED linear lamps, and general-use and decorative lamps) considering the Nova Scotia commercial, industrial and institutional markets.

A product adoption curve depicts the product market evolution process. When a new product is first introduced into the market, sales are relatively low, then sales grow over time, reach a point of maturity and sales peak. Sales then level off, taper and eventually phase out. Distributors were asked, for each measure category, whether measures were at initial uptake, gaining popularity, at sustained growth, nearing product maturity, levelling off, waning interest, or obsolete.

In general, distributors saw LED downlight fixtures as growing, although nearing product maturity. Distributors reported that the bulk of their new sales are LED downlight fixtures; they also reported that many customers still have older technology and are waiting for them to need to be replaced before switching to LED technology.

Compared to LED downlight fixtures, distributors reported that the market for LED linear fixtures is less evolved. Distributors reported that older technology (linear fluorescent fixtures) is still being sold and that the price of LED linear fixtures still needs to decrease to see this market fully evolve. Most distributors perceived LED linear fixtures as gaining popularity and being in sustained growth phase.

The majority of distributors saw the market for LED linear lamps as nearing maturity since more customers shift to integrated lamps as LED fixtures become more popular. That being said, there still remains a large market for customers who are not yet ready to replace their fluorescent fixtures and want to replace fluorescent lamps with LED linear lamps in those fixtures. Similarly, most distributors saw the market for general-use and decorative LEDs as nearing maturity. Distributors reported that costs have continued to decrease for these two lighting categories, customers are aware of the technology, and it is readily accessible.

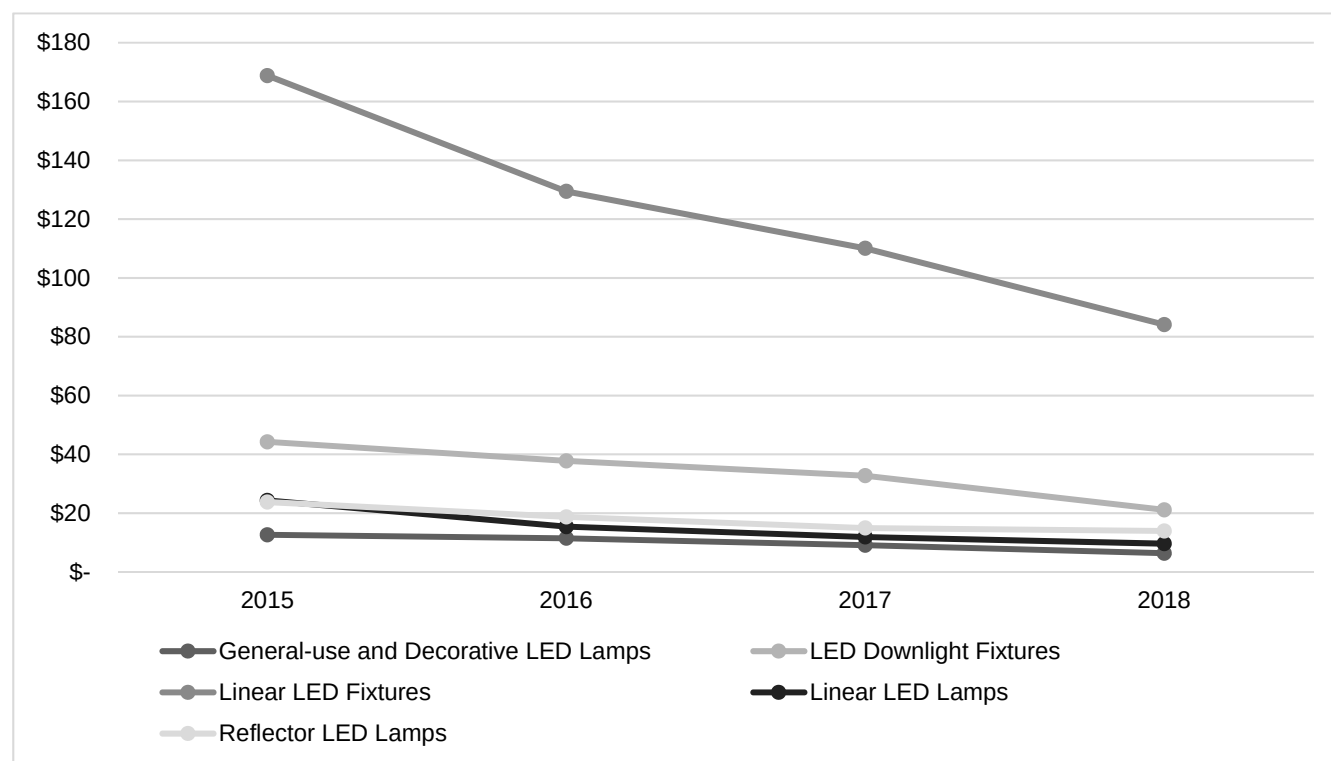
Therefore, distributors reported that, while the market for LED linear lamps and general-use and decorative LEDs is nearing maturity, more growth is expected in LED downlight and linear fixtures as more and more customers switch to integrated lamps.

7.1.4 Retail LED Prices

As prices vary greatly among LED lighting types, the evolution of LED prices was examined for the most popular lighting categories offered under Instant Rebates. Figure 15 further below illustrates the evolution of average cost per unit for the following LED categories: downlight fixtures, linear fixtures, general-use and decorative lamps, as well as linear lamps. The data originates from Instant Rebates tracking sheets and was unavailable prior to 2015.

Overall, the prices of all LED lighting types continue to decrease. The price of general-use and decorative LED lamps decreased by 30 percent from 2017, LED downlight fixtures and linear LED fixtures decreased 35 and 24 percent respectively from 2017. Linear LED lamps decreased 19 percent from 2017 from about \$12 to \$10.

Figure 15: Average Retail Prices of Rebated LED Measures, 2015-2018



In accordance with the decrease in retail prices for LED measures, rebate amounts offered by ENS have also declined. As listed in Table 24 below, the average rebate values offered under Instant Rebates have decreased for all LED measure categories, ranging from 31 percent (LED linear fixtures) to 56 percent (LED linear lamps).

Table 24: Average Rebate Values Under Instant Rebates for LED Measures, 2015-2018

Measure Category	2015	2016	2017	2018
Linear LED Fixtures	\$37.04	\$34.67	\$29.24	\$25.43
LED Downlight Fixtures	\$13.98	\$13.28	\$9.80	\$8.19
Reflector LED Lamps	\$8.56	\$6.77	\$5.69	\$5.25
General-use and Decorative LED Lamps	\$4.76	\$4.55	\$3.04	\$2.58
Linear LED Lamps	\$8.49	\$5.76	\$4.48	\$3.77

7.1.5 Codes and Standards

The ultimate indicator of market transformation is the adoption of more stringent codes and standards. Currently, general-use lamps¹⁶ are required to meet an efficiency level that corresponds to halogen incandescent bulbs. (For instance, a standard 60 W incandescent bulb is no longer allowed, and its equivalent is a 43 W halogen incandescent bulb.) This minimum energy performance standard has been enforced since early 2014 and early 2015, depending on lamp wattages. The latest amendment to the Canadian Energy Efficiency Regulations (Amendment 14 published on October 31, 2018)¹⁷ increased the range of fluorescent lamp ballasts affected by the regulation and introduced minimum energy performance requirements for metal halide ballasts in an effort to align Canadian to American regulations.

However, Amendment 14 did not have any significant impact on the efficiency of lamps and fixtures rebated through BER. While these new regulations are an indication that the market is evolving, they do not represent significant improvements to the overall efficiency of lighting measures and do not affect the base case technologies as defined in Instant Rebates savings calculations.

Although the United States is expected to enforce a standard requiring that general-service lamps meet the efficiency level of 45 lumens/W (equivalent to a technology between halogen incandescent and CFLs) by 2020, Canada does not yet have proposed legislation to align with U.S. regulations. The next update to general service lamps is expected to undergo pre-consultation in the winter of 2019 as part of Amendment 17.¹⁸ This Canadian update, which is likely to be enforced between 2021 and 2023, could have one of the two following impacts:

¹⁶ The Energy Efficiency Regulation for general-use lamps covers most A-type lamps (incandescent and LEDs). Natural Resources Canada, *General Service Lamps and Modified Spectrum Incandescent Lamps Energy Efficiency Regulations*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869> (Last accessed December 06, 2018).

¹⁷ Natural Resources Canada, *Amendment 14, October 2018*. <http://www.nrcan.gc.ca/energy/regulations-codes-standards/18437> (Last accessed December 06, 2018).

¹⁸ Natural Resources Canada, *Forward Regulatory Plan 2017-19*, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/18318> (Last accessed February 28, 2018).

- › CFLs will become the base case technology for general-use lighting because they will be the least efficient technology that complies with the regulation.
- › LED lamps will become the base case technology if prices continue to decrease. LED lamps are already more popular than CFLs, and the price difference might become too low (or the price of LED lamps will fall below CFL prices) for CFLs to remain the mainstream option for general-use lighting.

Given trends in LED prices and availability, LED general service lamps will likely become the base case technology under an updated regulation for general service lamps.

In summary, while current regulations do not make LED lamps and fixtures the base case technology in 2018, LED technology will likely become the base case technology within the next three to five years for decorative, general-use and reflector lamps, as well as downlight fixtures. This conclusion is consistent with ENS's decision to gradually remove those measure categories that will be affected by the upcoming regulatory changes from the BER offering. As of January 2019, decorative lamps, general-use lamps, reflector lamps, downlight fixtures, and LED wall sconces are no longer available under BER, unless the participant is a small business that is eligible under SBES.

7.2 Evaluation Results

The Evaluator looked at the unitary savings values and free-ridership levels to gain insights into the evolution of the LED BNI market in Nova Scotia.

7.2.1 Free-ridership Levels

For Instant Rebates, free-ridership corresponds to the proportion of savings that is due to natural market trends. The free-ridership levels were measured through in-depth interviews with distributors through the same approach used from 2012 to 2016. Conversely in 2017, the free-ridership approach was changed to include results from distributor interviews as well as an end-user survey. This should be considered when comparing 2017 and 2018 results to those of past evaluations. Table 25 below lists the free-ridership levels calculated since 2012. Free-ridership has remained relatively steady since 2016, with small decreases observed in 2018. For the latter year, free-ridership for all LED measures ranged between 29 and 37 percent. The free-ridership levels of LED measures all decreased marginally compared to 2017.

Table 25: LED Free-ridership Levels for BER Instant Rebates

Measure Category	2012	2013	2014	2015	2016	2017	2018
LED Linear Fixtures	-	-	-	25%	37%	32%	29%
LED Downlight Fixtures ¹⁹	11%	24%	35%	34%	37%	36%	34%
LED Reflector Lamps	-	-	-	33%	34%	-	-
LED General-use and Decorative Lamps	-	-	-	32%	35%	38%	32%
LED Linear Lamps	-	-	-	-	-	38%	37%
LED Outdoor Wallpacks	-	-	29%	-	-	-	-

7.3 Market Evolution Summary

In their recommendations on market transformation program planning, Rosenberg and Hoefgen (2009) identify a number of factors, listed in Table 26 below, to be analyzed to identify whether program support should be withdrawn or reduced in light of changes observed in the market.²⁰

Table 26: Analysis of Key Factors in Program Planning

Factor	Results
Market share of LEDs for BNI sector	LED shipments targeted at the commercial and industrial sectors in Atlantic Canada attained 56 percent in 2017. Linear LED lamps make up the majority of Atlantic LED shipments.
Trends in prices and availability	LED prices have continued to decline for the BNI sector, while downlight and linear LED fixtures had the most significant decrease in price in 2018. The technology is widely available to BNI customers across the province.
Likelihood of inclusion in a near-term code or standard	The efficiency levels of LED measures rebated through BER remain far superior to the efficiency levels required by current Canadian regulations. Canada will likely update the general service lamp minimum energy performance requirement in Amendment 17, which is planned for pre-consultation in 2019 and is likely to be enforced between 2021 and 2023. This standard will raise the baseline efficiency for general-use lamps, reflector lamps and fixtures most likely to LED level efficiency. It will, however, still not cover a variety of products offered under BER.
Market readiness of more efficient substitute technology	No more efficient substitute than LEDs has come to market.

¹⁹ This measure category has changed over the years. Before 2015, it included LED lamps in addition to fixtures.

²⁰ Rosenberg and Hoefgen, *Market Effects and Market Transformation: Their Role in Energy Efficiency Program Design and Evaluation*, Prepared for the California Institute of Energy and the Environment, 2009.

Assessing the above factors demonstrates that barriers to LEDs continue to decline in the BNI sector, as attested to by increases in LED lighting market share, availability, as well as by price reductions. Increasing LED adoption has also translated into higher free-ridership levels over the years, although free-ridership in 2018 decreased slightly.

Distributors reported that while the market for LED linear lamps and general-use and decorative LEDs is nearing maturity, more growth is expected in LED downlight and linear fixtures as more and more customers switch to integrated lamps. While prices across all lighting categories decreased, downlight and linear fixtures saw the largest price decreases. This is echoed in the trends observed in ENS rebated LED lamps. Although total ENS rebated LED units increased in all categories, the share of downlight and linear LED fixtures grew in 2018 while the share of linear lamps decreased.

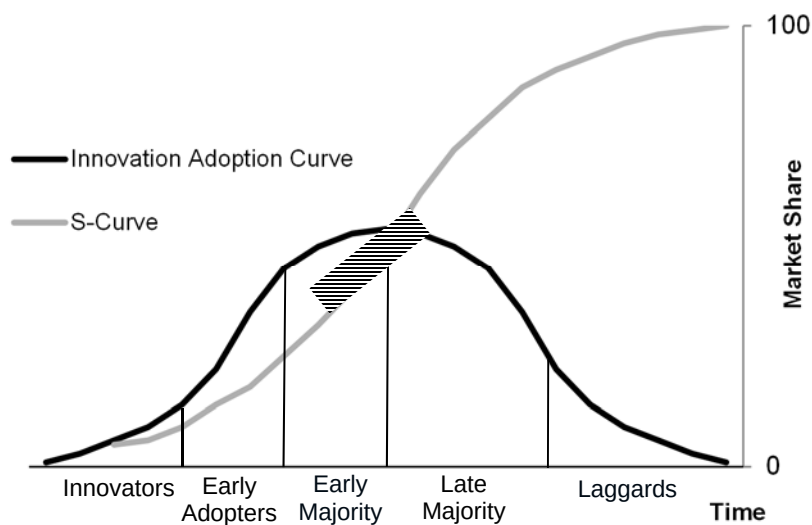
The savings potential of general-use, decorative and reflector lamps as well as downlight fixtures is negatively impacted by upcoming regulatory changes that will push the baseline efficiency for these technologies to LED levels within approximately five years. These regulatory changes and their effects on savings confirm ENS's decision to gradually remove decorative lamps, general-use lamps, reflector lamps, downlight fixtures, and LED wall sconces from the BER offering as of 2019.

Figure 16 below provides an indication of the stage of LED lamp adoption in the Nova Scotia BNI sector. The technology diffusion curve illustrates how successive groups of customers adopt the new technology (as illustrated by the innovation adoption curve in black)²¹ and how the market share (illustrated by the S-curve in grey) eventually reaches saturation levels. The 2017 evaluation found the market to be still in a growth phase and approaching maturity (early adopters – early majority).

Considering the above-mentioned factors, the Evaluator concludes that LEDs remain in a growth phase and are approaching maturity, particularly LED linear and general-use and decorative lamps, as indicated by the hatched area of the grey market share curve. Upcoming regulatory changes will further push general-use and decorative lamps, reflector lamps, and downlight fixtures toward maturity. Of the LED technologies analyzed, the market for LED linear fixtures is the least evolved and has the most growth potential. LED linear lamps and fixtures are not impacted by upcoming regulations.

²¹ Everett M. Rogers, *Diffusion of Innovations – Fifth Edition*, August 16, 2003.

Figure 16: Market Evolution for Commercial LED Lighting



8 BER RECOMMENDATIONS

The 2018 impact evaluation revealed that the accuracy of reported savings had improved, especially for Mail-in. In addition, ENS has been proactive in adapting their Instant Rebates offerings to the evolving market by removing products that are closer to market maturity. The recommendations formulated by the Evaluator therefore focus on the process evaluation findings, which concern the interrelations between Mail-in and Instant Rebates as well as the diversification of measures implemented through Mail-in. In addition to the general recommendations presented for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator makes the following recommendations for BER. These recommendations are also outlined in Appendix XVI.

- 2018 BER-R1. Review BER logic model and eligibility criteria to ensure that the intended projects and participants go through each service.** As evidenced by the process evaluation, no project types are exclusive to either service and many sold measures overlap the two services. Despite these similarities, the Evaluator also found that a significant proportion of Instant Rebates measures are installed in residential applications that would not be eligible for a Mail-in incentive. A review of the logic model and eligibility criteria would clarify the purpose of the similarities and differences between the two services and realign BER design in relation to its objectives. This review would result in a better definition of target participants and measures, which would in turn improve BER performance as well as the accuracy of the performance and savings assessment.
- 2018 BER-R2. Implement a system that enables connecting Instant Rebates sales data to participants.** While ENS implemented the Evaluator's past recommendations to improve Instant Rebates participant tracking, the information to fully capture the actual Instant Rebates market is still fairly limited, rendering it challenging to adjust savings assumptions to represent average conditions. One challenge, in particular, is clearly knowing whether Instant Rebates measures were purchased by contractors or end users and how many units were purchased by each of these types of participants. The Evaluator recommends that ENS implement a system that allows tracking sales and linking them to participating individuals. This would enable the Evaluator to collect more specific data from these individuals and gain a better sense of what their sales represent compared to overall service sales.

- 2018 BER-R3. Investigate ways to liaise more clients with non-lighting contractors.** Contractors are key players in achieving the goal of implementing more non-lighting measures through BER and ENS programs overall. Fewer interviewed participants have go-to non-lighting contractors than lighting contractors for potential projects. The Evaluator recommends findings ways to connect participants to non-lighting contractors and training the latter to further promote non-lighting projects.
- 2018 BER-R4. Analyze the incentive levels for non-lighting measures with a higher payback period.** Meeting company payback thresholds remains a key barrier to implementing non-lighting measures among participants. The Evaluator recommends that ENS assess possible ways of pushing more participants toward non-lighting measures that typically have longer payback periods. While actively promoting the energy and non-energy benefits of measures might be enough to push some participants to implement non-lighting measures, for other participants whose companies require specific payback thresholds before any energy efficiency project is approved, an ENS review of incentive levels for at least a few high-potential measures might be needed

CONCLUSION

The 2018 evaluation revealed that BER largely surpassed planned energy and peak demand savings, which were 50.6 GWh and 7.9 MW respectively, by achieving 75.298 GWh in net energy savings, the highest savings level in its history. Furthermore, BER achieved 11.327 MW in net peak demand savings at the generator. These energy savings represent 46,128 tonnes of CO₂ eq in avoided annual GHG emissions. The total net lifetime energy savings amount to 852.117 GWh.

This remarkable result is due to high participation in Instant Rebates, which achieved 54.884 GWh in 2018 compared to 30.805 GWh in 2017, a 78 percent increase. Instant Rebates increased its share of BER savings in 2018 because some measures such as downlight fixtures, which generate large unitary savings, continue to grow in popularity. The Mail-in service achieved 20.414 GWh in net energy savings and 3.073 MW in net peak demand savings at the generator. A total of 366 Mail-in projects were implemented by 257 unique participants, representing a 27 percent increase over 2017 project levels. The evaluation revealed that the accuracy of the tracked savings in Mail-in had improved compared to the previous year, in part, because of the improvements made to the application forms that serve to collect more precise information on HOU. Lighting measures were the most popular measures implemented by Mail-in participants, representing 75 percent of Mail-in gross energy savings.

One of the objectives of the process evaluation was to identify barriers to the implementation of non-lighting measures to inform an ENS measure diversification strategy. Approximately half of BER participants whose sites were visited reported having specific contractors they use for replacing and maintaining equipment. A smaller proportion of participants have a go-to contractor for non-lighting measures; about one-quarter of these participants noted having an HVAC contractor, and even fewer noted having specific plumbing or refrigeration contractors. Establishing closer relationships between participants and contractors who could recommend measures other than lighting was therefore identified as an improvement area.

The process evaluation also examined the interrelations between the Mail-in and Instant Rebates services and found that, while a few specific Mail-in measures comprised a significant percentage of service savings, a large proportion of the Mail-in offer did not differ from that of Instant Rebates. More specifically, half of 2018 Mail-in lighting savings were generated by lighting measures that were also available under Instant Rebates. Both Instant Rebates and Mail-in measures are used for a mix of retrofit and new construction projects, although in different proportions. Despite these similarities, the Evaluator also found that a significant proportion of Instant Rebates measures are implemented in residential applications that would not be eligible for incentives under Mail-in. This mix of both similarities and discrepancies between Instant Rebates and Mail-in suggests a lack of clarity in BER design and requires that additional data on Instant Rebates participants be collected to correctly adjust savings assumptions so that they are representative of actual completed projects.

For a second consecutive year, the Evaluator completed a market evolution assessment to establish the level of LED lamp market adoption in Nova Scotia. The Evaluator concluded that LEDs remain in a growth phase, although they are approaching maturity, particularly LED linear, general-use, and decorative lamps. Upcoming changes to regulations will further push general-use, decorative and reflector lamps, as well as downlight fixtures toward maturity. However, as of 1 January 2019, BER no longer offers rebates for LED decorative lamps, LED general-use lamps, LED reflector lamps, LED downlight fixtures, and LED wall sconces. ENS has been proactive in adjusting the BER offering and, as a result, the impact of the market evolution on savings will be mitigated. Of the LED technologies analyzed, the market for LED linear fixtures is the least evolved and has the most potential to grow and evolve. Finally, LED linear lamps and fixtures are not impacted by upcoming regulations.

LIST OF APPENDICES

The following are presented in the Efficient Products Rebates Program – Appendices.

BER

Appendix I - BER: Mail-in Participant Survey Questionnaire

Appendix II - BER: Mail-in Participant Survey Results

Appendix III - BER: Mail-in Interview Guide with Contractors

Appendix IV - BER: Mail-in On-site Visit Sampling Methodology and Protocol

Appendix V - BER: Instant Rebates Participant Survey Questionnaire

Appendix VI - BER: Instant Rebates Participant Survey Results

Appendix VII - BER: Instant Rebates Interview Guide with Distributors

Appendix VIII - BER: Mail-in Gross Savings Adjustments

Appendix IX - BER: Mail-in Adjustment Ratio Calculation Example

Appendix X - BER: Mail-in Effective Useful Life

Appendix XI - BER: Mail-in Algorithm for Free-ridership Calculation

Appendix XII - BER: Mail-in Algorithm for Participant Spillover Calculation

Appendix XIII - BER: Instant Rebates Evaluated Savings

Appendix XIV - BER: Instant Rebates Effective Useful Life

Appendix XV - BER: Instant Rebates Algorithm for Free-ridership Calculation

Appendix XVI - BER: 2018 Recommendations



ECONOLER

EFFICIENT PRODUCT REBATES

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Appendix Report

March 15, 2019



TABLE OF CONTENTS

APPENDIX I BER: MAIL-IN PARTICIPANT SURVEY QUESTIONNAIRE	1
APPENDIX II BER: MAIL-IN PARTICIPANT SURVEY RESULTS.....	19
APPENDIX III BER: MAIL-IN INTERVIEW GUIDE WITH CONTRACTORS.....	38
APPENDIX IV BER: MAIL-IN ON-SITE VISIT SAMPLING METHODOLOGY AND PROTOCOL.....	46
APPENDIX V BER: INSTANT REBATES PARTICIPANT SURVEY QUESTIONNAIRE.....	68
APPENDIX VI BER: INSTANT REBATES PARTICIPANT SURVEY RESULTS.....	77
APPENDIX VII BER: INSTANT REBATES INTERVIEW GUIDE WITH DISTRIBUTORS	87
APPENDIX VIII BER: MAIL-IN GROSS SAVINGS ADJUSTMENTS.....	97
APPENDIX IX BER: MAIL-IN ADJUSTMENT RATIO CALCULATION EXAMPLE.....	102
APPENDIX X BER: MAIL-IN EFFECTIVE USEFUL LIFE	105
APPENDIX XI BER :MAIL-IN ALGORITHM FOR FREE-RIDERSHIP CALCULATION	113
APPENDIX XII BER: MAIL-IN ALGORITHM FOR PARTICIPANT SPILLOVER CALCULATION ..	115
APPENDIX XIII BER: INSTANT REBATES EVALUATED SAVINGS.....	116
APPENDIX XIV BER: INSTANT REBATES EFFECTIVE USEFUL LIFE	127
APPENDIX XV BER:INSTANT REBATES ALGORITHM FOR FREE-RIDERSHIP CALCULATION	129
APPENDIX XVI BER: 2018 RECOMMENDATIONS.....	132

APPENDIX I

BER: MAIL-IN PARTICIPANT SURVEY QUESTIONNAIRE

Could I speak with [INSERT NAME]?

1. Yes [GO TO INTRODUCTION]
2. No [SAY "Perhaps you can help me anyway." GO TO INTRODUCTION]

[INTRODUCTION]

Hello, my name is _____ and I am calling from Corporate Research Associates, a Halifax-based survey research company. We are performing an evaluation of energy efficiency services provided by Efficiency Nova Scotia. Our records indicate that your organization recently participated in Efficiency Nova Scotia's Business Energy Rebates Program. We would appreciate your help in answering questions related to your participation in this program. The information you provide will be used to help Efficiency Nova Scotia evaluate and improve the program. Is this a good time for you?

(IF NEEDED: You may have recently been contacted by Corporate Research Associates or by an Efficiency Nova Scotia representative about your experience with the program. This survey is different as it focuses on other aspects of your participation in the program.)

(IF NEEDED: The survey will take about fifteen minutes.)

Verification and Recall (V Series)

V1. Our records indicate that your organization would have received a mail-in rebate for energy efficiency measures that were implemented at your facility located at [FACILITY ADDRESS] in [FACILITY CITY], as part of Efficiency Nova Scotia's Business Energy Rebates Program. Is this correct?

1. Yes [CONTINUE]
2. No [Is there someone else in your organization who would know about having participated in the Business Energy Rebates Program]?

Yes [ASK TO SPEAK TO THEM AND REPEAT INTRODUCTION]

No [THANK, TERMINATE, RECORD, AND KEEP DATA]

V2. Are you the person in your organization who is most knowledgeable about your experience with the Business Energy Rebates Program?

1. Yes (IF YES GO TO V4)
2. No

- V3. We would like to talk to the person who is the most knowledgeable about your organization's experience with the Business Energy Rebates Program. Could you give me the name and telephone number of this person? [Probe if respondent is unsure who best to forward the call to. This individual may be an engineer, equipment contractor, or utility account manager].

Name: _____

Telephone #: _____

(Note: Thank, terminate, record and keep data. Schedule interview with best contact regarding experience with the program.)

- V4. According to our information, through its participation in the Business Energy Rebates Program, your organization submitted [INSERT NUMBER OF APPLICATIONS] application(s) in 2018. For [THIS / ONE] application, you implemented [MEASURE CATEGORY] measures at your facility located at [FACILITY ADDRESS] in [FACILITY CITY], and received a rebate of [REBATE]. When answering the survey questions, please take into account this specific application for [MEASURE CATEGORY] measures.

Program Awareness and Participation (P Series)

- P1. Prior to your most recent Business Energy Rebates Program incented project, have you participated in projects that received Efficiency Nova Scotia incentives before? [CODE ONLY ONE]
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)

- P2. [ASK IF P1 =1] What program(s) did you participate in? [READ IN ORDER, CODE ALL THAT APPLY]
1. Business Energy Rebates (BER) Mail-in (*If needed: received incentives for installing designated equipment*)
 2. Business Energy Rebates (BER) Instant-rebates (*If needed: purchased equipment from a distributor that was discounted by Efficiency Nova Scotia*)
 3. Small Business Energy Solutions (*If needed: A program that serves small businesses by covering up to 60% of installation costs and provides interest free financing*)
 4. Custom (*If needed: received incentives based on calculation of savings*)
 5. Energy Management Information Systems (EMIS) (*If needed: received assistance and incentives for installing a comprehensive energy management system*)
 6. Strategic Energy Management (SEM) (*If needed: received assistance and incentives for participating in a year long cohort-based program to learn and implement energy management strategies*)
 7. New Commercial Construction (*If needed: received incentives for constructing a new building or remodeling/repurposing an old space*)
 96. Other, please specify
 98. (Don't know)
 99. (Refused)
- P3. [ASK IF P1 =1] On a scale of 1 to 10 where 1 is not at all influential and 10 is highly influential, how influential was your past participation in an Efficiency Nova Scotia program in your decision to participate in your most recent Business Energy Rebates Program project? [RESPONSE OPTIONS 1-10 AND NOT APPLICABLE, DK AND REFUSED]

- P4. [ASK IF P1=2] Other than the Business Energy Rebates Mail-in program you recently participated in, what Efficiency Nova Scotia program(s), if any, are you aware of? [READ IN ORDER, CODE ALL THAT APPLY]
1. Business Energy Rebates (BER) Instant-rebates (*If needed: purchased equipment from a distributor that was discounted by Efficiency Nova Scotia*)
 2. Small Business Energy Solutions (*If needed: A program that serves small businesses by covering up to 60% of installation costs and provides interest free financing*)
 3. Custom (*If needed: received incentives based on calculation of savings*)
 4. Energy Management Information Systems (EMIS) (*If needed: received assistance and incentives for installing a comprehensive energy management system*)
 5. Strategic Energy Management (SEM) (*If needed: received assistance and incentives for participating in a year long cohort-based program to learn and implement energy management strategies*)
 6. New Commercial Construction (*If needed: received incentives for constructing a new building or remodeling/repurposing an old space*)
 7. None – I am not aware of any other Efficiency Nova Scotia programs [MAKE EXCLUSIVE ANSWER]
 96. Other, specify
 98. (Don't know)
 99. (Refused)
- P5. [ASK IF P4_1=IS SELECTED] Why did you choose to participate in the Mail-in service of the Business Energy Rebates Program rather than the Instant Rebates service? [OPEN-ENDED RESPONSE. RECORD RESPONSE]
- P6. For your most recent Business Energy Rebates Program supported project, which of the following statements best describes who completed your rebate application? [READ IN ORDER, SINGLE RESPONSE]
1. I completed the application
 2. A coworker completed the application
 3. My contractor completed the application on my behalf
 98. (Don't know)
 99. (Refused)
- P7. Did you interact with any Efficiency Nova Scotia staff during the process of applying for the rebate? [DO NOT READ, CODE ONE ONLY]
1. Yes
 2. No
 98. Don't know
 99. Refused

- P8. On a scale of 1 to 10 where 1 equals not at all agree and 10 equals completely agree, how much do you agree with the following statements? [RANDOMIZE; RESPONSE OPTIONS 1-10 AND NOT APPLICABLE, DK AND REFUSED]
1. [ASK IF P6=1] The mail-in rebate application was easy to complete
 2. [ASK IF P7=1] Efficiency Nova Scotia staff responded to my questions quickly
 3. [ASK IF P7=1] Efficiency Nova Scotia staff responded to my questions knowledgeably
 4. I received my incentive from Efficiency Nova Scotia in the time I expected
 5. The list of eligible measures was sufficient for my needs
 6. The rebate I received was what I anticipated
 7. I was able to gather the information the program needed about my project easily
- P9. [ASK IF P8_5 <8] You mentioned that the eligible measures were not sufficient. Were there types of efficient equipment or services you would like to see Efficiency Nova Scotia provide rebates for? [OPEN-END RESPONSE]
- 98 Don't know
- P10. When completing your most recent project through the Business Energy Rebates Mail-in program, did your contractor provide you a choice of Efficiency Nova Scotia programs to participate in? [DO NOT READ, CODE ONLY ONE]
1. Yes
 2. No
 98. Don't know
 99. Refused

- P11. [ASK IF P10 = 1, YES] What other programs did they mention you could participate in for that project? [READ IN ORDER, CODE ALL THAT APPLY]
1. Business Energy Rebates (BER) Instant-rebates (If needed: purchased equipment from a distributor that was discounted by Efficiency Nova Scotia)
 2. Small Business Energy Solutions (If needed: A program that serves small businesses by covering up to 60% of installation costs and provides interest free financing)
 3. Custom (If needed: received incentives based on calculation of savings)
 4. Energy Management Information Systems (EMIS) (If needed: received assistance and incentives for installing a comprehensive energy management system)
 5. Strategic Energy Management (SEM) (If needed: received assistance and incentives for participating in a year long cohort-based program to learn and implement energy management strategies)
 6. New Commercial Construction (If needed: received incentives for constructing a new building or remodeling/repurposing an old space)
 7. None – I am not aware of any other Efficiency Nova Scotia programs [MAKE EXCLUSIVE ANSWER]
 96. Other, specify
 98. (Don't know)
 99. (Refused)

Free-Ridership (FR Series)

- FR1. Had your organization **already** decided to implement energy-efficient **[MEASURE CATEGORY]** measures **before** you heard about the Business Energy Rebates Program?
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)
- FR1a. **IF FR1= YES, THEN ASK:** I just want to make sure I understand - Before you decided to participate in the Business Energy Rebate Program, you had already made the decision to implement energy-efficient **[MEASURE CATEGORY]** measures?
1. Yes, I had already made the decision
 2. No, I had not made the decision
 98. (Don't know)
 99. (Refused)

FR2. Efficiency Nova Scotia paid your organization \$[REBATE VALUE FROM SAMPLE BY CATEGORY] for the energy-efficient [MEASURE CATEGORY] measures. If your organization had not received the rebate from Efficiency Nova Scotia, would you have paid the full cost of the energy-efficient [MEASURE CATEGORY] measures? Please answer on a scale of 0 to 10, with a 0 indicating that you “Definitely **Would Not** Have Paid,” and a 10 indicating that you “Definitely **Would Have** Paid.” PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE

___ Response ___98 Don't Know ___99 Refused

FR3a_2. [ASK IF MEASURE CATEGORY=LIGHTING] Were you aware that the lighting products rebated through the Business Energy Rebates Program are premium products certified by Design Light Consortium or ENERGY STAR®?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[READ FIRST TIME THROUGH ONLY] Now I would like to ask you to consider which actions your organization would have taken if the Business Energy Rebates Program had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is “Very Unlikely,” and a 10 indicating that it is “Very Likely.” [DO NOT ACCEPT A RANGE – ASK FR3 SEQUENCE IN ORDER/DO NOT RANDOMIZE]

FR3a_1. [ASK IF MEASURE CATEGORY <> LIGHTING] If the program rebate had not been offered, what is the likelihood that you would have implemented exactly the same energy-efficient [MEASURE CATEGORY] measures that you purchased through the Business Energy Rebates Program?

___ Response ___98 Don't Know ___99 Refused

FR3a_3. [ASK IF MEASURE CATEGORY=LIGHTING]

If the program rebate had not been offered, what is the likelihood that you would have purchased the exact same model of lighting products?

___ Response ___98 Don't Know ___99 Refused

FR3b. [ASK IF MEASURE CATEGORY = LIGHTING AND TOTAL MEASURE CATEGORY QTY>1] If the program rebate had not been offered, what is the likelihood that you would have implemented exactly the same quantity of lighting products that you installed through the program?

___ Response ___98 Don't Know ___99 Refused

FR3c. [IF FR2≥5] If the program rebate had not been offered, what is the likelihood that you would have postponed implementing the [MEASURE CATEGORY] measures by at least one year?

___ Response ___ 98 Don't Know ___ 99 Refused

FR4. Using a scale from 0 to 10, where 0 means “No influence” and 10 means “Great influence,” please rate the influence of each of the following in your organization’s decision to implement energy-efficient [MEASURE CATEGORY] measures.

Factor (READ AND RANDOMIZE)	Responses
a. The program rebate	___ Response ___ 98 Don't Know ___ 99 Refused
b. Information received from a program representative	___ Response ___ 98 Don't Know ___ 99 Refused
[ASK IF OEM=YES] c. The assistance provided by your on-site energy manager in identifying and implementing the measure	___ Response ___ 98 Don't Know ___ 99 Refused

FR5a. When it comes to deciding whether or not to implement energy efficient measures, does your organization use a payback period threshold as a decisional criterion? CODE ONLY ONE

1. YES
2. NO
8. (DON'T KNOW)
9. (Refused)

FR5aa. [ASK IF FR5a=1] What is the maximum acceptable payback period in order to move forward with energy-efficient measures? AVOID A RANGE.

RECORD RESPONSE [MONTHS/YEARS] [IF ANSWER IS TRACKED IN MONTHS ONLY, WRITE 0 UNDER YEARS]

98 (Don't know)

FR5b. [ASK IF FR5a=1] Without the rebate, was the payback period short enough for the measure to be implemented? CODE ONLY ONE

1. YES
2. NO
8. (DON'T KNOW)
9. (Refused)

[Ask IF FR5b=1]

FR5c. Just to be sure I understand correctly, you are saying that the measure was already attractive enough in terms of financial payback to be implemented without the rebate? CODE ONLY ONE

1. YES
2. NO
8. (DON'T KNOW)
9. (Refused)

FR6. Which of the following, if any, does your organization have in place for the facility where the measures were implemented as part of the Business Energy Rebates Program? READ AND ROTATE - CODE ONLY ONE PER STATEMENT

- a. A person responsible for monitoring or managing energy usage
 - b. Defined energy saving goals
 - c. A specific policy requiring that energy efficiency be considered when purchasing energy related equipment
1. YES
 2. NO
 8. (DON'T KNOW)
 9. (Refused)

[If FR5a=1 and/or FR6b or c=1]

FR7. Has your organization ever implemented energy efficiency projects that had a payback period longer than your standard payback time period ? CODE ONLY ONE

1. YES
2. NO
8. (DON'T KNOW)
9. (Refused)

Cross-Influence [CI Series]

READ AND ROTATE (CI1 + CI2a-c) AND (CI3 + CI4a-c) SEQUENCES

CI1. Before participating in the Business Energy Rebates program in [DATE], had your organization at any time in the past already participated in any other 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.

- CI2a. [IF CI1=1] Your company's previous participation in an Efficiency Nova Scotia program was a major factor in the decision to implement energy-efficient [MEASURE CATEGORY] measures.
- 1. Agree
 - 2. Disagree
 - 98. (Don't know)
 - 99. (Refused)
- CI2b. [IF CI1=1] Because of your company's previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, a company representative asked a contractor or a technical staff member to examine the energy efficiency options for your facility.
- 1. Agree
 - 2. Disagree
 - 98. (Don't know)
 - 99. (Refused)
- CI2c. [IF CI1=1] Because of your company's previous participation in an Efficiency Nova Scotia program and what was learned by participating in that program, a company representative took into account the cost-effectiveness of energy-efficient [MEASURE CATEGORY] measures when evaluating different options for your facility.
- 1. Agree
 - 2. Disagree
 - 98. (Don't know)
 - 99. (Refused)
- CI3. Before participating in the Business Energy Rebates program in [DATE], had you at any time in the past already seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?
- 1. Yes
 - 2. No
 - 98. (Don't know)
 - 99. (Refused)

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

CI4a. [IF CI3=1] The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in your company's decision to implement energy-efficient [MEASURE CATEGORY] measures.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

CI4b. [IF CI3=1] The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to ask a contractor or a technical staff member to examine the energy efficiency options for your facility.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

CI4c. [IF CI3=1] The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to take into account the cost-effectiveness of energy efficient [MEASURE CATEGORY] measures when evaluating different options for the facility.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

CI5. For the most recent project you completed under the Business Energy Rebates Program, did you use a contractor that was listed on the Efficiency Nova Scotia website – under their Efficiency Trade Network (ETN)?

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

CI6. [ASK IF CI5 = 1] On a scale of 1 to 10 where 1 is not at all important and 10 is very important, when selecting a contractor, how important was it that your contractor be listed on Efficiency Nova Scotia's Efficiency Trade Network? [RECORD NUMBER, 98=Don't know, 99 Refused]
DO NOT ACCEPT A RANGE

Satisfaction [S series]

- S1. Using a scale from 1 to 10 where 1 is “not at all satisfied” and 10 is “completely satisfied” how would you rate your satisfaction with the Business Energy Rebates program overall? [RECORD NUMBER, 98=Don’t know, 99 Refused] DO NOT ACCEPT A RANGE
- S2. [IF S1<8] What was the most important reason you were not more satisfied with the program overall? [DO NOT READ. PROBE FOR SPECIFIC REASON. ACCEPT MULTIPLE RESPONSES] Probe: Any other reasons?
1. (Timely process/Took too long)
 2. (Too expensive)
 3. (I don't like the products/measures rebated)
 4. (Rebate/incentive is too small)
 5. (Too difficult to sign up/too much work)
 96. (Other: _____)
 98. (Don't know)
 99. (Refused)
- S3. On a scale of 1 to 10, where 1=‘not at all satisfied’ and 10=‘completely satisfied,’ how was your organization’s experience with each of the following aspects of the Business Energy Rebates Program? If your organization did not have experience with one of these aspects please tell me. [DO NOT RANDOMIZE] [97 = Not Applicable, 98 = Don’t know/Don’t recall, 99 = Refused]
- a. The program application, forms and associated paperwork
 - b. Interaction and communication with contractors or distributors
 - c. Rebate amounts
 - d. Time required to receive rebate
- S4. Why were you not more satisfied with the READ STATEMENTS IN ORDER AS APPLICABLE? [DO NOT READ. PROBE FOR SPECIFIC REASON. ACCEPT MULTIPLE RESPONSES]
- a. [ASK S4a IF S3a <8] The program application, forms and associated paperwork
 1. (Difficult/too long to fill out)
 2. (Took too long/Time delay in processing)
 3. (Communication problems)
 96. (Other: _____)
 98. (Don't know)
 99. (Refused)

- b. [ASK S4b IF S3b <8] Interaction and communication with contractors or distributors
 - 1. (Lack of communication/availability with contractor/distributor)
 - 2. (Less knowledgeable about the program)
 - 3. (Took too long/Communication was slow)
 - 96. (Other: _____)
 - 98. (Don't know)
 - 99. (Refused)

- c. [ASK S4c IF S3c <8] Rebate amounts
 - 1. (Rebate is too small/Expected higher rebate)
 - 2. (Cost of measures was expensive)
 - 96. (Other: _____)
 - 98. (Don't know)
 - 99. (Refused)

- d. [ASK S4d IF S3d <8] Time required to receive rebate
 - 1. (Took too long to process/get rebate)
 - 2. (Lack of communication/follow-up)
 - 96. (Other: _____)
 - 98. (Don't know)
 - 99. (Refused)

Barriers and Recommendations [B Series]

- B1. In the last two years, did your organization make any upgrades without support or incentives from an Efficiency Nova Scotia program?
 - 1. Yes
 - 2. No
 - 98. (Don't know)
 - 99. (Refused)

- B2. [ASK IF B1=1] What types of upgrades did you make? [DO NOT READ, CODE ALL THAT APPLY]
1. Lighting
 2. HVAC
 3. Water heating
 4. Kitchen equipment
 5. Building shell
 6. Industrial equipment
 7. Compressed air
 8. Other, please specify: [OPEN-ENDED RESPONSE]
 98. (Don't know)
 99. (Refused)
- B3. [ASK IF B1=1] Why did you make upgrades without using an Efficiency Nova Scotia program? [DO NOT READ, ALLOW MULTIPLE RESPONSE]
1. The upgrades were not energy efficient enough
 2. The upgrade project seemed too small to bother with incentives
 3. I did not know about the Efficiency Nova Scotia programs at the time I made the upgrades
 4. Other, please specify: [OPEN-ENDED RESPONSE]
 98. (Don't know)
 99. (Refused)
- B4. In the next two years, are you or your organization planning to make any upgrades?
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)

- B5. [ASK IF B4 = 1] What types of upgrades will you be making? [DO NOT READ, ALLOW MULTIPLE RESPONSE]
1. Lighting
 2. HVAC
 3. Water heating
 4. Kitchen equipment
 5. Building shell
 6. Industrial equipment
 7. Compressed air
 8. Other, please specify: [OPEN-ENDED RESPONSE]
 98. (Don't know)
 99. (Refused)
- B6. [ASK IF B4 = 1] On a scale of 1 to 10 where 1 is not at all likely and 10 is highly likely, how likely are you to seek Efficiency Nova Scotia incentives for these future upgrades? [RECORD NUMBER, 98=Don't know, 99 Refused] DO NOT ACCEPT A RANGE
- B7. [ASK IF ((B5 = 1 AND B5 <> 2 through 8) OR (B4 =2))] Which of the following statements best reflects why you are not considering making efficiency upgrades [IF (B5 = 1 AND B5 <> 2 through 8) "other than lighting"] in the next two years? [SINGLE RESPONSE]
1. I have energy using equipment but cannot make improvements because I rent
 2. I have energy using equipment that is aging/failing but I don't have money to replace it
 3. I have energy using equipment that works ok and is already efficient
 4. I have energy using equipment that works ok even though it is not very efficient
 5. I only replace equipment when it fails beyond repair
 96. Other, please specify: [OPEN-ENDED RESPONSE]
 98. (Don't know)
 99. (Refused)

- B8a. Do you have any suggestions to improve the Business Energy Rebates Program? Consider all aspects of the program: process, measures covered, marketing, interactions with program staff, and program forms. PROBE: Anything else? [DO NOT READ. ACCEPT MULTIPLE]
1. (Provide more information/information sessions)
 2. (Better marketing/awareness)
 3. (Increase/better rebates)
 4. (Speed up process/receive rebate quicker)
 5. (Offer more measures rebated)
 6. (Make forms more user-friendly)
 7. (Efficiency Nova Scotia staff should be more knowledgeable)
 8. (No recommendation)
 96. (Other – SPECIFY: _____)
 98. (Don't know)
 99. (Refused)
- B8b. [ASK IF B8a=1] What kind of information would improve the Business Energy Rebate Program? [RECORD ANSWER. 98 = Don't know, 99 = Refused]

Firmographics [F Series]

These final questions are asked for statistical purposes only. The information collected is strictly confidential.

F1. What is the main activity of your organization? [DO NOT READ—BUT CONFIRM WITH RESPONDENT THAT THE CATEGORY YOU CHOOSE IS CORRECT]

1. (Education)
2. (Food Sales (grocery))
3. (Food Service (restaurant))
4. (Health Care – Inpatient)
5. (Health Care – Outpatient)
6. (Lodging)
7. (Mercantile– Retail (Enclosed and Strip Malls))
8. (Mercantile – Retail (Other than Mall))
9. (Office)
10. (Public Assembly)
11. (Public Order and Safety)
12. (Religious Worship)
13. (Service)
14. (Warehouse / storage)
15. (Manufacturing)
16. (Building is vacant)
17. (Agriculture)
18. (Other (SPECIFY: _____))
98. (Don't know)
99. (Refused)

F2. Approximately how many full-time equivalent workers DOES YOUR ORGANIZATION employ at all locations within Nova Scotia? DO NOT READ, CODE APPROPRIATE CATEGORY

1. (Fewer than 5)
2. (5 to 9)
3. (10 to 19)
4. (20 to 49)
5. (50 to 99)
6. (100 to 249)
7. (250 or more)
98. (Don't know)
99. (Refused)

F3. Is your organization independent, or part of a larger organization?

- 1. Independent
- 2. Part of a larger company/organization
- 96. Other (_____)
- 98. (Don't know)
- 99. (Refused)

F4. Do you own or rent your space?

- 1. Own
- 2. Rent
- 3. Other (_____)
- 98. (Don't know)
- 99. (Refused)

F5. How many business locations does your organization have in Nova Scotia? [RECORD A NUMBER 1-99; 998 = Don't know, 999 = Refused]

END. Those are all the questions I have for you. I thank you very much for your time and cooperation and have a nice day!

APPENDIX II

BER: MAIL-IN PARTICIPANT SURVEY RESULTS

Note: Due to rounding, certain percentages in the tables of this appendix do not sum to 100 percent.

P1. Prior to your most recent Business Energy Rebates Program incented project, have you participated in projects that received Efficiency Nova Scotia incentives before?

Previously Participated in Projects Receiving ENS Incentives	2018
Sample Size	70
Yes	44%
No	54%
Don't know	1%

P2. What program(s) did you participate in?

Previous Participation in ENS Program Components	2018
Sample Size	31
BER Mail-in	44%
BER Instant Rebates	31%
Custom	23%
Small Business Energy Solutions	13%
New Commercial Construction	3%
Strategic Energy Management	3%
Energy Management Information Systems	3%
Others	6%
Don't know	3%
Multiple Responses	
Base: Respondents who previously participated in projects receiving ENS incentives	

P3. On a scale of 1 to 10 where 1 is not at all influential and 10 is highly influential, how influential was your past participation in an Efficiency Nova Scotia program in your decision to participate in your most recent Business Energy Rebates Program project?

Influence of Past Participation on Decision	2018	
	Sample Size	Mean
Mean (1 = "Not at all influential" 10 = "Highly influential")		
Influence of past participation	30	8.2
Base: Respondents who previously participated in projects receiving ENS incentives		
Don't know/Refused excluded from calculations		

- P4. Other than the Business Energy Rebates Mail-in program you recently participated in, what Efficiency Nova Scotia program(s), if any, are you aware of?

Aware of Other ENS Program Components	2018
Sample Size	38
None – Not aware of any ENS programs	47%
New Commercial Construction	16%
BER Instant Rebates	13%
Residential programs	11%
Small Business Energy Solutions	8%
Custom	5%
Strategic Energy Management	3%
Energy Management Information Systems	3%
Others	13%
Don't know	3%
Base: Respondents who have not previously participated in projects receiving ENS incentives Multiple responses	

- P5. Why did you choose to participate in the Mail-in service of the Business Energy Rebates Program rather than the Instant Rebates service?

Reason for Participating In Mail-In Service Rather Than Instant Rebates Service	2018
Sample Size	5 (#)
Instant Rebates service not available for products/measures	2
Recommended by supplier	1
Recommended by contractor	1
Recommended by ENS representative	1
Base: Respondents who are aware of BER Instant Rebates service	

- P6. For your most recent Business Energy Rebates Program supported project, which of the following statements best describes who completed your rebate application?

Who Completed the Application	2018
Sample Size	70
I completed the application	57%
A co-worker completed the application	14%
My contractor completed the application on my behalf	29%

P7. Did you interact with any Efficiency Nova Scotia staff during the process of applying for the rebate?

Interaction with ENS Staff During Application Process	2018
Sample Size	70
Yes	63%
No	36%
Don't know	1%

P8. On a scale of 1 to 10 where 1 equals not at all agree and 10 equals completely agree, how much do you agree with the following statements?

Agreement With Statements About BER Mail-In Rebate	2018	
	Sample Size	Mean
Mean (1 = "Not at all agree" 10 = "Strongly agree")		
ENS staff responded to my questions quickly**	44	9.6
ENS staff responded to my questions knowledgeably**	44	9.5
I received my incentive from ENS in the time I expected	69	9.2
The list of eligible measures was sufficient for my needs	68	9.1
The rebate I received was what I anticipated	68	9.0
I was able to gather the information the program needed about my project easily	68	8.7
The mail-in rebate application was easy to complete*	40	8.4
*Base: Respondents who completed the rebate application		
**Base: Respondents who interacted with ENS staff during application process		
Don't know/Not Applicable excluded from calculations		

P9. You mentioned that the eligible measures were not sufficient. Were there types of efficient equipment or services you would like to see Efficiency Nova Scotia provide rebates for?

Other Types of Efficient Equipment or Services for ENS to Provide Rebates	2018 (#)
Sample Size	9
Ventilation systems	1
Would like to be able to customize	1
Hot water heating systems	1
More lighting	1
Others	2
Don't know	4
Base: Respondents who said that the list of eligible measures was insufficient	
Multiple responses	

P10. When completing your most recent project through the Business Energy Rebates Mail-in program, did your contractor provide you a choice of Efficiency Nova Scotia programs to participate in?

Contractor Provided a Choice of ENS Program Components for Participation	2018
Sample Size	70
Yes	20%
No	74%
Don't know/refused	6%

P11. What other programs did they mention you could participate in for that project?

Other ENS Program Components Mentioned by Contractor	2018
Sample Size	14
BER Instant Rebates	6
Small Business Energy Solutions	1
None – I am not aware of any other ENS program components	5
Don't know	2
Base: Respondents who said that the contractor provided a choice of ENS programs to participate in	

FR1. Had your organization already decided to implement energy-efficient [MEASURE CATEGORY] measures before you heard about the Business Energy Rebates Program?

FR1a. I just want to make sure I understand - Before you decided to participate in the Business Energy Rebate Program, you had already made the decision to implement energy efficient [MEASURE CATEGORY] measures?

Already Made Decision to Implement Energy Efficient Measures Prior to Program Component	2015	2016	2017	2018
Sample Size	74	70	70	70
Yes	36%	50%	46%	56%
No	58%	47%	50%	43%
Don't know	5%	3%	4%	1%

FR2. Efficiency Nova Scotia paid your organization \$[REBATE VALUE FROM SAMPLE BY CATEGORY] for the energy-efficient [MEASURE CATEGORY] measures. If your organization had not received the rebate from Efficiency Nova Scotia, would you have paid the full cost of the energy-efficient [MEASURE CATEGORY] measures?

Would Have Paid Cost of Project	2015		2016		2017		2018	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Mean (0 = "Definitely Would Not Have Paid" 10 = "Definitely Would Have Paid")								
Paid cost of project	72	5.6	69	6.7	70	6.0	69	6.3
Don't know/Refused excluded from calculations								

FR3a_2. Were you aware that the lighting products rebated through the Business Energy Rebates Program are premium products certified by Design Light Consortium or ENERGY STAR?

Aware that Lighting Products are Premium Certified Design Light Consortium or ENERGY STAR	2017	2018
Sample Size	43	43
Yes	49%	58%
No	47%	40%
Don't know	5%	2%
Base: Respondents who had lighting products installed		

FR3. Now I would like to ask you to consider which actions your organization would have taken if the Business Energy Rebates Program had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is "Very Unlikely," and a 10 indicating that it is "Very Likely."

Actions Taken in Absence of Program Component	2017		2018	
	Sample Size	Mean	Sample Size	Mean
Mean (0 = "Very Unlikely" 10 = "Very Likely")				
Implemented the exact same quantity of lighting products that you installed through the program component	41	6.7	40	6.7
Purchased the exact same model of lighting products	43	6.0	41	6.7
Implemented exactly the same energy-efficient [MEASURE CATEGORY] measures that you purchased through the Business Energy Rebates Program?	27	5.4	27	5.3
*Postponed implementing the [MEASURE CATEGORY] measures by at least one year?	51	3.6	49	4.6
Don't know/Refused excluded from calculations				
*Base: Respondents who would have likely paid full cost of the energy-efficient measure [IF FR2≥5]				
Results from 2016 are not presented due to wording changes in 2017				

FR4. Using a scale from 0 to 10, where 0 means “No influence” and 10 means “Great influence”, please rate the influence of each of the following in your organization’s decision to implement energy-efficient [MEASURE CATEGORY] measures.

Influence of Factors in Decision to Implement Energy-Efficient Measures	2016		2017		2018	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Mean (0 = “No influence” 10 = “Great influence”)						
The assistance provided by your on-site energy manager in identifying and implementing the measure	-	-	2	7.0	5	7.4
The program rebate	69	7.3	69	7.6	70	7.3
Information received by a program representative	67	5.8	64	5.7	69	5.0
Don't know/Refused excluded from calculations						

FR5a. When it comes to deciding on whether or not to implement energy efficiency measures, does your company use a payback period threshold as a decisional criterion?

Payback Period Threshold	2016	2017	2018
Sample Size	70	70	70
Yes	53%	53%	50%
No	46%	39%	44%
Don't know	1%	9%	6%

FR5aa. What is the maximum payback period acceptable in order to move forward with energy efficient upgrades?

Maximum Payback Period	2018
Sample Size	35
1 year or less	14%
2 years	23%
3 years	17%
4 years	11%
5 years	17%
6 years or more years	14%
Don't know	3%
Mean	3.7
Base: Company uses a payback period threshold as a decisional criterion Don't know removed from calculation	

FR5b. Without the rebate, was the payback period short enough for the measure to be implemented?

FR5c. Just to be sure I understand correctly, you are saying that the measure was already attractive enough in terms of financial payback to be implemented without the rebate?

Payback Period was Short Enough	2016	2017	2018
Sample Size	37	37	35
Yes	38%	35%	46%
No	46%	46%	43%
Don't know	16%	19%	11%
Base: Company uses a payback period threshold as a decisional criterion			

FR6. Which of the following, if any, does your company have in place for the facility where the measures were implemented as part of the BER Program?

Processes in Place in Facilities Where Measures Were Implemented	2016		2017		2018	
Sample Size	70		70		70	
	Yes	No/Don't know	Yes	No/Don't know	Yes	No/Don't know
A specific policy requiring that energy efficiency be considered when purchasing energy related equipment	47%	53%	60%	40%	46%	54%
A person responsible for monitoring or managing energy usage	56%	44%	50%	50%	50%	50%
Defined energy saving goals	33%	67%	47%	52%	50%	50%

FR7. Has your organization ever implemented energy efficiency projects that had a payback period longer than your standard payback time period?

Implemented an Energy Efficiency Project with a Longer Payback Period	2016	2017	2018
Sample Size	56	58	52
Yes	32%	24%	31%
No	61%	66%	58%
Don't know	7%	10%	12%
Base: Company uses a payback period threshold as a decisional criterion AND/OR company has defined energy saving goals OR company has a specific policy requiring energy efficiency be considered when purchasing energy related equipment			

CI1. Before participating in the Business Energy Rebates program in [DATE], had your organization at any time in the past already participated in any other Efficiency Nova Scotia programs?

Previous Participation in Another ENS Program Component	2016	2017	2018
Sample Size	70	70	70
Yes	51%	47%	49%
No	40%	51%	46%
Don't know	9%	1%	6%

CI2a. The company's previous participation in an Efficiency Nova Scotia program was a major factor in the decision to implement an energy-efficient [MEASURE CATEGORY] measure.

Previous Participation in Another ENS Program Component Was a Major Factor in Decision	2016	2017	2018
Sample Size	36	33	34
Agree	75%	76%	74%
Disagree	25%	21%	26%
Don't know	-	3%	-
Base: Respondents who previously participated in another ENS program component			

CI2b. Because of the company's previous participation in an Efficiency Nova Scotia program and what was learned by participating in the program, a company representative asked a contractor or a technical staff member to examine the energy efficiency options for the facility.

Previous ENS Program Component Participation Led to Examine Options for Facility	2016	2017	2018
Sample Size	36	33	34
Agree	78%	73%	71%
Disagree	22%	24%	26%
Don't know	-	3%	3%
Base: Respondents who previously participated in another ENS program component			

- C12c. Because of your company's previous participation in an Efficiency Nova Scotia program and what was learned by participating in the program, a company representative took into account the cost-effectiveness of energy efficient [MEASURE CATEGORY] measures when evaluating different options for the facility.

Previous ENS Program Component Participation Led to Assess Product Cost-effectiveness	2016	2017	2018
Sample Size	36	33	34
Agree	89%	91%	79%
Disagree	11%	9%	15%
Don't know/refused	-	-	6%
Base: Respondents who previously participated in another ENS program component			

- C13. Before participating in the Business Energy Rebates program in [DATE], had you at any time in the past already seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?

Previously Seen Energy Efficiency Promotional Materials Distributed by ENS	2016	2017	2018
Sample Size	70	70	70
Yes	84%	93%	76%
No	14%	7%	24%
Don't know	1%	-	-

- C14a. The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in the company's decision to implement energy-efficient [MEASURE CATEGORY] measures.

Previously Seen ENS Energy Efficiency Promotional Materials Was a Major Factor in Decision	2016	2017	2018
Sample Size	59	65	53
Agree	61%	68%	60%
Disagree	37%	32%	38%
Don't know	2%	-	2%
Base: Respondents who previously saw ENS energy-efficiency promotional materials			

- C14b. The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to ask a contractor or a technical staff member to examine the energy efficiency options for the facility.

Previously Seen ENS Energy Efficiency Promotional Materials Led to Examine Options for Facility	2016	2017	2018
Sample Size	59	65	53
Agree	61%	62%	53%
Disagree	37%	35%	43%
Don't know/refused	2%	3%	4%
Base: Respondents who previously saw ENS energy-efficiency promotional materials			

- C14c. The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to take into account the cost-effectiveness of energy efficient [MEASURE CATEGORY] measures when evaluating different options for the facility.

Previously Seen ENS Energy Efficiency Promotional Materials Led to Assess Product Cost-effectiveness	2016	2017	2018
Sample Size	59	65	53
Agree	83%	77%	75%
Disagree	15%	23%	23%
Don't know/refused	2%	-	2%
Base: Respondents who previously saw ENS energy-efficiency promotional materials			

- C15. For the most recent project you completed under the Business Energy Rebates Program, did you use a contractor that was listed on the Efficiency Nova Scotia website – under their Efficiency Trade Network (ETN)?

Use of a Contractor Listed Under the ETN	2018
Sample Size	70
Yes	19%
No	56%
Don't know	26%

- C16. On a scale of 1 to 10 where 1 is not at all important and 10 is very important, when selecting a contractor, how important was it that your contractor be listed on Efficiency Nova Scotia's Efficiency Trade Network?

Importance That Contractor is Listed Under the ETN	2018	
	Sample Size	Mean
Mean (1 = "Not at all important" 10 = "Highly important")		
Influence of past participation	13	7.8
Base: Respondents used a contractor listed on ENS's ETN		

- S1. Using a scale from 1 to 10 where 1 is "not at all satisfied" and 10 is "completely satisfied" how would you rate your satisfaction with the Business Energy Rebates program overall?

Satisfaction with BER Mail-in Overall	2016	2017	2018
Sample Size	70	70	69
Mean	8.6	9.0	9.1
Don't know/Refused excluded from calculations			

- S2. What was the most important reason you were not more satisfied with the program overall?
Any other reasons?

Key Reasons Not More Satisfied	2016 (#)	2017 (#)	2018 (#)
Sample Size	10	7	5
Too difficult to sign up/too much work	1	2	1
Timely process/Took too long before getting rebate	3	2	-
Equipment was not qualified	-	1	-
Didn't deal directly with ENS	-	1	-
Don't like location of equipment	-	1	-
Communication problems leading to believe rebate would be higher	2	-	-
Too expensive	1	-	-
I don't like the products/measures rebated	1	-	-
Rebate/incentive is too small	1	1	4
Did not receive rebate	-	-	1
Others	1	1	-
Base: Respondents who were not satisfied with the program component (NOT SATISFIED: S1<8) Multiple responses			

S3. On a scale of 1 to 10, where 1='not at all satisfied' and 10='completely satisfied', how was your organization's experience with each of the following aspects of the Business Energy Rebates Program?

Satisfaction with Aspects of BER Mail-in	2016		2017		2018	
	Sample Size	Mean	Sample Size	Mean	Sample Size	Mean
Mean (1 = 'Not at all satisfied', 10 = 'Completely satisfied')						
Interaction and communication with contractors, distributors or consultants	65	8.7	67	8.6	64	8.7
Rebate amounts	69	8.0	70	8.4	69	8.5
The program application, forms and associated paperwork	67	8.5	65	8.4	62	8.2
Time required to receive rebate	69	7.9	68	8.5	68	8.1
Don't know/Not applicable/Refused excluded from calculations						

S4a. Why were you not more satisfied with the program application, forms and associated paperwork?

Reasons Not More Satisfied with Application, Forms and Paperwork	2016 (#)	2017* (#)	2018* (#)
Sample Size	15	18	18
Difficult/too long to fill out	5	15	11
Communication problems	2	3	5
Didn't deal with ENS directly	-	1	-
Would prefer to fill out forms online	-	1	-
Took too long/Time delay in processing	5	1	-
Others	2	2	1
Don't know	1	-	1
Base: Respondents who were not satisfied with program component application, forms and associated paperwork (NOT SATISFIED: S3a<8)			
*Multiple responses			

S4b. Why were you not more satisfied with interaction and communication with contractors or distributors?

Reasons Not More Satisfied with Interaction and Communication with Contractors or Distributors	2016 (#)	2017* (#)	2018* (#)
Sample Size	9	10	8
Took too long/Communication was slow	1	4	1
Less knowledgeable about the program	2	4	4
Contractors didn't provide all the information to complete the application	-	1	1
Had to ensure the most energy efficient product was being used	-	1	-
The contractor tried to overcharge me	-	1	-
Lack of communication/availability with contractor/distributor	5	-	2
Others	1	-	1
Don't know	-	-	1
Base: Respondents who were not satisfied with interaction and communication with contractors or distributors (NOT SATISFIED: S3b<8) *Multiple responses			

S4c. Why were you not more satisfied with the rebate amounts?

Reasons Not More Satisfied with Rebate Amounts	2016 (%)	2017* (#)	2018* (#)
Sample Size	21	16	16
Rebate is too small/Expected higher rebate	86%	13	15
Cost of measures was expensive	14%	2	2
Others	10%	2	1
Don't know	-	1	-
Base: Respondents who were not satisfied with the rebate amounts (NOT SATISFIED: S3c<8) *Multiple responses			

S4d. Why were you not more satisfied with the time required to receive rebate?

Reasons Not More Satisfied with the Time Required to Receive Rebate	2016 (%)	2017* (#)	2018* (#)
Sample Size	24	13	13
Took too long to process/get rebate	75%	11	10
Lack of communication/follow-up	13%	3	-
Applications were too long to fill out and confusing	-	1	-
Have not received rebate			1
Others	13%	-	2
Base: Respondents who were not satisfied with the time required to receive rebate (NOT SATISFIED: S3d<8)			
*Multiple responses			

B1. In the last two years, did your organization make any upgrades without support or incentives from an Efficiency Nova Scotia program?

Upgrades Without Incentive From ENS	2018
Sample Size	70
Yes	33%
No	63%
Don't know	4%

B2. What types of upgrades did you make?

Types of Upgrades Made	2018
Sample Size	23
Lighting	61%
HVAC	39%
Water Heating	26%
Building shell	13%
Compressed air	9%
Appliances	4%
Industrial equipment	4%
Kitchen equipment	4%
Other	9%
Don't know	4%
Base: Respondents who made upgrades without using and ENS program component	
Multiple responses	

B3. Why did you make upgrades without using an Efficiency Nova Scotia program?

Reasons for Upgrades Without Using an ENS Program Component	2018
Sample Size	23
I did not know about the ENS program components at the time I made the upgrades	48%
The upgrade project seemed too small to bother with incentives	26%
The upgrades didn't qualify for rebates	13%
Too much of a hassle/It wasn't worth it	4%
The upgrades were not energy efficient enough	4%
Other	9%
Base: Respondents who made upgrades without using an ENS program component Multiple responses	

B4. In the next two years, are you or your organization planning to make any upgrades?

Planning to Make Upgrades in Next Two Years	2018
Sample Size	70
Yes	67%
No	23%
Don't know	10%

B5. What types of upgrades will you be making?

Types of Upgrades Planned	2018
Sample Size	47
Lighting	66%
HVAC	43%
Building shell	19%
Water Heating	17%
Industrial equipment	15%
Compressed air	4%
Appliances	4%
Kitchen equipment	4%
Other	13%
Don't know	2%
Base: Respondents who plan to make upgrades in next 2 years Multiple responses	

- B6. On a scale of 1 to 10 where 1 is not at all likely and 10 is highly likely, how likely are you to seek Efficiency Nova Scotia incentives for these future upgrades?

Likelihood of Seeking ENS Incentives for Future Upgrades	2018	
	Sample Size	Mean
Mean (1 = "Not at all likely" 10 = "Highly likely")		
Likelihood of seeking ENS incentives	47	9.7
Base: Respondents who plan to make upgrades in next 2 years		

- B7. [IF (B5 = 1 AND B5 <> 2 through 8) or B4=2] Which of the following statements best reflects why you are not considering making efficiency upgrades "other than lighting" in the next two years?

Reasons for Not Considering Efficiency Upgrades	2018
Sample Size	23
I have energy using equipment that works ok and is already efficient	39%
I only replace equipment when it fails beyond repair	35%
I have energy using equipment that is aging/failing but I don't have money to replace it	9%
I have energy using equipment that works ok even though it is not very efficient	4%
I have energy using equipment but cannot make improvements because I rent	4%
Other	4%
Don't know	4%
Base: Respondents who are not considering energy efficient upgrades other than lighting Multiple responses	

B8a. Do you have any suggestions to improve the Business Energy Rebates Program? Consider all aspects of the program: process, measures covered, marketing, interactions with program staff, and program forms. PROBE: Anything else?

Suggestions to Improve BER Mail-in Service	2018
Sample Size	70
No recommendation	59%
Make forms more user-friendly	14%
Better marketing/awareness	10%
Provide more information/information sessions	7%
Increase/better rebates	6%
ENS staff should be more knowledgeable	4%
Offer more measures rebated	4%
Speed up process/receive rebate quicker	4%
Improve quality of information on ENS website	3%
Provide information about rebate changes ahead of time	3%
Inform/Educate contractors	1%
Other	1%
Don't know	1%
Multiple responses	

B8b. What kind of information would improve the Business Energy Rebate Program?

Information to Improve BER Mail-in Service	2018
Sample Size	5
More information on equipment/measures	3
Information on the process	1
Better marketing/awareness	1

F1. What is the main activity of your organization?

Principal Building Activity	2015	2016	2017	2018
Sample Size	74	70	70	70
Farming/Agriculture	9%	6%	13%	13%
Property management/Real estate	-	4%	11%	10%
Mercantile/Retail (other than mall)	11%	11%	10%	1%
Lodging	4%	9%	10%	6%
Construction	-	7%	9%	7%
Manufacturing	7%	14%	7%	14%
Food service (restaurant)	8%	3%	6%	1%
Education	4%	4%	4%	9%
Recreation	-	4%	4%	6%
Wholesale	-	-	4%	-
Health care	4%	3%	3%	1%
Government	1%	1%	3%	4%
Mercantile/Retail (enclosed and strip malls)	4%	4%	1%	1%
Automotive repair	1%	4%	1%	4%
Transportation	-	4%	1%	1%
Warehouse/Storage	-	1%	1%	-
Service	27%	4%	-	6%
Public Assembly	-	4%	-	-
Religious worship	-	1%	-	1%
Property management	7%	-	-	-
Food sales (grocery)	4%	-	-	-
Food processing/manufacturing	1%	-	-	-
Public order and safety	1%	-	-	3%
Others	5%	9%	10%	9%

F2. Approximately how many full-time equivalent workers does your organization employ at all locations within Nova Scotia?

Number of Full-time Employees	2015	2016	2017	2018
Sample Size	74	70	70	70
Fewer than 5	22%	26%	40%	30%
5 to 9	18%	10%	10%	11%
10 to 19	12%	19%	7%	9%
20 to 49	12%	11%	10%	16%
50 to 99	14%	11%	11%	6%
100 to 249	8%	9%	6%	11%
250 or more	8%	10%	14%	14%
Don't know	7%	4%	1%	3%

F3. Is your organization independent, or part of a larger organization?

Type of Organization	2018
Sample Size	70
Independent	77%
Part of a larger company/organization	19%
Other	4%

F4. Do you own or rent your space?

Rent or Own Location	2018
Sample Size	70
Own	83%
Rent	10%
Other	6%

F5. How many business locations does your organization have in Nova Scotia?

Number of Locations	2015	2016	2017	2018
Sample Size	74	70	70	70
1-5	84%	83%	86%	77%
6 or more	12%	17%	11%	17%
Don't know	4%	-	3%	6%
Average	3.1	5.0	4.4	4.9
Don't know/Refused excluded from calculations				

APPENDIX III

BER: MAIL-IN INTERVIEW GUIDE WITH CONTRACTORS

Instrument Information

Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	In-depth interview
Estimated Time to Complete	30 minutes
Population Description	Contractors familiar with the mail-in rebate program
Sampling Strata Definitions	None
Contact List Source and Date	Efficiency Nova Scotia
Fielding Firm	Research Into Action staff

Program Description: BER

The Business Energy Rebates (BER) program provides financial incentives, through prescriptive rebates or financing, to Business, Non-Profit and Institutional (BNI) clients to reduce electrical energy consumption and demand.

There are two paths to participation:

- 1) Instant (in-store) rebates are available on energy efficient lighting and pumping products at participating electrical distributors. Rebates are automatically deducted from the invoice amount, when customers purchase products from any **Efficiency Partners in Nova Scotia**. In 2017, there were 315,867 products sold through the program that generated 30.8 GWh of savings.
- 2) Mail-in rebates allow customers to submit documentation of their eligible equipment post installation and receive rebates. They must submit required documentation within 90 days of installation. In 2017, there were 288 mail-in projects that generated 15.8 GWh of savings.

Instrument

Name:

Date:

Interviewer:

Thanks for taking the time to talk today. I work for Research Into Action, a subcontractor to Econoler, and we have been asked by Efficiency Nova Scotia to conduct the process evaluation for the Business Energy Rebates (BER) program. *[If needed: the BER program is the prescriptive program that provides financial incentives to end-users for installing energy efficient equipment within 90 days of installation.]* As part of that, we are interviewing contractors such as yourself, so we can make sure we understand how the program is working for you and your customers. We are particularly interested in learning about how the BER program relates to other ENS programs and about what can be done to encourage interest in program measures, especially non-lighting measures like pumps and heating and cooling equipment.

Our talk will take about 20-30 minutes.

Everything you say is confidential. We won't share our notes from the conversation unless we are legally required to, and we will not report findings in a way that would identify any individual respondent. I'll be taking notes as we talk, but I'd also like to record the call, just to help with my notetaking. Is that OK with you?

Do you have any questions before we get started?

Email

Hello [CONTRACTOR]

I work for Research Into Action and we are working with Efficiency Nova Scotia to conduct the process evaluation for their Business Energy Rebates (BER) program. As you may know, the BER program is the prescriptive program that provides financial incentives to end-users for installing energy efficient equipment within 90 days of installation. As part of that, we are interviewing contractors such as yourself, so we can make sure we understand how the program is working for you and your customers.

We are particularly interested in learning about how the BER program relates to other ENS programs and about what can be done to encourage interest in program measures, especially non-lighting measures like pumps and heating and cooling equipment.

Are you available to talk for about 30 minutes during one of the times indicated below?

ADT	Wed. 10/17	Thurs 10/18	Fri 10/19	Mon 10/29	Tues 10/30	Wed 10/31	Thurs 11/1	Fri 11/2
10 – 11 AM								
11 AM-12 PM								
12-1 PM								
1-2 PM								
2-3 PM								
3-4 PM								
4-5 PM								
5-6 PM								

Everything you say is confidential. We won't share our notes from the conversation unless we are legally required to, and we will not report findings in a way that would identify any individual respondent. I'll be taking notes as we talk, but I'd also like to record the call, just to help with my notetaking. Is that OK with you?

Do you have any questions before we get started?

Roles, Responsibilities, and Background

[ASK ALL]

Q1. Let's start with a bit about you. Can you please tell me your title and briefly describe your role with your company?

[ASK ALL]

Q2. What kind of organization do you represent?

[MULTIPLE response]

1. Lighting or electrical contractor
2. HVAC contractor
3. Building shell contractor (insulation, doors, windows, air sealing)
4. Industrial processes
5. Compressed air
6. Plumber
7. General contractor

[Do not read:]

96. Other, please specify: [Open-ended response]
98. Don't know
99. Refused

[ASK ALL]

Q3. How long have you been with your firm?

[ASK ALL]

Q4. When did you first learn about the BER Mail-in program?

[ASK ALL]

Q5. How did you first learn about the BER Mail-in program?

Interest in Non-lighting Measures [ASK IF Q2<>1]

I would like to talk with you about what you think can be done to generate more interest in the program, especially in generating interest in non-lighting measures.

[ASK IF Q2 <>1]

Q6. What type of BER program measures do you promote to your customers?

[ASK IF Q2 <>1]

Q7. Are there certain measure types that you avoid promoting? Why?

[ASK IF Q2 <>1]

Q8. Of all your projects in the last year, what percent use non-lighting program eligible measures?

[ASK IF Q2 <>1]

Q9. Of all your projects in the last year, what percent received program incentives?

[ASK IF Q8 <> Q9]

Q10. In what instances do you install non-lighting program eligible measures without receiving incentives?

[ASK IF Q2 <>1]

Q11. What, if anything, keeps you from completing more non-lighting program eligible projects?

[ASK IF Q2 <>1]

Q12. What types of customers or market segments (restaurants, office, etc.), if any, are underrepresented in the BER mail-in program? Why do you say that?

[ASK IF RESPONDENT IDs UNDER REPRESENTED MARKET SEGMENTS]

Q13. What can be done to encourage these market segments to participate in the program?

[ASK IF RESPONDENT IDs UNDER REPRESENTED MARKET SEGMENTS]

Q14. What type of measures or equipment do you think would appeal to these market segments?

[ASK IF Q2 <>1]

Q15. LED lighting measures are increasingly becoming more popular among the BNI sector and they increasingly need smaller rebates to drive interest in their adoption. What non-lighting measures or services should ENS and the BER program be looking to promote in place of lighting measures?

[ASK IF Q2 <>1]

Q16. For each of the following measure types, over the last year, what percentage do you sell through the ENS BER Mail-in program, and what percentage are sold without any incentives? If you do not sell a type of equipment, please let me know.

Measure Types	Percent Sold Through BER Mail-in	Percent Sold Without Incentives	Total	Not applicable
Compressed air equipment			100%	q
Heating equipment			100%	q
Refrigeration equipment			100%	q
Kitchen equipment			100%	q
Agricultural equipment			100%	q
Water heating			100%	q
Other, specify: _____			100%	q

[ASK IF Q2 <>1]

Q17. Which of the following measure types, if any, do you see an opportunity to increase the percentage that you sell that go through the ENS program? Why do you see this an opportunity? *[If needed: Are the incentives too low, Not enough knowledge about the efficiency of these measures, something else?]*

Measure Types	Opportunity	Not applicable
Compressed air equipment		q
Heating equipment		q
Refrigeration equipment		q
Kitchen equipment		q
Agricultural equipment		q
Water heating		q
Other, specify: _____		q

[ASK IF Q2 <>1]

Q18. On a scale of one to ten where one is do not agree at all and 10 is highly agree, how much do agree with each of the following statements? If you do not know about a measure, please let me know.

- 1 The incentives for compressed air equipment are sufficient to motivate most contractors to purchase them over standard equipment
- 2 The incentives for heating equipment are sufficient to motivate most contractors to purchase them over standard equipment
- 3 The incentives for refrigeration equipment are sufficient to motivate most contractors to purchase them over standard equipment
- 4 The incentives for kitchen equipment are sufficient to motivate most contractors to purchase them over standard equipment
- 5 The incentives for agricultural equipment are sufficient to motivate most contractors to purchase them over standard equipment
- 6 The incentives for water heating equipment are sufficient to motivate most contractors to purchase them over standard equipment

BER Mail-in Connections with Other ENS Programs and Services

[ASK IF Q2=1]

[ASK IF Q2=1]

Q19. Other than BER Mail-in, what other ENS programs, if any, do you have experience with?

[ASK IF NOT SPECIFIED IN Q19]

Q20. Are you familiar with the BER Instant Rebate program? *[If needed: This is the program that provides incentives to lighting and pump distributors to offered discounted equipment to contractors.]*

[ASK IF USE OTHER ENS PROGRAM]

Q21. How, if at all, do you promote the BER Mail-program to customers using other ENS programs?

[ASK IF Q2=1]

Q22. How does BER mail-in participation influence your customer's participation in other ENS programs? Do you have any examples or data that explain this influence?

[ASK IF Q2=1]

Q23. Is there an opportunity to connect the BER mail-in service to other ENS programs or services better? How would that work and what would it do for each program(s)?

[ASK IF Q2=1]

Q24. Generally, how aware are end-use customers that they are getting an incentive from ENS for buying energy efficient equipment through the BER Mail-in program?

[ASK IF Q13 or Q14 SHows respondent AWARE OF INSTANT REBATE PROGRAM]

Q25. You noted earlier that you are aware of ENS's Instant Rebate program. This is the program that provides discounts on efficient lighting and pumps when purchased from a participating distributor. How often do you purchase products through the Instant Rebate program?

[ASK IF Q13 or Q14 SHows respondent AWARE OF INSTANT REBATE PROGRAM]

Q26. If a project could go through the Instant Rebate program or the Mail-in program, which would you recommend to your customer and why?

[ASK IF Q2 =1]

Q27. For each of the following lighting types, over the last year, what percentage do you sell through the ENS BER Mail-in program, what percentage do you sell through the BER Instant Rebate Program, and what percentage are sold without any incentives?

Measure Types	Percent Sold Through BER Mail-in	Percent Sold Through BER Instant Rebates	Percent Sold Without Incentives	Total	Not applicable
Linear LED Fixtures				100%	q
LED Downlight Fixtures				100%	q
LED Linear Lamps				100%	q
General Use Decorative LED Lamps				100%	q

Successes, challenges, and opportunities with BER Mail-in

I have a few closing questions about the BER program.

[ASK ALL]

Q28. What do you see as key successes of the BER mail-in service over the last year?

[ASK ALL]

Q29. What are the key challenges the BER mail-in service faces?

[ASK ALL]

Q30. Is there anything else about the program that we have not discussed that you feel should be mentioned?

That is all the questions I have. Thanks for your time.

APPENDIX IV BER: MAIL-IN ON-SITE VISIT SAMPLING METHODOLOGY AND PROTOCOL

Sampling Methodology

The 2018 BER sample covered 78 projects, with six projects being counted in more than one measure category. These visits were rolled out as a first sample of 47 and a second sample of 31. The plan for the first sample was developed based on the July 2018 tracking sheet that included all completed projects to date. This tracking sheet contained a total of 219 projects implemented by a total of 142 participants. Both the laundry and solar measure categories were not included in the July 2018 tracking sheet. The Evaluator calculated the square root of tracked savings and used these percentages to determine the sample size per measure category.

The second sample was calculated in the same manner as the first sample, although by using an updated tracking sheet from September 2018. The second sample was based on the 285 projects completed up to that date. The results of the final sample calculations are summarized in Table 1 below. The lighting, motors and drives, and HVAC measures were the focus of the majority of visits since these measure categories comprised 73 percent, 12 percent and 8 percent respectively of total tracked savings in the BER Mail-in September tracking sheet.

Table 1: Total Number of Projects and Tracked Savings Used for Final On-site Visit Sampling¹

Measure Category	Tracked Savings ²		Target Sample Size ³	First Sample Size	Second Sample Size	Actual Sample Size ⁴
	kWh	Square Root % of Savings	n	n	n	n
Agriculture Technologies	402,873	6.9%	5	3	2	5
Compressed Air	79,635	3.1%	2	2	0	2
HVAC	1,701,768	14.1%	11	6	5	11
Commercial Kitchen	167,841	4.4%	4	2	2	4
Commercial Laundry	0	0%	0	0	0	0
Commercial Lighting	14,702,886	41.5%	34	21	13	34
Commercial Water Pumping	25,925	1.7%	1	2	0	2
Commercial Refrigeration	611,401	8.5%	7	6	2	8
Solar Thermal	0	0%	0	0	0	0
Motors and VSDs	2,429,232	16.9%	14	9	6	15
Water Heating Technologies	72,862	2.9%	2	1	1	2
Total	20,194,424	100.0%	80	52	31	83

In total, the Evaluator reviewed 83 individual projects. The actual samples were larger than the target samples in three categories since some visits served to revise measures in more than one measure category.

On-site Visit Protocol

The on-site visit protocol was only slightly modified from the 2017 BER protocol since eligible measures were similar. The main change for 2018 was adding columns to input the tracked values in addition to the values validated on-site. The Evaluator also added a column to note the age of replaced equipment to indicate if such equipment had reached its effective useful life. Each measure category contains a general section for project information common to all measures, as well as sections on measure-specific variables. The general section documents the facility type and contact information. The measure-specific data sections provide the parameters required for the savings calculations, based on the data documented in the 2018 CIRx Screening Tool v1.34, and completed with the information gathered on-site. These data consist of, but are not limited to, measure types, quantity, model number, wattages or capacity, runtime hours, and operation during the peak demand period. Most fields in the protocol were filled out prior to on-site visits with the information in the project documentation provided by ENS to allow the Evaluator to only record additional details if on-site conditions did not match the tracked information.

¹ As of December 2018, when the site visits were completed.

² As of September 2018, when the second sample was selected.

³ Calculated using each measure category percentage of tracked savings as of September 2018.

⁴ As of December 2018, when the site visits were completed.

On-Site Visit Protocol
1. General Information

Person conducting the visit:			
Date of visit:			
Project Name:			
Project Tracking sheet #:			
Company Name:			
Contact Name:			
Address:			
Telephone:			
Type of facility:	Retail:	☐ Manufacturing/ Industrial:	☐ Grocery/ Supermarket: ☐
	College/ University:	☐ Multi-Unit Res.:	☐ Other (Specify): ☐
Name of Contact Met with:			
Operation during Peak Period (b/w 5-7pm in Dec/Jan/Feb)?		Yes ☐	No ☐
If "yes", determine % Load Operational During Peak Period:			
Project Type:	Early Replacement ☐	End of Useful Life ☐	New / No Replacement ☐
Year existing equipment was installed (if applicable)			
Spillover Questions Completed:		Yes ☐	No ☐
Process Questions Completed:		Yes ☐	No ☐

Notes:

2. Building Heating/Cooling System Description

Heating Systems:

Please fill the table below for each heating system at the site

	Heating system 1	Heating system 2
Heat source		
% of heat		
Type of system		

Cooling Systems:

Please fill the table below for each cooling system at the site

	Cooling system 1	Cooling system 2
% of cooling		
Type of system		
If no prior AC, was AC install planned before HP?		
Secondary Systems changed after HP? (If yes, add system details to notes)		

Notes:

3. Facility Operation Hours and Lighting Usage

Business Hours (Mon-Fri)	
Open Weekends?	
Business Hours Weekends	
Staff Early open	
Staff Late Close	
Cleaning Hours per Week	
Days/yr with no occupancy (i.e holidays or weekends)	
Working Days	
Annual HOU	
Are heating/cooling systems setback during unoccupied times?	
Notes	

**Normal week/holidays lighting
operation schedule (hours per day):**

Please fill the table below for each lighting schedule reported by the site contact as usage could vary for each section of the facility. Use additional sheets if necessary.

Weekday - Hours/Day with Regular Schedule	Weekend - Hours/Day with Regular Schedule	Hours/Day with Holiday Schedule	Hours/Day with No Occupancy	Notes

Notes:

4. Measures information

Lighting : *Collect the information in the table below if lighting measures were installed. Use on-site observation and contact declaration. Use additional sheets if required. Econoler will then compare the information collected with the information in the tracking sheet.*

Is cooling installed in the section with the lighting measure?	☐ Yes ☐ No
Is heating installed in the section with the measure?	☐ Yes ☐ No
The percentage of lighting that remains on when the facility is closed:	
Validate if lamps are still installed and not burnt:	
If some are burnt or missing, indicate how many:	
When was the lamp removed or when did it burn?	
Is the facility manager planning to have them replaced?	
If, not why?	
Is Lighting Installed Inside, Outside, or in a refrigerated area?	
Are lights used seasonally?	
Explain if Quantity Found Onsite Differs from that Indicated in the Tracking Sheet:	
Notes (Occupancy sensor?)	

	Tracking Sheet	On-Site Validation
Location		
Baseline Equipment		
Type		
Quantity		
Wattage/Unit		
New Equipment Installed		
Type		
Quantity		
Wattage/Unit		
Notes:		

Additional information captured in the Notes sections of the protocol varies by category type, but may include any of the following:

- › Number of lamps per fixture and length of lamps for linear measures.
- › If existing strips were T12 HO, indicate length.

Motors and VFDs:
Motors :

	Existing Equipment		New Equipment	
	Tracking sheet	Validation on-site	Tracking sheet	Validation on-site
Location				
Motor Type				
HP Rating				
Nameplate Efficiency				
Hours/wk Runtime				
Function				
Speed (RPM)				
Quantity				
Difference (Y/N)				
Explanation if different:				
Does the new motor operate at least 2,000 hours a year?				
Is the new motor controlled by a VSD?				
Is the new motor operational?				
If not, explain.				
Notes:				

VFDS:

	Tracking Sheet	Validation On-site
Location		
Equipment Controlled by VSD		
Existing Control Method		
Manufacturer		
Model Number		
Usage - Hours/yr		
Quantity		
Difference		
HP of Motor Controlled by VSD		
Explanation if different:		
Is the VSD currently operational?		
If not, explain.		
Was the VSD commissioned? Y/N		
Describe how the VSD reduces energy consumption and demand		
Notes:		

HVAC:

Total number of AC & Air-Source Heat Pumps (Split & Unitary) installed: _____

Total number of Ground & Water Source Heat Pumps installed: _____

Are there any other heating and cooling systems than the ones
being replaced/installed? (note % of heating/cooling being provided) _____

	Existing Equipment		New Equipment	
	Tracking Sheet	Validated On-Site	Tracking Sheet	Validated On-Site
AC & Air-Source Heat Pumps				
Location on site:				
Manufacturer:				
Model number:				
Number of units				
Space heating source (electricity, fuel, etc.):				
HSPF V (HSPF IV x 1.15)				
Seasonal Energy Efficiency Ratio (SEER):				
Energy Efficiency Ratio (EER):				
Nominal kBtu/h per unit:				
Full Load Hours per year:				
Capacity (tons or kBTU/hr)				
kBTU/unit conversion				
Validate if the HVAC systems are properly installed and still operational:				
If no, why, and since when?				
Is unit < 65kBTUh? (Y/N):				
Capacity @ 5F (kBTU/hr)				
COP @ 5F				
Notes:				

	Existing Equipment		New Equipment	
	Tracking Sheet	Validated On-Site	Tracking Sheet	Validated On-Site
ASHP > 65 BTU/h, Ground & Water Source Heat Pumps, Air-To Water Heat Pumps				
Manufacturer:				
Model number:				
Quantity of units:				
Explain if quantity is different:				
Heat source (Electricity or other (specify)):				
Specify if open or closed loop:				
Specify if water-to-air, water-to-water, or air-to-water:				
Energy Efficiency Ratio (EER):				
Coefficient Of Performance (COP):				
Nominal heating capacity [kBtu/h]:				
Nominal cooling capacity [kBtu/h]:				
Hours of use for equipment (Indicate the corresponding schedule number for each section):				
Heating set point and setback (if any) temperature [°C] :				
Cooling set point and setback (if any) temperature [°C] :				
Validate if the HVAC systems are properly installed and still operational:				
If no, why, and since when?				
Notes:				

HVAC Hotel Occupancy Sensor

Existing control:

Is HVAC system <65kBTU/h?

Manufacturer:

Model number:

Quantity:

Explanation if quantity is different:

With building integrated control? [Y/N]:

Number of hotel rooms:

Typical vacancy rate:

Are occupancy sensors operational?

Dual Enthalpy Economizer Controls

Existing control:

HVAC system size:

Manufacturer:

Model number:

Quantity:

Explanation if quantity is different:

With building integrated control? [Y/N]:

EER:

Operational Testing Completed?:

Refrigeration:

	Tracking Sheet	Validation On-site
ECM Measure		
Location:		
kW of Evap fan:		
Quantity:		
Explanation if quantity is different:		
Is fan inside low, med or high temp cooler?:		
Any issues with fans?		
Strip-curtains, Cooler night covers, Open to closed cooler Conversion		
Manufacturer		
Model number		
Quantity of open case only [ft]:		
Explanation if quantity is different:		
Low, Medium or High Temp Cases?		
Number of hours/day that case cover/strip curtain is used:		
If open-to-closed measure, confirm anti-sweat heaters (Y/N):		
Zero-energy doors and frames		
Manufacturer		
Model number		
Low, Medium or High Temp?		
Quantity of Doors:		
Explanation if quantity is different:		
Control Measures:		
Manufacturer		
Model number		
Quantity of controllers:		
Explanation if quantity is different:		
Quantity of Doors Controlled:		
Explanation if quantity is different:		
Number of Evaporator Fans:		
kW of Defrost Element per Evap Fan:		
Low, Medium, or High Temp?		
Humidity or Conductivity based Control?		
Is there a circulating fan inside cooler?		

	Tracking Sheet	Validation On-site
Refrigeration Compressor		
Manufacturer:	_____	_____
Model Number:	_____	_____
Compressor Size (btu/h):	_____	_____
Compressor Type (scroll, discus):	_____	_____
Low, Medium, or High Temp?	_____	_____
Cooler Volume:	_____	_____
Replacing hermetic or semi-hermetic?	_____	_____
Is this new construction (Y/N)?	_____	_____
Refrigerant Type:	_____	_____
EER:	_____	_____
Outside air economizers for walk-in coolers		
Manufacturer:	_____	_____
Model Number:	_____	_____
Quantity:	_____	_____
Explanation if quantity is different:	_____	_____
Cooler Volume:	_____	_____
Quantity of Economizers:	_____	_____
Explanation if quantity is different:	_____	_____
Compressor Type	_____	_____
Compressor Size (HP)	_____	_____
Floating Heat Pressure Control?	_____	_____
Quantity of evaporator fans:	_____	_____
Recirc. Fan inside cooler?	_____	_____
Evap Fan Control?	_____	_____
Cooler temperature setpoint	_____	_____
kW of Economizer Fan:	_____	_____
Refrigerated vending machine controllers		
Manufacturer:	_____	_____
Model Number:	_____	_____
Quantity:	_____	_____
Explanation if quantity is different:	_____	_____
Notes:		

Agriculture: *Collect the information in the table below **if agriculture measures were installed**. Use on-site observation and contact declaration. Use additional sheets if required. The information collected will then be compared with the information in the tracking sheet by Econoler. Additionally, record Manufacturer and Model Number, and all Technical Data (Operating Temp, CFM, Size, Control Info)*

Tracking Sheet Validation On-site

High Efficiency Fans – High Volume Low Speed, Ventilation, Circulation

Type (HVLS or vent/circ)?	_____	_____
Location	_____	_____
Manufacturer:	_____	_____
Model Number:	_____	_____
Quantity:	_____	_____
Explanation if quantity is different:	_____	
If not, why and since when?	_____	
Fan diameter [ft]:	_____	_____
Fan Power:	_____	_____
Airflow (Vent/Circ only):	_____	_____
Hours of use [hr/yr]:	_____	_____

Dual & Natural Ventilation

Type (Dual or natural)?	_____	_____
Facility type:	_____	_____
Barn Hours of Use:	_____	_____
Livestock Capacity:	_____	_____
Explanation if quantity is different:	_____	

Livestock Waterer

Type (Low or Zero energy):	_____	_____
Location	_____	_____
Old Heater Wattage [W]:	_____	_____
New Heater Wattage [W]:	_____	_____
Hours of operation:	_____	_____
Quantity:	_____	_____
Explanation if quantity is different:	_____	

Agriculture heat pad

Location	_____	_____
Quantity:	_____	_____
Explanation if quantity is different:	_____	
Heat Pad Wattage [W]:	_____	_____
Heat Lamp Wattage [W]:	_____	_____
Hours of operation:	_____	_____

	Tracking Sheet	Validation On-site
Engine block heater timer		
Quantity:		
Explanation if quantity is different:		
Engine block heater wattage [W]:		
Hours per night:		
Timer active hours:		
Dairy scroll compressor		
Location		
Manufacturer:		
Model Number:		
Quantity:		
Explanation if quantity is different:		
Compressor HP:		
Hours of Operation per day:		
Number of cows milked per day (and # of dry cows):		
Does it Replace an Existing Compressor?		
Confirm cooling temp (1-13C)? (Y/N)		
Milk pre-cooler/heat recover – Number installed:		
Location		
Product type		
Number of cows milked per day (and # of dry cows):		
Hours/Day Equipment Operates:		
If HRU – did it replace electric water heater?	Yes	☐ No
If Pre-Cooler - did it replace existing unit?		☐
VSD on milk vacuum pump – Number installed:		
Location		
Number of cows milked/day:		
Milking setup (parlor, stanchion or tie stall):		
Pump type (rotary vane or blower):		
Pump Motor HP:		
Pump motor efficiency:		
Quantity:		
Explanation if quantity is different:		
Milking hours/day (excluding wash time):		
Milk at least 50 cows? (Y/N):		
Pump motor > 5 HP? (Y/N):		
Does it replace a pre-existing VSD? (Y/N):		

Compressed Air: *Collect the information in the table below **if compressed air measures were installed**. Use on-site observation and contact declaration. Use additional sheets if required. The information collected will then be compared with the information in the tracking sheet by Econoler. Additionally, record Manufacturer and Model Number, and all Technical Data (Operating Temp, CFM, Size, Control Info)*

	Tracking Sheet	Validation On-site
Cycling refrigerated air dryer		
Manufacturer:		
Model Number:		
Compressor HP Rating:		
Dryer Capacity (CFM):		
Quantity installed: Verify <300 cfm capacity		
Explanation if quantity is different:		
Compressor operation [hr/week]:		
Is the new dryer operational? If not, explain		
Is dryer <600CFM capacity? Y/N		
VSD screw compressor		
Location		
Manufacturer:		
Model Number:		
Quantity Installed:		
Is the equipment still used?		
If not, why?		
Hp rating [hp]: Verify < 40 hp		
Compressor operation [hr/week]:		
Air-entraining air nozzle		
Location		
Manufacturer:		
Model Number:		
Quantity Installed:		
Is the equipment operational?		
If not, explain?		
Compressor control type:		
Capacity [cfm]: Verify <14cfm @100psi		
Compressor operation [hr/week]:		

	Tracking Sheet	Validation On-site
No-loss drain		
Location		
Quantity Installed:		
Manufacturer:		
Model:		
Is the equipment operational?		
If not, explain?		
Compressor type:		
System pressure [psi]:		
Orifice Diameter (Inches):		
Compressor operation [hr/week]: Timer?		
Air tank for load / No-load screw compressor		
Location		
Manufacturer		
Quantity Installed:		
Is the equipment operational?		
If not, why and since when?		
Compressor type:		
Compressor hp rating [hp]:		
Compressor capacity [CFM]:		
Air receiver tank size [gallons]:		
Compressor operation [hr/week]:		
Notes :		

Kitchen: *Collect the information in the table below **if commercial kitchen measures** were installed. Use on-site observation and contact declaration. Use additional sheets if required. The information collected will then be compared with the information in the tracking sheet by Econoler. Additionally, record Manufacturer and Model Number, and all Technical Data (Operating Temp, CFM, Size, Control Info)*

	Tracking Sheet	Validation On-site
Commercial Dish Washers		
Quantity Installed:		
Location:		
Product type		
Manufacturer:		
Model number:		
Is the equipment used for commercial purpose?		
Is the equipment still used?		
If not, why and since when?		
High or low temp?		
Validate the equipment is ENERGY STAR certified:		
Booster water heater fuel type (if applicable):		
DHW heating source:		
Operation [days/year]:		
Operation [number of racks washed/day]:		
Commercial Fryers		
Standard capacity commercial fryer		
Quantity Installed:		
Location:		
Manufacturer:		
Model number:		
New fryer efficiency:		
New fryer idle energy rate:		
Specify if electric or gas?		
Does it replace an electric fryer?		
Is the equipment still used?		
If not, why and since when?		
Validate the equipment is ENERGY STAR certified:		
Operation [days/year]:		
Operation [hours/day]:		

	Tracking Sheet	Validation On-site
Commercial Hot Food Holding Cabinet		
Manufacturer:		
Model Number:		
Quantity:		
Explanation if quantity is different:		
Validate the equipment is ENERGY STAR certified:		
Interior Volume (ft ³)		
Is the equipment still used?		
If not, why and since when?		
Operation [days/year]:		
Operation [hours/day]:		
Commercial Griddles		
Location		
Product Type		
Manufacturer		
Model Number		
Width Installed (ft):		
Quantity:		
Explanation if quantity is different:		
Specify if electric or gas?		
Does it replace an electric griddle?		
Is it a new installation?		
Is the equipment still used?		
If not, why?		
Validate the equipment is ENERGY STAR certified:		
Griddle efficiency		
Griddle Idle Energy Rate		
Operation [days/year]:		
Operation [hours/day]:		
Commercial Refrigeration/Freezer		
Location		
Manufacturer:		
Model Number:		
Volume (ft ³)		
Quantity:		
Explanation if quantity is different:		
Product type		

	Tracking Sheet	Validation On-site
Validate the equipment is ENERGY STAR certified:		
Is the equipment still used?		
If not, why?		
Commercial Ice Makers		
Ice making head		
Location		
Quantity Installed:		
Product Type		
Manufacturer:		
Model number:		
Harvest [lbs/day]:		
Is the equipment still used?		
If not, why and since when?		
Does it replace non- certified ENERGY STAR icemaker?		
Validate the equipment is ENERGY STAR certified:		
Remote condensing unit		
Quantity Installed:		
Product type		
Manufacturer:		
Model number:		
Harvest [lbs/day]:		
Is the equipment still used?		
If not, why and since when?		
Does it replace non- certified ENERGY STAR ice maker?		
Validate the equipment is ENERGY STAR certified:		
Self-contained		
Quantity Installed:		
Product type		
Manufacturer:		
Model number:		
Harvest [lbs/day]:		
Is the equipment still used?		
If not, why and since when?		
Does it replace non- certified ENERGY STAR ice maker?		
Validate the equipment is ENERGY STAR certified:		

	Tracking Sheet	Validation On-site
Steam Cookers		
Quantity Installed:		
Location:		
Manufacturer:		
Model number:		
Product Type:		
Operation Days/yr:		
Operation Hours/yr:		
Number of pans per unit:		
Number of pans per day:		
Explanation if different:		
Validate the equipment is ENERGY STAR certified:		
Commercial Convection Ovens		
Location:		
Manufacturer:		
Model number:		
Product Type:		
Quantity Installed:		
Hours oven is operating:		
Preheats per day:		
Explanation if different:		
Specify if electric or gas:		
Specify if full size or half size:		
Is the equipment still used?		
If not, why and since when?		
Does it replace an electric convection oven?		
Is it a new installation?		
Validate the equipment is ENERGY STAR certified:		
Griddles		
Location:		
Manufacturer:		
Model number:		
Quantity Installed:		
Validate the equipment is ENERGY STAR certified:		
Operation [days/year]:		
Operation [hours/day]:		
Size (Feet)		

	Tracking Sheet	Validation On-site
Is the equipment still used?		
If not, why?		
Commercial Kitchen Ventilation Hoods		
VSD for kitchen exhaust fans		
Location		
Manufacturer:		
Model number:		
Quantity Installed:		
Explanation if quantity is different:		
Equipment Controlled by VSD:		
Existing Control Method		
Hours of use:		
Size of the motor controlled by the VSD [hp]:		
Explanation if different:		
Is the equipment still used?		
If not, why?		
Is the equipment controlled by T° and optical sensors located in exhaust hood?		
Was VSD commissioned? [Y/N]:		
Notes:		



Laundry: *Collect the information in the table below **if commercial laundry measures** were installed. Use on-site observation and contact declaration. Use additional sheets if required. The information collected will then be compared with the information in the tracking sheet by Econoler. Additionally, record Manufacturer and Model Number, and all Technical Data (Operating Temp, CFM, Size, Control Info)*

	Tracking Sheet	Validation On-site
Water heating source:		
Commercial Washing Machines Installed		
Location		
Quantity Installed:		
Manufacturer:		
Model number:		
Size [cubic feet/unit]:		
Is the equipment used for commercial purpose?		
Water heating source:		
Is the equipment still used?		
If not, why?		
Validate the equipment is ENERGY STAR certified:		
Operation [cycles/week]:		
Notes:		

APPENDIX V

BER: INSTANT REBATES PARTICIPANT SURVEY QUESTIONNAIRE

INTRODUCTION A – Business with a contact name

Could I speak with [INSERT NAME]?

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

Hello, I am with Corporate Research Associates, and we are performing an evaluation of energy efficiency services provided by Efficiency Nova Scotia. Our records indicate that you or your organization recently participated in Efficiency Nova Scotia’s Business Energy Rebates Program by purchasing rebated [PRODUCT] at a participating distributor.

- I1. Are you the person in your organization who is most knowledgeable about the decision to purchase these [PRODUCT] from [DISTRIBUTOR] in 2018.
 1. Yes (Go to I3)
 2. No (Go to I2)
- I2. Is there someone else in your organization who would know about the decision to purchase these [PRODUCT]? [Probe if respondent is unsure who best to forward the call to. This individual may be an engineer, equipment contractor, or utility account manager].
 1. Yes (Ask for name: _____ and telephone #: _____) (Ask to speak to that person and restart at introduction. If other person is unavailable, thank, terminate, record data and schedule interview with best contact)
 2. No (Thank, terminate, record and keep data)
- I3. Did you purchase these products for your own organization, or are you a company purchasing products for a client or project outside of your organization? [ALLOW ONE RESPONSE ONLY]
 1. I purchased them for my organization
 2. I purchased them for a client or project outside of my organization/I am a contractor
 3. Other, please specify (if both, select option 1)
 98. Don’t know
 99. Refused

14. We would appreciate your help in answering questions about these products and your participation in this program. The information you provide will help Efficiency Nova Scotia improve its program. The survey will take about 10 minutes to complete. Is now a good time to conduct this survey?
1. Yes (Continue)
 2. No [ASK "Can we schedule a more convenient time for you to conduct this survey?"]
[SCHEDULED, IF NECESSARY, FOR: _____]

INTRODUCTION B – Business with no contact name

Hello, I am with Corporate Research Associates, and we are performing an evaluation of energy efficiency services provided by Efficiency Nova Scotia. Our records indicate that you or your organization recently participated in Efficiency Nova Scotia's Business Energy Rebates Program by purchasing rebated [PRODUCT] at a participating distributor.

15. Could you help us identify the person who is most knowledgeable about the decision to purchase these products? [Probe if respondent is unsure who best to forward the call to. This individual may be an engineer, equipment contractor, or utility account manager].
1. Yes, the person is available (Ask for name: _____ and telephone #: _____) (And ask to speak to this person – Go back to Intro A)
 2. Yes, but the person is unavailable (Ask for name: _____ and telephone #: _____) (Thank and terminate; schedule call back to speak to that person)
 3. No (Thank and terminate)

Program Awareness and Participation (P Series)

- P1. [ASK IF CONTRACTOR (I3=2)] Who usually makes the decision to buy [PRODUCT] rather than standard [STANDARD PRODUCT]? Is it... [READ, CODE ONLY ONE]
1. You (or your organization) (Go to P3a)
 2. Your client
 98. Don't know
 99. Refused
- P2. [ASK IF P1=2 or 98] Before making the decision to purchase [PRODUCT], do clients usually ask for your advice? [CODE ONLY ONE]
1. Yes (Go to P3a)
 2. No (Go to P7a)
 98. Don't Know
 99. Refused

- P3a. [ASK IF I3=1, P1=1 OR P2=1] What was the SINGLE most important reason you purchased [PRODUCT] rather than standard [STANDARD PRODUCT]? [RECORD RESPONSE]
1. (Specify: _____)
 98. (Don't know)
 99. (Refused)
- P3b. [DO NOT POSE IF 98 OR 99 IN P3a] What was the SECOND most important reason you purchased [PRODUCT] rather than standard [STANDARD PRODUCT]? [RECORD RESPONSE]
96. No other reason
- P4. [ASK ALL] Did your distributor recommend [PRODUCT] to you? [CODE ONLY ONE]
1. Yes
 2. No
 98. (Don't know)
 99. (Refused)
- P5. [ASK ALL] Were you aware that the [PRODUCT] you purchased were premium products certified by Design Light Consortium or ENERGY STAR®? [CODE ONLY ONE]
3. YES
 4. NO
 98. (DON'T KNOW)
 99. (Refused)
- P6a. In the last year, did you also buy [STANDARD PRODUCT]? [CODE ONLY ONE]
1. Yes
 2. No
 98. Don't Know
 99. Refused
- P6b. [ASK IF YES IN P6a] What was the reason for buying [STANDARD PRODUCT] rather than [PRODUCT]?
Verbatim box
98. Don't know
- P7a. [ASK IF CONTRACTOR (I3=2)] For what type of project did you purchase the majority of the [PRODUCT]? Was it for a... [READ. CODE ONLY ONE]
1. New construction
 2. Replacement of existing fixtures or lamps
 98. (Don't know)
 99. (Refused)

- P7b. [ASK IF END-USER I3=1] For what type of project did you purchase the [PRODUCT] that you purchased through the Business Energy Rebates Program? Was it for a... [READ. CODE ONLY ONE]
1. New construction
 2. Replacement of existing fixtures or lamps
 98. (Don't know)
 99. (Refused)
- P7c. [ASK IF P7a or P7b=2] In what state were your existing fixtures or lamps when you decided to purchase the [PRODUCT]? Were they... [READ. CODE ONLY ONE]
1. Working but at the end of their useful life
 2. Working and not close to the end of their useful life
 3. Broken
 4. [DO NOT READ] Other, please specify
 98. Don't know
 99. Refused
- P8a. [ASK IF CONTRACTOR (I3=2)] and [PRODUCT=LED DOWNLIGHT FIXTURES OR GENERAL-USE AND DECORATIVE LED LAMPS] For what type of projects did you purchase the [PRODUCT] that you purchased through the Business Energy Rebates Program? Was it for... [READ. CODE ONLY ONE]
1. Residential projects
 2. Non-residential projects
 3. Both residential and non-residential projects
 98. Don't know
 99. Refused
- P8b. [ASK IF P8a=3] What percentage of the [PRODUCT] you purchased was for residential use? [RECORD NUMBER BETWEEN 0 AND 100. PROBE TO AVOID GETTING A RANGE]
1. (Specify: _____)
 98. (Don't know)
 99. (Refused)
- P9. [ASK ALL] Were you aware that you had received a rebate when purchasing these [PRODUCT]? [CODE ONLY ONE]
1. Yes (Go to P11)
 2. No
 98. (Don't know)
 99. (Refused)

10. [ASK IF P9=No or DK] I just want to make sure I understand – When you purchased [PRODUCT], you were unaware that a rebate was given to reduce the product's total cost? [CODE ONLY ONE]
1. Unaware of the rebate
 2. Aware of the rebate
 - 98 Don't know
 - 99 Refused
- P11. [ASK IF P9=Yes or P10=2] Were you aware that the rebate was offered by Efficiency Nova Scotia as part of its Business Energy Rebates Program? [CODE ONLY ONE]
1. Yes
 2. No
 98. Don't know
- P12. [ASK IF END-USER (I3=1)] How did you first become aware of the rebates available under Efficiency Nova Scotia's Business Energy Rebates Program? [DO NOT READ. CODE ONLY ONE]
1. Through my contractor
 2. Through my distributor
 3. Efficiency Nova Scotia staff contacted me about the program
 4. Efficiency Nova Scotia website
 5. Efficiency Nova Scotia promotion
 6. Past experience with another Efficiency Nova Scotia program
 96. Other, please specify
 98. Don't know
 99. Refused
- P13. [ASK ALL] The Business Energy Rebates Program also has a mail-in service where you apply for incentives to Efficiency Nova Scotia rather than to the distributor. Before today were you aware of this other service of the Business Energy Rebates program?
8. Yes
 9. No
 98. (Don't know)
 99. (Refused)
- P14. [ASK IF P13=YES] Why did you choose to participate in the Instant Rebates service of the Business Energy Rebates Program rather than the Mail-in service? [OPEN-ENDED RESPONSE. RECORD RESPONSE]
- 98 Don't know

Free-Ridership (FR Series)

FR1a. [ASK IF AWARE (P9=1 or P10=2)] Had you **already** decided to purchase [PRODUCT] **before** knowing that these products were rebated?

- 3. Yes
- 4. No
- 100. (Don't know)
- 101. (Refused)

FR1b. Had you **already** decided to purchase [PRODUCT] **before** knowing the price of those products?

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)
- 97 (Did not get any quotes)

FR3. Efficiency Nova Scotia offered a rebate for the purchase of efficient lighting products. If your organization had not received the rebate and the cost for each [PRODUCT] had been about \$[REBATE AVERAGE VALUE BY CATEGORY] higher, would you have paid the full cost of the [PRODUCT]? Please answer on a scale of 0 to 10, with a 0 indicating that you "Definitely **Would Not** Have Paid" and a 10 indicating that you "Definitely **Would Have** Paid." PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE

___ Response ___ 98 Don't Know ___ 99 Refused

[ASK FR3a-c IF AWARE OF REBATE (P9=1 or P10=2)]

READ FIRST TIME THROUGH ONLY: Now I would like to ask you to consider which actions your organization would have taken if the rebate had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is "Very Unlikely," and a 10 indicating that it is "Very Likely."

FR3a. If the rebate had not been offered, what is the likelihood that you would have purchased the exact same model of premium lighting products?

___ Response ___ 98 Don't Know ___ 99 Refused

FR3aa. [ASK IF P7c=2] If the rebate had not been offered, what is the likelihood that would you have kept your existing fixtures or lamps?

___ Response ___ 98 Don't Know ___ 99 Refused

FR3b. [ASK IF TOTAL MEASURE CATEGORY QTY>1] If the rebate had not been offered, what is the likelihood that you would have purchased exactly the same quantity of lighting products that you bought?

___ Response ___98 Don't Know ___99 Refused

FR3c. [ASK IF FR3≥5] If the rebate had not been offered, what is the likelihood that you would have postponed the purchase of the lighting products by at least one year?

___ Response ___98 Don't Know ___99 Refused

FR4. Using a scale from 0 to 10, where 0 means “No influence” and 10 means “Great influence”, please rate the influence of each of the following in your organization’s decision to purchase [PRODUCT].

Factor (READ AND RANDOMIZE)	Responses
a. ONLY SHOW IF P9=1 OR P10 =2 The program rebate	___ Response ___98 Don't Know ___99 Refused
b. [ASK IF P11=1] Information received by a program representative on high-efficiency lighting products	___ Response ___98 Don't Know ___99 Refused
c. Information received by a distributor on high-efficiency lighting products	___ Response ___98 Don't Know ___99 Refused
d. Prevalence of LED products among products that met your lighting requirements	___ Response ___98 Don't Know ___99 Refused

Cross-Influence (CI Series)

ASK ALL - READ AND ROTATE (CI1 + CI2a-c) AND (CI3 + CI4a-c) SEQUENCES

CI1. Before buying the rebated lighting products in [DATE], had your organization at any time in the past already participated in any other 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.

CI2a. [IF CI1=1] Your organization's previous participation in an Efficiency Nova Scotia program was a major factor in the decision to purchase [PRODUCT].

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

CI2b. [IF CI1=1] Because of your organization's previous participation in an Efficiency Nova Scotia program and what was learned by participating in the program, a company representative asked a contractor or a distributor about efficient lighting options for your facility.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

CI2c. [IF CI1=1] Because of your organization's previous participation in an Efficiency Nova Scotia program and what was learned by participating in the program, a company representative took into account the cost-effectiveness of [PRODUCT] when evaluating different options for your facility.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

CI3. Before participating in the Business Energy Rebates program, had you at any time in the past already seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

[READ IF CI3=1] For the following statements, please indicate whether you agree or disagree.

CI4a. [IF CI3=1] The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in the company's decision to purchase [PRODUCT].

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

CI4b. [IF CI3=1] The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to ask a contractor or a distributor about efficient lighting options for your facility.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

CI4c. [IF CI3=1] The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to take into account the cost-effectiveness of [PRODUCT] when evaluating different options for the facility.

- 1. Agree
- 2. Disagree
- 98. (Don't know)
- 99. (Refused)

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 BER: INSTANT REBATES PARTICIPANT SURVEY RESULTS

Note: Due to rounding, certain percentages in the tables of this appendix do not sum to 100 percent.

- I3. Did you purchase these products for your own organization, or are you a company purchasing products for a client or project outside of your organization??

Purchase for Contractor or End User	2018
Sample Size	50
I purchased them for my organization	60%
I purchased them for a client or project outside of my organization/I am a contractor	40%

- P1. Who usually makes the decision to buy [PRODUCT] rather than standard [STANDARD PRODUCT]? Is it...?

Purchase Decision-Maker	2018
Sample Size	20
Contractor (or their organization)	65%
Client	35%
Base: Contractors	

- P2. Before making the decision to purchase [PRODUCT], do clients usually ask for your advice?

Clients Seeking Purchase Decision Advice	2018
Sample Size	7 (#)
Yes	6
No	1
Base: Contractors whose client makes the purchase decision	

P3a. What was the SINGLE most important reason your organization chose to buy [PRODUCT] rather than a standard [STANDARD PRODUCT]?

P3b. What was the SECOND most important reason your organization chose to buy [PRODUCT] rather than a standard [STANDARD PRODUCT]?

Motivations for Buying Efficient Products	2018	
	Most Important Reason	Other Reasons*
Sample Size	49	49
Quality of efficiency products	29%	41%
To improve energy efficiency	27%	10%
Save on energy costs/bills	18%	14%
Reduce maintenance costs	8%	6%
Price of product	4%	6%
Availability of product/easier to get	2%	4%
Protect the environment	2%	-
Take advantage of program rebates	2%	2%
Update equipment	2%	-
What the customer/owner wanted	-	2%
Recommended by contractor	-	2%
Others	6%	2%
None/No other reason	-	10%
Base: Respondents who purchased products for their organization or who make the decision to buy efficient products, or before making the decision to purchase clients usually ask respondent for advice		
*Multiple Responses		

P4. Did your distributor recommend [PRODUCT] to you?

Distributor Recommended Product	2018
Sample Size	49
Yes	51%
No	43%
Don't know	6%
Base: Respondents who purchased products for their organization or who make the decision to buy efficient products, or before making the decision to purchase clients usually ask respondent for advice	

P5. Were you aware that the [PRODUCT] you purchased were premium products certified by Design Light Consortium or ENERGY STAR®?

Aware Product was Certified by Design Light Consortium or ENERGY STAR	2018
Sample Size	49
Yes	67%
No	31%
Don't know	2%
Base: Respondents who purchased products for their organization or who make the decision to buy efficient products, or before making the decision to purchase clients usually ask respondent for advice	

P6a. In the last year, did you also buy [STANDARD PRODUCT]?

Bought Standard Products in Past Year	2018
Sample Size	49
Yes	33%
No	63%
Don't know	4%
Base: Respondents who purchased products for their organization or who make the decision to buy efficient products, or before making the decision to purchase clients usually ask respondent for advice	

P6b. [What was the reason for buying [STANDARD PRODUCT] rather than [PRODUCT]?

Reasons for Buying Standard Product	2018
Sample Size	16
Cost/it was cheaper	44%
Match existing product	31%
Fixture won't support LED	6%
Availability of product/easier to get	6%
What the customer/owner wanted	6%
Others	13%
Base: Respondents who purchased a standard product	

P7a. For what type of project did you purchase the majority of the [PRODUCT]? Was it for a...

Type of Project – Contractors	2018
Sample Size	20
New construction	60%
Replacement of existing fixtures or lamps	35%
Don't know	5%
Base: Contractors	

P7b. For what type of project did you purchase the [PRODUCT] that you purchased through the Business Energy Rebates Program? Was it for a...

Type of Project – End-users	2018
Sample Size	30
New construction	17%
Replacement of existing fixtures or lamps	80%
Don't know	3%
Base: End users	

P7c. In what state were your existing fixtures or lamps when you decided to purchase the [PRODUCT]? Were they...

Condition of Existing Fixtures or Lamps	2018
Sample Size	31
Working but at the end of their useful life	29%
Working and not close to the end of their useful life	32%
Broken	16%
Some were working, some were not working	13%
Others	3%
Don't know	6%
Base: Respondents who are replacing existing fixtures	

P8a. [ASK IF CONTRACTOR (I3=2)] and [PRODUCT=LED DOWNLIGHT FIXTURES OR GENERAL-USE AND DECORATIVE LED LAMPS] For what type of projects did you purchase the [PRODUCT] that you purchased through the Business Energy Rebates Program? Was it for...

Types of Projects Products were Used For	2018 (#)
Sample Size	9
Residential projects	4
Both residential and non-residential projects	5
Base: Contractors who installed LED downlight fixtures or general use/decorative LED lamps	

P8b. [ASK IF P8a=3] What percentage of the [PRODUCT] you purchased was for residential use?

Percentage of Products Purchased for Residential Use	2018 (#)
Sample Size	5
1-25%	1
26-50%	2
76-100%	2
Base: Contractors who installed LED downlight fixtures or general use/decorative LED lamps, and who used products for both residential and non-residential products	

P9. [ASK ALL] Were you aware that you had received a rebate when purchasing these [PRODUCT]?

P10. I just want to make sure I understand – When you purchased [PRODUCT], you were unaware that a rebate was given to reduce the product's total cost?

Aware of Product Rebate prior to Purchase	2018
Sample Size	50
Yes	92%
No	8%

P11. [ASK IF P9=Yes or P10=2] Were you aware that the rebate was offered by Efficiency Nova Scotia as part of its Business Energy Rebates Program?

Aware Rebate was Offered by ENS	2018
Sample Size	46
Yes	93%
No	7%
Base: Respondents who were aware they received a rebate when purchasing products	

P12. How did you first become aware of the rebates available under Efficiency Nova Scotia's Business Energy Rebates Program?

Source of Awareness of Rebates	2018
Sample Size	30
Through my distributor	57%
ENS staff contacted me about the program	10%
Don't know	7%
Word of mouth	7%
ENS promotion	7%
ENS website	7%
Post experience with another ENS program component	3%
Through my contractor	3%
Base: End Users	

P13. The Business Energy Rebates Program also has a mail-in service where you apply for incentives to Efficiency Nova Scotia rather than to the distributor. Before today were you aware of this other service of the Business Energy Rebates program?

Aware of Mail-in Service through BER	2018
Sample Size	50
Yes	46%
No	54%

P14. Why did you choose to participate in the Instant Rebates service of the Business Energy Rebates Program rather than the Mail-in service?

Reason for Participating in Instant Rebates Instead of Mail-in Service	2018
Sample Size	23
It was easier/more convenient/easier to use	52%
Get the rebate quicker/don't have to wait for mail in rebate	30%
Less paperwork	22%
Mail-in only applies through commercial/doesn't apply to residential projects	9%
Others	4%
Don't know	9%
Base: Respondents who were aware of mail-in service Multiple Responses	

FR1a. Had you **already** decided to purchase [PRODUCT] **before** knowing that these products were rebated?

Already Made Decision to Purchase Product Before Knowing about Rebate	2018
Sample Size	46
Yes	59%
No	39%
Don't know	2%
Base: Respondents who were aware of rebate	

FR1b. Had you **already** decided to purchase [PRODUCT] **before** knowing the price of those products?

Already Made Decision to Purchase Product Before Knowing the Price of Products	2018
Sample Size	50
Yes	52%
No	42%
Don't know	6%

FR3. Efficiency Nova Scotia offered a rebate for the purchase of efficient lighting products. If your organization had not received the rebate and the cost for [PRODUCT] had been about \$[REBATE AVERAGE VALUE BY CATEGORY] higher, would you have paid the full cost of the [PRODUCT]? Please answer on a scale of 0 to 10, with a 0 indicating that you “Definitely **Would Not** Have Paid” and a 10 indicating that you “Definitely **Would Have** Paid.”

Would Have Paid Cost of Project	2018	
	Sample Size	Mean
Mean (0 = “Definitely Would Not Have Paid” 10 = “Definitely Would Have Paid”)		
Paid cost of project	49	5.7
Don't know/Refused excluded from calculations		

FR3a. Now I would like to ask you to consider which actions your organization would have taken if the rebate had NOT been available. I will read you a few options. For each one, please answer on a scale of 0 to 10, with a 0 indicating that it is “Very Unlikely,” and a 10 indicating that it is “Very Likely.”

Actions Taken in Absence of BER Instant Rebates	2018	
	Sample Size	Mean
Mean (0 = “Very Unlikely” 10 = “Very Likely”)		
If the rebate had not been offered, what is the likelihood that you would have purchased the exact same model of premium lighting products*	46	5.5
If the rebate had not been offered, what is the likelihood that you would have purchased exactly the same quantity of lighting products that you bought***	40	5.5
If the rebate had not been offered, what is the likelihood that you would have kept your existing fixtures or lamps**	10	4.8
If the rebate had not been offered, what is the likelihood that you would have postponed the purchase of the lighting products by at least one year****	31	2.4
*Base: Respondents who were aware of rebate **Base: Respondents who were aware of rebate and who had existing products that were working and not close to their useful life ***Base: Respondents who were aware of rebate and who purchased more than one product ****Base: Respondents who were aware of rebate and who would have likely paid full cost of the energy-efficient measure [IF FR2≥5] Don't know/Refused excluded from calculations		

FR4. Using a scale from 0 to 10, where 0 means “No influence” and 10 means “Great influence”, please rate the influence of each of the following in your organization’s decision to purchase [PRODUCT].

Influence of Factors in Decision to Implement Energy-efficient Products	2018	
	Sample Size	Mean
Mean (0 = “No influence” 10 = “Great influence”)		
The program rebate*	45	7.4
Prevalence of LED products among products that met your lighting requirements	50	7.1
Information received by a distributor on high-efficiency lighting products	49	6.2
Information received by a program representative on high-efficiency lighting products**	42	5.0
*Base: Respondents who were aware of rebate **Base: Respondents who were aware rebate was offered by ENS as part of program component Don't know/Refused excluded from calculations		

C11. Before buying the rebated lighting products in [DATE], had your organization at any time in the past already participated in any other Efficiency Nova Scotia programs?

Previous Participation in Another ENS Program Component	2018
Sample Size	50
Yes	58%
No	34%
Don't know	8%

C12a. Your organization's previous participation in an Efficiency Nova Scotia program was a major factor in the decision to purchase [PRODUCT].

Previous Participation in Another ENS Program Component Was a Major Factor in Purchase	2018
Sample Size	29
Agree	76%
Disagree	24%
Base: Respondents who previously participated in another ENS program component	

C12b. Because of your organization's previous participation in an Efficiency Nova Scotia program and what was learned by participating in the program, a company representative asked a contractor or a distributor about efficient lighting options for your facility.

Previous ENS Program Component Participation Led to Ask About Products	2018
Sample Size	29
Agree	69%
Disagree	24%
Don't know/refused	6%
Base: Respondents who previously participated in another ENS program component	

C12c. Because of your organization's previous participation in an Efficiency Nova Scotia program and what was learned by participating in the program, a company representative took into account the cost-effectiveness of [PRODUCT] when evaluating different options for your facility.

Previous ENS Program Component Participation Led to Assess Product Cost-effectiveness	2018
Sample Size	29
Agree	86%
Disagree	7%
Don't know	6%
Base: Respondents who previously participated in another ENS program component	

- CI3. Before participating in the Business Energy Rebates program, had you at any time in the past already seen Efficiency Nova Scotia promotional materials advertising the benefits of energy efficiency?

Previously Seen Energy Efficiency Promotional Materials Distributed by ENS	2018
Sample Size	50
Yes	96%
No	2%
Don't know	2%

- CI4a. The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in the company's decision to purchase [PRODUCT].

ENS Energy Efficiency Promotional Materials Was a Major Factor in Purchase Decision	2018
Sample Size	48
Agree	67%
Disagree	33%
Base: Respondents who previously saw ENS energy-efficiency promotional materials	

- CI4b. The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to ask a contractor or a distributor about efficient lighting options for your facility.

ENS Energy Efficiency Promotional Materials Led to Ask About Products	2018
Sample Size	48
Agree	63%
Disagree	35%
Don't know	2%
Base: Respondents who previously saw ENS energy-efficiency promotional materials	

- CI4c. The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted a company representative to take into account the cost-effectiveness of [PRODUCT] when evaluating different options for the facility.

ENS Energy Efficiency Promotional Materials Led to Assess Product Cost-effectiveness	2018
Sample Size	48
Agree	81%
Disagree	19%
Don't know	-
Base: Respondents who previously saw ENS energy-efficiency promotional materials	

APPENDIX VII

BER: INSTANT REBATES INTERVIEW GUIDE WITH DISTRIBUTORS

Interview Date and Time	
Company name	
Name	
Area code and phone number	
Email	
Interview Length	

Introduction

Thank you for taking the time to speak with me today. I am interested in your opinion regarding Efficiency Nova Scotia's Business Energy Rebates program, from your perspective as a program partner. As you may recall, Econoler, in partnership with Corporate Research Associates, is conducting a program evaluation again this year for the Business Energy Rebates program.

We would appreciate your collaboration in answering questions related to your involvement in this program. The information you provide will be used to help Efficiency Nova Scotia evaluate and improve the program. Our discussion should last approximately thirty minutes. Is this a good time for you?

Please note that your responses will be kept strictly confidential and that we will not share the information you provide with any other party in a way that could identify your individual or corporate responses.

IDENTIFICATION AND SCREENING OF RESPONDENT

11. I'd like to speak with someone in your company/store who is knowledgeable about the stocking and supplying of specific products that were rebated by the program. These products are 1) **linear LED fixtures**, 2) **LED downlight fixtures**, 3) **LED linear lamps** and 4) **general-use/decorative LED lamps**. Would that person be you?
 - › Person responsible available [CONTINUE]
 - › Person responsible currently unavailable [ARRANGE CALL BACK WITH THE RIGHT PERSON]
 - › No person responsible for stocking or management of products [CONTINUE INTERVIEW WITH STORE MANAGER/HEAD OFFICE CONTACT - CONTINUE]
 - › Don't know [CONTINUE INTERVIEW WITH STORE MANAGER/HEAD OFFICE CONTACT-CONTINUE]
 - › Refused [THANK AND TERMINATE]

Note that I will be asking the same questions for each of these product categories; we will discuss each product category one at a time. Also, if you work in many provinces, please always keep in mind only the Nova Scotia market when answering. First, I would like to discuss the LEDs lamps and fixtures in general.

SECTION A LINEAR LED FIXTURES

ASK IF LINEAR LED FIXTURES WERE REBATED THROUGH THE PROGRAM

I have a few questions about your sales of **linear LED fixtures** that are promoted by the Business Energy Rebates Program. This category includes the following measures (as defined in Efficiency Nova Scotia's rebate schedule): low-bay luminaires, troffers and linear ambient luminaires. Those fixtures would all be Design Light Consortium (DLC) certified. Our records indicate that you sold _____ linear LED fixtures as part of the BER Instant Rebates program up to September 2018, **[READ IF SALES DATA AVAILABLE]** while you sold _____ units for the year in 2017.

- A1. **[ASK IF SALES DATA AVAILABLE]** If the current trend is maintained, you should sell **[FROM SAMPLE: fewer / more]** linear LED fixtures by the end of 2018 than the number of units you sold in 2017. Does this sound accurate? If so, what explains this shift? **[PROBE: market trend, more competitors offering these products, etc.]**
- A1a. **[ASK IF SALES DATA NON AVAILABLE]** If the current trend is maintained, do you think you will sell more, less or the same number of linear LED fixtures by the end of 2018 than the number of units you sold in 2017? If "more" or "less", how do you explain the difference? **[PROBE: market trend, more competitors offering these products, etc.]**
- A2. In 2018, the Business Energy Rebates Program provided a per-unit incentive ranging from \$10 to \$30, depending on the type of linear LED fixtures. If this incentive had not been offered this year, would the number of linear LED fixtures you will sell in 2018 have been about the same or lower?
1. Same [GO TO A2a]
 2. Lower [GO TO A2b]
 98. (Don't know) [GO TO A4]
 99. (Refused) [GO TO A4]
- A2a. **[IF SAME]** Just to confirm... without the program incentive, you would have sold the same number of **linear LED fixtures** this year?
- A2b. **[IF LOWER]** In your estimation, by what percentage would the number of linear LED fixtures you sold have been lower in 2018 if the Business Energy Rebates Program incentive was not available?
- RECORD PERCENTAGE ____%
- RECORD EXPLANATION:

- A4. I am interested in understanding the impact of the Business Energy Rebates program on customers' product choice. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on your customers' choice of linear LED fixtures instead of fluorescent tube fixtures?

RECORD RATING: _____

RECORD EXPLANATION:

- A6. Is the incentive ranging from \$10 to \$30 per fixture enough to encourage customers who would not have done so otherwise to purchase linear LED fixtures? Why?
- A7. Through the Business Energy Rebates Program, only products meeting program's criteria, such as DLC or Energy Star certifications, are eligible for rebate. I would like to understand the impact of the program on the models of products your company carries. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on the proportion of DLC certified linear LED fixtures carried by your company?

RECORD RATING: _____

RECORD EXPLANATION:

SECTION B: LED DOWNLIGHT FIXTURES

ASK IF LED DOWNLIGHT FIXTURES WERE REBATED THROUGH THE PROGRAM

I have a few questions about your sales of **LED downlight fixtures** that are promoted by the Business Energy Rebates Program. This category includes the following measures (as defined in Efficiency Nova Scotia's rebate schedule): LED downlight recessed, LED downlight solid state retrofit, LED downlight surface mount, LED Wall Sconces, and LED ceiling mount fixtures. Those fixtures would all be Energy Star certified fixtures that replace standard incandescent, CFL or halogen fixtures. Our records indicate that you sold _____ LED downlight fixtures as part of the BER Instant Rebates program up to September 2018, **[READ IF SALES DATA AVAILABLE]** while you sold _____ units for the year 017.

- B1. **[ASK IF SALES DATA AVAILABLE]** If the current trend is maintained, you should sell **[FROM SAMPLE: fewer / more]** LED downlight fixtures by the end of 2018 than the number of units you sold in 2017. Does this sound accurate? If so, what explains this shift? **[PROBE: market trend, more competitors offering these products, etc.]**
- B1a. **[ASK IF SALES DATA NON AVAILABLE]** If the current trend is maintained, do you think you will sell more, less or the same number of LED downlight fixtures by the end of 2018 than the number of units you sold in 2017? If "more" or "less", how do you explain the difference? **[PROBE: market trend, more competitors offering these products, ability to purchase LEDs at a good price, etc.]**
- B1b. What percentage of the LED downlight fixtures you sold through the program was purchased for residential application so far in 2018?

B2. In 2018, the Business Energy Rebates Program provided a per-unit incentive ranging from \$8 to \$15, depending on the type of LED downlight fixture. If this incentive had not been offered this year, would the number of LED downlight fixtures you will sell in 2018 have been about the same or lower?

- 1. Same [GO TO B2a]
- 2. Lower [GO TO B2b]
- 98. (Don't know) [GO TO B4]
- 99. (Refused) [GO TO B4]

B2a. **[IF SAME]** Just to confirm...without the program incentive, you would have sold the same number of **LED downlight fixtures** this year?

B2b. **[IF LOWER]** In your estimation, by what percentage would the number of LED downlight fixtures you sold have been lower in 2018, if the Business Energy Rebates Program incentive had not been available?

RECORD PERCENTAGE ____%

RECORD EXPLANATION:

B4. I am interested in understanding the impact of the Business Energy Rebates program on customers' product choice. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on your customers' choice of LED downlight fixtures instead of incandescent or halogen fixtures?

RECORD RATING: ____

RECORD EXPLANATION:

B6. Is the incentive ranging from \$8 to \$15 per fixture enough to encourage customers who would not have done so otherwise to purchase LED downlight fixtures? Why?

B7. Through the Business Energy Rebates Program, only products meeting program's criteria, such as DLC or Energy Star certifications, are eligible for rebate. I would like to understand the impact of the program on the models of products your company carries. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on the proportion of ENERGY STAR certified LED downlight fixtures carried by your company?

RECORD RATING: ____

RECORD EXPLANATION:

SECTION C: LED LINEAR LAMPS

ASK IF LED LINEAR LAMPS WERE REBATED THROUGH THE PROGRAM

I have a few questions about your sales of LED linear lamps that are promoted by the Business Energy Rebates Program. This category includes lamps such as two-foot and foot-foot linear replacement lamps and retrofit kits for ambient lighting. Those lamps would all be Design Light Consortium (DLC) certified. Our records indicate that you sold _____ LED linear lamps as part of the BER Instant Rebates program up to September 2018, **[READ IF SALES DATA AVAILABLE]** while you sold _____ units for the year 2017.

C1. **[ASK IF SALES DATA AVAILABLE]** If the current trend is maintained, you should sell **[FROM SAMPLE: fewer / more]** LED linear lamps by the end of 2018 than the number of units you sold in 2017. Does this sound accurate? If so, what explains this shift? **[PROBE: market trend, more competitors offering these products, etc.]**

C1a. **[ASK IF SALES DATA NON AVAILABLE]** If the current trend is maintained, do you think you will sell more, less or the same number of LED linear lamps by the end of 2018 than the number of units you sold in 2017? If “more” or “less”, how do you explain the difference? **[PROBE: market trend, more competitors offering these products, ability to purchase LEDs at a good price, etc.]**

C2. In 2018, the Business Energy Rebates Program provided a per-unit incentive ranging from \$2.50 to \$4, depending on the type of LED linear lamp. If this incentive had not been offered this year, would the number of LED linear lamps you will sell in 2018 would have been about the same or lower?

- 1. Same [GO TO C2a]
- 2. Lower [GO TO C2b]
- 98. (Don't know) [GO TO C4]
- 99. (Refused) [GO TO C4]

C2a. **[IF SAME]** Just to confirm... without the program incentive, you would have sold the same number of **LED linear lamps** this year?

C2b. **[IF LOWER]** In your estimation, by what percentage would the number of LED linear lamps you sold have been lower in 2018, if the Business Energy Rebates Program incentive had not been available?

RECORD PERCENTAGE ____%

RECORD EXPLANATION:

- C4. I am interested in understanding the impact of the Business Energy Rebates program on customers' product choice. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on your customers' choice of LED linear lamps instead of fluorescent lamps?

RECORD RATING: _____

RECORD EXPLANATION:

- C6. Is the current incentive ranging from \$2.50 to \$4 per lamp enough to encourage customers who would not have done so otherwise to purchase LED linear lamps? Why?
- C7. Through the Business Energy Rebates Program, only products meeting program's criteria, such as DLC or Energy Star certifications, are eligible for rebate. I would like to understand the impact of the program on the models of products your company carries. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on the proportion of DLC certified LED linear lamps carried by your company?

RECORD RATING: _____

RECORD EXPLANATION:

SECTION D: GENERAL-USE/DECORATIVE LED LAMPS

ASK IF GENERAL-USE/DECORATIVE LED LAMPS WERE REBATED THROUGH THE PROGRAM

I have a few questions about your sales of **general-use/decorative LED lamps** that are promoted by the Business Energy Rebates Program. This category covers A19, globe and chandelier bulbs. Those lamps would all be ENERGY STAR certified. Our records indicate that you sold _____ general-use/decorative LED lamps up to September 2018, **[READ IF SALES DATA AVAILABLE]** while you sold _____ units for the year 2017.

- D1. **[ASK IF SALES DATA AVAILABLE]** If the current trend is maintained, you should sell **[FROM SAMPLE: fewer / more]** general-use/decorative LED lamps by the end of 2018 than the number of units you sold in 2017. Does this sound accurate? If so, what explains this shift? **[PROBE: market trend, more competitors offering these products, etc.]**
- D1a. **[ASK IF SALES DATA NON AVAILABLE]** If the current trend is maintained, do you think you will sell more, less or the same number of general-use/decorative LED lamps by the end of 2018 than the number of units you sold in 2017. If "more" or "less", how do you explain the difference? **[PROBE: market trend, more competitors offering these products, etc.]**
- D1b. What percentage of the general-use/decorative LED lamps you sold through the program was purchased for residential application so far in 2018?

D2. In 2018, the Business Energy Rebates Program provided a per-unit incentive of \$3 to \$4, depending on the type of general-use/decorative LED lamps. If this incentive had not been offered this year, would the number of general-use/decorative LED lamps you will sell in 2018 have been about the same or lower?

- 1. Same [GO TO D2a]
- 2. Lower [GO TO D2b]
- 98. (Don't know) [GO TO D4]
- 99. (Refused) [GO TO D4]

D2a. **[IF SAME]** Just to confirm... without the program incentive, you would have sold the same number of **general-use/decorative LED lamps** this year?

D2b. **[IF LOWER]** In your estimation, by what percentage would the number of general-use/decorative LED lamps you sold have been lower in 2018 if the Business Energy Rebates Program incentive was not available?

RECORD PERCENTAGE ____%

RECORD EXPLANATION:

D4. I am interested in understanding the impact of the Business Energy Rebates program on customers' product choice. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important," how would you rate the program's influence on your customers' choice of general-use/decorative LED lamps instead of incandescent bulbs or CFLs?

RECORD RATING: ____

RECORD EXPLANATION:

D6. Is the current incentive of \$3 to \$4 per lamp enough to encourage customers who would not have done so otherwise to purchase general-use/decorative LED lamps? Why?

D7. Through the Business Energy Rebates Program, only products meeting program's criteria, such as DLC or Energy Star certifications, are eligible for rebate. I would like to understand the impact of the program on the models of products your company carries. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on the proportion of ENERGY STAR certified general-use/decorative LED lamps carried by your company?

RECORD RATING: ____

RECORD EXPLANATION:

SECTION O: Process Questions

- O1. Generally, how aware are contractors that they are getting an incentive from ENS for buying energy efficient equipment through the Business Energy Rebates Instant-Rebate program?
- O2. Generally, how aware are end-use customers that they are getting an incentive from ENS for buying energy efficient equipment through the Business Energy Rebates Instant-Rebate program?
- O3. On a scale of 1 to 10 where 1 is do not agree at all and 10 is highly agree, how much do agree with each of the following statements?
1. The incentives for Linear LED Fixtures are sufficient to motivate most contractors to purchase them over standard equipment
 2. The incentives for LED Downlight fixtures are sufficient to motivate most contractors to purchase them over standard equipment
 3. The incentives for LED Linear Lamps are sufficient to motivate most contractors to purchase them over standard equipment
 4. The incentives for General Use Decorative LED Lamps are sufficient to motivate most contractors to purchase them over standard equipment
 98. (Don't know)
 99. (Refused)
- O4. Are you familiar with any of the following ENS programs?
1. Business Energy Rebates (BER) Mail-in (*If needed: provides incentives for installing designated equipment*)
 2. Custom (for industrial clients) (*If needed: provides incentives based on calculation of savings*)
 3. Small Business Energy Solutions (SBES) (*If needed: provides incentives for small businesses to install energy efficient equipment and receive financing*)
 4. New Commercial Construction (*If needed: received incentives for constructing a new building or remodeling/repurposing an old space*)
 5. Other, please specify: _____
 6. None – I am not aware of any other ENS programs [MAKE EXCLUSIVE ANSWER]
 98. (Don't know)
 99. (Refused)

- O5. [ASK IF Q4=1, Aware of BER Mail-in] For each of the following measure types, what percentage do you sell through the Business Energy Rebates Instant Rebate service, what percentage do you sell through the Business Energy Rebates Mail-in service, and what percentage are sold without any incentives?

Measure Types	Percent Sold Through Instant Rebate	Percent Sold Through Mail-in	Percent Sold Without Incentives	Total
Linear LED Fixtures				100%
LED Downlight Fixtures				100%
LED Linear Lamps				100%
General Use Decorative LED Lamps				100%

- O6. [ASK IF Q4=1, Aware of BER Mail-in] If a project could go through the Instant Rebates service or the Mail-in service of the Business Energy Rebates Program, which would you recommend to your customers and why?

SECTION M: MARKET EVOLUTION

- M1. For the next questions, please refer to the product adoption curve that was sent to you via email before this interview. Thinking of the Nova Scotia business lighting market, where on the product adoption curve would you place each of the following lighting products?

Please note that by business market we mean the commercial, industrial and institutional markets for lighting products.

Lighting Products	Letter on the Curve	Explanation
M1. LED downlight fixtures		
M2. LED linear fixtures		
M3. LED linear lamps		
M4. General-use/Decorative LED lamps		

SECTION S: SATISFACTION AND RECOMMENDATIONS

ASK ALL RESPONDENTS

S1. On a scale from 1 to 10 (where 1 = not at all satisfied and 10 = very satisfied)...

a) how would you rate your satisfaction with each of the following aspects?

b) If less than 8, please explain the reason(s) for your score.

Aspects of the program	Score	Reason
1. The overall program		
2. The program support and communications provided by ENS		
3. The rebate processing, tracking and reporting		

S2. What, if anything, has been a key success of the program for your firm over the last year?

S3. What, if anything, are the key challenges your firm experienced using the program over the last year?

S4. Finally, do you have any suggestions to improve the program?

Record: _____

☐ No suggestion at this time

Those are all the questions I have for you today. Would you like to add anything else regarding the program or talk about any other topic that was not covered during the interview?

THANK YOU FOR TAKING THE TIME TO TAKE PART IN THIS INTERVIEW.

APPENDIX VIII

BER: MAIL-IN GROSS SAVINGS ADJUSTMENTS

This appendix presents the detailed adjustments made by the Evaluator to the energy and demand savings of revised projects based on the project documentation review and on-site visit observations.

Commercial Lighting Measures

Thirty-four (34) lighting projects were evaluated in 2018, comprising 141 different commercial lighting measures.

- › Adjustments were limited, resulting in adjustment ratios of 0.984 for tracked energy savings and 0.909 for tracked peak demand savings. These adjustment ratios were extrapolated to the other projects since the margins of error were 4.5 percent for energy savings and 4.3 percent for peak demand savings adjustment ratios.
- › One measure was considered as an outlier since the fixtures were incompatible with the lamps purchased though BER and the participant had not yet decided if they would return those lamps or exchange the fixtures for another model. Therefore, one-time adjustments of -212,712 kWh and -24.222 kW were respectively made to the tracked energy and demand savings for this project.
- › The most common adjustment was revising HOU's to match collected site data, with only 23 percent of measures having more than a 5 percent difference. This is an improvement on the 36 percent observed in the 2017 evaluation. Adjustments of over 30 percent to HOU's were explained by transcription errors, poor HOU assessments by applicants, and incorrect space assignments by applicant.
- › Efficient wattages were revised for 16 percent of measures, most commonly revising a nominal wattage value to the system wattage as reported by the DesignLights Consortium (DLC). One project used external AC/DC power supplies for LEDs in refrigerated cases. The tracked efficient wattage was at the lamp level, not at the power supply level, which resulted in a different form of nominal vs system wattage error. This accounted for seven of the 23 revisions to efficient wattages.
- › The CF and IE/IEpd were tracked correctly 92 percent of the time, and the Wb were correctly tracked 95 percent of the time.

Motor and Variable Frequency Drive Measures

Fifteen (15) motor and variable speed drive projects were evaluated in 2018, comprising 71 different commercial motor and VSD measures.

- › Adjustments were limited, resulting in adjustment ratios of 0.821 for tracked energy savings and 0.831 for tracked peak demand savings. These adjustment ratios were extrapolated to the other projects since the margins of error were 2.9 percent for energy savings and 3.2 percent for peak demand savings adjustment ratios.
- › The most common adjustments were changing ESVG and DSVG factors to match motor applications with the actual installation conditions confirmed during site visits. ESVG values were revised in 12 cases, while DSVG values were adjusted in five cases.
- › Motor efficiencies were adjusted in one project where the same value was used for all motors ranging between 5 HP and 40 HP.

Heating, Ventilation and Air-conditioning (HVAC) Measures

Eleven (11) HVAC projects were evaluated in 2018, comprising 20 different commercial HVAC measures.

- › Adjustments were limited, with adjustment ratios of 0.990 for tracked energy savings and 0.955 for tracked peak demand savings. These adjustment ratios were extrapolated to the other projects since the margins of error were of 2.8 percent for energy savings and 3.5 percent for peak demand savings adjustment ratios.
- › The CIRx Screening Tool EFLH values were correctly used for 10 projects, while one project had incorrect values.
- › Two projects were adjusted to account for the presence of an air conditioner in the baseline situation.
- › The quantity of efficient products was adjusted in one project based on the quantity observed on-site. The value was correctly tracked in the “Measure Qty” column, but not correctly used in the savings calculations.
- › One project used AHRI performance rating values for a ground water heat pump when project documentation indicated it was installed on a water loop. Thus, the AHRI was revised to the value corresponding to a water source heat pump.

Commercial Refrigeration Measures

Eight (8) refrigeration projects were evaluated in 2018, comprising 24 different commercial refrigeration measures.

- › Adjustments were required for all revised projects, resulting in adjustment ratios of 1.258 for tracked energy savings and 1.200 for tracked peak demand savings. These adjustment ratios were extrapolated to the other projects since the margins of error were of 8.6 percent for energy savings and 8.1 percent for peak demand savings adjustment ratios.
- › The most common adjustments were revising kW_{evap}, kW_{circ} and kW_{econ} to match collected site data, with all ECM motors, controls and outside air economizer measures being affected. Evaporator fan wattages were revised to the value listed in supplied specification sheets. No circulator fans were observed on-site, so they were removed from the savings equation. Economizer fan wattages were not calculated according to the provided method in the CIRx tool thus were revised.
- › All adjustments made to fan motors were based on information available in the applications, not obtained from on-site visits.

Compressed Air Measures

Two (2) compressed air projects were evaluated in 2018, comprising two different commercial compressed air measures.

- › There were no adjustments required, resulting in adjustment ratios of 1.000 for tracked energy savings and 1.000 for tracked peak demand savings.

Agricultural Measures

Five (5) agriculture projects were evaluated in 2018, comprising 13 different commercial agricultural measures.

- › Adjustments were required for all revised projects except one, resulting in adjustment ratios of 1.451 for tracked energy savings and 0.763 for tracked peak demand savings. These adjustment ratios were not extrapolated to the other projects since the margins of error were above 10 percent. Instead, gross adjustments were applied to the final tracked savings. The energy savings gross adjustment was -171,346 kWh and the peak demand savings gross adjustment was -24.269 kW.
- › Equipment HOU's were the most commonly adjusted parameters. Many measures were confirmed to have higher HOU's than the tracked values since they run constantly. This mainly explains the higher energy savings adjustment ratio.

- › The CBTU variable (heat load of milk per cow per day) has two options: systems with and without a milk pre-cooler. One instance was revised to reflect that a pre-cooler was present in the system. The tracked value was an average of the two possible values, indicating the type of system was never confirmed with the participant.

Commercial Kitchen Measures

Four (4) kitchen projects were evaluated in 2018, comprising nine different commercial kitchen measures.

- › Adjustments were required for seven of the nine measures, resulting in adjustment ratios of 0.818 for tracked energy savings and 0.839 for tracked peak demand savings. These adjustment ratios were not extrapolated to the other projects since the margins of error were above 10 percent. Instead, gross adjustments were applied to the final tracked savings. The energy savings gross adjustment was -20,827 kWh and the peak demand savings gross adjustment was -3.219 kW.
- › The most common adjustments were to HOU and equipment usage per day. These adjustments were required most likely because on-site visits typically allow to confirm usage with kitchen staff while the applications are often completed by administration staff, thereby resulting in inconsistencies.
- › The EnergyStar calculator was not used properly in three cases. One case had a different energy savings value than the value obtained by the Evaluator when inputting the same tracked variables in the calculator. Another case involved using the energy consumption value for tracked savings rather than the value for calculated savings. The third case appears to not have tracked the correct EnergyStar savings result, since the tracked savings are greater than the calculated baseline consumption, which is impossible. The savings for those measures were revised to the values obtained from the calculator by the Evaluator.

Commercial Laundry Measures

No commercial laundry applications were submitted to the 2018 BER program component.

Commercial Pumping Measures

Two (2) pumping projects were evaluated in 2018, comprising six different commercial pumping measures.

- › Adjustments occurred in two measures, resulting in adjustment ratios of 0.917 for tracked energy savings and 0.917 for tracked peak demand savings. These adjustment ratios were not extrapolated to the other projects since the margins of error were above 10 percent. Instead, gross adjustments were applied to the final tracked savings. The energy savings gross adjustment was -746 kWh and the peak demand savings gross adjustment was -0.154 kW.
- › The two adjustments consisted of changing the number of pumps to match the actual number of units installed and operating on-site.

Commercial Solar Measures

No commercial solar applications were submitted to the 2018 BER program component.

Commercial Water Heating Measures

Two (2) water heating projects were evaluated in 2018, comprising two different commercial water heating measures.

- › Adjustments were made in both measures, resulting in adjustment ratios of 1.321 for tracked energy savings and 1.321 for tracked peak demand savings. These adjustment ratios were not extrapolated to the other projects since the number of revised measures was too small. Instead, gross adjustments were applied to the final tracked savings. The energy savings gross adjustment was 23,367.099 kWh and the peak demand savings gross adjustment was 5.762 kW.
- › One HPWH was installed in a boiler room. Thus, the F_{adj} variable was revised to account for the higher COP in a warmer environment.
- › One HPWH setpoint was found to be higher than the default value used in the CIRx tool.

APPENDIX IX

BER: MAIL-IN ADJUSTMENT RATIO CALCULATION EXAMPLE

This appendix presents a sample calculation to demonstrate the process of revising energy and peak demand savings. The motors and VFD vertical category was the second largest for both energy and demand savings in 2018. The category required repeated adjustments to the same variables; therefore one of the measures has been chosen to exemplify the calculation details for the following:

- › Algorithms for calculating energy and peak demand savings
- › Comparison of the calculation of tracked energy and peak demand savings and the calculation of revised energy and peak demand savings
- › The algorithm for establishing the adjustment ratio

Energy and Peak Demand Savings Algorithms

The following algorithms include the parameters required to determine the annual energy savings and annual peak demand savings associated with retrofitting a motor with a VFD.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = HP \times \left[\frac{1}{EFF_{motor}} \right] \times ESG$$

$$\text{Peak Demand Savings} \left[\frac{\text{kW}}{\text{yr}} \right] = HP \times \left[\frac{1}{EFF_{motor}} \right] \times DSVG \times CF$$

Where:

- › HP is the rated horsepower of the motor controlled by a VFD
- › EFF_{motor} is the rated efficiency of the motor controlled by a VFD
- › ESG is the energy savings factor for the motor application, in kWh/HP
- › $DSVG$ is the demand savings factor for the motor application, in kW/HP
- › CF is the coincidence factor

Tracked Savings Calculation

Parameters for the savings calculation were obtained from the BER Mail-in participant application and factors were taken from the BER CIRx Screening Tool. Table 2 presents the values used for the specific case of a 5 HP motor retrofitted with a VFD.

Table 2: Tracked Variables for Example Calculation

Measure – 5 HP Motor		
Parameter	Value	Source
Rated Horsepower (HP)	5	Tracking Sheet
Rated Efficiency of Motor	0.902	Tracking Sheet
Energy Savings Factor (kWh/HP)	3,061	Tracking Sheet
Demand Savings Factor (kW/HP)	0.457	Tracking Sheet
Coincidence Factor	0.42	Tracking Sheet
Tracked Savings		
Tracked Energy Savings (kWh)	33,936	Tracking Sheet
Tracked Demand Savings (kW)	2.128	Tracking Sheet

Revised Savings Calculation

The revised savings calculations are based on three adjustments.

The first adjustment consisted of revising the ESVG and DSVG values based on the motor use, as identified during an on-site visit. The motor was identified in the application as serving reheat coils on one floor of the building. Conversely, the tracked ESVG and DSVG values classify the application as a “water source heat pump circulating loop”. Although the source of the hot water is a heat pump, the “water source heat pump circulating loop” application does not apply to this motor since the site visit allowed to confirm that the heating and cooling loops in the system are separate and the pump only operates during the heating season. The ESVG and DSVG values were revised to the “hot water circulating pump” factors for university buildings.

The second adjustment consisted of revising the coincidence factor. The coincidence factor represents the fraction of time equipment is operational during the peak demand period between 5 pm and 7 pm in the months of December, January and February on non-holiday weekdays. The tracked value of 0.42 is a default value in the CIRx tool for motors and VFDs when the operation is unknown. The reheat coils were confirmed to be operational during the heating season, so the CF was revised to 1.0.

The final adjustment consisted of revising the rated efficiency of the motor based on the motor nameplate observed during the on-site visit. The application did not specify a motor efficiency, so the tracked value was obtained as a default value from the CIRx tool and was therefore revised.

The variables used to calculate the revised savings and the final results are summarized in Table 3.

Table 3: Revised Variables for Example Calculation

Baseline Measure – 295 W High Pressure Sodium Lamp		
Parameter	Value	Source
Rated Horsepower (HP)	5	Validated On-site
Rated Efficiency of Motor	0.895	Validated On-site
Energy Savings Factor (kWh/HP)	2,344	Calculated Based on the Detailed Schedule Provided During On-site Visits
Demand Savings Factor (kW/HP)	0.457	Industrial Bldg. with Electrical Heating and Cooling
Coincidence Factor	1.0	Industrial Bldg. with Electrical Heating
Revised Savings		
Revised Energy Savings (kWh)	13,095	Calculation
Revised Demand Savings (kW)	2.553	Calculation

Adjustment Ratio Algorithm

The adjustment ratio is determined by comparing the revised savings values with the tracked savings values. Due to the revisions made to this measure, the calculated ratios were 0.386 for energy savings and 1.200 for peak demand savings.

$$\frac{\text{Revised ES}}{\text{Tracked ES}} = \frac{13,095 \text{ kWh}}{33,936 \text{ kWh}} = 0.386$$

$$\frac{\text{Revised Peak DS}}{\text{Tracked Peak DS}} = \frac{2.553 \text{ kW}}{2.128 \text{ kW}} = 1.200$$

APPENDIX X

BER: MAIL-IN EFFECTIVE USEFUL LIFE

This appendix presents the revised equivalent effective useful life (EUL) of product types offered in the BER-Mail-in service. First, the EUL of lighting products are presented, followed by the other types of measures rebated through the program.

Lighting Measures

As part of the 2018 evaluation, the Evaluator updated the EUL value of each lighting measure type to account for the approaching scheduled change in regulations. The same methodology as for 2017 was applied. The Evaluator conserved the same years as the effective dates of each regulation; the only change made to the calculation is that the first year is now 2018 instead of 2017.

As it was the case in 2017, the EUL was obtained by dividing the rated lifetime of lamps or fixtures by the annual HOU, and then adjusted to account for increases in baselines throughout the lifetime of the measure to obtain the equivalent EUL. This value corresponds to the number of years by which the first-year savings estimate is multiplied to obtain lifetime energy savings. A summary of the revised equivalent EUL values by product type are presented in Table 7 at the end of this subsection. The following provides details on the methodology for establishing equivalent EUL values for LED lamps and fixtures.

The Evaluator used the annual HOU values from BER Instant Rebates since there are no fixed HOU values determined for Mail-in. The estimated rated life values remained the same as in the 2017 Evaluation Report; the values had been estimated based on the specification sheets of the most popular products of each measure. Rated life for outdoor LED fixtures, non-cutoff and semi or non-cutoff wall-mounted area luminaires, were modified from last year evaluation.

The following paragraphs discuss the lamp types for which baseline increases will occur during their EUL, namely general-use and decorative lamps, reflector lamps, non-recessed downlight fixtures, and recessed downlight fixtures. These measures are the only ones for which the EUL values had to be recalculated as part of the 2018 evaluation.

General-use and decorative lamps

The methodology used for establishing the equivalent EUL of general-use and decorative lamps is based on the information presented in Table 4 and the equation below. The equivalent EUL calculation is based on 9 W lamps. The baseline technology is 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 increase in the baseline upon burnout. The Evaluator assumes these lamps have a remaining lifetime of 1,000 hours, which translates to 0.23 years with an annual HOU of 4,410 hours. Since BER Mail-in targets commercial participants, the Evaluator assumes that some participants might have incandescent lamps stocked, and therefore the duration of this baseline was increased to a full year. Based on the LED A-type lamp rated life of 25,000 hours, the EUL of this product is 5.7 years, meaning the corresponding baseline will not be affected by the change in legislation occurring six years from now in 2024. Therefore, halogen incandescent lamps are considered to be the baseline technology for the remaining lifetime of LED A-type lamps. With the information presented in Table 4, the following equation sets the equivalent EUL of general-use lamps at 4.7 years.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen Incandescent and Incandescent}} \times 1 \text{ year} + \Delta W_{\text{Halogen Incandescent}} \times 4.7 \text{ years}}{\Delta W_{\text{Halogen Incandescent and Incandescent}}}$$

$$= 4.7 \text{ years}$$

Table 4: Baseline Evolution During the Effective Useful Life of LED A-type Lamps

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Incandescent and Incandescent Baseline 1 Year (2018)		Halogen Incandescent Baseline 4.7 Years (2019-2023)	
		Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)
43	9	52	43	43	34

Reflector lamps

LED reflector lamps typically replace halogen lamps. Their average rated life is estimated at 25,000 hours, which translates to an EUL of 5.7 years. The baseline for this lighting product will therefore not increase throughout its EUL. Hence, the equivalent EUL is 5.7 years.

Non-recessed downlight fixtures

Since non-recessed LED downlight fixtures replace fixtures using A-type lamps, the methodology for establishing their equivalent EUL is similar to that of A-type lamps. The equivalent EUL calculation is based on the example 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 EUL of 11.3 years, the baseline is affected by the change in regulation occurring in 2024. In other words, a second baseline increase will occur in 2024 (after changing from a baseline mix of 43 W halogen incandescent lamps and 60 W incandescent lamps to a 43 W halogen incandescent baseline in 2019). Starting in 2024 and for the remaining lifetime of the fixture (5.3 years), the baseline will be a 20 W CFL equivalent lamp. The equation and Table 5 below present the information used to calculate the equivalent EUL of 6.3 years.

Equivalent EUL

$$= \frac{\Delta W_{\text{Halogen Incandescent and Incandescent}} \times 1 \text{ year} + \Delta W_{\text{Halogen Incandescent}} \times 5 \text{ years} + \Delta W_{\text{CFL}} \times 5.3 \text{ years}}{\Delta W_{\text{Halogen Incandescent and Incandescent}}}$$

$$= 6.3 \text{ years}$$

Table 5: Baseline Evolution During the Effective Useful Life of for Downlight Fixtures

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Incandescent and Incandescent Baseline 1 Year (2018)		Halogen Incandescent Baseline 5 Years (2019-2023)		CFL Equivalent Baseline American Legislation ⁵ 5.3 Years (2024-2029)	
		Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)
43	9	52	43	43	34	20	11

Recessed downlight fixtures

LED recessed downlight fixtures typically replace fixtures housing reflector lamps for which the baseline technology is halogen lamps. The EUL of LED recessed downlight fixtures is established at 11.3 years based on a rated life of 50,000 hours. The equivalent EUL calculation is based on the typical case 12 W LED reflector lamp replacing a 43 W halogen lamp. Canadian regulations are expected to change approximately in 2022 and the impact on available lamps being fully achieved by 2024, which will increase the baseline to an equivalent CFL. Therefore, 43 W halogen lamps will be the baseline technology for six years, after which 20 W CFL equivalent lamps will become the baseline for the remaining lifetime of LED recessed downlight fixtures (5.3 years). The equivalent EUL was calculated at 7.4 years with the information presented in Table 6.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen}} \times 6 \text{ years} + \Delta W_{\text{CFL}} \times 5.3 \text{ years}}{\Delta W_{\text{Halogen}}} = 7.4 \text{ years}$$

Table 6: Baseline Evolution During the Effective Useful Life of LED Reflector Lamps in Downlight Fixtures

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Baseline 6 Years (2018-2023)		CFL Equivalent Baseline American Legislation ⁶ 5.3 Years (2024-2029)	
		Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)
43	12	43	31	20	8

⁵ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

⁶ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

Other lighting products

For products other than general-service lamps, there is no indication that regulations will significantly change over the lifetime of these products. Furthermore, in the case of linear ambient luminaires, linear replacement lamps, and metal halide lamps, the typical baseline products are already more efficient than the current regulation, which further suggests that a change in regulations would not affect the baseline efficiency in the near future. The revised EUL values of other lighting measures, including occupancy sensors, are based on the 2017 DSM Evaluation Report.

A summary of the EUL and equivalent EUL of all lighting product types offered in BER Mail-in is presented in Table 7.

Table 7: Revised Equivalent Effective Useful Life Values by Lighting Measure Category

Lighting Measure	List Category	Tracked Equivalent EUL (years)	Rated Life (hours)	Annual HOU (hours)	Revised EUL (years)	Revised Equivalent EUL (Years)
Linear LED Fixtures	1 x 4 Luminaires	11.3	50,000	4,410	11.3	11.3
	2 x 2 Luminaires & Retrofit Kits					
	2 x 4 Luminaires & Retrofit Kits					
	Linear Ambient & Low Bay Luminaires					
	High-bay Luminaires	12.1	100,000	4,410	22.7	22.7
	Troffers	11.3	90,000	4,410	20.4	20.4
Linear LED Lamps	4-foot Replacement Lamps	11.3	50,000	4,410	11.3	11.3
	2-foot Replacement Lamps					
	U-bend					
General-use and Decorative LED Lamps	LED Decorative (chandelier)	5.7	25,000	4,410	5.7	4.7
	LED Omnidirectional (A-lamp and globe)					
	Four Pin-base Replacement Lamps for CFLs	13.6	50,000	4,410	11.3	11.3
Reflector LED Lamps	Small LED Reflector Lamps - PAR, MR, MRX 16	5.7	25,000	4,410	5.7	5.7
	Small LED Reflector Lamps - PAR, R 20					
	Large LED Reflector Lamps - PAR, BR, R 30/30L					
	Large LED Reflector Lamps - PAR, BR, R 38/40					

Lighting Measure	List Category	Tracked Equivalent EUL (years)	Rated Life (hours)	Annual HOU (hours)	Revised EUL (years)	Revised Equivalent EUL (Years)
LED Downlight Fixtures	LED Recessed	N/A	50,000	4,410	11.3	7.4
	LED Ceiling Mount, LED Surface Mount, LED Solid State Retrofit, LED Inseparable Solid State Luminaire, LED Wall Sconces, LED Wall Sconce Retrofits	8.3	50,000	4,410	11.3	6.3
Outdoor LED Fixtures	Outdoor Full-cutoff Wall-mounted Area Luminaires	11.4	75,000	4,380	17.1	17.1
	Flood and Spot Luminaires	17.1	75,000	4,380	17.1	17.1
	Fuel Pump Canopy Luminaires	21.0	50,000	4,380	11.4	11.4
	LED Replacement for HID Lamps	18.0	50,000	4,380	11.4	11.4
	Non-cutoff and Semi-cutoff Wall-mounted Area Luminaires	11.4	100,000	4,380	22.8	22.8
	Pole/Arm-mounted Area Luminaires	8.1	60,000	4,380	13.7	13.7
	Pole/Arm-mounted Decorative Luminaires	18.0	100,000	4,380	22.8	22.8
	Parking Garage Luminaires	18.0	100 000	4,380	22.8	22.8
	Case Lighting for Sign Retrofit Applications	15.0	50,000	4,410	11.3	11.3
Directional and Architectural LED Fixtures	Track or Mono-point Directional Luminaires, LED Wall Wash Luminaires	11.3	50,000	4,410	11.3	11.3
Occupancy Sensors	Ceiling Remote-mounted	10	-	-	10	10
	Wall Remote-mounted					
	Fixture Mounted					
	Wall Switch					
	Exterior					
Other	Refrigerated Case Luminaires	8.0	70,000	4,410	15.9	15.9

Other Products

For product types other than lighting, the Evaluator established the EULs listed in Table 8 below. The EUL values of all measures eligible for the program component are based on the 2017 DSM Evaluation Report, except for efficient pool pumps, a product not included in the 2017 Report. For efficient pool pumps, the Evaluator maintained the value of 10 years used by ENS since it is the most commonly used value among other jurisdictions and is also found in the Database of Energy Efficient Resources.⁷

ENS accurately tracked the EUL for the vast majority of non-lighting measures, with only three measures being revised.

- › One heat pump was tracked as having an EUL of 12 years instead of 18 years, while all others were correctly tracked
- › The only milk vacuum pump VFD was tracked as having an EUL of 10 years instead of 15 years
- › The only cooler night cover measure was tracked as having an EUL of five years instead of four years

Table 8: Tracked and Revised Equivalent Effective Useful Life Values by Measure Category

Measure Category	Measure	Tracked Equivalent EUL	Revised Equivalent EUL
Agriculture	Agriculture Heat Pads	N/A	10
	Dairy Scroll Compressors	15	15
	Energy Efficient Ventilation and Circulation Fans	15	15
	Heat Reclaimer Units	15	15
	High-volume Low-speed Fans	15	15
	Low Energy and Zero Energy Livestock Waterers	N/A	10
	Milk Pre-coolers	N/A	15
	Natural and Dual Ventilation	15	15
	Tractor Engine-block Heater Timers	N/A	5
	VFD for Milk Vacuum Pumps	10	15
Compressed Air	Air Entraining Air Nozzles	15	15
	Air Receivers for Load/No Load Screw Compressors	N/A	15
	Cycling Air Dryers	10	10
	No-loss Drains	15	15
	VFD Screw Compressors	15	15

⁷ Database for Energy Efficiency Resources (DEER), *DEER 2014 EUL Table*, 2014.

Measure Category	Measure	Tracked Equivalent EUL	Revised Equivalent EUL
HVAC	Air Source Heat Pumps Greater Than or Equal to 65,000 BTU/hr	18	18
	Air Source Heat Pumps Less Than 65,000 Btu/hr (excluding air-to-water)	17.9	18
	Air-to-water Heat Pumps	N/A	18
	Dual-enthalpy Economizer Controls	10	10
	Ground Source Heat Pumps	N/A	25
	HVAC Hotel Occupancy Sensors	8	8
	Packaged Terminal Heat Pumps (PTHPs)	15.2	15
	Water Source Heat Pumps;	15	15
Kitchen	Demand Controlled Kitchen Exhausts	15	15
	Dishwashers	10, 15 or 20	10, 15 or 20
	Freezers/Refrigerators	12	12
	Fryers	12	12
	Griddles	N/A	12
	Hot Food Holding Cabinets	N/A	12
	Ice Machines	10	10
	Ovens	12	12
	Steam Cookers	N/A	12
Laundry	Commercial Clothes Dryers (NG Conversion)	N/A	14
	Commercial Washing Machines	N/A	11
Motors and VFDs	Energy Efficient Motors	N/A	15
	Variable Frequency Drives	15	15
Pumping	High Efficiency Circulator Pumps	15	15
Refrigeration	Brushless DC Motors	15	15
	Cooler Night Covers/Display Case Strip Curtains	5	4
	Door Heater Controls	12	12
	Efficient Refrigeration Compressors	N/A	15
	Evaporator Fan Motor Controls	10	10
	Intelligent Freezer Defrost Controls	N/A	10
	Refrigerated Vending Machine Controllers	N/A	5
	Refrigeration Economizers	15	15
	Vertical Refrigeration Open to Closed Cooler Conversion	N/A	12
	Zero Energy Doors	N/A	12
Water Heating	Electrical to Natural Gas Water Heating	N/A	15
	Heat Pump Water Heaters	10	10
Solar	Solar Water Heaters	N/A	20
Pool	Efficient Pool Pumps	10	10

APPENDIX XI

BER :MAIL-IN ALGORITHM FOR FREE-RIDERSHIP CALCULATION

The figure below present the algorithm for calculating the free-ridership level of Mail-in measures, along with the participant survey questionnaire. The latter included questions designed to assess variables such as planning, quantity, efficiency, timing, cost, and program influence. Each group of questions was transposed into a level of program attribution, which was then used to calculate the free-ridership level associated with each participant.

FR2. If your organization had not received the rebate from ENS, would you have paid the full cost of the energy-efficient [measure category] measures? (Scale 0 to 10)	IF DK OR REF: FR2 = EMPTY OTHERWISE: FR2 = Answer x 10%
FR3a_2. [ASK IF MEASURE CATEGORY=LIGHTING] Were you aware that the lighting products rebated through BER are premium products certified by Design Light Consortium or ENERGY STAR®?	IF 1. Yes: Use FR3a_1 or 3 IF 2. No OR DK OR REF: FR3a_1 or 3 = 0%
FR3a_1 or 3. [ASK IF MEASURE CATEGORY <> LIGHTING] If BER had not been offered, what is the likelihood that you would have implemented exactly the same energy-efficient [measure category] measures that was rebated through BER? (Scale 0 to 10) [ASK IF MEASURE CATEGORY=LIGHTING] If BER had <u>not been</u> offered, what is the likelihood that you would have purchased the exact same model of lighting products? (Scale 0 to 10)	IF DK OR REF: FR3a_1 or 3 = EMPTY OTHERWISE: IF Pre-FR2 = Yes: FR3a_1or 3 = (Answer x 10%) / 2 OTHERWISE: FR3a_1 or 3 = Answer x 10%
PA1 Score:	MEAN VALUE OF: (FR2; FR3a_1or 3)
FR1. Had your organization already decided to implement energy-efficient [measure category] measures before you heard about BER?	IF Yes: Use FR1a IF DK OR REF OR No: FR1 = 0%
FR1a. [ASK IF FR1=1] I just want to make sure I understand - Before you decided to participate in BER, you had already made the decision to implement the energy- efficient [measure category] measures?	IF Yes: FR1 = 100% IF DK OR REF OR No: FR1 = 0%
PA2 Score:	IF Pre-FR1 = Yes: FR1 / 2 OTHERWISE: FR1
FR4. Level of influence (Scale 0 to 10) Factors a, b and c	FR4 = MAX(FR4a; FR4b; FR4c)
PA3 Score:	(10 – FR4) x 10%
FR3c. [ASK IF FR2≥ 5] IF BER had not been offered, what is the likelihood that you would have postponed implementing the [measure category] measures by at least one year?	FR3c = (10 – Answer) x 10% IF DK OR REF: FR3c = EMPTY

PA4 Score:	IF Pre-FR3 = Yes: FR3c / 2 OTHERWISE: FR3c
FR3b. [ASK IF MEASURE CATEGORY = LIGHTING AND TOTAL MEASURE CATEGORY QTY>1] If BER had <u>not been</u> offered, what is the likelihood that you would have implemented exactly the same <u>quantity</u> of lighting products that you installed through BER?	FR3b = Answer x 10% IF DK OR REF: FR3b = EMPTY
PA5 Score:	FR3b
Inconsistency Test PA1	IF ABS(FR2 - FR3a_1 or 3) ≥ 50% PA1 = MIN (FR2; FR3a_1 or 3)
Inconsistency Test PA2	IF FR1a = 100% AND FR2 < 70% PA2 = EMPTY
Inconsistency Test PA5	IF FR2 < 70% PA5 = EMPTY
Free-Ridership	IF MIN(PA4; PA5) < MEAN (PA1; PA2; PA3) FR = MEAN (PA1; PA2; PA3; MIN(PA4; PA5)) OTHERWISE FR = MEAN (PA1; PA2; PA3)
CI2/4a. [The company's previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] was a major factor in your decision to implement an energy-efficient measure. CI2/4b. [The company's previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted a company representative to ask a contractor or a technical staff member to examine the energy efficiency options for the facility. CI2/4c. [The company's previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted a company representative to take into account the cost-effectiveness of energy-efficient measures when evaluating different options for the facility. (Agree or Disagree)	CI = IF(CI2a OR CI4a = Agree; 1) + IF(CI2b OR CI4b = Agree; 1) + IF(CI2c OR CI4c = 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 XII

BER: MAIL-IN ALGORITHM FOR PARTICIPANT SPILLOVER CALCULATION

Participant spillover for BER Mail-in was measured using a participant survey conducted during the on-site visits. Participants were asked whether, following their participation in BER, they implemented any additional energy efficiency measures, without benefitting from any rebates or financing offered by ENS programs. If a participant did admit to having implemented additional recommended measures, another question was asked to quantify the level of influence the program had on the participant's decision to implement these additional measures. The value established regarding this level of influence was used to determine the portion of the additional savings attributable to the program. Then for each additional energy efficiency measure identified, the participant was asked a set of questions designed to identify the additional energy efficiency measures implemented and to quantify their associated savings (type of measure, quantity, efficiency level, etc.).

The level of participant spillover was established by dividing the total quantity of the additional savings attributable to the program by the total quantity of savings achieved by the program for all the survey respondents.

The figure below illustrates the methodology used to calculate the participant spillover level.

SO1. Have you installed additional energy efficiency measures other than those implemented through BER?	IF 1. Yes: CONTINUE IF 2. No OR DK OR REF: END
SO2. Did you receive, or plan on requesting, financing or rebates from 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 BER influence your decision to implement these additional energy efficiency measures on your own? (Scale 0 to 10)	SO3 = Answer x 10%
Attribution Level:	SO3
Spillover Savings:	SO3 x SO4
Final Spillover Level = $\frac{\text{SUM of (SO3 x SO4) for All Respondents}}{\text{SUM of Program Savings for All Respondents}}$	

APPENDIX XIII

BER: INSTANT REBATES EVALUATED SAVINGS

The following subsections present the 2018 evaluated savings values for each product type offered under BER Instant Rebates (referred to as recommended savings), followed by the adjustments made to the 2018 tracked savings to ensure values match 2016 evaluation results.

Linear LED Fixtures

Recommended Savings

The linear LED fixtures category contains four subcategories of products eligible under Instant Rebates. Table 9 below presents the 2016 evaluation recommended values to calculate the energy and peak demand savings of this category.

Table 9: Recommended Values for Linear LED Fixtures

Subcategory	Lumens Output (lm)	Baseline Wattage (W)	Hours of Use
1 x 4 Luminaires	1,500 – 3,500	61.00	4,410
	≥ 3,500	83.25	
2 x 2 Luminaires & Retrofit Kits	1,500 – 4,500	61.00	4,410
	≥ 4,500	84.00	
2 x 4 Luminaires & Retrofit Kits	3,000 – 6,500	88.00	4,410
	≥ 6,500	128.50	
Linear Ambient & Low Bay Luminaires	< 2,500	29.50	4,410
	2,500 – 5,000	58.00	
	5,000 – 10,000	112.00	
	≥ 10,000	200.00	

The efficient wattage is not included in the above table since the actual wattage of each product is used, which is the case for all products offered under Instant Rebates.

Revised Savings

Baseline and Efficient Wattages

The Evaluator reviewed each category to confirm that the appropriate baseline wattages were applied to the tracked savings as per Table 9 above. The Evaluator found that the correct baseline was applied, with the exception of a single transaction which impacted 84 fixtures. To validate efficient wattages, the Evaluator reviewed specification sheets for the five most frequently purchased LED fixtures in this category. The Evaluator found that the difference between the rated wattage and the tracked wattage was either nil or below 2 percent for four products and therefore did not make any revisions. The tracked wattage for one product exhibited a 4.2 percent difference from the rated wattage and was revised, thereby impacting 253 fixtures. For two fixtures, the efficient wattage was superior to the baseline wattage, suggesting that there was a data entry error. The Evaluator adjusted the efficient wattage by consulting the product specification sheets.

Hours of Use

The hours of use value of 4,410 hours was correctly applied to all data entries and, thus, no adjustments were made.

Overall Adjustment Ratios

The above corrections to baseline and efficient wattages resulted in an overall adjustment ratio of 1.000 for energy savings and 1.000 for peak demand savings.

Linear LED Lamps

Recommended Savings

The linear LED lamps category includes LED replacement lamps for both two-foot and four-foot fluorescent lamps. Table 10 below lists the variables recommended in the 2016 Evaluation Report for the savings calculations in this category. In 2018, ENS included U-bend replacement lamps and high-output LED lamps and defined the baseline wattage respectively as 31 W and 49 W in their Lighting Calculation document, based on the same reference⁸ as other linear LED linear lamp measures.

Table 10: Recommended Values for Linear LED Lamps

Subcategory	Baseline Wattage (W)	HOU
4-foot Replacement Lamps	32	4,410
2-foot Replacement Lamps	17	4,410
U-bend Replacement Lamps	31	4,410
4-foot High Output Replacement Lamps	49	4,410

⁸ Duke Energy Progress. Fixture Wattage Table. <http://www.ahutton.com/LED/Progress%20wattages.pdf> (Last accessed November 21, 2018).

Revised Savings

Baseline and Efficient Wattages

The Evaluator reviewed each category to confirm that the appropriate baseline wattages were applied to the tracked savings as per Table 10 above. The baseline wattages were incorrect for 14 tracking sheet entries, thereby impacting 982 lamps. The Evaluator reviewed the specification sheets for the five most frequently purchased LED lamps in this category and confirmed that ENS tracked the correct efficient wattages.

Hours of Use

The hours of use value of 4,410 hours was correctly applied to all data entries and, thus, no adjustments were made.

Overall Adjustment Ratios

The above corrections to baseline wattages resulted in an overall adjustment ratio of 1.009 for energy savings and 1.009 for peak demand savings.

General-use and Decorative LED Lamps

Recommended Savings

General-use and decorative LED lamps include omnidirectional A-type and globe lamps, as well as chandelier and candle type lamps. The recommended baseline wattages for LED general-use and decorative lamps are consistent with current federal energy efficiency regulations⁹ (which allow incandescent technology for decorative lamps but require using the efficiency level of incandescent halogen lamps for omnidirectional lamps). Baseline wattage and hours of use values are outlined in Table 11.

⁹ Natural Resources Canada. General Service Lamps and Modified Spectrum Incandescent Lamps, <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869>. (Last accessed February 28, 2018).

Table 11: Recommended Values for General-use and Decorative LED Lamps

Subcategory	Lumens (lm)	Baseline Wattage (W)	Hours of Use
LED Decorative (chandelier)	220	25	4,410
	314	40	4,410
	506	60	4,410
LED Omnidirectional (A-lamp and globe)	< 750	29	4,410
	≥ 750 and < 1,050	43	4,410
	≥ 1,050 and < 1,490	53	4,410
	≥ 1,490	72	4,410

Revised Savings

Baseline and Efficient Wattages

The Evaluator reviewed each category to confirm that the appropriate baseline wattages were applied to the tracked savings as per Table 11 above and found that incorrect baseline wattages were applied to five entries, thereby impacting 23 fixtures. The Evaluator reviewed the specification sheets for the five most frequently purchased lamps in this category and found no errors in tracked wattages. For five lamps, the efficient wattage was superior to the baseline wattage, suggesting that there was a data entry error. The Evaluator adjusted the efficient wattage by consulting the product specification sheets.

Hours of Use

The hours of use value of 4,410 hours was correctly applied to all data entries and, thus, no adjustments were made.

Overall Adjustment Ratios

The above corrections to baseline wattages resulted in an overall adjustment ratio of 1.014 for energy savings and 1.014 for peak demand savings.

Reflector LED Lamps

Recommended Savings

Reflector LED lamps include lamp types such as BR and PAR lamps. The baseline technology used by ENS for each of the four category sizes is halogen lamps. Table 12 lists the baseline wattage values and hours of use recommended for this product category.

Table 12: Recommended Values for Reflector LED Lamps

Subcategory	Baseline Wattage (W)	Hours of Use
Small LED Reflector Lamp - PAR, MR, MRX 16	20	4,410
Small LED Reflector Lamp - PAR, R 20	50	4,410
Large LED Reflector Lamp - PAR, BR, R 30/30L	50	4,410
Large LED Reflector Lamp - PAR, BR, R 38/40	65	4,410

Revised Savings

Baseline and Efficient Wattages

The Evaluator reviewed each category to confirm that the appropriate baseline wattages were applied to the tracked savings as per Table 12 above. The correct baseline wattages were applied to all data entries, thus, no adjustments were required. The Evaluator reviewed the specification sheets for the five most frequently purchased LED fixtures in this category and verified that tracked wattages had no errors beyond 2 percent compared to rated values. For two lamps, the efficient wattage was superior to the baseline wattage, suggesting that there was a data entry error. The Evaluator adjusted the efficient wattage by consulting the product specification sheets.

Hours of Use

The hours of use value of 4,410 hours was correctly applied to all data entries and thus no adjustments were made.

Overall Adjustment Ratios

There were no adjustments made to this category, thereby resulting in an overall adjustment ratio of 1.003 for energy savings and 1.003 for peak demand savings.

LED Downlight Fixtures

Recommended Savings

The LED downlight fixtures category includes recessed, ceiling-mounted, surface-mounted, and wall sconce fixtures, as well as solid-state and wall sconce retrofit kits. The recommended wattage values and annual hours of use for LED downlight fixtures are presented in Table 13 below. LED recessed fixture savings are based on a halogen lamp baseline with corresponding baseline wattages of 45 W, 90 W and 250 W, depending on lumens output. All other subcategories use incandescent halogen lamps as the baseline technology because these fixtures house general-use lamps that are subject to federal energy efficiency regulations.

Table 13: Recommended Values for LED Downlight Fixtures

Subcategory	Lumens	Baseline Wattage (W)	Annual Hours of Use
LED Recessed	≥ 400 and $< 1,000$	45	4,410
	$\geq 1,000$ and $< 3,000$	90	4,410
	$\geq 3,000$	250	4,410
LED Ceiling Mount, LED Surface Mount, LED Solid State Retrofit, LED Inseparable Solid State Luminaire, LED Wall Sconces, LED Wall Sconce Retrofit	< 750	29	4,410
	≥ 750 and $< 1,050$	43	4,410
	$\geq 1,050$ and $< 1,490$	53	4,410
	$\geq 1,490$	72	4,410

Revised Savings

Baseline and Efficient Wattages

The Evaluator reviewed each category to confirm that the appropriate baseline wattages were applied to the tracked savings as per Table 13 above. One LED recessed fixture was rated at 360 lumens and was assigned a 45 W baseline. The baseline was revised for six model numbers, thereby affecting a total of 480 fixtures.¹⁰ The Evaluator reviewed the specification sheets for the five most frequently purchased LED downlight fixtures in this category to verify that tracked wattages had no errors above 2 percent compared to rated values. Three models¹¹ required revisions, affecting 4,074 fixtures. For one fixture, the efficient wattage was superior to the baseline wattage, suggesting that there was a data entry error. The Evaluator adjusted the efficient wattage by consulting the product specification sheet.

Hours of Use

The hours of use value of 4,410 hours was correctly applied to all data entries and, thus, no adjustments were made.

Overall Adjustment Ratios

The above corrections to baseline and efficient wattages resulted in an overall adjustment ratio of 0.999 for energy savings and 0.999 for peak demand savings.

¹⁰ 4SHP3240BTS, 4SLSTP404DD-120V, 4WPLD3140r9, 65032, FMLWL 48 840, and SHLDP 48IN 40K 80CRI CHR.

¹¹ WF4 LED XXK, FM9WR40R and FM11WR40R.

Outdoor LED Fixtures

Recommended Savings

The outdoor LED fixtures category contains outdoor wall-mounted area luminaires, as well as the architectural flood and spot luminaires subcategories with the majority of fixtures belonging to the latter. In 2018, ENS added non-cutoff and semi-cutoff wall-mounted area luminaires to the service offer, which were previously covered only by Mail-in. The baseline wattages for these lamp categories correspond to the 2017 recommended values presented for outdoor full-cutoff wall-mounted area luminaires.

Both subcategories are divided into groups by lumens output to assign the correct baseline wattages, and the baseline technology used for each subcategory is different. Weighted averages of 50 percent metal halide (MH) and 50 percent high-pressure sodium (HPS) fixture system wattages were used by ENS to determine the baseline wattage values for outdoor full-cutoff wall-mounted area luminaires, as presented in Table 14.

Table 14: Recommended 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)	Annual Hours of Use
≥ 300 and < 2,000	43	46	44.5	4,380
≥ 2,000 and < 5,000	95	95	95.0	4,380
≥ 5,000 and < 15,000	295	250	272.5	4,380

The architectural flood and spot luminaires 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 recommended values is provided in Table 15 below. The baseline technologies were derived from the Duke Energy Fixture Wattage table.¹² The annual HOU for this category are 4,380 based on the common assumption of 12 hours of use per day since these luminaires are used for outdoor lighting.

¹² Duke Energy, *Fixture Wattage Table*, <http://www.ahutton.com/LED/Progress%20wattages.pdf> (Last accessed January 10, 2018).

Table 15: Recommended Values for Architectural Flood and Spot Luminaires

Lumens Range of Efficient Luminaires	Baseline Fixture	Baseline Wattage (W)	Annual Hours of Use
≥ 250 and < 1,000	Halogen	37	4,380
≥ 1,000 and < 5,000	MH (70 W)	95	4,380
≥ 5,000 and < 15,000	MH (250 W)	295	4,380
≥ 15,000 and < 30,000	MH (250 W x 2)	590	4,380
≥ 30,000 and < 50,000	MH (1,000 W)	1,080	4,380
≥ 50,000	MH (1,500 W)	1,610	4,380

Revised Savings

Baseline and Efficient Wattages

The Evaluator reviewed each category to confirm that the appropriate baseline wattages were applied to the tracked savings as per Table 14 and Table 15 above. The tracking sheet contained the correct baseline wattage for all fixtures and thus did not require adjustments. The Evaluator reviewed the specification sheets for the five most frequently purchased outdoor LED fixtures in this category to verify that tracked wattages had no errors above 2 percent compared to rated values. Four entries for one product were revised, and the remaining 279 entries for that product tracked the correct wattage value. For one fixture, the efficient wattage was superior to the baseline wattage, suggesting that there was a data entry error. The Evaluator adjusted the efficient wattage by consulting the product specification sheet.

Hours of Use

The hours of use value of 4,380 hours was correctly applied to all data entries and, thus, no adjustments were made.

Overall Adjustment Ratios

The above corrections to efficient wattage resulted in an overall adjustment ratio of 1.000 for energy savings and 1.000 for peak demand savings.

Directional and Architectural LED Fixtures

Recommended Savings

The directional and architectural LED fixtures category contains track or mono-point directional luminaires. The baseline technology is halogen lamps generating 17 lumens/W. The recommended variables for this category are listed in Table 16.

Table 16: Recommended Values for Directional and Architectural LED Fixtures

Category	Lumens	Baseline Wattage (W)	Annual Hours of Use
Track or Mono-point Directional Luminaires	≥ 250	60.4	4,410

Revised Savings

Baseline and Efficient Wattages

The Evaluator reviewed each category to confirm that the appropriate baseline wattages were applied to the tracked savings as per Table 16 above. The baseline was correct for all fixtures and thus required no adjustments. The Evaluator reviewed the specification sheets for the five most frequently purchased LED fixtures in this category to verify that tracked wattages had no errors above 2 percent compared to rated values. One product was revised, thereby affecting one fixture.

Hours of Use

The hours of use value of 4,410 hours was correctly applied to all data entries and, thus, no adjustments were made.

Overall Adjustment Ratios

The above corrections to efficient wattages resulted in an overall adjustment ratio of 1.000 for energy savings and 1.000 for peak demand savings.

Occupancy Sensors

Recommended Savings

Occupancy sensors are tracked as five different categories to distinguish the types of technologies. The recommended energy savings and peak demand savings are unitary values derived from the savings equations used in the 2015 Efficiency Vermont TRM,¹³ which are summarized in Table 17.

Table 17: Recommended Values for Occupancy Sensors

Type	Energy Savings (kWh/year)	Tracked SVG Value	Tracked Pconn Value (W)
Ceiling Remote-mounted	471	24%	517
Wall Remote-mounted	471	24%	517
Fixture Mounted	164	24%	180
Wall Switch	278	24%	305
Exterior	118	41%	76

¹³ Efficiency Vermont, *Technical Reference User Manual (TRM) Measure Savings Algorithms and Cost Assumptions*, March 2015.

These unitary savings values are derived from the algorithm used in the BER CIRx Screening Tool. The equation is as follows:

$$ES = P_{conn} \times SVG \times OTF \times ISR \times HRS/1000$$

Where:

- › *P_{conn}* is the connected wattage controlled by the occupancy sensor (varies by lighting control type)
- › *SVG* is the percentage of annual lighting energy savings (varies by lighting control type)
- › *OTF* is the operational testing factor (constant value = 1)
- › *ISR* is the in-service rate (assumed to be 100%)
- › *HRS* is the annual hours of operation (3,799 hours as per the metering study from which the percentages of annual lighting energy savings are derived)
- › 1,000 is the conversion factor from W to kW

Revised Savings

The Evaluator reviewed the tracked variables for each occupancy sensor type to confirm that the appropriate recommended values from Table 17 were applied. The values for *P_{conn}* and *SVG* were found to be accurate for all products; thus no revisions were required. Moreover, the Evaluator revised the HOU's for all occupancy sensors, from 4,065 hours per year to 3,799 hours per year.

Overall Adjustment Ratios

The above corrections to the value for hours of use resulted in an overall adjustment ratio of 0.934 for energy savings and 1.000 for peak demand savings.

Pumps

Recommended Savings

Pumps are divided into three categories based on the input wattage range of installed pumps, as per Table 18 below. Each input wattage corresponds to unitary savings values for energy and peak demand savings.

Table 18: Recommended Savings for Pumps

Type	Max Input Power (W)	Estimated DS (kW)	Estimated ES (kWh)
Variable Speed ECM Circulator Pump	< 150	0.088	422
	≥ 150 and < 500	0.165	795
	≥ 500 and < 2,500	0.532	2,558

Revised Savings

The Evaluator reviewed the five most common pumps to verify the tracked wattages were accurate and determined that all were accurate within 1 percent. Therefore no adjustments were made. All pumps were correctly categorized into tiers to determine tracked savings values, as per Table 18, and thus no adjustments were required.

Overall Adjustment Ratios

There were no adjustments made to this category, thereby resulting in an overall adjustment ratio of 1.000 for energy savings and 1.000 for peak demand savings.

APPENDIX XIV

BER: INSTANT REBATES EFFECTIVE USEFUL LIFE

This appendix presents the revised equivalent effective useful life (EUL) of product types offered in the BER Instant Rebates service. First, the EUL of lighting products are presented, followed by the other types of measures rebated through the program.

Lighting Products

The Evaluator applied the same methodology as in the 2017 DSM evaluation to consider increased baselines over the lifetime of general-use, decorative and reflector lamps, as well as LED downlight fixtures (which replace fixtures including general-use lamps). This analysis was based on current and projected Canadian regulations for general-service lamps. The Evaluator conserved the same years as the effective dates of each regulation; the only change made to the calculation is that the first year is now 2018 instead of 2017.

The Evaluator maintains the conclusion presented in 2017 DSM Evaluation Report which anticipates a baseline change in 2024. The regulation change will affect the baselines of general-use, decorative and reflector lamps, as well as downlight fixtures, for all of which a minimum efficiency of 45 lumens/watt is expected.

Since general-use, decorative and reflector lamps have EULs of less than six years, their equivalent EUL is not affected by the change in baseline expected to occur in 2024. In contrast, the equivalent EUL of downlight fixtures, for which the basecase is fixtures including A-type and reflector lamps, is impacted since its EUL is 11.3 years. For this category, the Evaluator established equivalent EULs for LED recessed fixtures and other LED downlight fixtures separately.

For LED recessed fixtures, basecase fixtures mostly use reflector lamps, so the baseline is halogen lamps. As mentioned previously, Canadian regulation changes are expected to impact the market in 2024, which will increase the baseline to a CFL equivalent. The equivalent EUL calculation for LED recessed fixtures is based on 9 W lamps being the most common efficient measure purchased in this subcategory of Instant Rebates for 2018. With the information presented in Table 19 below, the following equation was used to establish the equivalent EUL to be applied to first-year savings to determine lifetime energy savings.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen}} \times 6 \text{ Years} + \Delta W_{\text{CFL}} \times 5.3 \text{ Years}}{\Delta W_{\text{Halogen}}} = 7.6 \text{ Years}$$

Table 19: Baseline Evolution During the Effective Useful Life of LED Recessed Fixtures

Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Baseline 6 Years (2018-2023)		CFL Equivalent Baseline American Legislation 5.3 Years (2024-2029)	
		Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)
45	9	45	36	20	11

The same methodology was used for the remaining LED downlight fixtures, which house A-type lamps, using the information presented in Table 20 below and the following equation. Again, the equivalent EUL calculation is based on 9 W lamps being the most common measure purchased among A-types in Instant Rebates for 2018.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen Incandescent}} \times 6 \text{ Years} + \Delta W_{\text{CFL}} \times 5.3 \text{ Years}}{\Delta W_{\text{Halogen Incandescent}}} = 7.7 \text{ Years}$$

Table 20: Baseline Evolution During the Effective Useful Life of LED Non-recessed Fixtures

Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Incandescent Baseline 6 Years (2018-2023)		CFL Equivalent Baseline American Legislation 5.3 Years (2024-2029)	
		Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)
43	9	43	34	20	11

For measures other than general-service lamps, there is no indication that regulations will change over the lifetime of these measures. In the case of linear ambient luminaires, linear replacement lamps, and MH lamps, the baseline products are already considered efficient, which further suggests that regulations will not be changed in the near future.

Other Measures

Instant Rebates also offers rebates for occupancy sensors and pumps. ENS tracked an EUL value of 10 years for occupancy sensors and 15 years for pumps, as in 2017, which corresponds to the values recommended in the 2017 DSM Evaluation Report.

APPENDIX XV

BER:INSTANT REBATES ALGORITHM FOR FREE-RIDERSHIP CALCULATION

The figure below present the algorithms for calculating the free-ridership level of Instant Rebates measures, along with the participant survey questionnaire. The latter included questions designed to assess variables such as planning, quantity, efficiency, timing, cost, and program influence. Each group of questions was transposed into a level of program attribution, which was then used to calculate the free-ridership level associated with each participant. The Instant Rebates distributor interview guide included questions designed to assess variables such as quantity, cost, and influence of the service.

BER Instant Rebates – Participant Survey

FR3. If your organization had not received the rebate and the cost for [PRODUCT] had been about \$[REBATE AVERAGE VALUE BY CATEGORY] higher, would you have paid the full cost of the [PRODUCT]? (Scale 0 to 10)	IF DK OR REF: FR3 = EMPTY OTHERWISE: FR3 = Answer x 10%
FR3a. If BER rebate had <u>not been</u> offered, what is the likelihood that you would have purchased the exact same model of premium lighting products? (Scale 0 to 10)	IF DK OR REF: FR3a = EMPTY OTHERWISE: FR3a = Answer x 10%
PA1 Score:	MEAN VALUE OF: (FR3; FR3a)
FR1b. Had you <i>already</i> decided to purchase [PRODUCT] <i>before</i> knowing the price of those products?	IF Yes: FR1 = 100% IF DK OR REF OR No: FR1 = 0%
PA2 Score:	FR1
FR4. Level of influence (Scale 0 to 10) Factors a, b, c and d	FR4 = MAX(FR4a; FR4b; FR4c; FR4d)
PA3 Score:	(10 – FR4) x 10%
FR3b. [ASK IF TOTAL MEASURE CATEGORY QTY>1] If the rebate had <u>not been</u> offered, what is the likelihood that you would have purchased exactly the same <u>quantity</u> of lighting products that you bought?	FR3b = Answer x 10% IF DK OR REF: FR3b = EMPTY
FR3c. [ASK IF FR3≥5] If the program rebate had <u>not been</u> offered, what is the likelihood that you would have postponed the purchase of the lighting products by at least one year?	FR3c = (10 – Answer) x 10% IF DK OR REF: FR3c = EMPTY

PA4 Score:	Min (FR3b; FR3c)
Inconsistency Test PA1	IF ABS(FR3 - FR3a) ≥ 50% PA1 = MIN (FR3; FR3a)
Inconsistency Test PA2	IF FR1 = 100% AND FR3 < 70% PA2 = EMPTY
Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3): MEAN (PA1; PA2; PA3; PA4) OTHERWISE MEAN (PA1; PA2; PA3)
CI2/4a. [Your organization's previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] was a major factor in your decision to implement an energy-efficient measure. CI2/4b. [Your organization's previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted a company representative to ask a contractor or a technical staff member to examine the energy efficiency options for the facility. CI2/4c. [Your organization's previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted a company representative to take into account the cost-effectiveness of energy-efficient measures when evaluating different options for the facility. (Agree or Disagree)	CI = IF(CI2a OR CI4a = Agree; 1) + IF(CI2b OR CI4b = Agree; 1) + IF(CI2c OR CI4c = Agree; 1)
Revised Free-Ridership	IF CI = 0 OR 1, Revised FR = FR IF CI = 2, Revised FR = FR*.75 IF CI = 3, Revised FR = FR*.50

BER Instant Rebates – Distributor Interviews

FR1. [ASK IF SALES DATA AVAILABLE] If the current trend is maintained, you should sell [FROM SAMPLE: fewer / more] [EFFICIENT PRODUCT] by the end of 2018 than the number of units you sold in 2017. Does this sound accurate? If so, what explains this shift? [ASK IF SALES DATA NON AVAILABLE] If the current trend is maintained, do you think you will sell more, less or the same number of [EFFICIENT PRODUCT] by the end of 2018 than the number of units you sold in 2017? If "more" or "less", how do you explain the difference?	IF DK OR REF: FR1 = EMPTY OTHERWISE: FR1 = Answer
FR2. In 2018, BER provided a per-unit incentive ranging from [REBATE RANGE], depending on the type of [EFFICIENT PRODUCT]. If this incentive had not been offered this year, would the number of [EFFICIENT PRODUCT] you will sell in 2018 have been about the same or lower? 1. Same [GO TO FR2a] 2. Lower [GO TO FR2b] 98. (Don't know) [GO TO FR4] 99. (Refused) [GO TO F4]	IF DK OR REF: FR2 = EMPTY OTHERWISE: FR2 = Answer
FR2a. [IF FR2 = SAME] Just to confirm... without the program incentive, you would have sold the same number of [EFFICIENT PRODUCT] this year? RECORD EXPLANATION:	IF YES: FR2a = 0% OTHERWISE: Use FR2b
FR2b. [IF FR2 = LOWER] In your estimation, by what percentage would the number of [EFFICIENT PRODUCT] you sold have been <u>lower</u> in 2018 if BER incentive was not available? RECORD PERCENTAGE ____% RECORD EXPLANATION:	FR2b = Answer %
PA1 Score:	100 % – (FR2a or FR2b)
FR4. I am interested in understanding the impact of BER on customers' product choice. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on your customers' choice of [EFFICIENT PRODUCT] instead of [BASELINE PRODUCT]? RECORD RATING: ____ RECORD EXPLANATION:	FR4 = Answer
PA2 Score:	(10 - FR4) x 10 %
FR6. Is the incentive ranging from [REBATE RANGE] per fixture enough to encourage customers who would not have done so otherwise to purchase [EFFICIENT PRODUCT]? Why?	FR6 = Answer
FR7. Through BER, only products meeting program's criteria, such as DLC or ENERGY STAR certifications, are eligible for rebate. I would like to understand the impact of BER on the models of products your company carries. Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important", how would you rate the program's influence on the proportion of DLC certified [EFFICIENT PRODUCT] carried by your company? RECORD RATING: ____ RECORD EXPLANATION:	FR7 = Answer
PA3 Score:	(10 – FR7) x 10%
Inconsistency Test PA1, PA2, PA3	IF EXPLANATION DOES NOT FIT PERCENTAGE/RATING PA SCORE = EMPTY
Free-Ridership	MEAN (PA1; PA2; PA3)

APPENDIX XVI

BER: 2018 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2018 evaluation, as well as all 2017 evaluation recommendations that were not fully implemented.

Sections	Recommendations
Executive Summary	1. Review BER logic model and eligibility criteria to ensure that the intended projects and participants go through each service. As evidenced by the process evaluation, no project types are exclusive to either service and many sold measures overlap the two services. Despite these similarities, the Evaluator also found that a significant proportion of Instant Rebates measures are installed in residential applications that would not be eligible for a Mail-in incentive. A review of the logic model and eligibility criteria would clarify the purpose of the similarities and differences between the two services and realign BER design in relation to its objectives. This review would result in a better definition of target participants and measures, which would in turn improve BER performance as well as the accuracy of the performance and savings assessment.
	2. Implement a system that enables connecting Instant Rebates sales data to participants. While ENS implemented the Evaluator's past recommendations to improve Instant Rebates participant tracking, the information to fully capture the actual Instant Rebates market is still fairly limited, rendering it challenging to adjust savings assumptions to represent average conditions. One challenge, in particular, is clearly knowing whether Instant Rebates measures were purchased by contractors or end users and how many units were purchased by each of these types of participants. The Evaluator recommends that ENS implement a system that allows tracking sales and linking them to participating individuals. This would enable the Evaluator to collect more specific data from these individuals and gain a better sense of what their sales represent compared to overall service sales.
	3. Investigate ways to liaise more clients with non-lighting contractors. Contractors are key players in achieving the goal of implementing more non-lighting measures through BER and ENS programs overall. Fewer interviewed participants have go-to non-lighting contractors than lighting contractors for potential projects. The Evaluator recommends findings ways to connect participants to non-lighting contractors and training the latter to further promote non-lighting projects.
	4. Analyze the incentive levels for non-lighting measures with a higher payback period. Meeting company payback thresholds remains a key barrier to implementing non-lighting measures among participants. The Evaluator recommends that ENS assess possible ways of pushing more participants toward non-lighting measures that typically have longer payback periods. While actively promoting the energy and non-energy benefits of measures might be enough to push some participants to implement non-lighting measures, for other participants whose companies require specific payback thresholds before any energy efficiency project is approved, an ENS review of incentive levels for at least a few high-potential measures might be needed.

Sections	Recommendations
2017 Recommendation (Not fully implemented at the time of evaluation)	5. Identify opportunities to diversify the portfolio of projects completed through BER Mail-In. As demonstrated in the 2017 evaluation, lighting projects account for over 60 percent of gross savings in BER Mail-in. Since Instant Rebates is designed to offer almost exclusively lighting products, Mail-in is the best option to diversify the BER portfolio which generates the most savings of all ENS program components. With LED lighting products becoming increasingly popular and transforming the lighting market, ENS is at risk of seeing its savings decline for this service. The Evaluator expects to see continued increases in both free-ridership and baselines as the technology is more widely adopted. Therefore, the Evaluator recommends that ENS identify BNI sectors that are currently underrepresented in the Mail-in service and that could potentially generate significant savings.



ECONOLER

CUSTOM INCENTIVES PROGRAM

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Final Report

March 15, 2019



ECONOLER

research>into>action^{inc}

 equilibrium
engineering

ABBREVIATIONS

ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
BAS	Building automation system
BDM	Business development manager
BER	Business Energy Rebates
BNI	Business, non-profit and institutional
CRA	Corporate Research Associates
DSM	Demand-side management
EMIS	Energy Management Information System
ENS	Efficiency Nova Scotia
ETN	Efficiency Trade Network
EUL	Effective useful life
GHG	Greenhouse gas
HVAC	Heating, ventilation and air conditioning
IPMVP	International Performance Measurement and Verification Protocol
M&V	Measurement and verification
NSP	Nova Scotia Power
NTGR	Net-to-gross ratio
PCF	Peak coincidence factor
QA	Quality assurance
SEM	Strategic Energy Management
SP	Service Provider

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

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

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

TABLE OF CONTENTS

EXECUTIVE SUMMARY	X
INTRODUCTION	1
1 CUSTOM OVERVIEW	3
1.1 Description	3
1.2 Follow-up on 2017 Evaluation Report Recommendations	4
1.3 Participation History	5
2 CUSTOM EVALUATION OBJECTIVES AND METHODOLOGY	9
3 RETROFIT MARKET EVALUATION	12
4 RETROFIT IMPACT EVALUATION	13
4.1 Gross Savings	13
4.1.1 Sampling Methodology	13
4.1.2 Project Review Findings	13
4.1.3 Interactive Effects	14
4.1.4 Effective Useful Life	15
4.1.5 Revised Gross Savings	15
4.2 Net-to-gross Ratio	17
4.2.1 Free-ridership	17
4.2.2 Participant Spillover	17
4.2.3 NTGR Calculation	18
4.3 Net Savings	18
5 NEW CONSTRUCTION MARKET AND PROCESS EVALUATION	20
5.1 Overview of Interviewed SPs	20
5.2 Awareness of the Service and Engagement with ENS	20
5.3 Satisfaction with New Construction	21
5.4 Benefits of New Construction	22
5.5 Barriers to Participation	23
5.6 Suggestions for Increasing Participation	23
5.7 Process and Market Evaluation Summary	25
6 NEW CONSTRUCTION IMPACT EVALUATION	26
6.1 Gross Savings	26
6.1.1 Project Review Findings	26
6.1.2 Interactive Effects	27
6.1.3 Effective Useful Life	27
6.1.4 Revised Gross Savings	28

6.2	Net-to-gross Ratio.....	29
6.2.1	Free-ridership	29
6.3	Net Savings.....	30
7	BUILDING OPTIMIZATION MARKET EVALUATION.....	31
8	BUILDING OPTIMIZATION IMPACT EVALUATION.....	32
8.1	Gross Savings.....	32
8.1.1	Project Review Findings	32
8.1.2	Interactive Effects	33
8.1.3	Effective Useful Life.....	33
8.1.4	Revised Gross Savings	33
8.2	Net-to-gross Ratio.....	34
8.3	Net Savings.....	35
9	OVERALL SAVINGS FOR CUSTOM	36
10	CUSTOM RECOMMENDATIONS.....	37
11	EMIS OVERVIEW.....	39
11.1	Description	39
11.2	Follow-up on 2017 Evaluation Report Recommendations.....	40
11.3	Participation History.....	40
12	EMIS EVALUATION OBJECTIVES AND METHODOLOGY.....	42
13	EMIS MARKET EVALUATION	44
14	EMIS IMPACT EVALUATION	45
14.1	Impact Definitions.....	45
14.2	Gross Savings.....	46
14.2.1	Project Review Findings	46
14.2.2	Interactive Effects	48
14.2.3	Effective Useful Life.....	48
14.2.4	Revised Gross Savings	49
14.3	Net-to-gross Ratio.....	50
14.4	Net Savings.....	50
15	SEM OVERVIEW.....	52
15.1	Description	52
15.2	Follow-up on 2016 Evaluation Report Recommendations.....	52
15.3	Participation History.....	54
16	SEM EVALUATION OBJECTIVES AND METHODOLOGY.....	55
17	SEM MARKET EVALUATION	57

18 SEM IMPACT EVALUATION	58
18.1 Gross Savings	58
18.1.1 Project Review Findings	58
18.1.2 Interactive Effects	59
18.1.3 Effective Useful Life	59
18.1.4 Revised Gross Savings	61
18.2 Net-to-gross Ratio	62
18.3 Net Savings	63
19 EMIS AND SEM RECOMMENDATIONS	65
20 OVERALL SAVINGS FOR THE CUSTOM INCENTIVES PROGRAM	66
CONCLUSION	67

LIST OF TABLES

Table 1: 2018 Overall Participation and Savings for Custom Incentives	x
Table 2: Retrofit Net-to-gross Ratio	xii
Table 3: Comparison of Tracked and Evaluated Savings at the Generator for Custom	xv
Table 4: Comparison of EMIS Tracked and Evaluated Savings at the Generator	xix
Table 5: Comparison of SEM Tracked and Evaluated Savings at the Generator	xxiii
Table 6: Types of Evaluations Conducted for Each Program Component	2
Table 7: Implementation Status of the 2017 Recommendations for Custom	4
Table 8: Example of a True-up Adjustment	16
Table 9: Revised Gross Energy and Peak Demand Savings for Retrofit	16
Table 10: Evaluated Net Energy and Peak Demand Savings for Retrofit	19
Table 11: Barriers to Participation	23
Table 12: Types of Buildings Served by SPs	24
Table 13: Revised Gross Energy and Peak Demand Savings for New Construction	28
Table 14: Evaluated Net Energy and Peak Demand Savings for New Construction	30
Table 15: Revised Gross Energy for Building Optimization	34
Table 16: Comparison of Tracked and Evaluated Savings at the Generator for Custom	36
Table 17: Implementation Status of the 2017 Recommendations for EMIS	40
Table 18: Definition of Terms Related to SEM and EMIS	45
Table 19: EMIS Revised Gross Energy and Peak Demand Savings	49
Table 20: Comparison of EMIS Total Tracked and Evaluated Savings at the Generator	51
Table 21: Implementation Status of the 2016 Recommendations for SEM	53
Table 22: SEM Revised Gross Energy and Peak Demand Savings	62
Table 23: SEM Revised Gross Energy and Peak Demand Savings	63
Table 24: Comparison of SEM Total Tracked and Evaluated Savings at the Generator	64
Table 25: 2018 Overall Participation and Savings for Custom Incentives	66

LIST OF FIGURES

Figure 1: Overview of Custom Performance, 2012-2018.....	xi
Figure 2: EMIS Performance Overview, 2015-2018	xviii
Figure 3: SEM Performance Overview, 2015-2018	xxi
Figure 4: Overview of Participation in Retrofit, 2012-2018	6
Figure 5: Overview of Participation in New Construction, 2012-2018.....	7
Figure 6: Overview of Participation in Building Optimization, 2014-2018	8
Figure 7: Methodological Model for Custom	9
Figure 8: Participant Satisfaction with Retrofit	12
Figure 9: Participant Satisfaction with New Construction	22
Figure 10: Summary of Participation in EMIS, 2015-2018.....	41
Figure 11: Summary of Gross Savings for EMIS, 2015-2018.....	41
Figure 12: Methodological Model for EMIS	42
Figure 13: Summary of Participation in SEM, 2015-2018.....	54
Figure 14: Summary of Gross Savings for SEM, 2015-2018.....	54
Figure 15: Methodological Model for SEM	55

EXECUTIVE SUMMARY

This report presents the results of the 2018 evaluation of the demand-side management (DSM) Custom Incentives program comprised of three components: (1) Custom; (2) Energy Management Information Systems (EMIS); and (3) Strategic Energy Management (SEM).

Table 1 below provides an overview of participation levels, net-to-gross ratios (NTGRs) as well as evaluated gross and net savings for each Custom Incentives program component and for the program as a whole.

Table 1: 2018 Overall Participation and Savings for Custom Incentives

	Participation Level	Gross Savings	NTGR	Net Savings
Custom				
Energy Savings	69 projects completed	14.315 GWh	0.81	11.603 GWh
Lifetime Energy Savings		196.661 GWh	0.79	156.077 GWh
Peak Demand Savings		1.695 MW	0.71	1.200 MW
EMIS				
Energy Savings	2 participants	1.616 GWh	1.00	1.616 GWh
Lifetime Energy Savings		3.655 GWh	1.00	3.655 GWh
Peak Demand Savings		0.051 MW	1.00	0.051 MW
SEM				
Energy Savings	4 participants	1.548 GWh	0.94	1.455 GWh
Lifetime Energy Savings		4.645 GWh	0.94	4.365 GWh
Peak Demand Savings		0.199 MW	0.95	0.190 MW
Total				
Energy Savings		17.479 GWh		14.674 GWh
Lifetime Energy Savings		204.961 GWh		164.097 GWh
Peak Demand Savings		1.945 MW		1.440 MW

Custom Overview

Custom provides business, non-profit and institutional (BNI) organizations with technical assistance, financial incentives, and project financing to help reduce their electricity consumption and demand. The current suite of services offered through Custom is as follows:

Retrofit: Provides eligible organizations with technical and financial support to help them conduct scoping and feasibility studies and implement technical improvements in their facilities where a customized and flexible approach is better suited.

New Construction: Provides eligible organizations with incentives to help them achieve significant and predictable electrical energy savings in new BNI buildings, as well as in additions to buildings and major renovations in existing buildings.

Building Optimization: Supports the implementation of no-cost or low-cost energy efficiency measures identified through a recommissioning process.

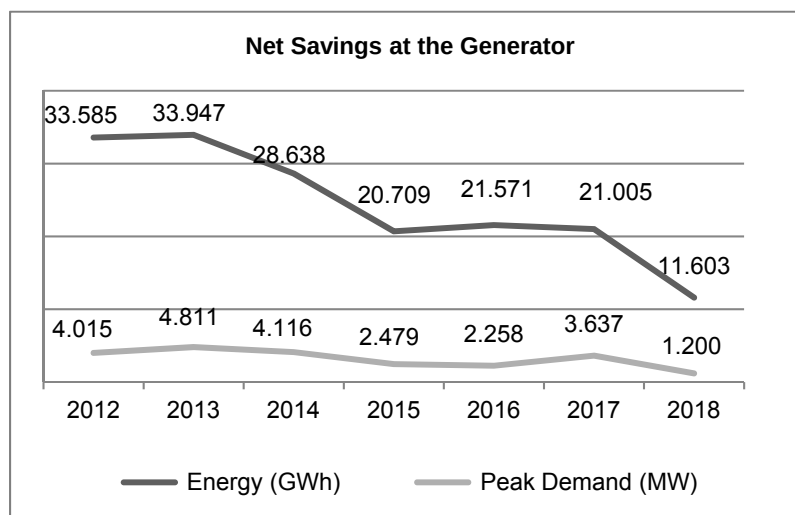
For each service, three types of savings can be claimed: (1) partial savings for projects started but not completed in 2018; (2) final savings of projects started and completed in 2018; and (3) final savings of multi-year projects.

Custom Key Findings

Custom Performance

Custom aimed to achieve 24.2 GWh in net electrical energy savings and 2.4 MW in net peak demand savings at the generator in 2018. Overall, 79 projects generated savings, among which 69 projects were completed. The Evaluator determined that Custom achieved 11.603 GWh in net electrical energy savings and 1.200 MW in net peak demand savings at the generator in 2018. These savings represent 7,024 tonnes of CO₂ eq in terms of annual avoided greenhouse gas (GHG) emissions. Custom's net lifetime energy savings were established at 156.077 GWh, which yields a weighted average effective useful life (EUL) value of 13.5 years. Figure 1 below illustrates the evolution in net electrical energy and peak demand savings at the generator from 2012 through 2018.

Figure 1: Overview of Custom Performance, 2012-2018



Retrofit

Retrofit accounted for both 77 percent of Custom savings and 84 percent of Custom projects completed in 2018 (58 of the 69 projects with final savings being claimed in 2018). The number of completed projects increased with respect to 2017 that had 46 projects claim final savings.

The 2018 Retrofit evaluation included reviews of 25 projects for which both project file reviews and on-site visits were conducted. The Evaluator used these site visits as an opportunity to ask participants about their satisfaction with Retrofit. Overall satisfaction was very high among participants, with the assistance of Efficiency Nova Scotia (ENS) being praised. Many participants also expressed being very satisfied with the outcomes and results of their projects.

Again in 2018, the Evaluator noticed an improvement in the documentation of Retrofit projects. A new quality assurance (QA) workbook was implemented, which made it easier to follow the changes in the savings value from the project development agreement to the final savings value. Importantly, the implementation of the QA procedures is still incomplete; the Evaluator found that three of the five project savings adjustments were higher than 10 percent due to either savings calculations that did not match final project parameters or insufficient documentation to back up the savings claims. It is expected that, as ENS continues to implement the new QA procedures, the accuracy of reported savings will improve. Another element that is yet to be improved is the inclusion of non-routine adjustments in measurement and verification (M&V) calculations when facilities undergo changes in their operating conditions that are not due to implemented energy efficiency measures. The Evaluator identified two projects where such adjustments should have been made, but the required data was not collected. Also, adjustments to the peak demand savings were more frequent and of higher magnitude than for energy savings, in large part because peak coincidence factors (PCFs) were often not taken into account correctly. There were also three projects for which peak demand savings had been omitted by ENS. Based on the 25 projects sampled, the savings adjustment ratios were established at 0.948 and 0.825 for energy and peak demand savings respectively.

To establish the 2018 NTGR, the Evaluator used the free-ridership and spillover levels measured through the questionnaire administered during the on-site visits with 24 Retrofit participants. The free-ridership level was established at 14 percent, an increase of a few percent compared to previously measured levels (it varied between 8% and 10% in previous years), while spillover remained nil. Table 2 lists the elements considered to obtain a NTGR of 0.86.

Table 2: Retrofit Net-to-gross Ratio

	Retrofit
Free-ridership Level	14%
Spillover Level	0%
Net-to-gross Ratio	0.86

In 2018, Retrofit generated 8.919 GWh in net electrical energy savings and 0.673 MW in net peak demand savings at the generator. These savings represent 5,464 tonnes of CO₂ eq of avoided annual GHG emissions. The net lifetime energy savings were established at 122.135 GWh, which yields an average EUL value of 13.7 years.

New Construction

In 2018, five projects were completed through New Construction. A detailed technical review, including a site visit and a simulation review, was performed for four of the completed projects. Additionally, a process and market evaluation of New Construction was carried out in 2018 by conducting eight interviews with service providers (SPs) and gathering participant feedback during the site visits.

New Construction Process and Market Evaluation

The key research question identified by previous evaluations and ENS staff was how to increase participation in New Construction. The evaluation aimed to answer this question by understanding SP awareness levels about the service, SP and participant satisfaction, as well as SP challenges and suggestions for increasing participation.

Since New Construction projects require an SP to carry out at least a portion of the work, the Evaluator assessed how often SP clients ask about ENS incentives and whether SPs promote ENS incentives. While SPs reported mentioning ENS incentives in their communications with clients, they also mentioned that not all their clients ask about ENS incentives. In spite of the high number of individuals or parties involved in New Construction projects (e.g. modellers, contractors, SPs), unless a sustainability team is assigned to the project or the client asks specifically for applicable energy efficiency incentives, the search for such incentives may not occur. Additionally, some of the interviewed SPs were not sure if they were members of the Efficiency Trade Network (ETN); ETN is a publicly available list of contractors and energy efficiency professionals published by ENS. Other interviewed SPs provided an inaccurate membership status.

Participants were satisfied with their relationship with ENS staff and found them helpful and prompt in providing responses. Participants were also satisfied with the overall service provided by ENS. Speeding up the payment process along with providing better definitions about the steps and requirements of New Construction were viewed as the two main areas that needed improvement. Not understanding the service requirements at the various project stages was actually the main challenge encountered by SPs. One SP also mentioned not understanding against which base case efficient designs must be measured. Additionally, SPs identified fear among participants that they have to alter their project timeline to accommodate service requirements, which constituted the main barrier to New Construction participation.

SPs observed many benefits to New Construction, including its ability to offset capital expenditures and provide improved forecasts of building operating costs and more information about the energy efficiency levels of new buildings. SPs perceived untapped opportunities in the commercial sector because fewer commercial clients than institutional clients approach them to complete new construction projects. SPs also recommended that ENS develop deeper connections with local trade and professional associations to increase awareness about the New Construction service.

New Construction Impact Evaluation

During the site visits, the Evaluator found that all energy efficiency measures had been implemented for the four visited projects. The energy savings were reduced by 36 percent for those four projects because errors in the energy models were found. For two projects, the reference building energy model was modified because the base case assumptions were not representative of the building that would have been built in the absence of the service. For three projects, the proposed building model was adjusted because the mechanical systems or their operation conditions were not modelled as per the conditions observed during the on-site visits. Peak demand savings were increased by 37 percent; the revised values were obtained by averaging the monthly peak demand reductions calculated by the revised energy models for the months of December, January and February.

Since 2018, ENS uses the building code as the base case for gross savings instead of having a participant-specific base case that yields net savings. Consequently, the Evaluator measured free-ridership using participant questionnaires in order to calculate net savings. The average free-ridership level was established at 36 percent and was applied to all New Construction savings. Spillover was not measured for New Construction and, as a result, the NTGR applied was 0.64.

In 2018, New Construction generated 1.500 GWh in net electrical energy savings and 0.500 MW in net peak demand savings at the generator. These savings represented 835 tonnes of CO₂ eq in avoided annual GHG emissions. The net lifetime energy savings were established at 25.960 GWh, yielding a weighted average EUL value of 17.3 years.

Building Optimization

In 2018, six projects were completed through Building Optimization service. The 2018 evaluation included a review of three of those projects for which both a project file review and an on-site visit was conducted. Similarly as for the other two services, the Evaluator gathered participant feedback about the service during these site visits.

Overall satisfaction with Building Optimization was very high among all participants who especially appreciated the streamlined approach of the service and the energy savings from the implemented measures. None of the three interviewed participants ran into challenges during participation and could not propose improvement recommendations.

The Evaluator reviewed three of the six Building Optimization projects completed in 2018, which represented all projects completed at the time the site visits took place. Although projects were carried out as intended, the Evaluator reduced the tracked energy savings by 39 percent and the peak demand savings by 22 percent. These adjustments were mostly due to incorrect engineering calculations. For instance, the load factor of motors had not been taken into account and heating degree days were not used appropriately in heating load calculations. These reductions were only applied to the three reviewed projects because the small sample size did not allow extrapolation.

The NTGR was assumed to be 1.00 for Building Optimization, as per interviews conducted with participants during on-site visits.

In 2018, Building Optimization generated 1.184 GWh in net electrical energy savings and 0.027 MW in net peak demand savings at the generator. These savings represent 725 tonnes of CO₂ eq in avoided annual GHG emissions. The net lifetime energy savings were established at 7.981 GWh, yielding a weighted average EUL value of 6.7 years.

Custom Energy Savings

Table 3 below compares the total tracked and evaluated savings for Custom, including savings from Retrofit, New Construction and Building Optimization.

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

	Initial Gross Savings	Adjusted Gross Savings	NTGR*	Net Savings
Energy Savings				
Tracked Savings from ENS	16.416 GWh	16.416 GWh	0.91	14.944 GWh
Evaluation Results	16.416 GWh	14.315 GWh	0.81	11.603 GWh
Peak Demand Savings				
Tracked Savings from ENS	1.814 MW	1.814 MW	0.90	1.636 MW
Evaluation Results	1.814 MW	1.695 MW	0.71	1.200 MW
* The NTGR was different for each component. The NTGRs listed in this table match the rounded averages obtained by dividing net savings by adjusted gross savings.				

The evaluated gross energy savings are 13 percent below the tracked value. This reduction is mostly due to New Construction and Building Optimization service's whose gross energy savings were reduced by 30 percent and 25 percent respectively. As for Retrofit, which accounted for 75 percent of Custom gross savings, a smaller adjustment was made to savings, resulting in an approximate reduction of 7 percent. The NTGR was also revised downward because the free-ridership for Retrofit increased compared to previous years, and the evaluated free-ridership for New Construction was also higher than the value tracked by ENS. Overall, the evaluated net energy savings for Custom are 22 percent below the tracked value.

The gross peak demand savings were adjusted downward by a larger margin than energy savings, especially for Retrofit. In addition, the decrease in the NTGR was more severe than for energy savings because a greater portion of peak demand savings were achieved in New Construction, which had the lowest NTGR of all three services. Overall, the evaluated net peak demand savings for Custom are 27 percent below the tracked value.

Custom Recommendations

Although the number of completed Retrofit projects increased and Retrofit remains the main contributor to overall Custom savings, Retrofit savings decreased significantly in 2018 compared to 2017. New Construction and Building Optimization participation levels remained similar to the past few years with only a handful of completed projects. Increasing participation in New Construction was actually the primary focus of the 2018 process and market evaluation. Interviewed participants and SPs mentioned challenges understanding New Construction steps and requirements, which led the Evaluator to conclude that this aspect of the service requires improvement.

In addition to the general recommendations presented for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator makes the following recommendations aimed at improving Custom. Recommendations to improve EMIS and SEM are presented further below in this Executive Summary. These recommendations are also included in Appendix IX.

2018-Custom-R1. Improve communication to SPs and participants about the various New Construction steps and corresponding service requirements. As previously mentioned, the key aspect of New Construction mentioned as problematic by participants and SPs is the lack of clear communication about service steps and requirements, with one SP mentioning not understanding the base case against which efficient designs need to be assessed. Additionally, there is a perception that projects cannot fit within the New Construction service timeline, which pushes some clients away from the service according to SPs. Clearer and sustained information about New Construction is recommended. Improved communication should include a clear and concise process chart, along with detailed checklists of what is required at each step of the participation process as well as timelines to complete each step. Clearer directions on the appropriate modelling approach would also reduce adjustments made to tracked savings and improve the quality of energy models. Given the small number of completed projects each year, the Evaluator encourages as much as possible a personalized follow-up approach and regular check-ins on projects to ensure that they progress how they should.

2018-Custom-R2. Further engage new and existing SPs and make them stronger advocates for New Construction. Interviewed SPs often could not accurately recall their membership status with ENS' ETN. In addition, the relative lack of modellers, architects and general contractors within the ETN suggests that there is an opportunity to engage those parties more in the service. Having more professionals in the ETN would allow ENS another communication channel to reach these professionals and share information about New Construction. Recruiting modellers, architects and general contractors and making the service more top-of-mind could be particularly important to expanding New Construction participation because such professionals are typically involved in the early stages of construction projects and may influence decisions to participate in the service. ENS could also engage with new trade associations and enhance relationships with associations they already know. This would serve to reinforce the service ENS offers to professionals. Reaching out to trade associations should not be limited to Nova Scotia because some SPs come from other provinces to work on projects.

Energy Management Information System

The main goal of EMIS is to assist industrial businesses and institutions in making real-time decisions about their processes using energy consumption data from metered systems. To achieve this goal, EMIS provides participants with the funding required to audit their systems (EMIS audit), develop an energy management information system implementation plan (EMIS implementation plan) and install the metering and monitoring equipment (implementation of EMIS). This program component also provides training and organizational support to help convert energy performance information into action, thereby allowing participants to achieve energy savings.

The 2018 EMIS evaluation was based on a program component documentation review, interviews with the program manager, and a review of two projects (including a phone or site visit interview with each participant).

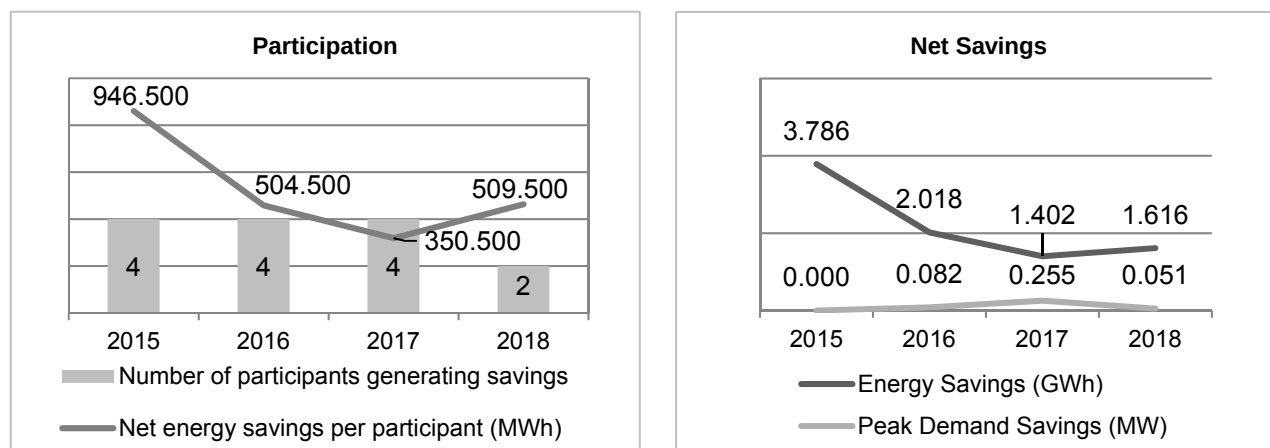
EMIS Key Findings

EMIS Performance

EMIS aimed to achieve 0.90 GWh in net electrical energy savings and 0.2 MW in net peak demand savings at the generator in 2018. The Evaluator determined that EMIS achieved 1.616 GWh in net electrical energy savings and 0.051 MW in net peak demand savings at the generator in 2018. These savings represent 990 tonnes of CO₂ eq in terms of annual avoided GHG emissions. EMIS lifetime energy savings were established at 3.655 GWh, which yields a weighted average EUL value of 2.3 years.

As illustrated in Figure 2, two participants generated savings in 2018; one was a continuing participant that began with EMIS in 2015 and the other was a new participant that reported savings through a special EMIS project. The 2018 results also include savings achieved by a participant in 2017 since their energy consumption data became available only in 2018, but this participant was not counted as a 2018 participant.

Figure 2: EMIS Performance Overview, 2015-2018¹



EMIS Market Evaluation Highlights

The two participants were asked questions regarding their satisfaction with EMIS, any barriers they encountered, and improvement suggestions. Although satisfaction with EMIS was high among participants, they both mentioned having encountered challenges: one had difficulty finding time to “dig in” to the energy management system and the other participant was feeling “buried in data”. One participant suggested having a working group of EMIS participants a few times a year while the other wanted more assistance with ongoing analysis.

EMIS Energy Savings

To evaluate the energy savings, the Evaluator reviewed the preliminary project documentation provided by ENS to prepare a phone interview for the continuing participant and an on-site visit for the new participant. The Evaluator used the information gathered in the project documentation and through the phone interview and on-site visit to validate the savings calculations.

The annual savings results for the continuing participant were accurately tracked, well documented and contained the necessary information for the Evaluator to assess the incremental savings values and non-routine adjustment. All documentation provided by the EMIS service provider was excellent and the Evaluator made no adjustments to the energy and peak demand savings values.

¹ The 2018 savings values per participant are based on the savings of 2018 participants only.

The new participant was the first institutional participant to take part in EMIS. This participant did not take part in the usual EMIS process and rather used the building automation system (BAS) that was implemented as a result of an EMIS investigation phase to make adjustments to equipment runtime schedules. This project was therefore more limited in scope than usual EMIS projects and closer to projects usually submitted to the Building Optimization service. The Evaluator made minor changes to the energy savings calculation methodology and calculated the peak demand savings, since no peak demand savings were tracked by ENS or presented in the savings report.

Free-ridership and spillover effects were assumed to be nil for EMIS, based on the limited market penetration of energy management information systems. Hence, net savings were equal to gross savings.

Table 4 below compares the total tracked and evaluated incremental savings for EMIS in 2018.

Table 4: Comparison of EMIS Tracked and Evaluated Savings at the Generator

	Initial Gross Savings	Adjusted Gross Savings	NTGR	Net Savings
Energy Savings				
ENS Tracked Savings	1.637 GWh	1.637 GWh	1.00	1.637 GWh
Evaluation Results	1.637 GWh	1.616 GWh	1.00	1.616 GWh
Peak Demand Savings				
ENS Tracked Savings	0.027 GWh	0.027 GWh	1.00	0.027 GWh
Evaluation Results	0.027 GWh	0.051 GWh	1.00	0.051 GWh

The evaluated energy savings were 1 percent lower than the tracked savings due to the minor changes made by the Evaluator to the energy savings calculation of the new participant. Also, the savings of the 2017 project were incorrectly tracked by ENS, resulting in slightly lower savings.

Conversely, the large increase in peak demand savings (100%) is attributable to the addition of peak demand savings to one project that had none tracked by ENS.

Strategic Energy Management

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. SEM provides participants with energy Kaizens² and mapping, energy management assessments, as well as performance monitoring and reporting tools. SEM also provides employee training and organizational support for the implementation of energy management engagement activities that use energy performance information to prompt actions aimed at achieving not only behavioural changes, but also operation and maintenance energy-saving measures. Ultimately, SEM helps develop an energy management plan focused on business practice changes to enhance long-term energy performance.

The 2018 EMIS evaluation was based on a program component documentation review, an interview with the program manager, and a savings review of each project, including an on-site visit with each participant.

SEM Key Findings

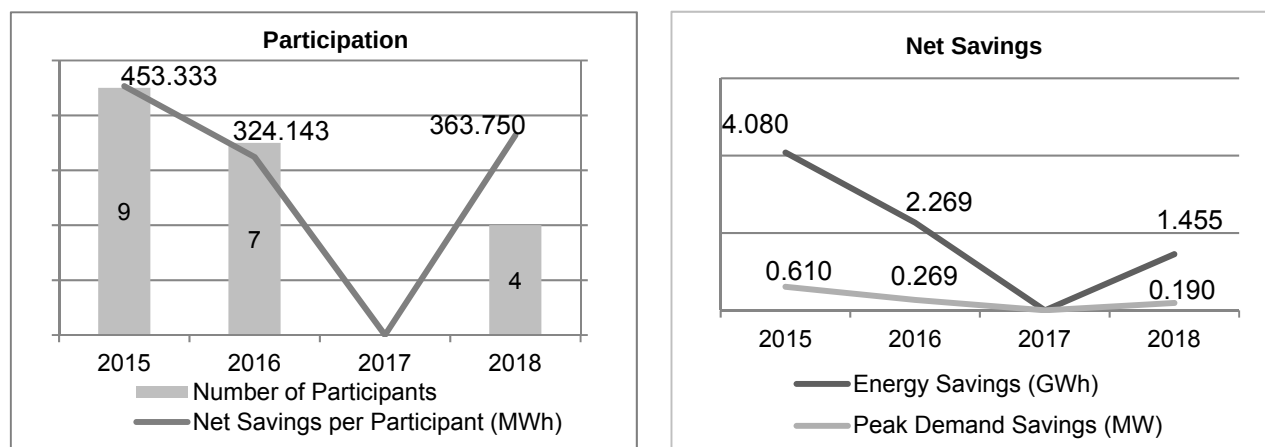
SEM Performance

SEM aimed to achieve 0.7 GWh in net electrical energy savings and 0.1 MW in net peak demand savings at the generator in 2018. The Evaluator determined that SEM achieved 1.455 GWh in net electrical energy savings and 0.190 MW in net peak demand savings at the generator. These savings represent 891 tonnes of CO₂ eq in terms of annual avoided GHG emissions. SEM net lifetime energy savings were established at 4.365 GWh, which yields a weighted average EUL value of 3.0 years

Although two projects were launched in the fall of 2017, these projects started generating savings only in January 2018 and were therefore included in the 2018 evaluation. As illustrated in Figure 3, four participants generated savings in 2018, and all were new participants.

² Energy Kaizens are activities that aim at continuously improving energy consumption by identifying waste and focusing on eliminating it.

Figure 3: SEM Performance Overview, 2015-2018



SEM Market Evaluation Highlights

The four participants were asked questions regarding their satisfaction with SEM, any barriers they encountered, and improvement suggestions. Although satisfaction with SEM was high among participants, two participants experienced challenges with implementing SEM. They mentioned difficulty with making strategic energy management part of normal business operations and having everyone on the same page. With regard to improving SEM, two participants mentioned wanting more in-person visits and another said they needed more help with identifying priorities within their SEM plan. Also, when questioned about persistency, most participants had low to medium confidence that they had enough resources to continue tracking and maintaining facility energy consumption levels without support from a service provider.

SEM Energy Savings

To evaluate energy savings, the Evaluator reviewed the preliminary project documentation provided by ENS to prepare on-site visits and understand the key operating variables that had been chosen to create the regression consumption models. On-site visits served to validate the regression models, review the initiatives carried out, and collect supplementary information about any operational changes that may have impacted the accuracy of the models during the 2018 reporting period. The Evaluator then thoroughly reviewed each regression workbook to verify that each of the four models was statistically significant and that any routine or non-routine adjustments needed to calculate 2018 savings had been applied.

The tracked energy savings of all four participants required relatively little adjustment. The main adjustments resulted from errors in ENS tracking, which were mostly due to savings claimed through projects in other program components that were not removed from the tracked savings, although these adjustments were appropriately included in the annual savings reports submitted by the service provider. While neither ENS nor the service provider tracked or calculated peak demand savings, the Evaluator established peak demand savings for each participant, which resulted in an important adjustment to tracked peak demand savings. Overall, the quality of the information supplied by the service provider was excellent and included enough detail to easily understand the savings methodology and see where routine and non-routine adjustments had been made.

Based on a literature review and participant interview results, the Evaluator estimated that participants were active in SEM on average two years, since most participants planned to renew participation for a second year, and that the savings persist for one additional year after participants withdraw from SEM. Since all 2018 participants were new, this resulted in applying an average EUL of three years to all 2018 SEM savings.

Free-ridership and spillover effects were assumed to be nil for SEM, based on the limited market penetration of strategic energy management. This assumption was confirmed by participant answers during the on-site visits, although one participant was aware and interested in strategic energy management before being approached by ENS. The latter was the first time that this situation had been identified through participant interviews. While SEM is not yet a mainstream approach, the Evaluator recommends that the free-ridership assumption continue to be monitored through participant interviews in future evaluations.

Table 5 below compares the total 2018 SEM tracked and evaluated incremental savings. Although free-ridership and spillover were identified to be nil, the overall NTGR was not equal to 1.00 because of a special adjustment made by the Evaluator to account for a participant that installed high-efficiency lighting through Business Energy Rebates (BER) Instant Rebates shortly before beginning SEM implementation. Since the deduction applied to obtain net savings resulted from a situation that is not likely to reoccur, the Evaluator recommends that ENS apply a NTGR of 1.00 to 2019 tracking.

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

	Initial Gross Savings	Adjusted Gross Savings	NTGR	Net Savings
Energy Savings				
ENS Tracked Savings	1.681 GWh	1.681 GWh	1.00	1.681 GWh
Evaluation Results	1.681 GWh	1.548 GWh	0.94	1.455 GWh
Peak Demand Savings				
ENS Tracked Savings	0.000 MW	0.000 MW	1.00	0.000 MW
Evaluation Results	0.000 MW	0.199 MW	0.95	0.190 MW

The evaluated gross energy savings were 8 percent below the tracked values mainly because the savings attributable to capital projects were not correctly tracked and accounted for by ENS. Moreover, the Evaluator adjusted the savings to be deducted from one capital project that installed lighting through BER Instant Rebates since the savings for the installed product were revised by the Evaluator. This adjustment could not be tracked by ENS since it occurred after the tracking sheet was submitted. Furthermore, the deduction made to the net savings of that same project resulted in net savings being 13 percent below tracked savings.

Since no peak demand savings were tracked, the evaluated peak demand savings were higher than the tracked value.

EMIS and SEM Recommendations

Both EMIS and SEM achieved their savings targets in 2018 and participation satisfaction remained high. EMIS saw additional incremental savings being achieved in the continuing participant's fourth year of participation. As for SEM, after one year with no participation in 2017, participation increased to four participants in 2018 and all generated considerable savings.

In addition to the general recommendations made for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary and the 2017 recommendations not yet being fully implemented, the Evaluator makes the following recommendation on how to improve EMIS and SEM. These recommendations are also listed in Appendix XIII.

2018 EMIS & SEM-R1. Review program delivery to improve participant understanding and mastery of energy performance tracking. Despite being satisfied with EMIS and SEM, many participants in both program components mentioned feeling they need more assistance with ongoing analysis and they lack resources to continue tracking and maintaining facility energy consumption levels on their own. Another indication of high dependence on service providers is that one 2017 EMIS participant stopped producing monthly reports for the second half of 2017 because the service provider could no longer remotely access their energy management information system. Furthermore, many SEM participants do not anticipate continuing their energy management efforts, particularly in terms of tracking energy performance, without the support of a service provider. The Evaluator believes that these examples indicate that EMIS and SEM participants heavily rely on their service providers to maintain their efforts and that the program components do not achieve the full potential of changing energy management practices. Therefore, it is recommended that EMIS and SEM delivery methods be reviewed to better equip participants to understand and fully master energy performance tracking methods. In addition to increasing the persistency of savings, this is also likely to improve participant satisfaction with EMIS and SEM since participants would feel less overwhelmed by the amount and complexity of the data provided to them through EMIS or SEM.

INTRODUCTION

Efficiency Nova Scotia (ENS) is operated by EfficiencyOne, an independent, non-profit organization. ENS 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 various segments of the population. ENS has a demand-side management (DSM) portfolio of three residential programs and three business, non-profit and institutional (BNI) programs. Each program has one or more program components that ENS markets to Nova Scotians. ENS receives funding for its activities from Nova Scotia Power (NSP) and the Province of Nova Scotia. The funds received from NSP cover the costs of activities designed to help reduce electricity consumption, whereas funds from the Province of Nova Scotia are primarily used for activities designed to help reduce the use of other fuels.

Econoler was commissioned to evaluate ENS's 2018 DSM program portfolio comprised of six electricity efficiency programs and assess the impacts of energy efficiency codes and standards introduced in Nova Scotia. To carry out this assignment, Econoler collaborated with Research Into Action, Equilibrium Engineering and Corporate Research Associates (CRA). 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 impact evaluation calculations, as well as preparing and reviewing evaluation reports. Research Into Action carried out the process evaluations, while Equilibrium Engineering conducted the on-site visits and contributed to some impact evaluation analyses. CRA conducted interviews and surveys with participants and partners, as well as analyzed and reported on the data collected from these activities. Throughout this report, this team is referred to as the Evaluator.

Table 6 below lists the various programs assessed as part of the 2018 evaluation and indicates their respective components and the types of evaluations conducted. In this table, "C" means a complete evaluation and "R" indicates that reduced evaluation activities were performed. Moreover, Section 1 of the DSM Programs Evaluation Executive Summary presents the scope of work in further detail, along with the rationale for the types of evaluations performed for each program component.

Table 6: Types of Evaluations Conducted for Each Program Component

Program	Program Component	2017			2018		
		Process	Market	Impact	Process	Market	Impact
Residential Efficient Product Rebates Program	Appliance Retirement			R		C	C
	Instant Savings		R	R		C	C
Existing Residential Program	Home Energy Assessment		C	C			R
	Green Heat	C	C	C		C	C
	Efficient Product Installation		C	C		C	R
New Residential Program	New Home Construction		C	C	C		C
Efficient Product Rebates Program	Business Energy Rebates		C	R	C	C	C
Custom Incentives Program	Custom	C*	C	R	C**	C	C
	Energy Management Information Systems		C	C		C	C
	Strategic Energy Management***					C	C
Direct Installation Program	Small Business Energy Solutions		C	C		R	R
* The process evaluation specifically targets the Retrofit service of the Custom program component. ** The process evaluation specifically targets the New Construction service of the Custom program component. *** Due to the start date of the latest Strategic Energy Management (SEM) cohort, SEM did not have any participants who achieved savings in 2017; therefore, no evaluation was conducted for 2017.							

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

This evaluation report is for the Custom Incentives program, which is comprised of three components: Custom, Energy Management Information Systems (EMIS) and Strategic Energy Management (SEM). In 2018, Custom, EMIS and SEM underwent a complete market and impact evaluation. A process evaluation was added for New Construction in 2018 because ENS modified the participation process and the incentive structure of this service to increase the participation levels. Each program component description, evaluation methodology and main evaluation findings are presented in the following sections.

1 CUSTOM OVERVIEW

This section describes the Custom component of the Custom Incentives program, presents the implementation status of 2017 evaluation recommendations, and provides an overview of participation history.

1.1 Description

Custom provides large BNI participants with technical assistance, financial incentives and project financing to help reduce their electricity consumption and demand.

Custom includes three different services, broken down as follows:

- › Retrofit
- › New Construction
- › Building Optimization

Retrofit provides eligible organizations with technical and financial support to help them conduct scoping and feasibility studies and implement technical improvements at their facilities using a customized and flexible approach. The Retrofit delivery process is structured in a way that enables participation regardless of the phase at which a project is, as long as implementation has not yet started. Retrofit is meant to meet a wide range of participant requirements and support a variety of energy efficiency initiatives. Eligible facilities are those that annually consume 350,000 kWh of energy or more; participants may group multiple smaller facilities under one project.

New Construction provides eligible organizations with incentives to help them achieve significant and predictable electrical energy savings in new BNI buildings, as well as in building extensions and major renovations in existing buildings. The New Construction delivery process was designed to involve participants as of the preliminary design stage to ensure the effective implementation of energy efficiency measures and achieve maximum energy savings. Eligible facilities must be 15,000 sq. ft or larger. In 2017, changes in the incentive structure and participant baseline were made to New Construction to simplify the service delivery.

The goal of Building Optimization is to achieve energy and peak demand savings through the appropriate and efficient operation of building systems. Building Optimization supports the implementation of no-cost or low-cost energy efficiency measures identified through a recommissioning process, such as operating schedule changes and modifications to the operating parameters of key mechanical systems. Building Optimization involves two stages, an investigation study and project implementation. Eligible facilities must not have been commissioned in the previous two years, have an operational building automation system, and annually consume 350,000 kWh of energy or more.

For all three services, business development managers (BDMs) work with participants to assist them in moving projects forward and finding consultants. ENS claims savings for a number of projects over multiple years since certain phases or specific project measures do not become fully operational until the entire project is completed. The three types of projects for which savings were claimed in 2018 were:

- › Projects that were not completed in 2018. For these projects, the portion of savings corresponding to the milestones achieved in 2018 were claimed (partial savings).
- › Projects that were started and completed in 2018. For these projects, all project savings were claimed in 2018 (final savings – 2018 projects).
- › Multi-year projects that had partial savings claimed in previous years and were fully completed in 2018. For these projects, the remaining portion of savings corresponding to the milestones achieved in 2018 were claimed (final savings – multi-year projects).

Combined, Retrofit, New Construction and Building Optimization aimed to generate net electrical energy savings of 25.8 GWh and peak demand savings of 4.5 MW for 2018.

1.2 Follow-up on 2017 Evaluation Report Recommendations

Custom was evaluated in 2017 and improvement recommendations were made by the Evaluator. Table 7 below provides a brief summary of the implementation status of each recommendation presented in the Executive Summary section of the 2017 Evaluation Report.

Table 7: Implementation Status of the 2017 Recommendations for Custom

2017 Recommendations for Custom	Status
2017 Custom-R1. Continue relying on BDMs to assist participants and find new markets.	Implemented
2017 Custom-R2. Continue conducting an in-depth review of energy models as part of the evaluation and improve ENS staff's capacity to identify discrepancies in energy models.	Being implemented
2017 Custom-R3. Establish clear objectives for Building Optimization.	Being implemented
2017 Custom-R4. Better document the base case conditions for Building Optimization projects.	Being implemented

ENS implemented or is in the process of implementing the four recommendations of the 2017 evaluation. In 2018, BDMs and Custom staff collaborated on a regular basis on project, program, and participant-related matters (recommendation 2017 Custom-R1). BDMs build relationships with major developers and consultants to secure New Construction projects. ENS also expanded BDM outreach to the seafood/fish-processing and mining sectors, and it is hoped that these efforts will result in large projects in upcoming years. In 2018, the Evaluator already noted a significant number of projects from the seafood processing sector.

ENS started implementing recommendation 2017 Custom-R2 by developing a quality assurance (QA) procedure to ensure that key variables are consistently reviewed in the energy models and by contracting an experienced energy modeller to review said models. Since this was implemented later in the year, the projects sampled by the Evaluator were not reviewed according to this new procedure.

Recommendation 2017 Custom-R3 was meant to clarify the objectives of Building Optimization to offer the right level of support to participants and help establish the correct base case. Therefore, ENS updated program component documents to more effectively screen projects and reflect clear objectives and eligibility criteria. ENS is also developing requirements for the ENS Building Optimization Service Provider list. These requirements, expected to be finalized in 2019, will ensure that service providers are engaged in Building Optimization and hold the appropriate qualifications.

ENS also started implementing recommendation 2017 Custom-R4 to better document the base case conditions for Building Optimization projects. ENS now requires more in-depth documentation of base case conditions, including gathering more information about pre-implementation conditions. ENS also plans to develop resources to assist service providers. These changes are expected to be seen in projects completed in the coming year.

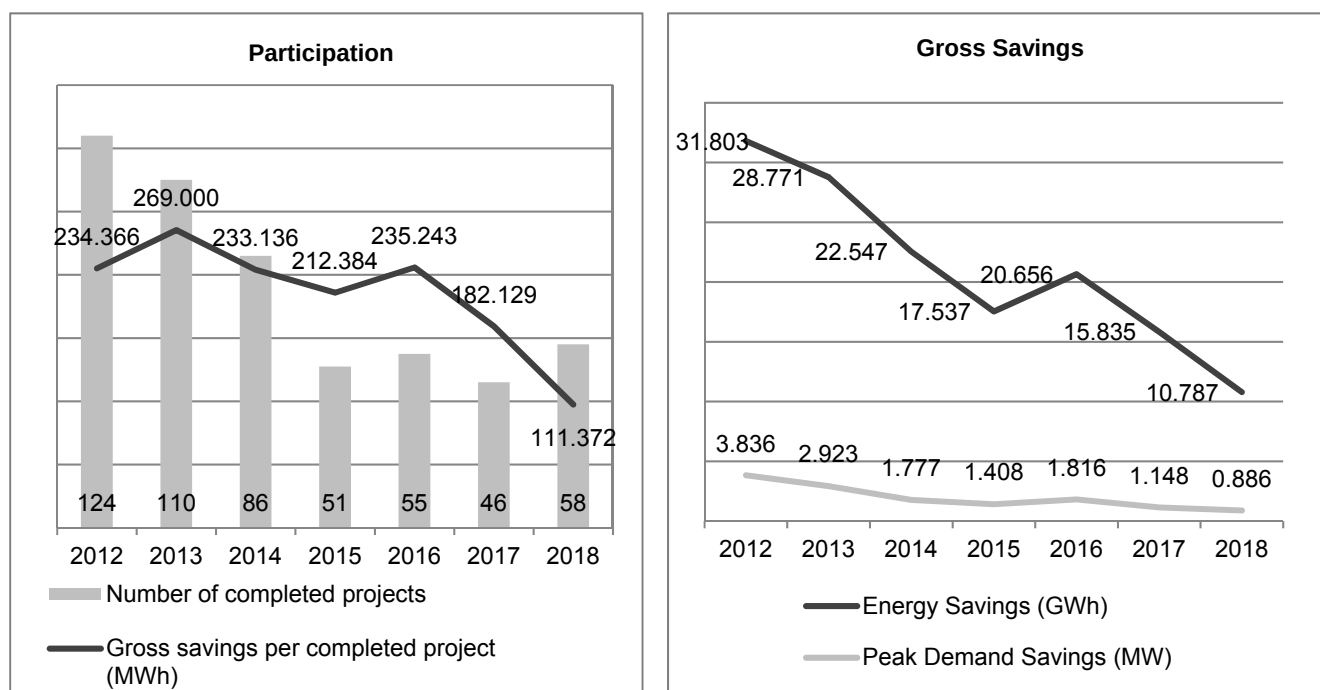
1.3 Participation History

Retrofit

In 2018, energy savings were generated by a total of 67 Retrofit projects, including 44 projects started and completed in 2018, 14 multi-year projects completed in 2018 and nine projects started in 2018 but not completed. The participation chart in Figure 4 below displays the number of projects completed over the 2011-2018 period, and the corresponding average gross energy savings per completed project. As observed in 2017, the number of Retrofit projects is on a downward trend, and the gross savings per completed project are also decreasing. Similarly to 2017, only two of the projects completed in 2018 generated gross energy savings higher than 1 GWh, thus leading to an overall decrease in gross energy and peak demand savings in 2018, as highlighted by the gross savings chart in Figure 4.

Prior to 2014, many lighting projects were completed through Retrofit instead of through other ENS program components such as Business Energy Rebates (BER). This explains why the number of projects and the gross savings were much higher before 2014.

Figure 4: Overview of Participation in Retrofit, 2012-2018



The projects covered by Retrofit were diverse and covered energy efficiency measures for equipment types including heating, ventilation and air conditioning (HVAC) controls, motors and drives, compressed air, and refrigeration, among others. The measure category field in the tracking sheet was sometimes found to be imprecise or inaccurate, so the Evaluator did not analyze the number of projects per measure category. However, it was noted that among the 25 sampled projects, five were process equipment upgrades for seafood processing facilities.

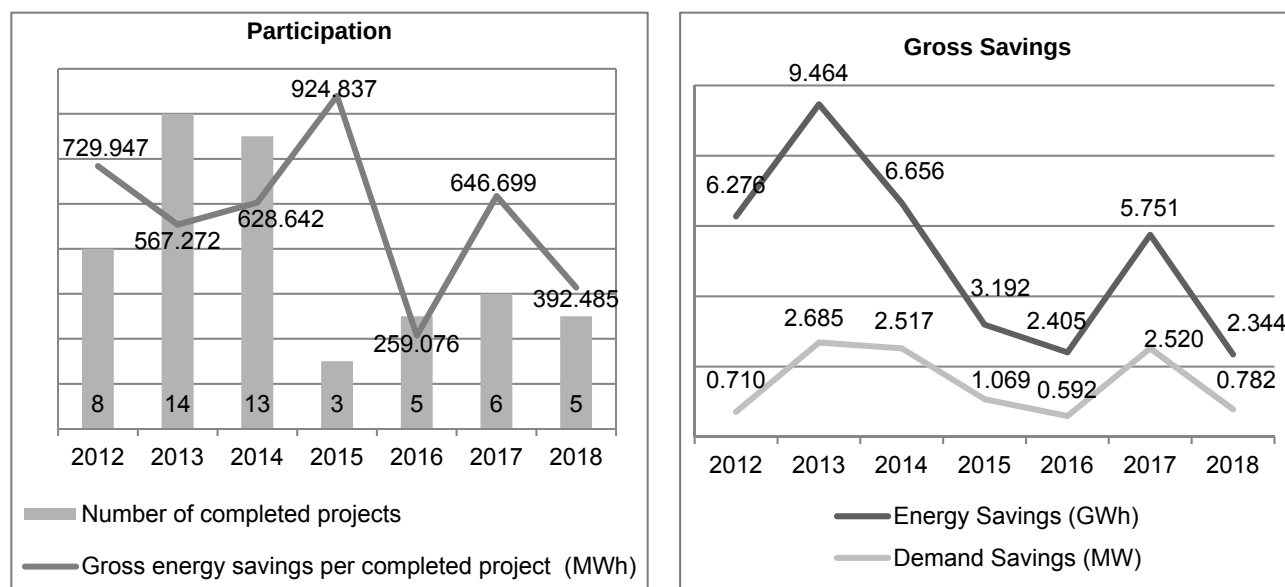
New Construction

In 2018, six projects reported savings under New Construction, five of which were started and completed in the same year and one reported partial savings. As highlighted in Figure 5 below, due to the small number of projects having a large impact on the average gross savings per project, the gross energy savings per completed project varied widely from one year to another. Still, the number of completed projects has remained nearly steady in the past three years.

The 2018 gross energy savings for New Construction were at their lowest point since its inception, for two main reasons: the savings per completed project were at the second-lowest value; and only one project claimed partial savings in 2018.

The low participation level over recent years led the Evaluator to investigate ways to increase participation in New Construction. The findings thereof are outlined in Section 5 of this report.

Figure 5: Overview of Participation in New Construction, 2012-2018

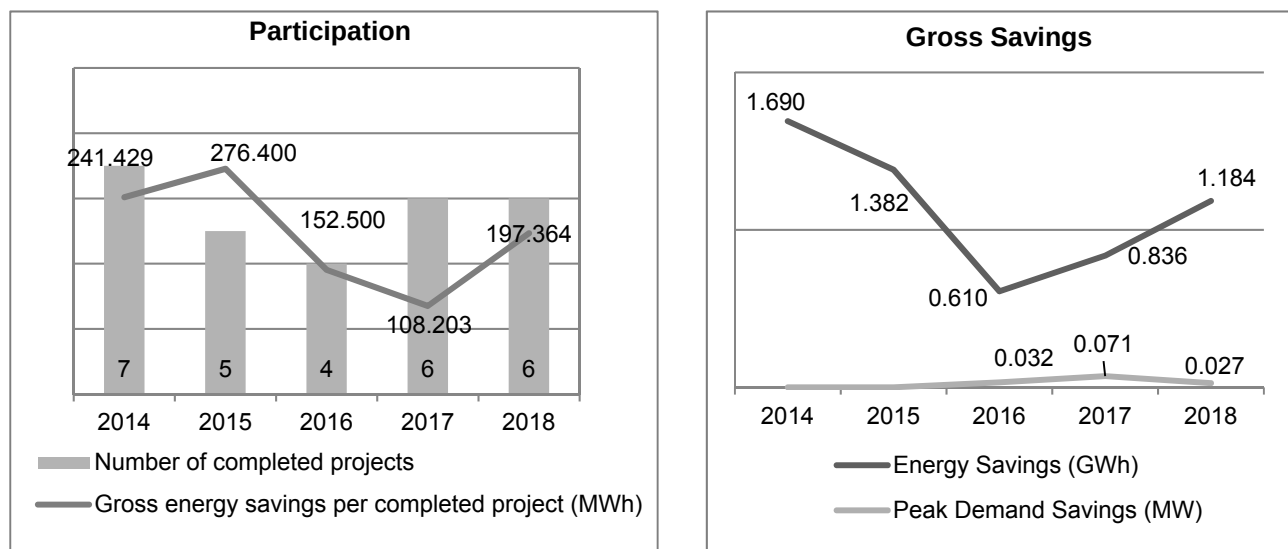


Building Optimization

A total of six Building Optimization projects reported savings in 2018 and all of them were completed in the same year. As depicted in Figure 6 below, after undergoing a decreasing savings trend for the past three years, Building Optimization generated more energy savings per project in 2018. This increase was mainly due to the registration of a multi-building project grouping the savings of ten buildings into a single project, which significantly impacted the average savings-per-project value, especially given the small population size.

In 2016, Building Optimization was halted for a few months to allow ENS to make changes to the structure and branding in the hopes of attracting more participants. These changes had a modest impact on participation in the ensuing two years because the number of projects per year remained comparable to the levels prior to 2016.

Figure 6: Overview of Participation in Building Optimization, 2014-2018



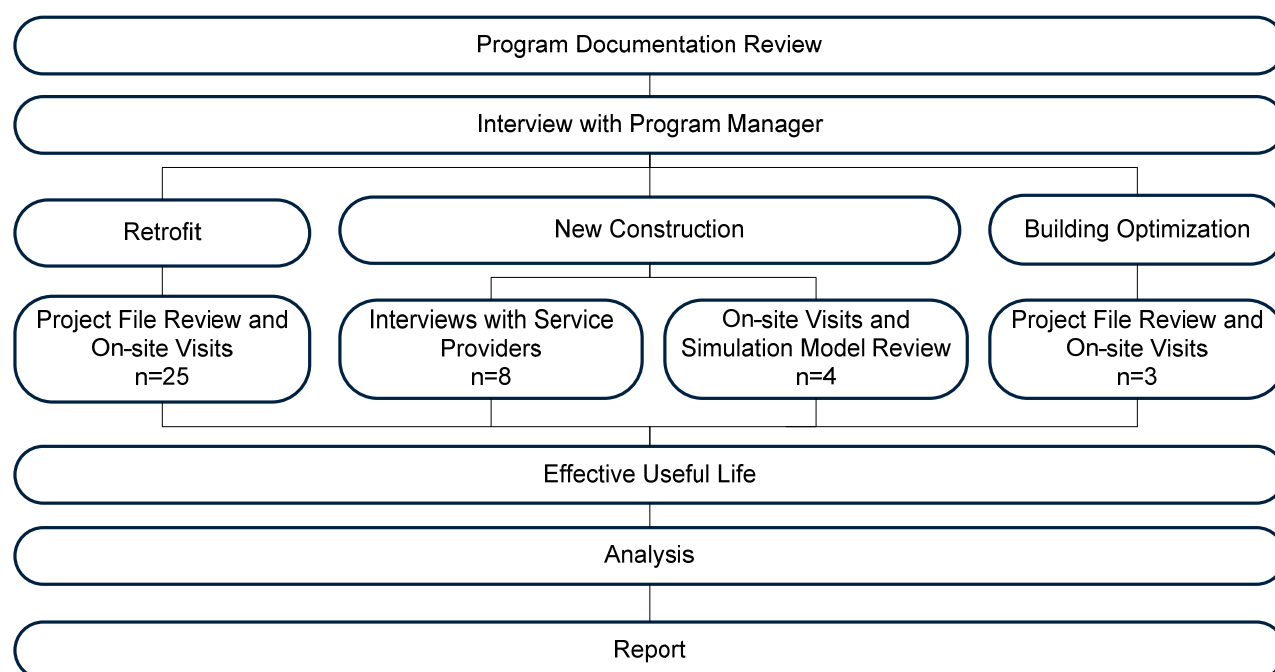
2 CUSTOM EVALUATION OBJECTIVES AND METHODOLOGY

The main objectives of the Custom evaluation are as follows:

- › Assessing the effectiveness of New Construction design and delivery
- › Reporting on participant and partner perspectives
- › Calculating program results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions

This section describes the methodology used and the activities carried out for the 2018 Custom evaluation to achieve the aforementioned objectives. Figure 7 below illustrates the research strategy and data-collection activities carried out for each Custom service, namely Retrofit, New Construction and Building Optimization.

Figure 7: Methodological Model for Custom



The Evaluator first reviewed program component documentation and then held a meeting with the program manager in September 2018 to verify the implementation status of the previous evaluation recommendations and learn about the main changes made to the program component. Based on the information obtained from this meeting, a list of questions and topics to be included in the data-collection instruments was prepared.

Once the program manager meeting and the program component documentation review were completed, specific evaluation activities were undertaken, as described in the following subsections.

For evaluation activities that yield quantitative results based on a sample, the Evaluator aimed to achieve a maximum margin of error of 10 percent at a confidence level of 90 percent. This means that if measurement were conducted many times with different samples, the data would be within 10 percentage points above or below the percentage reported 90 percent of the time. Thus, the margin of error indicates the relative level of precision³ of the measurement, while its associated confidence level indicates the probability of a measure falling within said margin of error.⁴

As part of this evaluation, the Evaluator calculated the margins of error for survey samples, free-ridership levels, in-service rates, and savings adjustment ratios where applicable. The margins of error are presented alongside the results in the relevant sections. Examples of calculations used to establish margins of error are presented in Appendix II of the 2018 DSM Programs Evaluation Executive Summary.

Project File Review and On-site Visits

In the fall of 2018, Equilibrium and Technosim, a subcontractor of Econoler, carried out a full technical review of project documentation and on-site visits on a sample of 2018 Retrofit, New Construction and Building Optimization participants.

A total of 25 Retrofit projects were reviewed. For each Retrofit project, the technical specifications of the new and old equipment were validated, as well as their operating parameters. In addition, the Evaluator collected information regarding the facilities' characteristics and operations on site, as well as the replacement timeframe (early or end-of-life) per measure category. In-depth interviews were also conducted with Retrofit participants during on-site visits to assess free-ridership, spillover and participant satisfaction.

Furthermore, four New Construction projects were reviewed by conducting full technical documentation reviews and on-site visits. These site visits served to not only validate the technical specifications and operating parameters of the new energy efficient equipment, but also collect information on facility characteristics and operations. In-depth interviews were conducted with New Construction participants during the on-site visits to collect information on free-ridership, participant satisfaction, barriers to implementation and improvement suggestions.

³ 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.

⁴ 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.

The Evaluator also reviewed three Building Optimization projects by conducting technical reviews of project documentation and on-site visits to formulate recommendations on the methodology used for documenting and calculating savings and the approach used by ENS to support and verify such projects. The free-ridership level was assumed to be negligible for Building Optimization, and this assumption was validated through participant interviews conducted during the on-site visits. Information related to participant satisfaction, barriers to implementation, and improvement suggestions were also collected during these interviews.

The project review protocols are outlined in Appendices I, II and III. All appendices are presented in the Custom Incentives Program – Appendices document.

Simulation Model Review

In addition to the project file review, Technosim performed a simulation model review for the four sampled New Construction projects. This activity involved comparing the simulation model against as-built drawings and results of the on-site verifications. More specifically, space and domestic water heating fuel sources, building dimensions, building envelope characteristics, weather data, as well as process, electrical and mechanical equipment characteristics and control strategies were verified.

Interviews with New Construction Service Providers

In October and November 2018, Research Into Action conducted eight interviews with service providers. The term service providers refers to engineering consultants, modellers, and architects who assist participants in the various steps required to design an efficient building. These interviews mainly served to identify ways of increasing participation in New Construction, while also investigating outreach and delivery processes, barriers to participation, successes and challenges related to participation, improvement opportunities, as well as perception of and satisfaction with New Construction and ENS.

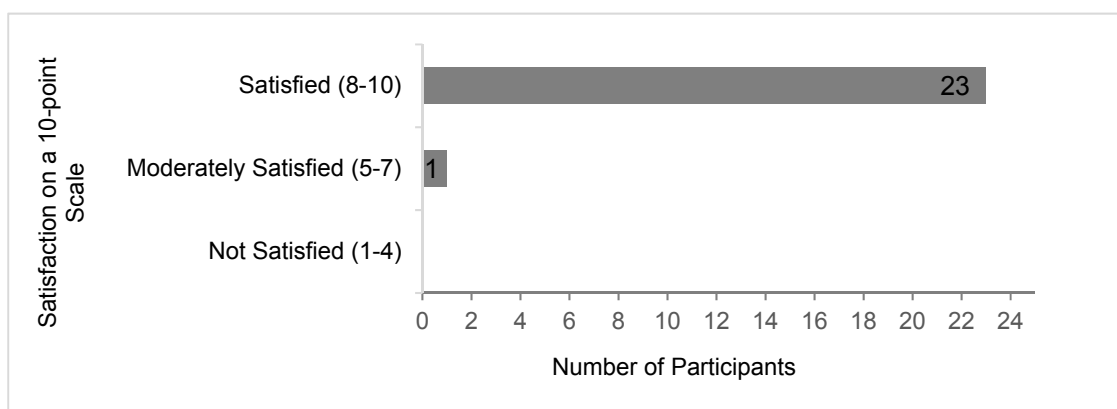
The guide used for the service provider interviews is presented in Appendix IV.

3 RETROFIT MARKET EVALUATION

As part of the Retrofit on-site visits, 24 participants commented on their satisfaction with the service.

Overall satisfaction with Retrofit was very high among participants who provided an average rating of 8.7 on a 10-point scale (with 1 indicating “not at all satisfied” and 10 “completely satisfied”). As outlined in Figure 8 below, the lowest rating given by one participant was 6, while all other ratings ranged from 8 to 10. Participants said they were very satisfied with the fast and smooth collaboration with ENS as well as the assistance provided by the staff, with one interviewee indicating that “staff is quick to help.” Some participants mentioned that the assistance provided by the service helped identify the best design option and that the incentives provided by the service helped lead to implementing measures. Many participants also expressed contentment with project outcomes, with one interviewee mentioning “incredible results.” These results are very positive for Retrofit, particularly since past evaluation results indicated that word-of-mouth contributed to promoting the service.

Figure 8: Participant Satisfaction with Retrofit



4 RETROFIT IMPACT EVALUATION

The objective of the 2018 Retrofit impact evaluation was to determine gross and net electrical energy and peak demand savings. As explained in the description, Retrofit includes three types of savings: (1) partial savings (projects to be completed in future years); (2) final savings of 2018 projects; and (3) final savings of multi-year projects. In 2018, nine projects achieved partial savings, 44 final savings projects were started and completed in 2018, and 14 multi-year projects claimed final savings in 2018.

4.1 Gross Savings

Gross savings correspond to changes in energy consumption resulting from actions taken by Retrofit participants, regardless of why they participated.⁵ ENS 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.

4.1.1 Sampling Methodology

The Evaluator selected a sample of 25 projects from a total of 58 completed projects as of January 2019. The nine projects with partially claimed savings were excluded from the project reviews because they will be covered by the next evaluation when they will be reviewed as completed projects.

At the time of conducting the sampling in November 2018, fewer than 58 projects were completed. Since a high proportion of the completed projects as of November were sampled, the Evaluator could not use a stratified sampling methodology. Using a similar process as in 2017, the Evaluator made an effort to ensure that the selected projects represented a variety of project types and that a higher proportion of the largest projects was sampled.

4.1.2 Project Review Findings

The 25 sampled projects were reasonably well documented and included some form of measurement and verification (M&V) documentation that defined how the savings were to be verified. A new QA workbook was implemented in 2018, which provided a summary of changes made to the savings between the project development agreement and the final tracked values. The QA workbook also included a project close-out checklist for ENS staff, a feasibility study checklist outlining the major deliverables for each project, a site visit log that mirrored the Evaluator's protocol, and an M&V plan summary sheet that laid out the proposed International Performance Measurement and Verification Protocol (IPMVP) approach. The QA workbook is an excellent process improvement for Custom Retrofit.

⁵ Definition adapted from the National Renewable Energy Laboratory, "Chapter 23: Estimating Net Savings: Common Practices," The Uniform Methods Project, September 2014, p. 3, available at: http://energy.gov/sites/prod/files/2015/02/f19/UMPCchapter23-estimating-net-savings_0.pdf (Last accessed November 19, 2015).

Of the 25 projects reviewed, 11 required an adjustment to energy savings and 13 to peak demand savings. Most of the adjustments made by the Evaluator were a result of gaps in the verification process, administrative oversights, minor errors in savings calculation workbooks (e.g. voltage, fan power, Excel formulas) and/or instances of not having measurements for key savings variables. While most adjustments were minor, the Evaluator made downward adjustments of more than 10 percent to energy savings of five projects. In one instance, part of a compressed air leak repair project was entirely undocumented and could not be accepted. For two other projects, it was found during the site visit that the project described in the documentation had not been carried out as planned. Another project was adjusted because the M&V calculations did not correctly account for the impact of weather. Finally, the savings of one project were a result of reduced operating hours that had increased by the time of the site visit. The Evaluator also found two instances where the M&V approach did not allow to make non-routine adjustments as required or to fully capture the impact of the measure on energy consumption; in those cases, no adjustments were made since the Evaluator did not have sufficient data. To improve the accuracy of savings, the Evaluator recommends that: (1) ENS ensure that the QA workbook and procedure is followed closely, notably when validating the final parameters of projects upon completion; and (2) special attention be paid to non-routine adjustments when planning M&V.

Peak demand savings were also adjusted by the Evaluator for similar reasons. In addition, some peak coincidence factors (PCFs) had not been taken into account correctly, for example plants that have seasonal schedules. Furthermore, the peak demand savings of some projects had been underestimated by ENS, or entirely omitted.

An example of the adjustment ratio calculations for a Retrofit project is presented in Appendix V. Based on the 25 projects sampled, an energy savings adjustment ratio of 0.948 was established, with an absolute margin of error of 3.5 percent. The adjustment ratio for peak demand savings was established at 0.825 with a margin of error of 14.5 percent. This margin of error is above target due to the large variation in adjustment ratios for the sampled projects. Since the adjustment ratio was below zero even when considering the upper limit of the confidence interval, the Evaluator elected to apply the adjustment ratio to all savings tracked in Custom Retrofit.

4.1.3 Interactive Effects

Since interactive effects vary significantly from one Retrofit project to another, they are generally taken into account in the project engineering calculations used to obtain initial gross savings. The calculation of lighting project interactive effects follows a standardized approach based on a methodology published in the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Journal.⁶

⁶ Rundquist, Robert A. et al., "Calculating Lighting and HVAC Interactions," in *ASHRAE Journal*, November 1993, pp. 28-37.

4.1.4 Effective Useful Life

For each of the 25 sampled projects, the Evaluator reviewed the effective useful life (EUL) values based on the literature review performed in 2017 and on an analysis of each project baseline.

The Evaluator found that 13 of the 25 projects required adjustments to their EUL value, although these adjustments resulted in minor changes overall. In most cases, the measure category assigned to the project was either incorrect or imprecise, which explained the discrepancy in EUL values. For instance, a few projects were categorized as HVAC projects, for which ENS tracks an EUL of 20 years, when in fact the projects comprised control measures with an EUL of three years. Another example is VFD projects that were categorized as process projects, for which an EUL of 10 years was tracked instead of an EUL value of 15 years. The Evaluator also noted two projects wherein a dual-baseline was identified; hence, a correction to the EUL value was needed. For these two projects, replaced equipment was close to the end of useful life and would have been replaced within a few years, effectively increasing the baseline efficiency level and reducing the savings after those few years. Therefore, the equivalent EUL value had to be reduced so that it could be multiplied by the first-year savings to establish the lifetime energy savings.

By applying all the adjustments discussed above, the Evaluator calculated a weighted average adjustment ratio of 0.940 for EULs, with a margin of error of 10.3 percent. Since the EUL value of each project is an estimated value and the tracked EUL was reasonably close to the revised values, the Evaluator did not extrapolate this ratio to all tracked EULs and instead only adjusted the projects that were reviewed. As a result, only the EULs of projects started and completed in 2018 were adjusted from 12.2 to 11.2 years.

4.1.5 Revised Gross Savings

For projects that claimed partial savings over previous years and were completed in 2018, 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 this sum is equivalent to the total tracked project savings multiplied by the adjustment ratio determined for the year of project completion.

The savings results are claimed under the three defined categories: (1) partial savings; (2) final savings for projects started and completed in the current year; and (3) final savings for multi-year projects. The overall current-year adjustment ratio was established by calculating a weighted average of individual completed project adjustment ratios according to respective project total savings. This overall current-year adjustment ratio was applied to all three categories, whereas true-up ratios were only applied to the final savings of multi-year projects.

Table 8 presents an example of how the true-up ratio was applied to the gross energy savings of a multi-year project completed in 2018.

Table 8: Example of a True-up Adjustment

	2017	2018	Total
Tracked Savings (kWh)	728,297	524,996	1,253,293
Year-specific Adjustment Ratio	0.995	0.948	-
Revised Savings Prior to True-up (kWh)	724,763	497,639	1,222,402
Project Total Revised Savings with True-up (kWh)			1,187,986
True-up (kWh)			-34,416

After applying the true-up adjustments to the final savings of multi-year projects completed in 2018, the 2018 gross energy savings at the generator for Retrofit were established at 10.787 GWh and the total gross peak demand savings were established at 0.886 MW at the generator, as listed in Table 9 below. Gross lifetime energy savings for Retrofit were established at 148.117 GWh.

Table 9: Revised Gross Energy and Peak Demand Savings for Retrofit

	Partial Savings	Final Savings for Projects Started and Completed in 2018	Final Savings for Multi-year Projects	Total
Number of Projects	9	44	14	67
Energy Savings				
Tracked Gross Energy Savings – at the Meter (GWh)	4.304	5.000	1.641	10.945
Adjustment Ratio for Energy Savings	0.948	0.948	0.948	-
Gross Energy Savings – at the Meter (GWh)	4.081	4.740	1.556	10.376
True-up Adjustment for Gross Energy Savings (GWh)	-	-	-0.199	-0.199
Adjusted Gross Energy Savings – at the Meter (GWh)	4.081	4.740	1.357	10.177
Line Loss Factor	1.060	1.061	1.056	-
Gross Energy Savings – at the Generator (GWh)	4.327	5.027	1.432	10.787
Effective Useful Life (years)	16.4	11.2	14.7	-
Gross Lifetime Energy Savings – at the Generator (GWh)	70.950	56.166	21.001	148.117
Peak Demand Savings				
Tracked Gross Peak Demand Savings – at the Meter (MW)	0.290	0.483	0.294	1.067
Adjustment Ratio for Peak Demand Savings	0.825	0.825	0.825	-
Gross Peak Demand Savings – at the Meter (MW)	0.240	0.398	0.242	0.881
True-up Adjustment for Gross Peak Demand Savings (MW)	-	-	-0.044	-0.044
Adjusted Gross Peak Demand Savings – at the Meter (MW)	0.240	0.398	0.198	0.836
Line Loss Factor	1.061	1.062	1.056	-
Gross Peak Demand Savings – at the Generator (MW)	0.254	0.423	0.209	0.886

4.2 Net-to-gross Ratio

The net-to-gross ratio (NTGR) determines the net savings, i.e. those savings that can be reliably attributed to a program component or service. More precisely, the NTGR includes effects such as free-ridership and spillover that positively or negatively affect the energy savings generated by a program component or service.

4.2.1 Free-ridership

In the case of Retrofit, free-ridership occurs when participants would have still implemented the energy efficiency upgrades and measures in the absence of the service. The free-ridership level was assessed using a self-report approach that involved asking participants a set of questions during on-site visit interviews. The questionnaire included questions for all applicable variables of the decision-making process, including planning, efficiency, timing and cost.

Some questions were also used to determine the extent to which participant decisions on whether to have products installed had been influenced by previous participation in an ENS program component or ENS efforts to raise awareness about energy efficiency. When participant answers indicated that they had been significantly influenced by these two factors, the free-ridership level was adjusted downward to better capture the overall influence of ENS activities on participant decisions.

The feedback collected from the participant interviews was converted into an overall free-ridership level using an algorithm presented in Appendix VI.

The 2018 survey results revealed an overall free-ridership level of 14 percent for Retrofit, with a margin of error of 3.0 percent. This level, although relatively low, is slightly higher than those identified by the evaluations of the previous four years (10% in 2016, 8% in 2015; 10% in 2014; and 9% in both 2013 and 2012). Higher free-ridership levels were observed for some refrigeration projects in seafood facilities, although it is difficult to attribute the small variation in the free-ridership level to a specific type of projects, considering the wide range of participants and project types under Retrofit.

4.2.2 Participant Spillover

For Retrofit, participant spillover occurs when participants implement eligible energy efficiency measures due to the influence of previously participating in the service without having had any kind of additional support. The Evaluator used on-site visits to directly question participants about any potential spillover effects. The algorithm used to determine the level of participant spillover is presented in Appendix VII.

In 2018, spillover was found to be nil. Although one participant reported having implemented an energy efficiency measure without receiving financing or a rebate from ENS, the energy savings resulting from that measure were not significant.

4.2.3 NTGR Calculation

The NTGR was calculated using the following equation:

$$NTGR = (1 - \% \text{ free-ridership} + \% \text{ participant spillover})$$

Using the free-ridership and spillover levels established for Retrofit, the NTGR value was established at 0.86.

4.3 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 the gross savings, as illustrated in the following equation:

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

The Evaluator applied a true-up adjustment to the net energy savings of multi-year projects completed in 2018 so that the total revised net savings over the complete duration of each project are equivalent to the total revised gross project savings multiplied by the NTGR for 2018. This approach is similar to the one described in Subsection 4.1.5 for adjusting gross savings.

In 2018, Retrofit generated 8.919 GWh in net energy savings and 0.673 MW in net peak demand savings at the generator. The results are listed in Table 10 below. Overall, using the Nova Scotia-specific factor⁷ of GHG generated by electricity production, i.e. 0.6126 kg CO₂ eq/kWh, it was estimated that the net energy savings translate into 5,464 tonnes of avoided annual CO₂ eq. Based on the average EUL value of 13.7 years, the net lifetime energy savings were established at 122.135 GWh.

⁷ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes), and total electricity generation (10,978 GWh) was found in the following two sources:

Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018).

Emera Inc., *Management's Discussion & Analysis* as at February 9, 2018

<http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

Table 10: Evaluated Net Energy and Peak Demand Savings for Retrofit

	Partial Savings	Final Savings for Projects Started and Completed in 2018	Final Savings for Multi-year Projects	Total
Energy Savings				
Revised Gross Energy Savings – at the Meter (GWh)	4.081	4.740	1.357	10.177
NTGR	0.86	0.86	0.86	-
Net Energy Savings – at the Meter (GWh)	3.509	4.076	1.167	8.752
True-up Adjustment for Net Energy Savings (GWh)	-	-	-0.339	-0.339
Adjusted Net Energy Savings – at the Meter (GWh)	3.509	4.076	0.828	8.413
Line Loss Factor	1.060	1.061	1.056	-
Net Energy Savings – at the Generator (GWh)	3.722	4.323	0.874	8.919
Effective Useful Life (years)	16.4	11.2	14.7	-
Net Lifetime Energy Savings – at the Generator (GWh)	61.017	48.303	12.816	122.135
Peak Demand Savings				
Revised Gross Peak Demand Savings – at the Meter (MW)	0.240	0.398	0.198	0.836
NTGR	0.86	0.86	0.86	-
Net Peak Demand Savings – at the Meter (MW)	0.206	0.343	0.170	0.719
True-up Adjustment for Net Peak Demand Savings (MW)	-	-	-0.085	-0.085
Adjusted Net Peak Demand Savings – at the Meter (MW)	0.206	0.343	0.085	0.634
Line Loss Factor	1.061	1.062	1.056	-
Net Peak Demand Savings – at the Generator (MW)	0.219	0.364	0.090	0.673

5 NEW CONSTRUCTION MARKET AND PROCESS EVALUATION

This section provides a summary of key findings from a review of New Construction documentation, as well as interviews with key ENS staff, eight service providers (SPs), and four participants during site visits.

The key research issue identified by previous evaluations and ENS staff was how to increase participation in New Construction. The subsections below address key aspects of this question such as understanding SP level of awareness about the service, SP and participant satisfaction, as well as SP successes, challenges, and suggestions for increasing participation.

5.1 Overview of Interviewed SPs

New Construction projects require the expertise of an experienced SP to carry out one or more of the required service steps such as identifying measures, quantifying savings, completing M&V and, occasionally, implementing measures.

The process and market evaluation relied heavily on primary data from SPs. Of the eight interviewed SPs, one was an architect, one was a modeller and the remaining six were consultants from green consulting or engineering firms.

5.2 Awareness of the Service and Engagement with ENS

Most SP respondents (5 of 8) have been aware of New Construction (and ENS in general) since the establishment of ENS, while the remainder learned of the service more recently because of demand from clients.

Since New Construction projects require an SP to carry out at least a portion of the work, the Evaluator assessed how often clients ask SPs about ENS incentives and whether SPs promote ENS incentives. Half of the interviewed SPs noted that at least some of their clients ask about incentives for their projects. All SPs reported mentioning ENS incentives, when they were able, in their communications with clients. Those SPs who are not always able to tell clients about ENS incentives said it was because of externalities that inhibit ENS participation. For example:

- › One SP noted that their firm does not always have access to the building owner because they work as a subcontractor to the general contractor.
- › Another SP reported not bringing up the service if a new construction project uses natural gas for heating, a fuel source exempt from New Construction.
- › A third SP mentioned that participating in New Construction produces negligible results if the owner already plans on achieving LEED® or a similar certification.

- › Another SP noted that participation in New Construction is heavily dependent on client requests. In their firm, a sustainability team separate from the project management team is brought in for projects when the client, typically a large chain store, expresses interest in sustainability or seeks incentives for energy efficiency measures. This sustainability team investigates programs that meet the client's interests. The project manager does not actively pursue incentives for clients.

When asked about the Efficiency Trade Network (ETN - ENS's list of contractors and energy efficiency professionals), three SPs were unable to report definitively on their ETN membership status. Among the other five SPs, only three provided an accurate status according to the ETN online directory. A recent ETN evaluation⁸ concluded that ENS could benefit from engaging more professionals such as engineers and architects. One way to act on this conclusion would be making the ETN more pertinent to engineers and architects. The inability of some SPs to accurately recall their connection to the ETN is in line with the abovementioned conclusion of the recent ETN evaluation.

Of the eight interviewed SPs, seven reported interacting with ENS staff during their most recent New Construction project. Although those seven SPs had varied amounts of interactions with ENS – three of them interacted with ENS at least 10 times – all were satisfied with their interactions.

5.3 Satisfaction with New Construction

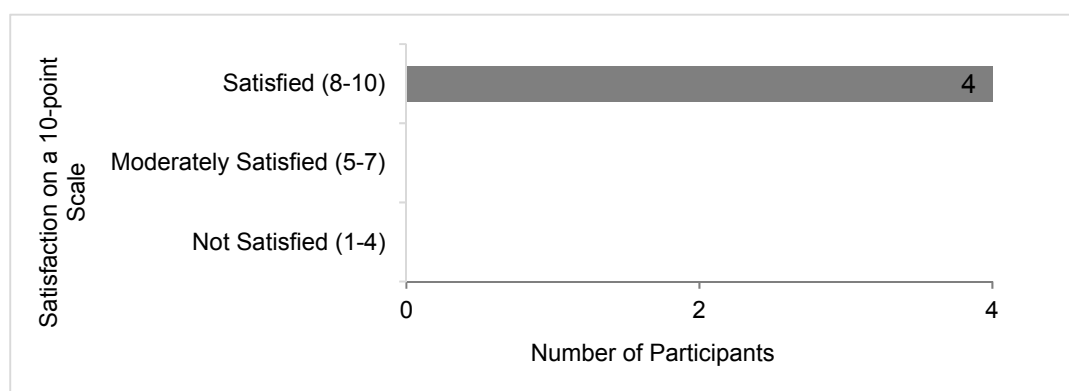
Most SPs (6 of 8) were generally satisfied with the overall service. Moreover, seven SPs noted some level of dissatisfaction with the participation process, mostly relating to understanding service requirements at the various project stages. More specifically, the SPs provided the following feedback.

- › Firstly, four SPs noted dissatisfaction with the ENS website. Specifically, SPs had difficulty finding forms and documents on the site (1 mention), instructions about how to submit required information (2 mentions), and information about what the service can provide to participants (2 mentions). One of these SPs mentioned that the website should provide more details on New Construction for those interested in participating. They suggested that a short PDF document summarizing the service and its benefits be added to the website.
- › Secondly, three SPs expressed difficulty finding information about service requirements throughout their projects. They mentioned not clearly understanding what is required of them at each step of the participation process. Another SP spoke of delays with ENS providing feedback on submitted documentation that does not meet New Construction requirements.
- › Thirdly, one SP noted that revised service forms, applications, and software requirements were not communicated to them, which resulted in the firm using old information to prepare an application that was ultimately rejected. This resulted in a frustrated SP and participant.
- › Fourthly, one SP noted not understanding how their efficient design was assessed and mentioned that it was unclear against which base case the design had to be measured.

⁸ Practices and Procedures Evaluation: Efficiency Trade Network. Final Report. November 26, 2018. Prepared by Research Into Action.

As part of the site visits, four of the five participants met by the Evaluator provided feedback about New Construction. Overall satisfaction with New Construction was very high among participants who provided an average rating of 8.8 on a 10-point scale (with 1 indicating “not at all satisfied” and 10 “completely satisfied”). As outlined in Figure 9, none of these four participants provided a rating below 8. Participants mentioned the incentive amounts and responsiveness of ENS staff as the most important reasons for their high satisfaction with New Construction. One participant in particular said that ENS staff were “very helpful” and that they “made things happen.”

Figure 9: Participant Satisfaction with New Construction



Only one of the four interviewed participants mentioned facing challenges during their participation process, with a mention of a delay in obtaining the incentive. This same participant, along with another participant, recommended speeding up the payment process. Two other recommendations were provided by participants to improve New Construction, one of them being to extend the service to include non-electrical measures and the second being to better define the next steps after each phase of the participation process is completed. This second improvement recommendation echoes some of the feedback mentioned by SPs at the beginning of this subsection about better understanding service requirements at the various project stages.

5.4 Benefits of New Construction

Many SPs indicated that New Construction provides their firm with benefits such as the ability to assist participants in designing a more energy efficient building. Additionally, one SP mentioned that the service generates a pull in the market, making the work of green consultants slightly easier because they do not have to push the market as hard. According to this SP, the overall market is a bit more savvy about efficiency because of New Construction, which in turn makes it more likely that end users will implement efficiency projects. Other benefits to participants mentioned by SPs include:

- › Improved forecast of building operating costs (3 mentions)
- › Opportunity to showcase how the organization is reducing its carbon footprint (3 mentions)
- › Money to offset capital expenditures (3 mentions)
- › More information about the energy efficiency level of the building (2 mentions)

5.5 Barriers to Participation

All eight SPs noted financial barriers, six reported measure-related barriers, and two reported social or political barriers to implementing energy efficient measures. The key barrier to service participation is participant fears related to having to alter project timelines to accommodate service requirements (Table 11). This perceived risk advocates for clear communications about service requirements.

Table 11: Barriers to Participation

Barriers to Implementing Energy Efficiency (n=8)	
Financial Barriers (n=8)	
Perceived increase in capital costs	5
Short-term owners unconcerned with long-term ownership costs	3
Long-term owners do not understand risk of future energy costs	1
Lack of financing opportunities for energy efficiency measures	1
Measure-related Barriers (n=6)	
Perceived project delay due to installing unplanned measures	2
Ignorance about general benefits of energy efficiency measures	2
Concern energy efficient measures will disrupt core business operations	2
Social/Political Barriers (n=2)	
Lack of adequate policy to encourage energy efficiency measures	2
Barriers to Participating in New Construction (n=8)	
Unwilling to alter timeline to accommodate service	4
Unwilling to alter design to accommodate service	1
Owners bring project to service too late in construction process	1
Negative experience with ENS in the past	1

5.6 Suggestions for Increasing Participation

When thinking in general about their projects from the past few years, SPs reported serving institutional clients on new construction projects more often than commercial clients; seven of the eight interviewed SPs reported serving university and hospital clients, and five of the seven reported serving k-12 schools. Moreover, six of the eight SPs serve multifamily and large offices and about half of the SPs serve other commercial sectors (see Table 12: Types of Buildings Served by SPs below). These findings suggest an opportunity to recruit more commercial customers.

Table 12: Types of Buildings Served by SPs

Types of Buildings	Number of SPs
Institutional	
College or University	7
Hospitals	7
K-12 Schools	5
Multifamily High-rises	6
Commercial	
Large Offices [≥25,000 sq. ft]	6
Small Offices [<25,000 sq. ft]	4
Small Retail Stores [<25,000 sq. ft]	3
Hotels/Motels	3
Large Retail Stores [≥25,000 sq. ft]	3
Refrigerated Warehouses	1

SPs also mentioned opportunities to increase ENS connections with local trade associations, which could lead to greater awareness and participation in New Construction. Furthermore, seven of the eight SPs noted professional associations that ENS should contact to develop or expand relationships and further encourage New Construction participation. Specifically, four mentioned ASHRAE and the Green Building Council. Other responses included the Building Operators Management Association (2 mentions), the local American Institute of Architects (2 mentions), the Green Globes Association (1 mention), the Federation of Canadian Municipalities (1 mention), and the Investment Property Owners of Nova Scotia (1 mention).

Other suggestions to increase participation included:

- › Providing an extra non-energy benefit to building owners and offering branding for buildings that go through the service so owners can promote their energy efficient credentials to prospective tenants, customers, or others (1 mention)
- › Attracting building owners and further promoting participation as a hedge against future fluctuations in energy prices (1 mention)
- › Making it as easy as possible for service providers to explain the service and its many benefits to prospective participants by providing a brief service overview sheet that outlines the participation steps (1 mention)

5.7 Process and Market Evaluation Summary

The process and market evaluation indicated that there is room to improve awareness of and engagement with the service. While SPs reported mentioning ENS incentives in their communications, they reported times and situations where bringing up ENS incentives is not possible. In spite of the high number of individuals or parties involved in New Construction projects, unless a sustainability team is assigned to the project or the client asks specifically for applicable energy efficiency incentives, the search for such incentives likely does not occur. Additionally, some of the interviewed SPs were either not sure whether they were ETN members or provided an inaccurate status.

Participants were satisfied with their relationship with ENS staff and found them helpful and prompt in providing responses. They are also satisfied with the service overall. Speeding up the payment process and more clearly defining the steps and requirements of the New Construction service were viewed as the two main areas that needed improvement. In fact, not understanding the service requirements at the various project stages was the main service issue mentioned by SPs. Providing SPs and participants with a clear picture of the service and its various steps and requirements would likely help attenuate the main barrier to participating in New Construction, as reported by SPs, which is the perception that projects cannot fit within the New Construction service timeline.

6 NEW CONSTRUCTION IMPACT EVALUATION

The objective of the 2018 New Construction impact evaluation was to determine the gross and net electrical energy and peak demand savings. Like Retrofit, New Construction claims three types of savings: (1) partial savings (projects to be completed in future years); (2) final savings of current year projects; and (3) final savings of multi-year projects. In 2018, one project had partial savings, five projects were started and completed in 2018 with final savings, and zero multi-year projects had final savings in 2018.

6.1 Gross Savings

In 2018, the Evaluator performed detailed technical reviews of four of the five New Construction completed projects. These four projects were those for which documentation was available at the time of site visits, in late November, and they represent 78 percent of 2018 reported savings.

6.1.1 Project Review Findings

The on-site visits served to establish that all energy efficiency measures had been implemented in the four visited buildings. The project reviews and on-site visits revealed that reported savings calculations could be improved for those four projects since the revised energy savings were found to be 36 percent below the tracked values due to the following issues.

- › For two projects, the base case assumptions were not representative of the buildings that would have been built in the absence of the service. In one case, the electrical heating system was modelled as a boiler instead of as electrical baseboards, which overestimated electricity consumption due to the pumping power and control losses. In another case, the reference building had a very large amount of fresh air that was not pre-heated with heat recovery. This assumption was based on an interpretation of the building code that the Evaluator considered unlikely to be proposed to a customer given the resulting increased heating costs.
- › For three projects, the mechanical systems or their operating conditions were not modelled in a way that was consistent with what was observed during the on-site visits. One notable example is a project that included an outdoor ice rink that was assumed to be refrigerated whenever the outdoor temperature fell below 12 °C, while in fact it only operated about three months per year. This project also included ventilation systems for which fresh air flow rates were largely overestimated and surpassed the capacity of the installed equipment. Other projects had smaller adjustments, namely for backup boilers that were found to be fueled by natural gas rather than electricity, and a condensing boiler that operated at a higher temperature set point, which required a downward adjustment to its modelled efficiency.
- › One project had reported savings attributed to the implementation of a full commissioning process. Conversely, the review of the commissioning documents revealed that only installation checklists had been filled out, so the commissioning process was considered to be incomplete and the revised savings were nil for this measure.

The largest portion of the 36 percent reduction to the energy savings is attributable to the project for which the ice rink operation hours and fresh air flow rates were significantly reduced; the savings of this project were reduced by 76 percent.

The Evaluator also found that two of the four projects had incomplete documentation. One project lacked most of the mechanical and architectural drawings. The other project was missing technical specifications for some mechanical equipment, which were needed to validate the performance data entered in the energy model. On the other hand, one project had outstanding documentation; all drawings and specification sheets were provided, along with excellent explanations of the modelling approach.

The peak demand savings were increased by 37 percent. To establish the revised savings, the Evaluator averaged the monthly peak demand reductions calculated by the revised energy models for the months of December, January and February since these months correspond to the peak demand period determined by NSP. Since the details of the peak demand savings calculation were not provided for the tracked value, the Evaluator could not conclude on the reason for the large discrepancy between the tracked and revised values.

The adjustments made to the four reviewed projects were not extrapolated to the fifth project completed in 2018. The overall adjustment ratios presented in Subsection 6.1.4 (0.716 for energy savings and 1.205 for peak demand savings) were therefore calculated using the revised savings of the four reviewed projects and the tracked savings of the fifth project.

6.1.2 Interactive Effects

Since New Construction savings are based on the results of simulation models that encompass the total electricity consumption of both the proposed and reference buildings, interactive effects are already included. No further interactive effects factor was thus applied to savings.

6.1.3 Effective Useful Life

The Evaluator reviewed the EUL of the four sampled projects by selecting an appropriate EUL for each measure implemented in those projects. The measure-level revised EULs were selected based on the literature review conducted in the 2017 evaluation. The weighted average revised EUL was established at 19.8 years, while ENS had tracked 20.1 years for those four projects. Because the sample was small and an adjustment ratio could not be extrapolated with high confidence, the Evaluator only applied the adjustments to the four reviewed projects and left the tracked EUL value as is for the other project. The average EUL for projects completed in 2018 was therefore established at 18.5. For the project claiming partial savings in 2018, the tracked value of 11.4 years was conserved.

6.1.4 Revised Gross Savings

The 2018 gross energy and peak demand savings calculated for New Construction are presented in Table 13 below. The line loss factor was calculated as a weighted average of each project's line loss based on savings at the meter. New Construction achieved gross electrical energy savings at the generator of 2.344 GWh and gross peak demand savings at the generator of 0.782 MW.

Lifetime energy savings were calculated at 40.563 GWh and the weighted average EUL value for gross energy savings was 17.3 years.

Table 13: Revised Gross Energy and Peak Demand Savings for New Construction

	Partial Savings	Final Savings for Projects Started and Completed in 2018	Final Savings for Multi-year Projects	Total
Number of Projects	1	5	0	6
Energy Savings				
Tracked Gross Energy Savings – at the Meter (GWh)	0.360	2.575	0	2.934
Adjustment Ratio for Energy Savings	1.000	0.716	-	-
Gross Energy Savings – at the Meter (GWh)	0.360	1.844	0	2.204
True-up Adjustment for Gross Energy Savings (GWh)	-	-	-	-
Adjusted Gross Energy Savings – at the Meter (GWh)	0.360	1.844	0	2.204
Average Line Loss Factor	1.060	1.064	-	-
Gross Energy Savings – at the Generator (GWh)	0.381	1.962	0	2.344
Effective Useful Life (years)	11.41	18.454	-	-
Gross Lifetime Energy Savings – at the Generator (GWh)	4.349	36.214	0	40.563
Peak Demand Savings				
Tracked Gross Demand Savings – at the Meter (MW)	0	0.610	0	0.610
Adjustment Ratio for Demand Savings	-	1.205	-	-
Gross Demand Savings – at the Meter (MW)	0	0.735	0	0.735
True-up Adjustment for Gross Demand Savings (MW)	-	-	-	-
Adjusted Gross Demand Savings – at the Meter (MW)	0	0.735	0	0.735
Line Loss Factor	-	1.064	-	-
Gross Demand Savings – at the Generator (MW)	0	0.782	0	0.782

6.2 Net-to-gross Ratio

The NTGR serves to determine net savings, i.e. the savings that can be reliably attributed to a program component or service. More precisely, the NTGR is established by considering the effects, namely free-ridership and spillover, that positively or negatively affect the energy savings generated by a program component or service. For New Construction, spillover is not measured as it is unlikely that participants have constructed other buildings since taking part in New Construction.

6.2.1 Free-ridership

In the case of New Construction, free-ridership occurs when participants would have still implemented the energy efficiency measures in the absence of the service. The assessment of the free-ridership level is based on a self-report approach that involves asking participants a set of questions during site visits, or follow-up calls if the person involved in the decision-making process is not available during the visit.

The questions factored in the applicable variables related to the decision-making process, including efficiency, cost and the influence that ENS support had on the decision to include energy efficiency measures in New Construction projects. Additional questions were asked to understand participant corporate policies in terms of new building energy efficiency, which energy efficiency measures were selected prior to ENS involvement, and how New Construction influenced the decision to use of energy modelling. The answers to the latter questions served to validate the consistency of the quantitative answers that are used to calculate the overall free-ridership level as per the algorithm presented in Appendix VIII.

The overall free-ridership level is a weighted average based on the revised energy savings for each project. An overall free-ridership level of 36 percent was obtained. The margin of error could not be calculated for this value since the sample only included four projects; therefore, the standard deviation could not be estimated with reasonable accuracy. Despite this, the Evaluator elected to apply the free-ridership rate to all projects for which savings were claimed in 2018 because the percentage of savings covered by the surveyed participants was high.

The percentage of free-ridership could not be compared to recent values. Indeed between 2014 and 2017, ENS had been using another approach to obtain net savings; each participant was assigned a specific base case that corresponded to what they would have built in the absence of the New Construction service. This approach resulted in only net savings being calculated; hence no NTGR was available.

6.3 Net Savings

For New Construction, the total net electrical energy and peak demand savings amounted to 1.500 GWh and 0.500 MW respectively at the generator. To calculate the avoided GHG emissions resulting from New Construction, the Evaluator applied Nova Scotia's specific factor⁹ for GHG emissions generated by electricity production, 0.6126 kg CO₂ eq/kWh, to electricity savings. An adjustment was also made to account for the increase or decrease in fossil fuel consumption for the four reviewed projects. It was estimated that together, the electricity savings and variation in fossil fuel consumption resulted in 835 tonnes of avoided annual CO₂ eq.

The net lifetime energy savings were established at 25.960 GWh and, as a result, the weighted average EUL value for net energy savings is 17.3 years. Detailed results are presented in Table 14.

Table 14: Evaluated Net Energy and Peak Demand Savings for New Construction

	Partial Savings	Final Savings for Projects Started and Completed in 2018	Final Savings for Multi-year Projects	Total
Energy Savings				
Revised Gross Energy Savings – at the Meter (GWh)	0.360	1.844	0	2.204
NTGR	0.64	0.64	-	-
Net Energy Savings – at the Meter (GWh)	0.230	1.180	0	1.411
True-up Adjustment for Net Energy Savings (GWh)	-	-	-	-
Adjusted Net Energy Savings – at the Meter (GWh)	0.230	1.180	0	1.411
Line Loss Factor	1.060	1.064	-	-
Net Energy Savings – at the Generator (GWh)	0.244	1.256	0	1.500
Effective Useful Life (years)	11.4	18.5	-	-
Net Lifetime Energy Savings – at the Generator (GWh)	2.783	23.177	0	25.960
Peak Demand Savings				
Revised Gross Peak Demand Savings – at the Meter (MW)	0	0.735	0	0.735
NTGR	0.64	0.64	-	-
Net Peak Demand Savings – at the Meter (MW)	0	0.470	0	0.470
True-up Adjustment for Net Peak Demand Savings (MW)	-	-	-	-
Adjusted Net Peak Demand Savings – at the Meter (MW)	0	0.470	0	0.470
Line Loss Factor	-	1.064	-	-
Net Peak Demand Savings – at the Generator (MW)	0	0.500	0	0.500

⁹ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes), and total electricity generation (10,978 GWh) was found in the following two sources: Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018).

Emera Inc., *Management's Discussion & Analysis* as at February 9, 2018, <http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

7 BUILDING OPTIMIZATION MARKET EVALUATION

As part of the Building Optimization on-site visits, three participants answered questions regarding their satisfaction with the service, any barriers they encountered, and improvement suggestions.

Overall satisfaction with Building Optimization was high among all participants who provided an average rating of 9.3 on a 10-point scale (with 1 indicating “not at all satisfied” and 10 “completely satisfied”). Participants were very satisfied with both the streamlined approach of Building Optimization and the energy savings from the implemented measures.

None of the three interviewed participants ran into particular challenges during participation in Building Optimization, indicating a smooth participation experience. Due to the high satisfaction and absence of challenges, the three participants could not think of any recommendations on how to improve Building Optimization, except accelerating the payment process (1 mention).

8 BUILDING OPTIMIZATION IMPACT EVALUATION

The objective of the 2018 Building Optimization impact evaluation was to establish the gross and net electrical energy and peak demand savings. Building Optimization claims three types of savings: (1) partial savings (projects to be completed in future years); (2) final savings of current year projects; and (3) final savings of multi-year projects. In 2018, there were no partial savings claimed, six projects were started and completed with final savings claimed, and zero multi-year projects had final savings claimed.

8.1 Gross Savings

Gross savings correspond to changes in energy consumption resulting from actions taken by Building Optimization participants regardless of why they participated.¹⁰ This section describes the review methodology used for all Building Optimization projects and the adjustments made to specific projects.

8.1.1 Project Review Findings

Three projects were included in the review sample from the six custom building optimization projects completed in 2018. Downward adjustments were made to the energy and demand savings of all three projects.

The reviewed projects were well documented overall and the measures were confirmed to be implemented at all sites. One project was comprised of multiple buildings and on-site access was restricted to only a few of the areas, although the Evaluator was able to validate the modified operation schedules on the building automation system, which was sufficient to ensure a high level of confidence in the revised savings.

Consequently, the downward adjustments made to savings were due to incorrect engineering equations rather than measures not being implemented. In all three projects, the energy consumption of motors was based on the nameplate power only, so the Evaluator multiplied that value by a load factor to obtain realistic energy consumption values. For one project, an adjustment was made to the calculation of the heat load of a fresh air system, which was overestimated since the calculation incorrectly used heating degree days.

Although the sample represented 77 percent of total tracked energy savings, the Evaluator did not extrapolate the adjustment ratio for the energy savings because the sample was too small to draw general conclusions. Only the three revised projects were adjusted, which resulted in a 39 percent reduction from their savings and an overall 30 percent reduction in savings for Building Optimization. Since the sample contained the only two projects that tracked peak demand savings, the adjustment of these two projects led to a reduction of peak demand savings of 22 percent for both the sample and the overall service.

¹⁰ Definition adapted from the National Renewable Energy Laboratory, "Chapter 23: Estimating Net Savings: Common Practices," *The Uniform Methods Project*, September 2014, p. 3, available at: http://energy.gov/sites/prod/files/2015/02/f19/UMPCChapter23-estimating-net-savings_0.pdf (Last accessed November 19, 2015).

8.1.2 Interactive Effects

Since interactive effects vary significantly from one Building Optimization project to another, they are taken into account in the project engineering calculations used to establish initial gross savings. No other adjustment was made to the gross savings of the three projects reviewed.

8.1.3 Effective Useful Life

As part of the 2018 evaluation, the Evaluator reviewed the lifetime energy savings and corresponding EUL values used by ENS. The EUL of an implemented measure serves to calculate the energy savings achieved throughout a measure lifetime.

ENS assigned an EUL value of 20 years to all measures implemented in Building Optimization projects because they were all HVAC measures. Such an EUL value usually applies to very long-lasting measures such as insulation installation or large mechanical upgrades, which are not measures covered by Building Optimization.

The Evaluator reviewed the EUL values of all the measures included in the three sampled projects based on the findings of the literature review performed in 2017. According to these results, a EUL value of three years was assigned to one project that concerned control parameters and a EUL value of 15 years was assigned to the two other projects that consisted of installing new VFDs to control HVAC equipment. For other non-sampled projects, the Evaluator applied the generic EUL value recommended in the 2017 Evaluation Report, which was 5.5 years. This value represents an average of the values for equipment repairs and controls from a study by SBW Consulting on retrocommissioning projects.¹¹

As a result, the 2018 weighted average EUL for Building Optimization was set to 6.7 years.

8.1.4 Revised Gross Savings

For Building Optimization, the gross savings at the generator were established at 1.184 GWh and 0.027 MW for energy and peak demand savings respectively, as outlined in Table 15 below. The gross lifetime energy savings for Building Optimization were established at 7.981 GWh.

¹¹ 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.

Table 15: Revised Gross Energy for Building Optimization

	Partial Savings	Final Savings for Projects Started and Completed in 2018	Final Savings for Multi-year Projects	Total
Number of Projects	0	6	0	6
Energy Savings				
Tracked Gross Energy Savings – at the Meter (GWh)	0	1.596	0	1.596
Adjustment Ratio for Energy Savings	-	0.699	-	-
Gross Energy Savings – at the Meter (GWh)	0	1.116	0	1.116
True-up Adjustment for Gross Energy Savings (GWh)	-	-	-	-
Adjusted Gross Energy Savings – at the Meter (GWh)	0	1.116	0	1.116
Average Line Loss Factor	-	1.061	-	-
Gross Energy Savings – at the Generator (GWh)	0	1.184	0	1.184
Effective Useful Life (years)	-	6.7	-	-
Gross Lifetime Energy Savings – at the Generator (GWh)	0	7.981	0	7.981
Peak Demand Savings				
Tracked Gross Demand Savings – at the Meter (MW)	0	0.032	0	0.032
Adjustment Ratio for Demand Savings	-	0.779	-	-
Gross Demand Savings – at the Meter (MW)	0	0.025	0	0.025
True-up Adjustment for Gross Demand Savings (MW)	-	-	-	-
Adjusted Gross Demand Savings – at the Meter (MW)	0	0.025	0	0.025
Line Loss Factor	-	1.060	-	-
Gross Demand Savings – at the Generator (MW)	0	0.027	0	0.027

8.2 Net-to-gross Ratio

For all projects implemented through Building Optimization, a NTGR of 1.00 was applied since it was assumed that free-ridership was likely very low considering that the number of participants was still very low for this relatively new component. The validity of this assumption was supported by the results and findings of the interviews conducted with participants during the on-site visits. Indeed, two of the three interviewed participants reported that, in the absence of the service, they would not have implemented energy efficiency measures that they implemented through this service. The other participant indicated they might have installed only a portion of the measures. Also, no participant had ever conducted any full commissioning project, except for one who did so with the help of ENS in another Building Optimization project.

8.3 Net Savings

Since the NTGR is assumed to be 1.00 for Building Optimization, net savings are equal to gross savings, as outlined in Table 15 above. For 2018, Building Optimization generated 1.184 GWh in net electrical energy savings and 0.027 MW in net peak demand savings at the generator. Overall, using the Nova Scotia-specific factor¹² of GHG generated by electricity production, i.e. 0.6126 kgCO₂ eq./kWh, it was estimated that the net energy savings resulted in 725 tonnes of avoided annual CO₂ eq.

The net lifetime energy savings were established at 7.981 GWh and, as a result, the weighted average EUL value for net energy savings is 6.7 years.

¹² At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 System Totals Emission Intensities in the following sources: "Total System Emissions", Nova Scotia Power, accessed January 25, 2019, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx>.

Emera Inc., "Management's Discussion & Analysis as at February 10, 2017", accessed December 17, 2017, <http://investors.emera.com/Cache/1500095769.PDF?Y=&O=PDF&D=&fid=1500095769&T=&iid=4072693>.

9 OVERALL SAVINGS FOR CUSTOM

Table 16 below compares the total tracked and evaluated savings for Custom, which includes savings from Retrofit, New Construction and Building Optimization.

Table 16: Comparison of Tracked and Evaluated Savings at the Generator for Custom

	Initial Gross Savings	Adjusted Gross Savings	NTGR*	Net Savings
Energy Savings				
Tracked Savings from ENS	16.416 GWh	16.416 GWh	0.91	14.944 GWh
Evaluation Results	16.416 GWh	14.315 GWh	0.81	11.603 GWh
Peak Demand Savings				
Tracked Savings from ENS	1.814 MW	1.814 MW	0.90	1.636 MW
Evaluation Results	1.814 MW	1.695 MW	0.71	1.200 MW
* The NTGRs are different for each component. The NTGRs listed in this table match the rounded averages obtained by dividing net savings by adjusted gross savings.				

The gross energy savings are 13 percent below the tracked value. This reduction is mostly due to New Construction and Building Optimization whose gross energy savings were reduced by 30 percent and 25 percent respectively. As for Retrofit, which accounted for 75 percent of Custom gross savings, a smaller adjustment was made to savings, resulting in an approximate reduction of 7 percent. The NTGR was also revised downward because the free-ridership for Retrofit increased compared to previous years, and the evaluated free-ridership for New Construction was also higher than the value tracked by ENS. Overall, the evaluated net energy savings for Custom are 22 percent below the tracked value.

The gross peak demand savings were adjusted downward by a larger margin than energy savings, especially for Retrofit. In addition, the decrease in the NTGR was more severe than for energy savings because a greater portion of peak demand savings were achieved in New Construction, which had the lowest NTGR of all three services. Overall, the evaluated net peak demand savings for Custom are 27 percent below the tracked value.

10 CUSTOM RECOMMENDATIONS

Although the number of completed Retrofit projects increased and Retrofit remains the main contributor to overall Custom savings, Retrofit savings decreased significantly in 2018 compared to 2017. New Construction and Building Optimization participation levels remained similar to the past few years with only a handful of completed projects. Increasing participation in New Construction was actually the primary focus of the 2018 process and market evaluation. Interviewed participants and SPs mentioned challenges understanding New Construction steps and requirements, which led the Evaluator to conclude that this aspect of the service requires improvement.

In addition to the general recommendations presented for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary, the Evaluator makes the following recommendations aimed at improving Custom. Recommendations to improve EMIS and SEM are presented further below in this Executive Summary. These recommendations are also included in Appendix IX.

2018-Custom-R1. Improve communication to SPs and participants about the various New Construction steps and corresponding service requirements. As previously mentioned, the key aspect of New Construction mentioned as problematic by participants and SPs is the lack of clear communication about service steps and requirements, with one SP mentioning not understanding the base case against which efficient designs need to be assessed. Additionally, there is a perception that projects cannot fit within the New Construction service timeline, which pushes some clients away from the service according to SPs. Clearer and sustained information about New Construction is recommended. Improved communication should include a clear and concise process chart, along with detailed checklists of what is required at each step of the participation process as well as timelines to complete each step. Clearer directions on the appropriate modelling approach would also reduce adjustments made to tracked savings and improve the quality of energy models. Given the small number of completed projects each year, the Evaluator encourages as much as possible a personalized follow-up approach and regular check-ins on projects to ensure that they progress how they should.

2018-Custom-R2. Further engage new and existing SPs and make them stronger advocates for New Construction. Interviewed SPs often could not accurately recall their membership status with ENS' ETN. In addition, the relative lack of modellers, architects and general contractors within the ETN suggests that there is an opportunity to engage those parties more in the service. Having more professionals in the ETN would allow ENS another communication channel to reach these professionals and share information about New Construction. Recruiting modellers, architects and general contractors and making the service more top-of-mind could be particularly important to expanding New Construction participation because such professionals are typically involved in the early stages of construction projects and may influence decisions to participate in the service. ENS could also engage with new trade associations and enhance relationships with associations they already know. This would serve to reinforce the service ENS offers to professionals. Reaching out to trade associations should not be limited to Nova Scotia because some SPs come from other provinces to work on projects.

11 EMIS OVERVIEW

The following sections present the EMIS evaluation results.

This section describes the EMIS program component, follows up on the 2017 evaluation recommendations and provides an overview of the participation history.

11.1 Description

EMIS offers incentives in the form of rebates or zero-percent on-bill financing to help facilities reduce their electricity consumption through the implementation of an energy management information system. First introduced in 2012 as a pilot, EMIS became a stand-alone program component of the Custom Incentives program in 2015.

The main goal of EMIS is to assist industrial businesses and institutions in making real-time decisions about their processes using energy consumption data from metered systems. To achieve this goal, EMIS provides participants with the funding required to audit their systems (EMIS audit), develop an energy management information system implementation plan (EMIS implementation plan) and install the metering and monitoring equipment (implementation of EMIS). This program component also provides training and organizational support to help convert energy performance information into concrete actions. To be eligible, participants must possess the necessary resources to carry out all the aforementioned stages, demonstrate commitment to energy management and an adequate level of expertise, and agree to complete all the stages of an EMIS project. EMIS can encompass an entire facility or just specific processes or departments within a facility.

Once approved, eligible participants must first enter into an agreement with ENS through a letter of intent before the EMIS audit is conducted. This letter of intent defines the anticipated costs and estimated incentives for each stage of participation, and the participant's overall simple payback for the project. Then, participants have the audit conducted by a qualified professional to define the EMIS scope. ENS helps participants find qualified professionals by providing a list of firms known to be able to meet the requirements of the different stages of an EMIS project. After reviewing the audit report, the participant has an implementation plan developed to detail the costs, potential savings, equipment to be installed, required training, etc. After ENS has reviewed and approved the implementation plan, the participant can start implementing the energy management information system. If necessary, ENS provides technical and organizational support to participants over a 12-month period after the energy management information system becomes fully operational to help them achieve their full potential savings.

EMIS aimed to achieve 0.90 GWh in net electricity savings and 0.2 MW in net peak demand savings in 2018.

11.2 Follow-up on 2017 Evaluation Report Recommendations

EMIS was evaluated in 2017 and improvement recommendations were made by the Evaluator. Table 17 below provides a brief summary of the implementation status of each recommendation presented in the Executive Summary section of the 2017 Evaluation Report.

Table 17: Implementation Status of the 2017 Recommendations for EMIS

2017 Recommendations	Status
2017 EMIS-R1. Ensure that the tracking sheet is complete and accurate.	Being Implemented
2017 EMIS-R2. Design baseline regressions and plan M&V activities to ensure accurate savings calculations even when changes occur in the facility.	Implemented

Although the Evaluator observed improvement in tracking compared to the 2017 evaluation, some discrepancies were observed again in 2018, namely incorrect savings for one project and missing demand savings for another project. Therefore, the Evaluator considered recommendation 2017 EMIS-R1 only partly implemented.

The Evaluator considered recommendation 2017 EMIS-R2 as implemented since the regressions were appropriately updated and the required M&V data were tracked. In addition, ENS now includes an event log in tracking, which was sufficiently detailed to allow the Evaluator to identify the major changes that occurred in facilities.

11.3 Participation History

Two participants took part in EMIS in 2018; one was a continuing participant that began with EMIS in 2014 and the other was a new participant that reported savings through a special EMIS project. The special project consisted of adjusting schedules in campus buildings as a result of the data made available by a building automation system (BAS). Although this project is more similar to those reported in the Building Optimization service of Custom, savings are reported in EMIS because the program component allocated funds for the feasibility study of said BAS.

As presented in Figure 10 below, fewer participants took part in EMIS in 2018 compared to previous evaluation years. This is mainly explained by many past participants reaching the end of their EMIS participation and only one new participant generating savings in 2018.

As presented in Figure 11, the gross energy savings remained at approximately the same level as in 2017 despite having fewer participants. This can be explained by the fact that, besides the savings achieved by the two participants who took part in EMIS in 2018, the 2018 results also include savings achieved by one participant in 2017. For this participant, energy consumption data became available only in 2018 so energy and peak demand savings of 0.596 GWh and -0.033 MW respectively were evaluated and added to the 2018 results.

As for incremental peak demand savings, the 2018 savings were considerably lower than in 2017. While the lower participation level partly explains this reduction, the impact of the 2017 savings claimed in 2018 considerably influenced these results since the peak demand savings of that project were overestimated in 2017 and were therefore negative for 2018.

Figure 10: Summary of Participation in EMIS, 2015-2018¹³

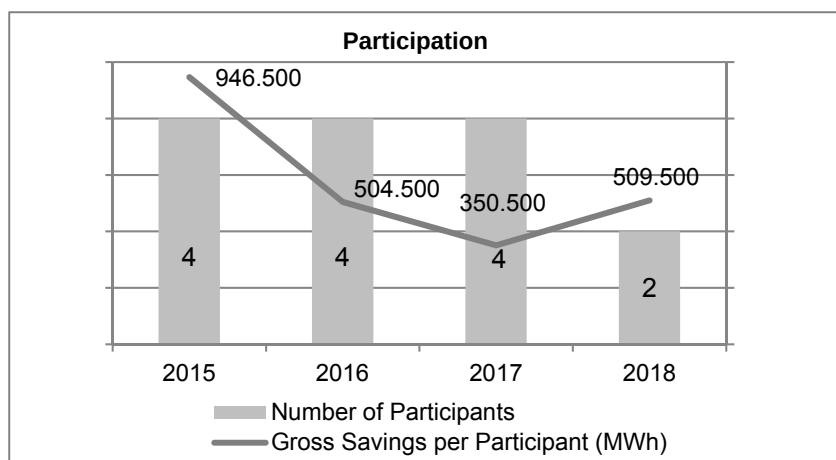
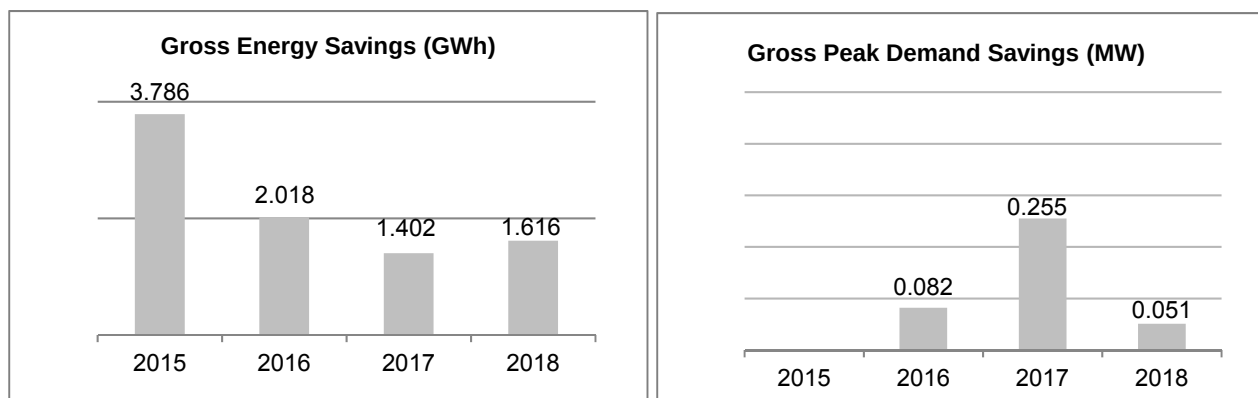


Figure 11: Summary of Gross Savings for EMIS, 2015-2018



¹³ The 2018 savings values per participant are based on the savings of 2018 participants only.

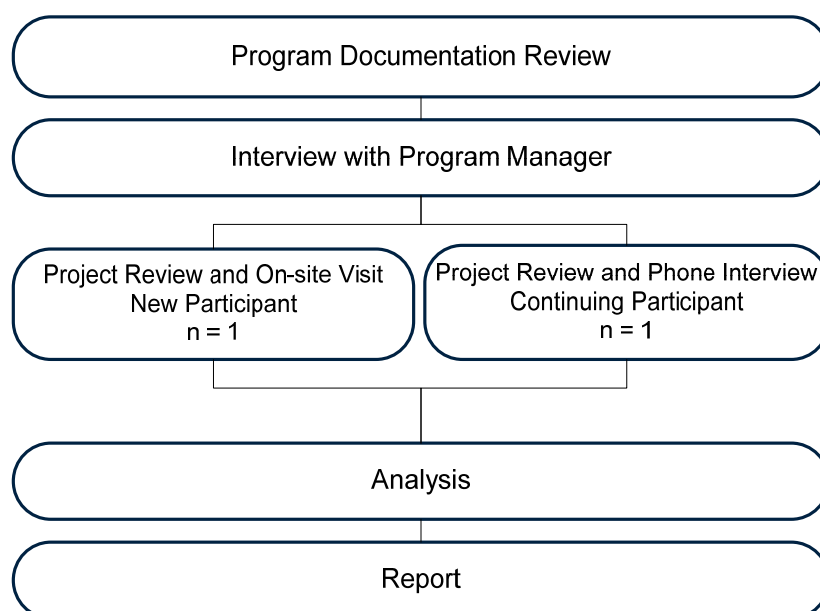
12 EMIS EVALUATION OBJECTIVES AND METHODOLOGY

The main objectives of the EMIS evaluation are as follows:

- › Reporting on participant perspectives
- › Calculating program results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions

This section presents the methodology used to achieve the aforementioned objectives. Figure 12 below illustrates the research strategy employed and the data-collection activities carried out in the 2018 EMIS evaluation.

Figure 12: Methodological Model for EMIS



The Evaluator first reviewed the EMIS program component documentation and then held a meeting with the program manager in September 2018 to verify the implementation status of the previous evaluation recommendations and learn about the main changes made to the program component.

These activities contributed to the Evaluator's overall understanding of EMIS and helped inform the development of the data-collection instruments. Specific evaluation activities were then undertaken, as described in the following subsections.

On-site Visit and Project Review of New EMIS Participant

For the new EMIS project, the Evaluator first reviewed documentation to understand the project and prepare the on-site visit protocol. The Evaluator then conducted an on-site visit to collect additional information on the measures implemented and facility operations. During the on-site visit, the Evaluator also asked participants questions about their satisfaction with this program component. The Evaluator used the information gathered in the project documentation and through the on-site visit to validate the energy model and the savings calculations.

The on-site visit and project review protocols are presented in Appendix X.

Project Review and Phone Interview with Continuing EMIS Participant

For the continuing EMIS project from 2014, the Evaluator reviewed updated documentation to determine what had changed since the last evaluation. The Evaluator then conducted a phone interview to collect additional information on measures implemented and changes made to the facility in 2018. During the interview, the Evaluator also asked the participant questions about satisfaction with this program component. The Evaluator then reviewed the savings calculations to ensure that the 2018 incremental savings were valid.

The project review protocol and interview guide are presented in Appendix XI.

13 EMIS MARKET EVALUATION

This section describes participant perspectives on EMIS. As part of the EMIS phone and on-site visit interviews, the two participants were asked questions regarding their satisfaction with EMIS, any barriers they encountered, and improvement suggestions.

Satisfaction with EMIS

Overall satisfaction with EMIS was high among participants, who provided an average rating of 8.0 on a 10-point scale (where 1 indicates “not at all satisfied” and 10 “completely satisfied”).

One participant was most satisfied with the energy savings and the money they saved. The other participant was slightly less satisfied since they felt like the service provider was more experienced in the industrial sector than the institutional sector.

Challenges and Barriers

When questioned on challenges and barriers encountered, one participant mentioned difficulty with allocating enough time to really “dig in” to the energy manager role since it was not his primary job. The other participant mentioned the significant capital investment required while feeling the system was only “mostly” operational and added that they are now “buried in data”. This participant also indicated that they needed more help to draw conclusions from the savings reports.

Recommendations

Both participants provided improvement suggestions. One suggested that having a working group of EMIS participants a few times a year could help. The other suggested that the report should provide more specific suggestions on what to target. They also mentioned wanting more assistance with ongoing analysis.

14 EMIS IMPACT EVALUATION

The objective of the 2018 EMIS project impact evaluation is to determine project gross and net electrical energy and peak demand savings.

14.1 Impact Definitions

Table 18 below defines certain terms to allow the reader to better understand the vocabulary and concepts used in the EMIS Impact Evaluation section of this report. SEM and EMIS vocabulary being the same, the definitions below apply to both program components.

Table 18: Definition of Terms Related to SEM and EMIS

Term	Definition
Baseline	Referring to the systems, time period, energy use, or conditions that provide a reference with which later performance of an energy conservation measure is compared.*
Baseline Period	Defined period of time chosen to represent the operation of the facility or system before the implementation of an energy conservation measure.*
Baseline Regression	A mathematical model correlating energy use to one or more independent variables during the baseline period.
Cumulative Savings	The annual savings achieved with respect to the baseline situation prior to SEM or EMIS participation.
Incremental Baseline	Referring to the systems, time period, energy use, or conditions that provide a reference with which later performance of an energy conservation measure is compared to obtain incremental savings.
Incremental Savings	The additional annual savings not measured in previous years. Incremental savings result from new measures implemented during the evaluation year or from recent improvements to energy efficiency measures that were initiated in previous evaluation years. These savings are calculated by using the previous year's situation as the baseline.
Independent Variable	Parameter that is expected to change routinely and have a measurable impact on energy consumption and/or demand of a system or facility.*
Reporting Period	Defined period of time chosen for the purposes of verifying savings after the implementation of an energy conservation measure.*

*The definitions identified with an asterisk are drawn from the IPMVP.¹⁴

¹⁴ Efficiency Valuation Organization, *Core Concepts, International Performance Measurement and Verification Protocol*, October 2016.

14.2 Gross Savings

This subsection describes the methodology used to review the two EMIS projects that generated savings in 2018 and summarizes the review findings.¹⁵ The interactive effects, EUL values, and the revised gross savings are also assessed.

14.2.1 Project Review Findings

ENS tracked savings for two EMIS projects in 2018; one was a continuing participant in the fourth year of participation and the other was a participant that had not yet reported any annual savings. Since those projects are different in scope, the findings are reported separately.

Continuing Participant

For the continuing participant, a documentation review was conducted with information provided by ENS in November, which included a monthly savings report from the service provider and a preliminary tracking sheet prepared by ENS. The Evaluator then conducted a phone interview to collect additional information on measures implemented or the changes made to the facility in 2018.

The final documentation provided to the Evaluator included: (1) the EMIS tracking sheet; (2) the annual savings report; and (3) the savings calculation workbook for the cumulative and incremental baselines. The 2018 tracking sheet contained monthly tracked incremental energy savings at the meter and at the generator, a peak demand savings value, and a tab with a monthly event log used to track changes in the facility and to the regression model.

The annual savings report and savings calculation workbook prepared by the service provider were used by the Evaluator as the primary source of information to verify the annual incremental energy savings. The savings report presented both the cumulative savings against the 2014 baseline and the incremental savings against the revised 2017 baseline for both energy and peak demand savings. A single non-routine adjustment was made by the service provider to account for changes made to one of the nine pieces of equipment that fall within the EMIS measurement boundary.

Overall, the annual savings results for the continuing participant were accurately tracked, well documented, and contained the necessary information for the Evaluator to assess the incremental savings values and the non-routine adjustment. All documentation provided by the EMIS service provider was excellent and the Evaluator made no adjustments to the energy and peak demand savings values.

Although the focus of the review was on the incremental savings, the Evaluator analyzed the cumulative savings presented in the annual savings report and concluded that they were accurately calculated. The 2018 cumulative savings were therefore established at 3,210,515 kWh.

¹⁵ The project for which a portion of the savings generated in 2017 were reported in this 2018 Evaluation Report was reviewed in 2017 and the findings were included in the 2017 Evaluation Report. The 2018 Evaluation Report therefore reports on savings from the second half of 2017 but does not present a detailed review of this project.

New Participant

This EMIS participant is the first one to implement an energy management system in an institutional facility, whereas other participants (including past participants), were exclusively in the medium to large industrial manufacturing sector. This new participant's energy consumption was spread over four separate campuses and several hundred buildings. Due to the structure of the operations, a single regression model could not be generated to accurately calculate the anticipated electrical consumption; instead the participant would have had to create hundreds of individual regression models and then combine the results into a single cumulative model. As this approach was not feasible to implement, the participant did not take part in the usual EMIS process and rather used a BAS system that was implemented as a result of an EMIS investigation phase to make adjustments to equipment runtime schedules, similarly to the types of projects encountered in the Building Optimization service.

Since the participant did not work directly with the EMIS service provider and the savings were not based on the baseline regression approach typically used under EMIS, the format of savings documentation differed from other EMIS participants. All savings documentation provided to the Evaluator were prepared by the participant's on-site energy manager and included a summary annual savings report and three separate Excel workbooks. The summary savings report outlined the scope of work that was carried out and the methodology used for calculating savings, which was based on standard engineering equations for motor energy use. The supporting workbooks contained nameplate data for the HVAC equipment that was being scheduled, as well as pre and post-runtime hours for each system. Savings were calculated for a total of 33 pieces of HVAC equipment across three separate campuses.

Overall, the data was easy to evaluate and contained sufficient detail to verify the calculation methodology used. Two minor changes were made to the energy savings calculation methodology. The first was to update the tracked load percentage to 85 percent to match the stated annual savings report value, and the second was to update motor efficiencies to match the National Electrical Manufacturers Association tables used by BER for various motor horsepower ranges since a single efficiency was applied to all motors even though their sizes varied. The resulting adjustment ratio was 0.984 for energy savings and no adjustment ratio could be calculated for the demand savings because ENS did not track any savings for this participant. The Evaluator calculated the demand savings by isolating the equipment scheduled to be turned off during the peak demand period, and because the schedules varied by equipment type, a weighted average PCF was calculated for the five pieces of equipment with peak demand savings. This resulted in calculated peak demand savings of 19.6 kW.

Since this project does not generate conventional EMIS savings, the evaluated energy and demand savings were counted in 2018 and will not have reoccurring or incremental savings in 2019.

14.2.2 Interactive Effects

The savings associated with EMIS are usually established based on the results of metered electrical energy consumption within a defined measurement boundary encompassing specific industrial processes.

This was the case for the continuing participant. Although that participant had process-related energy consumption that could impact HVAC equipment electrical consumption, the facility did not have electrical heating systems or air-conditioning systems.

As for the new participant, the claimed savings were the results of HVAC fan control measures. The Evaluator applied no interactive effects to the savings of this participant since most of the air handling units were roof-mounted or enclosed in a semi-conditioned rooftop mechanical space.

14.2.3 Effective Useful Life

As discussed in the 2017 Evaluation Report, the Evaluator decided to estimate savings conservatively by not claiming additional incremental savings as a result of avoided decay. However, persisting savings and avoided decay are accounted for through their impacts on EUL values.

To estimate the EUL to be applied to savings, two elements were considered:

- › **The remaining time in the program component:** As demonstrated in the 2017 evaluation, savings fully persist (i.e. have a nil decay rate) until participants stop participating in EMIS. Therefore, the number of years during which 100 percent of savings will persist is a function of how many years are left in program component participation. Based on the current participation trends, the Evaluator made the assumption that, on average, participants are active in EMIS (i.e. receiving support from ENS and their service provider) for four years. Therefore, the first portion of EUL can be calculated as four minus the number of years (excluding the current year) over which the energy management information system generates savings.
- › **The decay rate of savings after participation ends:** This value is unknown at this point since no measured data are available. As in the 2017 evaluation, the Evaluator assumed a conservative decay rate of 50 percent, which results in an additional one year of incremental savings after participants withdraw from the program component.

Since the EUL is influenced by the remaining time in the program component, an EUL was calculated for each participant. To do so, the EUL of savings during participation are added to the EUL of savings after participation. For example, a participant in the third year of participation has an EUL of two years (years remaining in the program component) plus one year (to account for savings occurring after participation), resulting in a total EUL of three years.

Although the continuing participant was in the fifth year of participation, which would result in an EUL of two years if the methodology mentioned above were applied, the Evaluator applied an EUL of three

years since the participant was known to continue participating in EMIS in 2019. For the new participant, the Evaluator applied the same EUL value as used in Building Optimization for measures related to HVAC controls, which was three years. In addition, the savings claimed for the 2017 project were attributed an EUL of one year since EMIS participation has ended for that project.

14.2.4 Revised Gross Savings

EMIS gross energy and peak demand savings are listed in Table 19 below only for incremental savings since those are the savings reported by ENS.

The average line loss factors were obtained by dividing total gross savings at the generator and total gross savings at the meter for both energy and peak demand savings. The gross incremental energy and peak demand savings at the generator were 1.616 GWh and 0.051 MW respectively. Lifetime energy savings were calculated to be 3.655 GWh, which results in an average equivalent EUL value of 2.3 years.¹⁶

Table 19: EMIS Revised Gross Energy and Peak Demand Savings

	2018 Projects			2017 Projects	Total
	Ongoing Project	New Project	Subtotal for 2018 Projects		
Number of Projects	1	1	2	1	3
Energy Savings					
Tracked Gross Energy Savings – at the Meter (GWh)	0.652	0.324	0.976	0.586	1.561
Adjustment Ratio for Energy Savings	1.000	0.984	-	0.975	-
Gross Energy Savings – at the Meter (GWh)	0.652	0.319	0.970	0.571	1.542
Line Loss Factor	1.044	1.064	-	1.044	-
Gross Energy Savings – at the Generator (GWh)	0.680	0.339	1.019	0.596	1.616
Equivalent Effective Useful Life (years)	3.0	3.0	-	1.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	2.041	1.017	2.378	0.596	3.655
Peak Demand Savings					
Tracked Gross Peak Demand Savings – at the Meter (MW)	0.060	0.000	0.060	-0.037	0.023
Adjustment Ratio for Peak Demand Savings	1.000	-	-	0.857	-
Gross Peak Demand Savings – at the Meter (MW)	0.060	0.020	0.080	-0.032	0.048
Line Loss Factor	1.044	1.064	-	1.044	-
Gross Peak Demand Savings – at the Generator (MW)	0.063	0.021	0.084	-0.033	0.051

¹⁶ The 2018 results also include savings achieved by a participant in 2017; energy consumption data became available only in 2018 for the latter, so savings of 0.596 GWh and -0.034 MW were evaluated this year and added to the 2018 results.

14.3 Net-to-gross Ratio

The NTGR serves to determine net savings, i.e. the energy savings that can be reliably attributed to a program component. More precisely, the NTGR represents the positive or negative impact of spillover and free-ridership effects on gross savings.

For EMIS, free-ridership and spillover effects were considered to be nil and a NTGR of 1.00 was applied. The Evaluator believes that the limited number of participants and the limited penetration of energy management information systems among industrial and institutional facilities justify the decision of not applying any factor associated with free-ridership.

In addition, the new participant did not actually install an energy management information system and rather implemented measures identified through an EMIS assessment. Since the assessment would not have been carried out without considerable influence from ENS, the Evaluator applied a NTGR of 1.00 for this participant as well.

The participant spillover effects were expected to be negligible because energy management information systems measure savings at facility level, which means that low potential savings would occur outside the system measurement boundaries.

14.4 Net Savings

Net savings are defined as the changes in energy use that are specifically attributable to EMIS. Since spillover and free-ridership effects were considered to be nil, the net program component impacts are equal to the gross savings generated by the program component. Overall, the total net electrical energy and peak demand savings amounted to 1.616 GWh and 0.051 MW at the generator respectively.

Using the Nova Scotia-specific factor¹⁷ for greenhouse gas emissions generated by electricity production, 0.6126 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 990 tonnes of avoided CO₂ eq annually.

Table 20 below compares EMIS total tracked savings and evaluated savings.

¹⁷ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes), and total electricity generation (10,978 GWh) was found in the following two sources:

Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018).

Emera Inc., *Management's Discussion & Analysis* as at February 9, 2018

<http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

Table 20: Comparison of EMIS Total Tracked and Evaluated Savings at the Generator

	Initial Gross Savings	Adjusted Gross Savings	NTGR	Net Savings
Energy Savings				
ENS Tracked Savings	1.637 GWh	1.637 GWh	1.00	1.637 GWh
Evaluation Results	1.637 GWh	1.616 GWh	1.00	1.616 GWh
Peak Demand Savings				
ENS Tracked Savings	0.027 GWh	0.027 GWh	1.00	0.027 GWh
Evaluation Results	0.027 GWh	0.051 GWh	1.00	0.051 GWh

The evaluated energy savings were 1 percent lower than the tracked savings due to the minor changes made by the Evaluator to the energy savings calculation of the new participant. Also, the savings of the 2017 project were incorrectly tracked by ENS, resulting in slightly lower savings.

Conversely, the large increase in peak demand savings (89%) is attributable to the addition of peak demand savings to one project, which ENS had not tracked.

15 SEM OVERVIEW

This section describes the SEM program component, follows up on 2016 evaluation recommendations, since SEM was not evaluated in 2017, and provides an overview of participation history.

15.1 Description

SEM was launched in 2014 as a pilot to provide industrial and institutional participants with funding and support to implement energy management practices within their organizations. The program component became a part of the overall portfolio of the Custom Incentives program in 2016.

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. SEM provides participants with energy Kaizens¹⁸ and mapping, energy management assessments, as well as performance-monitoring and reporting tools. SEM also provides employee training and organizational support for the implementation of energy management engagement activities that use energy performance information to prompt actions aimed at achieving behavioural change and operation and maintenance-related energy saving measures. Ultimately, SEM helps develop an energy management plan focused on business practice changes to enhance long-term energy performance. SEM participants have the opportunity to also register under EMIS, another program component under the Custom Incentives program, to have an audit conducted.

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 ENS throughout the duration of the project.¹⁹ SEM activities are conducted through a third-party service provider who delivers the program component. Participants commit to participating for 12 months, although ENS offers a second year to participants who want to continue with the energy management program.

SEM aimed to generate net electrical energy savings of 0.7 GWh and peak demand savings of 0.1 MW for 2018.

15.2 Follow-up on 2016 Evaluation Report Recommendations

SEM was evaluated in 2016 and improvement recommendations were made by the Evaluator. Table 21 below provides a brief summary of the implementation status of each recommendation presented in the Executive Summary section of the 2016 Impact Evaluation Report.

¹⁸ Energy Kaizens are activities that aim at continuously improving energy consumption by identifying waste and focusing on eliminating it.

¹⁹ An SEM project is defined as the implementation of a strategic energy management system in a facility.

Table 21: Implementation Status of the 2016 Recommendations for SEM

2016 Recommendations	Status
2016 SEM-R1. Continue to support SEM and identify potential new participants.	Implemented
2016 SEM-R2. Continue encouraging SEM participants to enroll in EMIS and strengthen integration between the two program components.	Implemented
2016 SEM-R3. Consider extending the SEM cycle to engage participants for a longer period of time.	Deferred
2016 SEM-R4. Track incremental savings rather than cumulative savings.	Implemented
2016 SEM-R5. Improve the identification of event types in the Event Log.	Implemented
2016 SEM-R6. Identify energy efficiency measures installed under ENS instant rebate programs.	Implemented
2016 SEM-R7. Apply the adjustments made to the baseline energy regression in the 2016 evaluation to continuing participants.	Not Applicable

Five of the seven 2016 recommendations were implemented by ENS. In 2017 and 2018, five new participants enrolled in SEM as a result of ENS efforts to identify potential new participants in response to recommendation 2016 SEM-R1. ENS also worked with past SEM participants to encourage them to take part in EMIS, which addressed recommendation 2016 SEM-R2; indeed, one SEM participant completed an EMIS audit and will be implementing an energy management information system. In response to recommendation 2016 SEM-R5, the event log now differentiates changes such as the removal or addition of measures, variations in production levels, and crossover participation. The addition of crossover participation (i.e. participation in other ENS program components) as an event type also addresses recommendation 2016 SEM-R6. Moreover, the annual reports were of excellent quality and provided sufficient details on events affecting facility energy consumption and how those events were taken into account in savings calculations. Recommendation 2016 SEM-R4 is also considered implemented since ENS has put in place a procedure to track incremental savings for any future participants that take part in SEM for more than one year.

Recommendation 2016 SEM-R3 was not implemented because ENS did not have all the information needed to perform a full analysis of the cost effectiveness of extending the SEM cycle over a two-year period. Once the savings persistency of SEM projects is measured or estimated with sufficient accuracy, ENS will reconsider this recommendation. In the meantime, ENS has been providing an additional year of support on a case-by-case basis, and two participants have engaged in a second year of participation. Finally, recommendation 2016 SEM-R7 could not be implemented since it relates to 2016 continuing participants and no continuing participants took part in SEM in 2017 and 2018.

15.3 Participation History

Although two projects were launched in fall 2017, these projects started generating savings only in January 2018 and were therefore included in the 2018 evaluation. Two other projects generated savings in 2018 after starting in March and June 2018 respectively. Another project started in July 2018, but did not generate savings in 2018 and was therefore not included in this evaluation; hence four participants were considered active in 2018. As presented in Figure 13 below, the participation level was higher than in 2017 when no SEM participants generated savings, although still considerably lower than 2015 and 2016 levels. Figure 13 also indicates that 2018 participants generated a similar amount of savings per participant as 2015, which makes sense since all participants were new participants both in 2015 and 2018. Consequently, Figure 14 outlines total savings that are lower than in 2015 and 2016 when more participants took part in SEM.

Figure 13: Summary of Participation in SEM, 2015-2018

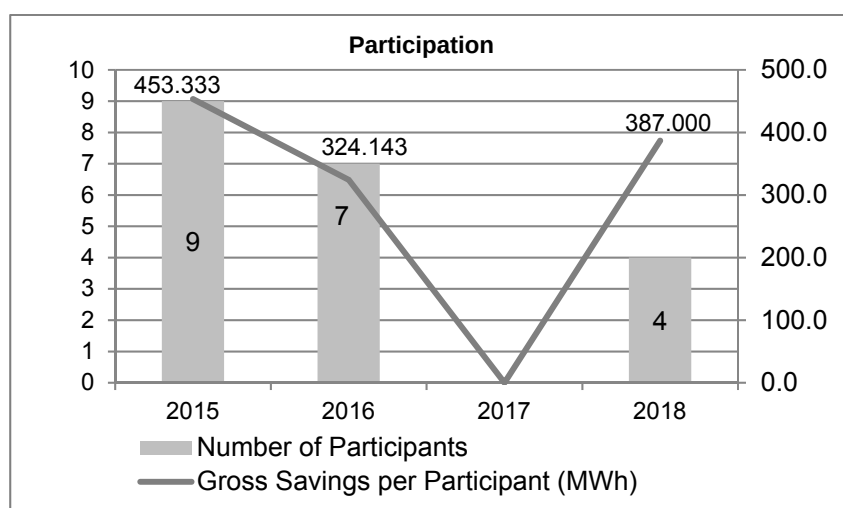
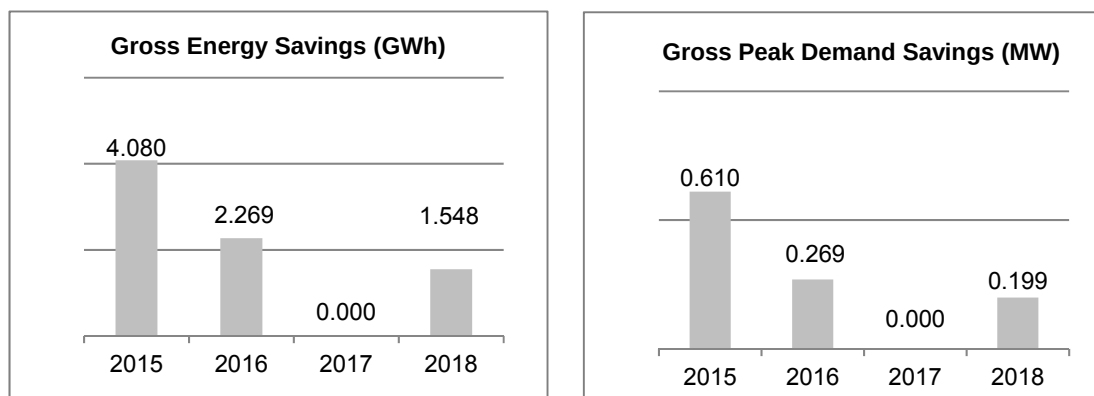


Figure 14: Summary of Gross Savings for SEM, 2015-2018



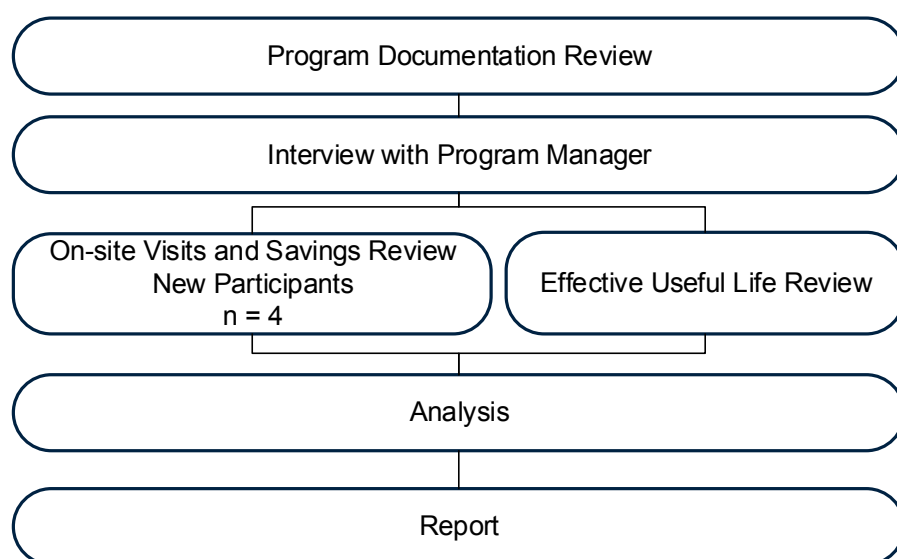
16 SEM EVALUATION OBJECTIVES AND METHODOLOGY

The main objectives of the SEM evaluation are as follows:

- › Reporting on participant perspectives
- › Calculating program results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions

This section presents the methodology used to achieve the aforementioned objectives. Figure 15 below illustrates the research strategy employed and the data-collection activities carried out in the 2018 SEM evaluation.

Figure 15: Methodological Model for SEM



The Evaluator first reviewed SEM documentation and then held a meeting with the program manager in September 2018 to verify the implementation status of the previous evaluation recommendations and learn about the main changes made to the program component.

These activities contributed to the Evaluator's overall understanding of SEM and helped inform the development of data-collection instruments. Specific evaluation activities were then undertaken, as described in the following subsections.

On-site Visits and Savings Review

In the fall of 2018, the Evaluator carried out a review of project documentation for all SEM projects in preparation for site visits.

The on-site visits, also performed in the fall of 2018, allowed the Evaluator to gain better understanding about the main energy consumption drivers of participating facilities and how energy savings were achieved, as well as to determine if any adjustments should be made to savings calculations. During on-site visits, the Evaluator asked participants questions to assess free-ridership, satisfaction with this program component, and savings persistence. The Evaluator used the information gathered in the project documentation and through the on-site visits to validate the energy models and the savings calculations.

The on-site visit protocol is outlined in Appendix XII.

Effective Useful Life Review

The Evaluator reviewed the EUL values used by ENS to calculate lifetime energy savings since lifetime energy savings were evaluated for the first time in 2018. To do so, the Evaluator surveyed participants about the persistency of the savings generated by implemented measures and conducted a thorough literature review of not only the technical reference manuals of other jurisdictions, but also evaluation reports and relevant studies.

17 SEM MARKET EVALUATION

This section describes participant perspectives on SEM.

As part of the SEM on-site visits, the four participants were asked questions regarding satisfaction with SEM, any barriers they encountered, and improvement suggestions.

Satisfaction with SEM

Overall satisfaction with SEM was high among all participants who provided an average rating of 8.1 on a 10-point scale (with 1 indicating “not at all satisfied” and 10 “completely satisfied”). Participants were most satisfied with the strategic energy management process itself and with the achieved savings. One mentioned that they “felt ENS staff were very willing, helpful and professional.” Another mentioned that “the process is very professional, detailed, and data driven.”

All four SEM participants were actively engaged at the time of site visits and reported that they were all still working periodically with the service provider to actively track progress and monthly savings. Each participant verbally confirmed that they were very happy with the support they had received from the service provider, and three of the four participants commented that they were planning to renew for 2019.

Challenges and Barriers

Among interviewed participants, two experienced challenges with coordinating efforts internally. One mentioned it was a challenge to make strategic energy management part of normal business operations, while the other mentioned difficulty having everyone on the same page.

The other two participants found no significant issue or barrier when implementing strategic energy management within their organization.

Recommendations

Three participants made suggestions on how to improve SEM.

One participant suggested reducing the number of in-person visits since they were somewhat dissatisfied by the number of visits conducted by ENS and the Evaluator. Indeed, many visits were conducted at their facility to validate the projects implemented as part of many ENS program components in which they took part in 2018. Two participants mentioned wanting more in-person visits by the service provider since they considered them valuable: “We had only one visit. They knew stuff and it would have been beneficial to have them on-site more through the process.” One participant mentioned wanting more help with identifying priorities such as a list of “five to ten measures to start with.”

18 SEM IMPACT EVALUATION

The objective of the 2018 impact evaluation of SEM projects is to determine their gross and net electrical energy and peak demand savings. The various terms related to the SEM impact evaluation are defined in the EMIS section of this report (Subsection 14.1) since the definitions apply to both program components.

18.1 Gross Savings

This subsection describes the methodology used to review the four SEM projects that generated savings in 2018 and summarizes the review findings. Interactive effects and revised gross savings are also assessed.

As recommended in the 2016 evaluation, ENS now tracks both incremental and cumulative savings. Since all 2018 participants are new participants, 2018 incremental savings are equal to cumulative savings. The savings reported by ENS to regulators are incremental savings and are therefore the focus of this evaluation.

18.1.1 Project Review Findings

In November 2018, ENS provided the Evaluator with an interim tracking sheet, copies of the SEM planning tools, and monthly performance workbooks for each site. The information was used to prepopulate the SEM protocols prior to carrying out the site visits and understand the key operating variables that had been chosen to create the regression consumption models. During the site visits, the Evaluator verified that participants understood how the regressions models functioned, reviewed the current list of initiatives that had been carried out, and collected supplementary information about any operational changes that might have impacted the accuracy of the models during the 2018 reporting period.

Upon completion of the site visits, the Evaluator performed a detailed desktop review of each regression workbook to verify that each of the four models were statistically significant and that any routine and non-routine adjustments needed to calculate 2018 savings had been applied.

The tracked savings of all four participants required relatively little adjustment. The adjustments made by the Evaluator were primarily due to the tracked savings values not matching the reported savings values prepared by the service provider. In fact, the tracking sheet did not include the adjustments made by the service provider with regard to savings attributable to capital projects. This change reduced the tracked energy savings by 3.3 percent. The other important adjustments were due solely to the fact that neither ENS nor the service provider tracked or calculated peak demand savings. The Evaluator estimated peak demand savings to be the average demand savings during the reporting period, which corresponds to dividing the total energy savings by the total number of hours within the reporting period. Since the savings of the 2018 projects are mostly driven by production levels and all participating facilities operated during peak hours, the Evaluator considered that average demands savings represent a conservative estimate of the peak demand savings.

Shortly before implementing SEM, one participant replaced linear lamps purchased through BER Instant Rebates, which generated savings accounted for in the SEM approach. For the lighting retrofit portion of that participant's savings, ENS established that 1,734 kWh were claimed in BER Instant Rebates based on the calculation methodology of that program service. As for all capital investment projects claimed through other programs, the service provider excluded these savings from SEM savings. Since the Evaluator revised BER Instant Rebates savings for this measure, the Evaluator recalculated the savings for this lighting retrofit project and established that BER Instant Rebates claimed 74,576 kWh. Moreover, by using engineering calculations such as those used in BER Mail-in, the Evaluator estimated that this lighting retrofit more likely generated 314,309 kWh in savings. Although the Evaluator accepted that the unclaimed savings of 239,733 kWh (314,309 - 74,576) be included in SEM gross savings given the unusual difference between estimated and actual savings, an adjustment had to be made to net savings. The Evaluator applied the BER Instant Rebates NTGR to these savings since the NTGR of SEM is not appropriate for savings that result from early lighting fixture replacements. More details about this adjustment are presented in the Subsection 18.3.

The quality of the information supplied by the service provider was excellent and included enough detail to easily understand the savings methodology and confirm where routine and non-routine adjustments had been made. With respect to improving the quality of the documentation for future years and for new SEM cohorts, the Evaluator recommends that peak demand savings be added to the scope of work and that the service provider prepare incremental baselines for subsequent years, as is currently done under EMIS. Additionally, the Evaluator recommends that ENS verify and update their tracked savings values to coincide with the values reported by the service provider in the annual savings reports.

18.1.2 Interactive Effects

The savings associated with SEM are established based on the results of metering the electrical consumption of an entire building for all the buildings evaluated. The on-site visits and analysis of the project documentation confirmed that the whole facility was metered. Since the measurement boundary included all existing systems, the interactive effects were already included in the metered savings. Hence, no additional interactive effects were applied to the measured savings.

18.1.3 Effective Useful Life

To establish the EUL of SEM, the Evaluator conducted a literature review and also questioned participants about savings persistency.

The literature review revealed that there is no consensus on SEM savings persistency within the industry. In 2018, the Consortium for Energy Efficiency notably published a summary of SEM programs across the United States and Canada which highlights this lack of consensus.²⁰

²⁰ Consortium for Energy Efficiency. *2017 Strategic Energy Management Program Summary*, May 3, 2018.

All four participants answered persistency questions. When asked a combination of questions about if they agreed that they had the intention and capacity to maintain and track the facility energy consumption level if their service provider no longer helped them, participants provided average scores of 4.5, 6.0, 6.0 and 7.8 (on a scale of 1 to 10 where 1 equals "not at all agree" and 10 equals "completely agree"). One participant mentioned that "they would keep some [measures] like the shutdowns, but feel that the service provider holds them accountable." In summary, three of the four participants had a low to moderate confidence that they would maintain and track their energy consumption level.

When asked about the likelihood of continuing to work with a service provider without ENS support, the participant that was the most confident in their ability to do the work on their own gave a low rating (3 out of 10). Among the other three participants, one also indicated that they were unlikely to hire the service provider, while the two other provided ratings of seven and eight out of ten. One mentioned that they "liked the service provider work," while another "feels like they are gaining some traction with the management team."

In summary, three of the four participants indicated a moderate to high probability of continuing strategic energy management in the absence of ENS support, either by hiring the service provider or by doing the work internally. The Evaluator used the interview results, along with an analysis of the measure types installed by SEM participants, to estimate the average EUL of SEM based on the same methodology as for EMIS, as described below:

- › **The remaining time in the program component:** The Evaluator assumed that the savings persist until participants stop taking part in SEM since it is likely that measures implemented during the first year of participation would be reconducted to the following year if the participant continued with SEM. This assumption was also observed by other evaluators such as Cadmus.²¹ Since SEM participants are allowed to take part in SEM for up to two years and three of the four 2018 participants mentioned planning to participate for a second year, the Evaluator made the assumption that, on average, participants are active in SEM (i.e. receiving support from ENS and the service provider) for two years. Therefore, the first portion of EUL can be calculated as two minus the number of years (excluding the current year) during which the energy management information system generates savings.

²¹ Cadmus. *Perspectives on SEM Evaluation Northeast SEM Collaborative Workshop*, November 8, 2017.

- › **The decay rate of savings after participation ends:** This value is unknown at this point since no measured data were available. The Evaluator decided to apply the same decay rate (50%) as for EMIS since a considerable portion of SEM savings resulted from implementing control measures and standard operating procedures that are likely to continue generating savings after SEM participation. Also, some participants will likely retain a service provider after the end of ENS support. Thus, applying a decay rate of 50 percent results in an additional one year of incremental savings after participants withdraw from the program component.

Consequently, the Evaluator estimated the EUL at three years for participants in their first year of participation and two year for those in their second year. Since all 2018 participants are new, this resulted in applying an average EUL of three years to all 2018 SEM savings.

18.1.4 Revised Gross Savings

For incremental savings, the 2018 SEM gross energy and peak demand savings at the generator are listed in Table 22 below.

The average line loss factors were obtained by dividing total gross savings at the generator and total gross savings at the meter for both energy and peak demand savings. The gross incremental energy and peak demand savings at the generator were 1.548 GWh and 0.199 MW respectively. Based on the equivalent EUL value of 3.0 years, lifetime energy savings were calculated at 4.645 GWh.

Table 22: SEM Revised Gross Energy and Peak Demand Savings

	Incremental Savings
Number of Projects	4
Energy Savings	
Tracked Gross Energy Savings – at the Meter (GWh)	1.597
Adjustment Ratio for Energy Savings	0.921
Gross Energy Savings – at the Meter (GWh)	1.471
Line Loss Factor	1.053
Gross Energy Savings – at the Generator (GWh)	1.548
Equivalent Effective Useful Life (years) ²²	3.0
Gross Lifetime Energy Savings – at the Generator (GWh)	4.645
Peak Demand Savings	
Tracked Gross Peak Demand Savings – at the Meter (MW)	0.000
Adjustment Ratio for Peak Demand Savings	-
Gross Peak Demand Savings – at the Meter (MW)	0.189
Line Loss Factor	1.053
Gross Peak Demand Savings – at the Generator (MW)	0.199

18.2 Net-to-gross Ratio

The NTGR serves to determine net savings, i.e. the energy savings that can be reliably attributed to a program component. More precisely, the NTGR represents the positive or negative impact of the spillover and free-ridership effects on gross savings.

As was the case for the 2015 and 2016 evaluations, the Evaluator applied a NTGR of 1.00 to the 2018 savings since free-ridership and spillover were considered to be nil. The Evaluator still believes that the small number of participants and the limited penetration of strategic energy management practices among industrial and institutional facilities justifies the decision of not applying any free-ridership effects. To validate this assumption, the Evaluator asked a set of questions to participants during the on-site visits. The questionnaire used for this interview is presented in Appendix XII.

²² The equivalent EUL for SEM represents the life of the incremental savings which occur in the current year.

The information gathered from the participants confirmed the Evaluator's assumption. In fact, three of the four participants indicated having limited knowledge of strategic energy management and no intention to implement it before participating in SEM. The other participant mentioned being aware of and interested in SEM prior to being contacted by ENS, but with no clear plan to implement a strategic energy management process in the near future. This is the first time since the inception of the program component that an SEM participant demonstrates such knowledge of strategic energy management. It is recommended that ENS continue to ask questions about knowledge of and interest in strategic energy management since the practice might become more widespread and warrant free-ridership measurement in the future.

Spillover effects were expected to be negligible and were therefore not measured.

18.3 Net Savings

Net savings are defined as the changes in energy use that are specifically attributable to SEM. Since one project had some savings reported through SEM that resulted from participation in BER Instant Rebates, the Evaluator applied a NTGR of 0.63 to that portion of savings based on the BER Instant Rebates value for this specific type of lighting. The adjustment to energy savings was calculated using the following equation:

$$\text{Deducted Savings (kWh)} = 239,733 \text{ kWh} - (239,733 \text{ kWh} \times 0.63) = 88,701 \text{ kWh}$$

Peak demand savings were deducted proportionally to energy savings. Table 23 below presents SEM overall net savings after applying this deduction. Overall, the total net energy and peak demand savings amounted to 1.455 GWh and 0.190 MW at the generator.

Table 23: SEM Revised Gross Energy and Peak Demand Savings

	Annual Savings
Energy Savings	
Revised Gross Energy Savings – at the Meter (GWh)	1.471
Special Deduction (GWh)	-0.089
Net Energy Savings – at the Meter (GWh)	1.382
Line Loss Factor	1.053
Net Energy Savings – at the Generator (GWh)	1.455
Effective Useful Life (years)	3.0
Net Lifetime Energy Savings – at the Generator (GWh)	4.365
Peak Demand Savings	
Revised Gross Peak Demand Savings – at the Meter (MW)	0.189
Special Deduction (MW)	-0.009
Net Peak Demand Savings – at the Meter (MW)	0.180
Line Loss Factor	1.053
Net Peak Demand Savings – at the Generator (MW)	0.190

Using the Nova Scotia-specific factor²³ for greenhouse gas emissions generated by electricity production, 0.6126 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 891 tonnes of avoided CO₂ eq annually. Based on an equivalent EUL of 3.0 years, the net lifetime energy savings were calculated at 4.365 GWh.

Table 24 below compares SEM total tracked savings and evaluated savings. It should be noted that the NTGR presented in this table is lower than one, as recommended in Subsection 18.2, because of the adjustment for the BER Instant Rebates project. Since the deduction applied to obtain net savings results from a situation that is not likely to occur again, the Evaluator recommends that ENS apply a NTGR of 1.00 to their tracking in 2019.

Table 24: Comparison of SEM Total Tracked and Evaluated Savings at the Generator

	Initial Gross Savings	Adjusted Gross Savings	NTGR	Net Savings
Energy Savings				
ENS Tracked Savings	1.681 GWh	1.681 GWh	1.00	1.681 GWh
Evaluation Results	1.681 GWh	1.548 GWh	0.94	1.455 GWh
Peak Demand Savings				
ENS Tracked Savings	0.000 MW	0.000 MW	1.00	0.000 MW
Evaluation Results	0.000 MW	0.199 MW	0.95	0.190 MW

The evaluated gross energy savings were 8 percent below the tracked values mainly because the savings attributable to capital projects were not correctly tracked and accounted for by ENS. Moreover, the Evaluator adjusted the savings to be deducted from one capital project that installed lighting through BER Instant Rebates since the savings for the installed product were revised by the Evaluator. This adjustment could not be tracked by ENS since it occurred after the tracking sheet was submitted. Furthermore, the deduction made to the net savings of that same project resulted in net savings being 13 percent below tracked savings.

Since no peak demand savings were tracked, the evaluated peak demand savings are higher than the tracked value.

²³ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes) and total electricity generation (10,978 GWh) was found in the following two sources: Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018) Emera inc., *Management's Discussion & Analysis* as at February 9, 2018, <http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

19 EMIS AND SEM RECOMMENDATIONS

Both EMIS and SEM achieved their savings targets in 2018 and participation satisfaction remained high. EMIS saw additional incremental savings being achieved in the continuing participant's fourth year of participation. As for SEM, after one year with no participation in 2017, participation increased to four participants in 2018 and all generated considerable savings.

In addition to the general recommendations made for all ENS program components in the 2018 DSM Programs Evaluation Executive Summary and the 2017 recommendations not yet being fully implemented, the Evaluator makes the following recommendation on how to improve EMIS and SEM. These recommendations are also listed in Appendix XIII.

2018 EMIS & SEM-R1. Review program delivery to improve participant understanding and mastery of energy performance tracking. Despite being satisfied with EMIS and SEM, many participants in both program components mentioned feeling they need more assistance with ongoing analysis and they lack resources to continue tracking and maintaining facility energy consumption levels on their own. Another indication of high dependence on service providers is that one 2017 EMIS participant stopped producing monthly reports for the second half of 2017 because the service provider could no longer remotely access their energy management information system. Furthermore, many SEM participants do not anticipate continuing their energy management efforts, particularly in terms of tracking energy performance, without the support of a service provider. The Evaluator believes that these examples indicate that EMIS and SEM participants heavily rely on their service providers to maintain their efforts and that the program components do not achieve the full potential of changing energy management practices. Therefore, it is recommended that EMIS and SEM delivery methods be reviewed to better equip participants to understand and fully master energy performance tracking methods. In addition to increasing the persistency of savings, this is also likely to improve participant satisfaction with EMIS and SEM since participants would feel less overwhelmed by the amount and complexity of the data provided to them through EMIS or SEM.

20 OVERALL SAVINGS FOR THE CUSTOM INCENTIVES PROGRAM

Table 25 presents the number of participants and gross and net savings for each Custom Incentives program component as well as those for the program as a whole for 2018.

Table 25: 2018 Overall Participation and Savings for Custom Incentives

	Participation Level	Gross Savings	NTGR	Net Savings
Custom				
Energy Savings	69 projects completed	14.315 GWh	0.81	11.603 GWh
Lifetime Energy Savings		196.661 GWh	0.79	156.158 GWh
Peak Demand Savings		1.695 MW	0.71	1.200 MW
EMIS				
Energy Savings	2 participants	1.616 GWh	1.00	1.616 GWh
Lifetime Energy Savings		3.655 GWh	1.00	3.655 GWh
Peak Demand Savings		0.051 MW	1.00	0.051 MW
SEM				
Energy Savings	4 participants	1.548 GWh	0.94	1.455 GWh
Lifetime Energy Savings		4.645 GWh	0.94	4.365 GWh
Peak Demand Savings		0.199 MW	0.95	0.190 MW
Total				
Energy Savings		17.479 GWh		14.674 GWh
Lifetime Energy Savings		204. 961 GWh		164.097 GWh
Peak Demand Savings		1.945 MW		1.440 MW

CONCLUSION

The Custom Incentives program is comprised of the Custom, EMIS and SEM program components, which combined aimed to achieve 24.2 GWh in net electrical energy savings and 2.7 MW in net peak demand savings at the generator in 2018. The program achieved 14.674 GWh in net electrical energy savings and 1.440 MW in net peak demand savings at the generator, resulting in 8,905 tonnes of CO₂ eq. in terms of annual avoided GHG emissions. The total net lifetime energy savings amount to 164.097 GWh, resulting in average equivalent EUL of 11.2 years. The program thus fell short of both its planned energy and peak demand savings values. This is mainly due to Custom, the largest contributor to program energy and peak demand savings, generating less than 50 percent of planned savings.

The following subsections summarize the main findings for each of the three Custom Incentives program components.

Custom

Custom is comprised of the Retrofit, New Construction and Building Optimization services. Altogether, these services generated 11.603 GWh in net electrical energy savings and 1.200 MW in net peak demand savings at the generator in 2018, with 79 projects generating savings and 69 projects completed in 2018.

Again in 2018, the Evaluator noticed an improvement in the documentation of Retrofit projects, which was mostly due to new ENS quality assurance procedures that began being implemented in 2018. The full implementation of the QA procedures is expected to improve the accuracy of reported savings and resolve most of the issues that led to adjustments higher than 10 percent for five of the reviewed projects, most importantly savings calculations that did not match final project parameters. Another element that is yet to be improved is the inclusion of non-routine adjustments in M&V calculations when facilities undergo changes in their operating conditions that are not due to implemented energy efficiency measures. Energy savings were only reduced by 5.2 percent, while peak demand savings were adjusted downward by 17.5 percent. The New Construction and Building Optimization project reviews resulted in more substantial adjustments to the energy savings than for Retrofit. These adjustments were mostly due to inappropriate energy models and incorrect engineering calculations. Overall, the adjustments made by the Evaluator to the gross energy savings for all the services reduced the ENS tracked value by 13 percent.

In 2018, the Evaluator measured free-ridership for Retrofit, as well as for New Construction since ENS began to use the building code as the base case instead of participant-specific base cases. The free-ridership level for Retrofit was established at 14 percent, which is higher than the levels measured in previous years by approximately 4 percent. As for New Construction, free-ridership was established at 36 percent.

As part of the 2018 evaluation, the Evaluator conducted a process evaluation that was aimed at identifying ways to increase participation in New Construction. Interviewed participants and SPs mentioned challenges understanding New Construction steps and requirements, which led the Evaluator to conclude that communications about this service require improvement.

Energy Management Information System

Two participants generated savings under EMIS in 2018; one was a continuing participant that began with EMIS in 2015 and the other was a new participant that reported savings through a special EMIS project. The 2018 evaluation revealed that EMIS achieved 1.616 GWh in net electrical energy savings and 0.051 MW in net peak demand savings at the generator.

The annual savings results for the continuing participant were accurately tracked, well documented, and contained the necessary information for the Evaluator to assess the incremental savings values and non-routine adjustment. All documentation provided by the EMIS service provider was excellent and the Evaluator made no adjustments to the energy and peak demand savings values.

For the new participant project, the documentation was sufficient and allowed the Evaluator to understand the savings calculations. The Evaluator made minor changes to the energy savings calculation methodology and calculated peak demand savings, since no peak demand savings were tracked by ENS or presented in the savings report.

Although satisfaction with EMIS was high among participants, they both mentioned having encountered challenges related to either finding the time to understand the energy management system or analyzing the large amount of data provided by the system.

Strategic Energy Management

Four participants generated savings in 2018, and all were new participants. The Evaluator determined that SEM achieved 1.455 GWh in net electrical energy savings and 0.190 MW in net peak demand savings at the generator.

The quality of the information supplied by the service provider was excellent and included enough detail to easily understand the savings methodology. Although the energy savings calculated by the service provider for all four participants required only minimal adjustments, the Evaluator found that ENS incorrectly reported those savings in their tracking sheets. One common mistake was to omit the deduction of savings attributable to capital projects. While neither ENS nor the service provider tracked or calculated peak demand savings, the Evaluator established peak demand savings for each participant, which resulted in a significant upward adjustment to tracked peak demand savings.

While satisfaction with SEM was high among participants, most participants had low to medium confidence that they had enough resources to continue tracking and maintaining facility energy consumption levels without support from a SP.

LIST OF APPENDICES

The following are presented in the Custom Incentives Program – Appendices.

Custom

Appendix I Custom: Retrofit On-site Visit Protocol

Appendix II Custom: New Construction Project Review Protocol

Appendix III Custom: Building Optimization On-site Visit Protocol

Appendix IV Custom: New Construction Service Provider Interview Guide

Appendix V Custom: Retrofit Calculation Example

Appendix VI Custom: Retrofit Algorithm for Free-ridership Calculation

Appendix VII Custom: Retrofit Algorithm for Participant Spillover Calculation

Appendix VIII Custom: New Construction Algorithm for Free-ridership Calculation

Appendix IX Custom: 2018 Recommendations

EMIS and SEM

Appendix X EMIS: On-site Visit and Project Review Protocol with EMIS New Participant

Appendix XI EMIS: Project Review Protocol and Interview Guide with Continuing Participant

Appendix XII SEM: On-site Visit Protocol

Appendix XIII EMIS/SEM: 2018 Recommendations



ECONOLER

CUSTOM INCENTIVES PROGRAM

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Appendix Report

March 15, 2019



research > into > action^{inc}

ECONOLER

 **equilibrium**
engineering

TABLE OF CONTENTS

APPENDIX I CUSTOM: RETROFIT ON-SITE VISIT PROTOCOL	1
APPENDIX II CUSTOM: NEW CONSTRUCTION PROJECT REVIEW PROTOCOL	14
APPENDIX III CUSTOM: BUILDING OPTIMIZATION ON-SITE VISIT PROTOCOL	24
APPENDIX IV CUSTOM: NEW CONSTRUCTION SERVICE PROVIDER INTERVIEW GUIDE	31
APPENDIX V CUSTOM: RETROFIT CALCULATION EXAMPLE	37
APPENDIX VI CUSTOM: RETROFIT ALGORITHM FOR FREE-RIDERSHIP CALCULATION	40
APPENDIX VII CUSTOM: RETROFIT ALGORITHM FOR PARTICIPANT SPILLOVER CALCULATION	42
APPENDIX VIII CUSTOM: NEW CONSTRUCTION ALGORITHM FOR FREE-RIDERSHIP CALCULATION	43
APPENDIX IX CUSTOM: 2018 RECOMMENDATIONS	44
APPENDIX X EMIS: ON-SITE VISIT AND PROJECT REVIEW PROTOCOL WITH EMIS NEW PARTICIPANT	46
APPENDIX XI EMIS: PROJECT REVIEW PROTOCOL AND INTERVIEW GUIDE WITH CONTINUING PARTICIPANT	53
APPENDIX XII SEM: ON-SITE VISIT PROTOCOL	61
APPENDIX XIII EMIS/SEM: 2018 RECOMMENDATIONS	66

APPENDIX I

CUSTOM: RETROFIT ON-SITE VISIT PROTOCOL

This appendix describes the protocol used as part of the Retrofit on-site visits.

On-site Visit Protocol

In 2018, the Evaluator made only minor improvement to the on-site visit protocol used for the 2017 evaluation.

The on-site protocol form was used by the Evaluator to collect technical data and summarize information, such as project details, a building's heating and cooling systems, key parameters to review during the site visit, and previous measurement and verification (M&V) activities. Other technical information collected could include, but is not limited to, the equipment's operating schedules, the equipment's specifications, quantities, baseline conditions, typical equipment loading, and changes that occurred since M&V had been conducted.

Prior to conducting the on-site visits, the Evaluator reviewed all project documentation submitted by Efficiency Nova Scotia (ENS). The documents reviewed included, but were not limited to, the following: Scoping and/or Feasibility studies, Energy Efficiency Measure (EEM) savings calculations, Project Development Agreements, M&V reports, and email correspondence.

On-site Visit Data Collection Form for Retrofit Projects



1. General Information

Site Visit Date: EQ Team: Contact Name:

Project ID: Contact Title:

Project Type: Contact Phone:

Company Name: Email:

Address:

List of people met during the visit:

Type of building:

Commercial/institutional	☐	Industrial/manufacturing	☐
Municipal	☐	Other (specify)	☐

 Specify:

2. Facility Operation Schedules

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: *Fill the table below for each occupancy schedule reported by the site contact as occupancy could vary for each section of the facility. Use additional sheets if necessary.*

Description	1 - Normal Schedule		2 - Specify:		3 - Specify:	
	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends
Number of day with regular schedule per year						
Number of day with regular holidays schedule per year						
Number of days with no occupancy per year (For example: seasonal closure)						
Total number of day per year	0	0	0	0	0	0

Total=261 Total=104

Facility Daily Schedule:

Fill the table below for each occupancy schedule reported by the site contact as occupancy could vary for each section of the facility. Use additional sheets if necessary.

Schedules		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Holidays
Schedule 1: Normal	Time of use (e.g. 8:00 am to 5:00 pm)								
	Hours per day								
Schedule 2 (specified above)	Time of use								
	Hours per day								
Schedule 3 (specified above)	Time of use								
	Hours per day								

3. Interactive Effects

Interactive Effects?

YES

NO

If YES the fill in the table below for each heating system at the site

Briefly describe interactive effects for the project.

4. Building Heating/Cooling System Description
Heating Systems

Fill the table below for each heating system at the site.

Description	Heating System 1	Heating System 2	Heating System 3	Heating System 4
Energy Source				
Heating System Type				
Nominal Capacity				
Efficiency or COP				
Percent of Load (Declaration)				
If any, changes in building set points (occ./ unocc. temp., % hum)				

Cooling Systems

Fill the table below for each cooling system at the site.

Description	Cooling System 1	Cooling System 2	Cooling System 3	Cooling System 4
Energy Source				
Cooling System Type				
Nominal Capacity				
SEER or COP				
Percent of Load (Declaration)				
If any, changes in building set points (occ./ unocc. temp., % hum)				



5. Pre-Visit Assessment of the Project

Indicate the key variables & observations from all available reports. These notes will serve on site to guide the visit and identify the main information to collect and/or verify.

6. On-Site Observations and Findings

Report the on-site visit and indicate the key observations and findings made on site.

[illegible]

7. M&V Post Implementation Results

Were any baseline measurements taken (Y/N)

Are electrical savings based on measurements? (Y/N)

Are demand savings based on measurements? (Y/N)

IF so summarize measurement plan, and measurement type.

Report the on-site visit and indicate the key observations and findings made on site.

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

Notes: Insert Comments from M&V Reports

8. Estimated Useful Life of the project

Type of replacement

If early replacement, indicate the remaining useful life of the equipment

Observations that justify the type of replacement choice

Main equipment considered in EUL calculation

Tracked Project EUL (yrs)

Evaluated Project EUL (yrs)

Refer to project documentation for tracked baseline EUL

Notes:

Detail reasoning if changes were made to the tracked EUL

9. Energy and Demand Savings Adjustments

Energy Savings from Tracking Sheet:		kWh/yr
Demand Savings from Tracking Sheet:		kW
Peak Coincidence Factor Used by ENSC:		

Project Estimated Finish Month:	
Notes on Project Status:	

Adjustment from the Evaluator

Adjusted Energy Savings:		kWh/yr
Adjusted Demand Savings:		kW
Adjusted Demand Savings with PCF:		kW
Peak Coincidence Factor Used by Econoler:		

Final Project Impacts at the Generator

Evaluated Energy Savings:	0.0	kWh/yr
Evaluated Demand Savings with PCF:	0.0	kW

Adjustments made to energy savings?		(Y/N)	Percent of Tracked Energy Savings	#DIV/0!
Adjustments made to demand savings?		(Y/N)	Client Rate Code	
Adjustments made to PCF?		(Y/N)	Line Loss Factor Used	
Changes between PDA and completion?		(Y/N)		
If Yes, was the tracking sheet adjusted accordingly?		(Y/N)		

10. Explain Project Adjustments between PDA and project completion

If any modification were made between PDA and project completion, describe and provide calculations

11. Summarize Project Adjustments and Final Savings Values

If any adjustments were made to the energy savings, demand savings or PCF, describe the rationale and provide calculations.

12. Free Ridership and Spill Over questionnaires

Free Ridership questionnaire filled-in (Y/N)

Spill Over questionnaire filled-in (Y/N)

Final Adjusted 'Total Project Savings:
Energy Savings (kWh)
Demand Savings (kW) =

Market Questions

Satisfaction

S1. Using a scale from 1 to 10 where 1 is “not at all satisfied” and 10 is “completely satisfied” how would you rate your satisfaction with the Custom program overall?

S2. **[IF S1<8]** Why were you not more satisfied with the program?

S3. **[IF S1≥8]** What was the most important reason you were satisfied with the program?

Free-Ridership

Reminder: always try to talk to someone who is knowledgeable about the decision-making process, especially if the visit is conducted with an OEM (who, as an ENS staff member, cannot answer those questions).

FR1a. **[IF OEM = YES]** If you had **not** received support from your on-site energy manager, would the measures implemented through the Custom program have been identified as energy saving opportunity?

1. Yes
2. No
98. (Don't know)
99. (Refused)

FR1b. **Before participating** in the Custom program, had your organization decided to implement the specific energy efficiency measures that were implemented through the Custom Program?

1. Yes
2. No
98. (Don't know)
99. (Refused)

FR1c. **[ASK IF FR1b=YES]** I just want to make sure I understand - **Before** you decided to participate in the Custom program, you had already made the decision to implement the energy efficiency measures you implemented through the program?

- 1. Yes
- 2. No
- 98. (Don't know)
- 99. (Refused)

[READ FIRST TIME THROUGH ONLY] Now I would like to ask you to consider what actions you would have taken if the Custom program had NOT been available. Please answer on a scale of 0 to 10, with a 0 indicating that it is "Very Unlikely," and a 10 indicating that it is "Very Likely. "

FR2a. If the program support or financial incentive had not been offered, what is the likelihood that you would have implemented exactly the same energy efficiency measures that you implemented through the program?

___ Response ___98 Don't Know ___99 Refused

FR2b. If the program support or financial incentive had not been offered, what is the likelihood that you would have kept your equipment as it was or installed new standard equipment instead of implementing your energy efficiency equipment?

___ Response ___98 Don't Know ___99 Refused

FR2c. If the program support or financial incentive had not been offered, what is the likelihood that you would have postponed the implementation of the energy efficiency measures by at least one year?

___ Response ___98 Don't Know ___99 Refused

FR3. If your organization had not received the [FINANCIAL INCENTIVES] from Efficiency Nova Scotia, would you have paid the full cost of the energy efficiency measures you implemented? Please answer on a scale of 0 to 10, with a 0 indicating that you "Definitely **Would Not** Have Paid" and a 10 indicating that you "Definitely **Would** Have Paid." [PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]

___ Response ___98 Don't Know ___99 Refused

FR4. Next, I'm going to ask you to rate the importance of factors that might have influenced your decision to implement the energy efficiency measures you implemented through the Custom program. Using a scale from 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 implemented through the Program.

Factor (READ AND RANDOMIZE)	Responses
a. The program financial incentives	___ Response___ 97 N/A 98 Don't Know 99 Refused
b. The recommendations and technical assistance provided by the Business Development Manager or other ENS staff in selecting and implementing your energy efficiency measures	___ Response___ 97 N/A 98 Don't Know 99 Refused
c. Increased confidence of company management in the project due to ENS involvement	___ Response___ 97 N/A 98 Don't Know 99 Refused
d. [ASK IF, IN DATABASE, SCOPING STUDY OR FEASIBILITY STUDY=YES] The funded Scoping Study and/or the Feasibility Study	___ Response___ 97 N/A 98 Don't Know 99 Refused
e. [ASK IF OEM=YES] The assistance provided by your on-site energy manager in identifying and implementing the energy efficiency measures	___ Response___ 97 N/A 98 Don't Know 99 Refused

FR5a. When it comes to deciding on whether or not to implement energy efficiency projects or not, does your company use a payback period threshold as a decisional criterion?

1. YES, RECORD: ___ → [CONTINUE]
2. NO → [SKIP TO CROSS-INFLUENCE]
8. (DON'T KNOW) → [SKIP TO CROSS-INFLUENCE]
9. (Refused) → [SKIP TO CROSS-INFLUENCE]

FR5b. **[ASK IF FR5a=YES] Without the incentive**, was the payback period short enough for the project to be implemented?

1. YES
2. NO
8. (DON'T KNOW)
9. (Refused)

FR5c. **[ASK IF FR5b= YES]** Just to be sure I understand correctly, you are saying that the project was already attractive enough in terms of financial payback to be implemented without the incentive?

1. YES
2. NO
8. (DON'T KNOW)
9. (Refused)

FR6. **[ASK IF FR5a= YES]** Has your company ever implemented energy efficiency projects that had a payback period longer than the usual payback time threshold?

1. YES
2. NO
8. (DON'T KNOW)
9. (Refused)

Cross-influence

FR7. Before participating in the Custom program, had you already participated in another Efficiency Nova Scotia program?

1. Yes → [CONTINUE]
2. No → [SKIP TO FR9]
98. (Don't know) → [SKIP TO FR9]
99. (Refused) → [SKIP TO FR9]

For the following statements, please indicate whether you agree or disagree on a scale of 1 to 10, where 1 indicates “completely disagree” and 10 indicates “completely agree.”

FR8a. **[IF FR7= YES]** Your previous participation in an Efficiency Nova Scotia program was a major factor in your decision to implement this measure.

FR8b. **[IF FR7= YES]** Because of your previous participation in an Efficiency Nova Scotia program and what you learned by participating in the program, you had asked a contractor or a technical staff member to examine the energy efficiency options for your facility.

FR8c. **[IF FR7= YES]** 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 cost-effectiveness of the energy efficiency measures by evaluating the different options for your organization.

FR9. Before participating in the Custom program, had you already seen energy-efficiency promotional materials distributed by Efficiency Nova Scotia?

1. Yes → [CONTINUE]
2. No → [SKIP TO SATISFACTION]
98. (Don't know) → [SKIP TO SATISFACTION]
99. (Refused) → [SKIP TO SATISFACTION]

For the following statements, please indicate whether you agree or disagree on a scale of 1 to 10, where 1 indicates “completely disagree” and 10 indicates “completely agree.”

- FR10a. **[IF FR9= YES]** The energy efficiency promotional materials distributed by Efficiency Nova Scotia were a major factor in your decision to implement this measure.
- FR10b. **[IF FR9= YES]** The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted you to ask for a contractor or a technical staff member to examine the energy efficiency options for your facility.
- FR10c. **[IF FR9= YES]** The energy-efficiency promotional materials distributed by Efficiency Nova Scotia prompted you to take into account the cost-effectiveness of an energy efficiency measure by evaluating the various options before participating in the Custom program.

Spillover

- SO1. Since the time that you participated in the Custom Retrofit program, have you implemented some additional energy efficiency measures other than those implemented through the program?
1. Yes → [CONTINUE]
 2. No → [THANK AND TERMINATE]
- SO2. For the energy efficiency upgrades that you implemented on your own after participating in Custom Retrofit, did you receive or plan on requesting financing or rebates from Efficiency Nova Scotia?
1. Yes → [THANK AND TERMINATE]
 2. No → [CONTINUE]
- SO3. Can you please describe these measures? *[If the measures were part of a Custom’s feasibility study¹, use the savings given in this study. Otherwise for each measure, record the following]:*
- SO3a. Name of measure (e.g. T8 28W replacing T12)
- SO3b. Type of energy source saved (if all non-electric → THANK AND TERMINATE)
- SO3c. Location of the facility where it was implemented (if not in Nova Scotia → THANK AND TERMINATE)
- SO3d. Quantity of measures (or area covered by the measure)
- SO3e. Technical information such as hours of operation, capacity, efficiency, etc.
- SO3f. Estimated savings (in kWh or \$)
- SO3g. If no quantitative information is available, but the measure is the same as the one implemented through Custom, probe participant on its relative size with respect to the Custom project evaluated (% of size, area covered by the measure or price of the measure)

¹ Feasibility studies (and scoping studies) are indicated in the tracking sheet: if amount of “Total Approved Feasibility Study” is >\$0, then the feasibility study should be available in the participant project files.

SO4. Did your experience with the energy efficiency measures implemented through the Custom program influence your decision to implement these additional energy efficiency measures on your own? Please, give your answer on a scale of 0 to 10, where 0 indicates that the program “had no influence at all on your decision to implement the energy efficiency measures” and 10 indicates that the program was “extremely influential to your decision to implement energy efficiency measures.”

___ Response ___98 Don't Know ___99 Refused

SO5. Why did not you implement this project through an Efficiency Nova Scotia program?

9. RECORD : _____

END: Those are all the questions I have for you. I thank you very much for your time and cooperation!

APPENDIX II

CUSTOM: NEW CONSTRUCTION PROJECT REVIEW PROTOCOL

This appendix describes the protocol used to conduct the project reviews for New Construction, which included an on-site visit and simulation model review for each sampled project.

Project Review Protocol

The Evaluator modified the 2017 New Construction on-site visit and simulation review protocols for the 2018 evaluation. The protocols were merged into a single protocol that was used to prepare the on-site visits, collect information during the visits, and document the findings of the simulation model review in a single document. The first page presents the key findings of the project review along with the adjustments made to energy savings and peak demand savings, while the ensuing pages detail the findings on the general building and then each individual measure.

Prior to conducting site visits, the Evaluator reviewed the project documentation submitted by ENS to note the main building characteristics and energy efficiency measures. The reviewed files included, although were not limited to, a summary report of the model and findings, the energy model, the drawings and equipment specifications, the project development agreement, and email correspondence.

The on-site visits were also used to ask participants questions related to the market evaluation and the free-ridership assessment when the right person was available on site. Otherwise, those questions were asked during a follow-up call with the most appropriate contact person. The questions are presented after the project review protocol further below.



1. Energy and Demand Savings Adjustments

Energy Savings from Tracking Sheet:		kWh/yr kW
Demand Savings from Tracking Sheet:		
Diversity Factor Used by ENSC:		

Project Estimated Finish Month:		
Notes on Project Status:		

Adjustment from the Evaluator	
Adjusted Energy Savings:	
Adjusted Demand Savings:	
Adjusted Demand Savings with PCF:	
Diversity Factor Used by Econoler:	

Final Project Impacts at the Generator	
Evaluated Energy Savings:	0.0 kWh/yr
Evaluated Demand Savings with PCE:	0.0 kW

Adjustments made to energy savings?		(Y/N)	Percent of Tracked Savings	
Adjustments made to demand savings?		(Y/N)	Client Rate Code	
Adjustments made to PCF?		(Y/N)	Line Loss Factor Used	

2. Summarize Adjustments to Energy, Demand & Diversity Factor

Total Project Savings:

Energy Savings
(kWh) =
Demand Savings
(kW) =

1. General Information

Site Visit Date: Staff: Contact Name:
 Project ID: Contact Title:
 Project Type: Contact Phone:
 Project Status: Email:
 Project Name:
 Address:

List of people met during the visit:

Efficiency Measures:	Type 1	Type 2	Comment
Building Envelope			
HVAC			
Refrigeration			
Pumps			
Fans			
Lighting			
Domestic Hot Water			
Other (specify)			

Energy Model Received Prior to Visit? (Y/N)

2. Facility Operation Schedules

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".

What is the current occupancy ratio?

When is building expected to be 90% occupied (if not already)?

When will building commissioning be completed?

Facility Annual Schedule: Fill the table below for each occupancy schedule reported by the site contact as occupancy could vary for each section of the facility. Use additional sheets if necessary.

Description	1 - Normal Schedule		2 - Specify:		3 - Specify:	
	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends
Number of day with regular schedule per year						
Number of day with regular holidays schedule per year						
Number of days with no occupancy per year (For example: seasonal closure)						
Total number of day per year	0	0	0	0	0	0

Total=261 Total=104

Facility Daily Schedule: Fill the table below for each occupancy schedule reported by the site contact as occupancy could vary for each section of the facility. Use additional sheets if necessary.

Schedules		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Holidays
Schedule 1: Normal	Time of use (e.g. 8:00 am to 5:00 pm)								
	Hours per day								
Schedule 2 (specified above)	Time of use								
	Hours per day								
Schedule 3 (specified above)	Time of use								
	Hours per day								

Non-prescriptive lighting measures

(Lighting measures incented through New Construction)

Measure 1 :		Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Location				
Type				
Fixture Quantity				
Watt/Fixture				
Schedule				
Comment				

Measure 2 :		Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Location				
Type				
Fixture Quantity				
Watt/Fixture				
Schedule				
Comment				

Building envelope measures

Measure 1 :		Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Location and area				
Type and specs				
Comment				

Measure 2 :		Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Location and area				
Type and specs				
Comment				

Plug loads measures

	Measure 1 :	Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Location				
Type and specs				
Quantity				
Comment				

	Measure 2 :	Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Location				
Type and specs				
Quantity				
Comment				

Motors (pumps & fans) measures

	Measure 1 :	Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Location				
Type and specs				
Quantity				
Comment				

	Measure 2 :	Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Location				
Type and specs				
Quantity				
Comment				

HVAC measures

Heating	Heating System 1 :	Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Energy Source				
Heating System Type				
Nominal Capacity				
Efficiency or COP				
If any, changes in building set points (occ./ unocc. temp., % hum)				
Area supplied				
Comments				

	Heating System 2 :	Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Energy Source				
Heating System Type				
Nominal Capacity				
Efficiency or COP				
If any, changes in building set points (occ./ unocc. temp., % hum)				
Area supplied				
Comment and adjustment				

Cooling	Cooling System 1 :	Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Energy Source				
Cooling System Type				
Nominal Capacity				
SEER or COP				
If any, changes in building set points (occ./ unocc. temp., % hum)				
Area supplied				
Comments				

	Cooling System 2 :	Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Energy Source				
Cooling System Type				
Nominal Capacity				
SEER or COP				
If any, changes in building set points (occ./ unocc. temp., % hum)				
Area supplied				
Comments				

DHW measures

	DHW System 1 :	Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Energy Source				
Heating System Type				
Nominal Capacity				
Efficiency or COP				
Temperature setpoint				
Comments				

	DHW System 2 :	Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Energy Source				
Heating System Type				
Nominal Capacity				
Efficiency or COP				
Temperature setpoint				
Comments				

Solar PV measures

	Measure 1 :	Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Pannel type and spe				
Quantity				
Inverter capacity				
Comments				

	Measure 2 :	Name		
	Description from project documentation	On-site visit	As modeled by participant	Changes to model by Econoler
Pannel type and spe				
Quantity				
Inverter capacity				
Comments				

Market Questions

NC Satisfaction Questions

- S1. Using a scale from 1 to 10 where 1 is “not at all satisfied” and 10 is “completely satisfied” how would you rate your satisfaction with the program overall?
- S2. [IF S1<8] What is the most important reason you are not more satisfied with the program overall?
- S3. [IF S1>8] What is the most important reason you are satisfied with the program overall?
- S4. Did you face any challenges or barriers when implementing your New Construction project through the program?
- S5. [IF S4 = YES, then ask:] What was the most important challenge or barrier?
- S6. Do you have any suggestions to improve the New Construction program? Consider all aspects of the program: Participation process, program forms, marketing, interactions with ENS staff or contractors, etc.

NC Free Ridership Questions

- B1a. Does your company have a corporate policy with respect to new building energy efficiency? If so, please describe the policy.
- B1b. At which point in your design and construction process did you first discuss this project with ENS?
- B2a. Before you knew about the amount of the incentive, had you decided to include any energy efficiency measures in your building?
- B2b. [IF B2a=YES] Which type of [system/technology] had you decided to implement? Anything else? [Probe for HVAC systems, controls, VFDs, efficient envelope, as necessary]
- B2c. For these energy efficiency measures, had you already estimated the investment cost prior to your involvement with the New Construction program?
- B3. In the absence of the program, what is the likelihood that an energy model would have been used as a design tool? Please answer on a scale of 0 to 10, where 0 is very unlikely and 10 is very likely.
- B4. You received an incentive of XXX\$ from ENS. In the absence of the program, what is the likelihood that you would have paid for the full cost of all the measures you implemented? Please answer on a scale of 0 to 10, where 0 is very unlikely and 10 is very likely.
- B5. In the absence of the program, what is the likelihood that you would have installed equipment as efficient as you did? Please answer on a scale of 0 to 10, where 0 is very unlikely and 10 is very likely.
- B6. Finally, I’m going to ask you to rate the importance of factors that might have influenced your decision to build an efficient building the way you did through New Construction.
- B7. Using a scale from 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 implemented through the Program.
 - a. The program financial incentive
 - b. The information on potential measures obtained through energy modeling.
 - c. The technical assistance offered by ENS staff

APPENDIX III

CUSTOM: BUILDING OPTIMIZATION ON-SITE VISIT PROTOCOL

This appendix describes the protocol used as part of the Building Optimization on-site visits.

On-site Visit Protocol

The protocol included a pre-visit assessment section that allowed the Evaluator to review all the project documents from the demand-side management data system (DSMDS) and highlight those questions and/or concerns regarding the project prior to arriving on site. ENS files included, although were not limited to, the M&V reports, project development agreement, and email correspondence.

The Evaluator reviewed such information as the quantity and type of systems commissioned, the equipment and facility operation schedules, and changes made to the control methods and set points. If a building automation system (BAS) was installed, the Evaluator also reviewed screenshots of the data monitored.

On-site Visit Data Collection Form for Building Optimization Projects

**BOPt Program
Efficiency Nova Scotia Corporation
On-Site Visit Protocol**
1. General Information

Site Visit Date:		EQ Team:		Contact Name:	
Project ID:				Contact Title:	
Project Type:				Contact Phone:	
Company Name:				Email:	
Address:					
List of people met during the visit:					
Type of building:	☐ Commercial/institutional	☐ Industrial/manufacturing	☐ Municipal	☐ Other (specify)	

2. Facility Operation Schedules

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: *Fill the table below for each occupancy schedule reported by the site contact as occupancy could vary for each section of the facility. Use additional sheets if necessary.*

Description	1 - Normal Schedule		2 - Specify:		3 - Specify:	
	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends
Number of day with regular schedule per year						
Number of day with regular holidays schedule per year						
Number of days with no occupancy per year (For example: seasonal closure)						
Total number of day per year	0	0	0	0	0	0

Total=261 Total=104

3. Building Heating/Cooling System Description

Heating Systems

Fill the table below for each heating system at the site, as applicable.

Description	Heating System 1	Heating System 2	Heating System 3	Heating System 4
Energy Source				
Heating System Type				
Nominal Capacity				
Efficiency or COP				
Percent of Load (Declaration)				
If any, changes in building set points (occ./ unocc. temp., % hum)				

Cooling Systems

Fill the table below for each cooling system at the site, as applicable

Description	Cooling System 1	Cooling System 2	Cooling System 3	Cooling System 4
Energy Source				
Cooling System Type				
Nominal Capacity				
SEER or COP				
Percent of Load (Declaration)				
If any, changes in building set points (occ./ unocc. temp., % hum)				

4. Systems Affected by Cx Process

To be filled out prior to visit and validated on-site

Notes:

Number of Systems Commissioned in Pr

Building Equipped with Central Automation System:

New Controls Added?

Functional Test Reports Available?

Equipment Type	Location	Controller Upgrade?	Schedule Change ?	Setpoint Change ?	Change Validated?
Electric Baseboard					
Notes:					
Notes:					
Notes:					
Notes:					
Notes:					
Notes:					
Notes:					
Other pre-visit notes					

5. On-Site Observations and Findings

Report the on-site visit and indicate the key observations and findings made on site.

6. Questionnaires

Market Information Questionnaire
Completed?
Free Ridership Questionnaire
Completed?

	(Y/N)
	(Y/N)

7. M&V Post Implementation Results

Are electrical Saving based on measurements? (Y/N)

Are demand savings based on measurements? (Y/N)

Were any measurements taken? (Y/N)

IF so summarize measurement plan, and measurement type.

Report the on-site visit and indicate the key observations and findings made on site.

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	Notes

Notes: Insert Comments from M&V Reports

8. Interactive Effects

Interactive Effects? YES ☐ NO ☐
***If YES the fill in the table below for
each heating system at the site***

Briefly describe interactive effects for the project.

9. Revised Energy and Peak Demand Savings

For each energy efficiency measure, determine if it operates during peak hours (between 5pm and 7pm in the months of December to February on a non-holiday weekday) and its corresponding peak coincidence factor.

Energy Efficiency Measure	Revised Energy Savings	During or outside peak?	Peak coincidence factor	Calculations

Notes

10. Energy and Demand Savings Adjustments

Energy Savings from Tracking Sheet:		kWh/yr
Demand Savings from Tracking Sheet:		kW
Diversity Factor Used by ENSC:		

Project Estimated Finish Month:	
Notes on Project Status:	

Adjustment from the Evaluator

Adjusted Energy Savings:	
Adjusted Demand Savings:	
Adjusted Demand Savings with PCF:	
Diversity Factor Used by Econoler:	

Final Project Impacts at the Generator

Evaluated Energy Savings:		kWh/yr
Evaluated Demand Savings with PCF:		kW

Adjustments made to energy savings? ☐ (Y/N)

Percent of Tracked Savings #DIV/0!

Adjustments made to demand savings? ☐ (Y/N)

Client Rate Code

Adjustments made to PCF? ☐ (Y/N)

Line Loss Factor Used

Market Questions

Satisfaction Questions

- S1. 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 Building Optimization program overall?
- S2. [IF S1<8] What is the most important reason you are not more satisfied with the program overall?
- S3. [IF S1>8] What is the most important reason you are satisfied with the program overall?
- S4. Did you face any challenges or barriers when implementing your Building Optimization project through the program?
- S5. [IF S4 = YES, then ask:] What was the most important challenge or barrier?
- S6. Do you have any suggestions to improve the Building Optimization program?

Consider all aspects of the program: Participation process, program forms, marketing, interactions with ENS staff or contractors, etc.

Free-ridership Questions

- FR1. Before taking part in the Building Optimization program, had you ever conducted commissioning on your building?
- FR2. Before taking part in the Building Optimization program, were you aware of what an existing building commissioning project was?
- FR3. Of all the energy efficiency measures implemented through your participation in the Building Optimization program, which proportion do you think you would have implemented even if you had not participated in the program?

APPENDIX IV

CUSTOM: NEW CONSTRUCTION SERVICE PROVIDER INTERVIEW GUIDE

Table 1: Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	In-depth interview
Estimated Time to Complete	30 minutes
Count	Up to 10
Population Description	New Commercial Construction Service Providers (Architects, Owner Reps, Etc.)
Sampling Strata Definitions	None
Contact List Source and Date	Efficiency Nova Scotia
Fielding Firm	Research Into Action staff

Table 2: Research Objectives and Associated Questions

Overarching issues	Research Questions	Question Numbers
How to increase participation?	What barriers keep organizations from participating?	Q19, Q20, Q21, Q22, Q23
	What successes have service providers experienced using the program?	Q29, Q30
	What challenges have service providers experienced using the program?	Q31, Q32
	How satisfied are service providers with program processes?	Q24, Q25, Q26, Q27, Q28
	How did service providers learn about the program?	Q8, Q9, Q10
	What suggestions do service providers have for increasing participation?	Q11, Q12, Q13, Q14, Q16, Q19, Q21, Q22, Q23
	How engaged are service providers with ENS?	Q14, Q15
	General profile of respondents	Q1, Q2, Q3, Q4, Q5, Q6, Q7

Instrument

Name:

Company:

Date:

Interviewer:

Thanks for taking the time to talk today. I work for Research Into Action, a subcontractor to Econoler, and we have been asked by EfficiencyOne to conduct the process evaluation for the New Commercial Construction program.

As part of that, we are interviewing people who are involved with the program, so we can make sure we understand how it is working.

Our talk will take about 30 minutes.

Everything you say is confidential. We won't share our notes from the conversation unless we are legally required to, and we will not report findings in a way that would identify any individual respondent. I'll be taking notes as we talk, but I'd also like to record the call, just to help with my notetaking. Is that OK with you?

Do you have any questions before we get started?

Roles and Experience

[ASK ALL]

Q1. Let's start with a bit about you. Can you please tell me your title and briefly describe your role with your company?

[ASK ALL]

Q2. What kind of company/organization do you represent?

[Single response]

1. Commercial developer
2. Architecture firm
3. Engineering firm
4. General contractor
5. Owner's representative/construction management
6. Green consulting firm (e.g. sustainability consultant)

[Do not read:]

96. Other, please specify: [Open-ended response]
98. Don't know
99. Refused

[ASK ALL]

Q3. How long have you been with your firm?

[ASK ALL]

Q4. What types of new construction building types have you been involved with in the past few years?

[MULTIPLE RESPONSE]

1. Small Offices [*<25,000 square feet: typically with small footprint, and/or 1-3 stories*]
2. Large Offices [*≥25,000 square feet: typically a large footprint and/or > 3 stories such as a city block or office park*]
3. Small Retail [*<25,000 square feet, e.g., bank, stand-alone apparel store, strip mall*]
4. Large Retail [*≥25,000 square feet, e.g., big box store*]
5. Restaurant
6. K-12 school
7. College or university
8. Multifamily high-rise [*≥4 stories of conditioned space*]
9. Mixed use buildings
10. Lodging: hotel/motel
11. Hospital and other large healthcare [*Medical offices should be marked as one of the “office” categories above*]
12. Grocery
13. Warehouse—refrigerated
14. Warehouse—non-refrigerated
15. Other [*e.g., parking garage, laboratory*], please specify: _____

[ASK ALL]

Q5. Are there other building types you or your firm have been interested in designing/constructing? If so, what are those building types? Would these projects go through the ENS NCC program? Why?

[ASK ALL]

Q6. How many new construction or major renovation projects were you involved with in the last year in Nova Scotia?

[RECORD NUMERIC RESPONSE]

[ASK ALL]

Q7. And of all those projects, how many New Commercial Construction program projects have you been involved in?

[RECORD NUMERIC RESPONSE]

Program Experience

The next few questions are about how you became aware of the New Commercial Construction program?

[ASK ALL]

Q8. When did you first learn about the New Commercial Construction program?

[ASK ALL]

Q9. How did you first learn about the New Commercial Construction program?

[ASK ALL]

Q10. How long ago did you first participate in New Commercial Construction program?

[ASK ALL]

Q11. Do you talk about the New Commercial Construction program with all clients who are eligible or do you offer it more selectively? Why? How do you present the program to your clients?

[ASK ALL]

Q12. When does the New Commercial Construction program get involved with your projects? *[If needed: Is it during the conceptual design phase, schematic design phase, implementation/construction]* Does it differ by project types, size, something else?

[ASK ALL]

Q13. For your most recent New Commercial Construction program project, can you walk me through how you participated in the program – how did it start and then what happened next? What steps were the easiest and worked the best? Which were more challenging (and why)?

[ASK ALL]

Q14. In the course of participating in the New Commercial Construction Program for your most recent project, how often did you communicate with ENS Staff? Would you say:

[Single response]

1. 0
2. 1-5 times
3. 6-10 times
4. 11-20 times
5. More than 20 times

[Do not read:]

98. Don't know
99. Refused

[ASK ALL]

Q15. Are you a member of the ENS Efficiency Trade Network (ETN)? Why or why not?

[ASK ALL]

Q16. What, if any, professional associations or groups should ENS be reaching out to to increase participation in this program?

[ASK ALL]

Q17. As a result of your work with ENS and the New Commercial Construction program, have you taken additional training or sought certifications in energy management, efficient design, or something else?

Motivation's to Participate

[ASK ALL]

Q18. What do you think motivates building owners to invest in energy efficiency? *[If needed: Is it demand from potential tenants, long term energy savings, etc. EE is defined as designing buildings to and specifying equipment that goes beyond code requirements.]*

[ASK ALL]

Q19. What, if anything, prevents building owners from investing in energy efficiency?

[ASK ALL]

Q20. What, if anything, prevents building owners from participating in the New Commercial Construction program?

[ASK ALL]

Q21. Under what circumstances do you find owners less interested in energy efficiency? *[Are there certain building types or owner types less interested than others?]*

[ASK ALL]

Q22. Other than higher incentives, what could ENS do to interest owners in building EE?

[ASK ALL]

Q23. What, if anything, prevents you from recommending the New Commercial Construction program to clients or customers?

Program Satisfaction

[ASK ALL]

Q24. The next few questions are about your satisfaction with various program elements? How satisfied were you with the information you received about the program? *[If needed: Was the information consistent with your experience?]*

[ASK ALL]

Q25. How satisfied were you with your interactions with program staff [*If needed: Ease of contacting, timeliness of response, knowledge of staff*]?

[ASK ALL]

Q26. How satisfied were you with the process of enrolling your project in the program? What would have made that easier or better, if anything?

[ASK ALL]

Q27. How satisfied were you with the timeliness of receiving your incentive?

[ASK ALL]

Q28. How would you rate your overall satisfaction with the program? Why?

Successes, challenges, and opportunities

To wrap-up I have a few general questions about the program related to program's successes, challenges, and opportunities.

[ASK ALL]

Q29. What do you see as a key success of the New Commercial Construction program for your company?

[ASK ALL]

Q30. What do you see as a key success of the New Commercial Construction program for your customers/clients?

[ASK ALL]

Q31. What are the key challenges the New Commercial Construction program gives your firm?

[ASK ALL]

Q32. What are the key challenges the New Commercial Construction program gives your customers/clients?

[ASK ALL]

Q33. Is there anything else about the program that we have not discussed that you feel should be mentioned?

That is all the questions I have. Thanks for your time.

APPENDIX V

CUSTOM: RETROFIT CALCULATION EXAMPLE

This appendix provides a sample of the calculations used to adjust the energy savings results for one of the projects reviewed as part of the 2018 Custom Retrofit impact evaluation. The calculation described below presents the adjustments made to a lobster pound refrigeration system upgrade project and is based on information collected during a site visit by the Evaluator.

The equations used for the savings calculations are presented first, followed by the tracked savings claimed by ENS. Revised savings are then calculated using information collected during the on-site visit and a subsequent analysis of the documentation provided by ENS.

Savings Equations

This project involved replacing seven old refrigeration condensers with three new efficient compressors and upgrading three older pumps with one new efficient pump. Documenting the energy savings calculations consisted of an Excel workbook containing two tables that calculated annual consumption for both the basecase and proposed case. The Excel workbook calculated the power demand and energy consumption for both cases using the standard three-phase power formula multiplied by annual runtime and duty cycle. The same equations, listed below, were used for both the condensers and the pumps.

$$POWER (kW) = \frac{V * A * \sqrt{3} * PF}{1,000}$$

Where:

- › V is the voltage in volts
- › A is the amperage in amps
- › PF is the power factor

$$ENERGY \left(\frac{kWh}{year} \right) = Power * Qty * Annual Runtime * Duty Cycle$$

The reported energy and demand savings were determined as the difference between the basecase and proposed case.

Tracked Savings Calculation

ENS used the equations mentioned above to calculate the power demand and energy consumption for each refrigeration condensing unit and pump, as presented in Figure 1. The voltage was obtained from the nameplate of each unit and the power factor value is an assumption. The amperage was measured and the average value of the unit in operation was used. The duty cycle (“% on” in the figure below) was also measured. The number of days of operation was based on an estimate of season length. The Evaluator noticed that the number of days was lower for pumps than for refrigeration condensing units, which seemed inconsistent since both pieces of equipment run at the same time. No justification for this was provided in the project documentation.

Figure 1: Tracked Savings Values

Tracked Savings										Energy	Demand
Refrigeration Condensing Units	Case	# Units	Amps	Volts	Phase	PF	Hrs/day	Days/yr	% On	kWh/year	kW
	Base Case	7.00	9.96	575	3	0.85	24	182.5	100%	258,511	59.02
	Efficient Case	1.00	6.54	575	3	0.85	24	182.5	94%	22,862	5.54
		2.00	8.23	575	3	0.85	24	182.5	97%	29,606	6.97
		3.00	7.52	575	3	0.85	24	182.5	96%	26,630	6.36
Condenser Savings										179,414	40.15
Pumps	Case	# Units	Amps	Volts	Phase	PF	Hrs/day	Days/yr	% On	Annual kWh	KW
	Base Case	3	5.00	575	3	0.85	24	130	100%	39,618	12.70
	Efficient Case	1	5.14	575	3	0.85	24	130	100%	13,564	4.35
	Pump Savings										26,055
Total										205,468	48.50
										kWh/year	kW

Revised Savings Calculation

Adjustments to energy savings were made based on data found by the Evaluator during the on-site visits. Although the initial calculations indicated that the original three pumps were being replaced with a single pump, the Evaluator documented three newly installed pumps during the site visit. Therefore, a change was made to the total quantity of pumps for the efficient case in the workbook, which directly impacted the energy and demand savings for that portion of the project. The Evaluator also validated on site that the pump motors had indeed not been replaced and that, consequently, the amperage for the base case pumps should match that of the efficient case (which was not the case in the submitted calculations). The revised amperage values used by the Evaluator for both the efficient and base cases was the average value from the single pump motor log provided by ENS.

When reviewing the current data for each of the three new condensers, the Evaluator identified that two of the three phases were reading significantly lower than the first phase. Since there was no accurate method to determine which reading was accurate, the Evaluator used the average current measurement from condensers one and three, which resulted in a small reduction from 8.23 A to 7.03 A. The energy and demand savings were recalculated by the Evaluator using the equations outlined above and the supplied workbook. The variables changed by the Evaluator are highlighted in gray in Figure 2.

Figure 2: Revised Savings Values

Revised Savings										Energy	Demand
	Case	# Units	Amps	Volts	Phase	PF	Hrs/day	Days/yr	% On	Annual kWh	kW
Refrigeration Condensing Units	Base Case	7	9.96	575	3	0.85	24	182.5	100%	258,511	59.0
	Efficient Case	1	6.54	575	3	0.85	24	182.5	94%	22,862	5.5
		2	7.03	575	3	0.85	24	182.5	97%	25,272	6.0
		3	7.52	575	3	0.85	24	182.5	96%	26,629	6.4
	Condenser Savings									183,748	41.2
Pumps	Case	# Units	Amps	Volts	Phase	PF	Hrs/day	Days/yr	% On	Annual kWh	KW
	Base Case	3	5.14	575	3	0.85	24	130	100%	40,691	13.0
	Efficient Case	3	5.14	575	3	0.85	24	130	100%	40,691	13.0
Pump Savings										-	0.0
Revised Total										183,748	41.2
										kWh/year	kW

Based on the above calculations, the revised annual savings were decreased by 21,720 kWh/year and demand savings were increased by 7.30 kW, as shown in Table 3.

Table 3: Revised Gross Savings Values

	Energy (kWh)	Demand (kW)
Tracked Gross Savings	205,468	48.5
Revised Gross Savings	183,748	41.2
Percent of Tracked Savings	89.4%	84.9%

APPENDIX VI

CUSTOM: RETROFIT ALGORITHM FOR FREE-RIDERSHIP CALCULATION

FR2a. If the program support or financial incentive had <u>not been</u> offered, what is the likelihood that you would have implemented exactly the same energy efficiency measures that you implemented through Custom Retrofit? (Scale 0 to 10)	$FR2a = \text{Answer} \times 10\%$ IF DK OR REF: FR2a = EMPTY
FR3. If your organization had not received the financial incentives from ENS, would you have paid the full cost of the energy efficiency measures you implemented? (Scale 0 to 10)	$FR3 = \text{Answer} \times 10\%$ IF DK OR REF: FR3 = EMPTY
FR5b-c. Without the incentive, was the payback period short enough for the project to be implemented?	IF 2. No: $FR3 / 2$ OTHERWISE: FR3
PA1 Score:	MEAN VALUE OF: (FR2a; FR3)
FR1b. Before participating in Custom Retrofit, had your organization decided to implement the specific energy efficiency measures that were implemented through Custom Retrofit?	IF 1. Yes: Use FR1c IF 2. NO OR DK OR REF: $FR1c = 0\%$
FR1c. [ASK IF FR1b=YES] I just want to make sure - Before you decided to participate in Custom, you had already made the decision to implement the energy efficiency measures you implemented through Custom?	IF 1. Yes: $FR1c = 100\%$ IF 2. No OR DK OR REF: $FR1c = 0\%$
PA2 Score:	FR1c
FR4. Level of influence (Scale 0 to 10) Factors a, b, c, d and e	$FR4 = \text{MAX}(FR4a; FR4b; FR4c; FR4d, FR4e)$
PA3 Score:	$(10 - FR4) \times 10\%$
FR2c. If the program support or financial incentive had not been offered, what is the likelihood that you would have postponed the implementation of the energy efficiency measures by at least one year ? (Scale 0 to 10)	$FR2c = (10 - \text{Answer}) \times 10\%$ IF DK OR REF: FR2c = EMPTY

PA4 Score:	FR2c
Inconsistency Test PA1	IF ABS(FR2a – FR3) ≥ 50%: PA1 = MIN OF (FR2a ; FR3)
Inconsistency Test PA2	IF FR1c=100% AND FR2a OR FR3 < 70%: PA2 = EMPTY
Free-Ridership	IF PA4 < MEAN (PA1; PA2; PA3) FR = MEAN (PA1; PA2; PA3; PA4) OTHERWISE FR = MEAN (PA1; PA2; PA3)
FR8a/FR10a. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] was a major factor in your decision to implement this measure. (Scale 0 to 10) FR8b/FR10b. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted you to ask for a contractor or a technical staff member to examine the energy efficiency options for your facility. (Scale 0 to 10) FR8c/FR10c. [Your previous participation in an ENS program]/[The energy efficiency promotional materials distributed by ENS] prompted you to take into account the cost-effectiveness of an energy efficiency measure by evaluating the various options [for your organization/before participating in the Custom program]. (Scale 0 to 10)	CI = IF(MAX(FR8a; FR10a) ≥ 8: 1) + IF(MAX(FR8b; FR10b) ≥ 8: 1) + IF(MAX(FR8c; FR10c) ≥ 8: 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 VII

CUSTOM: RETROFIT ALGORITHM FOR PARTICIPANT SPILLOVER CALCULATION

SO1. Since the time that you participated in Custom Retrofit, have you implemented some additional energy efficiency measures other than those implemented through Custom Retrofit?	IF 1. Yes: CONTINUE IF 2. No OR DK OR REF: END
SO2. For the energy efficiency measures that you implemented on your own after participating in Custom Retrofit, did you receive or plan on requesting financing or rebates from ENS?	IF 2. No: CONTINUE IF 1. Yes OR DK OR REF: END
SO3. Which measures have you implemented on your own after participating in Custom Retrofit?	SO3 = SUM of kWh associated with each upgrade
Additional Upgrade Savings:	SO3
SO4. Did your experience with the energy efficiency measures implemented through Custom Retrofit influence your decision to implement these additional energy efficiency measures on your own? (Scale 0 to 10)	SO4 = Answer x 10%
Attribution Level:	SO4
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 VIII

CUSTOM: NEW CONSTRUCTION ALGORITHM FOR FREE- RIDERSHIP CALCULATION

B4. You received an incentive of XXX\$ from ENS. In the absence of the program, what is the likelihood that you would have paid for the full cost of all the measures you implemented? (Scale 0 to 10)	$B4 = \text{Answer} \times 10\%$ IF DK OR REF: B4 = EMPTY
B5. In the absence of the program, what is the likelihood that you would have installed equipment as efficient as you did?(Scale 0 to 10)	$B5 = \text{Answer} \times 10\%$ IF DK OR REF: B5= EMPTY
PA1 Score:	MEAN VALUE OF: (B4; B5)
B6. Level of influence (Scale 0 to 10) Factors a, b and c	$FR4 = \text{MAX}(B6a; B6b; B6c)$
PA2 Score:	$(10 - B6) \times 10\%$

APPENDIX IX

CUSTOM: 2018 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2018 evaluation of the Custom program component, as well as all 2017 evaluation recommendations that were not fully implemented.

Sections	Recommendations
Executive Summary	1 Improve communication to SPs and participants about the various New Construction steps and corresponding service requirements. As previously mentioned, the key aspect of New Construction mentioned as problematic by participants and SPs is the lack of clear communication about service steps and requirements, with one SP mentioning not understanding the basecase against which efficient designs need to be assessed. Additionally, there is a perception that projects cannot fit within the New Construction service timeline, which pushes some clients away from the service according to SPs. Clearer and sustained information about New Construction is recommended. Improved communication should include a clear and concise process chart, along with detailed checklists of what is required at each step of the participation process as well as timelines to complete each step. Clearer directions on the appropriate modelling approach would also reduce adjustments made to tracked savings and improve the quality of energy models. Given the small number of completed projects each year, the Evaluator encourages as much as possible a personalized follow-up approach and regular check-ins on projects to ensure that they progress how they should.
	2 Further engage new and existing SPs and make them stronger advocates for New Construction. Interviewed SPs often could not accurately recall their membership status with ENS' Efficiency Trade Network (ETN). In addition, the relative lack of modellers, architects and general contractors within the ETN suggests that there is an opportunity to engage those parties more in the service. Having more professionals in the ETN would allow ENS another communication channel to reach these professionals and share information about New Construction. Recruiting modellers, architects and general contractors and making the service more top-of-mind could be particularly important to expanding New Construction participation because such professionals are typically involved in the early stages of construction projects and may influence decisions to participate in the service. ENS could also engage with new trade associations and enhance relationships with associations they already know. This would serve to reinforce the service ENS offers to professionals. Reaching out to trade associations should not be limited to Nova Scotia because some SPs come from other provinces to work on projects.

Sections	Recommendations
Project Review Findings	3 To improve the accuracy of savings, the Evaluator recommends that: (1) ENS ensure that the QA workbook and procedure is followed closely, notably when validating the final parameters of projects upon completion; and (2) special attention be paid to non-routine adjustments when planning M&V.
2017 Recommendations (Not fully implemented at the time of evaluation)	4 Continue conducting an in-depth review of energy models as part of the evaluation and improve ENS staff's capacity to identify discrepancies in energy models. The more in-depth review of energy models conducted during the 2017 evaluation identified discrepancies in all five projects and resulted in significant downward adjustments to savings. Modelling of heat pump systems and manual calculations to adjust baselines were most problematic. This showed that a systematic review should be conducted, even if energy models are prepared by experienced consultants. The Evaluator also recommends that ENS provide tools and training to their staff so that they are better able to conduct technical reviews of energy models. Those tools could include checklists of parameters to validate for certain types of projects or building systems
	5 Establish clear objectives for Building Optimization. The Building Optimization projects reviewed this year differed widely in scope. Some projects involved detailed investigative work to tap into deep energy savings, while others were limited to replacing known broken equipment or repairing recently installed mechanical systems that had never worked as intended. While all projects generated savings and all participants benefited from Building Optimization, the participants' needs were quite different from one another. The Evaluator believes that clearly establishing the objectives of the service would result in providing the right level of support to each participant and maximizing the added value of ENS support, that is, involving specialized consultants in retrocommissioning only when detailed investigation of energy-saving opportunities is a project's objective. Better defining objectives and eligibility criteria would also clarify how the basecase should be established. For example, the project whose mechanical systems had never worked as intended had a basecase with such a high number of hours of use that the cooling towers would have provided far too much cooling to the building. An analysis of what should qualify as an acceptable Building Optimization project would allow for distinguishing between the ordinary repairs that a building owner needs to make his or her building function normally and the real energy-saving opportunities for improving energy performance above a minimum level. Better objective-setting would allow for allocating Building Optimization's financial and technical resources to those projects that will most benefit from them
	6 Better document the basecase conditions for Building Optimization projects. The Evaluator observed that the basecase conditions were sometimes not measured or documented (using photos, for instance). Since these conditions cannot be verified because they no longer exist after project implementation, the Evaluator recommends that ENS gather more information about the pre-implementation conditions to support savings evaluation afterwards.

APPENDIX X

EMIS: ON-SITE VISIT AND PROJECT REVIEW PROTOCOL WITH EMIS NEW PARTICIPANT

The 2018 EMIS impact evaluation involved conducting one project review and one on-site visit for a new participant to collect additional information on measures implemented and ensure the Evaluator thoroughly understood facility activities. During the on-site visit, the Evaluator also asked questions to the participant about their satisfaction with this program component, as well as about the estimated useful life of the project. This appendix presents the protocol used to conduct the review and on-site visit.

Project Review Protocol and Participant Interview Guide

The Evaluator relied on the same on-site visit protocol as used in Custom Retrofit with only minor adjustments. The Evaluator decided to use that protocol since the new project was not a usual EMIS project and required a more comprehensive approach. The Evaluator reviewed project documentation prior to the visit and filled in the protocol with the appropriate information to prepare for the on-site visit. With the information gathered during the on-site visit, the Evaluator completed the remaining sections of the protocol on interactive effects, energy and demand savings adjustments, and final savings values. The on-site visit protocol also includes a series of questions that were asked during the visit on participant satisfaction and barriers to EMIS participation.

1. General Information

Site Visit Date: _____ EQ Team: _____ Contact Name: _____
Project ID: _____ Contact Title: _____
Project Type: _____ Contact Phone: _____
Company Name: _____ Email: _____
Address: _____

List of people met during the visit: _____
Type of building:

Commercial/institutional	☐	Industrial/manufacturing	☐
Municipal	☐	Other (specify)	☐

Specify: _____

2. Facility Operation Schedules

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: _____ Fill the table below for each occupancy schedule reported by the site contact as occupancy could vary for each section of the facility. Use additional sheets if necessary.

Description	1 - Normal Schedule		2 - Specify:		3 - Specify:	
	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends
Number of day with regular schedule per year						
Number of day with regular holidays schedule per year						
Number of days with no occupancy per year (For example: seasonal closure)						
Total number of day per year	0	0	0	0	0	0

Total=261 Total=104

Facility Daily Schedule: _____ Fill the table below for each occupancy schedule reported by the site contact as occupancy could vary for each section of the facility. Use additional sheets if necessary.

Schedules		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Holidays
Schedule 1: Normal	Time of use (e.g. 8:00 am to 5:00 pm)								
	Hours per day								
Schedule 2 (specified above)	Time of use								
	Hours per day								
Schedule 3 (specified above)	Time of use								
	Hours per day								

3. Interactive Effects

Interactive Effects? YES ☐ NO ☐

If YES the fill in the table below for each heating system at the site

Briefly describe interactive effects for the project.

4. Building Heating/Cooling System Description

Heating Systems

Fill the table below for each heating system at the site.

Description	Heating System 1	Heating System 2	Heating System 3	Heating System 4
Energy Source				
Heating System Type				
Nominal Capacity				
Efficiency or COP				
Percent of Load (Declaration)				
If any, changes in building set points (occ./ unocc. temp., % hum)				

Cooling Systems

Fill the table below for each cooling system at the site.

Description	Cooling System 1	Cooling System 2	Cooling System 3	Cooling System 4
Energy Source				
Cooling System Type				
Nominal Capacity				
SEER or COP				
Percent of Load (Declaration)				
If any, changes in building set points (occ./ unocc. temp., % hum)				

5. Pre-Visit Assessment of the Project

Indicate the key variables & observations from all available reports. These notes will serve on site to guide the visit and identify the main information to collect and/or verify.

6. On-Site Observations and Findings

Report the on-site visit and indicate the key observations and findings made on site.

7. M&V Post Implementation Results

Were any baseline measurements taken ? (Y/N)

Are electrical savings based on measurements? (Y/N)

Are demand savings based on measurements? (Y/N)

IF so summarize measurement plan, and measurement type.

Report the on-site visit and indicate the key observations and findings made on site.

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

Notes: Insert Comments from M&V Reports

8. Estimated Useful Life of the project

Type of replacement

If early replacement, indicate the remaining useful life of the equipment

Observations that justify the type of replacement choice

Main equipment considered in EUL calculation

Tracked Project EUL (yrs)

Evaluated Project EUL (yrs)

Refer to project documentation for tracked baseline EUL

Notes:

Detail reasoning if changes were made to the tracked EUL

9. Energy and Demand Savings Adjustments

Energy Savings from Tracking Sheet:		kWh/yr
Demand Savings from Tracking Sheet:		kW
Peak Coincidence Factor Used by ENSC:		

Project Estimated Finish Month:	
Notes on Project Status:	

Adjustment from the Evaluator

Adjusted Energy Savings:		kWh/yr
Adjusted Demand Savings:		kW
Adjusted Demand Savings with PCF:		kW
Peak Coincidence Factor Used by Econoler:		

Final Project Impacts at the Generator

Evaluated Energy Savings:		0.0 kWh/yr
Evaluated Demand Savings with PCF:		0.0 kW

Adjustments made to energy 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)

Percent of Tracked Energy Savings

Client Rate Code

Line Loss Factor Used

10. Explain Project Adjustments between PDA and project completion

If any modification were made between PDA and project completion, describe and provide calculations

11. Summarize Project Adjustments and Final Savings Values

IF any adjustments were made to the energy savings, demand savings or PCF, describe the rationale and provide calculations.

12. Satisfaction questionnaires

Satisfaction questionnaire filled-in?

(Y/N)

EMIS Satisfaction and Barriers

S1. 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 EMIS program overall?

Rate:

S2. [IF S1<8] What is the most important reason you are not more satisfied with the program overall?

S3. [IF S1>8] What is the most important reason you are satisfied with the program overall?

S4. Did you face any challenges or barriers when implementing the energy management information system in your company, or when managing the system after its implementation?

YES NO

S5. [IF S4 = YES, then ask:] What were these challenges or barriers?

S6. Do you have any suggestions on how to improve the EMIS program?

Consider all aspects of the program: Participation process, program forms, marketing, interactions with ENS staff or contractors, etc.

APPENDIX XI

EMIS: PROJECT REVIEW PROTOCOL AND INTERVIEW GUIDE WITH CONTINUING PARTICIPANT

The 2018 EMIS impact evaluation involved conducting one project review and one phone interview with a continuing participant from 2017 in order to collect additional information on measures implemented or changes made to the facility in 2018. During the interview, the Evaluator also asked questions to the participant about their satisfaction with this program component, as well as about savings persistence. This appendix describes the project review protocol used to conduct the review and the participant interview.

Project Review Protocol and Participant Interview Guide

The Evaluator relied on the 2017 evaluation protocol and only made minor adjustments. The information that was collected during the 2017 site visit was included in this protocol prior to the phone interview. The Evaluator used the information provided in the updated annual reports, the savings calculation workbooks, and the information gathered during phone interviews to complete the remaining sections of the protocol on interactive effects, energy and demand savings adjustments, and final savings values. The project review protocol also includes a series of questions that were asked during the phone interviews with participants on persistency of savings and participant satisfaction.

1. General Information

Interview Date:		EQ Team:		Contact Name:	
Project ID:				Contact Title:	
EMIS Provider:				Contact Phone:	
Company Name:				Email:	
Address:					
List of people interviewed:					

2. General Description of Facility/Products Manufactured

Identify/list primary purpose of the facility and all major products and/or processes

NOTE: PC Users "Alt+Enter" for new line in cell. MAC Users "CMD+Option+Enter".

Notes from previous years (2015, 2016 and 2017 protocols):

Notes from this year (2018 interview): Are there any changes in the facility main purpose, major projects and processes?

3. Facility Operation Schedules

Facility Description: Outline/describe the normal schedules for processes, office space etc. Obtain shutdown/PM schedules

NOTE: PC Users "Alt+Enter" for new line in cell. MAC Users "CMD+Option+Enter".

Notes from previous years (2015, 2016 and 2017 protocols):

Notes from this year (2018 interview): Are there any changes in the facility main purpose, major projects and processes?

4. Major Consumers Identified During the EMIS Audit

List all major consumers and percent of total loads below

Item #/Description/Energy Source/% of Total

Notes from previous years (2015, 2016 and 2017 protocols):

Notes from this year (2018 interview): Are there any changes in the facility main purpose, major projects and processes?

5. Sensor List

List all sensors identified in the implementation plan, and all major system components (i.e. historian, server etc)

Notes from previous years (2015, 2016 and 2017 protocols):

Notes from this year (2018 interview): Are there any changes in the facility main purpose, major projects and processes?

6. Pre-Visit Assessment of the Project (from Previous Years)

Indicate the key observations from the feasibility study and M&V report analysis. These notes will serve on site to guide the visit and identify the main information to collect and/or verify. Specifically look at how the adjusted baseline is established, and give consideration to any discrepancies or missing information.

Notes from previous years (2015, 2016 and 2017 protocols):

7. On-Site Observations and Findings (from Previous Years)

Report the on-site visit and indicate the key observations and findings made on site.

Notes from previous years (2015, 2016 and 2017 protocols):

8. Participant Questions (from Previous Years)

Notes from previous years (2015, 2016 and 2017 protocols):

Q1. How often are you reviewing the data/reports generated by the EMIS? Are there more than one user group for these reports?

Q2. Were any automatic feedback controls implemented to automate your production process?

Q3. Does the EMIS have alarm notifications when the energy consumption exceeds or falls below the baseline target?

Q4. If so who is responsible for taking action to correct or document the running conditions?

Q5. Can you explain your process of identifying and implementing production/operational changes that impact your energy consumption? How and where do you document these changes?

Q6. How do you manage/track changes in equipment and/or production that may impact the existing baseline? (i.e. addition of new equipment)

Q7. Can you describe seasonal variations in your production? What are the key variables that impact your energy consumption (ie. Weather, raw material characteristics, etc.)?

9. Persistency Questions

Notes from this year: Follow-up questions to be asked during the interview

P1. First of all, I would like to validate that my list of energy conservation measures implemented at your facility is complete.

For each measure, could you please confirm its beginning and end date, and if it is still ongoing?

Is there anything that I didn't mention?

Table 1: Measures Implemented under EMIS

	Description of measure (from documentation)	Year of implementation (from documentation)	P1. Beginning and end date	P1. Still ongoing?
Measure 1				
Measure 2				
Measure 3				
Measure 4				
Measure 5				

P2. In 2018, have you implemented any other energy conservation measures outside of the EMIS program (for example: Custom projects) or have you made any modifications to your production equipment that could impact the energy consumption of your facility?

Description of measures implemented outside of the EMIS program

Now, we would like you to answer some questions regarding the energy conservation measures implemented and the support provided by your EMIS service provider.

P3. We have looked at your incremental savings for 2015, 2016, 2017 and 2018. Those savings represent savings with respect to the previous year, so savings that would be the result of new initiative undertaken in that year. In 2015, 2016 and 2017, your incremental savings were of ...

Could you give us more information on the variation of savings from one year to another?

Table 2: Energy savings evolution

	Year	Incremental Savings (kWh)	Explanation of variation in savings
Year 1	2015		Notes from 2017
Year 2	2016		Notes from 2017
Year 3	2017		Notes from 2017
Year 4	2018 (up to end of Sept)		Notes from this year

For the next questions, we'd like you to think about the usefulness of the EMIS system in itself versus the support given by the service provider.

P4. Thinking specifically about the EMIS that is implemented in your facility and the information it provided you...

a) Can you describe how the EMIS system itself was helpful in maintaining the energy conservation measures put in place in previous years?

b) Using a scale from 1 to 10 where 1 is "not helpful at all" and 10 is "very helpful" how would you rate the helpfulness of the EMIS system itself in maintaining the energy conservation measures put in place in previous years?

Rate

c) Was the EMIS system more helpful in maintaining some measures than others? If so, what type of measures?

YES NO

Types of measures easier to maintain through the EMIS system

P5. Now thinking specifically about the support given by the service provider...

a) Can you describe how the service provider was helpful in maintaining the energy conservation measures put in place in previous years?

b) Using a scale from 1 to 10 where 1 is "not helpful at all" and 10 is "very helpful" how would you rate the helpfulness of the service provider in maintaining the energy conservation measures put in place in previous years?

Rate

c) Was the service provider more helpful in maintaining some measures than others? If so, what type of measures?

YES NO

*Types of measures easier to maintain
with the service provider*

P6. When you will no longer receive support from the service provider, how likely are you to maintain the measures implemented under the program? Please answer on a scale from 1 to 10 where 1 means "not likely at all" and 10 means "very likely".

(Ask this question for each measure identified in Table 3).

Table 3: Measures validated

	Description of measure	Year of implementation	P6.
Measure 1			
Measure 2			
Measure 3			
Measure 4			
Measure 5			

10. Interactive Effects & Variables Impacting Total Energy Consumption

Notes from this year:

Interactive Effects? YES NO

Seasonal Variables? YES NO

Production Variables? YES NO

Briefly describe interactive effects for the project, and identify if there are seasonal impacts that modify the normal energy baseline.

Notes from previous years (2015, 2016 and 2017 protocols):

Notes from this year:

11. Energy and Demand Savings Adjustments

Notes from this year:

Energy Savings from Tracking Sheet:		kWh/yr
Demand Savings from Tracking Sheet:		kW
Diversity Factor Used by ENSC:		-

Project Estimated Finish Month:	
Notes on Project Status:	

Adjustment from the Evaluator

Adjustment - M&V Energy Savings:	
Adjustment - M&V Demand Savings:	
Diversity Factor Used by Econoler:	

Final Project Impacts at the Meter

Evaluated Energy Savings:		kWh/yr
Evaluated Demand Savings:		kW

12. Summarize Project Adjustments and Final Savings Values

Notes from this year: Including both peak demand savings and energy savings

EMIS Satisfaction and Barriers

S1. 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 EMIS program overall?

Rate:

S2. [IF S1<8] What is the most important reason you are not more satisfied with the program overall?

S3. [IF S1>8] What is the most important reason you are satisfied with the program overall?

S4. Did you face any challenges or barriers when implementing the energy management information system in your company, or when managing the system after its implementation?

YES NO

S5. [IF S4 = YES, then ask:] What were these challenges or barriers?

S6. Do you have any suggestions on how to improve the EMIS program?

Consider all aspects of the program: Participation process, program forms, marketing, interactions with ENS staff or contractors, etc.

APPENDIX XII

SEM: ON-SITE VISIT PROTOCOL

The 2018 SEM impact evaluation involved conducting on-site visits, including assessing free-ridership, satisfaction and barrier levels, as well as gathering insight on the persistency of savings for SEM projects. This appendix presents the on-site visit protocol used to conduct the visits.

On-site Visit Protocol

For the 2018 SEM impact evaluation, the Evaluator reviewed the interview protocol used in 2016 and improved the statistical analysis questions of the protocol used to validate the accuracy of the regression model. Questions on satisfaction, barriers and savings persistency were also added.

The four on-site visits were conducted following a review of ENS digital project files. The protocol included a pre-visit assessment section, which allowed the Evaluator to review all project documents and list questions and/or concerns with respect to the project prior to arriving on site. ENS files included but were not limited to: M&V reports; Measurement Tracking and Recording (MT&R) worksheets; and SEM planning tools

The Evaluator reviewed components such as the baseline energy regression, independent variables, quality of correlation, and any usual variations.

1. General Information

Site Visit Date: _____ EQ 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)	

2. Manufacturing Process & Key Energy Consumption Drivers**3. Facility Operation**

General Schedule HOURS	Schedule	NOTES
Weekdays - (Days/Week)		
Hours Per Weekday (Hrs/Day)		
Weekends - (Days/Weekend)		
Hours Per Weekend (Hrs/Day)		
Seasonal Schedules (Y/N)		
Reduced Seasonal HOURS (Hrs/Day)		
Annual Seasonal Duration (Day/Year)		
Holiday Schedules (Y/N)		
Annual Holidays (Days/Year)		
Holiday HOURS (Hrs/Day)		
Production Facilities (Y/N)		
Planned Downtime (Hrs/Year)		
Reduced Production Level (Y/N)		
Percent Reduction (%)		
Seasonal Variations (Y/N)		
System(s) Impacted by Variation		
Description of Seasonal Variations		

NOTES:

4. SEM Details Analysis

SEM DETAILS		NOTES
Were all activities held according to the Event Log?		
Annual Reduction Target? (Y/N)		
Percent Target Reduction (%)		
Did you Meet the Reduction Target(s)? (Y/N)		
If Not, Can You Explain Why?		
Who Is Responsible for Managing the M&T?		
How Often is the M&T Reviewed?		
Does Energy Champion participate in a monthly call with Consultant?		
How Are the MT&R Results Communicated?		
How Do You Handle Variations In the M&T?		

MEASURES IMPLEMENTED - Section to be filled out prior to visit then validated

	Measure/Project	Date
Operational changes affecting baseline		

	Measure/Project	Date	Savings	Program
Projects incented by ENS (validate against BER/Custom/EMIS database 2013-2016)				

	Measure/Project	Date	During or outside peak?
Behavioural changes made (Compare this list against opportunity register)			

5. Impact Evaluation & Savings Adjustments

IMPACT EVALUATION	NOTES
Independent Variables	
Project Measurement Boundary (validate it is full facility meter)	
Reporting Period (Days)	
Baseline Period (Days)	
Summary of Non-Routine Baseline Adjustments in Current Model	
Statistical Analysis	
Regression Equation Used	
Coefficient of Determination (R ²)	
Is R ² IPMVP Compliant (0.75 or greater)?	
Coefficient of Variation (CV) – all	
Is the CV below 5%	
Is each independent variable useful? (P-value under 0.05)	
Are the baseline and reporting period well defined?	
When did the change occur?	
Is the baseline period adequate?	
Does the reporting period need to be extrapolated?	
Does the model account for changes in energy consumption due to factors other than the ECM?	
Are the independent variables correct?	
Are there changes other than the ECM between the baseline and reporting periods?	
Does the ECM cause other impacts outside of the measurement boundaries?	
Documented Savings Calculations	Tracking Sheet MTR
Energy Savings (kWh)	
Demand Savings (kW)	
PCF	

Summary of Evaluator's Adjustment

Evaluator's Savings Calculations

Energy Savings (kWh)	
Peak Demand Savings (kW)	
PCF	

Summary of Adjustments

Energy Adjustment Ratio (%)	
Peak Demand Adjustment Ratio (%)	

Final Suggestions/Comments

SEM Free Ridership Survey

FR1. Before being contacted by ENS to take part in the SEM program, were you aware of what a strategic energy management program was?

FR2. Before taking part in the SEM program, were you considering implementing a strategic energy management approach in your company?

FR3. Did you already have tools or procedures that allowed you to measure and improve your energy consumption before participating in the SEM program?

(For analysis: Check if these tools came from EMIS, in which case they shouldn't count toward FR)

FR4. Of all the energy efficiency measures implemented as part of your participation in the SEM program, which proportion do you think you would have implemented even if you had not participated in the SEM program?

NOTES:

SEM Satisfaction and Barriers

S1. 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?

Rate:

S2. [IF S1<8] What is the most important reason you are not more satisfied with the program overall?

S3. [IF S1>8] What is the most important reason you are satisfied with the program overall?

S4. Did you face any challenges or barriers when implementing strategic energy management within your organization, or after its implementation?

YES NO

S5. [IF S4 = YES, then ask:] What were these challenges or barriers?

S6. Do you have any suggestions on how to improve the SEM program?

Consider all aspects of the program: Participation process, program forms, marketing, interactions with ENS staff or contractors, etc.

SEM Persistency

Now I would like to ask you a few questions to know how independent you are when it comes to using your SEM tool.

On a scale of 1 to 10 where 1 equals not at all agree and 10 equals completely agree, how much do you agree with the following statements?

1. If our service provider no longer helped us to fill out our event log, we would continue to do it on our own every month.
2. Our internal energy team is able to interpret our energy model, including calculating monthly energy savings, without support from our SEM service provider
3. We will continue to calculate monthly savings, after direct support from our SEM service provider ends
4. Our site will maintain (or improve) its level of energy performance one year after direct support of our SEM service provider ends

On a scale of 1 to 10 where 1 is very unlikely and 10 very likely, How likely is your site to retain the services of an energy management service provider after support from the ENS SEM program ends?

APPENDIX XIII

EMIS/SEM: 2018 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2018 EMIS and SEM evaluations, as well as all 2017 evaluation recommendations that were not fully implemented.

Sections	Recommendations
Executive Summary	1 Review program delivery to improve participant understanding and mastery of energy performance tracking. Despite being satisfied with EMIS and SEM, many participants in both program components mentioned feeling they need more assistance with ongoing analysis and they lack resources to continue tracking and maintaining facility energy consumption levels on their own. Another indication of high dependence on service providers is that one 2017 EMIS participant stopped producing monthly reports for the second half of 2017 because the service provider could no longer remotely access their energy management information system. Furthermore, many SEM participants do not anticipate continuing their energy management efforts, particularly in terms of tracking energy performance, without the support of a service provider. The Evaluator believes that these examples indicate that EMIS and SEM participants heavily rely on their service providers to maintain their efforts and that the program components do not achieve the full potential of changing energy management practices. Therefore, it is recommended that EMIS and SEM delivery methods be reviewed to better equip participants to understand and fully master energy performance tracking methods. In addition to increasing the persistency of savings, this is also likely to improve participant satisfaction with EMIS and SEM since participants would feel less overwhelmed by the amount and complexity of the data provided to them through EMIS or SEM.
SEM Project Review Findings	2 The other important adjustments were due solely to the fact that neither ENS nor the service provider tracked or calculated peak demand savings. [...] With respect to improving the quality of the documentation for future years and for new SEM cohorts, the Evaluator recommends that peak demand savings be added to the scope of work and that the service provider prepare incremental baselines for subsequent years, as is currently done under EMIS.
SEM Project Review Findings	3 The adjustments made by the Evaluator were primarily due to the tracked savings values not matching the reported savings values prepared by the service provider. In fact, the tracking sheet did not include the adjustments made by the service provider with regard to savings attributable to capital projects. [Consequently], the Evaluator recommends that ENS verify and update their tracked savings values to coincide with the values reported by the service provider in the annual savings reports.

Sections	Recommendations
SEM Net-to-gross Ratio	4 [One] participant mentioned being aware of and interested in SEM prior to being contacted by ENS, but with no clear plan to implement a strategic energy management process in the near future. This is the first time since the inception of the program that an SEM participant demonstrates such knowledge of strategic energy management. It is recommended that ENS continue to ask questions about knowledge of and interest in strategic energy management since the practice might become more widespread and warrant free-ridership measurement in the future.
SEM Net Savings	5 It should be noted that the NTGR [...] is lower than one [...] because of the adjustment for the BER Instant Rebates project. Since the deduction applied to obtain net savings resulted from a situation that is not likely to occur again, the Evaluator recommends that ENS apply a NTGR of 1.00 to their tracking in 2019.
2017 EMIS Recommendations (Not fully implemented at the time of evaluation)	6 Ensure that the tracking sheet is complete and accurate. While reviewing the project documentation, the Evaluator found several discrepancies between the savings figures reported in the final tracking sheet and the savings figures documented in the annual savings reports. Also, two of the four projects claimed peak demand savings in their annual reports; however, this information was not tracked by ENS in the tracking sheet. The Evaluator recommends that, from now on, the final tracking sheet be updated with the final values documented in the annual reports and that annual peak demand savings be tracked.



ECONOLER



DIRECT INSTALLATION PROGRAM

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Final Report

March 15, 2019



ECONOLER



ABBREVIATIONS

BNI	Business, non-profit and institutional
CRA	Corporate Research Associates
DIY	Do-it-yourself
DSM	Demand-side management
ENS	Efficiency Nova Scotia
EUL	Effective useful life
GHG	Greenhouse gas
HOU	Hours of use
HVAC	Heating, ventilation and air conditioning
LED	Light-emitting diode
NSP	Nova Scotia Power
NTGR	Net-to-gross ratio
SBEA	Small Business Energy Auditor
SBES	Small Business Energy Solutions

DEFINITIONS

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

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

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

TABLE OF CONTENTS

EXECUTIVE SUMMARY	VIII
INTRODUCTION	1
1 SBES OVERVIEW.....	3
1.1 Description	3
1.2 Follow-up on 2017 Evaluation Report Recommendations	5
1.3 Participation History	6
2 SBES EVALUATION OBJECTIVE AND METHODOLOGY	8
3 SBES MARKET EVALUATION	10
4 SBES IMPACT EVALUATION.....	11
4.1 Gross Savings	11
4.1.1 Summary of Adjustments to Gross Savings – Audit Path.....	12
4.1.2 Summary of Adjustments to Gross Savings – DIY Path.....	12
4.1.3 Interactive Effects	13
4.1.4 Effective Useful Life	13
4.1.5 Revised Gross Savings	13
4.2 Net-to-gross Ratio.....	16
4.2.1 Free-ridership	16
4.2.2 Participant Spillover	16
4.2.3 NTGR Calculation.....	17
4.3 Net Savings.....	17
5 SBES RECOMMENDATIONS	22
CONCLUSION.....	23

LIST OF TABLES

Table 1: SBES Overall Participation and Savings in 2018.....	viii
Table 2: Comparison of Tracked and Evaluated Savings at the Generator for SBES.....	xi
Table 3: Types of Evaluations Conducted for Each Program Component	2
Table 4: Implementation Status of 2017 Recommendations for SBES	6
Table 5: Gross Savings Adjustments – Audit Path	12
Table 6: Gross Savings Adjustments – DIY Path	12
Table 7: Revised Gross Energy and Peak Demand Savings for SBES – Audit Path	14
Table 8: Revised Gross Energy and Peak Demand Savings for SBES – DIY Path	15
Table 9: Average Free-ridership Level by Path for SBES.....	16
Table 10: Evaluated Net Energy and Peak Demand Savings for SBES – Audit Path	18
Table 11: Evaluated Net Energy and Peak Demand Savings for SBES – DIY Path	19
Table 12: Comparison of Tracked and Evaluated Savings at the Generator for SBES.....	20
Table 13: SBES Overall Participation and Savings in 2018.....	21

LIST OF FIGURES

Figure 1: Overview of SBES Performance, 2015-2018	ix
Figure 2: Audit Path Participation Process	4
Figure 3: DIY Path Participation Process.....	5
Figure 4: Overview of Participation in SBES, 2015-2018	7
Figure 5: Summary of Gross Savings for SBES, 2015-2018	7
Figure 6: SBES Methodological Model	8

EXECUTIVE SUMMARY

This report presents the results of the 2018 demand-side management (DSM) evaluation of the Direct Installation program comprised of one program component, namely Small Business Energy Solutions (SBES). SBES offers Nova Scotia small businesses incentives and resources to make smart energy efficient upgrades at their facilities by participating in the audit path or the do-it-yourself (DIY) path.

As part of the 2018 evaluation, the Evaluator interviewed the SBES program manager and conducted 50 on-site visits.

Table 1 summarizes the participation level, as well as gross savings and net savings for the audit and the DIY paths of SBES.

Table 1: SBES Overall Participation and Savings in 2018

	Participation Level	Gross Savings	NTGR	Net Savings
Audit Path				
Energy Savings	28 ¹	0.912 GWh	0.95*	0.868 GWh
Lifetime Energy Savings		13.903 GWh	0.95*	13.272 GWh
Peak Demand Savings		0.204 MW	0.95*	0.197 MW
DIY Path				
Energy Savings	501	10.025 GWh	0.87	8.721 GWh
Lifetime Energy Savings		121.291 GWh	0.87	105.523 GWh
Peak Demand Savings		1.430 MW	0.87	1.244 MW
TOTAL				
Energy Savings		10.937 GWh	0.88	9.589 GWh
Lifetime Energy Savings		135.193 GWh	0.88	118.794 GWh
Peak Demand Savings		1.635 MW	0.88	1.441 MW
* The overall NTGR for the audit path includes the AMH pilot, which has a NTGR of 1. The NTGR of all other audit path projects was established at 0.93.				

Small Business Energy Solutions

SBES offers incentives and resources to Nova Scotia small businesses to encourage them to make smart energy efficient upgrades in their facilities. To be eligible, businesses must annually consume less than 350,000 kWh of electricity. Businesses with annual electricity consumption higher than this limit are directed toward the Efficiency Nova Scotia (ENS) Custom or Business Energy Rebates program components.

¹ Includes four projects completed as part of the AMH pilot.

In January 2018, ENS simplified SBES application forms by replacing the Business Profile with two forms: a Before You Buy Commercial Product Rebate Application and an Opportunities Worksheet. Participants who know which measures they wish to install fill out the former, while participants who need help to get started or are interested in applying for a free energy audit use the latter. ENS uses the application information and the business' electricity consumption history provided by Nova Scotia Power (NSP) or a municipal utility to determine whether that applicant is eligible for SBES and if an audit would help identify additional potential energy saving upgrades (audit path). Applicants that do not qualify for an audit must follow the DIY path.

In 2018, four participants also completed projects through the Affordable Multifamily Housing (AMH) pilot, which offers measures similar to other SBES projects, although it bases eligibility criteria on affordable housing rather than energy consumption.

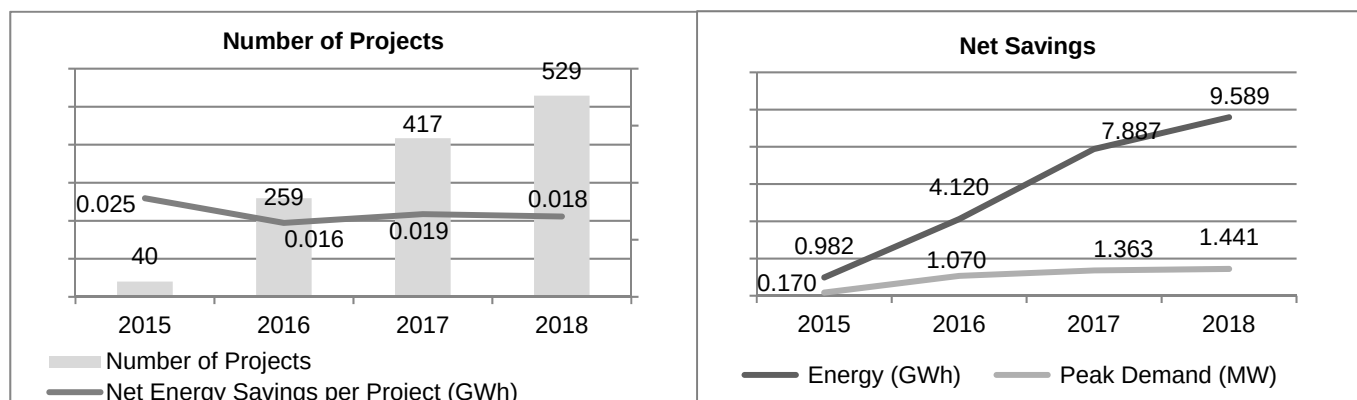
SBES Key Findings

SBES Performance

SBES aimed to achieve 9.6 GWh in net electrical energy savings and 1.7 MW in net peak demand savings at the generator in 2018. The Evaluator determined that SBES achieved 9.589 GWh in net electrical energy savings and 1.441 MW in net peak demand savings at the generator, continuing the trend of year-to-year savings growth. These savings represent 5,874 tonnes of CO₂ eq in terms of annual avoided greenhouse gas (GHG) emissions. SBES net lifetime energy savings were established at 118.825 GWh, which yields a weighted average effective useful life (EUL) value of 12.4 years.

As shown in Figure 1, a total of 529 projects were completed in 2018, which represents a 30 percent increase over 2017. This total includes four projects completed through the AMH pilot.

Figure 1: Overview of SBES Performance, 2015-2018



SBES Market Evaluation Highlights

The Evaluator asked questions during the site visits to better understand participant processes for initiating equipment purchases or installations, the types of market actors they are most likely to rely on for projects, and any types of equipment they are likely to consider upgrading. The results suggested that market interest in energy efficient heating, ventilation and air conditioning (HVAC) equipment remains high. Responses also indicated that many of the surveyed participants recognized that support is available from ENS, and they were likely to take advantage of that support in the future.

Many respondents stated they rely on regular lighting and HVAC contractors for their equipment purchase and installation needs, and they would turn to these contractors when considering an equipment upgrade. The Evaluator believes that HVAC contractors could be effective ambassadors for energy efficiency if engaged, trained in key SBES processes and requirements, and provided with promotional materials. As trusted experts with direct access to small business decision makers and their end-use equipment, HVAC contractors could be a leverage point to begin developing greater demand for non-lighting energy efficiency measures under SBES.

SBES Energy Savings

The Evaluator reviewed ENS gross savings estimates using the information contained in the tracking sheet, the CIRx Screening Tool, and findings from the on-site visits. Overall, this review found continued improvement in the accuracy of tracked energy savings, particularly in the DIY path. The implementation of new application forms appears to have improved the accuracy of tracked hours of use (HOU) in DIY projects. These factors contributed to an energy savings adjustment factor of 0.929 for DIY projects, compared to 0.889 in 2017. Although the accuracy of tracked HOU improved relative to 2017, HOU adjustments were common among the reviewed sample, which had significant impacts on the demand savings of DIY projects. Inaccuracies in tracked peak coincidence factors – caused by inaccurate HOU – led to an overall adjustment ratio for peak demand savings in the DIY path of 0.620, which was lower than the adjustment ratio of 0.744 found in 2017.

The downward adjustments made to energy savings in the audit path were more impactful than for the DIY path. Some issues included multiple measures not being included in the tracking sheet, not distinguishing HOU by space type, application of an incorrect baseline heating technology, and not accounting for operating procedures and schedules. Since adjustments were significant and the sample sizes were small, the adjustment ratio had a high margin of error and led the Evaluator to apply a one-time adjustment to audit path gross savings; this resulted in an overall adjustment ratio of 0.811. On the other hand, peak demand savings were increased by about 12 percent.

Since the Evaluator did not conduct an SBES participant survey in 2018, the free-ridership values assessed in 2017 were reapplied in 2018. These values were 7 percent for the audit path and 13 percent for the DIY path. Spillover was assessed in 2018 and found to be nil, as in 2017.

In 2018, the Evaluator established the total net energy and peak demand savings at the generator at 9.589 GWh and 1.441 MW respectively. Table 2 below provides a summary comparison of tracked and evaluated savings.

Table 2: Comparison of Tracked and Evaluated Savings at the Generator for SBES

	Initial Gross Savings	Adjusted Gross Savings	NTGR	Net Savings
Energy Savings				
Tracked Savings from ENS	11.852 GWh	11.852 GWh	0.82	9.673 GWh
Evaluation Results	11.852 GWh	10.937 GWh	0.88	9.589 GWh
Peak Demand Savings				
Tracked Savings from ENS	2.499 MW	2.499 MW	0.82	2.039 MW
Evaluation Results	2.499 MW	1.635 MW	0.88	1.441 MW

The evaluated net energy savings are approximately 1 percent below the corresponding tracked value. While the tracked gross energy savings were adjusted downward by 8 percent, the tracked net-to-gross ratio (NTGR) was significantly below the NTGR value established in 2017 and used again for the 2018 evaluation, which explains why the tracked net energy savings were underestimated.

The evaluated net peak demand savings were 29 percent lower than the tracked value. Overall, the gross peak demand savings were adjusted downwards as a result of the evaluation, with the Audit path savings being increased and the DIY path savings being reduced. The evaluated NTGR value being lower than the tracked value increased the variation between net evaluated and tracked peak demand savings.

SBES Recommendations

Since 2016 (its first full year of operation since SBES replaced the Business Energy Solution program component), SBES has succeeded in achieving continuous growth in participation levels and energy savings. Moreover, the 2018 evaluation found improvement in the accuracy of tracked energy savings in the DIY path, which is by far the most popular SBES path. The Evaluator does not have recommendations for SBES beyond the general recommendations made for all ENS program components in the Overall Evaluation Executive Summary of the 2018 DSM Programs. Appendix V lists minor recommendations made throughout the report as well as recommendations from previous years that have not yet been fully implemented.

INTRODUCTION

Efficiency Nova Scotia (ENS) is operated by EfficiencyOne, an independent, non-profit organization. ENS 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 various segments of the population. ENS has a demand-side management (DSM) portfolio of three residential programs and three business, non-profit and institutional (BNI) programs. Each program has one or more program components that ENS markets to Nova Scotians. ENS receives funding for its activities from Nova Scotia Power (NSP) and the Province of Nova Scotia. The funds received from NSP cover the costs of activities designed to help reduce electricity consumption, whereas funds from the Province of Nova Scotia are primarily used for activities designed to help reduce the use of other fuels.

Econoler was commissioned to evaluate ENS's 2018 DSM program portfolio comprised of six electricity efficiency programs and assess the impacts of energy efficiency codes and standards introduced in Nova Scotia. To carry out this assignment, Econoler collaborated with Research Into Action, Equilibrium Engineering and Corporate Research Associates (CRA). 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 impact evaluation calculations, as well as preparing and reviewing evaluation reports. Research Into Action carried out the process evaluations, while Equilibrium Engineering conducted the on-site visits and contributed to some impact evaluation analyses. CRA conducted interviews and surveys with participants and partners, as well as analyzed and reported on the data collected from these activities. Throughout this report, this team is referred to as the Evaluator.

Table 3 below lists the various programs assessed as part of the 2018 evaluation and indicates their respective components and the types of evaluations conducted. In this table, "C" means a complete evaluation and "R" indicates that reduced evaluation activities were performed. Moreover, Section 1 of the DSM Programs Evaluation Executive Summary presents the scope of work in further detail, along with the rationale for the types of evaluations performed for each program component.

Table 3: Types of Evaluations Conducted for Each Program Component

Program	Program Component	2017			2018		
		Process	Market	Impact	Process	Market	Impact
Residential Efficient Product Rebates Program	Appliance Retirement			R		C	C
	Instant Savings		R	R		C	C
Existing Residential Program	Home Energy Assessment		C	C			R
	Green Heat	C	C	C		C	C
	Efficient Product Installation		C	C		C	R
New Residential Program	New Home Construction		C	C	C		C
Efficient Product Rebates Program	Business Energy Rebates		C	R	C	C	C
Custom Incentives Program	Custom	C*	C	R	C**	C	C
	Energy Management Information Systems		C	C		C	C
	Strategic Energy Management***					C	C
Direct Installation Program	Small Business Energy Solutions		C	C		R	R
* The process evaluation specifically targets the Retrofit service of the Custom program component. ** The process evaluation specifically targets the New Construction service of the Custom program component. *** Due to the start date of the latest Strategic Energy Management (SEM) cohort, SEM did not have any participants who achieved savings in 2017; therefore, no evaluation was conducted for 2017.							

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

This evaluation report is for the Direct Installation program, which is comprised only of the Small Business Energy Solutions (SBES) component. In 2017, SBES underwent complete market and impact evaluations. In 2018, the evaluation scope of SBES was reduced since no participant survey was carried out. A description of SBES program component, evaluation methodology and main evaluation findings are presented in the following sections.

1 SBES OVERVIEW

This section describes the SBES program component, follows up on 2017 evaluation recommendations, and provides an overview of participation history.

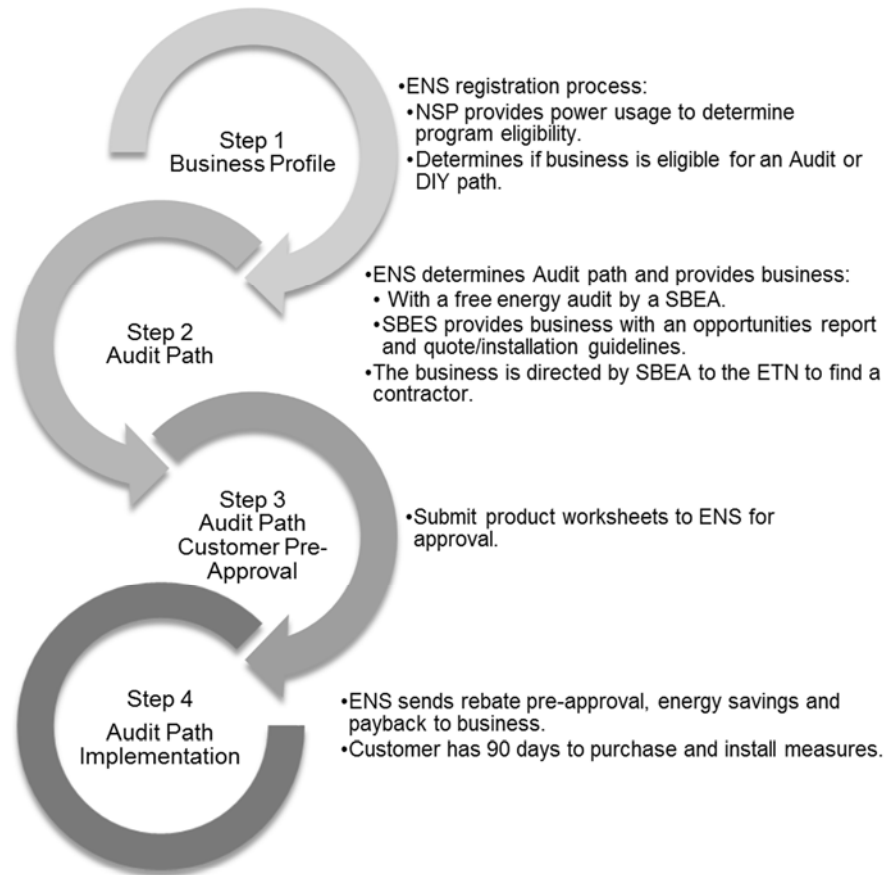
1.1 Description

SBES offers incentives and resources to Nova Scotia small businesses to encourage them to make smart energy efficient upgrades in their facilities. To be eligible, businesses must annually consume less than 350,000 kWh of electricity. Businesses with annual electricity consumption higher than this limit are directed toward the ENS Custom or Business Energy Rebates program components.

In January 2018, ENS simplified SBES application forms by replacing the Business Profile with two forms: an Before You Buy Commercial Product Rebate Application and an Opportunities Worksheet. Participants who know which measures they wish to install fill out the former, while participants who need help to get started or are interested in applying for a free energy audit use the latter. ENS uses the application information and the business' electricity consumption history provided by NSP to determine whether that applicant is eligible for SBES and if an audit would help identify additional potential energy saving upgrades (audit path). Applicants that do not qualify for an audit must follow the do-it-yourself (DIY) path.

The audit path provides a free-of-charge energy audit conducted by a Small Business Energy Auditor (SBEA). Participants who are not approved for an audit may choose to have an audit conducted at their own expense with no funding from ENS. Figure 2 below illustrates the audit path participation process.

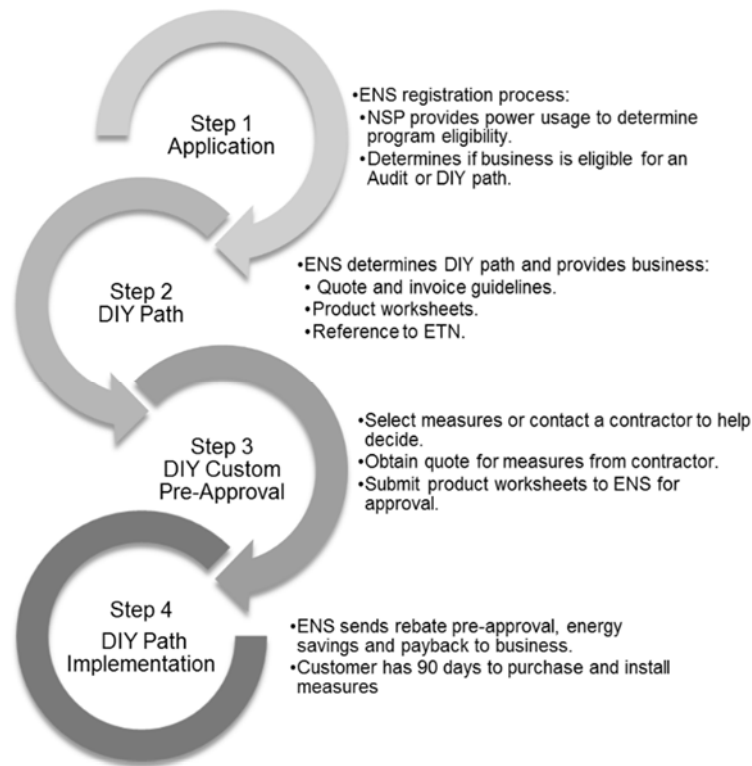
Figure 2: Audit Path Participation Process



The DIY path provides participants with quote and invoice guidelines, product worksheets, a reference to the Efficiency Trade Network, and a list of qualified energy service providers in the province. Participants may select the measures to be implemented or contact a contractor to help them make those decisions. Before implementing any upgrades, participants must obtain a quote from the contractor they are working with and submit the product worksheets and specification sheets to ENS for approval.

Rebates vary according to internal unit costs (\$/kWh) and various factors related to specific technologies, including incremental cost, adoption rate, and their strategic importance to SBES and the ENS portfolio. Figure 3 below presents the DIY path participation process.

Figure 3: DIY Path Participation Process



SBES aimed to achieve net electrical energy savings of 9.6 GWh and net peak demand savings of 1.7 MW at the generator in 2018.

Affordable Multifamily Housing Pilot

Launched in 2016, the Affordable Multifamily Housing (AMH) pilot provides affordable-housing owners with incentives for building-wide energy retrofit projects with the intent of reducing electrical energy consumption in Nova Scotia. This pilot uses the same delivery model as SBES and proposes similar measures, although eligibility criteria are based on affordable housing rather than energy consumption. In 2018, ENS re-engaged pilot participants, which resulted in four projects being completed with the potential for more projects to be completed in 2019.

1.2 Follow-up on 2017 Evaluation Report Recommendations

SBES was evaluated in 2017 and the Evaluator formulated several recommendations. Table 4 below provides a brief summary of the implementation status of each recommendation presented in the Executive Summary section of the 2017 Evaluation Report.

Table 4: Implementation Status of 2017 Recommendations for SBES

2017 Recommendations	Status
2017 SBES-R1. Implement an internal procedure to identify and thoroughly review the most complex custom projects to ensure savings calculation accuracy.	Implemented
2017 SBES-R2. Closely monitor the new lighting application forms' effectiveness to confirm that they are achieving their intended goals.	Implemented
2017 SBES-R3. Investigate new ways to encourage the implementation of non-lighting measures to increase their share of savings and ultimately increase SBES total savings.	Being implemented

At this time, all three recommendations made for SBES in the 2017 Evaluation Report are either implemented or in the process of being implemented. Regarding recommendation 2017 SBES-R1, SBES staff have engaged the Custom Incentive program team to support the savings estimation and project review procedures for large custom projects.

As for recommendation 2017 SBES-R2, on-site visits results indicated a slight improvement in the adjustment ratio for DIY projects compared with the 2017 ratio. Specifically, the accuracy of tracked hours of use (HOU) improved somewhat in 2018 relative to 2017. The share of sampled projects requiring an adjustment of 10 percent or greater to HOU in 2018 was 21 percent, compared to 32 percent of projects in 2017. These indicators suggest that the updated application forms are having a positive effect on the accuracy of tracked savings for DIY projects.

ENS is in the process of implementing recommendation 2017 SBES-R3 through various means such as promoting energy efficiency technologies other than lighting in their marketing materials and interactions with participants. To further address this recommendation, the Evaluator has been mandated to collect information during site visits on the other types of equipment or systems that participants are most interested in upgrading. Findings are presented in Section 3 below.

1.3 Participation History

Launched in August of 2015, SBES has seen a continual increase in participation levels and gross energy savings, as presented in Figure 4 and Figure 5 below. In 2018, a total of 529 projects were completed (26 audit path projects and 503 DIY path projects), which represents a 30 percent increase over 2017.

Figure 4: Overview of Participation in SBES, 2015-2018

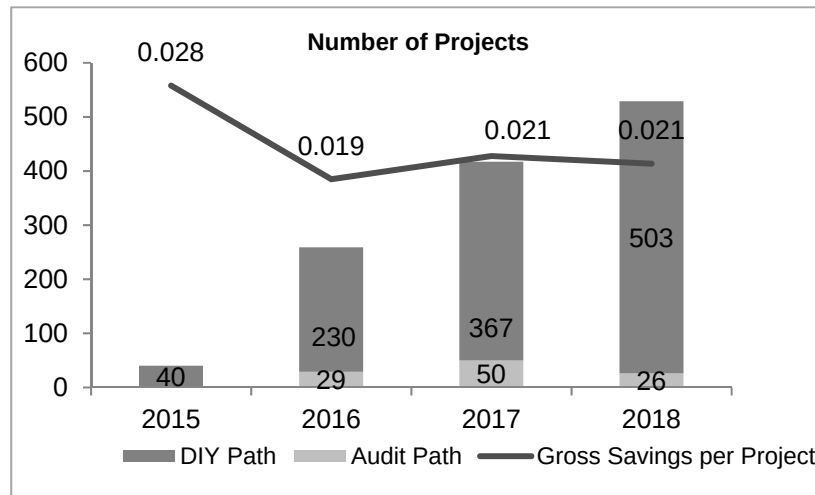
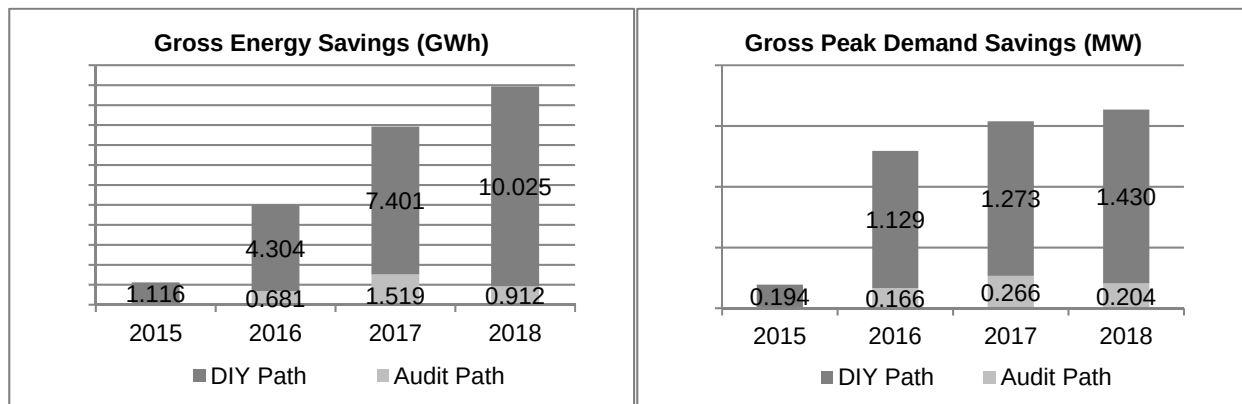


Figure 5: Summary of Gross Savings for SBES, 2015-2018



Among all SBES measure categories, lighting projects were the most common and accounted for 87 percent of total gross savings, which is the same share as in 2017 and somewhat greater than the 80 percent share in 2016. Lighting projects represent 92 percent of gross energy savings in the DIY path. The audit path comprises greater variability in the share of measure savings, with lighting representing 29 percent of total savings.

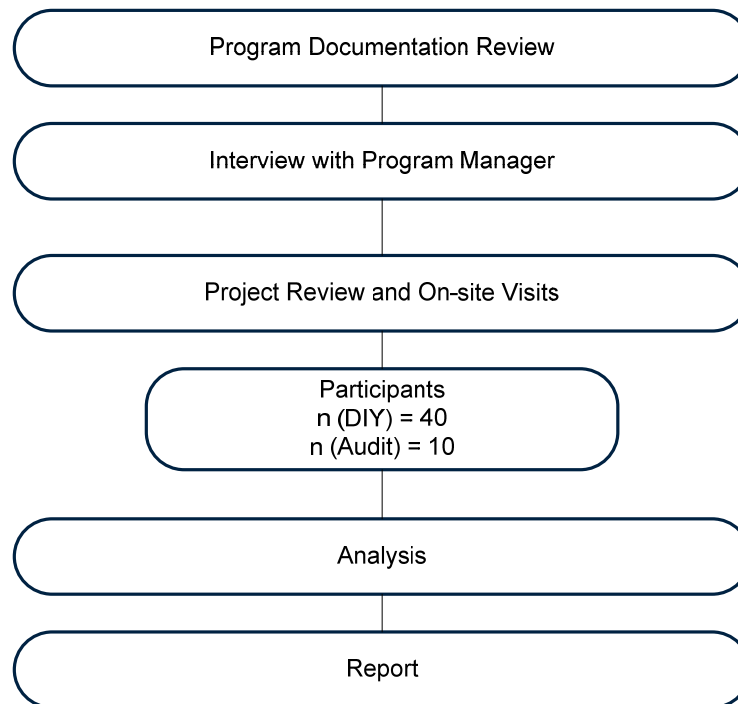
2 SBES EVALUATION OBJECTIVE AND METHODOLOGY

The main objectives of the SBES evaluation are as follows:

- › Collecting information during site visits on non-lighting measures that participants are most interested in upgrading
- › Calculating program results, namely electrical first-year and lifetime energy savings, peak demand savings, and avoided GHG emissions

This section describes the methodology used and the activities carried out for the SBES 2018 evaluation to achieve the aforementioned objectives. Figure 6 below illustrates the various data-collection activities carried out for the evaluation.

Figure 6: SBES Methodological Model



The Evaluator first reviewed program component documentation and then held a meeting with the program manager in September 2018 to verify the implementation status of the previous evaluation recommendations and learn about the main changes made to the program component. Based on the information obtained from this meeting, a list of questions and topics to be included in the data-collection instruments was prepared.

Once the program manager meeting and the program component documentation review were completed, specific evaluation activities were undertaken, as described in the following subsections.

For evaluation activities that yield quantitative results based on a sample, the Evaluator aimed to achieve a maximum margin of error of 10 percent at a confidence level of 90 percent. 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 percent of the time. Thus, the margin of error indicates the relative level of precision² of the measurement, while its associated confidence level indicates the probability of a measurement falling within the margin of error.³

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. Examples of calculations used to establish margins of error are provided in Appendix II of the 2018 DSM Programs Evaluation Executive Summary.

Project Reviews and On-site Visits

In October and November 2018, a technical review of the project documentation and on-site visits were carried out by Equilibrium Engineering for a sample of projects. The sampling methodology and the protocol used to conduct the visits are provided in Appendix I.

A total of 50 SBES projects were reviewed, including 40 DIY path projects and 10 audit path projects. These project reviews and visits were conducted to validate whether the measures implemented were consistent with the information contained in the tracking sheet and the CIRx Screening Tool. Additionally, the hours of operation, various operating conditions and, wherever possible, the old and new equipment characteristics (wattage, horsepower, efficiency, etc.) were validated. These elements were used to revise gross savings by adjusting savings of individual projects or applying an adjustment factor to all projects in a given category if the sample size was large enough. During the site visits, spillover was also assessed by asking questions to determine if participants had implemented additional energy efficiency measures as a result of participating in SBES without receiving an incentive from ENS. Questions were also asked to participants during site visits to collect information on the types of equipment or systems, other than non-lighting, that participants are most interested in upgrading.

Comparison with 2017 Evaluation Scope

No participant survey was carried out for SBES in 2018; hence, the market evaluation scope was considered reduced for 2018. The impact evaluation scope was also considered reduced since the free-ridership level was not measured in 2018. The rationale behind these choices is based on analysis of 2018 evaluation objectives, key results of previous evaluations and recent changes made to each program in the ENS portfolio. Further explanations are provided in Section 1 of the DSM Programs Evaluation Executive Summary.

² 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.

³ 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 SBES MARKET EVALUATION

The Evaluator asked questions during the site visits to better understand participant processes for initiating equipment purchases or installations, the types of market actors they are most likely to rely on for such projects, and any types of equipment they are likely to consider upgrading. The Evaluator surveyed 47 participants, although not all participants responded to each question.

Of the participants surveyed, 15 provided feedback regarding the types of equipment they were most interested in upgrading or adding to their facilities within the next year or two, while 32 respondents indicated that they were not interested in upgrading or adding new equipment in the next two years, or they declined to respond. Some participants indicated more than one equipment type they were interested in upgrading or adding, so the total number of types of equipment is greater than 15.

- › Nine participants indicated heating, ventilation and air conditioning (HVAC) equipment; of those nine, three specifically mentioned heat pumps
- › Solar technologies, refrigeration equipment, and lighting were each mentioned by three participants
- › Two participants indicated an interest in variable speed drives
- › One participant indicated water heating

Participants were also asked how they would initiate a project to upgrade an additional equipment type; 34 participants responded to these questions. 53 percent indicated they would contact ENS, 41 percent indicated they would proceed with a contractor, and 6 percent indicated they would rely on internal staff.

Forty-five (45) participants responded to questions about whether they have regular contractors that they turn to for equipment purchases and installations. Twenty-seven (27) participants (60%) indicated they did use regular contractors: 24 participants (51%) indicated that they use a regular lighting contractor, while 17 participants (36%) indicated they use a regular HVAC contractor, and four participants indicated they use a regular plumbing contractor (multiple mentions per respondent). As expected, a larger proportion of participants has a regular contractor for lighting than for other types of systems.

Among the 47 respondents, only 15 indicated an interest in upgrading additional equipment in the next two years. Although, of the participants who responded to this question, interest in energy efficient HVAC equipment was high.

Responses also demonstrate that many of these participants recognize that support is available from ENS, and they are likely to take advantage of that support in the future, which is an expected result for SBES participants. Many respondents also rely on regular lighting and HVAC contractors for their equipment purchase and installation needs, and they turn to these contractors when considering equipment upgrades. Continued engagement with these contractors offers an opportunity to influence the market toward greater overall SBES participation and broaden recognition of energy efficiency opportunities in HVAC and other non-lighting systems.

4 SBES IMPACT EVALUATION

The objective of the 2018 SBES impact evaluation was to determine the gross and net electrical energy and peak demand savings. This section discusses the gross and net savings results, as well as the findings from the on-site visits conducted during the energy audits.

4.1 Gross Savings

Gross savings correspond to the change in energy consumption resulting from actions taken by participants, regardless of their reasons for participating.⁴ For each SBES project, ENS tracks gross savings using the standard equations defined in the CIRx Screening Tool or the custom calculations performed by energy auditors and documented in the audit reports.

The Evaluator reviewed the ENS gross savings estimates for a sample of projects. The lighting measure category comprises 96 percent of all implemented SBES measures and accounts for 87 percent of total savings. Due to the predominance of lighting measures, a stratified sampling methodology based on project size was preferred, rather than a sampling approach based on measure categories. This ensured a sample that is representative of the program component population. A more detailed explanation of the sample selection is provided in Appendix I.

The Evaluator conducted 50 on-site visits as part of the 2018 SBES impact evaluation to assess the energy savings of implemented measures in both the audit and DIY paths. SBES mainly consisted of lighting and HVAC measures, so visits were distributed across five strata by project size – rather than by measure type – to ensure projects of all sizes were equally represented.

The on-site visits served to determine that the tracked data for lighting projects were generally representative of the implemented measures, with the exception of two common issues. First, the table of interactive effects values applied to all lighting projects had not been updated to 2017 values; updating these values affected all lighting measures except those implemented in non-electrically heated, outdoor or refrigerated spaces. Second, although the accuracy of tracked HOU improved relative to 2017, they required frequent adjustments to account for different operational schedules or holiday shutdowns and operation outside of posted business hours.

Beyond lighting measures, the sample of projects selected for on-site visits included nine HVAC projects, two custom projects, and one commercial laundry project. In general, HVAC projects were not analyzed in enough detail by the SBEAs, resulting in key performance variables not being captured or accurately identified. Sources of errors included misread performance tables, incorrect equipment model numbers, inaccurate baseline descriptions, and unverified system performance at a low temperature point.

⁴ 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/UMChapter23-estimating-net-savings_0.pdf (Last accessed November 25, 2016).

4.1.1 Summary of Adjustments to Gross Savings – Audit Path

The on-site visits revealed common and significant errors in tracked values recorded by SBEAs. The issues with tracked savings in the sampled audit path projects were not specific to any measure – the Evaluator found very significant discrepancies between tracked values and revised values based on participant declarations for HVAC and lighting measures. Issues included multiple measures not being included in the tracking sheet, not distinguishing HOU's by space type, applying an incorrect baseline heating technology, and incomplete accounting for operating procedures and schedules. Appendix II outlines an example calculation for the revised savings of an HVAC project.

Since adjustments were significant and the sample size was small, the adjustment ratio had a high margin of error and led the Evaluator to apply a one-time adjustment (meaning that the revised savings were used for the reviewed projects only, without extrapolating) to audit path gross savings. The adjustment is summarized in Table 5.

Table 5: Gross Savings Adjustments – Audit Path

Population		Energy Savings		Peak Demand Savings	
Total	Sample	One Time Adjustment	Overall Adjustment Ratio	One Time Adjustment	Overall Adjustment Ratio
24 ⁵	10	-137,980 kWh	0.811	11.0 kW	1.120

4.1.2 Summary of Adjustments to Gross Savings – DIY Path

Table 6 below summarizes the adjustment ratios used for all measure categories in the DIY path. The variations uncovered during site visits had a relatively small impact on energy savings and a large impact on demand savings. Site visit results indicated that the peak coincidence factors of many lighting projects in the DIY path were incorrectly tracked, often because of incorrect HOU's, resulting in a large adjustment ratio for peak demand savings.

Table 6: Gross Savings Adjustments – DIY Path

Population		Energy Savings		Peak Demand Savings	
Total	Sample	Overall Adjustment Ratio	Margin of Error	Overall Adjustment Ratio	Margin of Error
501	40	0.929	4.1%	0.620	5.3%

⁵ AMH pilot projects were not included in the population or sample for audit path on-site visits.

4.1.3 Interactive Effects

When a measure implemented as part of SBES is affected by interactive effects, this is taken into account by the gross savings standard equation in the ENS CIRx Screening Tool.⁶ Since 2016, specific interactive effects factors have been taken into account for both energy and peak demand savings. In 2017, ENS updated its methodology and values for interactive effects to be consistent across program components. The methodology and values for interactive effects remained consistent in 2018.

4.1.4 Effective Useful Life

As part of the 2018 evaluation, the Evaluator reviewed the effective useful life (EUL) values used by ENS to calculate energy savings that are expected to persist over time. The EUL values established through a literature review as part of the 2017 evaluation remained valid for the 2018 evaluation; the Evaluator therefore used those values to calculate evaluated lifetime energy savings.

In addition, the Evaluator revised the EUL values of lighting measures for which baseline changes are anticipated during the measure lifetime, such as general and decorative light-emitting diode (LED) lamps, as well as recessed and non-recessed downlight fixtures. The equivalent EUL values applied to each measure are presented in Appendix III.

With minor exceptions, ENS applied the correct EUL values to non-lighting measures. Among lighting measures, several product types were not tracked accurately, including downlight fixtures, high-bay luminaires, troffers, and most outdoor LED fixtures. Overall, the Evaluator found that the revised EUL values were higher than the tracked values: the weighted average tracked EUL value was 11.4 years, while the Evaluator calculated the weighted average revised EUL value at 12.4 years.

4.1.5 Revised Gross Savings

Table 7 and Table 8 further below present the revised total gross savings at the meter and at the generator for both paths. The savings at the generator were calculated by applying a line loss factor of 1.079 for the audit path and 1.072 for the DIY path. These values are weighted averages of the line loss factors provided by NSP for each rate code and the corresponding energy savings listed in the tracking sheet.

The total gross energy and peak demand savings at the generator were 0.912 GWh and 0.204 MW respectively for the audit path, and 10.025 GWh and 1.430 MW respectively for the DIY path. The total gross energy savings for SBES were established at 10.937 GWh at the generator and lifetime energy savings were established at 135.193 GWh, resulting in a weighted average EUL value of 12.4 years. The total gross peak demand savings were 1.635 MW at the generator.

⁶ Internal tool that references and defines, for each measure category, the standard equations to be used for gross savings calculations.

Table 7: Revised Gross Energy and Peak Demand Savings for SBES – Audit Path

Category of Measure	Custom	HVAC	Kitchen	Laundry	Lighting	Refrigeration	AMH Pilot	Total for All Categories
Energy Savings								
Tracked Gross Energy Savings (GWh)	0.132	0.232	0.004	0.003	0.304	0.053	0.255	0.983
Adjustment Ratio on Energy Savings	0.811	0.811	0.811	0.811	0.811	0.811	1.000	-
Gross Energy Savings – at the Meter (GWh)	0.107	0.188	0.003	0.003	0.246	0.043	0.255	0.845
Line Loss Factor	1.079	1.079	1.079	1.079	1.079	1.079	1.079	-
Gross Energy Savings – at the Generator (GWh)	0.116	0.203	0.004	0.003	0.266	0.046	0.275	0.912
Effective Useful Life (years)	15.7	16.3	12.6	14.0	11.7	14.4	17.8	-
Gross Lifetime Energy Savings - at the Generator (GWh)	1.821	3.309	0.047	0.043	3.121	0.665	4.897	13.903
Peak Demand Savings								
Tracked Gross Peak Demand Savings (MW)	0.000	0.035	0.000	0.003	0.044	0.009	0.087	0.178
Adjustment Ratio on Peak Demand Savings	1.120	1.120	1.120	1.120	1.120	1.120	1.000	-
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.040	0.001	0.004	0.049	0.010	0.087	0.189
Line Loss Factor	1.079	1.079	1.079	1.079	1.079	1.079	1.079	-
Gross Peak Demand Savings – at the Generator (MW)	0.000	0.043	0.001	0.004	0.053	0.010	0.094	0.204

Table 8: Revised Gross Energy and Peak Demand Savings for SBES – DIY Path

Category of Measure	Agriculture	HVAC	Kitchen	Lighting	MVSD	Refrigeration	Solar	Total
Energy Savings								
Tracked Gross Energy Savings (GWh)	0.022	0.746	0.011	9.252	0.028	0.007	0.003	10.069
Adjustment Ratio on Energy Savings	0.929	0.929	0.929	0.929	0.929	0.929	0.929	-
Gross Energy Savings – at the Meter (GWh)	0.021	0.693	0.011	8.595	0.026	0.006	0.002	9.354
Line Loss Factor	1.072	1.072	1.072	1.072	1.072	1.072	1.072	-
Gross Energy Savings – at the Generator (GWh)	0.022	0.743	0.011	9.211	0.028	0.007	0.002	10.025
Effective Useful Life (years)	15.0	16.3	12.6	11.7	15.0	14.4	20.0	-
Gross Lifetime Energy Savings - at the Generator (GWh)	0.335	12.123	0.142	108.127	0.419	0.094	0.050	121.291
Peak Demand Savings								
Tracked Gross Peak Demand Savings (MW)	0.012	0.236	0.005	1.895	0.004	0.001	0.000	2.152
Adjustment Ratio on Peak Demand Savings	0.620	0.620	0.620	0.620	0.620	0.620	0.620	-
Gross Peak Demand Savings – at the Meter (MW)	0.007	0.146	0.003	1.175	0.003	0.000	0.000	1.334
Line Loss Factor	1.072	1.072	1.072	1.072	1.072	1.072	1.072	-
Gross Peak Demand Savings – at the Generator (MW)	0.008	0.157	0.003	1.259	0.003	0.000	0.000	1.430

4.2 Net-to-gross Ratio

The net-to-gross ratio (NTGR) serves to determine net savings, i.e. the energy savings that can be reliably attributed to a program component. More precisely, the NTGR is established by giving due consideration to such effects as free-ridership and spillover that positively or negatively affect the energy savings generated by a program component.

The 2017 market evaluation revealed high satisfaction with SBES, and a low, steady free-ridership level. Changes made to the participation process in 2018 are not likely to be observed until late in the year; hence, a participant survey would likely yield similar results as in previous years. For those reasons, the Evaluator elected not to conduct a participant survey in 2018 and to use the same free-ridership value as in 2017. Participant spillover was assessed through participant interviews conducted during the site visits.

4.2.1 Free-ridership

Free-ridership occurs when participants would have implemented energy efficiency upgrades in the absence of the program component. Free-ridership levels were assessed in 2017 using the results of a telephone survey with participants. Free-ridership was established at 7 percent for the audit path and 13 percent for the DIY path. These results were reapplied in 2018 to obtain net evaluated savings, which are summarized in Table 9.

Table 9: Average Free-ridership Level by Path for SBES

Project Path	Average Free-ridership Level	Sample Size	Population Size ⁷	Margin of Error	Percentage of Gross Energy Savings in SBES Population
Audit	7%	20	49	2.9%	7%
DIY	13%	47	358	3.4%	93%

4.2.2 Participant Spillover

For SBES, participant 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 used on-site visits to directly question participants about any potential spillover effects. The algorithm used to determine the level of participant spillover is presented in Appendix IV.

Similarly as in 2017, negligible spillover occurred during 2018. Among the 50 surveyed participants in 2018, the Evaluator identified two measures with partial program component influence that were completed without incentives, resulting in a spillover value of less than 0.1 percent. The Evaluator therefore applied a spillover level of nil to the SBES net savings calculations in 2018.

⁷ Population size excludes the MURB Affordable Housing pilot projects.

4.2.3 NTGR Calculation

The NTGR for SBES was calculated using the following equation:

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

By applying the free-ridership and spillover levels established for SBES, the NTGR was estimated at 0.93 for the audit path and 0.87 for the DIY path.

4.3 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 NTGR listed above to the revised gross savings by using the following equation:

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

It should be noted that the NTGR was not applied to the revised gross savings of the four pilot projects due to the specific context in which these projects were included in the program component. A NTGR of 1 was thus applied to these projects.

The net energy and peak demand savings at the generator for the audit path were 0.868 GWh and 0.197 MW respectively. The net energy and peak demand savings at the generator for the DIY path were 8.721 GWh and 1.244 MW respectively.

In 2018, SBES achieved a total 9.589 GWh in net energy savings and 1.441 GW in net demand savings at the generator. The equivalent NTGR for the audit and DIY paths combined was 0.88. The net lifetime energy savings were established at 118.794 GWh, resulting in a weighted average EUL value of 12.4 years for net savings. The detailed results are listed in Table 10 and Table 11 below.

Using the Nova Scotia-specific factor⁸ for GHG generated by electricity production, 0.6126 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 5,874 tonnes of avoided CO₂ eq annually.

⁸ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes), and total electricity generation (10,978 GWh) was drawn from the following two sources:
Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018).
Emera inc., *Management's Discussion & Analysis* as at February 9, 2018, <http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

Table 10: Evaluated Net Energy and Peak Demand Savings for SBES – Audit Path

Category of Measure	Custom	HVAC	Kitchen	Laundry	Lighting	Refrigeration	AMH Pilot	Total for All Categories
Energy Savings								
Revised Gross Energy Savings – at the Meter (GWh)	0.107	0.188	0.003	0.003	0.246	0.043	0.255	0.845
NTGR	0.93	0.93	0.93	0.93	0.93	0.93	1.00	-
Net Energy Savings – at the Meter (GWh)	0.100	0.175	0.003	0.003	0.229	0.040	0.255	0.804
Line Loss Factor	1.079	1.079	1.079	1.079	1.079	1.079	1.079	-
Net Energy Savings – at the Generator (GWh)	0.108	0.189	0.003	0.003	0.247	0.043	0.275	0.868
Effective Useful Life (years)	15.7	16.3	12.6	14.0	11.7	14.4	17.8	-
Net Lifetime Energy Savings – at the Generator (GWh)	1.694	3.078	0.044	0.040	2.903	0.618	4.896	13.272
Peak Demand Savings								
Revised Gross Peak Demand Savings – at the Meter (MW)	0.000	0.040	0.001	0.004	0.049	0.010	0.087	0.189
NTGR	0.93	0.93	0.93	0.93	0.93	0.93	1.00	-
Net Peak Demand Savings – at the Meter (MW)	0.000	0.037	0.001	0.004	0.046	0.009	0.087	0.182
Line Loss Factor	1.079	1.079	1.079	1.079	1.079	1.079	1.079	-
Net Peak Demand Savings – at the Generator (MW)	0.000	0.040	0.001	0.004	0.049	0.010	0.094	0.197

Table 11: Evaluated Net Energy and Peak Demand Savings for SBES – DIY Path

Category of Measure	Agriculture	HVAC	Kitchen	Lighting	MVSD	Refrigeration	Solar	Total for All Categories
Energy Savings								
Revised Gross Energy Savings – at the Meter (GWh)	0.021	0.693	0.011	8.595	0.026	0.006	0.002	9.354
NTGR	0.87	0.87	0.87	0.87	0.87	0.87	0.87	-
Net Energy Savings – at the Meter (GWh)	0.018	0.603	0.009	7.478	0.023	0.005	0.002	8.138
Line Loss Factor	1.072	1.072	1.072	1.072	1.072	1.072	1.072	-
Net Energy Savings – at the Generator (GWh)	0.019	0.646	0.010	8.014	0.024	0.006	0.002	8.721
Effective Useful Life (years)	15.0	16.3	12.6	11.7	15.0	14.4	20.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	0.291	10.547	0.124	94.071	0.364	0.082	0.043	105.523
Peak Demand Savings								
Revised Gross Peak Demand Savings – at the Meter (MW)	0.007	0.146	0.003	1.175	0.003	0.000	0.000	1.334
NTGR	0.87	0.87	0.87	0.87	0.87	0.87	0.87	-
Net Peak Demand Savings – at the Meter (MW)	0.006	0.127	0.003	1.022	0.002	0.000	0.000	1.161
Line Loss Factor	1.072	1.072	1.072	1.072	1.072	1.072	1.072	-
Net Peak Demand Savings – at the Generator (MW)	0.007	0.136	0.003	1.095	0.002	0.000	0.000	1.244

Table 12 compares the tracked energy and peak demand savings values with those established by the Evaluator.

Table 12: Comparison of Tracked and Evaluated Savings at the Generator for SBES

	Initial Gross Savings	Adjusted Gross Savings	NTGR	Net Savings
Energy Savings				
Tracked Savings from ENS	11.852 GWh	11.852 GWh	0.82	9.673 GWh
Evaluation Results	11.852 GWh	10.937 GWh	0.88	9.589 GWh
Peak Demand Savings				
Tracked Savings from ENS	2.499 MW	2.499 MW	0.82	2.039 MW
Evaluation Results	2.499 MW	1.635 MW	0.88	1.441 MW

The evaluated net energy savings are approximately 1 percent below the corresponding tracked value. While the tracked gross energy savings were adjusted downward by 8 percent, the tracked NTGR was significantly below the NTGR value established in 2017 and used again for the 2018 evaluation, which explains why the tracked net energy savings were underestimated.

The evaluated net peak demand savings were 29 percent lower than the tracked value. Overall, the gross peak demand savings were adjusted downwards as a result of the evaluation, with the Audit path savings being increased and the DIY path savings being reduced. The evaluated NTGR value being lower than the tracked value increased the variation between net evaluated and tracked peak demand savings.

Table 13 below summarizes the participation level, as well as the gross savings and net savings for the SBES audit and DIY paths.

Table 13: SBES Overall Participation and Savings in 2018

	Participation Level	Gross Savings	NTGR	Net Savings
Audit Path				
Energy Savings	28 ⁹	0.912 GWh	0.95*	0.868 GWh
Lifetime Energy Savings		13.903 GWh	0.95*	13.272 GWh
Peak Demand Savings		0.204 MW	0.95*	0.197 MW
DIY Path				
Energy Savings	501	10.025 GWh	0.87	8.721 GWh
Lifetime Energy Savings		121.291 GWh	0.87	105.523 GWh
Peak Demand Savings		1.430 MW	0.87	1.244 MW
TOTAL				
Energy Savings		10.937 GWh	0.88	9.589 GWh
Lifetime Energy Savings		135.193 GWh	0.88	118.794 GWh
Peak Demand Savings		1.635 MW	0.88	1.441 MW
* The overall NTGR for the audit path includes the AMH pilot, which has a NTGR of 1. The NTGR of all other audit path projects was established at 0.93.				

⁹ Includes four projects completed as part of the AMH pilot.

5 SBES RECOMMENDATIONS

Since 2016 (its first full year of operation since SBES replaced the Business Energy Solution program component), SBES has succeeded in achieving continuous growth in participation levels and energy savings. Moreover, the 2018 evaluation found improvement in the accuracy of tracked energy savings in the DIY path, which is by far the most popular SBES path. The Evaluator does not have recommendations for SBES beyond the general recommendations made for all ENS program components in the Overall Evaluation Executive Summary of the 2018 DSM Programs. Appendix V lists minor recommendations made throughout the report as well as recommendations from previous years that have not yet been fully implemented.

CONCLUSION

In its third full year of operation in the Nova Scotia market, SBES achieved its highest level of energy savings with 9.589 GWh in net electrical energy savings and 1.441 MW in net peak demand savings. SBES missed its planned net energy value of 9.6 GWh by a small amount and it fell short of the 1.7 MW planned value for demand savings. The net energy savings resulted in 5,874 tonnes of CO₂ eq in terms of annual avoided GHG emissions. The net lifetime energy savings were established at 118.794 GWh.

Both the audit and DIY paths demonstrated increased per project energy savings in 2018 compared to 2017, which contributed to the increase in achieved savings. Lighting measures continue to account for the largest share of SBES energy savings, corresponding to 87 percent of total gross energy savings.

The DIY path contributed the majority of energy and peak demand savings achieved by SBES, with 501 DIY projects completed in 2018. The 2018 evaluation found that the accuracy of tracked energy savings in the DIY path improved compared to the 2017 evaluation. As for the audit path, participation actually declined from 50 projects in 2017 to 28 in 2018.¹⁰ The 2018 evaluation revealed that tracked savings for the audit path contained several significant inaccuracies in data collection or recording, resulting in a lower adjustment ratio than for projects in the DIY path. The audit path comprises greater variability in the types of measures offered, with lighting representing 29 percent of total gross savings. This suggests that greater emphasis on the audit path could support the goal of diversifying the measure mix within SBES. Interviews with SBES participants also revealed that HVAC equipment may offer the greatest near-term savings potential among non-lighting measures and that HVAC contractors could be an effective pathway to develop greater demand for non-lighting energy efficiency measures.

¹⁰ This total includes four projects completed through the AMH pilot.

LIST OF APPENDICES

The following are presented in the Direct Installation Program – Appendices.

SBES

Appendix I: On-Site Visit Sampling Methodology and Protocol

Appendix II: Calculation Example

Appendix III: Effective Useful Life

Appendix IV: Algorithm for Participant Spillover Calculation

Appendix V: 2018 Recommendations



ECONOLER



DIRECT INSTALLATION PROGRAM

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Appendix Report

March 15, 2019



ECONOLER



TABLE OF CONTENTS

APPENDIX I ON-SITE VISIT SAMPLING METHODOLOGY AND PROTOCOL	1
APPENDIX II CALCULATION EXAMPLE	16
APPENDIX III EFFECTIVE USEFUL LIFE	20
APPENDIX IV ALGORITHM FOR PARTICIPANT SPILLOVER CALCULATION	27
APPENDIX V 2018 RECOMMENDATIONS	28

Appendix I

ON-SITE VISIT SAMPLING METHODOLOGY AND PROTOCOL

Sampling Methodology for Participant Visits

In 2018, a total of 50 on-site visits were conducted to verify the performance of the measures installed as part of SBES.

The sampling plan was developed using the tracking sheet received in October 2018, which included all the projects completed between January 1 and September 28, 2018. The tracking sheet contained a total of 330 projects and 272 unique participants. Of the total 330 projects, 18 followed the audit path, and the remaining 312 projects followed the do-it-yourself (DIY) path; 10 site visits were allocated to audit path projects, and 40 to DIY projects.

The sample for the DIY path was generated using a stratified sampling method based on the projects' total tracked savings. This enabled the selection of a range of projects (smaller as well as larger ones) while ensuring that a significant proportion of the reported savings were covered by the evaluation. Sampling was based on the size and not the measure category, because like in previous years, lighting represented the overwhelming majority of the total measures. Table 1 below shows the different strata within which projects were randomly selected to constitute the sample.

Table 1: Total Number of Projects and Strata Used for DIY On-site Visit Sampling¹

DIY Path			
Stratum	Maximum Savings (kWh/year)	Number of Projects per Stratum	Sample Size
1	9,000	120	8
2	15,000	88	8
3	30,000	49	8
4	57,000	36	8
5	135,000	19	8
Total		312	40

For the Audit path, a total of 18 projects had been completed at the time of sampling. The Evaluator selected the 10 visits randomly.

¹ As of October 2017.

On-site Visit Protocol for Participant Visits

The SBES protocol was developed based on the Business Energy Rebates (BER) Mail-in protocol, the installed measures are very similar, with the exception of building envelope insulation upgrades. The protocol contains fields for entering measure-specific data based on the parameters required for the savings calculations. The Excel-based format included one tab for each measure category, and each tab contains columns for entering all the required information. A summary of each measure category's collection information is listed below.

In 2018, new questions were added to the data-collection form to gather information about the level of knowledge and interest among the participants regarding measures other than lighting.

On-site Visit Data-collection Form

1. General Information

Site Visit Date:			
Project ID#:			
Rate Code:			
Company Name:			
Contact Name:			
Address/City:			
Telephone:			
Type of facility:	Retail: ☐	Manufacturing/ Industrial: ☐	Grocery/ Supermarket: ☐
	College/ University: ☐	Multi-Unit Res.: ☐	Other (Specify): ☐
Name of Contact Met with:			
Operation during Peak Period?	Yes ☐	No ☐	
If "yes", determine % Load Operational During Peak Period:			
Project type:	Early Replacement: ☐	End of Useful Life: ☐	New/No Replacement : ☐
State hours equipment operates b/w 5-7 pm in Dec/Jan/Feb			
If yes to previous, % load that is operational			

2. Building Heating/Cooling System Description *(used when applicable)*

Heating Systems: *Please fill the table below for each heating system at the site.*

	Heating System #1	Heating System #2
Heat Source		
% of Heat		
Type of System		

Cooling Systems: *Please fill the table below for each cooling system at the site.*

	Cooling System #1	Cooling System #2
% of Cooling		
Type of System		

Notes:

3. Facility Operation Hours and Lighting Usage

Facility Occupancy Schedule: *Please fill the table below for each different occupancy schedule.*

Business Hours (Mon-Fri)	Business Hours (Weekend)	Staff Early Open	Staff Early Close	Cleaning Hours per Week	Days/Year with No Occupancy	Working Days (365 days)	Annual HOU	Notes

Daily Lighting Operation Schedule: *(used when applicable)*

Weekday - Hours/Day with Regular Schedule	Weekend - Hours/Day with Regular Schedule	Hours/Day with Holiday Schedule	Hours/Day with no Occupancy	Notes

Notes:

4. Interest in Future Upgrades

How did you first hear about the Small Business Energy Solutions (SBES) offering?	☐ Contractor Specify type of contractor:
	☐ Contact with an ENS representative such as a Business Development Manager
	☐ Advertisements
	☐ Trade group Which one:
	☐ Other Please specify:
Do you have specific contractors you use for replacing/maintaining /purchasing equipment?	☐ No
	☐ Yes (please select any that apply from the list below)
What types of equipment, if any, would you be most interested in upgrading or adding to your site in the next year or two? Select all that apply, up to five.	☐ Lighting ☐ HVAC ☐ Plumbing ☐ Engineer ☐ Architect
	☐ HVAC ☐ Lighting ☐ Water heating ☐ Kitchen equipment ☐ Compressed air ☐ Variable frequency drives ☐ Pumping ☐ Refrigeration equipment ☐ Agriculture technology ☐ Pool equipment ☐ Laundry equipment ☐ Data center ☐ Solar ☐ Other (specify):
Why are you interested in upgrading or adding to this item?	
If you were to upgrade or replace this item, how would you proceed?	☐ Contractor ☐ Internal staff ☐ ENS ☐ Other (specify):
Would you need to seek approval from other decision makers, such as the building owner or the organization's financial officer?	☐ No ☐ Yes If Yes, please specify:
Other than financial incentives, what additional information, support, or assistance could ENS provide to help the project move forward?	
Additional notes	

5. Measure Information

Lighting: Collect the information in the table below if lighting measures were installed. Econoler will then compare the information collected with the information in the tracking sheet.

Location:	Tracking Sheet:
	Validated Onsite:
Is there heating/cooling installed in this location?	☐ Heating
	☐ Cooling
The percentage of lighting that remains on when the facility is closed:	
Quantity of burnt out lamps:	
If burnt out, how long has it been burnt out and will it be replaced?	
Are lights used seasonally?	
If lamps are missing, explain why?	
Are lamps installed inside or outside?	
Are lamps on occupancy sensors?	
Explain if quantity found on-site differs from the tracking sheet quantity:	
<i>Use the table below to record the information on the baseline and new lighting measures installed on site. For each type of equipment, indicate the quantity and wattage.</i>	

New equipment installed						
Type	Quantity		Wattage		HOU	Notes:
	Tracking Sheet	On-Site validation	Tracking Sheet	On-Site validation		

Baseline equipment						
Type	Quantity		Wattage		HOU	Additional Info
	Tracking Sheet	On-Site validation	Tracking Sheet	On-Site validation		

The additional information captured in the Notes sections of the Protocol varies with the specific categories, but may include any of the following:

- › The number of lamps per fixture and the length of lamps for linear measures.
- › If existing strips were T12 HO, indicate the length.
- › Do dimmable measures replace non-dimmable?

Motors & VSDs

Collect the information in the table below if motor and/or VSDs measures were installed. Econoler will then compare the information collected with the information in the tracking sheet.

Motors and Drives:		
Motors		
Total number of motors installed:		

	In the Tracking Sheet	Validated On-Site
Location:		
Motor Type:		
Motor Size [hp]:		
National Electrical Manufacturers Association (NEMA) Nominal Efficiency (nameplate):		
Load Factor:		
Approx. product run time [hr/week]:		
Do the new motors operate at least 2,000 hours a year?		
Are the new motors listed in the CEE Premium Efficiency Motors List ² ?		
Are the motors controlled by a VSD? Specify RPM:		
Specify the type of application:		
Total number of VSDs installed:		

² Web Site : www.cee1.org/resrc/news_items/CEEMotorsList.php3

	VSD 1	VSD 2
Validate that the new VSDs do not replace old VSDs?		
Validate that the new VSDs are operational?		
If not, why and since when?		
Was the VSD commissioned? (Y/N):		
What is VSD using as feedback mechanism? (VSD either modulates speed through a range or at fixed setpoints):		
Specify the hp of the motor controlled by the VSDs:		
Specify the type of equipment controlled: (<i>Supply fan, return fan, exhaust fan, chilled water pump, boiler feed water, or other (Specify)</i>):		
Hours of use (<i>Indicate the corresponding schedule number</i>):		
Specify Manufacturer and Model Number of VSD:		

Heating, Ventilation and Air Conditioning (HVAC):

Total number of AC & Air-Source Heat Pumps (Split & Unitary) installed:

Total number of Ground & Water Source Heat Pumps installed:

Are there any other heating and cooling systems than the ones being replaced/installed? (note % of heating/cooling being provided)

	Existing HVAC 1	Existing HVAC 2	Existing HVAC 3	New HVAC 1	New HVAC 2	New HVAC 3
AC & Air-Source Heat Pumps						
Location on site:						
Manufacturer:						
Model number:						
Number of units						
Space heating source (electricity, fuel, etc.):						
HSPF V						
Seasonal Energy Efficiency Ratio (SEER):						
Energy Efficiency Ratio (EER):						
Nominal kBtu/h per unit:						
Hours of use (Indicate the corresponding schedule number):						
Heating set point and setback (if any) temperature [°C] :						
Cooling set point and setback (if any) temperature [°C] :						
Validate if the HVAC systems are properly installed and still operational:						
If no, why, and since when?						
Is unit > 65kBtu/h? (Y/N):						
Ground & Water Source Heat Pumps						
Manufacturer:						
Model number:						
Number of units:						
Original heat source (Electricity or other (specify)):						
Specify if open or closed loop:						
Specify if water-to-air, water-to-water, or air-to-water:						
Energy Efficiency Ratio (EER):						
Coefficient of Performance (COP):						
Nominal capacity [kBtu/h]:						
Hours of use for equipment (Indicate the corresponding schedule number for each section):						
Heating set point and setback (if any) temperature [°C] :						
Cooling set point and setback (if any) temperature [°C] :						
Validate if the HVAC systems are properly installed and still operational:						
If no, why, and since when?						

Water Heating:		
Heat Pump or Switch to Natural Gas		
New HP COP:		
Manufacturer & Model #:		
Is the HWHP used for DHW heating?		
Space Heating Energy Type?		
Hot Water Demand Metric		
Hot Water temp?		
Hours per day operation?		
Is HWHP in conditioned location?		
Does HWHP replace electric DHW heater?		
Is the HWHP operational?		
Kitchen:	<i>Collect the information in the table below if commercial kitchen measures were installed. Use on-site observation and contact declaration. Use additional sheets if required. The information collected will then be compared with the information in the tracking sheet by Econoler. Additionally, record Manufacturer and Model Number, and all Technical Data (Operating Temp, CFM, Size, Control Info)</i>	
Commercial Dish Washers Installed (Low T°)		
Under-counter commercial dish washer		
Quantity Installed:		
Location:		
Manufacturer:		
Model number:		
Is the equipment used for commercial purpose?		
Is the equipment still used?		
If not, why and since when?		
Does it use electricity heated hot water?		
Validate the equipment is ENERGY STAR certified:		
Operation [days/year]:		
Operation [number of racks washed/day]:		
Single-tank door type commercial dish washer		

Quantity Installed:	
Location:	
Manufacturer:	
Model number:	
Is the equipment used for commercial purpose?	
Is the equipment still used?	
If not, why and since when?	
Does it use electricity heated hot water?	
Validate the equipment is ENERGY STAR certified:	
Operation [days/year]:	
Operation [number of racks washed/day]:	
Single/Multi-tank conveyor commercial dishwasher	
Quantity Installed:	
Specify if single or multi-tank:	
Location:	
Manufacturer:	
Model number:	
Is the equipment used for commercial purpose?	
Is the equipment still used?	
If not, why and since when?	
Does it use electricity heated hot water?	
Validate the equipment is ENERGY STAR certified:	
Operation [days/year]:	
Operation [number of racks washed/day]:	
Commercial Dish Washers Installed (High T°)	
Does it use a built-in booster heater?	
If yes, specify booster water heater fuel type:	

Commercial Fryers	
Standard capacity commercial fryer	
Quantity Installed:	
Specify if electric or gas?	
Does it replace an electric fryer?	
Is it a new installation?	
Is the equipment still used?	
If not, why and since when?	
Validate the equipment is ENERGY STAR certified:	
Operation [days/year]:	
Operation [hours/day]:	

Commercial Refrigeration	
Interior Volume (ft ³)	
Specify if solid door or glass door:	
Manufacturer:	
Model number:	
Is it a standalone unit?	
Does it replace an existing solid door refrigerator?	
Does it replace an existing glass door refrigerator?	
Is the equipment still used?	
If not, why and since when?	
Validate the equipment is ENERGY STAR certified:	

Commercial Freezers	
Interior Volume (ft ³)	
Specify if solid door or glass door:	
Manufacturer:	
Model number:	
Is it a standalone unit?	
Does it replace an existing solid door freezer?	
Does it replace an existing glass door freezer?	
Is the equipment still used?	
If not, why and since when?	
Validate the equipment is ENERGY STAR certified:	

Commercial Ice Makers	
Ice making head	
Quantity Installed:	
Manufacturer:	
Model number:	
Harvest [lbs/day]:	
Is the equipment still used?	
If not, why and since when?	
Does it replace non- ENERGY STAR icemaker?	
Validate the equipment is ENERGY STAR certified:	
Remote condensing unit	
Quantity Installed:	
Manufacturer:	
Model number:	
Harvest [lbs/day]:	
Is the equipment still used?	
If not, why and since when?	
Does it replace non- ENERGY STAR ice maker?	
Validate the equipment is ENERGY STAR certified:	

Commercial Ice Makers	
Self-contained	
Quantity Installed:	
Manufacturer:	
Model number:	
Harvest [lbs/day]:	
Is the equipment still used?	
If not, why and since when?	
Does it replace non- ENERGY STAR ice maker?	
Validate the equipment is ENERGY STAR certified:	

Commercial Convection Ovens	
Standard convection commercial oven	
Quantity Installed:	
Specify if electric or gas:	
Specify if full size or half size:	
Oven efficiency:	
Idle [kW]:	
Pre-heat[kW]:	
Is the equipment still used?	
If not, why and since when?	
Does it replace an electric convection oven?	
Is it a new installation?	
Validate the equipment is ENERGY STAR certified:	

Commercial Kitchen Ventilation Hoods	
VSD for kitchen exhaust fans	
Quantity Installed:	
Size of the fan controlled by the VSD [hp]:	
Is the equipment still used?	
If not, why and since when?	
Is the equipment controlled by T° and optical sensors located in exhaust hood?	
Operation [hours/year]:	
Laundry:	<i>Collect the information in the table below if commercial laundry measures were installed. Use on-site observation and contact declaration. Use additional sheets if required. The information collected will then be compared with the information in the tracking sheet by Econoler. Additionally, record Manufacturer and Model Number, and all Technical Data (Operating Temp, CFM, Size, Control Info)</i>
Water heating source:	

Commercial Washing Machines Installed	
ENERGY STAR certified commercial washing machine	
Quantity Installed:	
Manufacturer:	
Model number:	
Size [cubic feet]:	
Is the equipment used for commercial purpose?	
Is the equipment still used?	
If not, why and since when?	
Validate the equipment is ENERGY STAR certified:	
Operation [cycles/week]:	

Commercial Washing Machines Installed	
CEE Tier 2 commercial washing machine	
Quantity Installed:	
Manufacturer:	
Model number:	
Size [cubic feet]:	
Is the equipment used for commercial purpose?	
Is the equipment still used?	
If not, why and since when?	
Validate the equipment is CEE Tier 2 listed:	
Operation [cycles/week]:	
CEE Tier 3 commercial washing machine	
Quantity Installed:	
Manufacturer:	
Model number:	
Size [cubic feet]:	
Is the equipment used for commercial purpose?	
Is the equipment still used?	
If not, why and since when?	
Validate the equipment is CEE Tier 3 listed:	
Operation [cycles/week]:	

Appendix II

CALCULATION EXAMPLE

This appendix presents a sample calculation to demonstrate the process of revising energy and peak demand savings. The HVAC measure category was the second largest savings category in terms of savings and these measures required making frequent adjustments. Therefore, a sampled measure from this category has been chosen to show the calculation details for the following:

- › Algorithms for calculating energy and peak demand savings;
- › Comparison of the calculation of the tracked energy and peak demand savings and the calculation of the revised energy and peak demand savings; and
- › Algorithm for establishing the adjustment ratio.

Energy and Peak Demand Savings Algorithms

The following algorithms include the parameters required to determine the annual energy savings and the annual peak demand savings associated with an air source heat pump greater than 65,000 kBtu/hr.

$$\text{Energy Savings} \left[\frac{\text{kWh}}{\text{yr}} \right] = \left[HC \times \left(\frac{1}{HEF_{base}} - \frac{1}{HEF_{ee}} \right) \times FLH_h + CC \times \left(\frac{1}{CEF_{base}} \times AC - \frac{1}{CEF_{ee}} \right) \times FLH_c \right] \times QTY$$

$$\text{Peak Demand Savings} \left[\frac{\text{kW}}{\text{yr}} \right] = HC_{min} \times \left[1 - \frac{1}{HEF_{ee_{min}}} \right] \times QTY$$

Where:

- › HC : the heat pump's rated heating capacity (kBtu/hr) at 0°C for air-source heat pumps.
- › HC_{min} : the heat pump's rated heating capacity (kBtu/hr) at -15°C for air-source heat pumps.
- › CC : the heat pump's rated cooling capacity (kBtu/hr).
- › CEF : the cooling efficiency factor (Btu/Wh) of the equipment.
- › HEF : the heating efficiency factor (Btu/Wh) at 0°C for air-source heat pumps.
- › $HEF_{ee_{min}}$: the heating efficiency factor (Btu/Wh) at -15°C for air-source heat pumps.
- › FLH_h : the full load heating hours per year.
- › FLH_c : the full load cooling hours per year.
- › QTY : the quantity of heat pumps installed.
- › AC : Air-conditioning in baseline = 1; no air-conditioning in baseline = 0.

Tracked Savings Calculation

The parameters for the savings calculation were obtained from the SBES participant application and factors determined from the BER CIRx Screening Tool lookup tables for the measure. Table 2 below shows the values used for the specific case of a 10-ton rooftop heat pump.

Table 2: An Example of the Tracked Variables Calculation

Measure – 10-ton Rooftop Heat Pump		
Parameter	Value	Source
Heating Capacity	82.5	Tracking Sheet
Low Temp Heating Capacity	59	Tracking Sheet
Cooling Capacity	114	Tracking Sheet
Heating Efficiency Factor, base case	3.412	Tracking Sheet
Heating Efficiency Factor, efficient case	9.6	Tracking Sheet
Heating Efficiency Factor, efficient case at Low Temp.	2.25	Tracking Sheet
Cooling Efficiency Factor, base case	8.9	Tracking Sheet
Cooling Efficiency Factor, efficient case	11.6	Tracking Sheet
Full Load Heating Hours	1966	Tracking Sheet
Full Load Cooling Hours	257	Tracking Sheet
Quantity	1	Tracking Sheet
Air Conditioning in base case	1	Tracking Sheet
Tracked Savings		
Tracked Energy Savings (kWh)	31,407.543	Tracking Sheet
Tracked Demand Savings (kW)	0.556	Tracking Sheet

It should be noted that although the equation descriptions in the tracking sheet indicate a tracked value of 59 kBTU/hr for HC_{min} , to obtain the tracked demand savings value of 0.556 kW, the HC_{min} variable must be set at 1 kBTU/hr. This seems to indicate that the equation descriptions were not updated after the savings were last modified.

Revised Savings Calculation

The revised savings calculations are based on two adjustments, and, as a result, the energy and demand savings have been impacted.

The first adjustment made was the revision of the base case HVAC systems to those found on site. The tracked variables indicate a baseline of electric resistance heat, and room air-conditioners were assumed as the baseline. The site visit determined this project was replacing an older rooftop heat pump unit that provided heating and cooling. The unit had been removed prior to the visit and performance data for this unit was not available. The Evaluator revised the baseline to the single package baseline in the CIRx tool, which provides a baseline HSPF (measure of heating efficiency factor) for the energy savings calculation. However, the CIRx tool does not establish a baseline Coefficient of Performance value at -15°C; in the absence of a reliable assumption, the Evaluator estimated that the demand savings were nil. This adjustment affected the energy and demand savings.

The second adjustment made was the revision of the Cooling Efficiency Factor for the efficient case. The Air Conditioning, Heating, and Refrigeration Institute (AHRI) rated integrated energy efficiency ratio (IEER) for this heat pump model is 13.5; however, a value of 11.6 was applied in the tracked calculations. The Evaluator cannot determine the cause of this discrepancy because there is insufficient project documentation to determine the process followed to arrive at this value. This adjustment had an impact on the revised energy savings.

The variables used in the calculation for the revised savings and the final results are summarized in Table 3 below.

Table 3: An Example of the Revised Variables Calculation

Measure – 10-ton Rooftop Heat Pump		
Parameter	Value	Source
Heating Capacity	82.5	AHRI Ratings
Low Temp Heating Capacity	0	Manual override for DS
Cooling Capacity	114	AHRI Ratings
Heating Efficiency Factor, base case	7.7	CIRx Tool Baseline for Single Package <5.42 tons
Heating Efficiency Factor, efficient case	9.6	AHRI Ratings
Heating Efficiency Factor, efficient case at Low Temp	2.25	Not needed in DS calculation, so not reviewed
Cooling Efficiency Factor, base case	11.8	CIRx Tool Baseline for Single Package <5.42 tons
Cooling Efficiency Factor, efficient case	13.5	AHRI Ratings
Full Load Heating Hours	1966	CIRx Tool FLH _h for Offices
Full Load Cooling Hours	257	CIRx Tool FLH _c for Offices
Quantity	1	Site Visit Confirmation
Air Conditioning in base case	1	Site Visit Confirmation
Revised Savings		
Revised Energy Savings (kWh)	4,549.817	Revised Calculation
Revised Demand Savings (kW)	0.000	Revised Calculation

Adjustment Ratio Algorithm

The adjustment ratio is determined by comparing the revised savings values with the tracked savings values. Due to the revisions made to this measure, the calculated ratios were 0.145 for energy savings and 0 for peak demand savings.

$$\frac{\text{Revised ES}}{\text{Tracked ES}} = \frac{4,550 \text{ kWh}}{31,408 \text{ kWh}} = 0.145$$

$$\frac{\text{Revised Peak DS}}{\text{Tracked Peak DS}} = \frac{0.000 \text{ kW}}{0.556 \text{ kW}} = 0.000$$

Appendix III

EFFECTIVE USEFUL LIFE

This appendix discusses the revised equivalent effective useful life (EUL) of product types offered in the SBES program component. First, the EUL of lighting products is discussed and then, the EULs of the other types of measures rebated through SBES are discussed.

Lighting Measures

As part of the 2018 evaluation, the Evaluator updated the EUL values of each lighting measure type as it is now one year nearer to the effective date of incoming regulations. The same methodology as that of last year was applied. The Evaluator used the same years as the effective dates of each regulation; the only change made to the calculation is that the first year is now set as 2018 instead of 2017.

As with 2017, the EUL was obtained by dividing the rated lifetime of lamps or fixtures by the annual hours of use (HOU), and then adjusted to account for the increases in baselines throughout the lifetime of the measure to obtain the equivalent EUL. This value corresponds to the number of years by which the first-year savings estimate is multiplied to obtain the lifetime energy savings. A summary of the revised equivalent EUL values by product type is provided in Table 7 at the end of this subsection. The following paragraphs provide details about the methodology for establishing the equivalent EUL values for light-emitting diode (LED) lamps and fixtures.

To calculate effective EUL the Evaluator used the annual HOU values from BER Instant Rebates since no fixed HOU values have been determined for SBES. The estimated rated life values remained the same as those in the 2017 Evaluation Report, where they had been estimated based on the specifications sheets of the most popular products in each measure category. The rated life for outdoor LED fixtures, non-cutoff and semi or non-cutoff wall-mounted area luminaires were modified from last year's evaluation.

The following paragraphs discuss the lamp types for which baseline increases will occur during their EUL, namely general-use and decorative lamps, reflector lamps, non-recessed downlight fixtures and recessed downlight fixtures. These measures are the only ones for which the EUL values had to be recalculated as part of the 2018 Evaluation Report.

General-use and decorative lamps

The methodology used for establishing the equivalent EUL of general-use and decorative lamps is based on the information shown in Table 4 and the equation below. The equivalent EUL calculation is based on 9 W lamps being the most common product purchased for these listed categories in 2017 SBES tracking sheet. The baseline technology is a blend 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 increase in the baseline upon burnout. The Evaluator assumes that these lamps have a remaining lifetime of 1,000 hours, which translates to 0.23 year with an annual HOU of 4,410 hours. However, since SBES targets commercial customers, the Evaluator assumes that some of customers might have incandescent lamps stocked, and therefore the duration of this baseline was increased to a full year. Based on the LED A-type lamp rated life of 25,000 hours, the EUL of this product is 5.7 years, meaning that the corresponding baseline will not be affected by the change in legislation occurring seven years from now in 2024. Therefore, halogen incandescent lamps are considered to be the baseline technology for the remaining lifetime of LED A-type lamps. With the information shown in Table 4, the following equation sets the equivalent EUL of general-use lamps at 4.7 years.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen Incandescent and Incandescent}} \times 1 \text{ year} + \Delta W_{\text{Halogen Incandescent}} \times 4.7 \text{ years}}{\Delta W_{\text{Halogen Incandescent and Incandescent}}} \\ = 4.7 \text{ years}$$

Table 4: Baseline Evolution during the Effective Useful Life of LED A-type Lamps

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Incandescent and Incandescent Baseline 1 year (2018)		Halogen Incandescent Baseline 4.7 years (2019-2023)	
		Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)
43	9	52	43	43	34

Reflector lamps

LED reflector lamps typically replace halogen lamps. Their average rated life is estimated at 25,000 hours, which translates to an EUL of 5.7 years. The baseline for this lighting product will therefore not increase throughout its EUL, so the equivalent EUL is equal to the EUL of 5.7 years.

Non-recessed downlight fixtures

Because non-recessed LED downlight fixtures replace fixtures using A-type lamps, the methodology for establishing their equivalent EUL is similar to what was described for A-type lamps. Once again, the equivalent EUL calculation is based on an example with 9 W LED lamps and their first baseline increase occurs one year following the anticipated burnout of the incandescent lamps. However, because their rated life of 50,000 hours and corresponding EUL of 11.3 years are longer than that of general use A-type LED lamps, their baseline is affected by the change specified in the regulation effective in 2024. This means that a second baseline increase will occur in 2024 and will persist for the remaining lifetime of the fixture (4.3 years). This new baseline will be a 20 W compact fluorescent lamp (CFL) equivalent lamp. Using the equation and the information shown in Table 5 below, the Evaluator established the equivalent EUL at 6.3 years.

Equivalent EUL

$$= \frac{\Delta W_{\text{Halogen Incandescent and Incandescent}} \times 1 \text{ year} + \Delta W_{\text{Halogen Incandescent}} \times 5 \text{ years} + \Delta W_{\text{CFL}} \times 5.3 \text{ years}}{\Delta W_{\text{Halogen Incandescent and Incandescent}}}$$

$$= 6.3 \text{ years}$$

Table 5: Baseline Evolution during the Effective Useful Life of LED A-type Lamps for Downlight Fixtures

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Incandescent and Incandescent Baseline 1 year (2018)		Halogen Incandescent Baseline 5 years (2019-2023)		CFL Equivalent Baseline American Legislation ³ 5.3 years (2024-2029)	
		Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)
43	9	52	43	43	34	20	11

Recessed downlight fixtures

LED recessed downlight fixtures typically replace fixtures housing reflector lamps, for which the baseline technology is halogen lamps. The EUL of LED recessed downlight fixtures has been established at 11.3 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. As previously mentioned, Canadian regulations are expected to change in 2024, which will increase the baseline to an equivalent CFL. Therefore, after the 43 W halogen lamp is considered as the baseline technology for seven years, 20 W CFL equivalent lamps will become the baseline for the remaining lifetime of LED recessed downlight fixtures (5.3 years). These assumptions have enabled the Evaluator to establish an equivalent EUL at 7.4 years. The details are shown in Table 6.

$$\text{Equivalent EUL} = \frac{\Delta W_{\text{Halogen}} \times 6 \text{ years} + \Delta W_{\text{CFL}} \times 5.3 \text{ years}}{\Delta W_{\text{Halogen}}} = 7.4 \text{ years}$$

Table 6: Baseline Evolution during the Effective Useful Life of LED Reflector Lamps in Downlight Fixtures

Typical Replaced Lamp (W)	Typical Efficient Lamp (W)	Halogen Baseline 6 years (2018-2023)		CFL Equivalent Baseline American Legislation ⁴ 5.3 years (2024-2029)	
		Baseline (W)	Displaced Wattage (W)	Baseline (W)	Displaced Wattage (W)
43	12	43	31	20	8

³ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

⁴ As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

Other lighting products

For products other than general-service lamps, there is no indication that the regulations will significantly change over the lifetime of these products. Furthermore, in the case of linear ambient luminaires, linear replacement lamps and metal halide lamps, the typical baseline products are already more efficient than required by the current regulation, which further suggests that a change in regulations would not affect the baseline efficiency in the near future. The revised EUL values of other lighting measures, including occupancy sensors, have been established based on the 2017 demand-side management (DSM) Evaluation Report.

A summary of the EUL and equivalent EUL of all lighting measure types offered in SBES is provided in Table 7.

**Table 7: Tracked and Revised Equivalent Effective Useful Life Values
by Lighting Measure Type**

Lighting Measure Type	List Category	Tracked Equivalent EUL (years)	Rated Life (hours)	Annual HOU (hours)	Revised EUL (years)	Revised Equivalent EUL (years)
Linear LED Fixtures	1 x 4 Luminaires	11.3	50,000	4,410	11.3	11.3
	2 x 2 Luminaires & Retrofit Kits					
	2 x 4 Luminaires & Retrofit Kits					
	Linear Ambient & Low Bay Luminaires					
	High-bay Luminaires	22.7	100,000	4,410	22.7	22.7
	Troffers	11.3	90,000	4,410	20.4	20.4
Linear LED Lamps	4-foot Replacement Lamps	11.3	50,000	4,410	11.3	11.3
	2-foot Replacement Lamps					
	U-bend					
General-use and Decorative LED Lamps	LED Decorative (chandelier)	4.7	25,000	4,410	5.7	4.7
	LED Omnidirectional (A-lamp and globe)					
	Four Pin-base Replacement Lamps for CFLs	13.6	50,000	4,410	11.3	11.3
Reflector LED Lamps	Small LED Reflector Lamps - PAR, MR, MRX 16	5.7	25,000	4,410	5.7	5.7
	Small LED Reflector Lamps - PAR, R 20					
	Large LED Reflector Lamps - PAR, BR, R 30/30L					
	Large LED Reflector Lamps - PAR, BR, R 38/40					

Lighting Measure Type	List Category	Tracked Equivalent EUL (years)	Rated Life (hours)	Annual HOU (hours)	Revised EUL (years)	Revised Equivalent EUL (years)
LED Downlight Fixtures	LED Recessed	8.8	50,000	4,410	11.3	7.4
	LED Ceiling Mount, LED Surface Mount, LED Solid State Retrofit, LED Inseparable Solid State Luminaire, LED Wall Sconces, LED Wall Sconce Retrofits	6.8	50,000	4,410	11.3	6.3
Outdoor LED Fixtures	Outdoor Full-cutoff Wall-mounted Area Luminaires	11.4	75,000	4,380	17.1	17.1
	Flood and Spot Luminaires	17.1	75,000	4,380	17.1	17.1
	Fuel Pump Canopy Luminaires	11.4	50,000	4,380	11.4	11.4
	Non-cutoff and Semi-cutoff Wall-mounted Area Luminaires	11.4	80,000	4,380	18.3	18.3
	Pole/Arm-mounted Area Luminaires	13.7	60,000	4,380	13.7	13.7
	Pole/Arm-mounted Decorative Luminaires	13.7	100,000	4,380	22.8	22.8
	Parking Garage Luminaires	22.8	100 000	4,380	22.8	22.8
	Case Lighting for Sign Retrofit Applications	11.3	50,000	4,410	11.3	11.3
Directional and Architectural LED Fixtures	Track or Mono-point Directional Luminaires, LED Wall Wash Luminaires	11.3	50,000	4,410	11.3	11.3
Occupancy Sensors	Ceiling Remote-mounted	10.0	-	-	10.0	10.0
	Wall Remote-mounted					
	Fixture Mounted					
	Wall Switch					
	Exterior					
Other	Refrigerated Case Luminaires	15.9	70,000	4,410	15.9	15.9

Other Products

The EULs established by the Evaluator for those product types other than lighting are shown in Table 8 below. The EUL values of all the measures eligible for the program component have been established based on the 2017 DSM Evaluation Report, except for efficient pool pumps, a product not included in the 2017 Report. For efficient pool pumps, the Evaluator maintained the value of 10 years used by Efficiency Nova Scotia (ENS) since it is the most commonly used value by other jurisdictions and is also found in the Database of Energy Efficient Resources.⁵

⁵ Database for Energy Efficiency Resources (DEER), *DEER 2014 EUL Table*, 2014.

Table 8: Revised Equivalent Effective Useful Life Values by Measure Category

Measure Category	Measure	Tracked Equivalent EUL	Revised Equivalent EUL
Agriculture	Agriculture Heat Pads	N/A	10
	Dairy Scroll Compressors	15	15
	Energy Efficient Ventilation and Circulation Fans	15	15
	Heat Reclaimer Units	15	15
	High-volume Low-speed Fans	15	15
	Low Energy and Zero Energy Livestock Waterers	N/A	10
	Milk Pre-coolers	10	15
	Natural and Dual Ventilation	15	15
	Tractor Engine-block Heater Timers	N/A	5
	VFD for Milk Vacuum Pumps	10	15
Compressed Air	Air Entraining Air Nozzles	15	15
	Air Receivers for Load/No Load Screw Compressors	N/A	15
	Cycling Air Dryers	10	10
	No-loss Drains	15	15
	VFD Screw Compressors	15	15
HVAC	Air Source Heat Pumps Greater Than or Equal to 65,000 BTU/hr	15	18
	Air Source Heat Pumps Less Than 65,000 Btu/hr (excluding air-to-water)	15	18
	Air-to-water Heat Pumps	N/A	18
	Dual-enthalpy Economizer Controls	10	10
	Ground Source Heat Pumps	N/A	25
	HVAC Hotel Occupancy Sensors	8	8
	Packaged Terminal Heat Pumps (PTHPs)	15	15
	Water Source Heat Pumps;	15	15
Kitchen	Demand Controlled Kitchen Exhausts	15	15
	Dishwashers	10, 15 or 20	10, 15 or 20
	Freezers/Refrigerators	12	12
	Fryers	12	12
	Griddles	N/A	12
	Hot Food Holding Cabinets	N/A	12
	Ice Machines	10	10
	Ovens	12	12
	Steam Cookers	12	12

Measure Category	Measure	Tracked Equivalent EUL	Revised Equivalent EUL
Laundry	Commercial Clothes Dryers (NG Conversion)	N/A	14
	Commercial Washing Machines	11.3	11
Motors and VFDs	Energy Efficient Motors	N/A	15
	Variable Frequency Drives	13	15
Pumping	High Efficiency Circulator Pumps	15	15
Refrigeration	Brushless DC Motors	15	15
	Cooler Night Covers/Display Case Strip Curtains	N/A	4
	Door Heater Controls	12	12
	Efficient Refrigeration Compressors	10	15
	Evaporator Fan Motor Controls	10	10
	Intelligent Freezer Defrost Controls	N/A	10
	Refrigerated Vending Machine Controllers	N/A	5
	Refrigeration Economizers	15	15
	Vertical Refrigeration Open to Closed Cooler Conversion	N/A	12
	Zero Energy Doors	12	12
Water Heating	Electrical to Natural Gas Water Heating	14	15
	Heat Pump Water Heaters	10	10
Solar	Solar Water Heaters	N/A	20
Pool	Efficient Pool Pumps	10	10

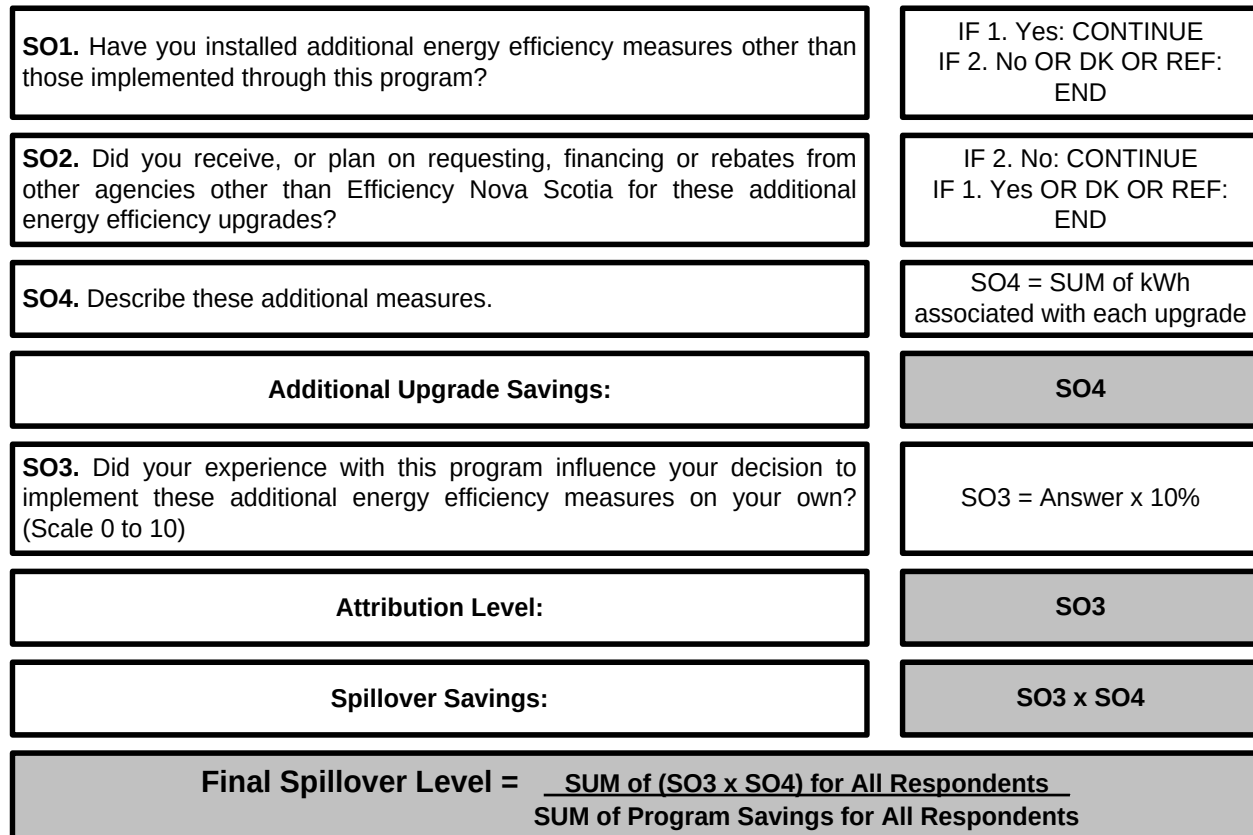
Appendix IV

ALGORITHM FOR PARTICIPANT SPILLOVER CALCULATION

Participant spillover of SBES was measured using a participant survey conducted during the on-site visits. Participants were asked whether following their participation in SBES, they implemented any additional energy efficiency measures, without benefitting from any rebates or financing offered by ENS programs. If a participant indicated that they had implemented additional measures, they were asked a set of questions designed to identify the additional energy efficiency measures implemented, and to quantify their associated savings (type of measure, quantity, efficiency level, etc.). Where participant declarations were not sufficient to quantify savings, values from leading jurisdictions' technical reference manuals were used. A further question was asked to quantify the program component influence on the participant's decision to implement additional measures. The influence value was used to determine the portion of savings attributable to the program component.

Participant spillover was calculated by dividing the total savings from non-incentivized measures attributable to the program component by the total quantity of savings achieved by incentivized measures, for all survey respondents.

The figure below illustrates the methodology used to calculate the participant spillover level.



Appendix V

2018 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2018 evaluation of the Small Business Energy Solutions (SBES) program component, as well as all 2017 evaluation recommendations that were not fully implemented.

Sections	Recommendations
Market Evaluation	1. Continue outreach to HVAC contractors as a means to build awareness of non-lighting energy savings opportunities and SBES participation. Many participants rely on regular lighting and HVAC contractors for their equipment purchase and installation needs, and they turn to these contractors when considering equipment upgrades. Continued engagement with these contractors offers an opportunity for ENS to influence the market toward greater overall SBES participation, and broaden recognition of energy efficiency opportunities in HVAC and other non-lighting systems.
2017 Recommendations (Not fully implemented at the time of evaluation)	2. Investigate new ways to encourage the implementation of non-lighting measures to increase their share of savings and ultimately increase SBES's total savings. Although SBES offers a wide variety of measures, lighting retrofits accounted for 82 percent of SBES's total gross savings in 2017. This predominance is not surprising among DIY participants, because lighting upgrades are energy-saving opportunities which are easy to identify. Surveyed participants mentioned that a lack of knowledge about equipment is one main barrier to installing energy-efficiency upgrades; so this is consistent with the small number of projects that include technologies that are more complex than lighting. With SBES gaining in maturity and as the market for energy efficient lighting becomes saturated, the Evaluator believes that ENS would benefit from exploring various options to favor a wider variety of measures among the DIY participants to ensure SBES's continued strong performance. Such options could include the development of new marketing and educational materials to better promote non-lighting measures and educate DIY participants with respect to dormant energy-saving opportunities, other than lighting, in their facilities. Project analyses under in the audit path can be used to identify sector-specific opportunities and provide content for the development of success stories on non-lighting measures. Another option would be to provide additional support to participants who do not complete the audit path, for instance by having an ENS staff member follow up to help them consider non-lighting measures if the facility includes other large energy-consuming equipment.



ECONOLER



INTRODUCTION OF NEW CODES AND STANDARDS IN NOVA SCOTIA

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Final Report

March 15, 2019



ECONOLER

ABBREVIATIONS

AHAM	Association of Home Appliance Manufacturers
BER	Business Energy Rebates
C&S	Codes & Standards
CFL	Compact fluorescent lamp
CMHC	Canada Mortgage and Housing Corporation
DSM	Demand-side management
EFC	Electro-Federation Canada
ENS	Efficiency Nova Scotia
EPI	Efficient Product Installation
GHG	Greenhouse gas
GSFL	General-service fluorescent lamps
HEA	Home Energy Assessment
HRM	Halifax Regional Municipality
LED	Light-emitting diode
MEPS	Minimum energy performance standards
NBC	National Building Code
NECB	National Energy Code for Buildings
NERHOU	Northeast Residential Lighting Hours-of-Use Study
NHC	New Home Construction
NRCan	Natural Resources Canada
NSP	Nova Scotia Power

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

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

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

TABLE OF CONTENTS

EXECUTIVE SUMMARY	X
1 CONTEXT AND BACKGROUND	1
2 METHODOLOGY	3
3 IMPACT EVALUATION.....	6
3.1 Incandescent Lamps.....	6
3.1.1 Product Description	6
3.1.2 Regulation Description.....	6
3.1.3 Market Size Estimate.....	7
3.1.4 Portion of the Market Impacted by the Regulation.....	8
3.1.5 Unitary Savings Values.....	8
3.1.6 Interactive Effects	9
3.1.7 Energy Savings - at the Meter	10
3.1.8 Peak Demand Savings - at the Meter.....	10
3.2 LED Street Lights.....	11
3.2.1 Product Description	11
3.2.2 Regulation Description.....	12
3.2.3 Market Size Estimate.....	12
3.2.4 Portion of the Market Impacted by the Regulation.....	13
3.2.5 Unitary Savings Values.....	14
3.2.6 Energy Savings – at the Meter	15
3.2.7 Peak Demand Savings – at the Meter	15
3.3 New Building Energy Codes	16
3.3.1 Product Description	16
3.3.2 Regulation Description.....	17
3.3.3 Market Size Estimate.....	17
3.3.4 Unitary Savings Values.....	20
3.3.5 Energy Savings – at the Meter	23
3.3.6 Peak Demand Savings – at the Meter	24
3.4 Clothes Washers.....	25
3.4.1 Product Description	25
3.4.2 Regulation Description.....	25
3.4.3 Market Size Estimate.....	26
3.4.4 Portion of the Market Impacted by the Regulation.....	26
3.4.5 Unitary Savings Values.....	26
3.4.6 Energy Savings - at the Meter	27
3.4.7 Peak Demand Savings - at the Meter.....	27
3.5 General Service Incandescent Reflector Lamps.....	28

3.5.1	Product Description	28
3.5.2	Regulation Description.....	28
3.5.3	Market Size Estimate.....	29
3.5.4	Portion of the Market Impacted by the Regulation.....	30
3.5.5	Unitary Savings Values.....	31
3.5.6	Interactive Effects	31
3.5.7	Energy Savings - at the Meter	32
3.5.8	Peak Demand Savings - at the Meter.....	32
3.6	General Service Fluorescent Lamps	34
3.6.1	Product Description	34
3.6.2	Regulation Description.....	34
3.6.3	Market Size Estimate.....	36
3.6.4	Portion of the Market Impacted by the Regulation.....	37
3.6.5	Unitary Savings Values.....	37
3.6.6	Interactive Effects	38
3.6.7	Energy Savings - at the Meter	40
3.6.8	Peak Demand Savings - at the Meter.....	41
3.7	Fluorescent Lamp Ballasts	43
3.7.1	Product Description	43
3.7.2	Regulation Description.....	44
3.7.3	Market Size Estimate.....	44
3.7.4	Portion of the Market Impacted by the Regulation.....	46
3.7.5	Unitary Savings Values.....	47
3.7.6	Interactive Effects	47
3.7.7	Energy Savings - at the Meter	49
3.7.8	Peak Demand Savings - at the Meter.....	49
3.8	Total Savings at the Generator	50
3.9	Recommendations	53

LIST OF TABLES

Table 1: Product Categories and Codes Impacted by Recent Changes to Energy Efficiency Regulations Enforced in Nova Scotia.....	xi
Table 2: Evaluated Energy and Peak Demand Savings at the Generator for 2018.....	xii
Table 3: Product Categories and Codes Impacted by Recent Changes to Energy Efficiency Regulations Enforced in Nova Scotia.....	2
Table 4: Methodology Used to Estimate Market Sizes	4
Table 5: Schedules for General Service Lamp Compliance with New Standards	7
Table 6: Incandescent Lamp Market Size Estimates for Nova Scotia, 2018	8
Table 7: Estimate of the Portion of the Incandescent Lamp Market Impacted by the Regulation	8
Table 8: Unitary Savings Values for Incandescent Lamps	9
Table 9: Interactive Effects Calculations for Lighting Products.....	9

Table 10: Energy Savings Associated with Phasing Out Incandescent Light Lamps in the Nova Scotia Market	10
Table 11: Adjusted Peak Demand-to-energy Ratios for Lighting Products.....	11
Table 12: Peak Demand Savings Associated with the Introduction of Incandescent Lamp Standards in the Nova Scotia Market	11
Table 13: Existing Lighting Unit Inventory in Nova Scotia, 2009	12
Table 14: Literature Review of LED Street Lighting Case Studies	15
Table 15: Energy Savings Associated with the Introduction of LED Street Lighting in the Nova Scotia Market	15
Table 16: Peak Demand Savings Associated with the Introduction of the LED Street Lighting in the Nova Scotia Market.....	16
Table 17: Key Figures on Nova Scotia Building Permits for January Through November 2018.....	18
Table 18: Number of Dwelling Units – Data on Nova Scotia Residential Building Permits for January Through November 2018	18
Table 19: Estimated Floor Areas in the Commercial and Industrial Sectors.....	20
Table 20: Building Archetypes Used in the Simulation Studies	22
Table 21: Electrical Energy Savings by Building Type.....	23
Table 22: Energy Savings Associated with the Introduction of the Building Code Regulation in the Houses and Small Buildings Sectors in the Nova Scotia Market	23
Table 23: Energy Savings Associated with the Introduction of the Building Code Regulation for Large Buildings, Apartments and Condominiums.....	24
Table 24: Total Peak Demand Savings Associated with the Introduction of the Building Code Regulation for the Houses and Small Buildings Sectors in the Nova Scotia Market.....	24
Table 25: Total Peak Demand Savings Associated with the Introduction of the Building Code Regulation for Large Buildings, Condos and Apartments	25
Table 26: Clothes Washer Market Size Estimates for Nova Scotia, 2018	26
Table 27: Estimate of the Portion of Clothes Washers Market Impacted by the Regulation	26
Table 28: Unitary Savings Values for Clothes Washers	27
Table 29: Energy Savings Associated with New Clothes Washer MEPS in the Nova Scotia Market...	27
Table 30: Peak Demand Savings Associated with the Introduction of Clothes Washer MEPS in the Nova Scotia Market.....	27
Table 31: Amendment 13 Requirements for Incandescent Reflector Lamp Compliance	29
Table 32: Incandescent Reflector Lamp Market Size Estimates for Nova Scotia, 2018.....	30
Table 33: Estimated Portion of the Incandescent Reflector Lamp Market Impacted by the Regulation	30
Table 34: Unitary Savings Values for Incandescent Reflector Lamps	31
Table 35: Interactive Effects for General-service Incandescent Reflector Lamps	32
Table 36: Energy Savings Associated with Phasing Out Incandescent Light Lamps in the Nova Scotia Market	32
Table 37: Peak Demand-to-energy Ratios for Commercial Lamps.....	33
Table 38: Adjusted Peak Demand-to-energy Ratios for Incandescent Reflector Lamps.....	33
Table 39: Peak Demand Savings Associated with the Introduction of Incandescent Reflector Lamp Standards in the Nova Scotia Market.....	33
Table 40: Schedules for Fluorescent Lamp Compliance with New Standards	35
Table 41: Fluorescent Lamp Market Size Estimates for Nova Scotia, 2018	36
Table 42: Estimated Portion of the Fluorescent Lamp Market Impacted by the Regulation	37
Table 43: Unitary Savings Values for Tier II General-service Fluorescent Lamps.....	38
Table 44: Interactive Effects for General-service Fluorescent Lamps	39

Table 45: Energy Savings Associated with Standards for Fluorescent Lamps in the Nova Scotia Market	40
Table 46: Peak Demand-to-energy Ratios for Commercial and Industrial Lamps	41
Table 47: Adjusted Peak Demand-to-energy Ratios for General-service Fluorescent Lamps.....	42
Table 48: Peak Demand Savings Associated with the Introduction of General-service Fluorescent Lamp Standards in the Nova Scotia Market.....	43
Table 49: Fluorescent Lamp Ballast Market Size Estimates for Nova Scotia, 2018	45
Table 50: Estimated Portion of the Fluorescent Lamp Ballast Market Impacted by the Regulation	46
Table 51: Unitary Savings Values for Fluorescent Lamp Ballasts	47
Table 52: Interactive Effects for Fluorescent Lamp Ballasts	48
Table 53: Energy Savings Associated with Phasing Out Fluorescent Lamp Ballasts in the Nova Scotia Market	49
Table 54: Peak Demand Savings Associated with the Introduction of Fluorescent Lamp Standards in the Nova Scotia Market	50
Table 55: Codes and Standards Overall Incremental Annual Energy and Peak Demand Savings, 2018	52

LIST OF FIGURES

Figure 1: Methodological Model	3

EXECUTIVE SUMMARY

This report presents the results of the 2018 demand-side management (DSM) impact evaluation of Codes & Standards (C&S). The 2018 evaluation was based on secondary data research and a number of interviews and exchanges with industry associations, government and municipality representatives, as well as retailers.

Context and Background

To improve the efficiency of energy-consuming products marketed in Canada, Natural Resources Canada (NRCan) has been implementing regulations regarding minimum energy efficiency standards (MEPS) by issuing a series of amendments to the *Energy Efficiency Regulations*. As part of Canada's Clean Air Regulatory Agenda established in 2006,¹ amendments to the *Energy Efficiency Regulations* have been regularly made to generate energy, greenhouse gas (GHG) and air pollutant reductions. The latest modification to the *Energy Efficiency Regulations* was Amendment 13, was published on December 28, 2016² and came into force on June 28, 2017, six months after its publication. The Nova Scotia Government also implemented regulations regarding minimum energy efficiency standards, notably by introducing legislation in 2011 requiring lighting on roads and highways to be replaced by light-emitting diode (LED) lighting and by enforcing the Nova Scotia Building code in 2017.

To evaluate the impact of these regulations, Efficiency Nova Scotia (ENS) hired the Evaluator to assess the annual energy and peak demand savings achieved as a result of the introduction of these regulations into the Nova Scotia market. The regulations evaluated in 2018 included the latest MEPS on general-service incandescent lamps (which came into force on January 1, 2014 for 75 W and 100 W lamps and on December 31, 2014 for 40 W and 60 W lamps),³ street lights⁴, Tier I clothes washers, Tier II clothes washers, incandescent reflector lamps, general-service fluorescent lamps, and fluorescent lamp ballasts, as well as the latest energy code for houses, small buildings, large buildings, condos and apartments.⁵

Table 1 outlines the product categories assessed herein and the related standards referenced by the current *Energy Efficiency Regulations*.

¹ Environment and Climate Change Canada. (2013). *Clean Air Regulatory Agenda: Backgrounder*. Retrieved from <http://www.ec.gc.ca/default.asp?lang=En&n=56D4043B-1&news=295B1964-9737-4F80-B064-B3088D9910BE> (Last accessed February 6, 2019).

² Natural Resources Canada. (2017) *Amendment 13 – December 2016 – Registration and publication of Regulations amending Canada's Energy Efficiency Regulations*. Retrieved from <http://www.nrcan.gc.ca/energy/regulations-codes-standards/18419> (Last accessed February 6, 2019).

³ Natural Resources Canada. (2017). *Amendment 12B – January 2014 – Registration and publication of Regulations amending Canada's Energy Efficiency Regulations*. Retrieved from <http://www.nrcan.gc.ca/energy/regulations-codes-standards/12342> (Last accessed February 6, 2019).

⁴ Nova Scotia. (2012). *New Law Means Road Lighting in Nova Scotia Must Be LED*. Retrieved from <http://novascotia.ca/news/release/?id=20120912004> (Last accessed February 6, 2019).

⁵ Nova Scotia. (2017). *Nova Scotia Buildings Code Regulations*. Retrieved from <https://novascotia.ca/just/regulations/regs/bcregs.htm> (Last accessed February 6, 2019).

**Table 1: Product Categories and Codes Impacted by Recent Changes to
Energy Efficiency Regulations Enforced in Nova Scotia**

Product Category	Existing MEPS Before Initiative	Regulation Source	Reference Standard
Incandescent Lamps (75 W and 100 W)	Yes	Canadian Energy Efficiency Regulations	CAN/CSA C862-09
Incandescent Lamps (40 W and 60 W)	Yes	Canadian Energy Efficiency Regulations	CAN/CSA C862-09
LED Street Lights	No	Nova Scotia Energy-Efficient Appliances Regulations	CAN/CSA C653-13
New Buildings (Houses and Small Buildings)	Yes	Nova Scotia Building Code Regulations	Nova Scotia Building Code Regulations, based on the 2015 National Building Code – Section 9.36
New Buildings (Large Buildings, Condos and Apartments)	Yes	Nova Scotia Building Code Regulations	Based on the 2015 National Energy Code for Buildings
Clothes Washers – Tier I and Tier II	Yes	Canadian Energy Efficiency Regulations	CAN/CSA-C360-13
General-service Incandescent Reflector Lamps	Yes	Canadian Energy Efficiency Regulations	CAN/CSA-C862-12
General-service Fluorescent Lamps	Yes	Canadian Energy Efficiency Regulations	CAN/CSA-C819-11
Fluorescent Lamp Ballasts	Yes	Canadian Energy Efficiency Regulations	CAN/CSA-C654-14

Key Findings

The 2018 evaluation served to estimate the 2018 annual impact on energy and peak demand savings as a result of introducing new regulations into the Nova Scotia market, which govern the products targeted by the federal government's Amendment 13 and the provincial regulations imposing greater stringency and a wider scope on existing MEPS.

The 2018 energy and peak demand savings at the generator for each evaluated product type or building code are summarized in Table 2 below. The overall energy and peak demand savings for C&S were estimated at 23.809 GWh and 4.008 MW at the generator respectively. These savings represent 14,585 tonnes of CO₂ eq in terms of annual avoided GHG emissions.

Table 2: Evaluated Energy and Peak Demand Savings at the Generator for 2018

Product	Energy Savings at the Generator (GWh)	Peak Demand Savings at the Generator (MW)
Incandescent Lamps	9.899	1.178
LED Street Lighting	1.291	0.321
New Buildings (Houses and Small Buildings)	1.524	0.432
New Buildings (Large Buildings, Condos and Apartments)	2.926	0.974
Clothes Washers	1.113	0.154
General-service Incandescent Reflector Lamps	1.441	0.176
General-service Fluorescent Lamps	3.081	0.421
Fluorescent Lamp Ballasts	2.532	0.352
Total	23.809	4.008

The savings attributable to C&S resulted from an increase in the mandatory minimum efficiency levels applicable to the targeted products and building codes in the market. Although similar products and buildings are targeted by ENS programs, it should be noted that their savings are distinct from those generated by C&S. The savings associated with ENS programs are based on increased product efficiency compared to the regulated minimum efficiency standard or the current baseline of a given product category, whereas the savings associated with C&S result from an increase in the minimum efficiency standard. Therefore, each set of savings is specifically attributable to either C&S or ENS programs and do not overlap.

Recommendations

International experience and the Evaluator's own experience suggest that evaluating the energy impact of regulations or policies is usually more difficult than calculating the impacts of DSM programs that have lists of participants and details on specific measures installed. For the C&S evaluation, the main challenge was to establish the size of the market impacted by the new codes and standards. This involves not only establishing the quantity of products sold in a specific market, but also making in-depth characterization of a given market (e.g. quantity by size, type, efficiency level, etc.). Depending on the product, this information can be difficult to obtain or even impossible in some cases. Based on the results of the evaluation activities, the Evaluator makes the following recommendations on how to ensure the success of future C&S impact evaluations. The following recommendations are also outlined in Appendix I of the Codes and Standards Appendix Report.

- CS-R1. Consider removing houses and small buildings from the scope of the 2019 evaluation.** While the adoption of the 2015 National Building Code (NBC) under the Nova Scotia Building Code is recent, the Evaluator found that the impact on energy efficiency is negligible and thus continued to apply the energy savings from the previous code in the 2018 evaluation for houses and small buildings. Considering that ENS has reported on C&S savings based on 2012 revision of the NBC since 2015, the Evaluator suggests removing the NBC 2015 from the scope of the 2019 evaluation. As for large buildings, condos and apartments, the introduction of the 2015 National Energy Code for Buildings (NECB) under the Nova Scotia Building Code has increased the minimum efficiency standards since the previous edition of the code, and thus the Evaluator recommends keeping the NECB 2015 in the 2019 evaluation scope.
- CS-R2. Consider removing incandescent lamps from the scope of the 2019 evaluation.** While incandescent lamps generate the largest share of Codes and Standards savings, ENS has reported on C&S savings for 75 W and 100 W lamps since the 2014 evaluation as well as savings for 40 W and 60 W lamps since the 2015 evaluation. Considering the time elapsed since the introduction of the regulation, the Evaluator recommends removing incandescent lamps from the scope of the 2019 evaluation and continuing to focus on more recent lighting regulations such as those for general service incandescent lamps, general service fluorescent lamps, and fluorescent lamp ballasts.

1 CONTEXT AND BACKGROUND

To improve the efficiency of energy-consuming products marketed in Canada, Natural Resources Canada (NRCan) has been implementing regulations regarding minimum energy efficiency standards (MEPS) by issuing a series of amendments to the *Energy Efficiency Regulations*. As part of Canada's Clean Air Regulatory Agenda established in 2006,⁶ amendments to the *Energy Efficiency Regulations* have been regularly made to generate energy, greenhouse gas (GHG) and air pollutant reductions. The latest modification to the *Energy Efficiency Regulations* was Amendment 13, which requires updating existing energy efficiency standards for 20 product categories to align with requirements in force or soon to come into force in the United States. Amendment 13 was published on December 28, 2016⁷ and came into force on June 28, 2017, six months after its publication.

The Nova Scotia Government has also implemented regulations regarding minimum energy efficiency standards, notably by introducing legislation in 2011 requiring lighting on roads and highways to be replaced by LED lighting and by modifying the regulations associated with the Nova Scotia Building code in 2017.

To evaluate the impact of these regulations, Efficiency Nova Scotia (ENS) hired the Evaluator to assess the annual energy and peak demand savings achieved as a result of the introduction of these regulations into the Nova Scotia market. The Codes and Standards (C&S) evaluation was carried out annually from 2012 to 2018 as part of ENS's annual evaluation.

The 2018 evaluation scope included regulations evaluated in 2017, namely the latest MEPS on general-service incandescent lamps (which came into force on January 1, 2014 for 75 W and 100 W lamps and on December 31, 2014 for 40 W and 60 W lamps),⁸ street lights⁹ and Tier I clothes washers.

In addition to the standards also evaluated in 2017, the 2018 evaluated scope included additional products targeted by Amendment 13, namely Tier II clothes washers, incandescent reflector lamps, general-service fluorescent lamps, and fluorescent lamp ballasts, as well as the latest energy code for houses, small buildings, large buildings, condos and apartments, as summarized in Table 3 below.¹⁰

⁶ Environment and Climate Change Canada. (2013). *Clean Air Regulatory Agenda: Backgrounder*. Retrieved from <http://www.ec.gc.ca/default.asp?lang=En&n=56D4043B-1&news=295B1964-9737-4F80-B064-B3088D9910BE> (Last accessed February 6, 2019).

⁷ Natural Resources Canada. (2017) *Amendment 13 – December 2016 – Registration and publication of Regulations amending Canada's Energy Efficiency Regulations*. Retrieved from <http://www.nrcan.gc.ca/energy/regulations-codes-standards/18419> (Last accessed February 6, 2019).

⁸ Natural Resources Canada. (2017). *Amendment 12B – January 2014 – Registration and publication of Regulations amending Canada's Energy Efficiency Regulations*. Retrieved from <http://www.nrcan.gc.ca/energy/regulations-codes-standards/12342> (Last accessed February 6, 2019).

⁹ Nova Scotia. (2012). *New Law Means Road Lighting in Nova Scotia Must Be LED*. Retrieved from <http://novascotia.ca/news/release/?id=20120912004> (Last accessed February 6, 2019).

¹⁰ Nova Scotia. (2017). *Nova Scotia Buildings Code Regulations*. Retrieved from <https://novascotia.ca/just/regulations/regs/bcregs.htm> (Last accessed February 6, 2019).

Contrary to the 2017 evaluation, the scope in 2018 did not include MEPS for refrigerators since the savings calculated in 2017 for this standard were not significant compared to the other regulations.

Table 3 outlines the product categories assessed herein and the related standards referenced by the current *Energy Efficiency Regulations*.

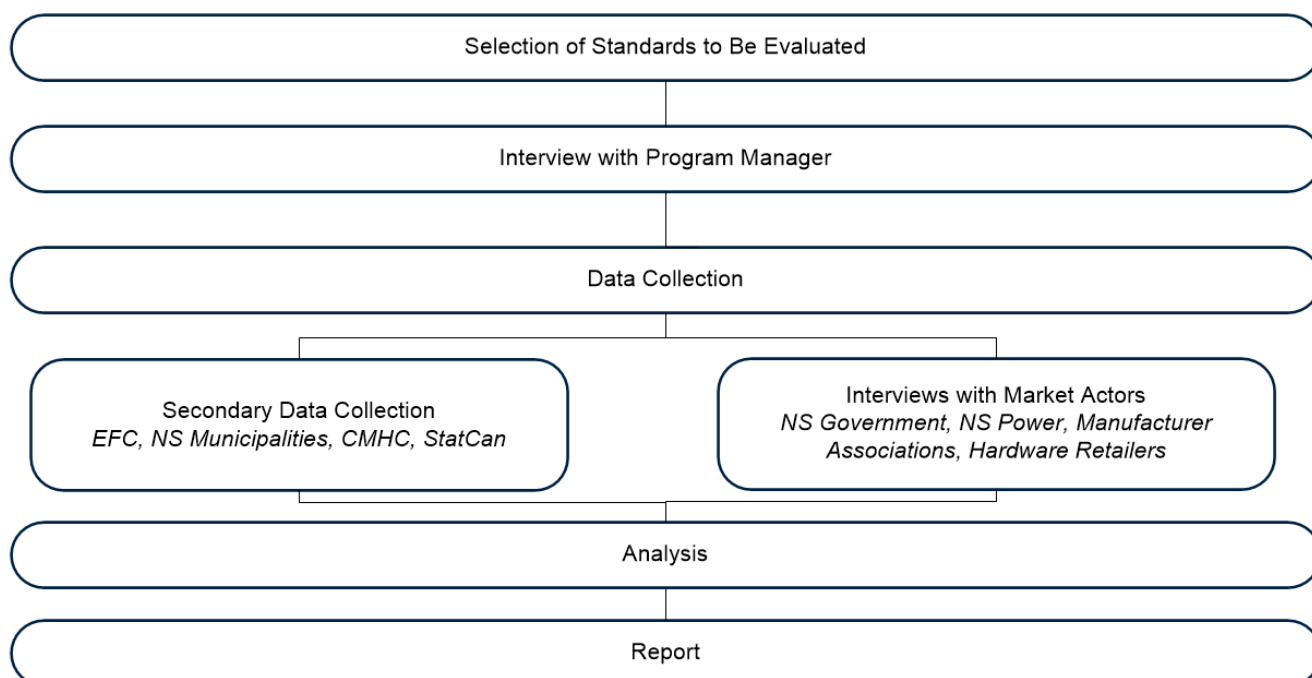
**Table 3: Product Categories and Codes Impacted by Recent Changes to
Energy Efficiency Regulations Enforced in Nova Scotia**

Product Category	Existing MEPS Before Initiative	Regulation Source	Reference Standard
Incandescent Lamps (75 W and 100 W)	Yes	Canadian Energy Efficiency Regulations	CAN/CSA C862-09
Incandescent Lamps (40 W and 60 W)	Yes	Canadian Energy Efficiency Regulations	CAN/CSA C862-09
LED Street Lights	No	Nova Scotia Energy-Efficient Appliances Regulations	CAN/CSA C653-13
New Buildings (Houses and Small Buildings)	Yes	Nova Scotia Building Code Regulations	Nova Scotia Building Code Regulations, based on the 2015 National Building Code – Section 9.36
New Buildings (Large Buildings, Condos and Apartments)	Yes	Nova Scotia Building Code Regulations	Based on the 2015 National Energy Code for Buildings
Clothes Washers – Tier I and Tier II	Yes	Canadian Energy Efficiency Regulations	CAN/CSA-C360-13
General-service Incandescent Reflector Lamps	Yes	Canadian Energy Efficiency Regulations	CAN/CSA-C862-12
General-service Fluorescent Lamps	Yes	Canadian Energy Efficiency Regulations	CAN/CSA-C819-11
Fluorescent Lamp Ballasts	Yes	Canadian Energy Efficiency Regulations	CAN/CSA-C654-14

2 METHODOLOGY

Figure 1 below illustrates the research strategy used and the various activities carried out as part of the 2018 evaluation.

Figure 1: Methodological Model



The Evaluator selected the standards to be evaluated based on the previous evaluation recommendations and held a meeting with ENS in September 2018 to confirm the selections and submit data requests. The purpose of the 2018 evaluation was to quantify the annual impact of seven regulations introduced in the Nova Scotia market. To this end, three major parameters were established:

- › The market size of each product category
- › The portion of the market on which the regulations have had an impact
- › The unitary savings values associated with each regulation, i.e. the difference between the energy consumption of products under the previous MEPS (baseline) and the energy consumption of products that meet the new regulations.

These parameters were assessed based on the information gathered from secondary data research and interviews with market actors and then compiled and analyzed, as described in more detail below.

Secondary Data Collection

This evaluation made extensive use of the market data provided by industry associations, particularly Electro-Federation Canada (EFC, with lamp-related shipment data), the Association of Home Appliance Manufacturers (AHAM Canada), NRCAN, Nova Scotia Municipalities (with street light stock data), the Canada Mortgage and Housing Corporation (CMHC, with building statistics), and Statistics Canada (StatCan, with building permit data and international imports of clothes washers). These sources provided monthly, quarterly or annual data for 2018.

To characterize the incandescent lamp market, the declining shipment trend from 2004 to 2013 (2013 was the last year before the standard for general service lamps was fully implemented) was used to make projections about the 2018 market.

When it was necessary to quantify a product market size for Nova Scotia, the proportion of Atlantic Canada's shipments was estimated based on the provincial population ratios from the latest Statistics Canada data. Consequently, it was estimated that, of all the evaluated product categories, the shipments delivered to Nova Scotia accounted for 39.6 percent of total shipments sent to Atlantic Canada.¹¹

A number of research studies were also consulted and have been listed in footnotes where appropriate.

The methodology used to estimate the market sizes for all product categories is summarized in Table 4 below.

Table 4: Methodology Used to Estimate Market Sizes

Source for Estimating Total Shipments Sent to Canada or the Atlantic Region	Method for Estimating Total Shipments Sent to Canada or the Atlantic Region	Method for Estimating Shipments Sent to Nova Scotia	Product Category
Industry Associations	Database for 2018 shipments in units	Using the population ratio of Nova Scotia (compared with Canada or the Atlantic Region)	› General-service incandescent lamps › General-service reflector lamps › General-service fluorescent lamps › General-service fluorescent lamp ballasts › New buildings
CMHC/StatCan	Building statistics about NS	Already specific to Nova Scotia	› New buildings
Nova Scotia Municipalities and NS Power	Street light inventory	Already specific to Nova Scotia	› LED street lights
Association of Home Appliance Manufacturers/ StatCan	AHAM database for 2017 shipments in units, StatCan trade data to determine year-to-year change in shipments	Using the population ratio of Nova Scotia (compared with Canada or the Atlantic Region)	› Clothes washers

¹¹ Statistics Canada. (2018). *Population and Dwelling Count Highlight Tables, 2016 Census*. Retrieved from <https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/hlt-fst/pd-pl/Table.cfm?Lang=Eng&T=101&S=50&O=A> (Last accessed February 4, 2019).

Interviews with Market Actors

From early December 2018 to the end of January 2019, representatives from industry associations and retailers provided help in explaining the data, confirming their reliability, and indicating how to best use the data for the evaluation. Information was also gathered from exchanges with Nova Scotia's municipal staff, provincial staff, and Nova Scotia Power (NSP). These interviews were valuable for understanding data updates for 2018, changes in expected energy savings, and market activity.

Analysis

Once all the interviews were completed and the data were collected, market size estimates were developed. With the market size for each product category, the portion of the Atlantic market impacted by the regulations were determined. Based on the portion of the market impacted, estimates were established relative to: (1) the number of units impacted by the introduction of the new regulations in Nova Scotia; and (2) the savings resulting from each regulation, using the unitary savings values determined based on secondary data research.

The Evaluator made efforts to ensure that there was no overlap or double-counting with savings from ENS programs. The savings attributable to C&S result from increasing the mandatory minimum efficiency applicable to the targeted products and building codes in the market. Although similar products and buildings are targeted by ENS programs, it should be noted that their savings are distinct from those generated by C&S. The savings associated with ENS programs are based on increases in product efficiency compared to the minimum efficiency standard or the current baseline of that product category, whereas C&S savings result from an increase in the regulated minimum efficiency standard. Thus, evaluated savings from C&S do not overlap with those of ENS programs.

3 IMPACT EVALUATION

The following subsections present the energy and peak demand savings achieved as a result of the introduction of seven regulations in the Nova Scotia market.

3.1 Incandescent Lamps

3.1.1 Product Description

For over 100 years, incandescent lamps have been widely used for lighting applications and their design and energy use have remained almost unchanged. Incandescent lamps are very inefficient converters of energy to light; most of the energy consumed is emitted as heat. Several other categories of products can meet consumer lighting needs. However, until the late 2000s, the lighting characteristics and costs of these products did not provide consumers with a strong enough incentive to abandon the high energy-consuming incandescent lamps.

3.1.2 Regulation Description

Amendment 10 to the Regulations Amending the Energy Efficiency Regulations was developed and put into effect on January 1, 2012 to enable a phased-in introduction of lighting standards. The regulation was intended to encourage the use of higher-efficiency lamps to help replace and phase out incandescent lamps because they are a major electricity end-use for lighting. This amendment was expected to result in a 30 percent improvement in overall lighting efficiency and electricity consumption.

In response to concerns raised by retailers, Amendment 12B was introduced, and the phased-in introduction was postponed by two years until January 1, 2014. The rationale for this delay was to allow more time to educate Canadians about the benefits of choosing energy-saving lighting solutions, to make further technology advances, and to address environmental and health concerns related to compact fluorescent lamps (CFLs).

Amendment 12B was intended to achieve three main objectives:

- › Provide Canadian consumers with more lighting options, specifically a lamp that closely resembles and performs like a traditional incandescent lamp
- › Reduce the regulatory compliance burden on the incandescent lamp manufacturing industry
- › Support the government regulatory policy of aligning with the American standards, where feasible

Energy impacts associated with the introduction of these standards were gradually felt for a number of reasons, including that the phase-out of incandescent lamps was designed to be completed in two stages, as listed in Table 5 below: (1) the regulations with respect to 100 W and 75 W lamps came into force on January 1, 2014; and (2) the regulations with respect to 60 W and 40 W lamps came into force on December 31, 2014. The new regulations require a level of lighting efficiency similar to that of a halogen incandescent lamp.

Table 5: Schedules for General Service Lamp Compliance with New Standards¹²

Traditional Incandescent Light Lamp	Light Lamp New Standards	Type of Light Lamp		Effective Date
Maximum Wattage	Maximum Wattage	Standard Spectrum (Lumens Range)	Modified Spectrum (Lumens Range)	Manufactured on or After
100 W	72 W	1,490 – 2,600	1,118 – 1,950	January 1, 2014
75 W	53 W	1,050 – 1,489	788 – 1,117	January 1, 2014
60 W	43 W	750 – 1,049	563 – 787	December 31, 2014
40 W	29 W	310 – 749	232 – 562	December 31, 2014

The Canadian lighting market offers three main types of products that meet the maximum wattage requirements set by the new standard, namely the incandescent halogen, the CFL and the light-emitting diode (LED).

3.1.3 Market Size Estimate

EFC provided information about lighting product shipments to Atlantic Canada from 2004 to the end of 2018, and this information was converted into estimates for Nova Scotia. Of note, 2013 was the last year of shipments before the 75 W and 100 W new energy efficiency requirements were implemented. Also, 2014 was the last year of shipments before the 40 W and 60 W requirements were implemented. The declining trend in shipments from 2004 to 2013 (-5.56% annual average) was applied to the 2013 data to estimate the expected market size for 2018 if the new standards had not been in force.

The Evaluator selected 2013 as the final baseline year since the lamp sales data provided by EFC was not categorized by wattage level, and thus the Evaluator could not distinguish lamps affected by the January 1, 2014 requirements (75 W and 100 W) from those affected by the December 31, 2014 requirements (40 W and 60 W). To determine the distribution of lamps among each wattage level, EFC provided the following estimates based on historical sales data: 24 percent of units shipped were 100 W lamps; 2 percent were 75 W lamps; 65 percent were 60 W lamps; and 9 percent were 40 W lamps.

Table 6 below lists the projected 2018 market sizes for incandescent lamps if energy efficiency requirements had not been implemented and compares the projections with actual shipment data obtained through EFC for the same year. The 2018 projected size of the Nova Scotia market assumes that it would have declined at the same annual rate it did between 2004 and 2013 (-5.56%). Since under the regulations in force, regular 40 W, 60 W, 75 W, and 100 W incandescent lamps should no longer be sold, the Evaluator assumed that the 2018 actual shipment quantities for 60 W and 40 W lamps represent incandescent lamp categories that are not affected by the new standards.

¹² Natural Resources Canada. (2017). *Amendment 12B – January 2014 – Registration and publication of Regulations amending Canada's Energy Efficiency Regulations*. Retrieved from <http://www.nrcan.gc.ca/energy/regulations-codes-standards/12342> (Last accessed February 6, 2019).

Table 6: Incandescent Lamp Market Size Estimates for Nova Scotia, 2018

Product Class	Projected Nova Scotia Market in 2018 (lamps)	Actual Shipments to Nova Scotia in 2018 (lamps)
100 W	159,050	-
75 W	13,254	-
60 W	430,761	100,614
40 W	59,644	13,931

3.1.4 Portion of the Market Impacted by the Regulation

The difference between the projected 2018 market and actual shipments represents the impact achieved by the standard, as summarized in Table 7.

Table 7: Estimate of the Portion of the Incandescent Lamp Market Impacted by the Regulation

Product Class	Percentage of Total Projected Shipments to Nova Scotia Affected by the Regulation in 2018	Shipments to Nova Scotia Affected by the Standard in 2018 (lamps)
100 W	100%	159,050
75 W	100%	13,254
60 W	77%	330,146
40 W	77%	45,713

3.1.5 Unitary Savings Values

The minimum peak demand savings (W/unit) were estimated based on the data outlined in Table 5 above. For example, a 100 W lamp must be replaced by a lamp of no more than 72 W (28 W in savings). The annual energy savings (kWh/unit) were estimated based on the average annual usage of these products, as listed in Table 8 below. The overall average number of hours of use is estimated at 2.9 hours per day (the same value used in the evaluation report of the Instant Savings program component). The Evaluator elected to use the hours of use in the residential sector since 90 percent of all incandescent lamps were sold in that sector. These estimates were applied to the demand savings per unit to calculate the annual energy savings estimates.

Table 8: Unitary Savings Values for Incandescent Lamps¹³

Product Class	Annual Energy Savings (kWh/unit)
100 W	30
75 W	23
60 W	18
40 W	12

3.1.6 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. In the case of C&S, replacing incandescent lamps with more efficient products, such as halogen incandescent lamps, causes an increase in the heating load during winter and a decrease in the cooling load during summer.

Table 9 below presents the interactive effects factor calculations for lighting products. These interactive effects were calculated as part of the evaluation of the Efficient Product Installation (EPI) program component. They were updated in 2018 by taking into consideration the percentages of houses using electrical heating (differentiating heat pump from electrical heating) and air conditioning based on the information in the EPI tracking sheet. As with the assessment of the hours of use for the unitary savings values, the assessment of interactive effects was focused on the residential sector since this sector represents 90 percent of incandescent lamp sales.

Table 9: Interactive Effects Calculations for Lighting Products

Parameter	% of Homes ¹⁴	Energy Interactive Effects Factor ¹⁵	Peak Demand Interactive Effects Factor
Heat Pump Heating with Air Conditioning	15%	-24.0%	-90.0%
Electrical Heating with Air Conditioning	3%	-54.4%	-90.0%
Electrical Heating Without Air Conditioning	29%	-58.0%	-90.0%
No Electrical Heating with Air Conditioning	5%	3.6%	0%
With Neither Electrical Heating nor Air Conditioning	47%	0%	0%
Weighted Interactive Effects Factor	100%	-22.20%	-43.00%

¹³ Natural Resources Canada. (2011). *Energy Efficiency Act: Regulations Amending the Energy Efficiency Regulations*. Retrieved from <http://canadagazette.gc.ca/rp-pr/p2/2011/2011-10-12/html/sor-dors182-eng.html> (Last accessed February 6, 2019).

¹⁴ Numbers may not add up due to rounding.

¹⁵ ADS ASSOCIÉS. (1992). *Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale*, report presented to Hydro-Québec.

3.1.7 Energy Savings - at the Meter

The Evaluator estimates that the phase-out of incandescent light lamps in Nova Scotia achieved a total of 9.000 GWh in energy savings in 2018, as summarized in Table 10.

Table 10: Energy Savings Associated with Phasing Out Incandescent Light Lamps in the Nova Scotia Market

Product Class	Shipments to Nova Scotia Affected by the Standard in 2018 (lamps)	Annual Energy Savings (kWh/yr/lamp)	Interactive Effects Factor	Total Energy Savings at the Meter in 2018 (GWh)
100 W	159,050	30	-22.20%	3.712
75 W	13,254	23	-22.20%	0.237
60 W	330,146	18	-22.20%	4.623
40 W	45,713	12	-22.20%	0.427
Total	548,163			9.000

3.1.8 Peak Demand Savings - at the Meter

Peak demand savings correspond to the demand savings that coincide in time with the peak demand of the electricity system. The projected electricity demand peak period in Nova Scotia is between 5 p.m. and 7 p.m. from December through February on non-holiday weekdays.

The Evaluator found that the recommendation formulated in the 2017 Evaluation Report is still valid and thus recommends applying the Northeast Residential Lighting Hours-of-Use Study (NERHOU) ratio of 0.162 W/kWh for incandescent lamps. As a reminder, the Evaluator conducted a lighting metering study, the Residential Lighting Metering Study,¹⁶ in 2017 among 75 homes and compared the results to other studies found in the literature. The Evaluator chose to recommend using the NERHOU ratio because it is very close to the value of 0.161 W/kWh established by the Residential Lighting Metering Study. In addition, the margin of error in the NERHOU study was 1 percent, which is lower than the 10 percent margin of error resulting from the Residential Metering study.

The NERHOU ratio does not include interactive effects. To account for interactive effects, the factors developed in Subsection 3.1.6 were applied to the peak demand-to-energy ratio for incandescent lamps, as outlined in Table 11.

¹⁶ Econoler. (2017). *Residential Lighting Metering Study*, report presented to Efficiency Nova Scotia.

Table 11: Adjusted Peak Demand-to-energy Ratios for Lighting Products

Product Class	Peak Demand-to-energy Ratio	Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings	Adjusted Peak Demand-to-energy Ratio
100 W	0.162	-22.2%	-43.00%	0.119
75 W	0.162	-22.2%	-43.00%	0.119
60 W	0.162	-22.2%	-43.00%	0.119
40 W	0.162	-22.2%	-43.00%	0.119

As outlined in Table 12 below, the Evaluator estimated Nova Scotia's total peak demand savings at 1.071 MW in 2018.

Table 12: Peak Demand Savings Associated with the Introduction of Incandescent Lamp Standards in the Nova Scotia Market

Product Class	Total Energy Savings at the Meter in 2018 (GWh)	Adjusted Peak Demand-to-energy Ratio (MW/GWh)	Total Peak Demand Savings at the Meter in 2018 (MW)
100 W	3.712	0.119	0.442
75 W	0.237	0.119	0.028
60 W	4.623	0.119	0.550
40 W	0.427	0.119	0.051
Total	9.000		1.071

3.2 LED Street Lights

3.2.1 Product Description

LED street lights provide a more energy efficient means of meeting the street lighting requirements of Nova Scotia municipalities. Many lighting manufacturers have been making major efforts to develop LED products, and the technology has been advancing rapidly.¹⁷

¹⁷ DMD and Associates Ltd., *Energy Efficient Street Lighting Strategies for Nova Scotia Municipalities*, July 16, 2009, available at https://unsm.ca/doc_download/1543-street-lighting-final-report-2009-07-16.html (Last accessed February 5, 2019).

3.2.2 Regulation Description

In May 2011, the province of Nova Scotia passed legislation requiring lighting on Nova Scotia roads and highways to be replaced by LED lighting. Nova Scotia is the first Canadian province to commit to switching to LED for existing street lights. Most street lights in the province are owned by NSP, while the remaining stock is owned by municipalities. NSP has until December 31, 2019¹⁸ to complete the replacements, while municipalities have until December 31, 2022.

The average life span of the most common street lights found in Nova Scotia (high-pressure sodium lights) is about five years, meaning that most of the existing stock will require replacement at some point within 10 years.

3.2.3 Market Size Estimate

In 2009, the Union of Nova Scotia Municipalities commissioned DMD & Associates Ltd. to prepare a report¹⁹ entitled Energy Efficient Street Lighting Strategies for Nova Scotia Municipalities. As part of this work, a complete inventory of all street lights in the province was compiled by type, and 135,964 lights were reported in total. The inventory indicated the energy consumption range for an average month and the proportions represented by various categories of lamps. The results are summarized in Table 13 below.

Table 13: Existing Lighting Unit Inventory in Nova Scotia, 2009

Type	Energy Consumption Range for an Average Month (kWh/month)	Proportion of Inventory	Proportion of Total Power Consumed
High-pressure sodium	From 32 to 150	82%	73.5%
Mercury vapour	From 43 to 363	12%	16.0%
Metallic additive	From 50 to 360	2%	4.0%
Others:		4%	6.5%
> Incandescent	From 97 to 154	-	-
> Low-pressure sodium	From 60 to 80	-	-
> Fluorescent	From 30 to 222	-	-

¹⁸ Nova Scotia Canada. (2012). *Energy-efficient Appliances Regulations made under Section 5 of the Energy-efficient Appliances Act*. Retrieved from <https://www.novascotia.ca/just/regulations/regs/eeappliances.htm> (Last accessed February 5, 2019).

¹⁹ DMD and Associates Ltd. (2009). *Energy Efficient Street Lighting Strategies for Nova Scotia Municipalities*.

3.2.4 Portion of the Market Impacted by the Regulation

In the abovementioned report, DMD & Associates Ltd. estimated that street light total electricity consumption in 2009 was 88,886,988 kWh. This represents an average annual electricity use of 653.8 kWh per lighting unit and an average power demand of 163 W per unit, based on an annual 4,000 hours of operation per unit.²⁰

A significant development related to the installation of LED street lights in Nova Scotia occurred in 2014. The Halifax Regional Municipality (HRM) took over full ownership of all street lights in its jurisdiction; approximately 44,000 units (one-third of all the lights in the province). Two-thirds of these lights were previously owned by NSP. The ownership transfer occurred on August 1, 2014. Approximately 7,000 units had already been replaced with LEDs at that time. HRM awarded a contract to a private firm in the fall of 2015 to replace the remaining units.

In February 2019, HRM officials reported to the Evaluator that all units owned by HRM had been converted to LED, since the final 1,200 units were replaced in 2018. Overall, 42,631 fixtures in the municipality were converted to LED.

NSP reported in 2015 that the total number of lights in its post-sale asset pool was 42,791, which are being scheduled for replacement over the next number of years. As part of the 2018 evaluation, a request was sent to NSP to obtain the number of LED light replacements completed in 2018. They estimated that 4,190 conversions were completed for that year. By comparison, NSP declared that they had replaced 2,353 units in 2017.

It was therefore estimated that 5,390 LED street lights were replaced in 2018 in Nova Scotia. This figure is the sum of the units replaced by HRM and NSP.

This number of replacements may be underestimated since some municipalities that own their street lights did not respond to the Evaluator's request for information.²¹ None of the non-reporting municipalities had large replacement programs since they are quite small jurisdictions. It should also be noted that the provincial Department of Transportation and Infrastructure Renewal reported that it had completed conversions prior to 2016 on all 100-series highways. The municipalities of Digby, East Hants, the Village of Kingston and the Town of Trenton completed all their conversions prior to 2016 as well.

²⁰ Nova Scotia Power. (2017). *Street and Area Lighting*, <https://www.nspower.ca/en/home/about-us/electricity-rates-and-regulations/rates/street-and-area-lighting.aspx> (Last accessed January 29, 2019).

²¹ NSP, the Nova Scotia Department of Transportation and Infrastructure Renewal, and municipalities that own street lights were all contacted as part of this evaluation.

The Evaluator assumed that NSP replaced the least efficient units first (i.e. those with higher energy consumption levels than the average consumption of existing lighting units). The total reduction in energy needs of those lights depends on the energy consumption of lamps replaced. Since the efficiency levels of the replaced units were unknown, the Evaluator used a conservative approach by applying the average baseline consumption value of 653.8 kWh per lamp for the 5,390 units replaced, resulting in 3,523,982 kWh in total baseline energy consumption.

3.2.5 Unitary Savings Values

To estimate the total reduction in energy use resulting from replacements with LEDs, the Evaluator conducted a literature review of LED street lighting case studies from other jurisdictions.

Although most jurisdictions used a similar baseline (high-pressure sodium) and most methodologies met the Illuminating Engineering Society of North America RP-8-00²² criteria of the American National Standard Practice for Roadway Lighting, various levels of average savings were identified, as listed in Table 14 below. Several differences could have led to varying estimates in the average savings levels, including the illuminance level differences between existing roadway street lights and new units, and the wattage of LED street lights. Furthermore, the specifications of the LED street lighting installed by NSP were unknown. Considering these observations, the Evaluator used a conservative approach and calculated a rounded average of the energy savings reported by all reviewed case studies. The rounded average was established at 35 percent and this value was used to estimate energy and peak demand savings. Thus, the Evaluator established a unitary energy savings value of 229 kWh per street lighting unit and a displaced wattage of 57 W per street lighting unit.

²² Illuminating Engineering Society of North America. Retrieved from <http://www.ies.org/> (Last accessed February 21, 2019).

Table 14: Literature Review of LED Street Lighting Case Studies

Baseline – Existing Fixture	Minimum Savings	Maximum Savings	Average Savings	Source
High-pressure sodium 100 W	0%	41%	24%	Street lights for local roads, National Lighting Product Information Program, February 2011 ²³
High-pressure sodium 100 W	36%	68%	46%	Nova Scotia LED Roadway Lighting Pilot Installations, DMD & Associates Ltd., 2010 ²⁴
High-pressure sodium 100 W – 400 W	31%	51%	39%	GATEWAY Program, Kansas City, 2013 ²⁵
High-pressure sodium 150 W	26%	57%	45%	GATEWAY Program, New York State, 2011 ²⁶
High-pressure sodium 150 W	10%	40%	25%	GATEWAY Program, Philadelphia, 2011 ²⁷
Rounded Average			35%	Calculated

3.2.6 Energy Savings – at the Meter

The total energy savings associated with the 5,390 LED lighting units installed in 2018 were estimated at 1.234 GWh, as summarized in Table 15 below.

Table 15: Energy Savings Associated with the Introduction of LED Street Lighting in the Nova Scotia Market

Product Class	Number of Lighting Units Replaced in 2018	Annual Energy Savings (kWh/unit)	Total Incremental Energy Savings at the Meter in 2018 (GWh)
LED Street Lighting (HRM and NSP)	5,390	229	1.234
Total	5,390	229	1.234

3.2.7 Peak Demand Savings – at the Meter

The Evaluator estimated that 0.307 MW were saved at the meter in 2018 as a result of introducing LED street lighting. As outlined in Table 16 below, a peak coincidence factor of 100 percent was considered because savings always occur during the winter peak load period.

²³ National Lighting Product Information Program. (2011). *Street Lights for Local Roads*. Retrieved from http://www.lrc.rpi.edu/programs/NLPIP/PDF/VIEW/SR_StreetlightsLocal.pdf (Last accessed February 5, 2019).

²⁴ DMD & Associates Ltd. (2010). *Nova Scotia LED Roadway Lighting Pilot Installations*. Retrieved from <http://docshare01.docshare.tips/files/25144/251443242.pdf> (Last accessed February 5, 2019).

²⁵ Office of Energy Efficiency and Renewable Energy. (2013). *Demonstration of LED Street Lighting*. Retrieved from http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2013_gateway-msslc_kc.pdf (Last accessed February 5, 2019).

²⁶ Office of Energy Efficiency and Renewable Energy. (2011). *Demonstration Assessment of Lighting-Emitting Diode (LED) Roadway Lighting*. Retrieved from apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2011_gateway_fdr-drive.pdf (Last accessed February 2019).

²⁷ Office of Energy Efficiency and Renewable Energy. (2013). *SSL Demonstration: Roadway Lighting Philadelphia*. Retrieved from http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/philadelphia_brief.pdf (Last accessed February 2019).

Table 16: Peak Demand Savings Associated with the Introduction of the LED Street Lighting in the Nova Scotia Market

Product Class	Number of Lighting Units Replaced in 2018	Peak Demand Savings (W/unit)	Peak Coincidence Factor (%)	Total Peak Demand Savings at the Meter in 2018 (MW)
LED Street Lighting (HRM and NSP)	5,390	57	100%	0.307
Total	5,390	57	100%	0.307

3.3 New Building Energy Codes

3.3.1 Product Description

In 2015, the Canadian Commission on Building and Fire Codes released the National Energy Code for Buildings (NECB 2015) and the National Building Code (NBC 2015), which enhanced the minimum requirements for the design and construction of buildings compared to NECB 2011 and in NBC 2010. National building codes serve as guidance documents for provinces that may either develop their own or adopt the national standards.

Nova Scotia adopted both NBC 2015 and NECB 2015 in March 2017 and enforced them April 2017 under the Nova Scotia Building Code Regulations. British Columbia is the only other province to have adopted NECB 2015,²⁸ which covers large buildings, condos and apartments. New houses and small buildings are covered by NBC 2015. The adoption of NBC 2015 is more widespread than NECB 2015. As of February 2019, Yukon, the Northwest Territories, Nunavut, British Columbia, Alberta, and Saskatchewan have adopted NBC 2015. The following subsections examine at the annual incremental impact of these new regulations on new houses and small buildings as well as large buildings, condos and apartments in 2018.

²⁸ National Research Council Canada. (2019). *Model Code Adoption Across Canada*. Retrieved from https://www.nrc-cnrc.gc.ca/eng/solutions/advisory/codes_centre/code_adoption.html (Last accessed February 17, 2019).

3.3.2 Regulation Description

As previously mentioned, the Nova Scotia Building Code Regulations are based on NBC 2015 and NECB 2015. Both codes provide minimum requirements for the design and construction of new buildings, including specifications for building envelopes, HVAC equipment and lighting.

The energy efficiency requirements of NBC 2015 are included in section 9.36 of Part 9. Almost half of the 2015 changes to Part 9 impact stairs, ramps, handrails, and guards to increase design options as well as maximize safety. The updates to section 9.36 include changes to referenced standards, notably to replace outdated standards for roofing, damp proofing, and waterproofing standards.²⁹ Another important change is how insulation is calculated, which now takes effective thermal resistance into account.³⁰ New houses and small buildings with 600 m² or less in building area are covered by Part 9 of NBC 2015.³¹

NECB 2015 includes over 90 changes to the 2011 edition.³² As highlighted in a report published by Caneta Research, the key differences between the 2011 and the 2015 editions are adjustments to lighting power density requirements, increased requirements for daylight sensing controls, and a reduction in the maximum flow rate for plumbing fixtures.³³ NECB 2015 targets large buildings, condos and apartments.

3.3.3 Market Size Estimate

To estimate market size, the Evaluator analyzed the data available from Statistics Canada regarding the monetary value represented by building permits for residential, commercial, and industrial buildings in the province of Nova Scotia. At the time of writing, data for 2018 was only available for January to the end of November. Table 17 below lists the key figures on building permits in Nova Scotia until November 2018.

²⁹ Construction Innovation. (2016). *Changes in Part 9 of NBC 2015*. Retrieved from <https://www.nrc-cnrc.gc.ca/ci-en/article/v20n1-4/> (Last accessed February 18, 2019).

³⁰ Office of the Fire Marshall. (2017). *Nova Scotia Building Code Regulations Energy Efficiency Requirements*. Retrieved from <https://ecologyaction.ca/sites/ecologyaction.ca/files/images-documents/Joe%20Rogers%20Energy%20Efficiency%2020170517.pdf> (Last accessed February 18, 2019).

³¹ Dalhousie University. *Wood construction and NBC Part 9 for Housing and Small Buildings*. Retrieved from <https://www.dal.ca/faculty/cce/programs/continuing-technical-education/courses/wood-construction-and-nbc-part-9-for-housing-and-small-buildings.html> (Last accessed March 6, 2019).

³² National Research Council Canada. (2017). *National Energy Code of Canada for Buildings 2015*. Retrieved from https://www.nrc-cnrc.gc.ca/eng/publications/codes_centre/2015_national_energy_code_buildings.html (Last accessed February 18, 2019).

³³ Caneta Research. (2017). *NECB 2015 Update to Economic Analysis for Archetype Buildings*. Retrieved from <https://docplayer.net/86714351-Necb-2015-update-to-economic-analysis-for-archetype-buildings.html> (Last accessed February 18, 2019).

Table 17: Key Figures on Nova Scotia Building Permits for January Through November 2018³⁴

	Total Value³⁵ (\$)	Estimated Floor Area (m²)
Residential	969,512,000	608,726 ³⁶
Non-residential	468,419,000	N/A
Commercial	310,277,000	111,610 ³⁷
Institutional/Government	54,773,000	19,667 ³⁸
Industrial	103,359,000	66,899 ³⁹

Similarly to past years, the total monetary value of building permits for commercial construction was approximately one-third of that of residential construction.

Houses and Small Buildings

Table 18 below presents the number of single house building permits issued in the residential sector in 2018.

Table 18: Number of Dwelling Units – Data on Nova Scotia Residential Building Permits for January Through November 2018⁴⁰

	Single Houses (Detached and Mobile Homes)	Value of Building Permits (\$)	Estimated Floor Area (m²)
Houses and Small Buildings	1,869	558,258,000	311,002

The estimated residential market size was determined on the basis of single residential units.

Table 18 indicates that, by the end of November 2018, the total number of units was 1,869. The total monetary value of the single residential building permits issued in 2018 was over \$558 million, and the estimated total floor area was 311,002 m².

³⁴ Numbers are rounded.

³⁵ Statistics Canada. (2018). *Table 34-10-0066-01. Building permits, by type of structure and type of work*. Retrieved from <https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3410006601#timeframe> (Last accessed January 15, 2019).

³⁶ To calculate the residential square meter values, estimates were based on the assumption that construction costs are \$143.176 per square foot. The total square foot figure is divided by 10.8 to convert it to a square meter value.

³⁷ Based on construction costs of \$2,699.25 per square meter (all base year construction costs considered using StatCan 327-0043).

³⁸ Based on construction costs of \$2,704.19 per square meter.

³⁹ Based on construction costs of \$1,500 per square meter.

⁴⁰ Statistics Canada (2018). *Table 34-10-0002-01 Building permits, dwelling units by type of dwelling and area*. Retrieved from <http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=260002> (Last accessed January 15, 2019).

Large Buildings, Condos and Apartments

Table 19 further below outlines the estimated floor areas of commercial and industrial facilities built in 2018 in Nova Scotia.

The first line in Table 19 provides an estimate of the multiple housing units assumed to be apartment and condominium complexes. In total, based on building permit data, it was estimated that the construction of 2,738 units has followed the National Energy Code in 2018. The Evaluator assumed that most complexes are large and each complex on average is comprised of 50 units, meaning 55 buildings were built. The dollar value of the residential apartment and condominium building permits was \$411 million. This value was obtained by subtracting \$558 million, listed in Table 18 for houses and small buildings, from \$969 million, listed in Table 17 for residential buildings. The estimated floor area was 345,535 m². Information about the number of buildings was not available from any published source.

Table 19 also indicates an estimate of the level of activity in the commercial sector based on building permit data. The total monetary value of the building permits for the commercial sector was \$310 million. By applying an assumed construction cost factor,⁴¹ it was estimated that the total floor area of new buildings in the commercial sector was 114,921 m². To estimate the energy use associated with the commercial sector, a breakdown was made between large-scale and small-scale development projects.

There is no published data available on this breakdown. The Evaluator used the findings from a 2009 NRCAN study that served to review commercial sector energy use in Canada.⁴² The study contained data on the existing stock of buildings in Atlantic Canada. The Evaluator used this data as a means to estimate a reasonable breakdown between small and large structures based on 2018 building permit data. Using the split ratio from the 2009 NRCAN study, the Evaluator established that 8,963 m² of the floor area is attributable to small-scale commercial development projects and 105,957 m² to large-scale projects.

The total monetary value of building permits for the industrial sector was \$103 million. By applying an assumed construction cost factor,⁴³ it was estimated that the total floor area of industrial buildings built in 2018 was 66,889 m².

⁴¹ Based on construction costs of \$2,800 per square meter for both small-scale and large-scale commercial development projects.

⁴² Natural Resources Canada completed a survey of commercial and industrial energy use in 2009 (CAT No. M 144 – 4/1-2012). In Table F1 of that survey, the ratio of large to small buildings in Atlantic Canada was 92.3: 7.7 on a per-m² basis. The Evaluator used the same ratio in this calculation. Natural Resources Canada, *Survey of Commercial and Institutional Energy Use – Buildings 2009*, December 2012, available at https://oee.nrcan.gc.ca/publications/statistics/scieu09/scieu_e.pdf (Last accessed January 15, 2018).

⁴³ Based on a construction cost of \$1,500 per square meter.

Table 19: Estimated Floor Areas in the Commercial and Industrial Sectors

	Units	Value of Permits (\$)	Estimated Floor Area (m ²)	Number of Buildings
Residential Multi-units	2,738 ⁴⁴	411,255,000 ⁴⁵	345,535 ⁴⁶	55 ⁴⁷
Commercial	N/A	310,287,000	114,921	80
Small		24,202,000	8,963	27
Large		286,085,000	105,957	53
Industrial	N/A	103,359,000	66,889	9

3.3.4 Unitary Savings Values

The Evaluator estimated the unitary savings values separately for (1) houses and small buildings, and (2) large buildings, apartments and condos (including multi-unit residential units).

Houses and Small Buildings

The Evaluator examined the impact of the updates made to energy efficiency requirements in section 9.36 of the NBC 2015 and concluded that the difference in energy efficiency compared to the previous edition, NBC Revision 2012 (section 9.36), is negligible. As mentioned previously, the most significant changes relate to referenced standards, notably to replace the outdated standards for roofing, damp proofing and waterproofing,⁴⁸ which have no impacts on building energy efficiency. Another important change is how insulation is calculated, which now takes effective thermal resistance into account.⁴⁹ In other words, the methodology now used to validate whether a building meets thermal resistance is different, although the thermal resistance requirement itself remains the same.

Since the changes to energy efficiency performance are negligible, the Evaluator opted to continue to apply the energy and demand savings determined in past evaluations for the previous edition of the NBC. More precisely, since the adoption of NBC 2015 has no significant impact on energy efficiency, the energy and peak demand savings related to the adoption of the 2012 Revision of Part 9 of the NBC still apply.

⁴⁴ Statistics Canada (2018). *Table 34-10-0002-01 Building permits, dwelling units by type of dwelling and area*. Retrieved from <http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=260002> (Last accessed January 15, 2019).

⁴⁵ Ibid.

⁴⁶ The estimated floor area is based on an assumption of approximately 1,000 sq. ft per unit. To convert square feet values to square meters, a factor of 10.8 sq. ft per sq. meter is used.

⁴⁷ The majority of apartment and condominium buildings being built in Nova Scotia are large multi-storey buildings. The number of buildings is based on approximately 50 units per building on average.

⁴⁸ Construction Innovation. (2016). *Changes in Part 9 of NBC 2015*. Retrieved from <https://www.nrc-cnrc.gc.ca/ci-en/article/v20n1-4/> (Last accessed February 18, 2019).

⁴⁹ Office of the Fire Marshall. (2017). *Nova Scotia Building Code Regulations Energy Efficiency Requirements*. Retrieved from <https://ecologyaction.ca/sites/ecologyaction.ca/files/images-documents/Joe%20Rogers%20Energy%20Efficiency%2020170517.pdf> (Last accessed February 18, 2019).

NRCan performed analyses using HOT2000 simulations to establish the average energy performance level reached by the 2012 Revision of Part 9 of the NBC. As a result of these analyses, NRCan concluded that the average energy performance level corresponds to an EnerGuide rating of 78, based on the simulations made with Version 10 of the HOT2000 software.⁵⁰

The literature review conducted by the Evaluator did not identify any detailed report on the practices followed in new construction in the residential market before the 2012 Revision was enforced. For the 2014 evaluation, ENS provided the Evaluator with a sample of 90 recently built houses (from 2010 to 2012) that participated in Home Energy Assessment (HEA) just a few years after construction. It can be assumed that most of these houses were built according to industry standards. Therefore, the EnerGuide assessment ratings they obtained through HEA participation a few years after construction can serve an indication of the baseline for standard residential houses built in Nova Scotia prior to the new regulation. The sample of 90 recently built houses had an average EnerGuide rating of 77. Based on this analysis, the implementation of the new building regulations would result in an EnerGuide rating increase of 1.

To determine the energy savings value of an EnerGuide rating point, the Evaluator used the unitary savings obtained from the 2015 evaluation, which was based on the evaluation of ENS New Home Construction (NHC). In 2015, the Evaluator analyzed building simulations and used home electricity billing data to calibrate the simulation results and more reliably estimate gross energy savings. This analysis revealed that the building simulations overestimated electricity consumption by a margin of 16 percent compared to actual billing data. The Evaluator used data from the 2015 evaluation because the latest NHC evaluation savings calculation methodology is based on modelled energy consumption rather than savings per EnerGuide point.

The average savings per EnerGuide point value was calculated for 2015 using the energy consumption values specific to NHC participants. The analysis was conducted on a total of 470 participants, including participants who used electricity as their main heating source and those who had both to-code and as-built EnerGuide ratings and consumption values available. Those participants with an unchanged EnerGuide rating were removed from the analysis. After selecting participants, the Evaluator calculated the average savings per EnerGuide point of each participant before calculating the sum of all the values.

The Evaluator established the overall average savings per EnerGuide point at 1,521 kWh/year. Using the overestimation ratio of 16 percent resulting from the billing analysis, the final savings value per EnerGuide point was established at 1,278 kWh/year.

The literature review conducted by the Evaluator regarding the current practices in Nova Scotia's residential market did not identify any detailed information about the main heating source for new

⁵⁰ Natural Research Council Canada, *Energy Efficiency in Housing and Small Buildings – General Introduction*, March 2013, available at http://www.nrc-cnrc.gc.ca/eng/solutions/advisory/codes_centre/presentations/2013/overview2013.html (Last accessed February 5, 2018).

houses. According to a survey conducted by ENS in 2011, 33 percent of existing households in Nova Scotia used electricity as a main heating source.⁵¹ The Evaluator thinks that this ratio does not reflect the new construction residential market.

Therefore, a cross-reference review of heating system types for new houses that participated in ENS programs was conducted. In fact, 91 percent of the houses from the ENS sample of 90 recently built houses and 89 percent of the houses registered in NHC in 2014 used electricity as their primary source for space heating. Therefore, the Evaluator decided not to apply an adjustment ratio to the percentage of households not heated electrically, since close to all new homes use electricity as their primary source for space heating.

The energy savings calculation remains conservative as the number of houses and small buildings built in 2018 excludes data for December 2018. Moreover, in the ENS sample, 42 percent of the houses had an EnerGuide rating of 78 or higher and the regulation in force in 2014 was followed when being constructed. This resulted in a non-compliance rate of 58 percent, which was applied to the savings.

Large Buildings, Condos and Apartments

In 2017, the Government of Newfoundland and Labrador contracted Caneta Research Inc. to conduct a study⁵² in which the energy savings from adopting the 2015 edition of the NECB were determined through performance simulations. More precisely, the study compared the energy consumption of buildings that meet the NECB 2015 requirements with the energy consumption of buildings that meet the NECB 2011 requirements. As part of this study, the prescriptive requirements of each code were applied to five archetype buildings. The changes were modelled for St. John's, Newfoundland and Labrador. Since both St John's and Nova Scotia are located within Climate Zone 6, the results are applicable to the Nova Scotian market.

The building archetypes used by Caneta for large buildings, apartments and condominiums are described in Table 20.

Table 20: Building Archetypes Used in the Simulation Studies

Sector	Building Archetype	Building Size	Other
Multi-unit Residential	Mid-rise Apartment	2,000 m ²	2-storey
Small Commercial	Box Retail Store	1,000 m ²	Ground floor only
Large Commercial	Office Building	1,500 m ²	2-storey
Industrial	Warehouse	2,000 m ²	Ground floor only

⁵¹ Corporate Research Associates Inc., *2011 ENS Socket Study*, Final Report prepared for Efficiency Nova Scotia, December 2011.

⁵² Caneta Research. (2017). *NECB 2015 Update to Economic Analysis for Archetype Buildings*. Retrieved from <https://docplayer.net/86714351-Necb-2015-update-to-economic-analysis-for-archetype-buildings.html> (Last accessed February 15, 2019).

Table 21 outlines how the study compared the estimated electrical energy savings from adopting NECB 2015 by building type relative to the NECB 2011. The energy savings ranged from 1.35 percent for warehouses to 5 percent for office buildings.

Table 21: Electrical Energy Savings by Building Type⁵³

Building Type	Energy Consumption (kWh/m ²)		Energy Savings (kWh/m ²)	Savings (%)
	NECB 2011	NECB 2015		
Mid-rise Apartment	218	213	5.08	2.33%
Box Retail Store	260	252	8.87	3.40%
Office Building	155	148	7.77	5.00%
Warehouse	107	106	1.44	1.35%

3.3.5 Energy Savings – at the Meter

Houses and Small Buildings

The Evaluator estimated that the introduction of the 2012 Revision of Part 9 of the NBC generated 1.385 GWh in energy savings in Nova Scotia in 2018, as listed in Table 22.

Table 22: Energy Savings Associated with the Introduction of the Building Code Regulation in the Houses and Small Buildings Sectors in the Nova Scotia Market

Product Class	Number of Single Houses	Non-compliance Rate (%)	Annual Energy Savings (kWh/house)	Total Incremental Energy Savings at the Meter in 2018 (GWh)
Houses and Small Buildings	1,869	58%	1,278	1.385

Large Buildings, Condos and Apartments

To establish the total electrical energy savings associated with the large building, apartment and condominium sectors, the Evaluator applied the energy savings per square meter outlined in Subsection 3.3.4 above to the total floor area values estimated based on the building permit data. The Evaluator estimated the total energy savings at 2.753 GWh, as outlined in Table 23 below. Multi-unit residential buildings accounted for 65 percent of total savings and large commercial buildings accounted for 30 percent.

⁵³ Ibid.

Table 23: Energy Savings Associated with the Introduction of the Building Code Regulation for Large Buildings, Apartments and Condominiums

Building Type	Total Floor Area (m ²)	Energy Savings (kWh/m ²)	Total Energy Savings at the Meter in 2018 (GWh)
Multi-unit Residential	345,535	5.08	1.754
Small Commercial	8,963	8.87	0.079
Large Commercial	105,957	7.77	0.823
Industrial	66,889	1.44	0.097
Total	527,344	-	2.753

3.3.6 Peak Demand Savings – at the Meter

Houses and Small Buildings

To calculate peak demand savings, the Evaluator used an on-peak demand-to-energy ratio of 0.283 MW/GWh, which was multiplied by the 1,278 kWh in unitary energy savings and resulted in 362 W of unitary peak demand savings. This ratio was established based on a weighted-average ratio of modelled system-coincident peak demand savings and energy savings for a projected deployment of measures supported by NHC, as developed by Navigant in the 2016-2018 demand-side management (DSM) Plan. Navigant developed these ratios using a projected Nova Scotia system peak demand occurring in the months of December through February, between 5 p.m. and 7 p.m. on non-holiday weekdays. Navigant also used local weather data to establish this ratio. The Evaluator estimated that the introduction of the regulation generated 0.392 MW in peak savings in Nova Scotia in 2018, as summarized in Table 24.

Table 24: Total Peak Demand Savings Associated with the Introduction of the Building Code Regulation for the Houses and Small Buildings Sectors in the Nova Scotia Market

Product Class	Number of Single Houses	Non-compliance Rate (%)	Annual Peak Demand Savings (W/house)	Peak Demand Savings at the Meter in 2018 (MW)
Houses and Small Buildings	1,869	58%	362	0.392

Large Buildings, Condos and Apartments

To estimate the total peak savings associated with large buildings, apartments and condominiums, the Evaluator applied a demand-to-energy ratio of 0.333 MW/GWh. This ratio was established based on the Custom New Construction service gross energy and peak demand savings at the meter for 2018, by dividing the total peak demand savings by the total energy savings. As outlined in Table 25, the peak demand savings were 0.917 MW in 2018.

Table 25: Total Peak Demand Savings Associated with the Introduction of the Building Code Regulation for Large Buildings, Condos and Apartments

Building Type	Demand-to-energy Ratio (MW/GWh)	Total Peak Demand Savings at the Meter in 2018 (MW)
Multi-unit Residential	0.333	0.584
Small Commercial	0.333	0.026
Large Commercial	0.333	0.274
Industrial	0.333	0.032
Total	-	0.917

3.4 Clothes Washers

3.4.1 Product Description

Residential clothes washers are common household appliances. They are classified in Canada according to size (standard over 45 L or compact under 45 L) and loading axis (top-loading or front-loading). According to the NRCAN National Energy Use Database, approximately 90 percent are standard size, and top-loading types are more common across the country. Residential clothes washers are electrically operated and do not require mechanical fastening to a floor or wall. These appliances have an internal control system that regulates the water temperature without the need for user intervention after the machine begins operating. The water used comes from a source heated by electricity, oil, or natural gas; hence, the energy savings analysis also categorizes clothes washers by water heating source.

3.4.2 Regulation Description

Amendment 13 to the Energy Efficiency Regulations was registered on December 9, 2016, published on December 28, 2016 and came into force on June 28, 2017. The new MEPS have been divided into two tiers: Tier I targets both top and front-loading appliances manufactured on or after March 7, 2015 and before January 1, 2018 and is aligned with the U.S. standard in effect since March 2015. On the other hand, Tier II MEPS targets top-loading appliances manufactured on or after January 1, 2018 and is aligned with the U.S. standard in effect January 2018.⁵⁴ Tier II MEPS do not include front-loading appliances. Therefore, the Evaluator assumed in this evaluation that top-loading appliances are regulated by Tier I MEPS and front-loading appliances are regulated by Tier II MEPS.

⁵⁴ Natural Resources Canada. (2018). *Clothes washers (and household-style commercial)* Retrieved from <http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6925> (Last accessed February 6, 2019).

3.4.3 Market Size Estimate

AHAM Canada provided information about clothes washer shipments to Atlantic Canada from 2014 to 2018, and this information was converted into estimates for Nova Scotia based on its share of Atlantic Canada's total population. The NRCAN cost-benefit analysis report on the standards covered by Amendment 13⁵⁵ provided a breakdown of shipments by loading axis (top-loading or front-loading). Table 26 lists the market size of each clothes washer type for 2018.

Table 26: Clothes Washer Market Size Estimates for Nova Scotia, 2018

Product Class	Atlantic Market in 2018	Nova Scotia Market in 2018
Tier I - Front-loading	12,418	4,917
Tier II - Top-loading	42,276	16,741
Total	54,694	21,659

3.4.4 Portion of the Market Impacted by the Regulation

The NRCAN cost-benefit analysis report on the standards covered by Amendment 13 provided the non-compliance rate for Tier I and Tier II clothes washers in Canada prior to the application of the new MEPS. Since no province-specific statistics were available, the non-compliance rate for Nova Scotia was assumed to be the same as for Canada. Table 27 below shows the estimated portion of the market impacted by the regulation on Tier I and Tier II clothes washers.

Table 27: Estimate of the Portion of Clothes Washers Market Impacted by the Regulation

Product Class	Percentage of Total Shipments to Nova Scotia Affected by the Regulation in 2018
Tier I - Front-loading	5%
Tier II - Top-loading	54%

3.4.5 Unitary Savings Values

In Amendment 13, NRCAN specifies the average unitary savings values for Tier I and Tier II clothes washer categories according to their water heating sources, as listed in Table 28 below.⁵⁶ Higher-efficiency clothes washers use less water in washing cycles, resulting in additional savings associated with a reduced load on the domestic hot water heating system (if electrically heated). The Evaluator used the proportions of electrical and non-electrical domestic water heating in Nova Scotia from the 2018 Instant Savings evaluation to calculate a weighted average for all types of clothes washers.

⁵⁵ Natural Resources Canada. (2016). *Energy Efficiency Regulations: A cost-benefit analysis, Canada Gazette, Part II*.

⁵⁶ Natural Resources Canada. (2016). *Energy Efficiency Regulations: A cost-benefit analysis, Canada Gazette, Part II*.

Table 28: Unitary Savings Values for Clothes Washers

Product Class		Annual Energy Savings (kWh/unit)	Domestic Water Heating Source Proportion	Weighted Average Electricity Energy Savings (kWh/unit)
Type	Domestic Water Heating Source			
Tier I – Front-loading	Electrical	123	78.6%	109
	Non-electrical	58	21.4%	
Tier II Top-loading	Electrical	123	78.6%	109
	Non-electrical	58	21.4%	

3.4.6 Energy Savings - at the Meter

By multiplying the above-listed unitary savings values to the number of Tier I front-loading and Tier II top-loading clothes washers affected by the regulation in 2018 in Nova Scotia, the Evaluator estimated that the introduction of the regulation on clothes washers resulted in energy savings of 1.012 GWh at the meter (see Table 29).

Table 29: Energy Savings Associated with New Clothes Washer MEPS in the Nova Scotia Market

Product Class	Nova Scotia Market in 2018 - Units	Percentage of Nova Scotia Market Affected by the Standard in 2018	Annual Energy Savings (kWh/yr/unit)	Total Energy Savings at the Meter in 2018 (GWh)
Tier I - Front-loading	4,917	5%	109	0.027
Tier II - Top-loading	16,741	54%	109	0.985
Total	21,659	-	-	1.012

3.4.7 Peak Demand Savings - at the Meter

The peak demand savings were calculated by applying a peak demand-to-energy ratio of 0.138 MW/GWh to the energy savings at the meter presented in Table 30. This ratio was calculated using the peak demand-to-energy ratios for residential clothes washers developed by Navigant in the 2016-2018 DSM Plan. The Evaluator estimated that the introduction of the regulation generated 0.140 MW in peak savings in Nova Scotia for 2018, as summarized in Table 30.

Table 30: Peak Demand Savings Associated with the Introduction of Clothes Washer MEPS in the Nova Scotia Market

Product Class	Total Energy Savings at the Meter in 2018 (GWh)	Demand-to-Energy Ratio	Total Peak Demand Savings at the Meter in 2018 (MW)
Tier I - Front-loading	0.027	0.138	0.004
Tier II - Top-loading	0.985	0.138	0.136
Total	1.012		0.140

3.5 General Service Incandescent Reflector Lamps

3.5.1 Product Description

General service incandescent reflector lamps are used in residential track and pot lighting and are often used in retail store display lighting systems. The products regulated in Canada are of certain shapes with a diameter over 57 mm. The nominal voltage of regulated products is all or partially between 100 V and 130 V, and the lamp wattage ranges between above 40 W and under 205 W. There are a number of exceptions, such as coloured lamps, rough service lamps, vibration service lamps, lamps for heat-sensitive applications, and lamps for mine, airfield, aircraft, and automotive uses.

3.5.2 Regulation Description

Amendment 13 to the Energy Efficiency Regulations was registered on December 9, 2016, published on December 28, 2016 and came into force on June 28, 2017. General-service incandescent reflector lamps were included to align Canadian regulations with the energy efficiency requirements in force in the United States since July 2012.

Table 31 lists the energy performance requirements for general-service incandescent reflector lamps. The standards for ER 30 and ER 40 type lamps affect products manufactured on or after June 1, 2009. The regulations for all other R, PAR, BPAR, BR and ER type lamps affect products manufactured on or after July 15, 2012. The standards divide the products into categories according to nominal power range (W), lamp type, size, and voltage, then minimum light efficiency ratings are applied (lumens/W) for each category (see Table 31 below). Amendment 13 also sets energy performance standards for R, PAR, BPAR, BR and ER type lamps manufactured before July 15, 2012, although the Evaluator assumed all incandescent reflector lamps on the market were manufactured after this date.

Table 31: Amendment 13 Requirements for Incandescent Reflector Lamp Compliance⁵⁷

Lamp Type	Nominal Power (W)	Spectrum	Diameter (cm)	Voltage (V)	Minimum Average Efficacy (lm/W)	Manufactured on or After
ER 30 or ER 40	50	All	All	All	7.0	June 1, 2009
ER 30 or ER 40	< 50	All	All	All	10.5	June 1, 2009
ER 40	65	All	All	All	12.5	June 1, 2009
R, PAR, BPAR, BR, ER	40 - 205	Standard	> 6.35	≥ 125	6.8	July 15, 2012
R, PAR, BPAR, BR, ER	40 - 205	Standard	> 6.35	< 125	5.9	July 15, 2012
R, PAR, BPAR, BR, ER	40 - 205	Standard	≤ 6.35	≥ 125	5.7	July 15, 2012
R, PAR, BPAR, BR, ER	40 - 205	Standard	≤ 6.35	< 125	5.0	July 15, 2012
R, PAR, BPAR, BR, ER	40 - 205	Modified	> 6.35	≥ 125	5.8	July 15, 2012
R, PAR, BPAR, BR, ER	40 - 205	Modified	> 6.35	< 125	5.0	July 15, 2012
R, PAR, BPAR, BR, ER	40 - 205	Modified	≤ 6.35	≥ 125	4.9	July 15, 2012
R, PAR, BPAR, BR, ER	40 - 205	Modified	≤ 6.35	< 125	4.2	July 15, 2012

Note: R = reflector; PAR = parabolic aluminized reflector; BPAR = bulged PAR; BR = bulged reflector; ER = elliptical reflector.

3.5.3 Market Size Estimate

EFC provided information about lighting product shipments to Atlantic Canada from 2004 to the end of 2018. NRCAN data indicated that EFC reported shipments in 2017 represented about 75 percent of the full residential market and 72 percent of the commercial market.⁵⁸ EFC shipment data are adjusted using the NRCAN percentages to reflect full market sales. The Atlantic Canada shipment information was converted into estimates for Nova Scotia based on population share.

In the United States, energy efficiency requirements were introduced for general service reflector lamps in 2009. From 2004 to 2007, incandescent reflector lamp shipments remained steady, and 2008 was the first year in which CFL reflectors appeared on the market and captured about 10 percent of total reflector lamp market sales. LED reflectors first appeared in 2011 and grew to 61 percent of the reflector lamp market in 2017. Sales of all other types declined with the rise of longer-lasting LEDs; consequently reflector lamp sales declined by 45 percent between 2013 and 2018.

Table 32 below presents the projected market size for 2018 under a scenario in which the standard was not implemented and compares it to actual shipment estimates for the same year. The product class breakdown was based on 2017 NRCAN⁵⁹ estimates since the EFC data does not provide details on the

⁵⁷ Natural Resources Canada. (2018). *General service incandescent reflector lamps*. Retrieved from <https://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6957> (Last accessed February 6, 2019).

⁵⁸ Natural Resources Canada. (2016). *Energy Efficiency Regulations: A cost-benefit analysis, Canada Gazette, Part II*.

⁵⁹ Ibid.

number of units of each wattage level. It was assumed that there would be no natural shift in consumer behaviour toward new LED products.⁶⁰

Table 32: Incandescent Reflector Lamp Market Size Estimates for Nova Scotia, 2018

Product Class	NRCan Estimates of Class Shipments in 2017	Projected Nova Scotia Market in 2018 (lamps)	Actual Shipments to Nova Scotia in 2018 (lamps)
Residential 50 W	36%	160,904	39,813
Residential 75 W	45%	199,994	49,485
Residential 90 W	19%	82,606	20,439
Total	100%	443,504	109,737
Commercial 50 W	35%	66,285	7,290
Commercial 75 W	46%	87,117	9,581
Commercial 90 W	19%	35,983	3,957
Total	100%	189,386	20,828

3.5.4 Portion of the Market Impacted by the Regulation

According to NRCan, a portion of each product class already met the requirements due to U.S. standards, and only the affected portion of the 2018 actual shipments represents the impact achieved by the standard, as summarized in Table 33.

Table 33: Estimated Portion of the Incandescent Reflector Lamp Market Impacted by the Regulation⁶¹

Product Class	Percentage of Total Projected Shipments to Nova Scotia Affected by the Regulation in 2018	Shipments to Nova Scotia Affected by the Standard in 2018
Residential 50 W	100%	39,813
Residential 75 W	44%	21,773
Residential 90 W	89%	18,191
Residential Total	-	79,777
Commercial 50 W	100%	7,290
Commercial 75 W	44%	4,216
Commercial 90 W	89%	3,522
Commercial Total	-	15,027
Total		94,805

⁶⁰ Navigant. (2015). *Market Analysis for Incandescent Reflector Lamps. Final Report*. Prepared for: Natural Resources Canada,

⁶¹ Numbers may not add up due to rounding.

3.5.5 Unitary Savings Values

As outlined in Table 34, NRCan specifies the annual unitary energy savings for general-service incandescent reflector lamps affected by Amendment 13.⁶² NRCan estimates that the increase energy efficiency was approximately 25 percent.

Table 34: Unitary Savings Values for Incandescent Reflector Lamps

Product Class	Annual Energy Savings (kWh/unit)
Residential 50 W	7
Residential 75 W	13
Residential 90 W	18
Commercial 50 W	28
Commercial 75 W	52
Commercial 90 W	69

3.5.6 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. In the case of C&S, replacing lamps with more efficient products causes an increase in the heating load during winter and a decrease in the cooling load during summer.

For residential reflector lamps, the Evaluator applied the energy interactive effects factor developed for general-service incandescent lamps, as presented in Subsection 3.1.6.

For commercial reflector lamps, the Evaluator applied an energy interactive effects factor developed for reflector lamps purchased through the Instant Rebates service of the Business Energy Rebates (BER) program component. The interactive effects for BER Instant Rebates were based on the building types and associated heating and cooling systems verified during the SBES and BER Mail-in lighting project on-site visits conducted as part of the 2016 evaluation. In 2016, the energy interactive effects factor was -8.2 percent, while for BER Mail-in the average energy interactive effects factor was 0.3 percent for BER Mail-in. When averaged, these values resulted in an overall interactive effects factor of -4.0 percent for energy savings. As for peak demand savings interactive effects factors, the peak demand-to-energy ratios established by Navigant, and referenced in Subsection 3.5.8 below, already account for interactive effects since they were established through whole-building energy modelling.

Table 35 below summarizes the interactive effects for each product class.

⁶² Natural Resources Canada. (2016). *Energy Efficiency Regulations: A cost-benefit analysis, Canada Gazette, Part II*.

Table 35: Interactive Effects for General-service Incandescent Reflector Lamps

Product Class	Energy Interactive Effects Factor	Peak Demand Interactive Effects Factor
Residential 50 W	-22.20%	-43.00%
Residential 75 W	-22.20%	-43.00%
Residential 90 W	-22.20%	-43.00%
Commercial 50 W	-4.00%	-
Commercial 75 W	-4.00%	-
Commercial 90 W	-4.00%	-

3.5.7 Energy Savings - at the Meter

The Evaluator estimated that phasing out incandescent reflector lamps in Nova Scotia allowed to achieve a total of 1.331 GWh in energy savings in 2018, as summarized in Table 36.

Table 36: Energy Savings Associated with Phasing Out Incandescent Light Lamps in the Nova Scotia Market

Product Class	Shipments to Nova Scotia Affected by the Standard in 2018 (lamps)	Annual Energy Savings (kWh/yr/lamp)	Energy Interactive Effects Factor	Total Energy Savings at the Meter in 2018 (GWh)
Residential 50 W	39,813	7	-22.20%	0.217
Residential 75 W	21,773	13	-22.20%	0.220
Residential 90 W	18,191	18	-22.20%	0.255
Commercial 50 W	7,290	28	-4.00%	0.196
Commercial 75 W	4,216	52	-4.00%	0.210
Commercial 90 W	3,522	69	-4.00%	0.233
Total	94,805	-	-	1.331

3.5.8 Peak Demand Savings - at the Meter

As detailed in Subsection 3.1.7, the Evaluator recommends applying the NERHOU ratio of 0.162 W/kWh for residential incandescent lamps. As for commercial lamps, the Evaluator calculated the peak demand savings using the on-peak demand-to-energy ratios developed by Navigant in the 2016-2018 DSM Plan. The ratios outlined in Table 37 below were established for lighting in various commercial building types based on modelled system-coincident peak demand savings and energy savings for a projected deployment of measures. Navigant used local data to establish the ratios applicable for the 2016-2018 period. The Evaluator calculated the simple average peak demand-to-energy ratio for lighting in commercial buildings and obtained a value of 0.125 W/kWh.

Table 37: Peak Demand-to-energy Ratios for Commercial Lamps

Type of Commercial Building	Peak Demand-to-energy Ratio (W/kWh)
School	0.129
Retail	0.135
Office	0.121
Other	0.114
Average	0.125

The interactive effects factors developed and outlined in Subsection 3.5.6 were then applied to the residential peak demand-to-energy ratio for incandescent reflector lamps, as outlined in Table 38. As for commercial lamps, the peak demand-to-energy ratios established by Navigant already accounted for interactive effects since they were established through whole-building energy modelling.

Table 38: Adjusted Peak Demand-to-energy Ratios for Incandescent Reflector Lamps

Product Class	Peak Demand-to-energy Ratio	Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings	Adjusted Peak Demand-to-energy Ratio
Residential 50 W	0.162	-22.20%	-43.00%	0.119
Residential 75 W	0.162	-22.20%	-43.00%	0.119
Residential 90 W	0.162	-22.20%	-43.00%	0.119
Commercial 50 W	0.125	-	-	0.125
Commercial 75 W	0.125	-	-	0.125
Commercial 90 W	0.125	-	-	0.125

As presented in Table 39 below, the Evaluator estimated Nova Scotia's total peak demand savings at 0.162 MW for 2018.

Table 39: Peak Demand Savings Associated with the Introduction of Incandescent Reflector Lamp Standards in the Nova Scotia Market

Product Class	Total Energy Savings at the Meter in 2018 (GWh)	Adjusted Peak Demand-to-energy Ratio (MW/GWh)	Total Peak Demand Savings at the Meter in 2018 (MW)
Residential 50 W	0.217	0.119	0.026
Residential 75 W	0.220	0.119	0.026
Residential 90 W	0.255	0.119	0.030
Commercial 50 W	0.196	0.125	0.024
Commercial 75 W	0.210	0.125	0.026
Commercial 90 W	0.233	0.125	0.029
Total	1.331		0.162

3.6 General Service Fluorescent Lamps

3.6.1 Product Description

General-service fluorescent lamps (GSFL) are tube lights generally used for overhead lighting in offices and commercial spaces. They are often installed in areas where they are used for long periods of time. T12 lamps were introduced in the 1930s and they offered a much longer lifespan than incandescent lamps. T8 lamps were introduced in the early 1980s; they utilize the same sockets as the T12 lamps and provide more energy efficiency and even greater lifespans. T5 lamps were introduced in the 1990s in metric sizes, but they did not capture much of the market since they used different sockets than T8 lamps. The “T” indicates the tubular shape and the number represents the diameter in eighths of an inch (i.e. 12/8, 8/8, 5/8 inches). A number of fluorescent lamps were excluded from the regulatory definition, such as fluorescent lamps used for: plants; cold temperatures; coloured lighting; impact resistance; and producing ultraviolet radiation.

3.6.2 Regulation Description

Amendment 13 to the Energy Efficiency Regulations included general-service fluorescent lamps to align energy efficiency requirements to those in force in the United States. The Canadian regulations were introduced in two stages: Tier I regulations became effective in 2016; and Tier II regulations became effective in 2018. Since the introduction of Tier II regulations occurred in 2018, and distributors can ship units manufactured before the compliance date, the impact on the market will likely be felt starting in 2019. Therefore the 2018 evaluation focuses on the impact of the Tier I regulation.

These were brought in following equivalent regulations developed in the U.S. The regulations were intended to encourage the use of higher-efficiency lamps, with Tier I regulations requiring approximately 20 percent greater efficiency. The Tier I regulations listed in Table 40 were applied according to product length, socket or pin type, start type (instant or rapid), output (standard or high), and correlated colour temperature (under 4,500 Kelvin, or between 4,500 and 7,000 Kelvin).

Table 40: Schedules for Fluorescent Lamp Compliance with New Standards⁶³

Lamp Type	Correlated Colour Temperature (K)	Minimum average efficacy (lm/W)	Manufactured on or After
1,200 mm (48 in) medium bi-pin base, rapid-start	≤ 4,500	89	July 15, 2012
	> 4,500 and ≤ 7,000	88	
560 to 635 mm (22 to 25 in) U-shaped, rapid-start	≤ 4,500	84	July 15, 2012
	> 4,500 and ≤ 7,000	81	
2,400 mm (96 in) Slimline, single-pin base, instant-start	≤ 4,500	97	July 15, 2012
	> 4,500 and ≤ 7,000	93	
2,400 mm (96 in) High-output, recessed double-contact base, rapid-start	≤ 4,500	92	July 15, 2012
	> 4,500 and ≤ 7,000	88	
≥ 1,125 mm (45 in) and ≤ 1,200 mm (48 in), miniature bi-pin, ≥ 25 W (standard output)	≤ 4,500	86	July 15, 2012
	> 4,500 and ≤ 7,000	81	
≥ 1,125 mm (45 in) and ≤ 1,200 mm (48 in), miniature bi-pin, ≥ 44 W (high output)	≤ 4,500	76	July 15, 2012
	> 4,500 and ≤ 7,000	72	

Note: K = Kelvin; lm/W = lumens per W.

⁶³ ICF Consulting Canada. (2015). *Market Study: General Service Fluorescent Lamps (GSFLs)*. Prepared for: Office of Energy Efficiency, Natural Resources Canada.

3.6.3 Market Size Estimate

EFC provided information about lighting product shipments to Atlantic Canada from 2004 to the end of 2018, and this information was converted into estimates for Nova Scotia based on population share. There was a peak of total general service fluorescent lamp shipments in 2013, followed by minor annual variability with an overall declining trend to 2017 when shipments were just 40 percent below the levels reached in 2013, followed by a small increase in 2018. The decline was primarily due to the improved lifespan of products and reduced need for replacements. All three lamp types maintained steady market shares from 2008 onward with T5 lamps below 5 percent, T8 lamps between 60 and 65 percent, and T12 lamps between 30 and 35 percent. NRCan provided further breakdowns for T5, T8, and T12 residential and commercial shipments for 2017, and the percentage shares for each product class were applied to the Nova Scotia estimates. The 2017 shipment levels were the basis for the projected 2018 shipments assuming the new standards had not been in force. Table 41 presents the projected market size in 2018 and compares it to actual shipment data obtained through EFC for the same year.

Table 41: Fluorescent Lamp Market Size Estimates for Nova Scotia, 2018

Product Class	NRCan Share of Class* Shipments in 2017	Actual Shipments to Nova Scotia in 2018 (lamps)
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 25 W (standard-output)	37%	6,669
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W (high-output)	63%	11,601
Res. T8 1,200 mm, ≥ 25 W	97%	335,793
Res. T8 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	3%	11,972
Res. T12 1,200 mm, ≥ 25 W	97%	249,208
Res. T12 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	3%	6,419
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 26 W (standard-output)	36%	10,469
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W (high-output)	64%	18,213
C&I T8 1,200 mm, ≥ 25 W	97%	301,238
C&I T8 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	3%	10,740
C&I T12 1,200 mm, ≥ 25 W	97%	125,406
C&I T12 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	3%	3,230

*Each pair of shaded rows is a product class where NRCan shares total 100%.

Note: Res = Residential; C&I = Commercial and Industrial.

3.6.4 Portion of the Market Impacted by the Regulation

According to NRCan, a portion of each product class already met the requirements due to U.S. standards, and only the affected portion of the 2018 actual shipments represents the impact achieved by the standard, as summarized in Table 42.

Table 42: Estimated Portion of the Fluorescent Lamp Market Impacted by the Regulation

Product Class	Percentage of Total Projected Shipments to Nova Scotia Affected by the Regulation in 2018 ⁶⁴	Shipments to Nova Scotia Affected by the Standard in 2018
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 26 W (standard-output)	0%	-
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W (high-output)	0%	-
Res. T8 1,200 mm, ≥ 25 W	0%	-
Res. T8 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	0%	-
Res. T12 1,200 mm, ≥ 25 W	100%	249,208
Res. T12 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	100%	6,419
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 26 W (standard-output)	0%	-
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W (high-output)	0%	-
C&I T8 1,200 mm, ≥ 25 W	0%	-
C&I T8 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	0%	-
C&I T12 1,200 mm, ≥ 25 W	100%	125,406
C&I T12 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	100%	3,230
Total		384,264

Note: Res = Residential; C&I = Commercial and Industrial.

3.6.5 Unitary Savings Values

In Amendment 13, NRCan specifies the average unitary savings values listed in Table 43 for T5, T8 and T12 fluorescent lamps with a residential, commercial or industrial use.⁶⁵

⁶⁴ Natural Resources Canada. (2016). *Energy Efficiency Regulations: A cost-benefit analysis, Canada Gazette, Part II.*

⁶⁵ Ibid.

Table 43: Unitary Savings Values for Tier II General-service Fluorescent Lamps

Product Class	Unitary Savings Value (kWh)
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 26 W (standard-output)	0.2
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W (high-output)	0.4
Res. T8 1,200 mm, ≥ 25 W	0.5
Res. T8 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	2.8
Res. T12 1,200 mm, ≥ 25 W	2.8
Res. T12 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	3.0
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 26 W (standard-output)	1.3
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W (high-output)	2.5
C&I T8 1,200 mm, ≥ 25 W	3.4
C&I T8 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	19.7
C&I T12 1,200 mm, ≥ 25 W	18.2
C&I T12 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	19.7

3.6.6 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. In the case of C&S, replacing lamps with more efficient products causes an increase in the heating load during winter and a decrease in the cooling load during summer.

For residential lamps, the Evaluator applied the interactive effects factors developed for general-service incandescent lamps, as presented in Subsection 3.1.6.

For commercial and industrial lamps, the Evaluator applied the energy interactive effects factors developed for linear lamps purchased through the BER Instant Rebates service of the Efficient Product Rebates program. The interactive effects for BER Instant Rebates were based on the building types and associated heating and cooling systems verified during the SBES and BER Mail-in lighting project on-site visits conducted as part of the 2016 evaluation. In 2016, the energy interactive effects factor was -8.2 percent for SBES, while the average energy interactive effects factor was 0.3 percent for BER Mail-in. When averaged, these values resulted in an overall interactive effects factor of -4.0 percent for energy savings. Additionally, the Evaluator applied a factor of 57 percent to the interactive effects of both residential and commercial/industrial lamps to take into account the limited contribution of recessed fixtures. In 2018, the Evaluator estimated that 42 percent of the energy savings generated by linear lamps in BER Instant Rebates was from recessed fixtures. As for peak demand savings interactive effects factors, the peak demand-to-energy ratios established by Navigant, and referenced in Subsection 3.6.7 below, already account for interactive effects since they were established through whole-building energy modelling.

Table 44 summarizes the interactive effects for each product class.

Table 44: Interactive Effects for General-service Fluorescent Lamps

Product Class	Energy Interactive Effects Factor	Peak Demand Interactive Effects Factor
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 26 W (standard-output)	-18.19%	-35.23%
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W (high-output)	-18.19%	-35.23%
Res. T8 1,200 mm, ≥ 25 W	-18.19%	-35.23%
Res. T8 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	-18.19%	-35.23%
Res. T12 1,200 mm, ≥ 25 W	-18.19%	-35.23%
Res. T12 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	-18.19%	-35.23%
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 26 W (standard-output)	-2.32%	-
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W (high-output)	-2.32%	-
C&I T8 1,200 mm, ≥ 25 W	-2.32%	-
C&I T8 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	-2.32%	-
C&I T12 1,200 mm, ≥ 25 W	-2.32%	-
C&I T12 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	-2.32%	-

3.6.7 Energy Savings - at the Meter

The Evaluator estimated that the standards for fluorescent lamps in Nova Scotia allowed to achieve a total of 2.878 GWh in energy savings in 2018, as summarized in Table 45.

**Table 45: Energy Savings Associated with Standards for Fluorescent Lamps
in the Nova Scotia Market**

Product Class	Shipments to Nova Scotia Affected by the Standard in 2018 (lamps)	Annual Energy Savings (kWh/yr/lamp)	Interactive Effects Factor	Total Energy Savings at the Meter in 2018 (GWh)
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 26 W (standard-output)	0	0.2	-18.19%	0.000
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W (high-output)	0	0.4	-18.19%	0.000
Res. T8 1,200 mm, ≥ 25 W	0	0.5	-18.19%	0.000
Res. T8 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	0	2.8	-18.19%	0.000
Res. T12 1,200 mm, ≥ 25 W	249,208	2.8	-18.19%	0.571
Res. T12 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	6,419	3	-18.19%	0.016
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 26 W (standard-output)	0	1.3	-2.32%	0.000
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W (high-output)	0	2.5	-2.32%	0.000
C&I T8 1,200 mm, ≥ 25 W	0	3.4	-2.32%	0.000
C&I T8 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	0	19.7	-2.32%	0.000
C&I T12 1,200 mm, ≥ 25 W	125,406	18.2	-2.32%	2.229
C&I T12 ≥ 560 mm and ≤ 635 mm, U-shaped, ≥ 25 W	3,230	19.7	-2.32%	0.062
Total	384,264			2.878

Note: Res = Residential; C&I = Commercial and Industrial.

3.6.8 Peak Demand Savings - at the Meter

As detailed in Subsection 3.1.7 above, the Evaluator recommends applying the NERHOU ratio of 0.162 W/kWh for residential lamps. As for commercial and industrial lamps, the Evaluator calculated the peak demand savings using the on-peak demand-to-energy ratios developed by Navigant in the 2016-2018 DSM Plan. The ratios outlined in Table 46 below were established for lighting in various commercial and industrial building types based on modelled system-coincident peak demand savings and energy savings for a projected deployment of measures. Navigant used local data to establish the ratios applicable for the 2016-2018 period. As detailed in Subsection 3.5.8, the Evaluator calculated the average peak demand-to-energy ratio for commercial lighting products, which was established at 0.125 W/kWh. The Navigant ratio for industrial lighting was 0.180 W/kWh. Based on 2018 BER Mail-in results, the Evaluator found that 25 percent of lighting savings were from the industrial sector and 75 percent from the commercial sector, and therefore applied these weights to determine the overall peak demand-to-energy ratio. The average of these two values was established at 0.139 W/kWh.

Table 46: Peak Demand-to-energy Ratios for Commercial and Industrial Lamps

Type of Building	Average Peak Demand-to-energy Ratio per Sector (W/kWh)	Overall Average Peak Demand-to-energy Ratio (W/kWh)
Commercial	0.125	0.139
Industrial	0.180	

The interactive effects factors outlined in Subsection 3.6.6 were then applied to the peak demand-to-energy ratio for residential general-service fluorescent lamps, as outlined in Table 47. As for commercial and industrial lamps, the peak demand-to-energy ratios established by Navigant already accounted for interactive effects since they were established through whole-building energy modelling.

Table 47: Adjusted Peak Demand-to-energy Ratios for General-service Fluorescent Lamps

Product Class	Peak Demand-to-Energy Ratio	Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings	Adjusted Peak Demand-to-energy Ratio
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 25 W	0.162	-18.19%	-35.23%	0.128
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W	0.162	-18.19%	-35.23%	0.128
Res. T8 1,200 mm, ≥ 25 W	0.162	-18.19%	-35.23%	0.128
Res. T8 ≥ 560 mm and ≤ 635 mm, ≥ 25 W	0.162	-18.19%	-35.23%	0.128
Res. T12 1,200 mm, ≥ 25 W	0.162	-18.19%	-35.23%	0.128
Res. T12 ≥ 560 mm and ≤ 635 mm, ≥ 25 W	0.162	-18.19%	-35.23%	0.128
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 25 W	0.139	-	-	0.139
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W	0.139	-	-	0.139
C&I T8 1,200 mm, ≥ 25 W	0.139	-	-	0.139
C&I T8 ≥ 560 mm and ≤ 635 mm, ≥ 25 W	0.139	-	-	0.139
C&I T12 1,200 mm, ≥ 25 W	0.139	-	-	0.139
C&I T12 ≥ 560 mm and ≤ 635 mm, ≥ 25 W	0.139	-	-	0.139

As presented in Table 48 below, the Evaluator estimated Nova Scotia's total peak demand savings at 0.394 MW in 2018.

Table 48: Peak Demand Savings Associated with the Introduction of General-service Fluorescent Lamp Standards in the Nova Scotia Market

Product Class	Total Energy Savings at the Meter in 2018 (GWh)	Adjusted Peak Demand-to-energy Ratio (MW/GWh)	Total Peak Demand Savings at the Meter in 2018 (MW)
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 25 W	0.000	0.128	0.000
Res. T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W	0.000	0.128	0.000
Res. T8 1,200 mm, ≥ 25 W	0.000	0.128	0.000
Res. T8 ≥ 560 mm and ≤ 635 mm, ≥ 25 W	0.000	0.128	0.000
Res. T12 1,200 mm, ≥ 25 W	0.571	0.128	0.073
Res. T12 ≥ 560 mm and ≤ 635 mm, ≥ 25 W	0.016	0.128	0.002
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 25 W	0.000	0.139	0.000
C&I T5 $\geq 1,125$ mm and $\leq 1,200$ mm, ≥ 49 W	0.000	0.139	0.000
C&I T8 1,200 mm, ≥ 25 W	0.000	0.139	0.000
C&I T8 ≥ 560 mm and ≤ 635 mm, ≥ 25 W	0.000	0.139	0.000
C&I T12 1,200 mm, ≥ 25 W	2.229	0.139	0.310
C&I T12 ≥ 560 mm and ≤ 635 mm, ≥ 25 W	0.062	0.139	0.009
Total	2.878		0.394

Note: Res = Residential; C&I = Commercial and Industrial.

3.7 Fluorescent Lamp Ballasts

3.7.1 Product Description

Fluorescent lamp ballasts include electronic or magnetic ballasts that regulate the flow of electricity to fluorescent lighting systems. The most common ballasts are those used in GSFL for overhead lighting in offices and commercial spaces. Ballasts include specifications for their usage, such as different lamps (T5, T8, and T12), the number of combined lamps from 1 to 6, standard and high-output lamps, instant and rapid-start lamps, and programmable start lamps.

3.7.2 Regulation Description

Amendment 13 to the Energy Efficiency Regulations included fluorescent lamp ballasts to align energy efficiency requirements to those in force in the United States. The regulation is detailed in the Canadian Standards Association document entitled CAN/CSA-C654-14 for fluorescent lamp ballast efficacy measurements and aligns with the U.S. standard in effect since November 2014. The MEPS raised the energy efficiency to what was considered the state-of-the-art technology at the time. This standard also introduced a new method of measuring ballast efficacy. Instead of comparing a test ballast to a reference ballast to determine a ballast efficacy factor, the new method of ballast luminous efficacy compares arc power across the lamp, modified by a frequency adjustment. This modification reduces measurement errors and equipment requirements for testing. The MEPS requires non-dimmable lamp ballasts to reach 94.4 to 99.3 percent efficiency when converting input power to lamp arc power.

3.7.3 Market Size Estimate

EFC provided information about ballast product shipments to Atlantic Canada from 2004 to the end of 2018, and this information was converted into estimates for Nova Scotia based on population share. Since ballasts are used for general-service fluorescent lamps, the historical trends were similar. Sales of ballasts for T12 lamps declined steadily as ballasts for T8 lamps increased to a peak in 2009, then declined to 2017. There were minor annual variations in shipments of all ballasts, with an overall declining trend to 2017 when shipments were about 39 percent of the peak, and then an increase which occurred in 2018. The decline was primarily due to the improved lifespan of products and reduced need for replacements. NRCan provided further breakdowns for residential, commercial, and industrial shipments for 2017, and the percentage shares for each product class were applied to the Nova Scotia estimates. The 2017 shipment levels were the basis for the projected 2018 shipments assuming that the new standards had not been in force. Table 49 presents the projected market size in 2018 and compares it to actual shipment data obtained through EFC for the same year.

Table 49: Fluorescent Lamp Ballast Market Size Estimates for Nova Scotia, 2018

Product Class	NRCan Share of Class* Shipments in 2017	Actual Shipments to Nova Scotia in 2018
Com – 2 lamp med bi-pin (IS) 4-ft	84%	16,402
Ind – 2 lamp med bi-pin (IS) 4-ft	7%	1,348
Res – 2 lamp med bi-pin (IS) 4-ft	9%	1,700
Com – 4 lamp med bi-pin (IS) 4-ft	84%	6,706
Ind – 4 lamp med bi-pin (IS) 4-ft	7%	551
Res – 4 lamp med bi-pin (IS) 4-ft	9%	695
Com – 2 lamp slimline (IS) 8-ft	78%	863
Ind – 2 lamp slimline (IS) 8-ft	9%	99
Res – 2 lamp slimline (IS) 8-ft	13%	144
Com – 2 lamp (IS/RS) 8-ft high-output	31%	186
Ind – 2 lamp (IS/RS) 8-ft high-output	69%	412
Res – 2 lamp (IS/RS) 8-ft high-output	0%	0
Com – 4 lamp (IS/RS) 8-ft high-output sign	11%	607
Ind – 4 lamp (IS/RS) 8-ft high-output sign	89%	4,941
Res – 4 lamp (IS/RS) 8-ft high-output sign	0%	0
Com – 2 lamp med pin	85%	23,121
Ind – 2 lamp med pin	6%	1,742
Res – 2 lamp med pin	9%	2,468

*Each set of three shaded rows represents a product class wherein NRCan shares total 100%.

Note: Com = Commercial; Ind = Industrial; Res = Residential; IS = Instant Start; RS = Rapid Start

3.7.4 Portion of the Market Impacted by the Regulation

According to NRCan, a portion of each product class already met the requirements due to U.S. standards, and only the affected portion of the 2018 actual shipments represents the impact achieved by the standard, as summarized in Table 50.

Table 50: Estimated Portion of the Fluorescent Lamp Ballast Market Impacted by the Regulation

Product Class	Percentage of Total Projected Shipments to Nova Scotia Affected by the Regulation in 2018	Shipments to Nova Scotia Affected by the Standard in 2018
Com – 2 lamp med bi-pin (IS) 4-ft	63%	10,333
Ind – 2 lamp med bi-pin (IS) 4-ft	63%	850
Res – 2 lamp med bi-pin (IS) 4-ft	63%	1,071
Com – 4 lamp med bi-pin (IS) 4-ft	63%	4,225
Ind – 4 lamp med bi-pin (IS) 4-ft	63%	347
Res – 4 lamp med bi-pin (IS) 4-ft	63%	438
Com – 2 lamp slimline (IS) 8-ft	63%	544
Ind – 2 lamp slimline (IS) 8-ft	63%	62
Res – 2 lamp slimline (IS) 8-ft	63%	91
Com – 2 lamp (IS/RS) 8-ft high-output	79%	147
Ind – 2 lamp (IS/RS) 8-ft high-output	79%	325
Res – 2 lamp (IS/RS) 8-ft high-output	79%	-
Com – 4 lamp (IS/RS) 8-ft high-output sign	44%	267
Ind – 4 lamp (IS/RS) 8-ft high-output sign	44%	2,174
Res – 4 lamp (IS/RS) 8-ft high-output sign	44%	-
Com – 2 lamp med pin	77%	17,803
Ind – 2 lamp med pin	77%	1,341
Res – 2 lamp med pin	77%	1,900
Total	-	41,919

Note: Com = Commercial; Ind = Industrial; Res = Residential; IS = Instant Start; RS = Rapid Start

3.7.5 Unitary Savings Values

As listed in Table 51 below, NRCan specifies in Amendment 13 the average unitary savings values for T5, T8 and T12 fluorescent lamp ballasts with a residential, commercial and industrial use.

Table 51: Unitary Savings Values for Fluorescent Lamp Ballasts⁶⁶

Product Class	Annual Energy Savings (kWh/unit)
Com – 2 lamp med bi-pin (IS) 4-ft	12
Ind – 2 lamp med bi-pin (IS) 4-ft	15
Res – 2 lamp med bi-pin (IS) 4-ft	3
Com – 4 lamp med bi-pin (IS) 4-ft	11
Ind – 4 lamp med bi-pin (IS) 4-ft	13
Res – 4 lamp med bi-pin (IS) 4-ft	2
Com – 2 lamp slimline (IS) 8-ft	30
Ind – 2 lamp slimline (IS) 8-ft	37
Res – 2 lamp slimline (IS) 8-ft	6
Com – 2 lamp (IS/RS) 8-ft high-output	112
Ind – 2 lamp (IS/RS) 8-ft high-output	137
Res – 2 lamp (IS/RS) 8-ft high-output	23
Com – 4 lamp (IS/RS) 8-ft high-output sign	430
Ind – 4 lamp (IS/RS) 8-ft high-output sign	526
Res – 4 lamp (IS/RS) 8-ft high-output sign	87
Com – 2 lamp med pin	46
Ind – 2 lamp med pin	56
Res – 2 lamp med pin	9

Note: Com = Commercial; Ind = Industrial; Res = Residential; IS = Instant Start; RS = Rapid Start

3.7.6 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. In the case of C&S, replacing lamps with more efficient products causes an increase in the heating load during winter and a decrease in the cooling load during summer.

⁶⁶ Natural Resources Canada. (2016). *Energy Efficiency Regulations: A cost-benefit analysis, Canada Gazette, Part II*.

For fluorescent ballasts, the interactive effects factors for residential, commercial and industrial fluorescent lamp ballasts correspond to those developed for general-service fluorescent lamps, as presented in Subsection 3.6.6.

Table 52 below summarizes the interactive effects for each product class.

Table 52: Interactive Effects for Fluorescent Lamp Ballasts

Product Class	Energy Interactive Effects Factor	Peak Demand Interactive Effects Factor
Com – 2 lamp med bi-pin (IS) 4-ft	-2.32%	-
Ind – 2 lamp med bi-pin (IS) 4-ft	-2.32%	-
Res – 2 lamp med bi-pin (IS) 4-ft	-18.19%	-35.23%
Com – 4 lamp med bi-pin (IS) 4-ft	-2.32%	-
Ind – 4 lamp med bi-pin (IS) 4-ft	-2.32%	-
Res – 4 lamp med bi-pin (IS) 4-ft	-18.19%	-35.23%
Com – 2 lamp slimline (IS) 8-ft	-2.32%	-
Ind – 2 lamp slimline (IS) 8-ft	-2.32%	-
Res – 2 lamp slimline (IS) 8-ft	-18.19%	-35.23%
Com – 2 lamp (IS/RS) 8-ft high-output	-2.32%	-
Ind – 2 lamp (IS/RS) 8-ft high-output	-2.32%	-
Res – 2 lamp (IS/RS) 8-ft high-output	-18.19%	-35.23%
Com – 4 lamp (IS/RS) 8-ft high-output sign	-2.32%	-
Ind – 4 lamp (IS/RS) 8-ft high-output sign	-2.32%	-
Res – 4 lamp (IS/RS) 8-ft high-output sign	-18.19%	-35.23%
Com – 2 lamp med pin	-2.32%	-
Ind – 2 lamp med pin	-2.32%	-
Res – 2 lamp med pin	-18.19%	-35.23%

3.7.7 Energy Savings - at the Meter

The Evaluator estimated that the standards for fluorescent lamp ballasts in Nova Scotia allowed to achieve a total of 2.381 GWh in energy savings for 2018, as summarized in Table 53.

Table 53: Energy Savings Associated with Phasing Out Fluorescent Lamp Ballasts in the Nova Scotia Market

Product Class	Shipments to Nova Scotia Affected by the Standard in 2018	Annual Energy Savings (kWh/yr/unit)	Interactive Effects Factor	Total Energy Savings at the Meter in 2018 (GWh)
Com – 2 lamp med bi-pin (IS) 4-ft	10,333	12	-2.32%	0.121
Ind – 2 lamp med bi-pin (IS) 4-ft	850	15	-2.32%	0.012
Res – 2 lamp med bi-pin (IS) 4-ft	1,071	3	-18.19%	0.003
Com – 4 lamp med bi-pin (IS) 4-ft	4,225	11	-2.32%	0.045
Ind – 4 lamp med bi-pin (IS) 4-ft	347	13	-2.32%	0.004
Res – 4 lamp med bi-pin (IS) 4-ft	438	2	-18.19%	0.001
Com – 2 lamp slimline (IS) 8-ft	544	30	-2.32%	0.016
Ind – 2 lamp slimline (IS) 8-ft	62	37	-2.32%	0.002
Res – 2 lamp slimline (IS) 8-ft	91	6	-18.19%	0.000
Com – 2 lamp (IS/RS) 8-ft high-output	147	112	-2.32%	0.016
Ind – 2 lamp (IS/RS) 8-ft high-output	325	137	-2.32%	0.044
Res – 2 lamp (IS/RS) 8-ft high-output	0	23	-18.19%	0.000
Com – 4 lamp (IS/RS) 8-ft high-output sign	267	430	-2.32%	0.112
Ind – 4 lamp (IS/RS) 8-ft high-output sign	2,174	526	-2.32%	1.117
Res – 4 lamp (IS/RS) 8-ft high-output sign	0	87	-18.19%	0.000
Com – 2 lamp med pin	17,803	46	-2.32%	0.800
Ind – 2 lamp med pin	1,341	56	-2.32%	0.073
Res – 2 lamp med pin	1,900	9	-18.19%	0.014
Total	41,919			2.381

Note: Com = Commercial; Ind = Industrial; Res = Residential; IS = Instant Start; RS = Rapid Start

3.7.8 Peak Demand Savings - at the Meter

For fluorescent ballasts, the adjusted peak demand-to-energy ratios for residential, commercial and industrial fluorescent lamp ballasts correspond to those developed for general-service fluorescent lamps, as presented in Subsection 3.6.8.

As outlined in Table 54 below, the Evaluator estimated Nova Scotia's total peak demand savings at 0.331 MW for 2018.

Table 54: Peak Demand Savings Associated with the Introduction of Fluorescent Lamp Standards in the Nova Scotia Market

Product Class	Total Energy Savings at the Meter in 2018 (GWh)	Adjusted Peak Demand-to-energy Ratio (MW/GWh)	Total Peak Demand Savings at the Meter in 2018 (MW)
Com – 2 lamp med bi-pin (IS) 4-ft	0.121	0.139	0.017
Ind – 2 lamp med bi-pin (IS) 4-ft	0.012	0.139	0.002
Res – 2 lamp med bi-pin (IS) 4-ft	0.003	0.128	0.000
Com – 4 lamp med bi-pin (IS) 4-ft	0.045	0.139	0.006
Ind – 4 lamp med bi-pin (IS) 4-ft	0.004	0.139	0.001
Res – 4 lamp med bi-pin (IS) 4-ft	0.001	0.128	0.000
Com – 2 lamp slimline (IS) 8-ft	0.016	0.139	0.002
Ind – 2 lamp slimline (IS) 8-ft	0.002	0.139	0.000
Res – 2 lamp slimline (IS) 8-ft	0.000	0.128	0.000
Com – 2 lamp (IS/RS) 8-ft high-output	0.016	0.139	0.002
Ind – 2 lamp (IS/RS) 8-ft high-output	0.044	0.139	0.006
Res – 2 lamp (IS/RS) 8-ft high-output	0.000	0.128	0.000
Com – 4 lamp (IS/RS) 8-ft high-output sign	0.112	0.139	0.016
Ind – 4 lamp (IS/RS) 8-ft high-output sign	1.117	0.139	0.155
Res – 4 lamp (IS/RS) 8-ft high-output sign	0.000	0.128	0.000
Com – 2 lamp med pin	0.800	0.139	0.111
Ind – 2 lamp med pin	0.073	0.139	0.010
Res – 2 lamp med pin	0.014	0.128	0.002
Total	2.381		0.331

Note: Res = Residential; C&I = Commercial and Industrial.

3.8 Total Savings at the Generator

Incremental annual energy savings at the meter were calculated by taking into account all product categories for which information about the market size, non-compliance rates, and unitary savings values was available. As for the savings calculations at the generator, the Evaluator used a line loss factor of 1.100 for the residential sector, 1.063 for the commercial and industrial sectors, and 1.046 for the municipal sector, as provided by NSP, to account for transmission and distribution losses.

The 2018 overall energy and peak demand savings for C&S were estimated at 23.809 GWh and 4.008 MW at the generator respectively, as summarized in Table 55 below. Overall, using the 2017 Nova Scotia-specific factor⁶⁷ of GHG generated by electricity production, 0.6126 kg CO₂ eq/kWh, it was estimated that the net energy savings resulted in 14,585 tonnes of avoided CO₂ eq annually.

⁶⁷ At the time of writing, 2018 data were not yet available. The Nova Scotia-specific factor was obtained from Nova Scotia Power's 2017 total system emissions data (6,725,126 CO₂ eq tonnes) and total electricity generation (10,978 GWh) was found in the following two sources:

Nova Scotia Power, *Total System Emissions*, <https://www.nspower.ca/en/home/about-us/environmental-commitment/air-emissions-reporting/total-system-emissions-all-plants.aspx> (Last accessed November 28, 2018).

Emera Inc., *Management's Discussion & Analysis* as at February 9, 2018, <http://investors.emera.com/Cache/1001232090.PDF?Y=&O=PDF&D=&fid=1001232090&T=&iid=4072693> (Last accessed November 28, 2018).

Table 55: Codes and Standards Overall Incremental Annual Energy and Peak Demand Savings, 2018

Product Category	Incandescent Lamps	LED Street Lighting	New Buildings (Houses and Small Buildings)	New Buildings (Large Buildings, Condos and Apartments)	Clothes Washers	General Service Incandescent Reflector Lamps	General Service Fluorescent Lamps	Fluorescent Lamp Ballasts	Total
Energy Savings									
Number of Units	548,163	5,390	1,869	224	21,659	94,805	384,264	41,919	-
Total Energy Savings-at the Meter (GWh)	9.000	1.234	1.385	2.753	1.012	1.331	2.878	2.381	21.975
Line Loss Factor	1.100	1.046	1.100	1.063	1.100	1.082	1.071	1.063	-
Total Energy Savings-at the Generator (GWh)	9.899	1.291	1.524	2.926	1.113	1.441	3.081	2.532	23.809
Peak Demand Savings									
Total Peak Demand Savings-at the Meter (MW)	1.071	0.307	0.392	0.917	0.140	0.162	0.394	0.331	3.714
Line Loss Factor	1.100	1.046	1.100	1.063	1.100	1.082	1.070	1.063	-
Total Peak Demand Savings-at the Generator (MW)	1.178	0.321	0.432	0.974	0.154	0.176	0.421	0.352	4.008

3.9 Recommendations

International experience and the Evaluator's own experience suggest that evaluating the energy impact of regulations or policies is usually more difficult than calculating the impacts of DSM programs that have lists of participants and details on specific measures installed. For the C&S evaluation, the main challenge was to establish the size of the market impacted by the new codes and standards. This involves not only establishing the quantity of products sold in a specific market, but also making in-depth characterization of a given market (e.g. quantity by size, type, efficiency level, etc.). Depending on the product, this information can be difficult to obtain or even impossible in some cases. Based on the results of the evaluation activities, the Evaluator makes the following recommendations on how to ensure the success of future C&S impact evaluations. The following recommendations are also outlined in Appendix I of the Codes and Standards Appendix Report.

- CS-R3. Consider removing houses and small buildings from the scope of the 2019 evaluation.** While the adoption of the 2015 National Building Code (NBC) under the Nova Scotia Building Code is recent, the Evaluator found that the impact on energy efficiency is negligible and thus continued to apply the energy savings from the previous code in the 2018 evaluation for houses and small buildings. Considering that ENS has reported on C&S savings based on 2012 revision of the NBC since 2015, the Evaluator suggests removing the NBC 2015 from the scope of the 2019 evaluation. As for large buildings, condos and apartments, the introduction of the 2015 National Energy Code for Buildings (NECB) under the Nova Scotia Building Code has increased the minimum efficiency standards since the previous edition of the code, and thus the Evaluator recommends keeping the NECB 2015 in the 2019 evaluation scope.
- CS-R4. Consider removing incandescent lamps from the scope of the 2019 evaluation.** While incandescent lamps generate the largest share of Codes and Standards savings, ENS has reported on C&S savings for 75 W and 100 W lamps since the 2014 evaluation as well as savings for 40 W and 60 W lamps since the 2015 evaluation. Considering the time elapsed since the introduction of the regulation, the Evaluator recommends removing incandescent lamps from the scope of the 2019 evaluation and continuing to focus on more recent lighting regulations such as those for general service incandescent lamps, general service fluorescent lamps, and fluorescent lamp ballasts.

LIST OF APPENDICES

The following is presented in the C&S– Appendices.

Codes and Standards

Appendix I - C&S: 2018 Recommendations



ECONOLER

INTRODUCTION OF NEW CODES AND STANDARDS IN NOVA SCOTIA

2018 DSM EVALUATION

EFFICIENCY NOVA SCOTIA

Appendix Report

March 15, 2019



ECONOLER

TABLE OF CONTENTS

APPENDIX I 2018 RECOMMENDATIONS	1

APPENDIX I

2018 RECOMMENDATIONS

This appendix summarizes all the recommendations made by the Evaluator as part of the 2018 evaluation. There were no incomplete 2017 recommendations at the time of writing.

Sections	Recommendations
Executive Summary	1 Consider removing houses and small buildings from the scope of the 2019 evaluation. While the adoption of the 2015 National Building Code (NBC) under the Nova Scotia Building Code is recent, the Evaluator found that the impact on energy efficiency is negligible and thus continued to apply the energy savings from the previous code in the 2018 evaluation for houses and small buildings. Considering that ENS has reported on C&S savings based on 2012 revision of the NBC since 2015, the Evaluator suggests removing the NBC 2015 from the scope of the 2019 evaluation. As for large buildings, condos and apartments, the introduction of the 2015 National Energy Code for Buildings (NECB) under the Nova Scotia Building Code has increased the minimum efficiency standards since the previous edition of the code, and thus the Evaluator recommends keeping the NECB 2015 in the 2019 evaluation scope.
	2 Consider removing incandescent lamps from the scope of the 2019 evaluation. While incandescent lamps generate the largest share of Codes and Standards savings, ENS has reported on C&S savings for 75 W and 100 W lamps since the 2014 evaluation as well as savings for 40 W and 60 W lamps since the 2015 evaluation. Considering the time elapsed since the introduction of the regulation, the Evaluator recommends removing incandescent lamps from the scope of the 2019 evaluation and continuing to focus on more recent lighting regulations such as those for general service incandescent lamps, general service fluorescent lamps, and fluorescent lamp ballasts.



ECONOLER