Appendix D – Econoler Evaluation Reports

List of Reports

1. 2018/2019-2019/2020 Electricity Efficiency And Conservation (EE&C) Program Evaluation: Summary of Portfolio Results Prepared on June 29, 2020
2. 2018/2019 And 2019/2020 Energy Efficient Equipment Rebates Program Evaluation: Final Report Prepared on June 29, 2020
3. 2018/2019 And 2019/2020 Home Insulation Rebates Program Evaluation: Final Report Prepared on June 26, 2020
4. 2018/2019 And 2019/2020 Instant Energy Savings Program Evaluation: Final Report Prepared on June 29, 2020
5. 2018/2019 And 2019/2020 New Home Construction Program Evaluation: Final Report Prepared on June 26, 2020
6. 2018/2019 And 2019/2020 Winter Warming Program Evaluation: Final Report Prepared on June 29, 2020
7. 2018/2019 And 2019/2020 Business Energy Rebates Program Evaluation: Final Report Prepared on June 29, 2020
8. 2019/2020 Small Business Energy Solutions and Custom Programs Assessment: Letter from Econoler to efficiencyPEI Prepared on June 26, 2020

2018/2019-2019/2020 ELECTRICITY EFFICIENCY AND CONSERVATION (EE&C) PROGRAM EVALUATION

EFFICIENCYPEI

Summary of Portfolio Results

June 29, 2020

ECONOLER

ACRONYMS

BER	Business Energy Rebates (program)
EE&C	Electricity Efficiency and Conservation
EEER	Energy Efficient Equipment Rebates (program)
ePEI	efficiencyPEI
HIR	Home Insulation Rebates (program)
IES	Instant Energy Savings (program)
NHC	New Home Construction (program)
PAC	Program Administrator Cost (test)
PEI	Prince Edward Island
TRC	Total Resource Cost (test)
WW	Winter Warming (program)

DEFINITIONS

Evaluated savings	Gross and net savings calculated by the Evaluator using parameters (installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process.
Free-ridership	Percentage of 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 energy efficiency program, regardless of why they participated.
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.
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 between the net energy savings and gross energy savings that includes effects, such as free ridership and spillover, that positively or negatively affect the energy savings generated by a program.
Peak demand savings	The demand savings that coincide in time with the peak demand of the electricity system.
Program Administrator Cost test	This test compares program administrator costs to utility resource savings.
Spillover	Savings attributable to participants who continue to implement the energy efficiency measures introduced by a program after participating in it once, without participating in the program a second time.
Total Resource Cost test	This test compares program administrator and participant costs to utility resource savings and in some cases, other resource savings and program benefits accrued by participants, such as non-energy benefits.

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INTRODUCTION

Under the Government of Prince Edward Island (PEI), efficiencyPEI (ePEI) is responsible for administering Electricity Efficiency and Conservation (EE&C) programs in the province. The programs are meant to help Islanders not only improve the energy efficiency and conservation of energy in their homes and workplaces by installing high-efficiency equipment and products, but also change behaviours. Econoler was commissioned by ePEI to evaluate its EE&C program portfolio comprised of the following programs:

- **New Home Construction (NHC):** The program encourages homeowners and builders to implement energy efficient features in their new builds by providing customized energy efficiency recommendations through a review of house plans and financial incentives.
- **Winter Warming (WW):** The program provides low to moderate-income Islanders with free-of-charge direct installation of energy efficient products, such as weatherization products, as well as light bulbs, low-flow showerheads and programmable thermostats.
- **Energy Efficient Equipment Rebates (EEER):** The program provides homeowners with rebates for high-efficiency space and water heating equipment such as heat pumps and water heaters, as well as biomass stoves, boilers and furnaces.
- **Home Insulation Rebates (HIR):** The program encourages homeowners to perform energy efficient upgrades by providing information about the energy efficiency of their homes through home energy assessments and by offering financial incentives for the implementation of energy efficient upgrades.
- **Instant Energy Savings (IES):** The program offers instant cash rebates to customers who purchase eligible energy efficient products, such as lighting products, low-flow water products, and appliances, in participating stores across PEI.
- **Business Energy Rebates (BER):** The program provides commercial, industrial and agricultural customers with rebates for qualified high-efficiency products such as lighting, controls and heat pumps.

The evaluation was focused on assessing program processes, implementation and cost-effectiveness, as well as providing evaluated gross and net electricity energy and peak demand savings. The evaluation covered the 2019/2020 fiscal year. Based on the parameters established through the evaluation, results for the 2018/2019 fiscal year were also calculated.

This report summarizes the individual EE&C savings and cost-effectiveness program evaluation results to provide evaluation results at the EE&C portfolio level.

1 PORTFOLIO PERFORMANCE

This section summarizes the 2018/2019 and 2019/2020 net electricity annual and lifetime energy savings, net peak demand savings and cost-effectiveness test ratios, based on the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests. When performing these tests, ratios greater than 1 are desired as they show that the benefits of the program outweigh the costs. The evaluated savings and cost-effectiveness results were also compared to ePEI targets, where possible.

1.1 Energy Savings

Table 1 presents the net electricity energy savings of each program, as well as for the portfolio as a whole. The ePEI EE&C portfolio reached net electricity energy savings of 4.074 GWh and 7.978 GWh for 2018/2019 and 2019/2020 respectively. The 2018/2019 and 2019/2020 net energy savings fell short of targets by 19% and 15%, respectively.

During both fiscal years, IES and EEER were the biggest contributors to portfolio energy savings. However, these two programs did not meet all their targets, which explains why the portfolio targets were not met, in addition to HIR and BER also not meeting all their targets.

- The unitary savings value for the most popular EEER program equipment, mini-split heat pumps, was below the value that was expected at the time of setting the targets.
- Fewer products than expected were sold during the 2019/2020 IES program campaigns.
- Participation in HIR was lower than expected.
- BER was launched later than initially planned during the 2018/2019 fiscal year.

On a positive note, NHC and WW exceeded their targets during both fiscal years.

The portfolio achieved lifetime energy savings of 59.960 GWh for 2018/2019 and 120.169 GWh for 2019/2020.

Table 1: Summary of Energy Savings

Program	Annual Energy Savings (GWh)				Lifetime Energy Savings (GWh)	
	Targets		Evaluation Results		Evaluation Results	
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Residential						
NHC	0.10	0.20	0.249	0.792	7.462	23.749
WW	0.30	0.30	0.349	0.462	3.035	4.031
EEER	2.10	2.80	1.976	2.097	35.609	37.772
HIR	0.50	1.30	0.128	0.692	2.899	15.718
IES	1.10	3.70	1.175	2.914	8.320	21.121
Non-Residential						
BER	0.90	1.10	0.197	1.021	2.634	17.778
Total - Portfolio	**5.00**	**9.40**	**4.074**	**7.978**	**59.960**	**120.169**

1.2 Peak Demand Savings

Table 2 presents the net peak demand savings of each program, as well as for the portfolio as a whole. The ePEI EE&C portfolio reached net peak demand savings of 2.202 MW and 3.003 MW for 2018/2019 and 2019/2020 respectively. The 2018/2019 and 2019/2020 net peak demand savings exceeded targets by 69% and 20%, respectively.

Similar to the energy savings, EEER was by far the biggest contributor to portfolio peak demand savings, followed by IES and BER. These three programs, along with NHC, all surpassed their peak demand savings targets.

Table 2: Summary of Peak Demand Savings

Program	Targets (MW)		Evaluation Results (MW)	
	2018/2019	2019/2020	2018/2019	2019/2020
Residential				
NHC	0.00	0.00	0.074	0.234
WW	0.10	0.10	0.044	0.058
EEER	0.70	1.00	1.744	1.773
HIR	0.20	0.40	0.038	0.205
IES	0.20	0.80	0.168	0.423
Non-Residential				
BER	0.10	0.20	0.134	0.310
Total - Portfolio	**1.30**	**2.50**	**2.202**	**3.003**

1.3 Cost-Effectiveness

Table 3 presents the PAC and TRC test ratios of each program, as well as for the portfolio as a whole. The ePEI EE&C portfolio was cost-effective in 2018/2019 and 2019/2020, from both the PAC and TRC perspectives. The PAC is the primary cost-effectiveness test used by ePEI.

All the programs were cost-effective during the two fiscal years. In addition, all the programs surpassed their cost-effectiveness targets, except for IES falling short of its PAC targets.

Table 3: Summary of Cost-Effectiveness Test Ratios

Program	PAC				TRC			
	Targets		Evaluation Results		Targets		Evaluation Results	
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Residential								
NHC	3.1	3.2	4.51	7.56	1.2	1.2	3.27	4.00
WW	2.1	2.0	4.47	4.56	2.2	2.1	5.45	5.65
EEER	5.8	5.5	9.98	10.46	3.0	3.0	3.19	3.15
HIR	4.5	5.1	3.35	7.22	0.8	0.8	3.48	4.11
IES	4.9	8.6	2.15	3.94	2.4	3.1	4.67	6.84
Non-Residential								
BER	2.6	2.8	12.20	9.42	1.1	1.2	8.03	15.18
Total - Portfolio	**-**	**-**	**6.47**	**7.36**	**-**	**-**	**3.12**	**3.69**

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2018/2019 AND 2019/2020 ENERGY EFFICIENT EQUIPMENT REBATES PROGRAM EVALUATION

EFFICIENCYPEI

Final Report

June 29, 2020

ECONOLER

ACRONYMS

CASHP	Central air source heat pump
COP	Coefficient of performance
DSM	Demand-side management
EE&C	Electricity Efficiency and Conservation
EEER	Energy Efficient Equipment Rebates (program)
ePEI	efficiencyPEI
ERV	Energy recovery ventilator
ETS	Electric thermal storage
EUL	Effective useful life
GSHP	Ground source heat pump
HHWH	Hybrid hot water heater
HRV	Heat recovery ventilator
HWH	Hot water heater
IPC	Incremental product cost
MSHP	Mini-split heat pump
NEEP	Northeast Energy Efficiency Partnerships
NPV	Net Present Value
NTGR	Net-to-gross ratio
PAC	Program Administrator Cost (test)
PEI	Prince Edward Island
TRC	Total Resource Cost (test)

DEFINITIONS

Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
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.
Evaluated savings	Gross and net savings calculated by the Evaluator using parameters (installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process.
Free-ridership	Percentage of 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 energy efficiency program, regardless of why they participated.
Interactive effects	Interactive effects occur when the installation of an energy efficiency measure has an impact on the energy consumption of other elements in the building such as heating and cooling.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for 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.
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 between the net energy savings and gross energy savings that includes effects, such as free ridership and spillover, that positively or negatively affect the energy savings generated by a program.
Peak demand-to-energy ratio	The ratio between peak demand savings and energy savings.
Peak demand savings	The demand savings that coincide in time with the peak demand of the electricity system.
Program Administrator Cost test	This test compares program administrator costs to utility resource savings.

Sample size	The number of observations or replicates included in a statistical sample.
Spillover	Savings attributable to participants who continue to implement the energy efficiency measures introduced by a program after participating in it once, without participating in the program a second time.
Total Resource Cost test	This test compares program administrator and participant costs to utility resource savings and in some cases, other resource savings and program benefits accrued by participants, such as non-energy benefits.
Tracked savings	Gross and net savings calculated by the utility in its internal tracking, based on various parameters such as number of participants, installation rates, interactive effects, and 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).

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EXECUTIVE SUMMARY

This report presents the evaluation results of the efficiencyPEI (ePEI) Energy Efficient Equipment Rebates (EEER) program. The program provides homeowners with rebates for high-efficiency space and water heating equipment such as heat pumps and water heaters, as well as biomass stoves, boilers and furnaces.

Summary of Evaluation Assignment

ePEI hired Econoler (hereinafter the Evaluator) to evaluate the EEER program and achieve the following key objectives:

- Establish the gross electricity energy and peak demand savings generated by the program;
- Establish the net electricity energy and peak demand savings generated by the program;
- Assess whether the program is cost-effective;
- Assess the effectiveness of program processes and implementation.

The evaluation addresses program savings and cost-effectiveness results associated with equipment that displace electrical usage only.

The evaluation was carried out based on a review of the program database and documentation, a participant survey, literature review, engineering calculations and cost-effectiveness analyses based on the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests.

The evaluation covers the 2019/2020 fiscal year. Based on the parameters established through the evaluation, this report also presents results for the 2018/2019 fiscal year.

Summary of Evaluation Results

This subsection presents the key findings of the evaluation.

Participation Level and Equipment Mix

A total of 3,654 homeowners completed the participation process in the EEER program during the 2019/2020 fiscal year and installed a total of 4,320 units. In the 2018/2019 fiscal year, 3,546 homeowners participated in the program, for a total of 4,031 units installed. About 90% of the units installed during either fiscal year were mini-split heat pumps (MSHPs).

Satisfaction with the Program

MSHP participants were surveyed and mentioned being very satisfied with the program. Participant satisfaction was particularly high for the quality of work performed by heat pump installers and for the new heat pump equipment. The only issues reported by a significant number of participants (14 of the 70 surveyed) were regarding the rebate processing time. Albeit a small proportion, a few participants (n=3) also indicated that they did not know about the possibility of implementing home improvement upgrades through the ePEI Home Insulation Rebates (HIR) program.

Program Data Tracking

The program database contained all the necessary information about participants and equipment. The Evaluator found that information used to calculate and compile energy and demand savings was not always tracked, or tracked incompletely. The Evaluator also found opportunities to improve the organization and accessibility of program data, including tracking in separate columns the type and quantity of each equipment unit installed by a given participant and creating a dedicated database for the program.

Gross Savings

The Evaluator established savings calculation parameters for key eligible equipment to cover at least 80% of program savings. Given that MSHPs represented 87% of 2019/2020 gross energy savings at the time of designing the evaluation methodology, the Evaluator only established the savings parameters of this equipment category. For the other equipment categories, the Evaluator used the savings values established as part of program design.

Regarding the gross energy savings from MSHPs, the Evaluator determined the following:

› Based on participant survey results, units implemented through the EEER program saved electricity in 20% of participating households.
› Also based on participant survey results, it was appropriate to consider a standard heating system (not a heat pump) as the base case for savings calculations. For participants with an electrical baseline (generating electricity savings), the standard heating system is electric resistance baseboards or furnaces.
› Based on the results of a billing analysis conducted in Nova Scotia, the unitary savings value for MSHPs was established at 2,638 kWh at the meter for those households previously heated using electricity.

Net Savings

A net-to-gross ratio (NTGR) is used to determine net savings based on program gross savings. The Evaluator established the NTGR for MSHPs using free-ridership; spillover was considered to be nil. Based on the participant survey, the Evaluator determined free-ridership for MSHPs to be 26%, resulting in a NTGR of 0.77 for MSHPs after considering the proportion of low-income and non-low-income participants who installed MSHPs in 2019/2020 (a NTGR of 1 is assumed for low-income participants).

Cost-Effectiveness

The Evaluator assessed the cost-effectiveness of the Electricity Efficiency and Conservation (EE&C) portion of the program by performing specific cost-effectiveness tests, namely the TRC and PAC tests. When performing these tests, ratios greater than 1 are desired because they indicate that program benefits outweigh costs. The evaluation revealed that the program was very cost-effective in both 2018/2019 and 2019/2020, with PAC and TRC results all higher than 3.0.

Summary of Savings and Cost-Effectiveness Results

Table 1 summarizes the key results of the program savings and cost-effectiveness evaluations for 2019/2020 and 2018/2019, as well as participation levels and program targets.

Table 1: Summary of Program Savings and Cost-Effectiveness Targets and Evaluated Results

Parameters	2018/2019 Targets	2018/2019 Evaluation Results	2019/2020 Targets	2019/2020 Evaluation Results
Program Participation[1]				
Number of EE&C Participants	550	-	820	-
Number of Units	-	4,031	-	4,320
Number of Units Claimed for EE&C	-	831	-	876
Gross Electricity Savings at the Generator				
Gross Electricity Energy Savings (GWh)	-	2.647	-	2.832
Gross Lifetime Electricity Savings (GWh)	-	47.698	-	51.000
Gross Peak Demand Savings (MW)	-	2.302	-	2.341
Net Electricity Savings at the Generator				
NTGR	-	0.75	-	0.74
Net Electricity Energy Savings (GWh)	2.1	1.976	2.8	2.097
Net Lifetime Electricity Savings (GWh)	-	35.609	-	37.772
Net Peak Demand Savings (MW)	0.7	1.744	1.0	1.773
Cost-Effectiveness				
PAC Test	5.8	9.98	5.5	10.46
TRC Test	3.0	3.19	3.0	3.15

[1] Program participation targets were established on a participant basis while evaluated results were calculated on an equipment unit basis since some participants installed more than one equipment type or unit.

- The 2018/2019 evaluated net electricity energy savings were similar to program targets (about 6% lower). For 2019/2020, the evaluated results were 25% lower than program targets. The evaluation results indicate that the unitary savings value for the most popular equipment, MSHPs, was below the value that was expected at the time of setting the targets.
- The evaluated net peak demand savings exceeded program targets by 149% and 77% for 2018/2019 and 2019/2020, respectively.
- The PAC and TRC tests revealed that the program was very cost-effective from both perspectives and reached the cost-effectiveness targets for both fiscal years.

Recommendations

In light of these findings, the Evaluator makes the following three recommendations.

Recommendation 1: Use the evaluation parameters established through this evaluation for MSHP program savings tracking going forward. These parameters include the NTGR and unitary savings value. The exception to this recommendation is data collected from participants through program application forms subsequent to this evaluation, such as the heating system data. Indeed, ePEI intends to use program application forms to collect information from participants regarding existing heating system types (primary and secondary).

Recommendation 2: Ensure that EEER program participants are aware of other ePEI programs for which they may be eligible, including the HIR program, which, like EEER, encourages home retrofits.

Recommendation 3: Update program tracking to implement the following:

a. Continue tracking current items and try collecting data on currently untracked or incomplete items.
b. In the compilation tab, add a field for the proportion of units claimed for EE&C (that generate electrical savings) and ensure this value is multiplied by the total number of units rebated.
c. Consider creating a database specific to the program instead of using the database for the HIR program and two other programs and eliminate unneeded columns to customize the database to the program.
d. Use the “Notes” field only for sporadic or complementary data. All data that are systematically written under the “Notes” field should instead have their own column.
e. Track upgrade types and quantities under separate columns.
f. Clearly name all columns to avoid interpretation as well as facilitate overall understanding of the information tracked and data-collection sampling.

INTRODUCTION

Under the Government of Prince Edward Island (PEI), efficiencyPEI (ePEI) is responsible for administering Electricity Efficiency and Conservation (EE&C) programs in the province. The programs are meant to help Islanders not only improve the energy efficiency and conservation of energy in their homes and workplaces by installing high-efficiency equipment and products, but also change behaviours. Econoler was commissioned by ePEI to evaluate its EE&C program portfolio comprised of five residential programs and three commercial programs.

One of the five residential programs is the Energy Efficient Equipment Rebates (EEER) program, which provides homeowners with rebates for high-efficiency equipment such as heat pumps and boilers.

The evaluation of the EEER program is focused on assessing program processes, implementation and cost-effectiveness, as well as providing evaluated gross and net energy and peak demand savings. The evaluation covers the 2019/2020 fiscal year. Based on the parameters established through the evaluation, this report also presents results for the 2018/2019 fiscal year. This report presents the program EE&C results, namely the savings and cost-effectiveness results associated with equipment that displace electrical usage only. Evaluation activities were carried out considering both electrically-heated and non-electrically-heated participants to assess program processes and implementation, but certain sections of the report reference only subsets of the total participants included in the evaluation, depending on the topic assessed.

To complete this evaluation, Econoler worked with Vision Research, a PEI-based market research firm, on a participant survey. Throughout this report, the team of Econoler and Vision Research is referred to as the Evaluator.

1 PROGRAM OVERVIEW

The ePEI EEER program encourages the installation of space and water heating equipment in PEI homes. More specifically, the program provides financial incentives to homeowners for eligible equipment within the following categories:

› Mini-split air source heat pumps (MSHPs)
› Central air source heat pumps (CASHPs)
› Geothermal ground source heat pumps (GSHPs)
› Domestic hot water heaters such as hybrid hot water heaters (HHWHs)
› Heat or energy recovery ventilators (HRVs/ERVs)
› Biomass (wood and pellet) stoves
› Biomass boilers and furnaces
› Electric thermal storage heaters (ETS heaters)
› ETS furnaces
› ETS hot water heaters (HWHs)

These equipment categories are those that have the potential to generate electrical savings. The program also incentivizes equipment that generates non-electrical savings such as oil and propane boilers and furnaces.

To be eligible, equipment must meet certain energy efficiency criteria, the main one being ENERGY STAR® Most Efficient requirements.

Heat pumps must be supplied and installed by a contractor from the ePEI Network of Excellence to be eligible for rebates. Rebates are provided on a per-unit basis after the purchase and installation of the energy efficient equipment.

Rebates are available for both regular and low-income households. The program offers larger rebates to low-income households; low income is defined as an annual household income of $35,000 or less. For example, the regular rebate provided by ePEI for an MSHP is $1,200 while the low-income rebate is $2,400. Financing is also available through the Government of PEI to offset some of the upfront costs.

Participants can enter the EEER program directly or participate after having received recommendations for energy efficient space and water heating systems through the ePEI Home Insulation Rebates (HIR) program.

2 EVALUATION APPROACH

The main objectives of the EEER program evaluation are as follows:

- Establish the gross electricity energy and peak demand savings generated by the program;
- Establish the net electricity energy and peak demand savings generated by the program;
- Assess whether the program is cost-effective;
- Assess the effectiveness of program processes and implementation.

The Evaluator identified key research questions aimed at achieving the aforementioned objectives. The following table outlines the evaluation objectives and maps them to the research questions and methods. Each method is described further below.

Table 2: Evaluation Approach

Evaluation Objective	Research Question	Method
Gross energy and peak demand savings	How are program MSHPs being used?	Participant survey
	What are the equipment unitary energy savings values?	› Application form review › Program savings analysis
	What are the equipment unitary peak demand savings values?	
	What are the equipment effective useful life (EUL) values?	
	What are the evaluated annual and lifetime gross energy savings and peak demand savings?	
Net energy and peak demand savings	What is the free-ridership level for the program?	Participant survey
	What are the evaluated annual and lifetime net energy savings and peak demand savings?	
Program cost-effectiveness	In addition to the other cost-effectiveness calculation parameters already collected (e.g. EUL values, net savings), what are the equipment incremental product costs (IPCs)?	Cost-effectiveness analysis
	Is the program cost-effective from the perspective of the program administrator and participants?	
Program processes and implementation	Is program tracking effective, complete, consistent and clear?	Program database review
	How did participants hear about the program?	Participant survey
	Why did participants want to install a MSHP?	
	What is the level of participant satisfaction with the program?	
	What issues or challenges, if at all, have participants had with their MSHPs?	
	What concerns did participants have about installing a MSHP?	
	What recommendations do participants have to improve the program?	

The Evaluator first conducted an in-depth interview with program staff to learn about program processes, discuss program performance and identify evaluation objectives. Then, specific evaluation methods were undertaken as described in the following subsections.

Participant Survey

In February 2020, the Evaluator conducted a telephone survey with 70 program participants who had installed one or more MSHPs. The average length of the survey was 16 minutes. A sample of 70 participants yields a margin of error of 9.7% at a 90% confidence level. The survey questionnaire is provided in Appendix I.

Application Form Review

The Evaluator reviewed 30 MSHP application forms, including project receipts and invoices, to verify that the rebated equipment met program eligibility criteria and to inform certain parameters of the program savings and cost-effectiveness assessments, such as unitary savings and IPCs.

Program Savings and Cost-Effectiveness Analyses

The Evaluator analyzed the program database, conducted a literature review and performed engineering calculations to provide evaluated savings calculation values and parameters, including the parameters used in calculating IPCs, gross and net energy and peak demand savings, as well as the EUL values used for the lifetime energy savings calculations. As part of the literature review, the Evaluator consulted technical reference manuals and public evaluation reports of jurisdictions similar to ePEI, with a focus on the most recent and accurate sources.

The Evaluator also performed two cost-effectiveness tests, namely the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests.

Program Database Review

The Evaluator reviewed the program database to: (1) assess tracking practices and processes and whether they meet program needs; (2) identify any gaps in tracked data to better inform program savings calculations, management and evaluation; and (3) assess the consistency and organization of tracked data.

3 PROGRAM SAVINGS AND COST-EFFECTIVENESS

This section presents the evaluation results related to program gross and net electrical energy and peak demand savings, as well as cost-effectiveness for the fiscal year 2019/2020. The parameters used to obtain these results were also used to calculate program savings and cost-effectiveness results for the 2018/2019 fiscal year. The section opens with an overview of program participation in 2018/2019 and 2019/2020.

3.1 Program Participation

During the 2019/2020 fiscal year, 3,654 participants took part in the program and installed one or more energy efficient space and/or water heating equipment units in their home to reduce their electricity consumption. This represents a slight increase compared to the 3,546 participants generating electricity savings in the 2018/2019 fiscal year.

Of the 2019/2020 participants who generated electricity savings, 10% were low-income participants, whereas this proportion was slightly higher in 2018/2019 (14%).

While some of the 2018/2019 and 2019/2020 participants installed more than one equipment type as part of their participation, the vast majority of them installed at least one MSHP. Figure 1 below illustrates the proportion of participants that installed MSHPs compared with the other equipment that generated electricity savings, i.e. biomass, CASHPs, GSHPs, HRVs/ERVs, HHWHs, ETS heaters, ETS furnaces, and ETS HWHs.

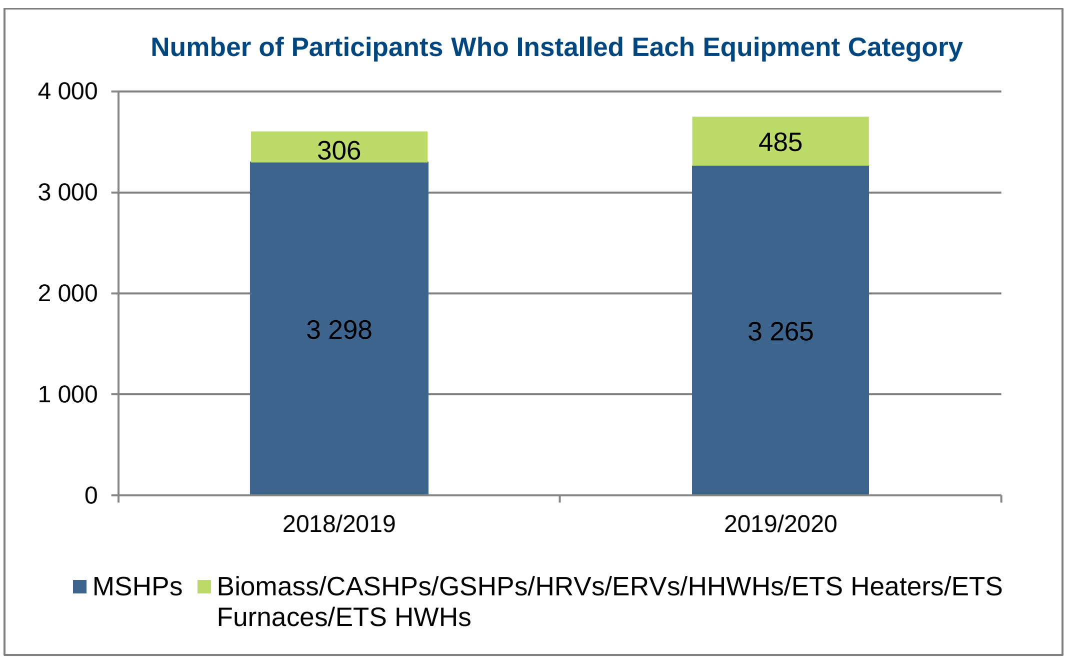

Figure 1: Summary of EEER Program Participation

3.2 Gross Savings

Gross savings correspond to the change in energy consumption that results from actions taken by participants regardless of their reasons for participating. For the EEER program, gross savings are determined by multiplying the proportion of units generating electricity savings (percentage claimed for EE&C) with the number of units installed for each equipment category and the energy or peak demand savings value using the following equation:

$$\textit{Gross Savings} = \textit{Percentage Claimed for EE\&C} \times \textit{Number of Units} \times \textit{Unitary Savings}$$

Lifetime gross energy savings are then obtained by multiplying the annual gross energy savings with the EUL value associated with each equipment category.

The Evaluator established savings calculation parameters for key eligible equipment to cover at least 80% of program savings. Given that MSHPs represented 87% of the tracked gross energy savings at the time of selecting the evaluation methodology, the Evaluator only established savings parameters of this equipment category. For the other equipment categories, the Evaluator used the savings values established as part of program design and derived from the results presented in the EfficiencyOne 2016 DSM Evaluation Report of the Green Heat program.[2]

3.2.1 Percentage of Units Claimed for EE&C

The participant survey results indicate that 20% of the MSHPs installed through the EEER program save electricity and the remaining 80% reduce the usage of non-electrical heating fuels, mainly oil, wood and propane. The Evaluator therefore considered that the proportion of EEER program participants who have an electrical heating baseline is 20% and used this proportion to calculate the number of units that reduce the use of electricity, which corresponds to the percentage claimed for EE&C, for each equipment category rebated through the program.

3.2.2 Unitary Energy Savings

This subsection presents how the Evaluator established the MSHP unitary savings value.[3]

[2] Econoler, *2016 DSM Evaluation Reports*, a set of reports prepared for EfficiencyOne, https://www.efficiencyone.ca/dsm/ (last accessed January 30, 2020).
[3] All the unitary savings values were calculated at the meter. Line loss factors were added to obtain savings at the generator in the gross savings compilation table (see Table 8).

MSHPs

The Evaluator first sought to establish the proper baseline for MSHPs. The Evaluator analyzed the results of the participant survey and observed that nearly half of participants (46%) would have kept their existing heating system or bought something other than a heat pump if the program rebate had not been offered. Therefore, the Evaluator deemed appropriate to consider a standard heating system (not a heat pump) as the base case for savings calculations; deductions for participants who would have purchased a heat pump in the absence of the program are made at the net savings level in the form of free-ridership. For participants with an electrical baseline (generating electricity savings), the standard heating system is electrical resistance baseboards or furnaces.

The Evaluator then reviewed the literature to determine an appropriate source for revising the MSHP unitary savings value. Metered results were preferred over engineering calculations because of their accuracy. Indeed, the Evaluator decided to rely on the results of a billing analysis completed in 2017 for the evaluation of a program similar to the EEER program; that program comprised 170 Nova Scotia households wherein an MSHP had been installed. The Evaluator deemed that it was a reliable source of information because of the similarities between the two programs.

For instance, monthly average heating and cooling degree days in Nova Scotia and PEI were compared, and no significant difference was found between the two provinces for both the winter and summer seasons, which indicates that heat pumps operate under similar conditions. Also, that billing analysis established savings over an electrical resistance baseline, which is consistent with the baseline recommended for the EEER program. It should however be noted that, while eligibility criteria for MSHPs are similar in both programs, they are not exactly the same. Indeed, ePEI requires MSHPs to meet the ENERGY STAR Most Efficient requirements, while EfficiencyOne developed its own eligible MSHPs list using performance parameters that are more restrictive than ENERGY STAR requirements.[4] EfficiencyOne uses criteria to ensure that MSHPs work efficiently at low outdoor temperatures. The Evaluator considered these differences to be relatively minor since, on average, equipment of similar performance was installed through both programs even though eligibility criteria differ. Therefore, the Evaluator retained the results of the EfficiencyOne billing analysis to assess EEER program savings. The following subsection details how the results of that billing analysis were adapted to obtain a unitary savings value for previously electrically-heated homes.

[4] EfficiencyOne requirements are as follows: ENERGY STAR certified equipment, heating seasonal performance factor [HSPF] for climate Region V greater than or equal to 9.565 for single-zone systems (HSPF Reg. V ≥ 8.696 for multi-zone systems) and a coefficient of performance greater than or equal to 1.75 at an outdoor air temperature of -15° C. The Cold Climate Heat Pump list developed by EfficiencyOne, which outlines the eligible models and performance parameters is available at: https://www.efficiencyns.ca/residential/services-rebates/heating-system-rebates/.
For the sake of comparison, ENERGY STAR Most Efficient requirements are the following: HSPF Reg. V ≥ 8.7 for both single and multi-zone systems, seasonal energy efficiency ratio [SEER] greater than or equal to 20 and a minimum energy efficiency ratio [EER] of 12.5. There is no requirement for the performance of MSHPs at low outdoor air temperatures. ENERGY STAR Most Efficient requirements are available at: https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about-energy-star-canada/energy-star-most-efficient/13612.

Electrical Unitary Savings

For the electrical heating baseline (resulting in electricity savings), the Evaluator used average energy savings values per heating capacity derived from the billing analysis. This analysis served to establish different unitary savings for fully electrically-heated households and mainly electrically-heated households, i.e. households that have a secondary non-electric heating system. These two types of electricity usage were considered through the different calculation steps performed, as outlined in Table 3. The proportions used for the types of electricity usage were derived from the participant survey. As a result, the unitary savings value was established at 2,638 kWh for an MSHP installed in a house previously heated with electricity.

Table 3: Calculation of Unitary Electrical Energy Savings for MSHPs

	Fully Electrically-Heated	Mainly Electrically-Heated
Energy Savings per Capacity (kWh/BTU/hr)	0.179	0.060
Average Rated Heating Capacity at 8°C (BTU/hr)[5]	16,574	16,574
Average Unitary Energy Savings (kWh)	2,967	994
Proportion of EEER Program Participants According to Participant Survey	83%	17%
Weighted Average Unitary Energy Savings (kWh)	**2,638**	

Summary of All Eligible Equipment

The unitary savings values for each equipment category are presented in Table 4. The Evaluator established the unitary savings value of MSHPs generating electricity savings at 2,638 kWh, while the unitary savings values of the other equipment categories were defined as part of program design.

[5] Weighted average of AHRI certified heating capacities (available at https://www.ahridirectory.org/Search/SearchHome?ReturnUrl=%2f) calculated using the 30 application forms reviewed.

Table 4: Electrical Unitary Energy Savings Values

Equipment	Unitary Electrical Energy Savings (kWh)	Source[6]
MSHPs	2,638	Established by the Evaluator
CASHPs	11,966	Defined by program design
GSHPs	10,659	Defined by program design
HRVs/ERVs	368	Defined by program design
HHWHs	2,205	Defined by program design
Wood Stoves	9,809	Defined by program design
Pellet Stoves	9,809	Defined by program design
Biomass Boilers	14,703	Defined by program design
Biomass Furnaces	14,703	Defined by program design

3.2.3 Unitary Peak Demand Savings

Electricity peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The peak demand period in PEI occurs between 5 p.m. and 7 p.m. from mid-December through early March inclusively, on any day when the maximum temperature is -10° C or lower.

MSHPs

Peak demand savings occur for participants who have an electrical heating system baseline (electric resistance). Unlike MSHPs, this baseline system has a constant efficiency of 100% (coefficient of performance [COP] of 1) regardless of the outdoor air temperature. The Evaluator analyzed temperature data to determine that, on average, an outdoor temperature of -14° C is likely to occur between 5 p.m. and 7 p.m. on days when the maximum temperature is -10° C or lower. The Evaluator used the COP and heating capacity values at -15° C (the closest available data point) of MSHPs models included in the application form review to calculate peak demand savings through the equation below. The Evaluator assumed a COP of 1 for one model (out of the 22 reviewed) whose specifications at -15° C were not available and thus did not consider peak demand savings for this model.

$$Peak\ Demand\ Savings_W = \left(\frac{HC_{min}}{3.412} * \left[\frac{1}{COP_{base,min}} - \frac{1}{COP_{ee,min}}\right]\right)$$

The parameters outlined in this equation are described in Table 5.

[6] The unitary electrical energy savings values marked as "Defined by program design" were provided by ePEI, but since they were at the generator, the Evaluator divided them by the line loss factor used by ePEI at the time of program design (1.115 for energy loss).

Table 5: Calculation of Peak Demand Savings for MSHPs

Acronym	Variable	Value/Unit	Source
HC_{min}	Rated maximal heating capacity of the new heat pump at outdoor air temperature of -15° C	16,451 BTU/h	Weighted average value based on the application form review (data extracted for each model from NEEP)[7]
-	Conversion factor for BTU/h to W	3.412 BTU/h/W	Convention
$COP_{base,min}$	COP for the assumed base case (electrical resistance)	1 kW/kW	Resistance heater has a COP of 1 (corresponds to a system efficiency of 100%)
$COP_{ee,min}$	COP at maximum capacity for the new heat pump at an outdoor air temperature of -15° C	2.00 kW/kW	Weighted average value based on the application form review (data extracted for each model from NEEP)
Unitary Peak Demand Savings		**2,411 W**	**Calculation**

Summary of All Eligible Equipment

Table 6 presents the unitary peak demand savings values used for each equipment category. For the MSHP, the unitary peak demand savings were directly calculated. For equipment other than MSHPs, the Evaluator used the peak demand-to-energy ratio that had been defined through program design to calculate the unitary peak demand savings value. Since ETS equipment does not generate electricity savings, peak demand-to-energy ratios are not applicable. The Evaluator used the unitary peak demand savings values provided by ePEI.

[7] NEEP, *Cold Climate Air Source Heat Pump (ccASHP) Specification*, https://neep.org/ASHP-Specification#Listing%20Products, (last accessed March 25, 2020).

Table 6: Unitary Peak Demand Savings Values

Equipment	Peak Demand-to-Energy Ratio (W/kWh)	Unitary Peak Demand Savings (W)	Source[8]
MSHPs	-	2,411	Established by the Evaluator
CASHPs	0.283	3,386	Defined by program design
GSHPs	0.283	3,016	Defined by program design
HRVs/ERVs	0.283	104	Defined by program design
HHWHs	0.162	357	Defined by program design
Wood Stoves	0.283	2,776	Defined by program design
Pellet Stoves	0.283	2,776	Defined by program design
Biomass Boilers	0.283	4,161	Defined by program design
Biomass Furnaces	0.283	4,161	Defined by program design
ETS Heaters	N/A	2,161	Defined by program design
ETS Furnaces	N/A	4,322	Defined by program design
ETS HWHs	N/A	500	Defined by program design

3.2.4 Interactive Effects

Interactive effects occur in a home when the implementation of energy efficiency equipment has an impact on the energy consumption of other systems, most commonly heating and cooling systems. In the case of the EEER program, high-efficiency space heating and cooling equipment is implemented, which does not have an impact on any other systems. Therefore, there are no interactive effects associated with MSHPs.

3.2.5 Effective Useful Life

The Evaluator performed a literature review to establish the EUL value of MSHPs. A period of 18 years was deemed appropriate because it is currently used in recent and available technical reference manuals and public evaluation reports. For instance, this value is reported in the GDS Measure Life Report[9] that is commonly cited in technical reference manuals. The EUL values for the other eligible equipment types were kept as defined by program design.

Table 7 lists the EUL value of each equipment category.

[8] The unitary peak demand savings values marked as "Defined by program design" were provided by ePEI, but since they were at the generator, the Evaluator divided them by the line loss factor used by ePEI at the time of program design (1.157 for demand loss).

[9] GDS Associates. *Measure Life Report. Residential and Commercial/Industrial Lighting and HVAC Measures*, June 2007, pp. 1-3.

Table 7: EUL Values

Equipment	EUL (years)	Source
MSHPs	18	Established by the Evaluator
CASHPs	18	Defined by program design
GSHPs	25	Defined by program design
HRVs/ERVs	18	Defined by program design
HHWHs	13	Defined by program design
Biomass Stoves	18	Defined by program design
Biomass Boilers/Furnaces	18	Defined by program design

3.2.6 Summary of Gross Savings

The annual gross savings for each equipment category that generated electrical energy savings in 2019/2020 are listed in Table 8 below. Results for 2018/2019 are presented in Table 9. Savings at the generator were obtained by applying line loss factors of 1.120 for energy and 1.171 for peak demand, as provided by Maritime Electric, the electricity utility.

Table 8: Gross Energy and Peak Demand Savings for 2019/2020

Equipment Category	MSHP	CASHP	GSHP	HRV/ERV	HHWH	Biomass Stove	Biomass Boiler/Furnace	ETS Heater	ETS Furnace	ETS HWH	Total
Number of Units	3,767	16	4	257	24	229	7	12	1	3	4,320
Percentage Claimed for EE&C	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	-
Number of Units Claimed for EE&C	753	3	1	51	5	46	1	12	1	3	876
Energy Savings											
Unitary Energy Savings (kWh)	2,638	11,966	10,659	368	2,205	9,809	14,703	-	-	-	-
Gross Energy Savings – at the Meter (GWh)	**1.986**	**0.036**	**0.011**	**0.019**	**0.011**	**0.451**	**0.015**	**0.000**	**0.000**	**0.000**	**2.529**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120	-
Gross Energy Savings – at the Generator (GWh)	**2.225**	**0.040**	**0.012**	**0.021**	**0.012**	**0.505**	**0.016**	**0.000**	**0.000**	**0.000**	**2.832**
Effective Useful Life (years)	18	18	25	18	13	18	18	-	-	-	-
Gross Lifetime Energy Savings – at the Generator (GWh)	**40.046**	**0.724**	**0.298**	**0.378**	**0.161**	**9.096**	**0.296**	**0.000**	**0.000**	**0.000**	**51.000**
Peak Demand Savings											
Unitary Peak Demand Savings (W)	2,411	3,386	3,016	104	357	2,776	4,161	2,161	4,322	500	-
Gross Peak Demand Savings – at the Meter (MW)	**1.815**	**0.010**	**0.003**	**0.005**	**0.002**	**0.128**	**0.004**	**0.026**	**0.004**	**0.002**	**1.999**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171	-
Gross Peak Demand Savings – at the Generator (MW)	**2.126**	**0.012**	**0.004**	**0.006**	**0.002**	**0.150**	**0.005**	**0.030**	**0.005**	**0.002**	**2.341**

Table 9: Gross Energy and Peak Demand Savings for 2018/2019

Equipment Category	MSHP	CASHP	GSHP	HRV/ERV	HHWH	Biomass Stove	Biomass Boiler/Furnace	ETS Heater	ETS Furnace	ETS HWH	Total
Number of Units	3,721	5	4	74	9	180	7	22	2	7	4,031
Percentage Claimed for EE&C	20%	20%	20%	20%	20%	20%	20%	100%	100%	100%	-
Number of Units Claimed for EE&C	744	1	1	15	2	36	1	22	2	7	831
Energy Savings											
Unitary Energy Savings (kWh)	2,638	11,966	10,659	368	2,205	9,809	14,703	-	-	-	-
Gross Energy Savings – at the Meter (GWh)	**1.963**	**0.012**	**0.011**	**0.006**	**0.004**	**0.353**	**0.015**	**0.000**	**0.000**	**0.000**	**2.363**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120	-
Gross Energy Savings – at the Generator (GWh)	**2.198**	**0.013**	**0.012**	**0.006**	**0.005**	**0.395**	**0.016**	**0.000**	**0.000**	**0.000**	**2.647**
Effective Useful Life (years)	18	18	25	18	13	18	18	-	-	-	-
Gross Lifetime Energy Savings – at the Generator (GWh)	**39.567**	**0.241**	**0.298**	**0.111**	**0.064**	**7.119**	**0.296**	**0.000**	**0.000**	**0.000**	**47.698**
Peak Demand Savings											
Unitary Peak Demand Savings (W)	2,411	3,386	3,016	104	357	2,776	4,161	2,161	4,322	500	-
Gross Peak Demand Savings – at the Meter (MW)	**1.794**	**0.003**	**0.003**	**0.002**	**0.001**	**0.100**	**0.004**	**0.048**	**0.009**	**0.004**	**1.966**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171	-
Gross Peak Demand Savings – at the Generator (MW)	**2.101**	**0.004**	**0.004**	**0.002**	**0.001**	**0.117**	**0.005**	**0.056**	**0.010**	**0.004**	**2.302**

3.3 Net Savings

Net savings are defined as the energy use reductions specifically attributable to the EEER program. Effects that positively or negatively affect the energy savings generated by a program, namely free-ridership and spillover, are generally considered. They are then combined into a net-to-gross ratio (NTGR) that is applied to gross energy savings.

For the EEER program, the Evaluator assessed the free-ridership level using the participant survey. It should be noted that, while the survey sample included participants who had been identified as low-income since the program provides rebates for them, they were not included in the free-ridership assessment; evaluation standards assume that free-ridership is nil in the case of low-income participants.

As for spillover, this effect was considered to be nil. Spillover is usually low for programs like EEER, especially when participants are allowed to install multiple units as part of the program.

3.3.1 Free-Ridership

For the EEER program, free-ridership occurs when participants would still have installed a new more efficient heating system in the absence of the program. Non-low-income participants (n=62 out of 70) were asked questions concerning two factors: (1) their decision to install a heat pump system instead of another type of heating system or simply keep their existing system (type-of-system factor); and (2) their decision to install a high-efficiency heat pump rather than a regular heat pump (high-efficiency factor). All other applicable variables in the decision-making process were also considered in the free-ridership questions, including planning, efficiency level, timing and cost.

The feedback collected from the participant survey was converted into a free-ridership level using the algorithm presented in Appendix II. The efficiencies of the baseline heating system, namely electric resistance and non-electric system, were considered in the algorithm, leading to different weights for the two factors measured by the algorithm. However, to reach an acceptable margin of error on the average free-ridership level, the Evaluator had to combine all results and could not only consider those for participants with electrically-heated houses. The Evaluator established the free-ridership level of MSHPs at 26%.

The collected answers revealed that 48% (n=30) of non-low-income participants had not decided to implement an MSHP system in their house before they heard about the program and would have kept their existing heating system or purchased a new less efficient system than a heat pump. If the rebates had not been offered, the likelihood that they would have postponed the upgrade of their heating system by at least one year is on average 4.3/10 using a 0 to 10 scale where 0 means “not at all likely” and 10 means “very likely”. In addition, almost half of respondents (48%) were not aware that ENERGY STAR most-efficient heat pumps were available before they heard about the EEER program, thereby reducing the free-ridership level associated with the high-efficiency factor. This also demonstrates that the program might have increased participants’ awareness of certified energy efficient equipment.

For CASHPs, GSHPs, and biomass space heating equipment, the Evaluator noticed some discrepancies between the free-ridership levels used by ePEI at the time of designing the program and the values presented in the EfficiencyOne 2016 DSM Evaluation Report of the Green Heat program, which is the reference used by ePEI for the EEER program. Since the free-ridership levels associated with these equipment categories were not assessed in the survey of this evaluation, the Evaluator updated these free-ridership levels according to the most recent evaluation report of the Green Heat program.

Table 10 summarizes the average free-ridership levels for MSHPs established by surveying EEER program participants, as well as for the other program equipment types. The Evaluator kept the free-ridership levels of the other equipment types as per program design since they were not assessed through the survey of this evaluation or during the evaluation of EfficiencyOne’s Green Heat program.

Table 10: Free-Ridership Levels

	MSHP	CASHP and GSHP	Biomass Stove, Boiler, and Furnace	Others
Free-Ridership Level	**26%**	**33%**	**42%**	**39%**
Margin of error	6.4%	N/A	N/A	N/A

3.3.2 Net-to-Gross Ratio Calculations

The NTGR was calculated using the following equation:

$$NTGR = (1 – \%\ Free\text{-}Ridership)$$

Table 11 summarizes the NTGRs for MSHPs as well as for the other equipment types. Since the 2019/2020 program database indicated that 10% of all MSHPs installed were in low-income households, the NTGR at the program level was calculated as a weighted average. For the other equipment, the Evaluator made a similar adjustment using the proportions of low-income and non-low-income participants for each equipment category.

Table 11: 2019 NTGRs

	MSHP		CASHP and GSHP		Biomass Stove, Boiler, and Furnace		Others	
	Non-Low-Income	Low-Income	Non-Low-Income	Low-Income	Non-Low-Income	Low-Income	Non-Low-Income	Low-Income
Free-Ridership	26%	0%	33%	0%	42%	0%	39%	0%
Proportion	**90%**	**10%**	**100%**	**0%**	**89%**	**11%**	**97%**	**3%**
NTGR	**0.77**		**0.67**		**0.63**		**0.62**	

3.3.3 Summary of Net Savings

Net savings are determined by applying the NTGRs to evaluate gross savings using the following equation:

$$Net\ Savings = Evaluated\ Gross\ Savings \times NTGR$$

The detailed net savings results for 2019/2020 and 2018/2019 are summarized in Table 12 and Table 13 respectively.

Table 12: Net Energy and Peak Demand Savings for 2019/2020

Equipment Category	MSHP	CASHP	GSHP	HRV/ERV	HHWH	Biomass Stove	Biomass Boiler/Furnace	ETS Heater	ETS Furnace	ETS HWH	Total
Energy Savings											
Gross Energy Savings – at the Meter (GWh)	1.986	0.036	0.011	0.019	0.011	0.451	0.015	0.000	0.000	0.000	2.529
NTGR	0.77	0.67	0.67	0.62	0.62	0.63	0.63	0.62	0.62	0.62	-
Net Energy Savings – at the Meter (GWh)	**1.530**	**0.024**	**0.007**	**0.012**	**0.007**	**0.284**	**0.009**	**0.000**	**0.000**	**0.000**	**1.873**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120	-
Net Energy Savings – at the Generator (GWh)	**1.713**	**0.027**	**0.008**	**0.013**	**0.008**	**0.318**	**0.010**	**0.000**	**0.000**	**0.000**	**2.097**
Effective Useful Life (years)	18	18	25	18	13	18	18	-	-	-	-
Net Lifetime Energy Savings – at the Generator (GWh)	**30.836**	**0.485**	**0.200**	**0.235**	**0.100**	**5.731**	**0.187**	**0.000**	**0.000**	**0.000**	**37.772**
Peak Demand Savings											
Gross Peak Demand Savings – at the Meter (MW)	1.815	0.010	0.003	0.005	0.002	0.128	0.004	0.026	0.004	0.002	1.999
NTGR	0.77	0.67	0.67	0.62	0.62	0.63	0.63	0.62	0.62	0.62	-
Net Peak Demand Savings – at the Meter (MW)	**1.398**	**0.007**	**0.002**	**0.003**	**0.001**	**0.080**	**0.003**	**0.016**	**0.003**	**0.001**	**1.514**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171	-
Net Peak Demand Savings – at the Generator (MW)	**1.637**	**0.008**	**0.002**	**0.004**	**0.001**	**0.094**	**0.003**	**0.019**	**0.003**	**0.001**	**1.773**

Table 13: Net Energy and Peak Demand Savings for 2018/2019

Equipment Category	MSHP	CASHP	GSHP	HRV/ERV	HHWH	Biomass Stove	Biomass Boiler/Furnace	ETS Heater	ETS Furnace	ETS HWH	Total
Energy Savings											
Gross Energy Savings – at the Meter (GWh)	1.963	0.012	0.011	0.006	0.004	0.353	0.015	0.000	0.000	0.000	2.363
NTGR	0.77	0.67	0.67	0.62	0.62	0.63	0.63	0.62	0.62	0.62	-
Net Energy Savings – at the Meter (GWh)	**1.511**	**0.008**	**0.007**	**0.003**	**0.003**	**0.222**	**0.009**	**0.000**	**0.000**	**0.000**	**1.764**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120	-
Net Energy Savings – at the Generator (GWh)	**1.693**	**0.009**	**0.008**	**0.004**	**0.003**	**0.249**	**0.010**	**0.000**	**0.000**	**0.000**	**1.976**
Effective Useful Life (years)	18	18	25	18	13	18	18	-	-	-	-
Net Lifetime Energy Savings – at the Generator (GWh)	**30.467**	**0.162**	**0.200**	**0.069**	**0.040**	**4.485**	**0.187**	**0.000**	**0.000**	**0.000**	**35.609**
Peak Demand Savings											
Gross Peak Demand Savings – at the Meter (MW)	1.794	0.003	0.003	0.002	0.001	0.100	0.004	0.048	0.009	0.004	1.966
NTGR	0.77	0.67	0.67	0.62	0.62	0.63	0.63	0.62	0.62	0.62	-
Net Peak Demand Savings – at the Meter (MW)	**1.381**	**0.002**	**0.002**	**0.001**	**0.000**	**0.063**	**0.003**	**0.029**	**0.005**	**0.002**	**1.489**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171	-
Net Peak Demand Savings – at the Generator (MW)	**1.617**	**0.003**	**0.002**	**0.001**	**0.001**	**0.074**	**0.003**	**0.035**	**0.006**	**0.003**	**1.744**

3.4 Cost-Effectiveness

The Evaluator assessed program cost-effectiveness by performing specific cost-effectiveness tests, namely the TRC and the PAC tests. When performing these tests, ratios greater than 1 are desired because they indicate that program benefits outweigh costs. This section presents the calculations performed to assess the cost-effectiveness of the EE&C portion of the program.

Various values and parameters were necessary to conduct these tests:

› The gross and net electrical savings as well as the EUL were drawn from the results presented in Subsections 3.2 and 3.3 of this report. To quantify the economic value of those savings (i.e. the program benefits), the Evaluator used the unitary avoided costs of electrical energy savings and peak demand savings that were provided by the electricity utility, Maritime Electric. Total program costs, broken down by administrative and incentive costs, were provided by ePEI. The Evaluator estimated the proportion of those costs allocated to EE&C based on the ratio of electrical and non-electrical savings[10] generated by the program in 2019/2020. The IPCs associated with products generating electrical savings were estimated by the Evaluator and is described in further detail in Subsection 3.4.1 below.

› The net present value (NPV) calculations of all cash flows (costs and benefits) considered in the cost-effectiveness tests were performed using the ePEI discount rate (3.2%) and inflation rate (2%).

3.4.1 Incremental Product Costs

For the EEER program, IPCs represent the difference in cost between the energy efficient product rebated by the program and what would have been purchased in the absence of the program (baseline scenario), regardless of who pays.

The baseline scenario for the IPC of MSHPs is the existing heating system, namely an electric resistance heating system. Surveyed participants also indicated that a vast majority of MSHPs were purchased even if the existing equipment was in good working condition. Since the replacement of the existing system by another baseline system would have likely occurred many years in the future, the Evaluator considered the IPC of MSHPs to be its total cost, including labour. This assumption is conservative because it slightly overestimates the lifetime IPC by neglecting the cost of replacing the existing system in many years. This cost was established at $4,440 (including taxes) per unit according to the information collected during the review of the 30 application forms.

For the other equipment offered by the program, the Evaluator maintained the unitary IPC values established upon program design.

[10] Although the quantification of non-electrical energy savings was outside of the scope of the evaluation, the Evaluator used the number of products, listed in the database, generating non-electrical savings as well as estimates of the unitary energy savings of each product to produce a high-level estimate of the non-electrical savings for the EEER program and compared that value to electrical energy savings to obtain a percentage of savings attributed to EE&C activities.

Table 14 outlines the resulting unitary IPC values for the 2019/2020 period.

Table 14: Unitary IPC Values

Equipment	IPC per Unit	Source
MSHPs	$4,440	Established by the Evaluator
CASHPs	$9,000	Defined by program design
GSHPs	$23,000	Defined by program design
HRVs/ERVs	$1,800	Defined by program design
HHWHs	$3,238	Defined by program design
Biomass Stoves	$4,200	Defined by program design
Biomass Boilers/Furnaces	$9,530	Defined by program design
ETS Heaters	$2,000	Defined by program design
ETS Furnaces	$5,000	Defined by program design
ETS HWHs	$1,326	Defined by program design

The unitary IPC values were multiplied by the number of units claimed for EE&C to obtain an overall IPC of $3,737,018for the EE&C portion of the EEER program.

3.4.2 Cost-Effectiveness Tests

This subsection presents the equations used for the PAC and TRC tests. For each test, benefits are at the numerator and costs at the denominator, and they both need to be NPVs.

PAC Test

The PAC test measures the net economic benefit of a program from the program administrator perspective using the equation presented below:

$$PAC = \frac{NPV\ (Avoided\ Costs)}{NPV\ (\,Total\ Gross\ Program\ Admnistrator\ Costs)}$$

- **Avoided costs** are the avoided supply costs achieved by the net electrical energy and peak demand savings generated by the program. The avoided unitary costs in $/kWh and $/kW saved were multiplied by the electrical energy and peak demand savings respectively.
- **Total gross program administrator costs** are the program costs incurred by the program administrator. Program administrator costs include costs related to program planning, design, marketing, implementation and evaluation, as well as incentives. Incentives typically represent the amounts that the program administrator offers participating customers for the upgrades they implement. The program costs were provided by ePEI and only the proportion attributable to EE&C savings was considered since the PAC test is performed for the EE&C portion of the program.

TRC Test

The TRC test reveals the total net benefits of a program from the perspective of both the utility and participating customers. It is not necessary to know who realizes the benefits and bears the costs.

The TRC test is calculated based on the following formula:

$$TRC = \frac{NPV\ (Avoided\ Costs + Customer\ Benefits)}{NPV\ (Net\ Tech.Costs + Gross\ Program\ Administrator\ Non{-}Incentive\ Costs)}$$

- For the TRC test, the **avoided costs** are the same as those of the PAC test.
- **Customer benefits** are participant non-energy benefits such as water savings and improved comfort or safety. For the EEER program, no customer benefits were included.
- **Net technical costs** correspond to the IPCs discussed in Subsection 3.4.1 above.
- The **gross program administration non-incentive costs** are the same costs as in the PAC ratio denominator, except that they exclude incentives. Incentives are excluded because they are financial transfers between ePEI and participating customers, thus not representing an expense.

3.4.3 Cost-Effectiveness Results

Table 15 and Table 16 present the cost-effectiveness results for the 2019/2020 and 2018/2019 periods respectively. As outlined in Table 15 and Table 16, the EEER program was cost-effective in both years based on the PAC and TRC test results.

Table 15: 2019/2020 Cost-Effectiveness Results

Cost-Effectiveness Test	Ratio	Benefits	Costs
PAC Test	**10.46**	$8,962,391	$856,803
TRC Test	**3.15**	$8,962,391	$2,845,967

Table 16: 2018/2019 Cost-Effectiveness Results

Cost-Effectiveness Test	Ratio	Benefits	Costs
PAC Test	**9.98**	$8,703,473	$872,430
TRC Test	**3.19**	$8,703,473	$2,728,305

3.5 Summary of Program Savings and Cost-Effectiveness Results

Table 17 summarizes the key results from the program savings and cost-effectiveness evaluations and compares these results to program targets.

Table 17: Summary of Program Savings and Cost-Effectiveness Targets and Evaluated Results

Parameters	2018/2019 Targets	2018/2019 Evaluation Results	2019/2020 Targets	2019/2020 Evaluation Results
Program Participation[11]				
Number of EE&C Participants	550	-	820	-
Number of Units	-	4,031	-	4,320
Number of Units Claimed for EE&C	-	831	-	876
Gross Electricity Savings at the Generator				
Gross Electricity Energy Savings (GWh)	-	2.647	-	2.832
Gross Lifetime Electricity Savings (GWh)	-	47.698	-	51.000
Gross Peak Demand Savings (MW)	-	2.302	-	2.341
Net Electricity Savings at the Generator				
NTGR	-	0.75	-	0.74
Net Electricity Energy Savings (GWh)	2.1	1.976	2.8	2.097
Net Lifetime Electricity Savings (GWh)	-	35.609	-	37.772
Net Peak Demand Savings (MW)	0.7	1.744	1.0	1.773
Cost-Effectiveness				
PAC Test	5.8	9.98	5.5	10.46
TRC Test	3.0	3.19	3.0	3.15

- The 2018/2019 evaluated net electricity energy savings were similar to program targets (about 6% lower). For 2019/2020, the evaluated results were 25% lower than program targets. The evaluation results indicate that the unitary savings value for the most popular equipment, MSHPs, was below the value that was expected at the time of setting the targets.
- The evaluated peak demand savings exceeded program targets by 149% and 77% for 2018/2019 and 2019/2020, respectively.
- The PAC and TRC tests revealed that the program was very cost-effective from both perspectives and reached the cost-effectiveness targets for both fiscal years.

[11] Program participation targets were established on a participant basis while evaluated results were calculated on an equipment unit basis since some participants installed more than one equipment type or unit.

4 PROGRAM PROCESSES AND IMPLEMENTATION

This section includes the evaluation results related to program processes and implementation. Specifically, it presents the Evaluator's findings related to program data tracking and participant feedback about their experience with the program.

4.1 Program Data Completeness

Figure 2 presents the important data types for the EEER program and their status in the EEER program database.

Figure 2: Summary of EEER Program Data Tracking

Information about program participants and implemented equipment is complete and consistent. The Evaluator recommends adding a column to track whether each EEER program participant also participated in the HIR program since the two programs may overlap.

More information is missing in the portion of the database that serves to compile program-level results. The Evaluator observed that the proportion of units that generate electrical savings is not currently considered; hence, the database includes all EEER program units in savings results, with the same electrical unitary savings being applied to all of them.

Also, it should be clearly indicated whether the savings values are at the meter or at the generator. If they are at the generator, the line loss factors should be included in the database.

Recommendation: Continue tracking current items and try collecting data on currently untracked or incomplete items.

Recommendation: In the compilation tab, add a field for the proportion of units claimed for EE&C (that generate electrical savings) and ensure this value is multiplied by the total number of units rebated.

Also, the number of units used is actually the number of applications, so it does not correctly account for applications that include multiple units. It is important that compiled quantities be in number of equipment units since unitary savings are on this basis.

Recommendation: Compile the number of units and use that value to calculate program-level savings by multiplying that value by the unitary savings value recommended in this evaluation report.

Some parameters used in the unitary savings calculations or in the compilation are currently based on evaluation data-collection activities such as either the application form review conducted on a sample of projects or the participant survey. That is the case for instance for the percentage of units generating electrical savings and the performance parameters in cold temperatures (used for the unitary peak demand savings calculation). ePEI might consider collecting some of that information in application forms; this would allow not only obtaining more accurate numbers by avoiding sampling errors, but also following the evolution of the program parameters on a continuous basis rather than updating it every few years through evaluation activities.

On a related note, the Evaluator does not have any recommendations related to the eligibility of the 30 MSHPs that were reviewed as part of the application form review. The Evaluator found that all of them met program eligibility criteria.

4.2 Program Data Organization

There are several opportunities to improve the organization of the EEER program database.

- EEER program data tracking is currently combined in a single database with three other programs. In part because four programs share one database, the database can be challenging to navigate, with many unused or partially used columns.

  Recommendation: Consider creating a database specific to each program and eliminating unneeded columns to customize each database to its program.

- The “Notes” field is used to record many data points including equipment quantity, implementation date and invoice number. This creates challenges for sorting and analyzing the tracked data.

  Recommendation: Use the “Notes” field only for sporadic or complementary data. All data that are systematically written under the "Notes" field should instead have their own column.

- The database records all equipment in a single column labelled “Upgrade Type”, as illustrated in Figure 3. This creates difficulty in sorting and analyzing information about implemented equipment. Tracking should be improved by assigning each upgrade and its respective quantity to its own column, as illustrated in Figure 4.

Upgrade Type
Heat/Energy Recovery Ventilator (10)
Heat/Energy Recovery Ventilator (10)
Propane Boiler (6), Propane Hot Water Heater (6)
Propane Boiler (6), Propane Hot Water Heater (6)
Air Source Heat Pump (12)
Air Source Heat Pump (1), Biomass Furnace
Air Source Heat Pump (1), Biomass Furnace

Figure 3: Excerpt from 2019/2020 Database

Upgrade Type	Qty 1	Upgrade Type 2	Qty 2
Heat/Energy Recovery Ventilator	10		
Heat/Energy Recovery Ventilator	10		
Propane Boiler	6	Propane Hot Water	6
Propane Boiler	6	Propane Hot Water	6
Air Source Heat Pump	12		
Air Source Heat Pump	1	Biomass Furnace	
Air Source Heat Pump	1	Biomass Furnace	

Figure 4: Recommended Data Tracking Practice

Recommendation: Track upgrade types and quantities under separate columns.

- Some of the column header names are unclear, for example those related to dates (i.e. "Date Processed" and "Invoice Date"). Another example is the "Amount" column. The Evaluator understands that this column refers to the rebate amount paid to participants but the header should be clearer.

  Recommendation: All columns should be clearly named to avoid interpretation, as well as facilitate overall understanding of the information tracked and data-collection sampling.

Data tracking and reporting are crucial for program management and evaluation. The Evaluator understands that ePEI is in the process of acquiring a data management system that would allow program tracking to be centralized rather than being performed in multiple individual tracking sheets. The Evaluator supports ePEI's goal to improve data management, which would contribute not only to the implementation of the data-completeness and data-organization recommendations in this report, but also ensure that program data is up to date and easy to use, for program management.

4.3 Participant Awareness and Motivations

Slightly more than half of surveyed participants first learned about the EEER program by word of mouth. Marketing via radio, newspapers, social media and the ePEI website represented the primary source of awareness about the EEER program for 25% of surveyed participants.

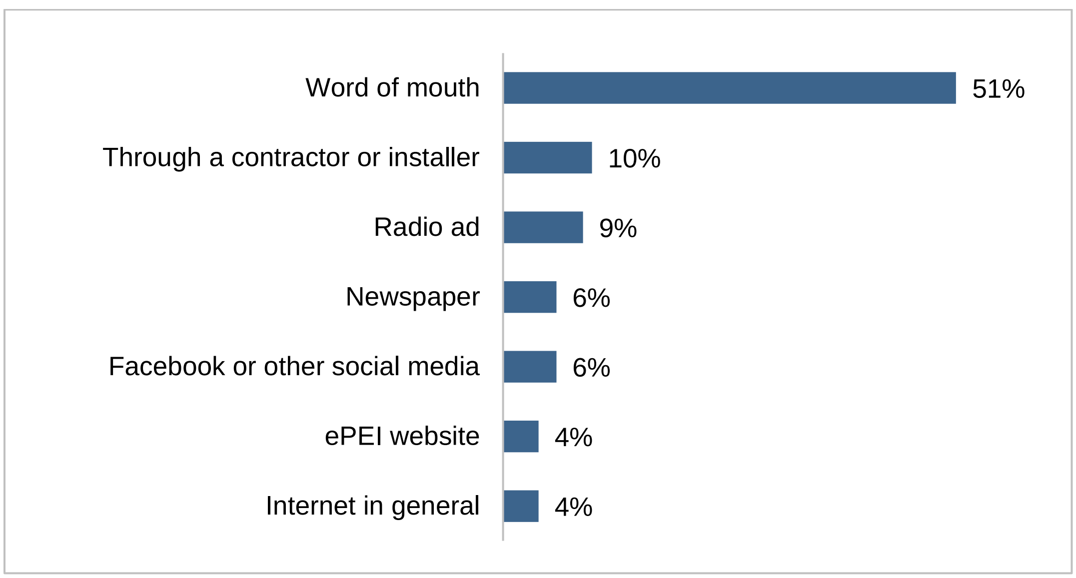

Figure 5: Primary Source of Awareness about the Program

More than half of surveyed participants indicated that their primary motivation for participating in the EEER program was saving money or reducing their energy bill. Other motivations mentioned by approximately one in 10 surveyed participants were saving energy and being more environmentally friendly, as well as adding air conditioning. Although mentioned only a few times as a primary motivation, improving home comfort was the most common secondary motivation among surveyed participants.

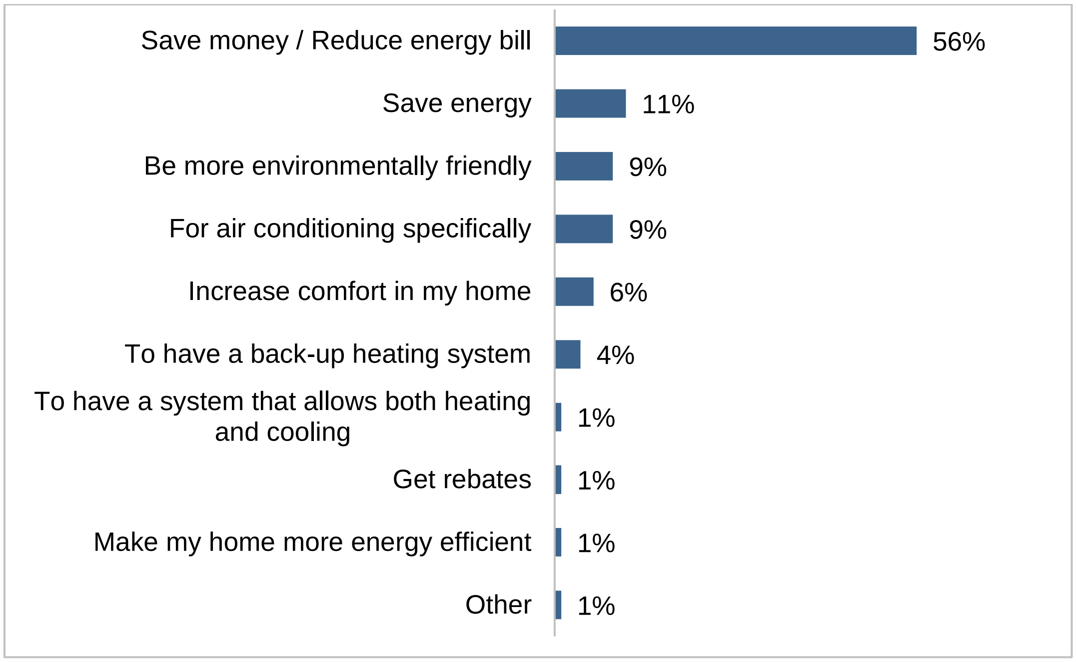

Figure 6: Primary Motivation for Participating in the Program

4.4 Participant Purchasing Concerns

The Evaluator asked surveyed participants to provide a score, on a scale of 0 to 10 where 0 is “not at all a concern” and 10 is “a major concern”, on potential barriers that they faced when they started thinking about installing a heat pump. Issues with higher scores indicate areas where heat pump purchasers may need information or decision support tools to enable them to make informed purchasing decisions.

Overall, participants identified technical knowledge about heat pump equipment – energy performance, capacity reliability – and equipment costs compared to other options to be the most significant barriers. The appearance of the equipment and finding a qualified contractor to install it were relatively lesser issues.

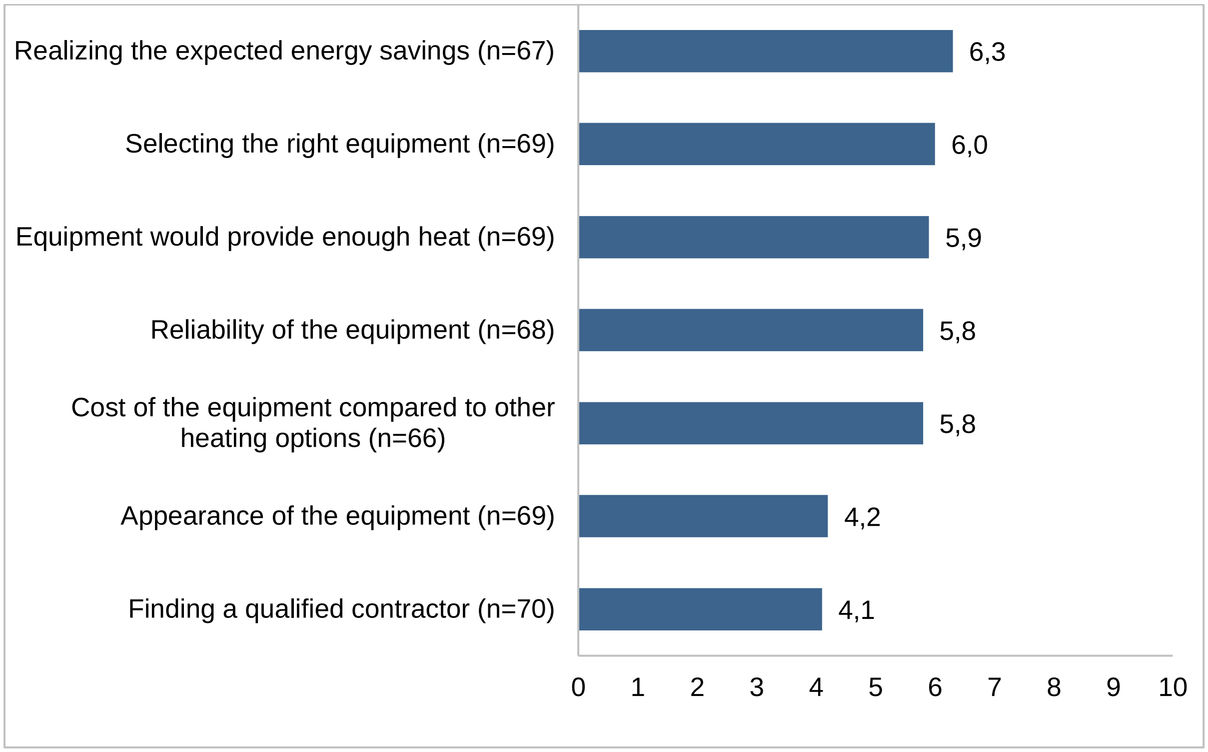

Figure 7: Participant Concerns about Installing a Heat Pump

4.5 Participant Satisfaction with the Program

Participant satisfaction with the EEER program is very high. Participants rated all aspects of the program – with the exception of rebate processing time – as 9.0 or higher out of 10, on average, using a scale from 0 to 10 where 0 means "not at all satisfied" and 10 means "completely satisfied". Participant satisfaction was particularly high for the quality of work performed by heat pump installers and for the new heat pump equipment.

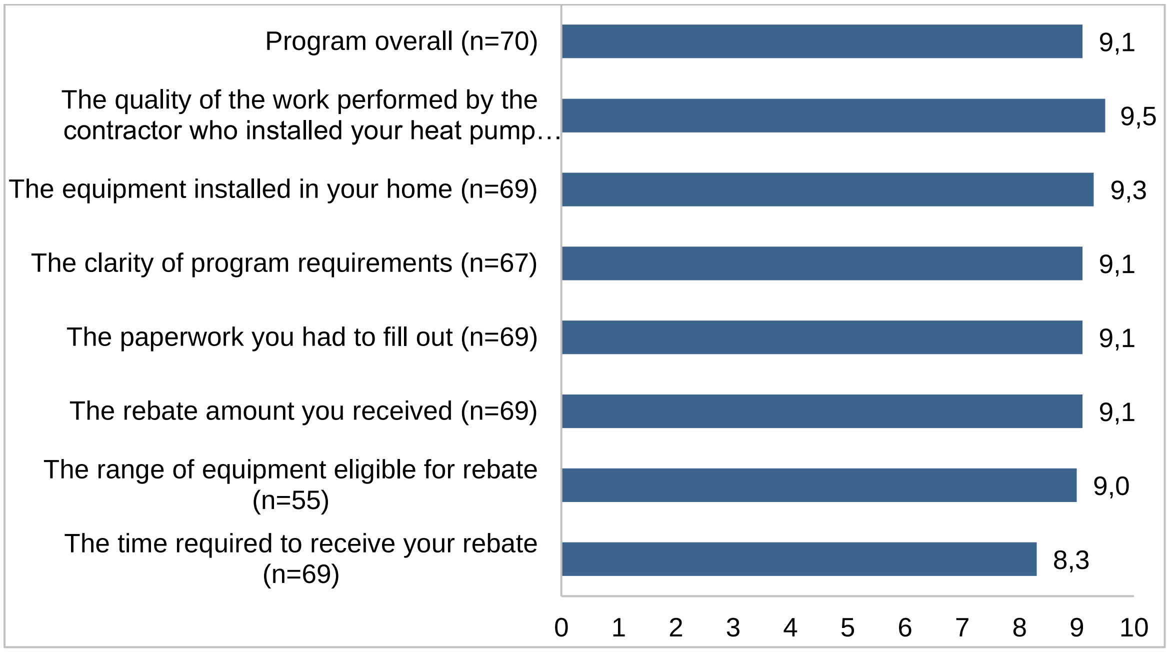

Figure 8: Participant Satisfaction Levels

The Evaluator asked participants to explain any satisfaction scores of 7 or less. The list below summarizes participants' explanations on program aspects for which at least five respondents provided scores of 7 or less.

- **Program paperwork**: Five surveyed participants noted that program paperwork was onerous to complete.
- **Time to receive the rebate**: Fourteen participants indicated a score of 7 or less for the time it took to receive their rebate. The average processing time reported by these participants was 10 weeks. Ten of these participants reported processing times of eight weeks or more, while two reported processing times of 20 weeks or more.
- **Range of eligible equipment**: Five participants suggested a wider range of heating products would be valuable, including electric convection heaters, propane heaters and less expensive heat pump models. Three participants indicated they would have liked the program to provide support for holistic home heating improvements, including doors, windows and insulation. This feedback indicates a lack of awareness among these participants about the full suite of EEER program equipment and the Home Insulation Rebates program that provides incentives for insulation, windows and doors.

The Evaluator asked surveyed participants whether they had any issues with the new heat pump that was installed as part of the program or with the installation work. Four participants experienced issues, two of which were minor and quickly resolved. The remaining two issues included a heat pump that is underperforming even after replacing the head and an issue with a head unit being installed at an incorrect height on the exterior wall and too close to a window.

4.6 Participant Recommendations for Improvement

Half of surveyed participants did not have any recommendations to improve the EEER program. The two most common recommendations were to increase the rebate value and to increase the number of eligible equipment types. Figure 9 presents all recommendations made by two or more participants.

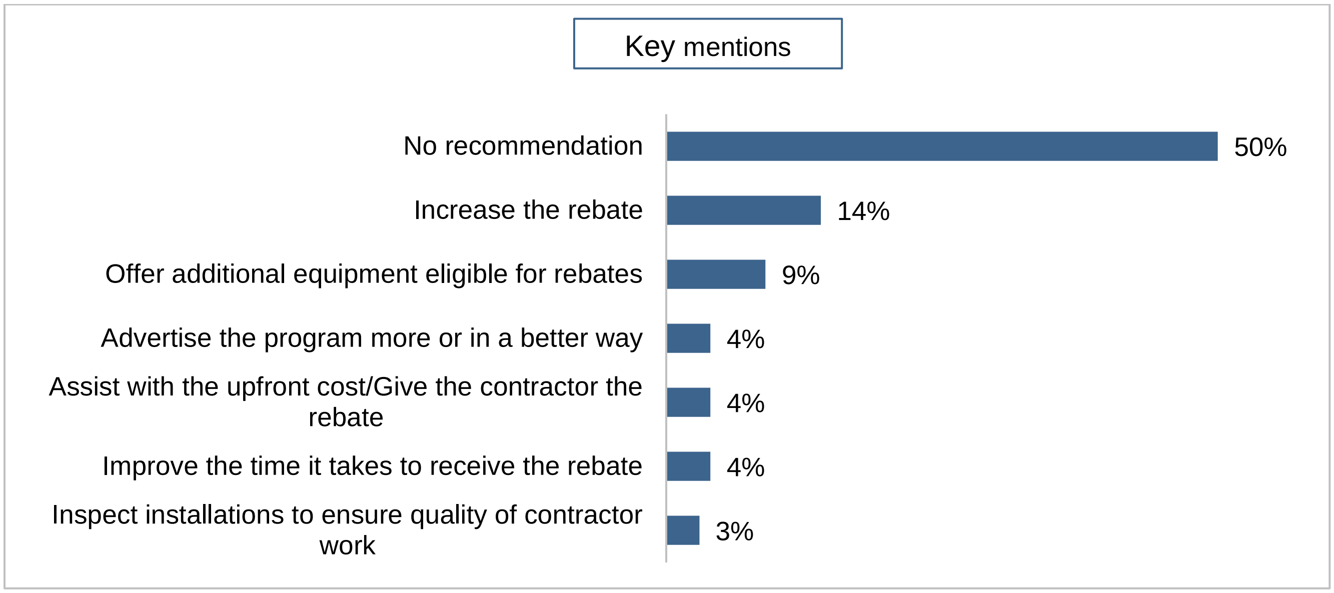

Figure 9: Main Recommendations for Improving the Program

CONCLUSIONS AND RECOMMENDATIONS

The evaluation of the EEER program was intended to achieve the following objectives:

- Establish the gross electricity energy and peak demand savings generated by the program;
- Establish the net electricity energy and peak demand savings generated by the program;
- Assess whether the program is cost-effective;
- Assess the effectiveness of program processes and implementation.

This section provides the Evaluator's conclusions and recommendations related to program processes, implementation, cost-effectiveness, as well as energy and peak demand savings.

The program achieved the targets for participation, peak demand savings and cost-effectiveness but fell slightly short of the energy savings target.

Participation levels exceeded targets by more than four times for both 2019/2020 and 2018/2019. High participation enabled the program to exceed peak demand savings targets in both years, by 77% in 2019/2020 and 149% in 2018/2019. The EEER program also met targets for cost-effectiveness in both years, based on both PAC and TRC test results. The program achieved 75% of the electricity energy savings target in 2019/2020 and 94% of the target in 2018/2019. The primary reason that the EEER program did not meet the energy savings target was a lower-than-anticipated unitary energy savings value for MSHPs.

MSHPs represent the majority of measures implemented and energy savings achieved.

MSHPs account for 87% of implemented measures and 79% of gross electricity energy savings achieved in 2019/2020. For this reason, only the savings calculation parameters of this equipment category were evaluated.

Gross savings evaluation results for non-MSHP equipment rely on key assumptions about baseline equipment.

The Evaluator surveyed a group of MSHP participants to learn what type of heating systems they used prior to purchasing a heat pump and used this information to inform the baseline and unitary savings value for MSHPs. Without this information for other equipment types, unitary savings values rely on assumptions rather than on data from PEI households.

The Evaluator supports ePEI's intention to use program application forms to collect information from participants regarding existing heating system types (primary and secondary). This data collection activity will enable program staff and the Evaluator to determine accurate existing condition baselines and ensure that the program is able to measure and claim the full extent of energy savings achieved.

Recommendation 1: Use the evaluation parameters established through this evaluation for MSHP program savings tracking going forward. These parameters include the NTGR and unitary savings value. The exception to this recommendation is data collected from participants through program application forms subsequent to this evaluation, such as the heating system data.

Participant satisfaction with the EEER program is very high.

Participants rated all aspects of the program – with the exception of rebate processing times – as 9 or higher out of 10, on average. Participants were particularly satisfied with the quality of the work performed by heat pump installers and their new heat pump equipment.

Some program participants are not aware of other ePEI programs.

Eight of 70 surveyed participants indicated that they would have liked to receive ePEI support for equipment or measures that are not eligible through the EEER program but are eligible through other programs. Another participant noted that they only learned about the HIR program at the last minute and nearly lost the opportunity to participate. This suggests that some EEER program participants may be interested in performing holistic upgrades to their homes but are unaware of the opportunity to obtain ePEI support.

Recommendation 2: Ensure that EEER program participants are aware of other ePEI programs for which they may be eligible, including the HIR program, which, like EEER, encourages home retrofits.

There are opportunities to improve the completeness and organization of program tracking data.

The Evaluator reviewed the program database and identified the important data types that should be collected and tracked, as well as the verifications that should be conducted by ePEI to effectively manage and evaluate the program and accurately calculate savings. Information about program participants and new equipment is complete and consistent. Some information is missing in the areas of the database used to compile program-level results. The Evaluator also observed opportunities to improve the organization of the program database to make data more accessible for analysis.

Recommendation 3: Update program tracking to implement the following:

a. Continue tracking current items and try collecting data on currently untracked or incomplete items.
b. In the compilation tab, add a field for the proportion of units claimed for EE&C (that generate electrical savings) and ensure this value is multiplied by the total number of units rebated.
c. Consider creating a database specific to the program instead of using the database for the HIR program and two other programs and eliminate unneeded columns to customize the database to the program.
d. Use the “Notes” field only for sporadic or complementary data. All data that are systematically written under the “Notes” field should instead have their own column.
e. Track upgrade types and quantities under separate columns.
f. Clearly name all columns to avoid interpretation as well as facilitate overall understanding of the information tracked and data-collection sampling.

Subsections 4.1 and 4.2 of this report provide additional information on the findings that led to these sub-recommendations.

APPENDIX I
PARTICIPANT SURVEY QUESTIONNAIRE

Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Participant survey
Estimated Time to Complete	15 minutes
Target Audience	Participants who installed mini-split heat pumps as part of the program
Expected Number of Completions	70
Contact List Source	efficiencyPEI
Fielding Firm	Vision Research
Estimated Timeline for Fielding	February 2020

Research Objectives and Associated Questions

Research Objectives	Section
How did participants learn about the program?	B1
Why did participants want to participate in the program?	B2-B3
What heating system did participants have before the program and what is their main system now?	B4-B7
How satisfied are participants with the program and its aspects?	C1-C3
Did participants have any issues with their equipment or installation?	C4-C5
What concerns did participants have before getting their equipment?	D1-D2
What is the free-ridership level for mini-split heat pumps?	E series
What recommendations do participants have to improve the program?	F1

Import variables from database **< LIKE THIS >**

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

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

INTRODUCTION

Could I speak with **<INSERT NAME>**?

1. Yes **[CONTINUE]**
2. No **[SAY "PERHAPS YOU CAN HELP ME ANYWAY." CONTINUE]**

Hello, my name is *** and I am with Vision Research, a PEI-based survey research company. We are performing an evaluation of energy efficiency programs and services provided by efficiencyPEI. Our records indicate that you or your household recently participated in efficiencyPEI's Energy Efficient Equipment program. The program provides a rebate for the installation of energy efficiency equipment such as mini-split heat pumps.

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

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

A. Verification

A1. Our records indicate that in the last year your household installed **<NUMBER OF HEAT PUMPS>** mini-split heat pump(s) through the Energy Efficient Equipment program. Is this correct?

1. Yes **[CONTINUE]**
2. Yes, but the number of heat pumps mentioned is incorrect **[CONTINUE]**
3. No, does not recall participating **[PROBE:** You would have received a rebate from efficiencyPEI for installing one or more heat pumps in your home. **[IF PERSIST AS NO, THANK, TERMINATE, RECORD AND KEEP DATA]**

99. Don't know/Refused [**PROBE**: "Is there someone else in your household who would know about having participated in the Energy Efficient Equipment 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: ______________________________]

B. Program Awareness and Reasons for Participation

B1. How did you first learn about the Energy Efficient Equipment program? **[DO NOT READ; ALLOW MULTIPLE RESPONSES BUT DO NOT PROBE FOR MULTIPLE]**

1. efficiencyPEI website
2. Through a contractor or installer
3. At a home show
4. Word of mouth / Friends / Family
5. Facebook or other social media
6. Power bill insert
7. Through participation in another efficiencyPEI program
8. Newspaper
9. Radio ad
10. Television ad
11. Community event
12. Internet in general
13. Hardware store

96. Other [SPECIFY: ______________]
98. Don't know

B2. What was the SINGLE most important reason you were interested in installing a mini-split heat pump? **[DO NOT READ – CODE ONE ONLY]**

1. Save money / Reduce energy bill
2. Save energy
3. Get rebates
4. Be more environmentally friendly
5. Make my home more energy efficient
6. Increase comfort in my home
7. Increase value of my home
8. For air conditioning specifically
9. To have a system that allows both heating and cooling
10. To have a back-up heating system
11. It was easy to install compared with other systems

96. Other [SPECIFY_______________]
98. Don't know

B3. Were there any other reasons? **[SAME LIST AS IN B2] [DO NOT READ. ACCEPT MULTIPLE RESPONSES]**

B4. Before participating in the Energy Efficient Equipment 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, propane or oil-fired furnace
96. Or something else (**SPECIFY:** _________)
98. (Don't know)
99. (Refused)

B5. **[DO NOT ASK IF DON'T KNOW/REFUSED IN B4]** When you decided to participate in the Energy Efficient Equipment 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)

B6. Is the heat pump that you installed as part of the Energy Efficient Equipment program your main heating system now?

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

B7. **[ASK IF NO IN B6]** What do you use as your main heating system? Is it…? **[READ AND ACCEPT ONE RESPONSE ONLY]**

1. Electric baseboards or electric furnace
2. Geothermal system
3. Heating stove (wood or pellet)
4. Gas, propane or oil-fired furnace
96. Or something else (**SPECIFY:** _________)
98. (Don’t know)
99. (Refused)

B8. **[ASK IF YES IN B6]** Do you use a secondary heating system?

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

B9. **[ASK IF YES IN B8]** What do you use as your secondary heating system? Is it…? **[READ AND ACCEPT ONE RESPONSE ONLY]**

1. Electric baseboards or electric furnace
2. Geothermal system
3. Heating stove (wood or pellet)
4. Gas, propane or oil-fired furnace
5. Fireplace
96. Or something else (**SPECIFY:** _________)
98. (Don’t know)
99. (Refused)

C. Satisfaction with Program

C1. 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]**

C2. **[IF C1<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)
99. (Refused)

C3. On the same scale of 0 to 10, where 0 is 'not at all satisfied' and 10 is 'completely satisfied', how satisfied were you with each of the following aspects of the Energy Efficient Equipment program? **[DO NOT RANDOMIZE] [97 = NOT APPLICABLE, 98 = DON'T KNOW/DON'T RECALL, 99 = REFUSED]**

a. The clarity of program requirements ***[IF SCORE IS 7 OR LESS, ASK:*** *What about the program requirements was unclear?* ***] RECORD VERBATIM***
b. The paperwork you had to fill out ***[IF SCORE IS 7 OR LESS, ASK:*** *What about the paperwork could be improved?* ***] RECORD VERBATIM***
c. The amount of the rebate you received ***[IF SCORE IS 7 OR LESS, ASK:*** *What rebate amount would you have liked to receive?* ***] RECORD VERBATIM***
d. The time required to receive your rebate ***[IF SCORE IS 7 OR LESS, ASK:*** *How long did it take to receive your rebate* ***] RECORD VERBATIM***
e. The equipment installed in your home ***[IF SCORE IS 7 OR LESS, ASK:*** *Why aren't you more satisfied with the equipment?* ***] RECORD VERBATIM***
f. The quality of the work performed by the contractor who installed your heat pump ***[IF SCORE IS 7 OR LESS, ASK:*** *What about the contractor's work could have been improved?* ***] RECORD VERBATIM***
g. The range of equipment eligible for rebate ***[IF SCORE IS 7 OR LESS, ASK:*** *What equipment would you like to see eligible under the program?* ***] RECORD VERBATIM***

C4. Did you have any issues with the mini-split heat pump that was installed as part of the Energy Efficient Equipment program, whether it be with the equipment installed or how it was installed? **[DO NOT READ – CODE ONE ONLY]**

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

C5. **[ASK IF C4=1]** Can you describe the issue? ***RECORD VERBATIM***

D. Barriers and Concerns

D1. For the next few statements, I'd like you to think back to the point when you started to consider installing a heat pump. 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 expected energy savings
g. The cost of the equipment compared to other heating options

D2. What other concerns, if any, did you have with installing a heat pump? [**RECORD VERBATIM]**

97. None/no concerns
98. (Don't know)
99. (Refused)

E. Free-Ridership

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

E1. Had you already decided to install a heat pump before you heard about the Energy Efficient Equipment program? **[DO NOT READ – CODE ONE ONLY]**

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

E2. **[IF E1=1]** I just want to make sure I understand – before you learned about the Energy Efficient Equipment program, you had already made the decision to install a heat pump? **[DO NOT READ – CODE ONE ONLY]**

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

E3. **[IF E1=2, 98, 99 OR E2=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
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
98. (Don't know)
99. (Refused)

E4. **[IF E2=1 OR E3=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 ENERGY STAR most-efficient heat pump models are eligible for a rebate under the Energy Efficient Equipment program. The ENERGY STAR Most Efficient certification is given to products that deliver cutting edge energy efficiency. So, the heat pump you installed is much more efficient than the standard heat pump models on the market. Now, we will discuss your decision to install a ENERGY STAR most-efficient heat pump model rather than a less efficient model.

E5. Were you aware that ENERGY STAR most-efficient heat pumps were available before you heard about the Energy Efficient Equipment program? **[DO NOT READ – CODE ONE ONLY]**

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

E6. **[IF E5=1]** Before you heard about the Energy Efficient Equipment program, which heat pump energy efficiency level had you decided to install? Was it… **[READ – CODE ONE ONLY]**

1. A standard efficiency model
2. An ENERGY STAR model
3. An ENERGY STAR Most Efficient model, OR
4. You had not decided on an efficiency level

98. (Don't know)

99. (Refused)

E7. EfficiencyPEI gave you a rebate of $**<REBATE AMOUNT>** for your new ENERGY STAR most-efficient heat pump. If you had not received the rebate from efficiencyPEI, would you have paid the total cost of your ENERGY STAR most-efficient 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

E8. Next, I'm going to ask you to rate the importance of factors that might have influenced your decision to install a ENERGY STAR most-efficient 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 ENERGY STAR most-efficient 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 ENERGY STAR most-efficient heat pumps provided by efficiencyPEI	___ Response ___98 Don't Know ___99 Refused
c. Information on the benefits of ENERGY STAR most-efficient heat pumps provided by a retailer or contractor	___ Response ___98 Don't Know ___99 Refused
d. Promotion done by efficiencyPEI or a previous participation in an efficiencyPEI program	___ Response ___98 Don't Know ___99 Refused

F. Recommendations for Program Improvements

F1. Do you have any recommendations for improving the Energy Efficient Equipment program? PROBE: Anything else? **[DO NOT READ. ACCEPT MULTIPLE]**

1. (Increase the rebate)
2. (Offer additional equipment eligible for rebates)
3. (Offer more information on the eligible equipment)
4. (Simplify program application, forms, and associated paperwork)
5. (Advertise the program more or in a better way)
6. (Assist with the upfront cost/Give the contractor the rebate)
7. (Inspect installations to ensure quality of contractor work)
8. (Improve the time it takes to receive the rebate)
9. (Increase the number of approved contractors)

97. (No recommendation)
96. (Other [SPECIFY_______________])
98. (Don't know)
99. (Refused)

G. Demographics

These final questions are asked for statistical purposes only. The information collected is strictly confidential.

G1. What type of residence do you live in? **[READ RESPONSES 1-6, THEN 96; SELECT ONE RESPONSE]**

1. Detached single-family house
2. Semi-detached house
3. Mobile home or house trailer
4. Townhouse or duplex that shares adjacent walls
5. Row house
6. Apartment building that have fewer than five stories

96. Or Another type [SPECIFY: ________________________]
98. (Don't know)
99. (Refused)

G2. How many bedrooms are in your home? **[98=DK; ENTER ZERO FOR A STUDIO APARTMENT WITH NO BEDROOMS]**

G3. Including yourself, how many people live in this residence on a full-time basis?

Number of people: ______________ **[DON'T ALLOW ZERO FOR A RESPONSE]**

97. (Nobody lives in the house on a full-time basis)
99. (Refused)

G4. What is your age group? Are you… **[READ. CODE ONLY ONE]**

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)

G5. What is the highest level of education you have completed? **[DO NOT READ. CODE ONLY ONE]**

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)

G6. Which of the following income categories best describes your total annual household income before taxes in 2018? 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)

This completes the survey. Your responses are very important to efficiencyPEI. We appreciate your participation and thank you for your time. Have a good [evening/day].

APPENDIX II
FREE-RIDERSHIP ALGORITHM

The figures below respectively present the algorithms for calculating the free-ridership levels for MSHPs installed in electrically-heated households and those installed in previously non-electrically heated households. The participant survey questionnaire included questions designed to assess the planning, quantity, efficiency, period, cost, and influence of the program. Participant responses to each group of questions were converted into a value indicating the level of program attribution, and this value was used to calculate the free-ridership level associated with each participant.

The algorithm also consisted of two portions. The first portion assessed a participant's decision to install a heat pump, while the second assessed a participant's decision to purchase a high-efficiency heat pump. The Evaluator attributed a weight to each portion of the algorithm, based on the proportion of the savings associated with the efficiency increase between the baseline and the standard efficiency level, and between the standard and the high-efficiency level, and then calculated the free-ridership level as a weighted average. The weights assigned to the electrically-heated households were different from those assigned to the non-electrically-heated households as shown at the last step of the algorithms, since their baseline efficiency levels are not the same (100% for an electrical resistance heating system and 84% for a non-electrical heating system).

MSHP installed in electrically heated household	
Series A: Decision to install a HP	
E1. Had you already decided to install a heat pump before you heard about the Energy Efficient Equipment Program?	IF 1. Yes: Use E2 IF 2. No OR DK OR REF: E2 = 0%
E2. [IF E1=1] I just want to make sure I understand - before you learned about the Energy Efficient Equipment program, you had already made the decision to install a heat pump?	IF 1. Yes: E2 = 100% IF 2. No OR DK OR REF: E2 = 0%
E3. [ASK IF E1<>1 OR E2<>1] If the program rebate 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 E4
E4. [ASK IF E2=1 OR E3=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? (Scale 0 to 10)	E4 = (10 – Answer) x 10% IF DK OR REF: E4 = EMPTY
Series A Score	**MEAN VALUE OF: (E2 ; E4)**

Series B: Decision to install a high-efficiency HP	
E5. Were you aware that ENERGY STAR most-efficient heat pumps were available before you heard about the Energy Efficient Equipment program?	IF 1. Yes: Use E6 IF 2. No, DK OR REF: E6 = 0% AND **END**
E6. [ASK IF E5=1] Before you heard about the Energy Efficient Equipment program, which heat pump energy efficiency level had you decided to install? 1. A standard efficiency model 2. An ENERGY STAR model 3. An ENERGY STAR Most Efficient model, OR 4. You had not decided on an efficiency level	IF 1: E6 = 0% IF 2: E6 = 75% IF 3: E6 = 100% IF 4: E6 = 0%
E7. If you had not received the rebate from efficiencyPEI, would you have paid the total cost of your ENERGY STAR most-efficient heat pump? (Scale 0 to 10)	E7 = Answer x 10% IF DK OR REF: E7 = EMPTY
E8. Level of influence of four factors (Scale 0 to 10) **a.** The program rebate **b.** Information on the benefits of ENERGY STAR most-efficient heat pumps provided by efficiencyPEI **c.** Information on the benefits of ENERGY STAR most-efficient heat pumps provided by a retailer or contractor **d.** Promotion done by efficiencyPEI or a previous participation in an efficiencyPEI program	E8 = (10 – MAX(a ; b ; c ; d)) x 10%
Series B Score	**IF Series A ≤ 50% OR E5<>1: Series B = 0%, OTHERWISE MEAN VALUE OF: (E6 ; E7 ; E8)**
Inconsistency Test #1	IF E6 = 100% AND E7 < 70%: E6 = EMPTY
Inconsistency Test #2	IF E6 = 0% OR 50% AND E7 > 70%: E7 = EMPTY
Free-Ridership	**0.75 x Series A + 0.25 x Series B**

MSHPs installed in non-electrically-heated households	
Series A: Decision to install a heat pump	
E1. Had you already decided to install a heat pump before you heard about the Energy Efficient Equipment Program?	IF 1. Yes: Use E2 IF 2. No OR DK OR REF: E2 = 0%
E2. [IF E1=1] I just want to make sure I understand - before you learned about the Energy Efficient Equipment program, you had already made the decision to install a heat pump?	IF 1. Yes: E2 = 100% IF 2. No OR DK OR REF: E2 = 0%
E3. [ASK IF E1<>1 OR E2<>1] If the program rebate 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 E4
E4. [ASK IF E2=1 OR E3=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? (Scale 0 to 10)	E4 = (10 – Answer) x 10% IF DK OR REF: E4 = EMPTY
Series A Score	**MEAN VALUE OF:** **(E2 ; E4)**

Series B: Decision to install a high-efficiency heat pump	
E5. Were you aware that ENERGY STAR most-efficient heat pumps were available before you heard about the Energy Efficient Equipment program?	IF 1. Yes: Use E6 IF 2. No, DK OR REF: E6 = 0% AND **END**
E6. [ASK IF E5=1] Before you heard about the Energy Efficient Equipment program, which heat pump energy efficiency level had you decided to install? 1. A standard efficiency model 2. An ENERGY STAR model 3. An ENERGY STAR Most Efficient model, OR 4. You had not decided on an efficiency level	IF 1: E6 = 0% IF 2: E6 = 75% IF 3: E6 = 100% IF 4: E6 = 0%
E7. If you had not received the rebate from efficiencyPEI, would you have paid the total cost of your ENERGY STAR most-efficient heat pump? (Scale 0 to 10)	E7 = Answer x 10% IF DK OR REF: E7 = EMPTY
E8. Level of influence of four factors (Scale 0 to 10) **a.** The program rebate **b.** Information on the benefits of ENERGY STAR most-efficient heat pumps provided by efficiencyPEI **c.** Information on the benefits of ENERGY STAR most-efficient heat pumps provided by a retailer or contractor **d.** Promotion done by efficiencyPEI or a previous participation in an efficiencyPEI program	E8 = (10 – MAX(a ; b ; c ; d)) x 10%
Series B Score	**IF Series A ≤ 50% OR E5<>1: Series B = 0%, OTHERWISE MEAN VALUE OF: (E6 ; E7 ; E8)**
Inconsistency Test #1	IF E6 = 100% AND E7 < 70%: E6 = EMPTY
Inconsistency Test #2	IF E6 = 0% OR 50% AND E7 > 70%: E7 = EMPTY
Free-Ridership	**0.85 x Series A + 0.15 x Series B**

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2018/2019 AND 2019/2020 HOME INSULATION REBATES PROGRAM EVALUATION

EFFICIENCYPEI

Final Report

June 26, 2020

ECONOLER

ACRONYMS

DSM	Demand-side management
EA	Energy Advisor
EE&C	Electricity Efficiency and Conservation
EEER	Energy Efficient Equipment Rebates (program)
ePEI	efficiencyPEI
ERS	EnerGuide Rating System
EUL	Effective useful life
HIR	Home Insulation Rebates (program)
IPC	Incremental product cost
NPV	Net Present Value
NRCan	Natural Resources Canada
NTGR	Net-to-gross ratio
PAC	Program Administrator Cost (test)
PEI	Prince Edward Island
SO	Service Organization
TRC	Total Resource Cost (test)

DEFINITIONS

Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
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.
Evaluated savings	Gross and net savings calculated by the Evaluator using parameters (installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process.
Free-ridership	Percentage of 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 energy efficiency program, regardless of why they participated.
Interactive effects	Interactive effects occur when the installation of an energy efficiency measure has an impact on the energy consumption of other elements in the building such as heating and cooling.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for 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.
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 between the net energy savings and gross energy savings that includes effects, such as free ridership and spillover, that positively or negatively affect the energy savings generated by a program.
Peak demand-to-energy ratio	The ratio between peak demand savings and energy savings.
Peak demand savings	The demand savings that coincide in time with the peak demand of the electricity system.
Program Administrator Cost test	This test compares program administrator costs to utility resource savings.

Sample size	The number of observations or replicates included in a statistical sample.
Spillover	Savings attributable to participants who continue to implement the energy efficiency measures introduced by a program after participating in it once, without participating in the program a second time.
Total Resource Cost test	This test compares program administrator and participant costs to utility resource savings and in some cases, other resource savings and program benefits accrued by participants, such as non-energy benefits.
Tracked savings	Gross and net savings calculated by the utility in its internal tracking, based on various parameters such as number of participants, installation rates, interactive effects, and 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).

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EXECUTIVE SUMMARY

This report presents the evaluation results of the efficiencyPEI (ePEI) Home Insulation Rebates (HIR) program. The program encourages homeowners to perform energy efficient upgrades by providing information about the energy efficiency of their homes through home energy assessments and by offering financial incentives for the implementation of energy efficient upgrades. Eligible upgrades include insulation, air sealing, as well as windows, doors and skylights. Participants have the option to participate in the ePEI Energy Efficient Equipment Rebates (EEER) program to receive incentives for space or water heating equipment recommended to them as part of the HIR program.

An initial home energy assessment is conducted to collect information on houses and provide homeowners with upgrade recommendations in a report. A final home energy assessment is conducted after upgrade implementation to confirm installation and the energy efficiency level of the home. The home energy assessments and resulting HOT2000 simulations are conducted by Energy Advisors (EAs) who are hired by Service Organizations (SOs) responsible for delivering the program across the province.

Summary of Evaluation Assignment

ePEI hired Econoler (hereinafter the Evaluator) to evaluate the program and achieve the following key objectives:

› Establish the gross electricity energy and peak demand savings generated by the program;
› Establish the net electricity energy and peak demand savings generated by the program;
› Assess whether the program is cost-effective;
› Assess the effectiveness of program processes and implementation.

The evaluation addresses the program savings and cost-effectiveness results associated with equipment that displace electricity usage only.

The evaluation was carried out based on a review of the program database and documentation, a participant survey, literature review, engineering calculations and cost-effectiveness analyses based on the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests.

The evaluation covers the 2019/2020 fiscal year. Based on the parameters established through the evaluation, this report also presents results for the 2018/2019 fiscal year.

Summary of Evaluation Results

This subsection presents the key findings of the evaluation.

Participation Level

A total of 345 HIR program projects were completed during the 2019/2020 fiscal year, 101 of which were completed by participants who used electricity as their main heating source. In 2018/2019, 61 projects were completed, with 16 of them being in electrically-heated homes.

Satisfaction with the Program

Participants reported being very satisfied with the program overall and most of its aspects such as the customer service and expertise of EAs, home energy assessments, and rebate amounts. The one aspect of the program that received a slightly lower average satisfaction rating is the audit report. Similarly, while participants did not encounter significant challenges during participation, the program stages between the initial and final energy assessments represent the part of the program that participants found most challenging, specifically reviewing the audit report and choosing upgrades, finding a contractor, getting the upgrades completed and completing program paperwork. To improve the program, participants have asked for more communication, follow-up and support after the initial home energy assessment. Additionally, one-third of surveyed participants who worked with a contractor said that their contractor did not know about program eligibility criteria and measures.

Program Data Tracking

The program database contained most of the important participant and upgrade data. The Evaluator found that information used to calculate and compile energy and demand savings was not always tracked, or tracked incompletely, including the primary and secondary heating system and fuel types. The Evaluator also found opportunities to improve the organization and accessibility of program data, including by tracking in separate columns the type and quantity of each equipment type implemented and by creating a dedicated program database for the program.

Furthermore, the Evaluator found duplicate projects and projects with abnormal savings. The Evaluator also found that savings had been counted twice in the case of some projects that participated in both the HIR and EEER programs. Combined, these scenarios represented only a small minority of projects.

Gross Savings

Since HIR program savings are generated by reduced heating needs, the Evaluator only attributed electricity savings to participating homes for which the primary heating system was tracked as electric in the database.

During the review of gross electricity energy savings, the Evaluator determined the following:

› Recent evaluations of similar programs in other Canadian provinces have indicated that the HOT2000 software is known to overestimate the consumption of simulated buildings. Based on the results of a billing analysis conducted in Nova Scotia and the heating system types of the HIR program participants in 2019/2020, the Evaluator established an overestimation ratio of 8.9% to be applied to gross electricity energy savings.
› The savings of three HIR program projects that also involved the installation of a mini-split heat pump as part of the EEER program had to be reduced since they had been counted twice.

Net Savings

A net-to-gross ratio (NTGR) is used to determine net savings based on program gross savings. The Evaluator established the NTGR for the program using free-ridership; spillover was considered to be nil. Based on the participant survey, the Evaluator determined free-ridership to be 23%, resulting in a NTGR of 0.79 after considering the proportion of low-income and non-low-income participants in 2019/2020 (a NTGR of 1 is assumed for low-income participants).

Cost-Effectiveness

The Evaluator assessed the cost-effectiveness of the Electricity Efficiency and Conservation portion of the program by performing specific cost-effectiveness tests, namely the TRC and PAC tests. When performing these tests, ratios greater than 1 are desired because they indicate that program benefits outweigh costs.

The evaluation revealed that the program was very cost-effective in both 2018/2019 and 2019/2020, with PAC and TRC results above 3.0.

Summary of Savings and Cost-Effectiveness Results

Table 1 summarizes the key results of the program savings and cost-effectiveness evaluations for 2019/2020 and 2018/2019, as well as participation levels and program targets.

Table 1: Summary of Program Savings and Cost-Effectiveness Targets and Evaluated Results

Parameters	2018/2019 Targets	2018/2019 Evaluation Results	2019/2020 Targets	2019/2020 Evaluation Results
Program Participation				
Number of Participants	80	16	210	101
Gross Electricity Savings at the Generator				
Gross Electricity Energy Savings (GWh)	-	0.162	-	0.876
Gross Lifetime Electricity Savings (GWh)	-	3.670	-	19.896
Gross Peak Demand Savings (MW)	-	0.048	-	0.259
Net Electricity Savings at the Generator				
NTGR	-	0.79	-	0.79
Net Electricity Energy Savings (GWh)	0.5	0.128	1.3	0.692
Net Lifetime Electricity Savings (GWh)	-	2.899	-	15.718
Net Peak Demand Savings (MW)	0.2	0.038	0.4	0.205
Cost-Effectiveness				
PAC Test	4.5	3.35	5.1	7.22
TRC Test	0.8	3.48	0.8	4.11

- In 2019/2020, the evaluated net electrical energy and peak demand savings failed to reach program targets by 47% and 49% respectively. The program evaluated savings were also below targets for the 2018/2019 period. This is mainly due to lower than expected participation levels, with fewer than 50% of the expected number of participants.
- Nonetheless, the PAC and TRC tests revealed that the program was very cost-effective from both perspectives and for both fiscal years. The evaluated IPC value likely explains why the evaluated TRC results are much higher than targets.

Recommendations

In light of these findings, the Evaluator issues the following recommendations.

Recommendation 1: Use the evaluation parameters established by this evaluation for program savings tracking going forward.

Recommendation 2: Update program tracking to implement the following:

a. Continue tracking current items and try collecting data on currently untracked or incomplete items. This includes the NRCan simulation numbers, primary and secondary heating system and fuel types, the overestimation ratio, as well as gross and net electrical energy and peak demand savings.
b. Identify the projects that generate electrical savings to calculate program gross and net electrical savings.
c. Consider creating a database specific to the program instead of using the database for the HIR program and two other programs and eliminate unneeded columns to customize the database to the program.
d. Track upgrade types (and quantities when applicable) under separate columns.
e. Use consistent wording to track upgrade types.
f. Clearly name all columns to avoid interpretation as well as facilitate overall understanding of the information tracked and data-collection sampling.
g. Ensure that the data tracked for each project or grant match the tracked status.
h. Screen for possible duplicate projects to ensure they are not claimed twice in program savings.

Recommendation 3: Implement a quality assurance process to ensure the accuracy of gross savings. Verification should be automatically conducted on certain types of projects including: (1) projects with negative savings; (2) projects that have the same address; (3) projects with savings that account for over 50% of consumption; and (4) projects that also go through the EEER program.

Recommendation 4: Provide additional support to participants after the initial home energy assessment. This could be achieved by requiring that SOs conduct regular check-ins with participants between the two assessments to ensure that participants understand next steps and that EAs spend more time explaining the audit report to participants.

Recommendation 5: Incorporate ways to increase contractor awareness about the HIR program into the program or portfolio marketing strategy. The Evaluator understands that having contractors become more aware and involved in the HIR program may be a long-term goal.

INTRODUCTION

Under the Government of Prince Edward Island (PEI), efficiencyPEI (ePEI) is responsible for administering Electricity Efficiency and Conservation (EE&C) programs in the province. The programs are meant to help Islanders not only improve the energy efficiency and conservation of energy in their homes and workplaces by installing high-efficiency equipment and products, but also change behaviours. Econoler was commissioned by ePEI to evaluate its EE&C program portfolio comprised of five residential programs and three commercial programs.

One of the five residential programs is the Home Insulation Rebates (HIR) program, which provides homeowners with information about the energy efficiency of their homes through home energy assessments and recommendations, as well as rebates for the implementation of energy efficient upgrades such as insulation, air sealing and windows.

The evaluation of the HIR program is focused on assessing program processes, implementation and cost-effectiveness, as well as providing evaluated gross and net energy and peak demand savings. The evaluation covers the 2019/2020 fiscal year. Based on the parameters established through the evaluation, this report also presents results for the 2018/2019 fiscal year. This report presents the program EE&C results, namely the savings and cost-effectiveness results associated with equipment that displace electrical usage only. Evaluation activities were carried out considering both electrically-heated and non-electrically-heated participants to assess program processes and implementation, but certain sections of the report reference only subsets of the total participants included in the evaluation, depending on the topic assessed.

To complete this evaluation, Econoler worked with Vision Research, a PEI-based market research firm, on a participant survey. Throughout this report, the team of Econoler and Vision Research is referred to as the Evaluator.

1 PROGRAM OVERVIEW

The ePEI HIR program is a home energy assessment-based program that encourages homeowners to perform energy efficiency upgrades in their home to reduce electricity usage. Eligible upgrades focus on building envelope and include three upgrade categories: (1) insulation (e.g. walls, exposed floors and attics); (2) windows, doors and skylights; and (3) air sealing.

Homeowners who wish to participate in the program must start by scheduling a home energy assessment with one of the two program Service Organizations (SOs) hired by ePEI to deliver the program. The home energy assessment is carried out by an Energy Advisor (EA) according to the Natural Resources Canada (NRCan) EnerGuide Rating System. It 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. Once the home energy assessment is completed, the EA develops a list of potential upgrades and includes them in a report that is sent to the homeowner usually within two or three weeks. In addition to the list of potential upgrades, those reports also include an EnerGuide rating of the home. The EnerGuide ratings, along with the efficiency levels of the proposed upgrades, are calculated using HOT2000, a simulation tool developed by NRCan.

Following the initial home energy assessment, participants who decide to install building envelope upgrades will continue on under the HIR program, while participants who either exclusively or additionally decide to install space or water heating equipment will need to apply under the Energy Efficient Equipment Rebates (EEER) program if they wish to receive rebates for such equipment.

Homeowners have 12 months from the date of their home energy assessment to complete upgrades and schedule a final home energy assessment; extensions are available for participants who request them. During the final home energy assessment, an EA verifies the implemented upgrades and performs another blower door test. Based on the results of the final home energy assessment, a final EnerGuide rating is established. Homeowners are charged a $99 + tax fee for the initial home energy assessment. ePEI covers the remaining cost of the initial home energy assessment and the full cost of the final home energy assessment.

Rebates are available for both regular and low-income households. The program offers larger rebates to low-income households; low income is defined as an annual household income of $35,000 or less. Financing is also available through the Government of PEI to offset some of the upfront costs. To be eligible for rebates, the upgrades installed as part of the program must meet certain criteria. For example:

- Windows, door and skylights must be ENERGY STAR® certified.
- Insulation upgrades must meet certain R-value requirements depending on where they are installed (attics, exposed floors, above grade walls, etc.).
- Air sealing upgrades must result in an air leakage reduction of at least 10%.

2 EVALUATION APPROACH

The main objectives of the HIR program evaluation are as follows:

- Establish the gross electricity energy and peak demand savings generated by the program;
- Establish the net electricity energy and peak demand savings generated by the program;
- Assess whether the program is cost-effective;
- Assess the effectiveness of program processes and implementation.

The Evaluator identified key research questions aimed at achieving the aforementioned objectives. The following table outlines the evaluation objectives and maps them to the research questions and methods. Each method is described further below.

Table 2: Evaluation Approach

Evaluation Objective	Research Question	Method
Gross energy and peak demand savings	What overestimation ratios should be applied to program gross savings?	Program savings analysis
	What formula should be used to calculate gross savings?	
	What is the average peak demand-to-energy ratio for the program?	
	What are the appropriate upgrade effective useful life (EUL) values?	
	What are the evaluated annual and lifetime gross energy savings and peak demand savings?	
Net energy and peak demand savings	What is the free-ridership level for the program?	Participant survey
	What are the evaluated annual and lifetime net energy savings and peak demand savings?	
Program cost-effectiveness	In addition to the other cost-effectiveness calculation parameters already collected (e.g. EUL values, net savings), what is the average incremental cost of program projects?	Cost-effectiveness analysis
	Is the program cost-effective from the perspective of the program administrator and participants?	
Program processes and implementation	Is program tracking effective, complete, consistent and clear?	Program database review
	How did participants hear about the program?	Participant survey
	Why did participants want to participate in the program and which upgrades were they most interested in installing?	
	What is the level of participant satisfaction with the program?	
	What issues or challenges, if at all, did participants encounter during their participation?	
	What prevented participants from making certain upgrades?	
	What recommendations do participants have to improve the program?	

The Evaluator first conducted an in-depth interview with program staff to learn about program processes, discuss program performance and identify evaluation objectives. Then, specific evaluation methods were undertaken as described in the following subsections.

Program Savings and Cost-Effectiveness Analyses

The Evaluator analyzed the program database, conducted a literature review and performed engineering calculations to provide evaluated savings calculation values and parameters, including the parameters used in calculating project incremental costs, gross and net energy and peak demand savings, as well as the EUL values used for the lifetime energy savings calculations. As part of the literature review, the Evaluator consulted technical reference manuals and public evaluation reports of jurisdictions similar to ePEI, with a focus on the most recent and accurate sources.

The Evaluator also performed two cost-effectiveness tests, namely the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests.

Participant Survey

In February 2020, the Evaluator conducted a telephone survey with 29 program participants. The average length of the survey was 26 minutes. A sample of 29 participants yields a margin of error of 14.4% at a 90% confidence level. The survey questionnaire is provided in Appendix I.

Program Database Review

The Evaluator reviewed the program database to: (1) assess tracking practices and processes and whether they meet program needs; (2) identify any gaps in tracked data to better inform program savings calculations, management and evaluation; and (3) assess the consistency and organization of tracked data.

3 PROGRAM SAVINGS AND COST-EFFECTIVENESS

This section presents the evaluation results related to program gross and net electrical energy and peak demand savings, as well as cost-effectiveness for the fiscal year 2019/2020. The parameters used to obtain these results were also used to calculate program savings and cost-effectiveness results for the 2018/2019 fiscal year. The section opens with an overview of program participation in 2018/2019 and 2019/2020.

3.1 Program Participation

As presented in Figure 1 below, 345 projects were completed under the HIR program during the 2019/2020 fiscal year, which is about five times more than during the 2018/2019 fiscal year during which 61 projects were completed. Of the total projects completed in 2019/2020 and 2018/2019 respectively, 101 and 16 projects were completed by participants who used electricity as their main heating source, which represents under one-third of projects.

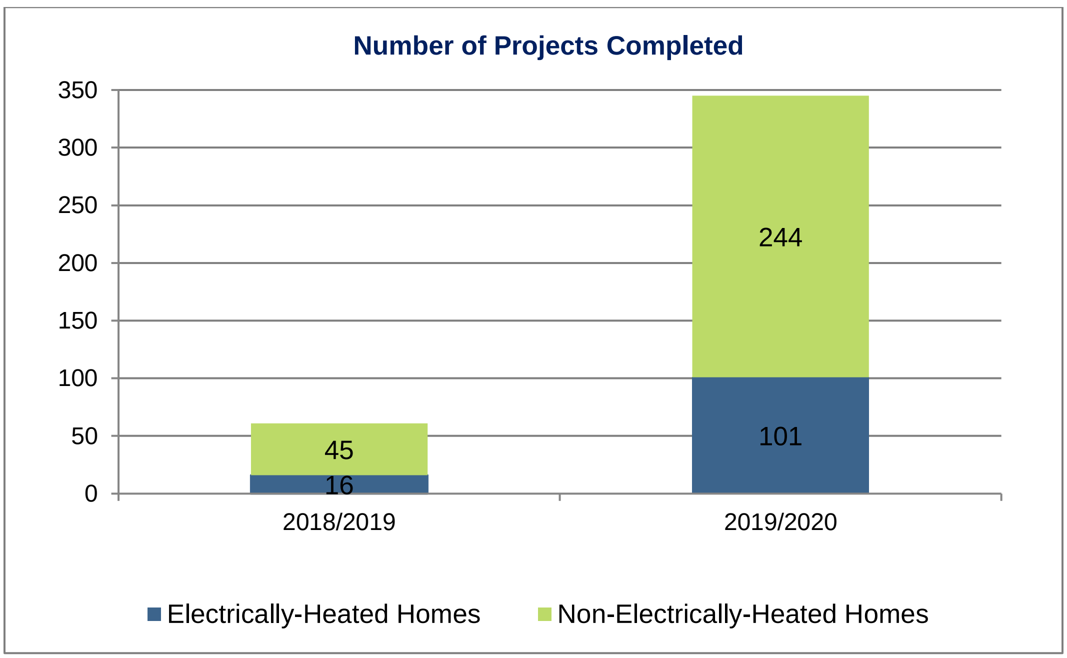

Figure 1: Summary of HIR Program Participation

Regardless of the heating source, 10% of 2019/2020 projects were completed by low-income participants. In 2018/2019, 20% of total projects were completed by low-income participants, and the proportion of low-income participants was higher for that fiscal year when considering only projects completed in electrically-heated homes (31%).

3.2 Gross Savings

Gross savings correspond to the change in energy consumption that results from actions taken by participants regardless of their reasons for participating. For the HIR program, gross energy savings are determined on a project basis by comparing modelled home energy consumption levels before and after participating in the program. Lifetime gross energy savings are then obtained by multiplying the annual gross energy savings with the average EUL value associated with a given HIR program project.

3.2.1 Percentage of Projects Claimed for EE&C

HIR program savings come from reduced heating needs. Therefore, the Evaluator only attributed electricity savings, which correspond to the savings claimed for EE&C, to participating homes for which the primary heating system was tracked as electric in the database.

3.2.2 Energy Savings Calculation

For the HIR program, ePEI tracks each participant's initial and final modelled EnerGuide Rating System (ERS) score resulting from HOT2000 simulations. An ERS score corresponds to building energy consumption in GJ and is used to estimate energy savings. Based on recent evaluations of similar programs in other Canadian provinces, the HOT2000 software is known to overestimate the consumption of simulated buildings. Depending on which equipment is included in the HOT2000 simulation and the mix of cooling and heating systems of each region, different overestimation ratios have been calculated as part of those recent evaluations. Similarly, the Evaluator decided to apply an overestimation ratio to the modelled ERS scores to establish the savings of HIR program projects.

The overestimation ratio was established based on a literature review and program data. The Evaluator first identified two jurisdictions that have similar programs designed around the use of HOT2000, namely Nova Scotia (through EfficiencyOne) and New Brunswick (through NB Power). Both jurisdictions established their overestimation ratios by comparing simulation results to the actual building consumption data of their participants. The Evaluator chose to use the EfficiencyOne overestimation ratios since they were established to adjust building heating consumption specifically, rather than the entire building energy consumption, which is consistent with HIR program measures that are aimed at reducing heating consumption.

The most recent overestimation ratios used for EfficiencyOne were based on heating system type, more precisely whether the building had a heat pump or not. By comparing simulation results to actual consumption data, overestimation ratios of 19% for buildings without a heat pump and 0% for buildings with a heat pump were found. To adapt these ratios to the ePEI HIR program, the Evaluator analyzed the simulation outputs of a sample of 47 projects and concluded that about half of them (53%) had a heat pump. Thus, an overestimation of 8.9% was applied to all modelled ERS scores, which corresponds to the weighted average of the two overestimation ratios applied by EfficiencyOne.

Based on the information available in the database and simulation outputs, the Evaluator concluded that the majority of participants had the same heating system before and after their home upgrade (some exceptions are presented in the Double-Counted Savings subsection on the next page). Hence, the difference between the initial and final ERS scores are only attributable to the measures installed through the HIR program. The following equation was used to calculate the gross savings from the energy efficiency upgrades modelled in HOT2000.[1]

$$Gross\ Savings = (ERS_{Initial} - ERS_{Final}) \times (1 - Overestimation\ Ratio)$$

Where:

- ERS corresponds to the building energy consumption in GJ obtained for all energy sources from the initial and final HOT2000 simulation models.
- Overestimation ratio refers to the 8.9% value used to adjust the modelled energy consumption values.

In addition, the Evaluator identified 13 projects whose savings were negative or represented what appeared to be an unrealistic proportion of the initial modelled ERS score. Since it is unlikely that the measures installed through the HIR program would result in higher energy consumption or a building energy consumption reduction of more than 50%, the Evaluator conducted a more specific analysis of those cases to ensure that it was not a mistake either in the simulation files or during the process of inputting the simulation results into the database. Upon analysis, the Evaluator concluded that 10 of the 13 projects had savings that were deemed unrealistic. Those projects were not removed from the savings calculations, but the Evaluator attributed the average savings of the other projects to those project results. To prevent such issues in the future, the Evaluator recommends that ePEI implement a quality assurance process to identify projects with abnormal savings percentages, as well as simulations with unrealistic ERS scores, and investigate if simulation errors occurred for those projects.

Double-Counted Savings

Following their initial home energy assessment, HIR program participants have the possibility to install heating systems through the EEER program. The Evaluator wanted to verify whether equipment installed through the EEER program had been included in the final HIR program simulations. This would result in savings being calculated twice; once under the HIR program and again under the EEER program. When this occurs, the savings claimed through the EEER program need to be deducted from those claimed though the HIR program to prevent double-counting the savings. The Evaluator analyzed the simulation outputs of each HIR participant that had also participated in the EEER program and identified three projects (two in 2019/2020 and one in 2018/2019) that included savings for an added heat pump in both programs. Using the evaluated EEER program unitary savings value for mini-split heat pumps, the Evaluator deducted 2,638 kWh for each of these participants in the HIR program.

[1] All savings were calculated at the meter. Line loss factors were added to obtain savings at the generator in the gross savings compilation table (see Table 4).

3.2.3 Peak Demand Savings

Electricity peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The peak demand period in PEI occurs between 5 p.m. and 7 p.m. from mid-December through early March inclusively, on any day when maximum temperature is -10° C or lower.

For the HIR program, the Evaluator relied on the peak demand-to-energy ratios established for Nova Scotia, as found in the EfficiencyOne 2019 DSM evaluation reports.[2] Although the Nova Scotia peak demand period occurs during weekdays only, the Evaluator considered that Nova Scotia and PEI peak demand periods are sufficiently similar to use the Nova Scotia peak demand-to-energy ratios.

Thus, peak demand savings were calculated using a peak demand-to-energy ratio of 0.283 MW/GWh.

3.2.4 Interactive Effects

Interactive effects occur in a home when the implementation of energy efficiency equipment has an impact on the energy consumption of other systems, most commonly heating and cooling systems. In the case of the HIR program, the simulation models encompass the total energy consumption of the house; therefore, interactive effects are already considered in the savings calculation.

3.2.5 Effective Useful Life

EUL values are used to determine the energy savings that occur throughout the lifetime of installed upgrades. To assess these values, the Evaluator conducted a literature review to determine an EUL for each upgrade category eligible under the HIR program. Based on this review and according to the implementation rate of each upgrade based on information from the 2019/2020 program database, the Evaluator then established a weighted average EUL value for the program as a whole.

Table 3 outlines the EUL value for each upgrade category along with the implementation rate[3] and the revised average EUL value of 22.7 years for the HIR program.

[2] Econoler, 2019 DSM Evaluation Reports, prepared for EfficiencyOne, March 2020.
[3] Implementation rates were based on the number of measures implemented.

Table 3: Effective Useful Life Values

Upgrade Category	Implementation Rate (%)	Effective Useful Life (years)	Source
Insulation	73.2%	25	GDS Measure Life Report[4]
Air Sealing	19.6%	15	GDS Measure Life Report
Windows and Doors	7.2%	20	DEER 2014 Effective Useful Life (EUL) Table[5]
Weighted Average	**100%**	**22.7**	

3.2.6 Summary of Gross Savings

The annual gross electricity energy savings for the HIR program during the 2018/2019 and 2019/2020 fiscal years are presented in Table 4. Savings at the generator were obtained by applying line loss factors of 1.120 for energy and 1.171 for peak demand, as provided by Maritime Electric, the electricity utility.

Table 4: Gross Energy and Peak Demand Savings for 2018/2019 and 2019/2020

	2018/2019	2019/2020
Number of Projects	61	345
Number of Projects Claimed for EE&C	16	101
Energy Savings		
Gross Energy Savings Before Deductions (GWh)	**0.147**	**0.788**
Double-Counted Savings Deductions (GWh)	0.003	0.005
Gross Energy Savings – at the Meter (GWh)	**0.144**	**0.783**
Line Loss Factor	1.120	1.120
Gross Energy Savings – at the Generator (GWh)	**0.162**	**0.876**
Effective Useful Life (years)	22.7	22.7
Gross Lifetime Energy Savings – at the Generator (GWh)	**3.670**	**19.896**
Peak Demand Savings		
Peak Demand-to-Energy Ratio (MW/GWh)	0.283	0.283
Gross Peak Demand Savings – at the Meter (MW)	**0.041**	**0.221**
Line Loss Factor	1.171	1.171
Gross Peak Demand Savings – at the Generator (MW)	**0.048**	**0.259**

[4] GDS Associates, Inc., *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures,* report prepared for the New England State Program Working Group, June 2007.
[5] Database for Energy Efficiency Resources (DEER), DEER 2014 EUL Table, 2014.

3.3 Net Savings

Net savings are defined as the energy use reductions specifically attributable to the HIR program. Effects that positively or negatively affect the energy savings generated by a program, namely free-ridership and spillover, are generally considered. They are then combined into a net-to-gross ratio (NTGR) that is applied to gross energy savings.

For the HIR program, the Evaluator assessed the free-ridership level using the participant survey. It should be noted that while the survey sample included participants who had been identified as low-income, since the program provides rebates for them, they were not included in the free-ridership assessment; evaluation standards assume that free-ridership is nil in the case of low-income participants. As for spillover, this effect was not measured and considered to be nil since it is unlikely that additional building envelope improvements would be made shortly after having undertaken renovations such as those needed in the HIR program.

3.3.1 Free-Ridership

Free-ridership occurs when participants would have still implemented the energy efficiency upgrades in the absence of the program. Non-low-income participants (26 out of the 29 who answered the survey) were asked questions about all applicable variables of the decision-making process, including planning, efficiency, timing, and cost. Another set of questions was used to assess the influence of various program factors on participants' decisions to implement energy efficiency upgrades, including the program financial incentive, expert information or advice from program EAs, the information and recommendations received through the audit report, as well as promotion done by ePEI or previous participation in an ePEI program.

The feedback collected from the participant survey was converted into a free-ridership level using the algorithm presented in Appendix II. The resulting overall free-ridership level is a weighted average based on the revised energy savings for each participant.

As outlined in Table 5, the Evaluator calculated a free-ridership level of 23%.

Table 5: Average Free-Ridership Level

Average Free-Ridership Level	Sample Size	Population Size	Margin of Error
23%	26	309	4.0%

Approximately 81% of survey respondents indicated having plans to install only some or none (38% some, 42% none) of the implemented upgrades before having their home evaluated by an EA, indicating that the HIR program was successful in encouraging participants to implement upgrades. Furthermore, the financial incentive was identified by participants as the most influential factor on their decision to install the energy efficiency upgrades implemented through the HIR program.

3.3.2 Net-to-Gross Ratio Calculations

The NTGR was calculated using the following equation:

Net-to-Gross Ratio = (1 – % Free-Ridership)

By using the free-ridership level presented above and the proportion of low-income and non-low-income participants, a NTGR was calculated as a weighted average at the program level. As a result, a NTGR of 0.79 was established for the HIR program. Table 6 summarizes the NTGR calculation.

Table 6: Average NTGR

	Non-Low-Income	Low-Income
Free-Ridership	23%	0%
Proportion	**90%**	**10%**
NTGR	**0.79**	

3.3.3 Summary of Net Savings

Net savings are determined by applying the NTGR to evaluate gross savings using the following equation:

Net Savings = Evaluated Gross Savings × NTGR

The detailed net electricity energy savings results for 2018/2019 and 2019/2020 are summarized in Table 7.

Table 7: Net Energy and Peak Demand Savings for 2018/2019 and 2019/2020

	2018/2019	2019/2020
Energy Savings		
Gross Energy Savings – at the Meter (GWh)	0.144	0.783
NTGR	0.79	0.79
Net Energy Savings – at the Meter (GWh)	0.114	0.618
Line Loss Factor	1.120	1.120
Net Energy Savings – at the Generator (GWh)	0.128	0.692
Effective Useful Life (years)	22.7	22.7
Net Lifetime Energy Savings – at the Generator (GWh)	**2.899**	**15.718**

	2018/2019	2019/2020
Peak Demand Savings		
Gross Peak Demand Savings – at the Meter (MW)	0.041	0.221
NTGR	0.79	0.79
Net Peak Demand Savings – at the Meter (MW)	0.032	0.175
Line Loss Factor	1.171	1.171
Net Peak Demand Savings – at the Generator (MW)	0.038	0.205

3.4 Cost-Effectiveness

The Evaluator assessed program cost-effectiveness by performing specific cost-effectiveness tests, namely the TRC and the PAC tests. When performing these tests, ratios greater than 1 are desired because they indicate that program benefits outweigh costs. This section presents the calculations performed to assess the cost-effectiveness of the EE&C portion of the program.

Various values and parameters were necessary to conduct these tests:

- The gross and net electrical savings as well as the EUL were drawn from the results presented in Subsections 3.2 and 3.3 of this report. To quantify the economic value of those savings (i.e. the program benefits), the Evaluator used the unitary avoided costs of electrical energy savings and peak demand savings provided by the electricity utility, Maritime Electric. Total program costs, broken down into administrative and incentive costs, were provided by ePEI. The Evaluator estimated the proportion of those costs allocated to EE&C based on the ratio of electrical and non-electrical savings[6] generated by the program in 2019/2020. The incremental product cost (IPC) associated with products generating electrical savings was estimated by the Evaluator and is described in further detail in Subsection 3.4.1 below.
- The Net Present Value (NPV) calculation of all cash flows (costs and benefits) considered in the cost-effectiveness tests were performed using ePEI's discount rate (3.2%) and inflation rate (2%).

3.4.1 Incremental Product Costs

IPCs are defined as the difference between the costs of energy efficient products offered by a program and the costs of base case products that would have been installed in the absence of the program over the life cycle of a product or upgrade.

[6] Although the quantification of non-electrical energy savings was outside of the scope of the evaluation, the Evaluator used the number of projects generating non-electrical savings in the database as well as their energy savings to produce a high-level estimate of the non-electrical savings for the HIR program and compared that value to electrical energy savings to obtain a percentage of savings attributed to EE&C activities.

For all upgrades implemented through the HIR program except windows and doors, the base case is to not install the efficient product (meaning keeping the house insulation as it is). Therefore, the base case corresponds to a nil cost and the incremental cost is the full cost of the upgrade. For windows and doors, the incremental cost is the difference between installing standard and energy efficient windows and doors. However, since windows and doors represent only 7.2% of implemented upgrades, they would not have a significant impact in the average program IPC value and, therefore, the Evaluator decided to use their full cost as the incremental cost.

ePEI tracked project total costs in the 2019/2020 database, although the costs were not available or nil for 26% of completed projects. The Evaluator used the average costs between all completed projects with the tracked cost, regardless of the heating source, to establish an average IPC value of $4,980. The heating source was not considered when calculating the IPC since it does not have an impact on the cost of measures installed under the HIR program (insulation, windows and doors). This IPC value was then multiplied by the number of projects claimed for EE&C to obtain overall IPC values of $79,680 and $502,980 for the EE&C portion of the 2018/2019 and 2019/2020 program years respectively.

3.4.2 Cost-Effectiveness Tests

This subsection presents the equations used for the PAC and TRC tests. For each test, benefits are at the numerator and costs at the denominator, and they both need to be NPVs.

PAC Test

The PAC test measures the net economic benefit of a program from the program administrator perspective using the equation presented below:

$$PAC = \frac{NPV\ (Avoided\ Costs)}{NPV\ (\ Total\ Gross\ Program\ Admnistrator\ Costs)}$$

- **Avoided costs** are the avoided supply costs achieved by the net electrical energy and peak demand savings generated by the program. The avoided unitary costs in $/kWh and $/kW saved were multiplied by the electrical energy and peak demand savings respectively.
- **Total gross program administrator costs** are the program costs incurred by the program administrator. Program administrator costs include costs related to program planning, design, marketing, implementation and evaluation, as well as incentives. Incentives typically represent the amounts that the program administrator offers participating customers for the upgrades they implement. The program costs were provided by ePEI and only the proportion attributable to EE&C savings was considered since the PAC test is performed for the EE&C portion of the program.

TRC Test

The TRC test reveals the total net benefits of a program from the perspective of both the utility and participating customers. It is not necessary to know who realizes the benefits and bears the costs.

The TRC test is calculated based on the following formula:

$$TRC = \frac{NPV\ (Avoided\ Costs + Customer\ Benefits)}{NPV\ (Net\ Tech.Costs + Gross\ Program\ Administrator\ Non\!-\!Incentive\ Costs)}$$

- The **avoided costs** are the same as those of the PAC test.
- **Customer benefits** are participant non-energy benefits such as water savings and improved comfort or safety. For the HIR program, no customer benefits were included.
- **Net technical costs** correspond to the program IPCs discussed in Subsection 3.4.1 above.
- The **gross program administration non-incentive costs** are the same costs as in the PAC test, except that they exclude incentives. Incentives are excluded because they are financial transfers between ePEI and participating customers, thus not representing an expense.

3.4.3 Cost-Effectiveness Results

Table 8 and Table 9 below present the cost-effectiveness results for the 2019/2020 and 2018/2019 periods respectively. The HIR program was cost-effective in both years from the program administrator perspective. The TRC test, which accounts for all benefits and costs, also indicates that the program was cost-effective.

Table 8: 2019/2020 Cost-Effectiveness Results

Cost-Effectiveness Test	Ratio	Benefits	Costs
PAC Test	**7.22**	$2,017,088	$279,380
TRC Test	**4.11**	$2,017,088	$490,359

Table 9: 2018/2019 Cost-Effectiveness Results

Cost-Effectiveness Test	Ratio	Benefits	Costs
PAC Test	**3.35**	$372,056	$111,020
TRC Test	**3.48**	$372,056	$106,912

3.5 Summary of Program Savings and Cost-Effectiveness Results

Table 10 summarizes the key results from the program savings and cost-effectiveness evaluations and compares these results to program targets.

Table 10: Summary of Program Savings and Cost-Effectiveness Targets and Evaluated Results

Parameters	2018/2019 Targets	2018/2019 Evaluation Results	2019/2020 Targets	2019/2020 Evaluation Results
Program Participation				
Number of Participants	80	16	210	101
Gross Electricity Savings at the Generator				
Gross Electricity Energy Savings (GWh)	-	0.162	-	0.876
Gross Lifetime Electricity Savings (GWh)	-	3.670	-	19.896
Gross Peak Demand Savings (MW)	-	0.048	-	0.259
Net Electricity Savings at the Generator				
NTGR	-	0.79	-	0.79
Net Electricity Energy Savings (GWh)	0.5	0.128	1.3	0.692
Net Lifetime Electricity Savings (GWh)	-	2.899	-	15.718
Net Peak Demand Savings (MW)	0.2	0.038	0.4	0.205
Cost-Effectiveness				
PAC Test	4.5	3.35	5.1	7.22
TRC Test	0.8	3.48	0.8	4.11

› In 2019/2020, the evaluated net electrical energy and peak demand savings failed to reach program targets by 47% and 49% respectively. The program evaluated savings were also below targets for the 2018/2019 period. This is mainly due to lower than expected participation levels, with fewer than 50% of the expected number of participants.

› Nonetheless, the PAC and TRC tests revealed that the program was very cost-effective from both perspectives and for both fiscal years. The evaluated IPC value likely explains why the evaluated TRC results are much higher than targets.

4 PROGRAM PROCESSES AND IMPLEMENTATION

This section includes the evaluation results related to program processes and implementation. Specifically, it presents the Evaluator's findings related to program data tracking and participant feedback about their experience with the program.

4.1 Program Data Completeness

Figure 2 presents the important data types for the HIR program and their status in the HIR program database.

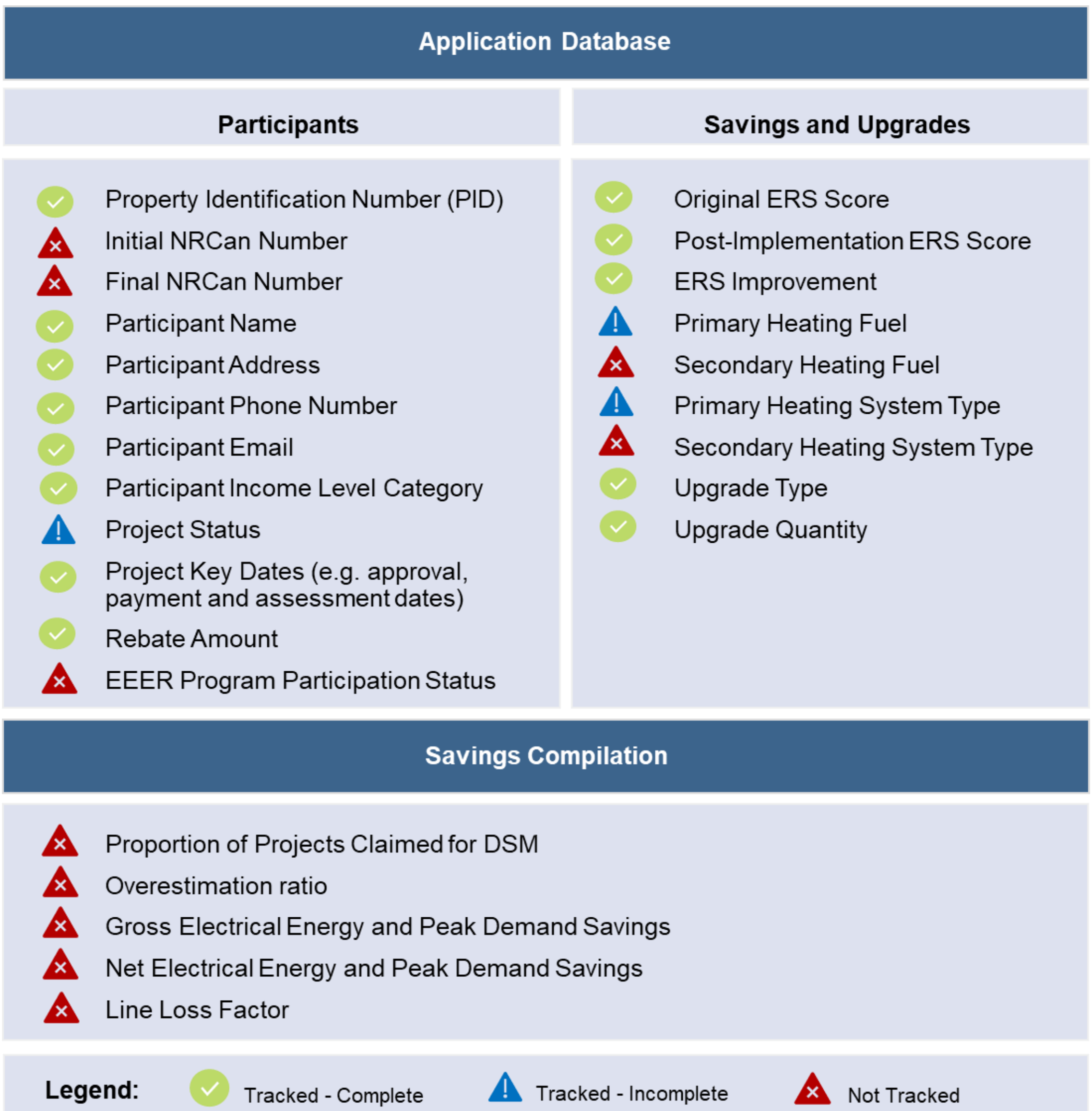

Figure 2: Summary of HIR Program Data Tracking

The program database includes most of the important participant and upgrade data. The Evaluator recommends tracking the NRCan numbers to be able to easily and correctly connect projects to their simulation files. Also, the Evaluator recommends adding a column to track whether each HIR program participant also participated in the EEER program since the two programs may overlap.

The key items missing from the program database pertain to how savings are calculated and then compiled. Overestimation ratios are used to adjust the modelled energy consumption values generated by HOT2000 since the software tends to overestimate those values. Since the heating systems in place and the presence of mini-split heat pumps are the factors that tend to affect the overestimation ratios the most, tracking the primary and secondary heating fuels and types, both before and after program upgrades, is noted as key for the HIR program. The 2019/2020 database includes primary heating fuel and system types with no clear indication of whether they refer to before or after the upgrades, and there are no data on secondary heating fuel and system types.

The program database should include gross and net electrical energy and peak demand savings values for each project so that tracked savings are available to program staff and the Evaluator. Also, it should be clearly indicated whether the savings values are at the meter or at the generator. If they are at the generator, the line loss factor should be included in the database.

Recommendation: Continue tracking current items and try collecting data on currently untracked or incomplete items.

Recommendation: Identify the projects that generate electrical savings to calculate program gross and net electrical savings.

4.2 Program Data Organization

The Evaluator identified the following opportunities to improve the organization of the HIR program database:

- Data tracking for the HIR program is currently combined into a single database with three other programs. In part because four programs share one database, the database can be challenging to navigate, with many unused or partially used columns.

  Recommendation: Consider creating a database specific to each program and eliminating unneeded columns to customize each database to its program.
- Another opportunity is to assign a new column for each implemented measure. The program database records all measures in a single column labelled “Upgrade Type”, as illustrated in Figure 3. This creates difficulty in sorting and analyzing information about implemented measures. Tracking could be improved by assigning each upgrade to its own column, as presented in Figure 4.

Upgrade Type
Attic Insulation, Air Sealing, Widows/Doors
Attic Insulation, Below Grade, Air Sealing
Attic Insulation, Below Grade, Air Sealing
Attic Insulation, Below Grade, Air Sealing
Attic Insulation, Below Grade, Exposed Floors/Headers
Attic Insulation, Below Grade, Exposed Floors/Headers, Air Sealing
Attic Insulation, Exposed Floors/Headers
Attic Insulation, Exposed floors/headers, Air sealing
Attic Insulation, Exposed Floors/Headers, Air sealing
Attic Insulation, Exposed floors/headers, Air Sealing, Windows/Doors (3)
Attic Insulation, Exposed Floors/Headers, Below Grade, Above Grade Walls, Air Sealing
Attic Insulation, Exposed floors/headers, Below Grade, Air Sealing

Figure 3: Excerpt from 2019/2020 Database

Upgrade 1 Type	Upgrade 2 Type	Upgrade 3 Type	Upgrade 4 Type
Attic Insulation	Air Sealing	Windows/Doors	
Attic Insulation	Below Grade	Air Sealing	
Attic Insulation	Below Grade	Air Sealing	
Attic Insulation	Below Grade	Air Sealing	
Attic Insulation	Below Grade	Exposed Floors/Headers	
Attic Insulation	Below Grade	Exposed Floors/Headers	
Attic Insulation	Exposed Floors/Headers		
Attic Insulation	Exposed Floors/Headers	Air Sealing	
Attic Insulation	Exposed Floors/Headers	Air Sealing	
Attic Insulation	Exposed Floors/Headers	Air Sealing	Windows/Doors
Attic Insulation	Exposed Floors/Headers	Below Grade	Above Grade Walls
Attic Insulation	Exposed Floors/Headers	Below Grade	Air Sealing

Figure 4: Recommended Tracking Practice

<u>**Recommendation:**</u> Track upgrade types (and quantities when applicable) under separate columns.

› Additionally, while the upgrade type is filled in, the nomenclature is not consistent; some projects indicate "insulation" only while others include the specific type of insulation installed, such as "exposed floors".

<u>**Recommendation:**</u> Use consistent wording to track upgrade types.

› Some of the column header names are unclear, for example those related to dates (i.e. "Date Processed" and "Invoice Date"). Another example is the "Amount" column. The Evaluator understands that this column refers to the rebate amount paid to participants but the header should be clearer.

<u>**Recommendation:**</u> All columns should be clearly named to avoid interpretation, as well as facilitate overall understanding of the information tracked and data-collection sampling.

- The database should clearly indicate which projects have been completed. This information is critical for savings calculations and evaluation. The 2019/2020 database identifies project status as “Not Eligible”, “In Progress”, and “Approved”. However, many participants with an “Approved” status do not include a final ERS score. Without clear information about whether these projects have been completed or not, it is not clear for the Evaluator whether savings for these participants should be included in the annual claimed savings or deferred to a future year. This is why the “Project Status” field was marked as “incomplete” in Figure 2 above.

  Recommendation: Ensure that the data tracked for each project or grant matches the tracked status.

- The Evaluator noticed that five participating homes had two completed projects that had the same initial and final ERS scores. While it is possible that a participant conducted more than one retrofit project for the same location, the initial ERS score of the second round of retrofit should match the final ERS score of the first round of retrofit. Therefore, the Evaluator assumed that these projects were duplicates and only claimed the savings once.

  Recommendation: Screen for possible duplicate projects to ensure they are not claimed twice in program savings.

Data tracking and reporting are crucial for program management and evaluation. The Evaluator understands that ePEI is in the process of acquiring a data management system that would allow program tracking to be centralized rather than being performed in multiple individual tracking sheets. The Evaluator supports ePEI’s goal to improve data management, which would contribute not only to the implementation of the data-completeness and data-organization recommendations in this report, but also ensure that program data is up to date and easy to use, for program management.

4.3 Participant Awareness and Motivations

Participants learned about the HIR program from various sources, with word of mouth being the main source, followed by the ePEI website. Although not used to promote the program, television was mentioned as a source of awareness by 14% of respondents.

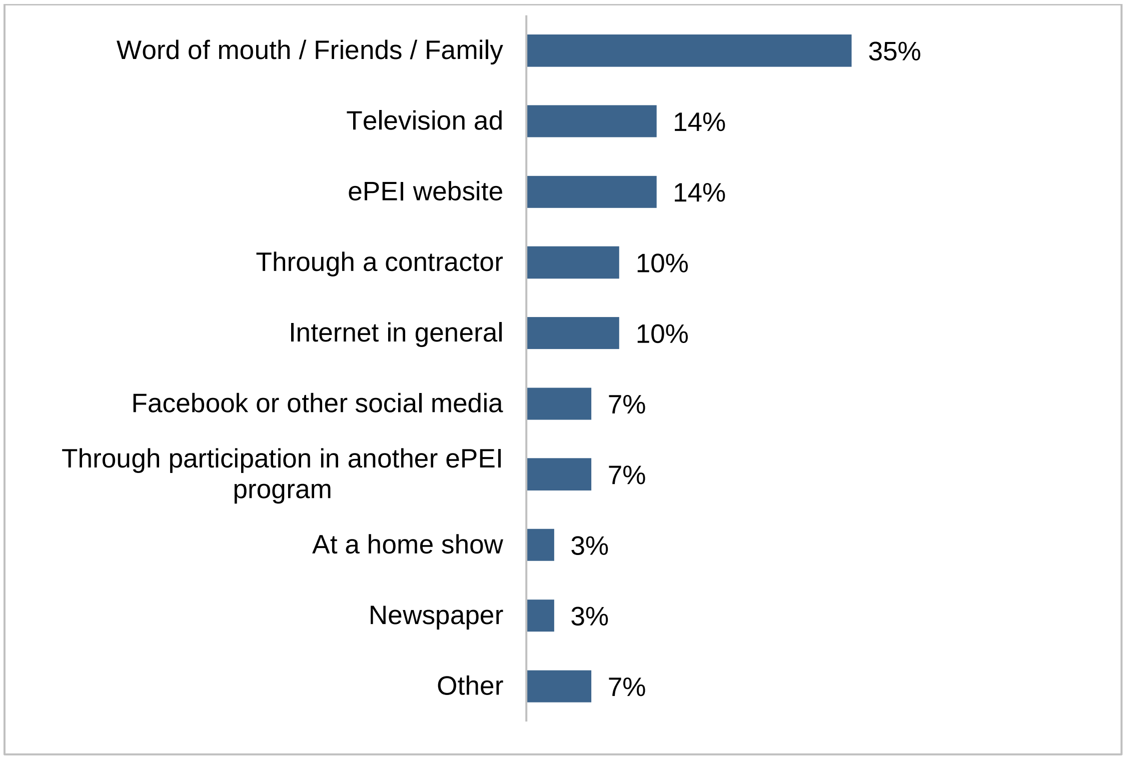

Figure 5: Primary Source of Awareness about the Program

Participants were interested in participating in the program mainly to save money or lower their energy bills, followed by to save energy and improve insulation. Overall, financial reasons were a key driver for participating in the program since saving money and obtaining rebates were also mentioned by many participants as the second most important reasons for participation.

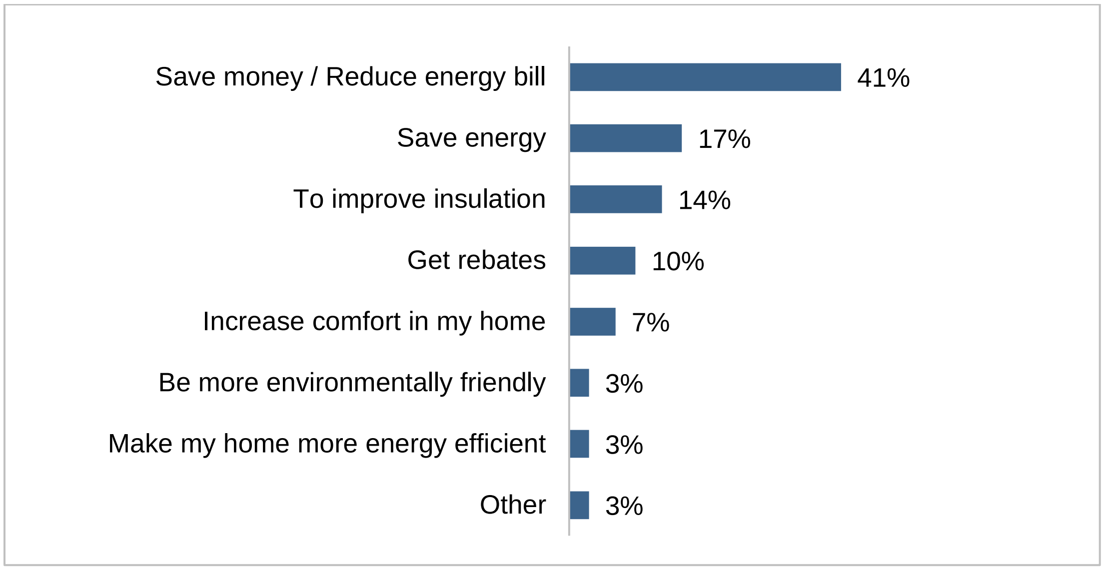

Figure 6: Primary Motivation for Participating in the Program

Participants were asked about the type of upgrade they were most interested in when they decided to have their home evaluated through the program. As illustrated in the Figure 7 below, just over 60% of participants were most interested in installing insulation, with heating systems coming in second place. In terms of the second upgrade type, participant responses were once again mostly distributed among insulation and heating systems.

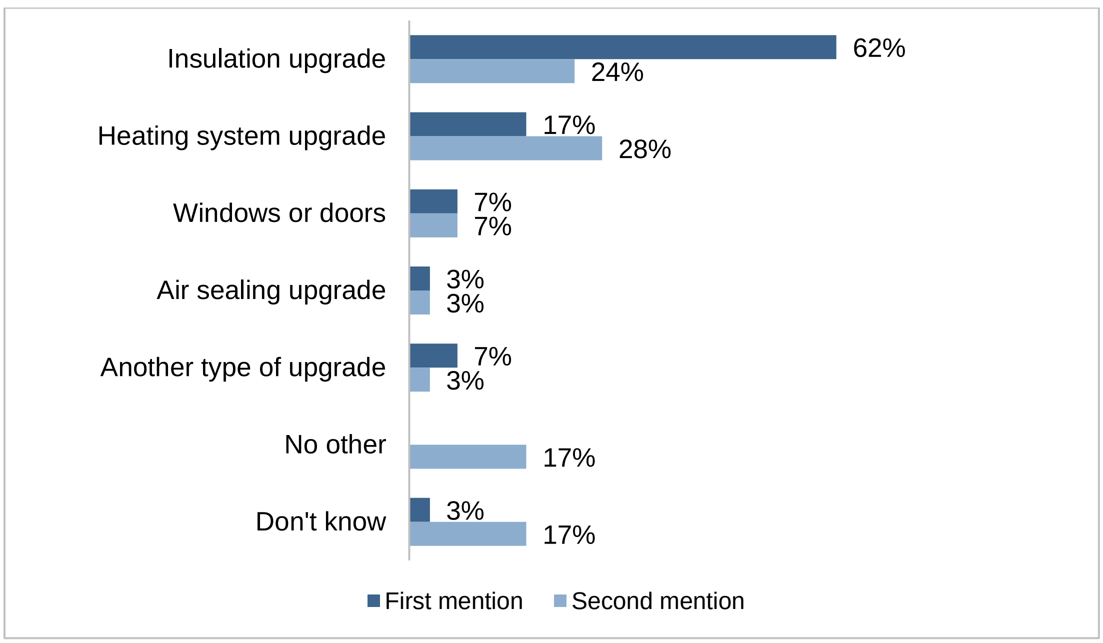

Figure 7: Upgrades of Main Interest to Participants

4.4 Participation Processes

Participants were asked to rate their experience with various program steps according to a 0 to 10 scale where 0 means "very difficult" and 10 meant "very easy". Survey results indicate that, overall, participants did not encounter significant challenges during participation. The parts of the program that received somewhat lower ratings, however, pertain to the part of the program where participants navigate the program on their own between the initial and final energy assessments. Participants who struggled with the report found it overwhelming and unclear. Participants who struggled with finding a contractor mentioned that it was difficult to find a contractor that seemed knowledgeable about the program and energy efficient options, while some found it challenging to find a contractor.

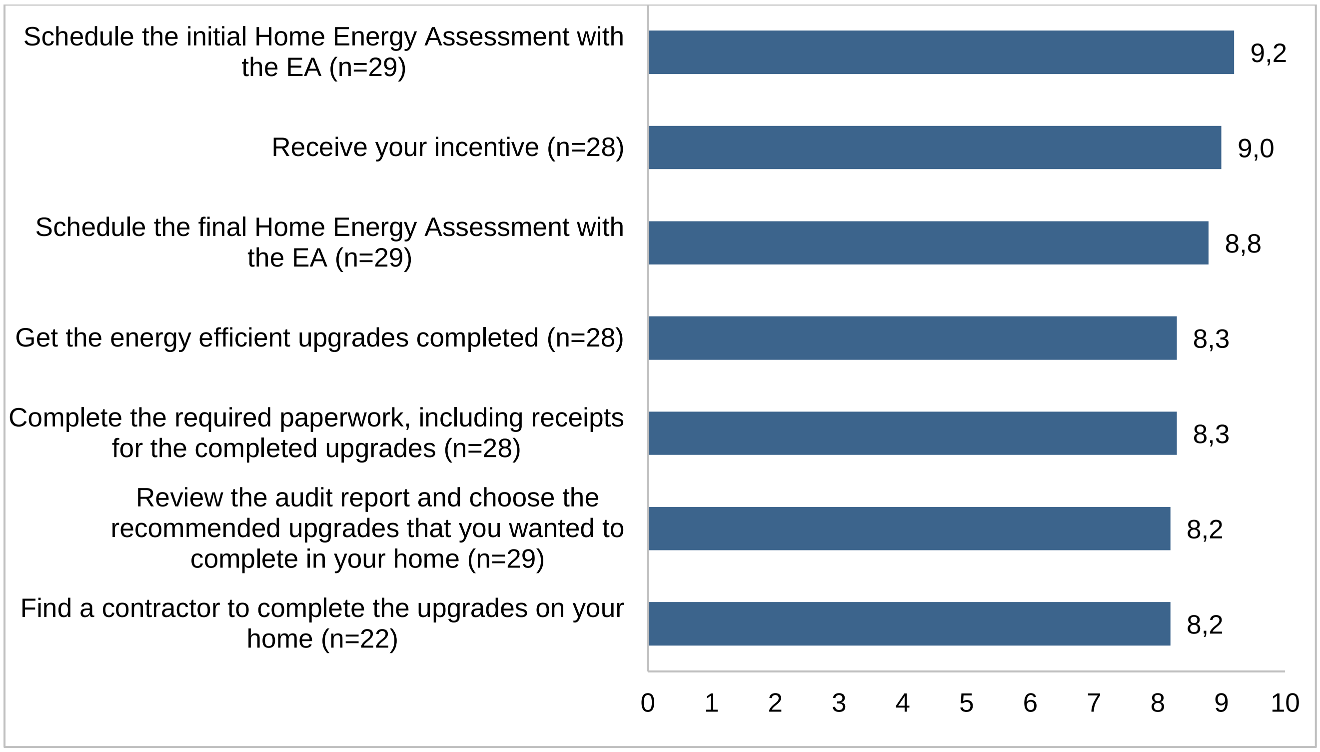

Figure 8: Ease of Completing Program Steps

Participants were asked about the clarity of the incentive structure by answering whether they had a clear understanding of the incentives they could receive from the HIR program when they started looking at which upgrades they might install. As observed in the figure below, only about half of participants clearly understood the incentives they could obtain at the beginning of their project. Participants mentioned overall confusion about the rebate amount they could expect, a lack of clarity about exactly which types of windows were rebated, and a lack of information about the rebates associated with the recommended upgrades following the initial home energy assessment. Fortunately, participant understanding of the incentives improved as their projects progressed since 86% of them said that, after having installed their upgrades, they received the incentives they had in mind.

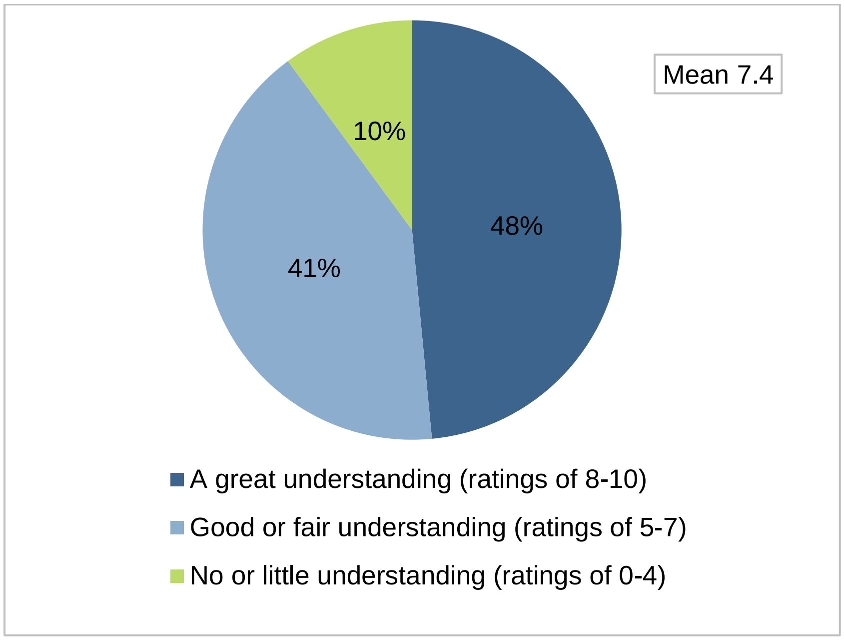

Figure 9: Ease of Understanding the Incentives

4.5 Barriers to Installing Upgrades

Participants were asked to recall upgrades that were recommended through the program but that they decided not to install and why. Not being able to afford the upgrades was mentioned as the main reason, followed by a lack of time or interest to install the upgrades and not being convinced that the upgrades were worth the expense. Given the small subset of participants who answered this part of the survey, it was not possible to isolate specific barriers per upgrade type.

4.6 Participant Satisfaction and Recommendations for Improvement

Participant satisfaction with the program is very high. The one aspect of the program that received a slightly lower average satisfaction rating is the audit report. About half of participants who were not satisfied with the report mentioned that it was too technical or difficult to understand and that they would have liked more follow-up and support to ensure they had understood it. Conversely, the other half thought the report was not specific enough or did not focus on the elements of their house that they were hoping it would. One participant also mentioned that the report had to be revised by the EA a few times to finally capture the correct information. Most of this feedback also explains the very few dissatisfaction ratings related to the initial home energy assessment and the EA.

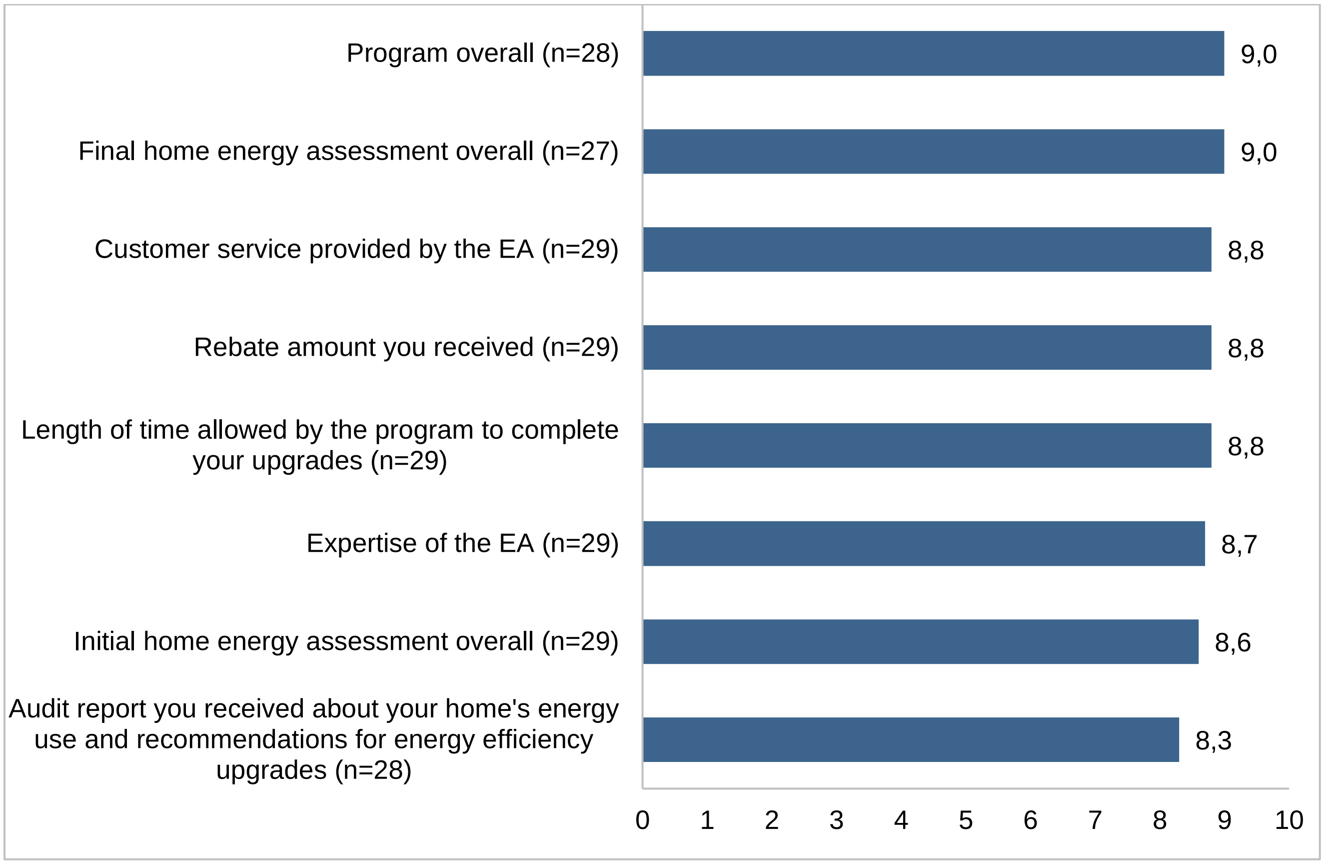

Figure 10: Participant Satisfaction with the Program and its Aspects

Three quarters of surveyed participants (76%) mentioned working with a contractor to install their upgrades as part of the HIR program. Overall, participants were satisfied with the quality of the work performed by their contractor and the contractor's ability to advise them on upgrades. Among the participants who were not satisfied with their contractor's work (1 in 3), the majority said that the work was messy or not well done, while the others mainly said that the contractor did not properly communicate the scope of the work. The participants who were dissatisfied with contractor ability to advise (almost 1 in 3) all said that their contractor did not know the program and its eligibility criteria and measures.

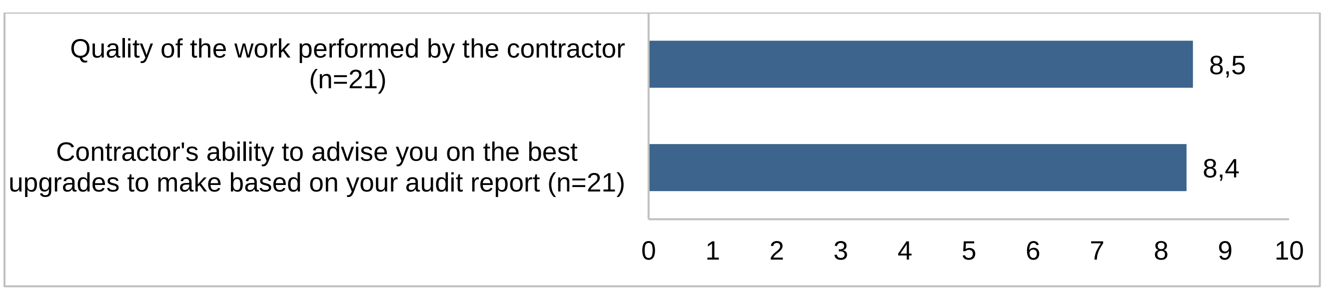

Figure 11: Participant Satisfaction with their Contractor

Just under half of surveyed participants did not provide any recommendations to improve the program. The remaining participants provided a variety of suggestions:

- Provide more assistance and support after the initial home energy assessment;
- Improve communication throughout the participation process;
- Follow up with participants during the participation process;
- Advertise the program more;
- Improve EA competence;
- Improve the content of the audit report.

It should be noted, however, that each of these recommendations was mentioned by no more than three of the 29 surveyed participants. While the first three suggestions are slightly different, they all revolve around better communication and support throughout the entire participation process, including after the initial home energy assessment when participants navigate the program on their own, which is a key takeaway from the survey.

CONCLUSIONS AND RECOMMENDATIONS

The evaluation of the HIR program was conducted to achieve the following objectives:

- Establish the gross electricity energy and peak demand savings generated by the program;
- Establish the net electricity energy and peak demand savings generated by the program;
- Assess whether the program is cost-effective;
- Assess the effectiveness of program processes and implementation.

This section provides the Evaluator's conclusions and recommendations related to program processes, implementation, cost-effectiveness, as well as electricity energy and peak demand savings.

The program did not reach its energy and peak demand savings targets but did surpass its cost-effectiveness targets.

For 2018/2019 and 2019/2020 respectively, net electricity energy savings targets of 0.5 GWh and 1.3 GWh had been set for the HIR program. The program achieved 0.128 GWh and 0.692 GWh in net electricity energy savings in 2018/2019 and 2019/2020 respectively, therefore not reaching targets mainly due to lower-than-expected participation. The program also did not achieve its net peak demand savings targets. On a positive note, despite not reaching savings targets, the program was very cost-effective during both fiscal years, based on the PAC and TRC tests.

To establish these program results, the Evaluator assessed various program savings calculation parameters such as the overestimation ratio, NTGR and EUL values.

Recommendation 1: Use the evaluation parameters established by this evaluation for program savings tracking going forward.

There are opportunities to improve the completeness, organization and quality of program tracking data.

The Evaluator reviewed the program database and identified the important data types that should be collected and tracked as well as verifications that should be conducted by ePEI to effectively manage and evaluate the program and accurately calculate savings.

Most of the important participant and upgrade data are tracked in the program database. Some information is missing in the areas of the database used to compile program-level results. The Evaluator also observed opportunities to improve the organization of the program database to make data more accessible for analysis.

Recommendation 2: Update program tracking to implement the following:

a. Continue tracking current items and try collecting data on currently untracked or incomplete items. This includes the NRCan simulation numbers, primary and secondary heating system and fuel types, the overestimation ratio, as well as gross and net electrical energy and peak demand savings.
b. Identify the projects that generate electrical savings to calculate program gross and net electrical savings.
c. Consider creating a database specific to the program instead of using the database for the HIR program and two other programs and eliminate unneeded columns to customize the database to the program.
d. Track upgrade types (and quantities when applicable) under separate columns.
e. Use consistent wording to track upgrade types.
f. Clearly name all columns to avoid interpretation as well as facilitate overall understanding of the information tracked and data-collection sampling.
g. Ensure that the data tracked for each project or grant match the tracked status.
h. Screen for possible duplicate projects to ensure they are not claimed twice in program savings.

Subsections 4.1 and 4.2 of the report provide additional information on the findings that led to these sub-recommendations.

The Evaluator also noticed inconsistencies that could be solved through easy quality assurance verifications.

Recommendation 3: Implement a quality assurance process to ensure the accuracy of gross savings. Verification should be automatically conducted on certain types of projects including: (1) projects with negative savings; (2) projects that have the same address; (3) projects with savings that account for over 50% of consumption; and (4) projects that also go through the EEER program.

Participant satisfaction with the program is very high. For the most part, the program participation process was easy for most participants, although some struggled with the stages following the initial home energy assessment.

Participants reported being very satisfied with the program overall and most of its aspects such as the customer service and expertise of EAs, home energy assessments and rebate amounts. The one aspect of the program that received a slightly lower average satisfaction rating is the audit report. Similarly, while participants did not encounter significant challenges during participation, the program stages between the initial and final energy assessments represent the part of the program that participants found most challenging, specifically reviewing the audit report and choosing upgrades, finding a contractor, getting the upgrades completed and completing program paperwork. To improve the program, participants have asked for more communication, follow-up and support after the initial home energy assessment. Additionally, one-third of surveyed participants who worked with a contractor said that their contractor did not know about program eligibility criteria and measures.

Recommendation 4: Provide additional support to participants after the initial home energy assessment. This could be achieved by requiring that SOs conduct regular check-ins with participants between the two assessments to ensure that participants understand next steps and that EAs spend more time explaining the audit report to participants.

Recommendation 5: Incorporate ways to increase contractor awareness about the HIR program into the program or portfolio marketing strategy. The Evaluator understands that having contractors become more aware and involved in the HIR program may be a long-term goal.

APPENDIX I
PARTICIPANT SURVEY QUESTIONNAIRE

Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Telephone survey
Estimated Time to Complete	15 minutes
Target Audience	Participants who completed Home Insulation program projects and received rebates for the implementation of upgrades
Expected Number of Completions	30
Contact List Source	efficiencyPEI
Fielding Firm	Vision Research
Estimated Timeline for Fielding	February 2020

Research Objectives and Associated Questions

Research Objectives	Questions
How did participants learn about the program?	B1
Why did participants want to participate in the program?	B2-B3
Which upgrades were participants interested in when they registered?	B4-B5
How satisfied were participants with the program and its aspects?	C1-C3
How well did participants understand the incentive structure?	C4-C6
Did participants work with a contractor and how satisfied were they with their contractor?	C7-C8
Did participants encounter issues or challenges with the program?	C9-C10
Which recommended upgrades did participants implement, and why did they not implement certain upgrades?	D1-D3
What is the free-ridership level?	E series
What recommendations do participants have to improve the program?	F1

Import variables from database **< LIKE THIS >**

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

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

INTRODUCTION

Hello may I please speak with **<INSERT NAME>**?

1. Yes **[GO TO INTRODUCTION]**
2. No **[SAY "PERHAPS YOU CAN HELP ME ANYWAY." GO TO INTRODUCTION]**

Hello, my name is *** and I am with Vision Research, a PEI-based survey research company. We are performing an evaluation of energy efficiency programs and services provided by efficiencyPEI. Our records indicate that you or your household recently participated in efficiencyPEI's Home Insulation program. This program encourages homeowners to improve the energy efficiency of their home by having an energy advisor conduct an assessment of the home, including a blower door test, and provide them with a set of energy efficiency upgrade recommendations.

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

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

A. Verification and Recall

A1. We understand you participated in the Home Insulation program. Is that correct?

1. Yes **[CONTINUE]**
2. No, does not recall participating **[PROMPT**: "Someone would have come to your house to evaluate the energy efficiency of your home and conducted a blower door test to verify the air tightness of your home. Then, you would have received an audit report telling you about upgrades you could make to your home to improve its energy efficiency. They might have talked about the possibility of you getting rebates to cover some of the cost of these upgrades."] **[IF PERSIST AS NO, THANK, TERMINATE AND RECORD]**
3. Don't know/Refused [**PROBE**: "Is there someone else in the household who would know about having participated in the Home Insulation program?"] **[IF YES, ASK TO SPEAK TO THE APROPRIATE PERSON AND RESTART AT INTRODUCTION. IF PERSISTS AS NO, THANK, TERMINATE AND RECORD.] [IF REFUSED, ASK "CAN WE SCHEDULE A MORE CONVENIENT TIME FOR YOU TO CONDUCT THIS SURVEY?"] [SCHEDULED, IF NECESSARY, FOR: ______________________________]**

B. Program Awareness and Reasons for Participation

B1. How did you first learn about the Home Insulation program? **[DO NOT READ; ALLOW MULTIPLE RESPONSES BUT DO NOT PROBE FOR MULTIPLE]**

1. efficiencyPEI website
2. Through a contractor
3. At a home show
4. Word of mouth / Friends / Family
5. Facebook or other social media
6. Power bill insert
7. Through participation in another efficiencyPEI program
8. Newspaper
9. Radio ad
10. Television ad
11. Community event
12. Internet in general
96. Other [SPECIFY: _______________]
98. Don't know

B2. What was the SINGLE most important reason you were interested in participating in the program? **[DO NOT READ – CODE ONE ONLY]**

1. Save money / Reduce energy bill
2. Save energy
3. Get rebates
4. Be more environmentally friendly
5. Make my home more energy efficient
6. Increase comfort in my home
7. Increase value of my home
8. Improve my insulation
96. Other [SPECIFY________________]
98. Don't know

B3. Were there any other reasons? **[SAME LIST AS IN B2] [DO NOT READ. ACCEPT MULTIPLE RESPONSES]**

B4. Which type of upgrade were you most interested in when you decided to have your home evaluated as part of the Home Insulation program? Was it…. **[RANDOMIZE. READ AND CODE ONLY ONE]**

1. Insulation upgrade
2. Air sealing upgrade
3. Windows and/or doors
4. Heating system upgrade
5. Water heating upgrade
6. Or another type of upgrade?

98. (Don't know)
99. (Refused)

B5. What other type of upgrade were you most interested in? **[SAME LIST AS IN B4 BUT ADD CODE 97 "NO OTHER"] [ACCEPT ONLY ONE RESPONSE. IF NONE OTHER, CODE 97]**

C. Satisfaction with Program

C1. 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]**

C2. **[IF C1<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)
99. (Refused)

C3. On the same scale of 0 to 10, where 0 is ‘not at all satisfied’ and 10 is ‘completely satisfied’, how satisfied were you with each of the following aspects of the Home Insulation program? **[DO NOT RANDOMIZE] [97 = NOT APPLICABLE, 98 = DON’T KNOW/DON’T RECALL, 99 = REFUSED]**

a. The initial home energy assessment overall **[IF SCORE IS 7 OR LESS, ASK:** What about the initial energy assessment could have been improved?**] RECORD VERBATIM**

b. The audit report you received about your home’s energy use and recommendations for energy efficiency upgrades **[IF SCORE IS 7 OR LESS, ASK:** What about this report could have been improved?**] *RECORD VERBATIM***

c. The final home energy assessment overall **[IF SCORE IS 7 OR LESS, ASK:** What about the final energy assessment could have been improved?**] *RECORD VERBATIM***

d. The expertise of the energy advisor **[IF SCORE IS 7 OR LESS, ASK:** What about the energy advisor’s expertise could have been improved?**] *RECORD VERBATIM***

e. The customer service provided by the energy advisor **[IF SCORE IS 7 OR LESS, ASK:** What about the energy advisor’s customer service could have been improved?**] *RECORD VERBATIM***

f. The rebate amount you received

g. Length of time allowed by the program to complete your upgrades

C4. When you started looking at which upgrades you might install, did you have a clear understanding of the incentives you could receive from the Home Insulation program? Please answer on a scale from 0 to 10 where 0 means ‘’no understanding at all’’ and 10 means ‘’a great understanding’’. **[RECORD NUMBER, 98=DON’T KNOW, 99 REFUSED. DO NOT ACCEPT A RANGE]**

C5. **[ASK IF SCORE IN C4 IS 7 OR LESS]** What was unclear about the incentives? **[RECORD VERBATIM]**

C6. After having installed your upgrades, did you receive the incentive amount you had in mind? **[CODE ONE ONLY – DO NOT READ RESPONSES]**

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

C7. Did you work with a contractor to install your energy efficiency upgrades? **[CODE ONE ONLY – DO NOT READ RESPONSES]**

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

C8. **[ASK IF C7=1]** On a scale of 0 to 10, where 0 is 'not at all satisfied' and 10 is 'completely satisfied', how satisfied were you with the following aspects of the contractor.

a. **[ASK IF C7=1]** The quality of the work performed by the contractor **[IF SCORE IS 7 OR LESS, ASK:** Which aspects of the contractor's work could have been improved?**]**

b. **[ASK IF C7=1]** The contractor's ability to advise you on the best upgrades to make based on your audit report **[IF SCORE IS 7 OR LESS, ASK:** How could the contractor have advised you better?**]**

C9. Using a scale of 0 to 10, where 0 is ''very difficult'', and 10 is ''very easy'', how easy was it for you to complete each of the following program steps: **[READ] [DO NOT ROTATE STATEMENTS] [0 TO 10 SCALE, 97=NOT APPLICABLE, 98 = DON'T KNOW/DON'T RECALL THIS STEP]**

a. Schedule the initial home energy assessment with the energy advisor
b. Review the audit report and choose the recommended upgrades that you wanted to complete in your home
c. **[ASK IF C7=1]** Find a contractor to complete the upgrades on your home
d. Get the energy efficient upgrades completed
e. Schedule the final home energy assessment with the energy advisor
f. Complete the required paperwork, including receipts for the completed upgrades
g. Receive your incentive
98. (Don't know)
99. (Refused)

C10. **[FOR EACH C9A-G ≤ 7] [DO NOT ASK IF DON'T KNOW]** What was difficult about completing this program step? **[VERBATIM BOX]**

D. Upgrades and Barriers

D1. I am going to read you a list of upgrades that may have been recommended for your home following the initial home energy assessment. For each one, can you please tell me if that upgrade was recommended or not? **[READ] [DO NOT ROTATE - CODE ONE ONLY PER STATEMENT] [1 = YES, RECOMMENDED, 2 = NO, NOT RECOMMENDED, 98 = DON'T KNOW / DON'T REMEMBER]**

a. Attic insulation

b. Above grade walls insulation

c. Exposed floors or headers insulation

d. Below grade insulation

e. Windows, doors or skylights

f. Air sealing

D2. **[ASK FOR EACH ITEM IN D1 A THROUGH F = 1**] Which of the following recommended upgrades did you decide NOT to make, if any? **[CHECK ALL THAT APPLY. 97=NONE. 98 = DON'T KNOW / DON'T REMEMBER, 99 = REFUSED]**

D3. **[ASK FOR EACH ITEM IN D2]** Why did you decide not to make the **[INSERT ITEM FROM D2]** upgrade to your home? **[DO NOT READ. ACCEPT MULTIPLE]**

1. Couldn't afford this upgrade
2. Couldn't find the time to put in the upgrade
3. Difficult to make the upgrade in my home (such as access, or the need to move belongings)
4. Lack of interest
5. Not having enough information to proceed with this upgrade
6. Not convinced that making that energy efficient upgrade was worth the money
7. Not knowing how to do the work yourself or challenges in hiring a contractor

96. Other:_______

98. Don't know

E. Free-Ridership

Now I'm going to ask you to think of all the energy efficient upgrades that were made to your home under the Home Insulation program.

E1. BEFORE having your home evaluated by an energy advisor, did you already have plans to install the energy efficient upgrades that were installed through the program? Did you … **[CODE ONLY ONE]**

1. Have plans to install <u>all</u> of the upgrades
2. Have plans to install <u>some</u> of the upgrades
3. Have no plan to install <u>any</u> of the upgrades
98. (Don't know)
99. (Refused)

E2. **[IF E1=1 OR 2, THEN ASK:]** I just want to make sure I understand - Before you had your home evaluated by an energy advisor, you had already made the decision to install **[all/some of]** the energy efficiency upgrades that were installed through the program? **[CODE ONE ONLY – DO NOT READ RESPONSES]**

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

E3. EfficiencyPEI paid you $**<AMOUNT>** for the energy efficiency upgrades you installed in your home. If you had not received the rebate from efficiencyPEI, would you have paid for the full cost of the energy efficiency upgrades you installed? Please answer using a scale of 0 to 10, with a 0 indicating that you "Definitely Would Not Have Paid" and a 10 indicating that you "Definitely Would Have Paid." **[PROBE FOR SPECIFIC RESPONSE – DO NOT ACCEPT A RANGE]**

___ 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 Home Insulation 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 E4 TO E6 SEQUENCE IN ORDER/DO NOT RANDOMIZE]

E4. If the program or its rebate had not been offered, what is the likelihood that you would have installed exactly the same quantity of energy efficiency upgrades that were installed through the Home Insulation program?

___ Response ___98 Don't Know ___99 Refused

E5. If the program or its rebate had not been offered, what is the likelihood that you would have installed standard equipment, material or product instead of energy efficient equipment, material or product in your home?

___ Response ___98 Don't Know ___99 Refused

E6. **[ASK IF E3 >=5]** If the program or its rebate had not been offered, what is the likelihood that you would have postponed making energy efficient upgrades to your home by at least one year?

___ Response ___98 Don't Know ___99 Refused

E7. Next, I'm going to ask you to rate the importance of factors that might have influenced your decision to install the energy efficiency upgrades you that were installed through the program. 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 the energy efficiency upgrades. **[DO NOT ACCEPT A RANGE]**

Factor (READ AND RANDOMIZE)	Responses
a. The program rebate	___ Response ___98 Don't Know ___99 Refused
b. Information or recommendations provided in the audit report	___ Response ___98 Don't Know ___99 Refused
c. Expert information or advice from the energy advisor who came to your home to conduct the home energy assessment	___ Response ___98 Don't Know ___99 Refused
d. Promotion done by efficiencyPEI or a previous participation in an efficiencyPEI program	___ Response ___98 Don't Know ___99 Refused

F. Recommendations for Program Improvement

F1. Do you have any recommendations for improving the Home Insulation program? [**PROBE**: Anything else]? **[DO NOT READ. ACCEPT MULTIPLE]**

1. (Offer more products/measures eligible to rebates)
2. (Offer more information on the products/measures recommended)
3. (Improve the content of the audit report)
4. (Increase the time given to complete the upgrades)
5. (Advertise the program more or in a better way)
6. (Simplify the incentive structure/Make it easier to understand how to reach incentives)
7. (Increase rebates)
8. (No recommendation)
9. (Improve energy advisor competence)
10. (Follow up with participants during the process)
11. (Provide more support and assistance after the initial assessment)
12. (Continue the program)
13. (Improve communication)
14. (Provide clearer guidelines for financing)
96. (Other [SPECIFY_______________])
98. (Don’t know)
99. (Refused)

G. Demographic Characteristics

These final questions are asked for statistical purposes only. The information collected is strictly confidential.

G1. What type of residence do you live in? **[READ RESPONSES 1-7, SELECT ONE RESPONSE]**

1. Detached single-family house
2. Semi-detached house
3. Mobile home or house trailer
4. Townhouse or duplex that shares adjacent walls
5. Row house
6. Apartment building that have fewer than five stories
7. Apartment building that have five or more stories

96. (Other [SPECIFY: ________________________])
98. (Don't know)
99. (Refused)

G2. How many bedrooms are in your home? **[98=DK; ENTER ZERO FOR A STUDIO APARTMENT WITH NO BEDROOMS]**

G3. Is your home occupied year round, or is it a seasonal home?

1. Year round residence
2. Seasonal / vacation home

96. (Other Specify _______)
98. (Don't Know)
99. (Refused)

G4. Including yourself, how many people live in this residence on a full-time basis?

Number of people: ______________

G5. In what age category do you fall? 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)

G6. 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)
98. (Don't know)
99. (Refused)

G7. Which of the following income categories best describes your total annual household income before taxes in 2018? 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
98. (Don't know)
99. (Refused)

This completes the survey. Your responses are very important to efficiencyPEI. We appreciate your participation and thank you for your time. Have a good [evening/day].

APPENDIX II
FREE-RIDERSHIP ALGORITHM

The figure below presents the algorithm for calculating the free-ridership level for the HIR program. The participant survey questionnaire included questions designed to assess the planning, quantity, efficiency, timing and cost parameters of the project, as well as the influence of the program. Participants' responses to each group of questions were converted into a value indicating the level of program attribution, and this value was used to calculate the free-ridership level associated with each participant.

E1. Before having your home evaluated by an EA, did you already have plans to install the energy efficient upgrades that were installed through the program? 1. Have plans to install all of the upgrades 2. Have plans to install some of the upgrades 3. Have no plan to install any of the upgrades	IF 1 OR 2 : GO TO E2 IF 3 OR DK/REF: E2 = 0%
E2. [ASK IF E1=1 OR 2] I just want to make sure - Before you had your home evaluated by a EA, you had already made the decision to install all or some of the energy efficiency upgrades that were installed through the program? 1. Yes 2. No	IF 1 and E1=1, E2 = 100% IF 1 and E1=2, E2 = 25% IF 2 OR DK/REF: E2 = 0%
Planning Score:	**E2**
E3. If you had not received the rebate from efficiencyPEI, would have paid the full cost of the energy efficiency upgrades you installed? (Scale 0 to 10)	E3 = Answer x 10% IF DK/REF: EMPTY
E4. If the program or its rebate had not been offered, what is the likelihood that you would have Installed exactly the same quantity of energy efficiency upgrades that were installed through the HIR program? (Scale 0 to 10)	E4 = Answer x 10% IF DK/REF: EMPTY
Cost and Quantity Score:	**MEAN VALUE OF: (E3; E4)**
E6. [ASK IF E3>=5] If the program or its rebate had <u>not been</u> offered, what is the likelihood that you would have postponed making energy efficient upgrades to your home **by at least one year**? (Scale 0 to 10)	E6 = (10 – Answer) x 10% IF DK/REF. E7 = EMPTY

Timing Score:	**E6**
INTENTION Score:	**MEAN VALUE OF: (Planning, Cost and Quantity, Timing)**
E7. Level of influence of four factors (Scale 0 to 10) **a.** The program rebate **b.** Information or recommendations provided in the audit report **c.** Expert information or advice from the energy advisor who came to your home to conduct the Home Energy Assessment **d.** Promotion done by ePEI or a previous participation in an ePEI program	E7 = MAX(a ; b ; c ; d)
INFLUENCE Score:	**(10 – E7) x 10%**
Inconsistency Test #1	IF E2=100% AND E3 OR E4 < 70%: Planning Score = EMPTY
Inconsistency Test #2	IF ABS(E3 – E4) ≥ 50%: Cost and Quantity Score= MIN(E3 ; E4)
Free-Ridership	**MEAN VALUE OF: (INTENTION; INFLUENCE)**

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2018/2019 AND 2019/2020 INSTANT ENERGY SAVINGS PROGRAM EVALUATION

EFFICIENCYPEI

Final Report

June 29, 2020

ECONOLER

ACRONYMS

CDD	Cooling degree days
CFL	Compact fluorescent lamp
COP	Coefficient of performance
DHW	Domestic hot water
DSM	Demand-side management
EE&C	Electricity Efficiency and Conservation
EISA	Energy Independence and Security Act
ePEI	efficiencyPEI
EUL	Effective useful life
HDD	Heating degree days
HOU	Hours of use
IES	Instant Energy Savings (program)
IPC	Incremental product cost
LED	Light-emitting diode
NERHOU	Northeast Residential Lighting Hours-of-Use (study)
NTGR	Net-to-gross ratio
OPA	Ontario Power Authority
PAC	Program Administrator Cost (test)
PEI	Prince Edward Island
TRC	Total Resource Cost (test)
TRM	Technical reference manual
UMP	Uniform Methods Project

DEFINITIONS

Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
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.
Evaluated savings	Gross and net savings calculated by the Evaluator using parameters (installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process.
Free-ridership	Percentage of 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 energy efficiency program, regardless of why they participated.
Interactive effects	Interactive effects occur when the installation of an energy efficiency measure has an impact on the energy consumption of other elements in the building such as heating and cooling.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for 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.
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 between the net energy savings and gross energy savings that includes effects, such as free ridership and spillover, that positively or negatively affect the energy savings generated by a program.
Peak demand-to-energy ratio	The ratio between peak demand savings and energy savings.
Peak demand savings	The demand savings that coincide in time with the peak demand of the electricity system.
Program Administrator Cost test	This test compares program administrator costs to utility resource savings.

Sample size	The number of observations or replicates included in a statistical sample.
Spillover	Savings attributable to participants who continue to implement the energy efficiency measures introduced by a program after participating in it once, without participating in the program a second time.
Total Resource Cost test	This test compares program administrator and participant costs to utility resource savings and in some cases, other resource savings and program benefits accrued by participants, such as non-energy benefits.
Tracked savings	Gross and net savings calculated by the utility in its internal tracking, based on various parameters such as number of participants, installation rates, interactive effects, and 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).

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EXECUTIVE SUMMARY

This report presents the evaluation results of the efficiencyPEI (ePEI) Instant Energy Savings (IES) program. The program offers instant cash rebates to customers who purchase eligible energy efficient products, such as lighting products, low-flow water products, and appliances, in participating stores across Prince Edward Island (PEI). Some of the eligible products, such as light-emitting diode (LED) lamps are sold during spring and fall campaigns while others, such as appliances, are sold year-round.

Summary of Evaluation Assignment

ePEI hired Econoler (hereinafter the Evaluator) to evaluate the IES program and achieve the following key objectives:

› Establish the gross electricity energy and peak demand savings generated by the program;
› Establish the net electricity energy and peak demand savings generated by the program;
› Assess whether the program is cost-effective;
› Assess the effectiveness of program processes and implementation.

The evaluation addresses program savings and cost-effectiveness results associated with products that displace electrical usage only.

The evaluation was carried out based on a review of the program database and documentation, a LED participant intercept survey, literature review, engineering calculations and cost-effectiveness analyses based on the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests.

The evaluation covers the 2019/2020 fiscal year. Based on the parameters established through the evaluation, this report also presents results for the 2018/2019 fiscal year.

Summary of Evaluation Results

This subsection presents the key findings of the evaluation.

Product Sales

A total of 74,621 products that generate electricity savings were rebated during the 2019/2020 fiscal year, compared to 29,774 products in the 2018/2019 fiscal year.[1] About 90% of the products sold were LED lamps.

[1] The 2019/2020 fiscal year included two store campaigns while the 2018/2019 fiscal year included only one.

Program Data Tracking

Overall, the program database, including its various spreadsheets, contained the information about the products sold that was needed to evaluate the energy and peak demand savings. The Evaluator found opportunities for improving the organization and clarity of program data and these opportunities include compiling each individual campaign's data in a single data sheet or ensuring that there is consistency across the tracked data types and unitary savings values to facilitate data compilation.

Gross Savings

The Evaluator established savings calculation parameters for key eligible products to cover at least 80% of program savings. Because LED lamps and fixtures accounted for 91% of the 2019/2020 gross energy savings when the evaluation methodology was being designed, the Evaluator established the savings parameters of these products. To do so, the Evaluator performed engineering calculations using data from a literature review, product specifications of the best-selling products and, for A-type LED lamps, information collected through the intercept survey. The Evaluator also reviewed the savings parameters that were missing for four product categories, namely smart thermostats, dehumidifiers, low-flow showerheads and faucet aerators. For the other product categories, the Evaluator used the savings values established as part of program design.

Table 1 below lists the unitary gross energy savings values used for each eligible product category.

Table 1: Electrical Unitary Energy Savings Values

Product Category	Unitary Savings Value [kWh]	Source
LED A-type Lamps	32.3	Established by the Evaluator
LED Non-A-type Lamps (R, BR and Decorative)	52.2	Established by the Evaluator
LED Non-A-type Lamps (Excluding R, BR and Decorative)	47.8	Established by the Evaluator
Solid-State LED Recessed Downlight Fixtures	53.3	Established by the Evaluator
Solid-State LED Fixtures without Motion Sensor	47.5	Established by the Evaluator
Solid-State LED Fixtures with Motion Sensor	48.7	Established by the Evaluator
Dimmer Switches	17.0	Defined by program design
Outdoor Motion Sensors	159	Defined by program design
Indoor Motion Sensors	45.8	Defined by program design
Indoor Occupancy Sensors with Dimmer	53.6	Defined by program design
Outdoor Heavy Duty Timers	122	Defined by program design
Power Bars and Smart Power Strips	53.7	Defined by program design
Low-Flow Showerheads	169	Established by the Evaluator
Low-Flow Faucet Aerators	115	Established by the Evaluator
Programmable Thermostats	221	Defined by program design
Smart Thermostats	322	Established by the Evaluator
Dehumidifiers	81.3	Established by the Evaluator
Clothes Washers	171	Defined by program design
Refrigerators	104	Defined by program design
Clotheslines and Clothes Dryers	150	Defined by program design

Net Savings

A net-to-gross ratio (NTGR) is used to determine net savings based on program gross savings. The NTGR is typically established based on free-ridership (a negative effect) and spillover (a positive effect) levels. Based on the intercept survey, the Evaluator determined the free-ridership level for LED lamps at 63%. About one-half of the LED participants who answered the survey mentioned not being aware of the program rebates before paying at the cash register, meaning that the program did not influence their purchase decisions.

Spillover was not measured since measuring it requires making a high level of effort by collecting high-quality sales data and interviewing market actors who are able to provide credible observations about the effects of the program on the market. Therefore, an NTGR of 1.00 was used for LEDs as well as for all the other product categories and doing so has resulted in the net savings being equivalent to the gross savings. Canadian jurisdictions including Nova Scotia, New Brunswick, Newfoundland and Ontario have had NTGRs for LEDs that are often under but sometimes over 1 as a result of considering both the free-ridership and spillover levels.

Cost-Effectiveness

The Evaluator assessed the cost-effectiveness of the Electricity Efficiency and Conservation (EE&C) portion of the program by performing two specific cost-effectiveness tests, namely the TRC and PAC tests. When performing these tests, ratios greater than 1 are desired because they indicate that program benefits outweigh costs.

The evaluation revealed that the program was cost-effective in both 2018/2019 and 2019/2020, with PAC and TRC results being all higher than 2.0.

Summary of Savings and Cost-Effectiveness Results

Table 2 below summarizes the key results of the program savings and cost-effectiveness evaluations for 2019/2020 and 2018/2019, as well as participation levels and program targets.

Table 2: Summary of Program Savings and Cost-Effectiveness Targets and Evaluated Results

Parameters	2018/2019 Targets	2018/2019 Evaluation Results	2019/2020 Targets	2019/2020 Evaluation Results
Program Participation				
Number of Products	28,291	29,774	95,901	74,621
Gross Electricity Savings at the Generator				
Gross Electricity Energy Savings (GWh)	-	1.175	-	2.914
Gross Lifetime Electricity Savings (GWh)	-	8.320	-	21.121
Gross Peak Demand Savings (MW)	-	0.168	-	0.423
Net Electricity Savings at the Generator				
NTGR	-	1.00	-	1.00
Net Electricity Energy Savings (GWh)	1.1	1.175	3.7	2.914
Net Lifetime Electricity Savings (GWh)	-	8.320	-	21.121
Net Peak Demand Savings (MW)	0.2	0.168	0.8	0.423
Cost-Effectiveness				
PAC Test	4.9	2.15	8.6	3.94
TRC Test	2.4	4.67	3.1	6.84

- The evaluated net electricity energy savings were respectively 7% higher and 21% lower than the program targets set for 2018/2019 and 2019/2020. Although the unitary savings values of LED lamps are higher than what was expected at the time of setting the targets, those results are explained by the fact that the number of products sold were higher than the targets by 5% in 2018/2019 fiscal year but were lower than the targets by 22% in 2019/2020.
- The evaluated peak demand savings were 16% and 47% lower than the program targets for 2018/2019 and 2019/2020 respectively. During the peak demand period, the interactive effects had a higher impact on the savings, thus partly explaining why the results were lower than the targets set.
- The PAC and TRC tests revealed that the program was cost-effective from both perspectives. In addition, the TRC evaluated results exceeded the targets in both fiscal years.

Recommendations

In light of these findings, the Evaluator makes the following recommendations.

Recommendation 1: Use the evaluation parameters established through this evaluation for the key product categories evaluated. These parameters include the unitary savings values, interactive effects factors and effective useful life (EUL) values.

Recommendation 2: Monitor the evolution of the LED market. Because the lighting market is in a period of change and LEDs are becoming much more popular, the Evaluator recommends monitoring market indicators such as the market shares of lighting technologies, socket saturation and LED prices, to ensure that the program is aligned with market trends. This information could be collected through site visits or surveys.

Recommendation 3: Continue collecting LED sales data from during the campaigns and try collecting sales data from outside the campaigns to facilitate a spillover assessment in the future. This spillover assessment should be combined with a free-ridership assessment to fully capture the program effects.

Recommendation 4: Update program tracking to implement the following:

a. Continue tracking current items and try collecting data on currently untracked or incomplete items. Incomplete items include product model and SKU numbers.
b. Compile the number of units and use that value to calculate program-level electricity savings by multiplying it by the unitary savings values recommended in this evaluation report and the proportion of units generating electrical savings (percentage claimed for EE&C).
c. Consolidate the various spreadsheets into a single database, thus providing a standardized and easy-to-use tracking system. If that is not possible, another option would be to use the same template so that data can be easily merged.
d. Remove unused columns to simplify program tracking.

INTRODUCTION

Under the Government of Prince Edward Island (PEI), efficiencyPEI (ePEI) is responsible for administering Electricity Efficiency and Conservation (EE&C) programs in the province. The programs are meant to help Islanders not only improve the energy efficiency and conservation of energy in their homes and workplaces by installing high-efficiency equipment and products, but also change behaviours. Econoler was commissioned by ePEI to evaluate its EE&C program portfolio comprised of five residential programs and three commercial programs.

One of the five residential programs is the Instant Energy Savings (IES) program, which provides customers with instant cash rebates for the purchase of eligible energy efficient products such as light-emitting diode (LED) lamps and fixtures, programmable and smart thermostats, low-flow showerheads, refrigerators and clothes washers.

The evaluation of the IES program is focused on assessing program processes, implementation and cost-effectiveness, as well as providing evaluated gross and net energy and peak demand savings. The evaluation covers the 2019/2020 fiscal year. Based on the parameters established through the evaluation, this report also presents results for the 2018/2019 fiscal year. This report presents the program EE&C results, namely the savings and cost-effectiveness results associated with equipment that displace electrical usage only. Evaluation activities were carried out considering both electrically-heated and non-electrically-heated participants to assess program processes and implementation, but certain sections of the report reference only subsets of the total participants included in the evaluation, depending on the topic assessed.

To complete this evaluation, Econoler worked with Vision Research, a PEI-based market research firm, on a participant intercept survey. Throughout this report, the team of Econoler and Vision Research is referred to as the Evaluator.

1 PROGRAM OVERVIEW

The ePEI IES program offers instant cash rebates to customers who purchase eligible energy efficient products. The program is delivered by a program implementer, Summerhill, and carried out with the help of major nationwide retailers as well as independent retailers across PEI. Most eligible products are rebated during campaigns that typically last between one month and two months in the spring and fall. Other more expensive and substantial products, such as refrigerators and clothes washers, are rebated year-round. Launched in the fall of 2018, the program only included a fall campaign during the 2018/2019 fiscal year, while the 2019/2020 fiscal year included both a spring and a fall campaign. Table 3 lists the energy efficient products offered through the IES program in 2018/2019 and 2019/2020 and their respective rebate amounts. It should be noted that, for some products such as lighting, dimmer switches and programmable thermostats, rebate amounts vary based on the number of units per eligible pack.

Table 3: List of Program-Eligible Products and Rebates

Product Category	Rebate Amount
Lighting	
LED A-type Lamps	$2-5
LED Non-A-type Lamps	$3-7
Solid-State LED Recessed Downlight Fixtures	$10-20
Solid-State LED Recessed Fixtures (with or without a motion sensor)	$10
Controls	
Dimmer Switches	$3-6
Outdoor and Indoor Motion Sensors	$4
Outdoor Heavy Duty Timers	$6
Power Bars with Integrated Timers	$5
Smart Power Strips	$10
Water Products	
Low-Flow Showerheads	$12
Low-Flow Faucet Aerators	$2
Space Heating Products	
Programmable Thermostats (for both electric and non-electric heaters)	$15-45
Smart Thermostats (with occupancy sensors, for electric baseboards)	$50
Smart Thermostats (for both electric and non-electric heaters)	*$75-100
Appliances	
Dehumidifiers	$30
Clothes Washers	*$75
Refrigerators	*$75
Low-Flush Toilets	*$75
Other	
Clotheslines and clothes dryers	$5
*Products offered year round	

Pursuant to obtaining federal funding from the Low Carbon Economy Fund, ePEI included in the program offer certain energy efficient products that have the potential to generate non-electrical savings, namely thermostats, faucet aerators and showerheads.

The program is advertised through in-store promotion materials and signage, as well as through other sources that include the ePEI website, social media and traditional media such as radio and television. During the two campaign periods, customer engagement events are also held in certain stores.

2 EVALUATION APPROACH

The main objectives of the IES program evaluation are as follows:

› Establish the gross electricity energy and peak demand savings generated by the program;
› Establish the net electricity energy and peak demand savings generated by the program;
› Assess whether the program is cost-effective;
› Assess the effectiveness of program processes and implementation.

The Evaluator identified key research questions aimed at achieving the aforementioned objectives. The following table outlines the evaluation objectives and maps them to the research questions and methods. Each method is described further below.

Table 4: Evaluation Approach

Evaluation Objective	Research Question	Method
Gross energy and peak demand savings	What are the customer bulb replacement behaviours to evaluate the product base case?	Program savings analysis
	What are the unitary savings by product category?	
	What are the peak demand-to-energy ratios by product category?	
	What are the interactive effects factors for lighting products?	
	What are the evaluated annual and lifetime gross energy and peak demand savings?	
Net energy and peak demand savings	What is the free-ridership level for the program?	Participant intercept survey Program savings analysis
	What net-to-gross ratio (NTGR) should be used for the program?	
	What are the evaluated annual and lifetime net energy savings and peak demand savings?	
Program cost-effectiveness	In addition to the other cost-effectiveness calculation parameters already collected (e.g. EUL values, net savings), what are the incremental product cost (IPC) values?	Cost-effectiveness analysis
	Is the program cost-effective from the perspective of the program administrator and participants?	
Program processes and implementation	Is program tracking effective, complete, consistent and clear?	Program database review
	Were participants aware of the program and LED rebates and how had they heard about them?	Participant intercept survey
	How influential was the program on participants' decisions to purchase LEDs?	
	Besides LEDs, what other products rebated by ePEI did participants know about?	

The Evaluator first conducted an in-depth interview with program staff to learn about program processes, discuss program performance and identify evaluation objectives. Then, specific evaluation methods were undertaken as described in the following subsections.

Program Savings and Cost-Effectiveness Analyses

The Evaluator analyzed the program database, conducted a literature review and performed engineering calculations to revise the savings calculation values and parameters used by ePEI, including the assumptions used in calculating IPCs, gross and net energy and peak demand savings, as well as the EUL values used for the lifetime energy savings calculations. As part of the literature review, the Evaluator consulted technical reference manuals (TRMs) and public evaluation reports of jurisdictions similar to ePEI, with a focus on the most recent and accurate sources.

The Evaluator also performed two cost-effectiveness tests, namely the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests.

Participant Intercept Survey

An in-store intercept survey was conducted with a total of 71 participants who had purchased eligible LED lamps during the fall 2019 campaign. To ensure the highest possible incidence, the interviews were conducted in Charlottetown and Summerside at locations of the three highest-selling retailers. The average survey length was 10 minutes. A sample of 71 participants yields a margin of error of ±9.8% at a 90% confidence level. The survey questionnaire is provided in Appendix I.

Program Database Review

The Evaluator reviewed the program database to: (1) assess tracking practices and processes and whether they meet program needs; (2) identify any gaps in tracked data to better inform program savings calculations, management and evaluation; and (3) assess the consistency and organization of tracked data.

3 PROGRAM SAVINGS AND COST-EFFECTIVENESS

This section presents the evaluation results related to program gross and net electrical energy and peak demand savings, as well as cost-effectiveness for the fiscal year 2019/2020. The 2019/2020 fiscal year includes the products sold during the spring 2019 and fall 2019 program promotional campaigns, as well as the products sold year-round. The parameters used to obtain these results were also used to calculate program savings and cost-effectiveness results for the 2018/2019 fiscal year, which includes the products sold during the fall 2018 promotional campaign, as well as the products sold year-round during the 2018/2019 fiscal year. The section opens with an overview of program participation in 2018/2019 and 2019/2020.

3.1 Program Participation

As part of IES program, 74,621 products that generate electricity savings were sold in participating stores across PEI during the 2019/2020 fiscal year. This number includes the products sold year-round and during the two campaigns. A total of 29,774 products were sold in the 2018/2019 fiscal year, during which only one campaign was carried out in addition to the year-round sales. As shown in Figure 1, in both fiscal years, lighting products dominated the sales, representing 97% of the products sold. LED lamps specifically represented more than 90% of all the products sold in both years.

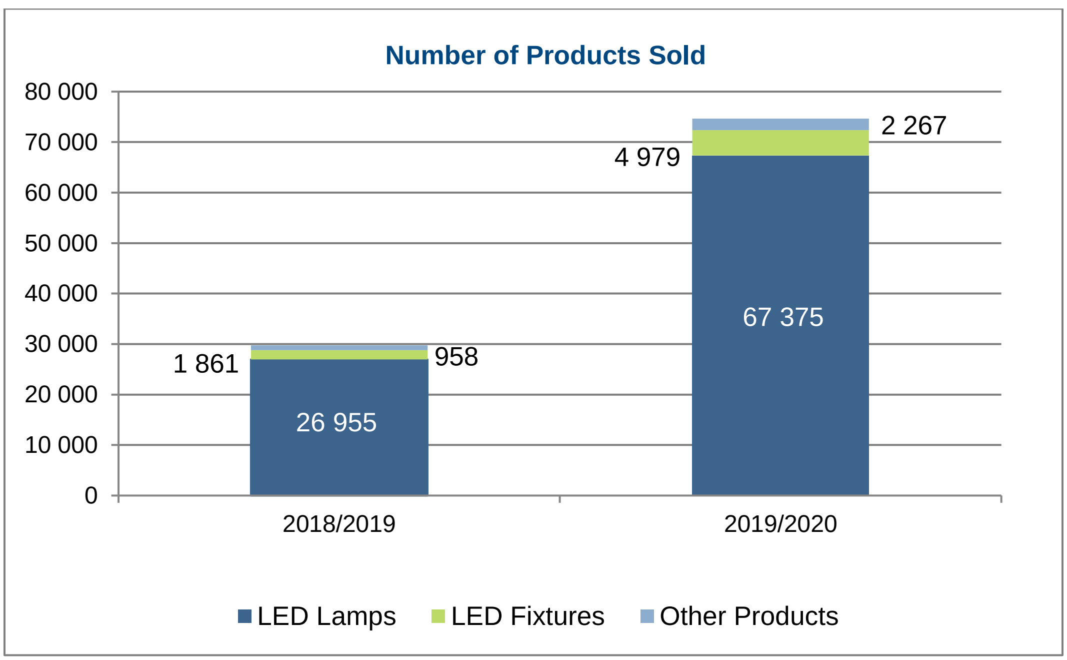

Figure 1: Summary of IES Program Participation

3.2 Gross Savings

Gross savings correspond to the change in energy consumption that results from actions taken by participants regardless of their reasons for participating. For the IES program, gross savings are determined by multiplying the proportion of units generating electricity savings (percentage claimed for EE&C) with the number of units installed for each product category, the energy or peak demand savings value, and the interactive effects factor, using the following equation:

Gross Savings = Percentage Claimed for EE&C× Number of Units × Unitary Savings × Interactive Effects Factor

Lifetime gross energy savings are then obtained by multiplying the annual gross energy savings with the EUL value associated with each product category.

The Evaluator established savings calculation parameters for key eligible products to cover at least 80% of program savings, based on the ePEI program database. The product categories included and their proportion of gross energy savings are listed in Table 5.

Table 5: Key Eligible Product Categories

Product Category	Proportion of Gross Energy Savings
LED A-type Lamps	51%
LED Non-A-type Lamps (R, BR and Decorative)	14%
LED Non-A-type Lamps (Excluding R, BR and Decorative)	12%
Solid-State LED Recessed Downlight Fixtures	4%
LED Fixtures without Motion Sensors	9%
Solid-State LED Recessed Fixtures with Motion Sensors	2%
Total	**91%**[2]

The savings calculation parameters were missing for four product categories, namely smart thermostats, dehumidifiers, low-flow showerheads and faucet aerators. Therefore, the Evaluator also reviewed the savings calculation parameters of those product categories.

For the other product categories, the Evaluator used the savings values established as part of program design and derived from the results presented in the EfficiencyOne 2016 demand-side management (DSM) Evaluation Report of the Instant Savings program.[3]

[2] The sum of the percentage values may not add up due to rounding.
[3] Econoler, *2016 DSM Evaluation Reports*, report prepared for EfficiencyOne, https://www.efficiencyone.ca/dsm/, (last accessed January 30, 2020).

3.2.1 Percentage of Units Claimed for EE&C

For most product categories rebated under the IES program, such as lighting products, motion sensors, power bars or appliances, the proportion of units generating electricity savings is assumed to be 100% since they are directly connected to the electricity grid.

Other product categories only generate electricity savings if they are used conjointly with electrical heating or electrical water heating systems. This is the case for programmable thermostats, smart thermostats, faucet aerators and low-flow showerheads. The Evaluator determined the proportion of units generating electricity savings per product category, which corresponds to the percentage of units claimed for EE&C.

For smart thermostats, a review of the models rebated through the IES program revealed that 2% were compatible with typical electric baseboards, operating at a voltage of 120 V or 140 V. All the other models had a voltage compatibility of 24 V, which is too low to operate with such systems. Therefore, the Evaluator determined that electricity savings related to smart thermostats represent 2%.

Following the same methodology, a review of the models of programmable thermostats sold through the IES program revealed that 15% of them were compatible with electric baseboards (120-240 V).

As for faucet aerators and low-flow showerheads, electricity savings are generated when they are installed in houses equipped with an electric water heater. Since no information is available on the water heating system of program participants, the Evaluator assumed that 21% of PEI houses are equipped with an electric water heater based on 2017 statistics from Natural Resources Canada.[4]

Table 6 presents the percentage of units claimed for EE&C for each product category.

[4] Natural Resources Canada, Single-Detached and Single-Attached Water Heater Stock by Energy Source, https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=pei&rn=29&page=0 (Last accessed March 20, 2020).

Table 6: Percentage of Units Claimed for EE&C

Product Category	Proportion of Units	Source
LED A-type Lamps	100%	Assumption
LED Non-A-type Lamps (R, BR and Decorative)	100%	Assumption
LED Non-A-type Lamps (Excluding R, BR and Decorative)	100%	Assumption
Solid-State LED Recessed Downlight Fixtures	100%	Assumption
Solid-State LED Fixtures without Motion Sensor	100%	Assumption
Solid-State LED Fixtures with Motion Sensor	100%	Assumption
Dimmer Switches	100%	Assumption
Outdoor Motion Sensors	100%	Assumption
Indoor Motion Sensors	100%	Assumption
Indoor Occupancy Sensors with Dimmer	100%	Assumption
Outdoor Heavy Duty Timers	100%	Assumption
Power Bars and Smart Power Strips	100%	Assumption
Low-flow Showerheads	21%	Natural Resources Canada, 2017[5]
Low-flow Faucet Aerators	21%	Natural Resources Canada, 2017[6]
Programmable Thermostats	15%	Based on models sold through the IES program, which are compatible with electric baseboards
Smart Thermostats	2%	Based on models sold through the IES program, which are compatible with electric baseboards
Dehumidifiers	100%	Assumption
Clothes Washers	100%	Assumption
Refrigerators	100%	Assumption
Clothes line and Clothes Dryers	100%	Assumption

3.2.2 Unitary Energy Savings

The Evaluator conducted a literature review, performed engineering calculations and used program data to establish the unitary energy savings values for key eligible product categories as well as for product categories with missing program design values.

[5] Ibid.
[6] Ibid.

For LED lamps and fixtures, dehumidifiers and low-flow showerheads, the Evaluator identified the 10 most sold models during the 2019/2020 fiscal year and based the unitary savings calculation on the specifications (wattage, water removal capacity, flow rate, etc.) of each model. For faucet aerators and smart thermostats, the Evaluator based the unitary savings calculation on a literature review and on household statistics in PEI. The complete methodology is presented in Appendix II.

Table 7 outlines the unitary energy savings values[7] for each product category.

Table 7: Electrical Unitary Energy Savings Values

Product Category	Unitary Savings Value [kWh]	Source
LED A-type Lamps	32.3	Established by the Evaluator
LED Non-A-type Lamps (R, BR and Decorative)	52.2	Established by the Evaluator
LED Non-A-type Lamps (Excluding R, BR and Decorative)	47.8	Established by the Evaluator
Solid-State LED Recessed Downlight Fixtures	53.3	Established by the Evaluator
Solid-State LED Fixtures without Motion Sensor	47.5	Established by the Evaluator
Solid-State LED Fixtures with Motion Sensor	48.7	Established by the Evaluator
Dimmer Switches	17.0	Defined by program design
Outdoor Motion Sensors	159	Defined by program design
Indoor Motion Sensors	45.8	Defined by program design
Indoor Occupancy Sensors with Dimmer	53.6	Defined by program design
Outdoor Heavy Duty Timers	122	Defined by program design
Power Bars and Smart Power Strips	53.7	Defined by program design
Low-Flow Showerheads	169	Established by the Evaluator
Low-Flow Faucet Aerators	115	Established by the Evaluator
Programmable Thermostats	221	Defined by program design
Smart Thermostats	322	Established by the Evaluator
Dehumidifiers	81.3	Established by the Evaluator
Clothes Washers	171	Defined by program design
Refrigerators	104	Defined by program design
Clotheslines and Clothes Dryers	150	Defined by program design

[7] All unitary savings values were calculated at the meter. Line loss factors were added to obtain savings at the generator in the gross savings compilation table (see Table 11).

3.2.3 Unitary Peak Demand Savings

Electricity peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The peak demand period in PEI occurs between 5 p.m. and 7 p.m. from mid-December through early March inclusively on any day when maximum temperature is of -10 °C or lower.

To calculate the unitary peak demand savings values for each product category, the Evaluator used peak demand-to-energy ratios. These ratios are multiplied by the unitary energy savings values established in Table 8 below to obtain unitary peak demand savings values. For lighting products, the Evaluator applied a value of 0.162 W/kWh drawn from the Northeast Residential Lighting Hours-of-Use (NERHOU) Study.[8] As for the other product categories, the Evaluator used the ratios defined by program design or, for the few cases where program design values were missing, the Evaluator relied on peak demand-to-energy ratios established for Nova Scotia in the EfficiencyOne 2019 DSM evaluation reports.[9] Although the Nova Scotia peak demand period occurs during weekdays only, the Evaluator considered that the Nova Scotia and PEI peak demand periods are sufficiently similar to use the Nova Scotia peak demand-to-energy ratios.

Table 8 lists the peak demand-to-energy ratios used for each product category and the resulting unitary peak demand savings values.

[8] NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014.
[9] EfficiencyOne, 2019 DSM Evaluation Reports, Final Report, March 2020.

Table 8: Unitary Peak Demand Savings Values

Product Category	Peak Demand-to-energy Ratio [W/kWh]	Unitary Peak Demand Savings (W)	Source
LED A-type Lamps	0.162	5.23	Northeast Residential Lighting Hours-of-Use Study
LED Non-A-type Lamps (R, BR and Decorative)	0.162	8.46	Northeast Residential Lighting Hours-of-Use Study
LED Non-A-type Lamps (Excluding R, BR and Decorative)	0.162	7.74	Northeast Residential Lighting Hours-of-Use Study
Solid-State LED Recessed Downlight Fixtures	0.162	8.63	Northeast Residential Lighting Hours-of-Use Study
Solid-State LED Fixtures without Motion Sensor	0.162	7.70	Northeast Residential Lighting Hours-of-Use Study
Solid-State LED Fixtures with Motion Sensor	0.162	7.89	Northeast Residential Lighting Hours-of-Use Study
Dimmer Switches	0.162	2.75	Northeast Residential Lighting Hours-of-Use Study
Outdoor Motion Sensors	0.000	0.00	Defined by program design
Indoor Motion Sensors	0.000	0.00	Defined by program design
Indoor Occupancy Sensors with Dimmer	0.000	0.00	Defined by program design
Outdoor Heavy Duty Timers	0.000	0.00	Defined by program design
Power Bars and Smart Power Strips	0.000	0.00	Defined by program design
Low-flow Showerheads	0.162	27.4	EfficiencyOne 2019 DSM Evaluation Report
Low-Flow Faucet Aerators	0.162	18.6	EfficiencyOne 2019 DSM Evaluation Report
Programmable Thermostats	-0.399	-88.2	Defined by program design
Smart Thermostats	-0.399	-128.5	EfficiencyOne 2019 DSM Evaluation Report
Dehumidifiers	0.335	27.2	EfficiencyOne 2019 DSM Evaluation Report
Clothes Washers	0.138	23.6	Defined by program design
Refrigerators	0.138	14.4	Defined by program design
Clotheslines and Clothes Dryers	0.000	0.00	Defined by program design

3.2.4 Interactive Effects

Interactive effects occur in a home 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 the IES program, replacing less efficient lighting products with LED lamps or fixtures causes an increase in the heating load in the winter and a decrease in the cooling load in the summer.

The Evaluator established the interactive effects factors based on a study conducted by ADS Groupe-conseil Inc. for Hydro-Québec.[10] Since LED lamps installed through the program can also be used for outdoor lighting, the interactive effects factors for these products were adjusted to take this into account. The methodology and detailed calculations for establishing the interactive effects factors are presented in Appendix III.

Table 9 below summarizes the interactive effects factors that the Evaluator calculated for LED lamps and fixtures. These interactive effects were applied to the unitary energy and peak demand savings values established for each product category.

Table 9: Interactive Effects Factors for Lighting Products

Product Category	% Indoor	% Outdoor	Energy Interactive Effects Factor Calculation	Peak Demand Interactive Effects Factor Calculation
LED A-type Lamps	92%	8%	-11.3%	-21.1%
LED Non-A-type Lamps (R, BR and Decorative)	92%	8%	-11.3%	-21.1%
LED Non-A-type Lamps (excluding R, BR and Decorative)	92%	8%	-11.3%	-21.1%
Solid-State LED Recessed Downlight Fixtures	100%	0%	-12.3%	-23.0%
LED Fixtures without Motion Sensor[11]	100%	0%	-12.3%	-23.0%
Solid-State LED Fixtures with Motion Sensor[12]	90%	10%	-11.0%	-20.6%
Dimmer Switches	100%	0%	-12.3%	-23.0%
Indoor Motion Sensors	100%	0%	-12.3%	-23.0%
Indoor Occupancy Sensors with Dimmer	100%	0%	-12.3%	-23.0%

Interactive effects were therefore reviewed for all lighting product categories. For all the other products, interactive effects were considered negligible or null.

[10] ADS ASSOCIÉS, *Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale*, report submitted to Hydro-Québec, 1992.
[11] Indoor and outdoor distribution was defined according to the database review.
[12] Ibid.

3.2.5 Effective Useful Life

The EUL values of products correspond to the number of years over which savings are expected to be realized. They are used to determine the energy savings throughout product lifetimes. The Evaluator performed engineering calculations and used program data to establish the EUL values of the key product categories and those for which program design values were missing.

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. An equivalent EUL corresponds to the number of years by which first year savings need to be multiplied to obtain lifetime savings. The calculation methodology is presented in more detail in Appendix IV. For the product categories that have no program design values, the Evaluator based the EUL values on a literature review.

Table 10 outlines the EUL values for each product category.

Table 10: EUL Values

Product Category	EUL Value (Year)	Source
LED A-type Lamps	6.4	Established by the Evaluator
LED Non-A-type Lamps (R, BR and Decorative)	6.6	Established by the Evaluator
LED Non-A-type Lamps (Excluding R, BR and Decorative)	6.7	Established by the Evaluator
Solid-State LED Recessed Downlight Fixtures	7.0	Established by the Evaluator
Solid-State LED Fixtures without Motion Sensor	12.8	Established by the Evaluator
Solid-State LED Fixtures with Motion Sensor	11.9	Established by the Evaluator
Dimmer Switches	10.0	Defined by program design
Outdoor Motion Sensors	10.0	Defined by program design
Indoor Motion Sensors	8.0	Defined by program design
Indoor Occupancy Sensors with Dimmer	10.0	Defined by program design
Outdoor Heavy Duty Timers	8.0	Defined by program design
Power Bars and Smart Power Strips	4.0	Defined by program design
Low-flow showerheads	10.0	GDS Measure Life Report, Table 1[13]
Low-Flow Faucet aerators	10.0	GDS Measure Life Report, Table 1
Programmable Thermostats	10.0	Defined by program design
Smart Thermostats	10.0	GDS Measure Life Report, Table 1
Dehumidifiers	12.0	GDS Measure Life Report, Table 1
Clothes Washers	14.0	Defined by program design
Refrigerators	12.0	Defined by program design
Clotheslines and Clothes Dryers	10.0	Defined by program design

3.2.6 Summary of Gross Savings

The annual gross savings for each product category that generated electrical energy savings in 2019/2020 are listed in Table 11 below. Results for 2018/2019 are presented in Table 12. Savings at the generator were obtained by applying line loss factors of 1.120 for energy and 1.171 for peak demand, as provided by Maritime Electric, the electricity utility.

[13] GDS Associates, Inc., *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures,* Report prepared for the England State Program Working Group, June 2007, Table 1, pp. 1-3.

Table 11: Gross Energy and Peak Demand Savings for 2019/2020

Product Category	LED A-type Lamps	LED Non-A-type Lamps		LED Fixtures			Dimmer Switches	Outdoor Motion Sensors
		R, BR and Decorative	Others	LED Recessed Downlights	Without Motion Sensor	With Motion Sensor		
Number of Units								
Number of Units – Spring 2019	24,447	4,343	2,570	1,089	2,273	33	343	74
Number of Units – Fall 2019	26,682	3,306	4,979	1,310	1,297	25	440	133
Number of Units – Year-round	0	0	0	0	0	0	0	0
Total Number of Units	**51,129**	**7,649**	**7,549**	**2,399**	**3,570**	**58**	**783**	**207**
Percentage Claimed for EE&C	100%	100%	100%	100%	100%	100%	100%	100%
Number of Units Claimed for EE&C	**51,129**	**7,649**	**7,549**	**2,399**	**3,570**	**58**	**783**	**207**
Energy Savings								
Unitary Savings Value (kWh)	32.3	52.2	47.8	53.3	47.5	48.7	17	159
Energy Interactive Effects Factor	-11.3%	-11.3%	-11.3%	-12.3%	-12.3%	-11.0%	-12.3%	0.0%
Gross Energy Savings – at the Meter (GWh)	**1.465**	**0.354**	**0.320**	**0.112**	**0.149**	**0.003**	**0.012**	**0.033**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120
Gross Energy Savings – at the Generator (GWh)	**1.641**	**0.397**	**0.358**	**0.126**	**0.167**	**0.003**	**0.013**	**0.037**
Effective Useful Life (years)	6.4	6.6	6.7	7.0	12.8	11.9	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	**10.500**	**2.618**	**2.402**	**0.879**	**2.132**	**0.034**	**0.131**	**0.369**
Peak Demand Savings								
Unitary Peak Demand Savings (W)	5.23	8.46	7.74	8.63	7.70	7.89	2.75	-
Peak Demand Interactive Effects Factor	-21.1%	-21.1%	-21.1%	-23.0%	-23.0%	-20.6%	0.0%	0.0%
Gross Peak Demand Savings – at the Meter (MW)	**0.211**	**0.051**	**0.046**	**0.016**	**0.021**	**0.000**	**0.002**	**0.000**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171
Gross Peak Demand Savings – at the Generator (MW)	**0.247**	**0.060**	**0.054**	**0.019**	**0.025**	**0.000**	**0.003**	**0.000**

Table 11: Gross Energy and Peak Demand Savings for 2019/2020 (Continued)

Product Category	Indoor Motion Sensors	Outdoor Heavy Duty Timers	Indoor Occupancy Sensors with Dimmer	Power Bars and Smart Power Strips	Low-Flow Showerheads	Faucet Aerators	Programmable Thermostats
Number of Units							
Number of Units – Spring 2019	18	37	4	14	309	4	70
Number of Units – Fall 2019	29	82	0	40	283	15	214
Number of Units – Year-round	0	0	0	0	0	0	0
Total Number of Units	**47**	**119**	**4**	**54**	**592**	**19**	**284**
Percentage Claimed for EE&C	100%	100%	100%	100%	21%	21%	15%
Number of Units Claimed for EE&C	**47**	**119**	**4**	**54**	**124**	**4**	**42**
Energy Savings							
Unitary Savings Value (kWh)	45.8	53.6	122	53.7	115	169	221
Energy Interactive Effects Factor	-12.3%	0.0%	-12.3%	0.0%	0.0%	0.0%	0.0%
Gross Energy Savings – at the Meter (GWh)	**0.002**	**0.006**	**0.000**	**0.003**	**0.014**	**0.001**	**0.009**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120
Gross Energy Savings – at the Generator (GWh)	**0.002**	**0.007**	**0.000**	**0.003**	**0.016**	**0.001**	**0.010**
Effective Useful Life (years)	8.0	10.0	8.0	4.0	10.0	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	**0.017**	**0.071**	**0.004**	**0.013**	**0.160**	**0.008**	**0.104**
Peak Demand Savings							
Unitary Peak Demand Savings (W)	0	0	0	0	18.6	27.4	-88.2
Peak Demand Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Gross Peak Demand Savings – at the Meter (MW)	**0.000**	**0.000**	**0.000**	**0.000**	**0.002**	**0.000**	**-0.004**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171
Gross Peak Demand Savings – at the Generator (MW)	**0.000**	**0.000**	**0.000**	**0.000**	**0.003**	**0.000**	**-0.004**

Table 11: Gross Energy and Peak Demand Savings for 2019/2020 (Continued)

Product Category	Smart Thermostats	Certified Dehumidifiers	Clothes Washers	Efficient Refrigerators	Outdoor Clotheslines and Clothes Dryers	Total for All Products
Number of Units						
Number of Units – Spring 2019	47	0	0	0	119	35,794
Number of Units – Fall 2019	39	110	0	0	15	38,999
Number of Units – Year-round	141	0	337	298	0	776
Total Number of Units	**227**	**110**	**337**	**298**	**134**	**75,569**
Percentage Claimed for EE&C	2%	100%	100%	100%	100%	99%
Number of Units Claimed for EE&C	**4**	**110**	**337**	**298**	**134**	**74,621**
Energy Savings						
Unitary Savings Value (kWh)	322	81.3	171	104	150	-
Energy Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	-
Gross Energy Savings – at the Meter (GWh)	**0.001**	**0.009**	**0.058**	**0.031**	**0.020**	**2.602**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	-
Gross Energy Savings – at the Generator (GWh)	**0.001**	**0.010**	**0.065**	**0.035**	**0.023**	**2.914**
Effective Useful Life (years)	10.0	12.0	14.0	12.0	10.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	**0.014**	**0.120**	**0.904**	**0.417**	**0.225**	**21.121**
Peak Demand Savings						
Unitary Peak Demand Savings (W)	-128.5	27.2	23.6	14.4	0	-
Peak Demand Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	-
Gross Peak Demand Savings – at the Meter (MW)	**-0.001**	**0.003**	**0.008**	**0.004**	**0.000**	**0.361**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	-
Gross Peak Demand Savings – at the Generator (MW)	**-0.001**	**0.004**	**0.009**	**0.005**	**0.000**	**0.423**

Table 12: Gross Energy and Peak Demand Savings for 2018/2019

Product Category	LED A-type Lamps	LED Non-A-type Lamps		LED Fixtures			Dimmer Switches	Outdoor Motion Sensors
		R, BR and Decorative	Others	LED Recessed Downlights	Without Motion Sensor	With Motion Sensor		
Number of Units								
Number of Units – Fall 2018	18,961	3,190	4,804	883	975	3	320	81
Number of Units – Year-round	0	0	0	0	0	0	0	0
Total Number of Units	**18,961**	**3,190**	**4,804**	**883**	**975**	**3**	**320**	**81**
Percentage Claimed for EE&C	100%	100%	100%	100%	100%	100%	100%	100%
Number of Units Claimed for EE&C	**18,961**	**3,190**	**4,804**	**883**	**975**	**3**	**320**	**81**
Energy Savings								
Unitary Savings Value (kWh)	32.3	52.2	47.8	53.3	47.5	48.7	17	159
Interactive Effects Factor	-11.3%	-11.3%	-11.3%	-12.3%	-12.3%	-11.0%	-12.3%	0.0%
Gross Energy Savings – at the Meter (GWh)	**0.543**	**0.148**	**0.204**	**0.041**	**0.041**	**0.000**	**0.005**	**0.013**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120
Gross Energy Savings – at the Generator (GWh)	**0.608**	**0.165**	**0.228**	**0.046**	**0.045**	**0.000**	**0.005**	**0.014**
Effective Useful Life (years)	6.4	6.6	6.7	7.0	12.8	11.9	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	**3.894**	**1.092**	**1.528**	**0.324**	**0.582**	**0.002**	**0.053**	**0.144**
Peak Demand Savings								
Unitary Peak Demand Savings (W)	5.23	8.46	7.74	8.63	7.70	7.89	2.75	0
Peak Demand Interactive Effects Factor	-21.1%	-21.1%	-21.1%	-23.0%	-23.0%	-20.6%	0.0%	0.0%
Gross Peak Demand Savings – at the Meter (MW)	**0.078**	**0.021**	**0.029**	**0.006**	**0.006**	**0.000**	**0.001**	**0.000**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171
Gross Peak Demand Savings – at the Generator (MW)	**0.092**	**0.025**	**0.034**	**0.007**	**0.007**	**0.000**	**0.001**	**0.000**

Table 12: Gross Energy and Peak Demand Savings for 2018/2019 (Continued)

Product Category	Indoor Motion Sensors	Outdoor Heavy Duty Timers	Indoor Occupancy Sensors with Dimmer	Power Bars and Smart Power Strips	Low-Flow Showerheads	Faucet Aerators	Programmable Thermostats
Number of Units							
Number of Units – Fall 2018	24	203	0	40	140	12	195
Number of Units – Year-round	0	0	0	0	0	0	0
Total Number of Units	**24**	**203**	**0**	**40**	**140**	**12**	**195**
Percentage Claimed for EE&C	100%	100%	100%	100%	21%	21%	15%
Number of Units Claimed for EE&C	**24**	**203**	**0**	**40**	**29**	**3**	**29**
Energy Savings							
Unitary Savings Value (kWh)	45.8	53.6	122	53.7	115	169	221
Interactive Effects Factor	-12.3%	0.0%	-12.3%	0.0%	0.0%	0.0%	0.0%
Gross Energy Savings – at the Meter (GWh)	**0.001**	**0.011**	**0.000**	**0.002**	**0.003**	**0.001**	**0.006**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120
Gross Energy Savings – at the Generator (GWh)	**0.001**	**0.012**	**0.000**	**0.002**	**0.004**	**0.001**	**0.007**
Effective Useful Life (years)	8.0	10.0	8.0	4.0	10.0	10.0	10.0
Gross Lifetime Energy Savings – at the Generator (GWh)	**0.009**	**0.122**	**0.000**	**0.010**	**0.037**	**0.006**	**0.072**
Peak Demand Savings							
Unitary Peak Demand Savings (W)	0	0	0	0	18.6	27.4	-88.2
Peak Demand Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Gross Peak Demand Savings – at the Meter (MW)	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.000**	**-0.003**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171
Gross Peak Demand Savings – at the Generator (MW)	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.000**	**-0.003**

Table 12: Gross Energy and Peak Demand Savings for 2018/2019 (Continued)

Product Category	Smart Thermostats	Certified Dehumidifiers	Clothes Washers	Efficient Refrigerators	Outdoor Clotheslines and Clothes Dryers	Total for All Products
Number of Units						
Number of Units – Fall 2018	31	0	0	0	15	29,877
Number of Units – Year-round	0	0	93	120	0	213
Total Number of Units	**31**	**0**	**93**	**120**	**15**	**30,090**
Percentage Claimed for EE&C	2%	100%	100%	100%	100%	99%
Number of Units Claimed for EE&C	**1**	**0**	**93**	**120**	**15**	**29,774**
Energy Savings						
Unitary Savings Value (kWh)	322	81.3	171	104	150	-
Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	-
Gross Energy Savings – at the Meter (GWh)	**0.000**	**0.000**	**0.016**	**0.012**	**0.002**	**1.050**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	-
Gross Energy Savings – at the Generator (GWh)	**0.000**	**0.000**	**0.018**	**0.014**	**0.003**	**1.175**
Effective Useful Life (years)	10.0	12.0	14.0	12.0	10.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	**0.004**	**0.000**	**0.249**	**0.168**	**0.025**	**8.320**
Peak Demand Savings						
Unitary Peak Demand Savings (W)	-128.48	27.2	23.6	14.4	0	-
Peak Demand Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	-
Gross Peak Demand Savings – at the Meter (MW)	**0.000**	**0.000**	**0.002**	**0.002**	**0.000**	**0.143**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	-
Gross Peak Demand Savings – at the Generator (MW)	**0.000**	**0.000**	**0.003**	**0.002**	**0.000**	**0.168**

3.3 Net Savings

Net savings are defined as the energy use reductions specifically attributable to a program. The effects that negatively and positively affect the energy savings generated by a program, respectively free-ridership and spillover, are generally considered. They are then combined into a net-to-gross ratio (NTGR) that is applied to gross energy savings.

Depending on a program's nature and delivery model, free-ridership is often the only effect measured and spillover is assumed to be marginal. However, for instant rebates programs, both the free-ridership and spillover effects are important. Since instant rebates programs provide rebates to all customers purchasing the eligible energy efficient products, free-ridership allows for understanding what proportion of all those customers would still have purchased the products in the absence of the rebate or program promotion. Moreover, since instant rebates programs often offer rebates only over a specific period of time, it is expected that energy efficient products would be purchased beyond these periods thanks to the program's influence on energy efficiency knowledge and product offerings for example, resulting in potential spillover. Nevertheless, measuring this type of spillover requires making a high level of effort to collect high-quality sales data and interview market actors who are able to provide credible observations about the effects of the program on the market.

For the 2019/2020 evaluation of the IES program, only the free-ridership level was measured. To do so, the Evaluator used the participant intercept survey for one specific product category, LED lamps, which was the best-selling product category of the program, accounting for over 75% of total program savings.

3.3.1 Free-Ridership

The free-ridership level was calculated using an algorithm that served to assess the likelihood of participants purchasing LED lamps without the program rebate. This algorithm is presented in Appendix V. The algorithm considered all applicable variables in the decision-making process, including awareness about the rebate, efficiency, cost, timing and quantity.

The intercept survey revealed a free-ridership level of 63% for LED lamps sold through the IES program during the 2019 fall campaign, with a margin of error of 7.6%. More than half (56%) of survey respondents indicated that they were not aware of the rebate offered on the purchase of LEDs before paying at the cash register, which greatly affected the free-ridership level.

3.3.2 Net-to-Gross Ratio Calculations

The NTGR is calculated using the following equation:

NTGR = (1 – % Free-Ridership + % Spillover)

As mentioned above, only the free-ridership level was measured for this evaluation, and since free-ridership and spillover are both significant effects for programs like the IES program, the Evaluator decided to use an NTGR of 1 for all products purchased through the program. As presented further below in Subsection 4.3, just over one third of survey respondents indicated being aware of other energy efficient products rebated by ePEI, besides LEDs, which may indicate the influence of other ePEI programs or activities on LED purchasing decisions. Additionally, Canadian jurisdictions including Nova Scotia, New Brunswick, Newfoundland and Ontario have measured free-ridership and spillover levels for their instant rebates programs and have established NTGRs close to 1 and sometimes even higher than 1. The free-ridership level measured for LED lamps is still an informative market indicator for the most popular product of the program and should continue to be monitored, especially because the lighting market is evolving so fast.

3.3.3 Summary of Net Savings

Net savings are determined by applying NTGRs to evaluate gross savings using the following equation:

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

The detailed net savings results for 2019/2020 and 2018/2019 are summarized in Table 13 and Table 14 respectively.

Table 13: Net Energy and Peak Demand Savings for 2019/2020

Product Category	LED A-type Lamps	LED Non-A-type Lamps		LED Fixtures			Dimmer Switches	Outdoor Motion Sensors
		R, BR and Decorative	Others	LED Recessed Downlights	Without Motion Sensor	With Motion Sensor		
Energy Savings								
Gross Energy Savings – at the Meter (GWh)	1.465	0.354	0.320	0.112	0.149	0.003	0.012	0.033
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net Energy Savings – at the Meter (GWh)	**1.465**	**0.354**	**0.320**	**0.112**	**0.149**	**0.003**	**0.012**	**0.033**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120
Net Energy Savings – at the Generator (GWh)	**1.641**	**0.397**	**0.358**	**0.126**	**0.167**	**0.003**	**0.013**	**0.037**
Effective Useful Life (years)	6.4	6.6	6.7	7.0	12.8	11.9	10.0	10.0
Net Lifetime Energy Savings – at the Generator (GWh)	**10.500**	**2.618**	**2.402**	**0.879**	**2.132**	**0.034**	**0.131**	**0.369**
Peak Demand Savings								
Gross Peak Demand Savings – at the Meter (MW)	0.211	0.051	0.046	0.016	0.021	0.000	0.002	0.000
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)	0.211	0.051	0.046	0.016	0.021	0.000	0.002	0.000
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171
Net Peak Demand Savings – at the Generator (MW)	**0.247**	**0.060**	**0.054**	**0.019**	**0.025**	**0.000**	**0.003**	**0.000**

Table 13: Net Energy and Peak Demand Savings for 2019/2020 (Continued)

Product Category	Indoor Motion Sensors	Outdoor Heavy Duty Timers	Indoor Occupancy Sensors with Dimmer	Power Bars and Smart Power Strips	Low-Flow Showerheads	Faucet Aerators	Programmable Thermostats
Energy Savings							
Gross Energy Savings – at the Meter (GWh)	0.002	0.006	0.000	0.003	0.014	0.001	0.009
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net Energy Savings – at the Meter (GWh)	**0.002**	**0.006**	**0.000**	**0.003**	**0.014**	**0.001**	**0.009**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120
Net Energy Savings – at the Generator (GWh)	**0.002**	**0.007**	**0.000**	**0.003**	**0.016**	**0.001**	**0.010**
Effective Useful Life (years)	8.0	10.0	8.0	4.0	10.0	10.0	10.0
Net Lifetime Energy Savings – at the Generator (GWh)	**0.017**	**0.071**	**0.004**	**0.013**	**0.160**	**0.008**	**0.104**
Peak Demand Savings							
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.002	0.000	-0.004
NTGR	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Net Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.002	0.000	-0.004
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171
Net Peak Demand Savings – at the Generator (MW)	**0.000**	**0.000**	**0.000**	**0.000**	**0.003**	**0.000**	**-0.004**

Table 13: Net Energy and Peak Demand Savings for 2019/2020 (Continued)

Product Category	Smart Thermostats	Certified Dehumidifiers	Clothes Washers	Efficient Refrigerators	Outdoor Clotheslines and Clothes Dryers	Total for All Products
Energy Savings						
Gross Energy Savings – at the Meter (GWh)	0.001	0.009	0.058	0.031	0.020	2.602
NTGR	1.00	1.00	1.00	1.00	1.00	-
Net Energy Savings – at the Meter (GWh)	**0.001**	**0.009**	**0.058**	**0.031**	**0.020**	**2.602**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	-
Net Energy Savings – at the Generator (GWh)	**0.001**	**0.010**	**0.065**	**0.035**	**0.023**	**2.914**
Effective Useful Life (years)	10.0	12.0	14.0	12.0	10.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	**0.014**	**0.120**	**0.904**	**0.417**	**0.225**	**21.121**
Peak Demand Savings						
Gross Peak Demand Savings – at the Meter (MW)	-0.001	0.003	0.008	0.004	0.000	0.361
NTGR	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**-**
Net Peak Demand Savings – at the Meter (MW)	-0.001	0.003	0.008	0.004	0.000	0.361
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	-
Net Peak Demand Savings – at the Generator (MW)	**-0.001**	**0.004**	**0.009**	**0.005**	**0.000**	**0.423**

Table 14: Net Energy and Peak Demand Savings for 2018/2019

Product Category	LED A-type Lamps	LED Non-A-type Lamps		LED Fixtures			Dimmer Switches	Outdoor Motion Sensors
		R, BR and Decorative	Others	LED Recessed Downlights	Without Motion Sensor	With Motion Sensor		
Energy Savings								
Gross Energy Savings – at the Meter (GWh)	0.543	0.148	0.204	0.041	0.041	0.000	0.005	0.013
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net Energy Savings – at the Meter (GWh)	**0.543**	**0.148**	**0.204**	**0.041**	**0.041**	**0.000**	**0.005**	**0.013**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120	1.120
Net Energy Savings – at the Generator (GWh)	**0.608**	**0.165**	**0.228**	**0.046**	**0.045**	**0.000**	**0.005**	**0.014**
Effective Useful Life (years)	6.4	6.6	6.7	7.0	12.8	11.9	10.0	10.0
Net Lifetime Energy Savings – at the Generator (GWh)	**3.894**	**1.092**	**1.528**	**0.324**	**0.582**	**0.002**	**0.053**	**0.144**
Peak Demand Savings								
Gross Peak Demand Savings – at the Meter (MW)	0.078	0.021	0.029	0.006	0.006	0.000	0.001	0.000
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)	0.078	0.021	0.029	0.006	0.006	0.000	0.001	0.000
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171	1.171
Net Peak Demand Savings – at the Generator (MW)	**0.092**	**0.025**	**0.034**	**0.007**	**0.007**	**0.000**	**0.001**	**0.000**

Table 14: Net Energy and Peak Demand Savings 2018/2019 (Continued)

Product Category	Indoor Motion Sensors	Outdoor Heavy Duty Timers	Indoor Occupancy Sensors with Dimmer	Power Bars and Smart Power Strips	Low-Flow Showerheads	Faucet Aerators	Programmable Thermostats
Energy Savings							
Gross Energy Savings – at the Meter (GWh)	0.001	0.011	0.000	0.002	0.003	0.001	0.006
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net Energy Savings – at the Meter (GWh)	**0.001**	**0.011**	**0.000**	**0.002**	**0.003**	**0.001**	**0.006**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120
Net Energy Savings – at the Generator (GWh)	**0.001**	**0.012**	**0.000**	**0.002**	**0.004**	**0.001**	**0.007**
Effective Useful Life (years)	8.0	10.0	8.0	4.0	10.0	10.0	10.0
Net Lifetime Energy Savings – at the Generator (GWh)	**0.009**	**0.122**	**0.000**	**0.010**	**0.037**	**0.006**	**0.072**
Peak Demand Savings							
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.001	0.000	-0.003
NTGR	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Net Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.000	0.000	0.001	0.000	-0.003
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171
Net Peak Demand Savings – at the Generator (MW)	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.000**	**-0.003**

Table 14: Net Energy and Peak Demand Savings for 2018/2019 (Continued)

Product Category	Smart Thermostats	Certified Dehumidifiers	Clothes Washers	Efficient Refrigerators	Outdoor Clothesline and Clothes Dryers	Total for All Products
Energy Savings						
Gross Energy Savings – at the Meter (GWh)	0.000	0.000	0.016	0.012	0.002	1.050
NTGR	1.00	1.00	1.00	1.00	1.00	-
Net Energy Savings – at the Meter (GWh)	**0.000**	**0.000**	**0.016**	**0.012**	**0.002**	**1.050**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	-
Net Energy Savings – at the Generator (GWh)	**0.000**	**0.000**	**0.018**	**0.014**	**0.003**	**1.175**
Effective Useful Life (years)	10.0	12.0	14.0	12.0	10.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	**0.004**	**0.000**	**0.249**	**0.168**	**0.025**	**8.320**
Peak Demand Savings						
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.002	0.002	0.000	0.143
NTGR	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**-**
Net Peak Demand Savings – at the Meter (MW)	0.000	0.000	0.002	0.002	0.000	0.143
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	-
Net Peak Demand Savings – at the Generator (MW)	**0.000**	**0.000**	**0.003**	**0.002**	**0.000**	**0.076**

3.4 Cost-Effectiveness

The Evaluator assessed program cost-effectiveness by performing specific cost-effectiveness tests, namely the TRC and the PAC tests. When performing these tests, ratios greater than 1 are desired because they indicate that program benefits outweigh costs. This section presents the calculations performed to assess the cost-effectiveness of the EE&C portion of the program.

Various values and parameters were necessary to conduct these tests:

- The gross and net electrical savings as well as the EUL were taken from the results presented in Subsections 3.2 and 3.3 of this report. To quantify the economic value of those savings (i.e. the program benefits), the Evaluator used the unitary avoided costs of electrical energy savings and peak demand savings that were provided by the electricity utility, Maritime Electric. Total program costs, broken down by administrative and incentive costs, were provided by ePEI. The Evaluator estimated the proportion of those costs allocated to EE&C based on the ratio of electrical and non-electrical savings[14] generated by the program in 2019/2020. The IPCs associated with products generating electrical savings was estimated by the Evaluator and is described in further details in Subsection 3.4.1 below.
- The net present value (NPV) calculations of all cash flows (costs and benefits) considered in the cost-effectiveness tests were performed using the ePEI discount rate (3.2%) and inflation rate (2%).

3.4.1 Incremental Product Cost

IPCs are defined as the difference between the cost of an energy efficient product offered by a given program and the cost of the base case product that would have been installed in the absence of the program. The Evaluator established the IPC of each product category based on a literature review and program data.

- For some product categories, the base case is not to install the efficient product. Therefore, the incremental product cost equals the full cost of the product for those product categories. This is the case for products such as dimmer switches and low-flow showerheads.
- For the product categories that involve purchasing a high-efficiency product instead of a standard product, such as ENERGY STAR appliances, the incremental product cost is the difference between the cost of the high-efficiency product and the cost of the standard product and is thus only a portion of the retail cost of the high-efficiency product.

[14] Although the quantification of non-electrical energy savings was outside of the scope of the evaluation, the Evaluator used the number of products generating non-electrical savings in the database as well as estimates of the unitary energy savings of each product to produce a high-level estimate of the non-electrical savings for the IES program, and compared that value to electrical energy savings to obtain a percentage of savings attributed to EE&C activities.

› For LED products, IPCs cannot simply be the difference between the cost of a standard product and the cost of a LED lamp or fixture. Although LED products are more expensive, their useful life is much longer than that of halogen incandescent lamps and fluorescent lamps or fixtures. The rated life of typical LED lamps is between 15,000 and 25,000 hours (or between 15 and 25 years if used in residential applications), whereas halogen incandescent lamps only last about 1,000 to 2,000 hours. Other types of lamps last longer (halogen reflector lamps last up to 4,000 hours and CFLs up to 10,000 hours), but they do not last as long as LEDs. Similarly, the typical rated LED linear lamps last 50,000 hours whereas LED fluorescent tubes last 20,000 hours. Therefore, to provide a service life equivalent to that of one LED product, many standard lamps, tubes or fixtures have to be purchased. Since IPCs are used to calculate lifetime cost-to-benefit ratios of energy efficiency measures, they must reflect the true lifetime differences in cost. In this context, some jurisdictions calculate negative incremental product costs for LED products, such as Ontario's Independent Electricity System Operator. However, applying negative IPCs to cost-effectiveness tests is challenging. For instance, if negative IPCs exceed the program costs, the denominator of the TRC test ratio will be negative, resulting in a negative ratio. To avoid overestimating cost-effectiveness test results, certain jurisdictions such as Manitoba and Nova Scotia use a nil value as the IPC of LED products. The Evaluator considered this a reasonable assumption and applied it to the LED products purchased through the IES program. This type of analysis is not necessary for products other than LED lighting because the efficient product and base case product, when there is one, are assumed to have the same EUL.

Table 15 below lists the resulting IPC for each product category.

Table 15: IPC Values

Product Category	IPC Definition	IPC	Source
LED Lamps	0% of full cost	$0	Assumption
LED Fixtures	0% of full cost	$0	Assumption
Dimmer Switches	100% of full cost	$32	Average retail price in database
Outdoor Motion Sensors	100% of full cost	$28	Average retail price in database
Indoor Motion Sensors	100% of full cost	$30	Average retail price in database
Outdoor Heavy Duty Timers	100% of full cost	$21	Average retail price in database
Indoor Occupancy Sensors with Dimmer	100% of full cost	$43	Average retail price in database
Power Bars and Smart Power Strips	100% of full cost	$27	Average retail price in database
Low-Flow Showerheads	100% of full cost	$86	Average retail price in database
Faucet Aerators	100% of full cost	$12	Average retail price in database
Programmable Thermostats	Cost difference with standard product	$30	Illinois Technical Reference Manual 2019[15]
Smart Thermostats	Cost difference with standard product	$174	Illinois Technical Reference Manual 2019
Dehumidifiers	Cost difference with standard product	$50	Minnesota Technical Reference Manual 2020
Clothes Washers	Cost difference with standard product	$163	Minnesota Technical Reference Manual 2020
Efficient Refrigerators	Cost difference with standard product	$40	Illinois Technical Reference Manual 2019
Outdoor Clotheslines and Clothes Dryers	100% of full cost	$62	Average retail price in database

3.4.2 Cost-Effectiveness Tests

This subsection presents the equations used for the PAC and TRC tests. For each test, benefits are at the numerator and costs at the denominator, and they both need to be NPVs.

[15] Illinois Energy Efficiency Stakeholder Advisory Group, Illinois Statewide Technical Reference Manual for Energy Efficiency Version 7.0, Volume 3: Residential Measures, September 2018.

PAC Test

The PAC test measures the net economic benefit of a program from the program administrator perspective using the equation presented below:

$$PAC = \frac{NPV\ (Avoided\ Costs)}{NPV\ (\ Total\ Gross\ Program\ Admnistrator\ Costs)}$$

- **Avoided costs** are the avoided supply costs achieved by the net electrical energy and peak demand savings generated by the program. The avoided unitary costs, in $/kWh and $/kW saved, were multiplied by the electrical energy and peak demand savings respectively.
- **Total gross program administrator costs** are the program costs incurred by the program administrator. The program administrator costs include the costs related to program planning, design, marketing, implementation and evaluation, as well as the incentives. Incentives typically represent the amounts that the program administrator offers participating customers for the upgrades they implement. The program costs were provided by ePEI and only the proportion attributable to EE&C savings was considered, since the PAC test is performed for the EE&C portion of the program.

TRC Test

The TRC test reveals the total net benefits of a program from the perspective of both the utility and participating customers. It is not necessary to know who realizes the benefits and bears the costs.

The TRC test is calculated based on the following formula:

$$TRC = \frac{NPV\ (Avoided\ Costs + Customer\ Benefits)}{NPV\ (Net\ Tech.Costs + Gross\ Program\ Administrator\ Non\ Incentive\ Costs)}$$

- For the TRC test, the **avoided costs** are the same as those of the PAC test.
- **Customer benefits** are participants' non-energy benefits, such as water savings and improved comfort or safety. For the IES program, only water savings from low-flow showerheads, low-flow faucet aerators, and low-flush toilets were included, as presented in Appendix II, along with the unitary energy savings values associated with those water savings.
- **Net technical costs** correspond to the IPCs discussed in Subsection 3.4.1.
- The **gross program administration non-incentive costs** are the same costs as in the PAC ratio denominator, except that they exclude incentives. Incentives are excluded because they are financial transfers between ePEI and participating customers, thus not an expense.

3.4.3 Cost-Effectiveness Results

Table 16 and Table 17 present the cost-effectiveness results for the 2019/2020 and 2018/2019 periods respectively. The IES program was cost-effective in both years, based on the PAC and TRC test results.

Table 16: 2019/2020 Cost-Effectiveness Results

Cost-Effectiveness Test	Ratio	Benefits	Costs
PAC Test	**3.94**	$2,748,518	$556,644
TRC Test	**6.84**	$2,190,778	$402,045

Table 17: 2018/2019 Cost-Effectiveness Results

Cost-Effectiveness Test	Ratio	Benefits	Costs
PAC Test	**2.15**	$1,206,622	$408,360
TRC Test	**4.67**	$879,571	$258,406

3.5 Summary of Program Savings and Cost-Effectiveness Results

Table 18 summarizes the key results from the program savings and cost-effectiveness evaluations and compares these results to program targets.

Table 18: Summary of Program Savings and Cost-Effectiveness Targets and Evaluated Results

Parameters	2018/2019 Targets	2018/2019 Evaluation Results	2019/2020 Targets	2019/2020 Evaluation Results
Program Participation				
Number of Products	28,291	29,774	95,901	74,621
Gross Electricity Savings at the Generator				
Gross Electricity Energy Savings (GWh)		1.175		2.914
Gross Lifetime Electricity Savings (GWh)		8.320		21.121
Gross Peak Demand Savings (MW)		0.168		0.423
Net Electricity Savings at the Generator				
NTGR		1.00		1.00
Net Electricity Energy Savings (GWh)	1.1	1.175	3.7	2.914
Net Lifetime Electricity Savings (GWh)		8.320		21.121
Net Peak Demand Savings (MW)	0.2	0.168	0.8	0.423
Cost-Effectiveness				
PAC Test	4.9	2.15	8.6	3.94
TRC Test	2.4	4.67	3.1	6.84

› The evaluated net electricity energy savings were respectively 7% higher and 21% lower than the program targets set for 2018/2019 and 2019/2020. Although the unitary savings values of LED lamps are higher than what was expected at the time of setting the targets, those results are explained by the fact that the number of products sold were higher than the targets by 5% in 2018/2019 fiscal year but were lower than the targets by 22% in 2019/2020.
› The evaluated peak demand savings were 16% and 47% lower than the program targets for 2018/2019 and 2019/2020 respectively. During the peak demand period, the interactive effects had a higher impact on the savings, thus partly explaining why the results were lower than the targets set.
› The PAC and TRC tests revealed that the program was cost-effective from both perspectives but did not reach the cost-effectiveness targets from the program administrator's perspective for either fiscal year.

4 PROGRAM PROCESSES AND IMPLEMENTATION

This section includes the evaluation results related to program processes and implementation. Specifically, it presents the Evaluator's findings related to program data tracking and participant feedback about their experience with the program.

4.1 Program Data Completeness

In terms of program tracking, the IES program is different from standard energy efficiency programs that require participants to provide information about themselves, their homes or facilities and their projects. Under an instant rebates program, participants enter participating retail stores, purchase products and leave without having to provide their contact information or details about the products they have chosen to purchase and how they plan to use them. This program delivery system is straightforward for both the program administrator and participants but provides limited tracking information especially about participants. Tracking is therefore focused on retailer sales data about program-eligible products. Essentially, the program database is filled in with data provided by retailers after each campaign ends.

Figure 2 below presents the important data types for the IES program and their status in the IES program database.

Figure 2: Summary of IES Program Data Tracking

IES program tracking is performed using multiple Excel spreadsheets, one for each program campaign and other spreadsheets for products sold year-round. Therefore, some of the data types tracked as incomplete in the figure above are present in certain spreadsheets but less present in others. That being said, overall tracking of product and retailer information meets evaluation needs.

The Evaluator did notice that about 3% of product models used to establish the unitary savings values in this evaluation did not correspond to the products described in the program database. This applied to LED lamps and fixtures. For example, a model number for a LED fixture was used for a LED recessed downlight. Another common example was a LED lamp model not referring to the right type of specialty lamp. The Evaluator made the necessary corrections before calculating savings results. The Evaluator understands that the quality of such data heavily depends on retailers, but nonetheless mentions it here. In addition to the above-mentioned data types that should be included in the program database, another key piece of information about this type of program is unitary savings values. Product unitary savings values should be included in the database so that they are applied consistently to product quantities sold. Specifically, ePEI should add a table with the unitary savings values for each product category and calculate the savings across the database using a formula linked to the values in the unitary savings table. This was partly accomplished in the ePEI spreadsheets, the issue being that multiple tables of the sort were prepared, with sometimes inconsistent unitary savings values. Additionally, some of these tables did not always include formulas to understand the specific fields or cells of the sales data that had been used to populate the tables. The Evaluator did note, however, that the quality of tracking increased as the campaigns progressed; in other words, the fall 2019 campaign data quality and compilation were better than that of the fall 2018 campaign.

Recommendation: Continue tracking current items and try collecting data on currently untracked or incomplete items.

Recommendation: Compile the number of units and use that value to calculate program-level electricity savings by multiplying it by the unitary savings values recommended in this evaluation report and the proportion of units generating electrical savings (percentage claimed for EE&C).

Also, it should be clearly indicated whether the savings values are at the meter or at the generator. If they are at the generator, the line loss factor should be included in the database.

4.2 Program Data Organization

The Evaluator identified the following opportunities to improve the organization of the IES program database:

- IES program tracking is stored in multiple tracking sheets, with various spreadsheets that do not all use the same template.
- **Recommendation:** Consolidate the various spreadsheets into a single database, thus providing a standardized and easy-to-use tracking system. If that is not possible, another option would be to use the same template so that data can be easily merged.
- The campaign tracking sheets include several unused columns, including Name, Date, Month, and Order ID.

  Recommendation: Remove unused columns to simplify program tracking.

4.3 Awareness About and Influence of the Program

During the intercept survey, 55% of surveyed LED purchasers mentioned having heard of the program. A smaller proportion of survey respondents (44%) mentioned knowing that a rebate was offered on the purchase of LEDs before paying at the cash register, and less than 10% of respondents were aware before the beginning of the campaign that rebates would be available in the fall. Overall, this level of awareness of the LED rebates implies that the program did not influence the purchasing decisions of about one-half of participants.

Additionally, almost all intercept survey respondents (96%) mentioned already having LEDs in their homes at the time of purchasing LED lamps.

The main source of program awareness was radio ads. In-store promotions were identified as the second most common source of program awareness, followed by newspaper ads.

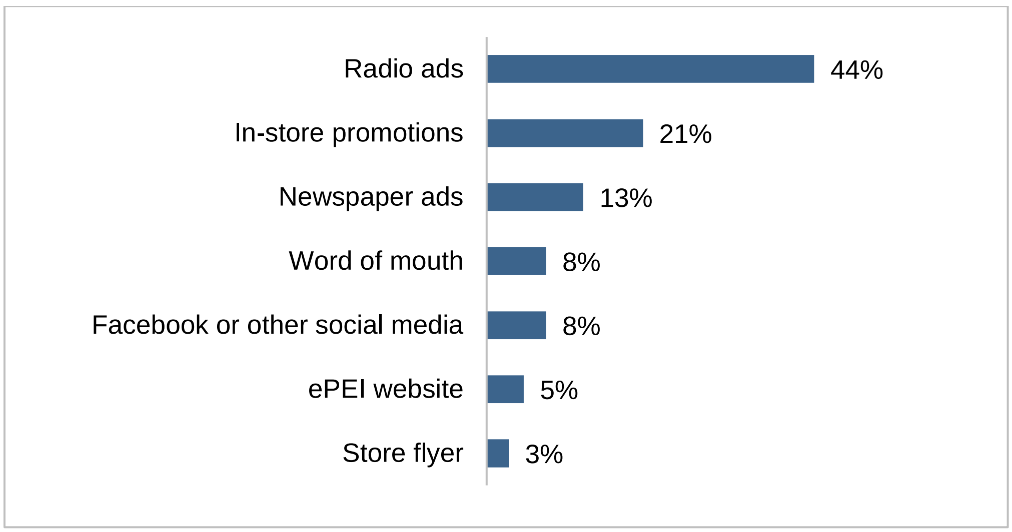

Figure 3: Sources of Program Awareness

Unsurprisingly, in-store promotions and store flyers were the main ways LED purchasers learned about the rebates offered on the purchase of specific LED packages.

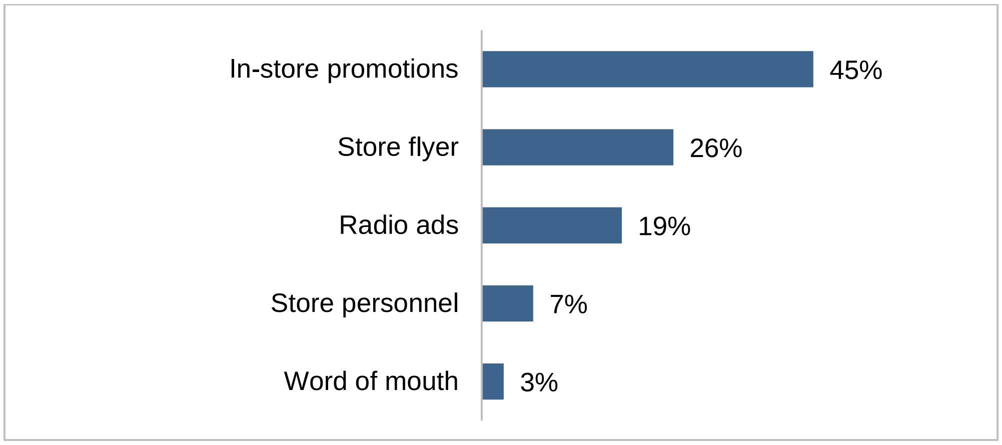

Figure 4: Sources of LED Rebate Awareness

Just over one third of survey respondents indicated being aware of other energy efficient products besides LEDs being rebated by ePEI (34%). Heat pumps were by far the most mentioned product category, followed by toilets, clotheslines and programmable thermostats. It should be noted, however, that heat pumps are rebated in other ePEI programs outside of the IES program.

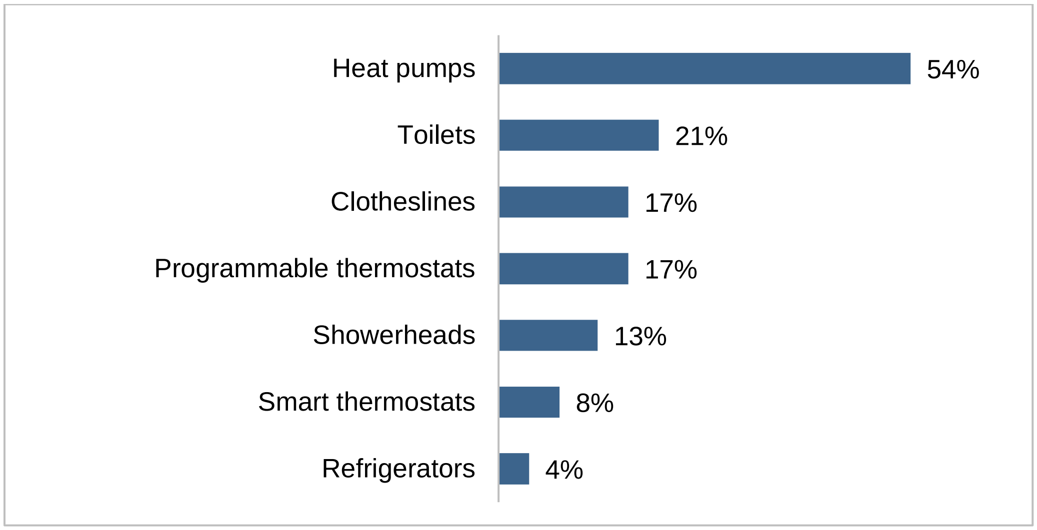

Figure 5: Products Participants Were Aware of Besides LEDs

CONCLUSIONS AND RECOMMENDATIONS

The evaluation of the IES program was intended to achieve the following objectives:

› Establish the gross electricity energy and peak demand savings generated by the program;
› Establish the net electricity energy and peak demand savings generated by the program;
› Assess whether the program is cost-effective;
› Assess the effectiveness of program processes and implementation.

This section provides the Evaluator's conclusions and recommendations related to program processes, implementation, cost-effectiveness, as well as energy and peak demand savings.

The program was cost-effective in both fiscal years but did not achieve its energy savings target in 2019/2020.

The 2019/2020 energy savings were lower than the targets set by 21%, while the 2018/2019 energy savings exceeded the targets by 7%. Those results are explained by the difference between the targeted number and the actual number of products sold. The number of products sold is 5% higher than the target set for the 2018/2019 fiscal year, while it is 22% lower than the target set for the 2019/2020 fiscal year. As for the peak demand savings, the evaluated results are respectively 16% and 47% lower than the program targets set for 2018/2019 and 2019/2020 due to the higher interactive effects factors considered for the peak demand period. Although the PAC test results are lower than the targets, the program was still cost-effective in both fiscal years, from both the PAC and TRC perspectives.

LED lamps were the main contributor to program energy savings.

LED lamps accounted for about 90% of the products sold and 83% of gross electricity energy savings achieved in each fiscal year. For this reason, the savings calculation parameters of this product category were evaluated, along with LED fixtures and a few other products for which the program design did not include the applicable savings calculation parameters.

Recommendation 1: Use the evaluation parameters established through this evaluation for the key product categories evaluated. These parameters include the unitary savings values, interactive effects factors and EUL values.

While the influence of the program was not fully captured through the data collection activities of this evaluation, survey results indicated a propensity for LED lamps.

Almost all intercept survey respondents mentioned already having LEDs in their homes at the time of purchasing LED lamps, and a portion of them already had plans to purchase LEDs despite the program rebates.

Recommendation 2: Monitor the evolution of the LED market. Because the lighting market is in a period of change and LEDs are becoming much more popular, the Evaluator recommends monitoring market indicators such as the market shares of lighting technologies, socket saturation and LED prices, to ensure that the program is aligned with market trends. This information could be collected through site visits or surveys.

Recommendation 3: Continue collecting LED sales data from during the campaigns and try collecting sales data from outside the campaigns to facilitate a spillover assessment in the future. This spillover assessment should be combined with a free-ridership assessment to fully capture the program effects.

There are opportunities to improve the organization of program tracking data.

Overall, the program database, including its various spreadsheets, contained the information needed for the evaluation. The Evaluator found opportunities to improve the organization and clarity of the program data.

Recommendation 4: Update program tracking to implement the following:

a. Continue tracking current items and try collecting data on currently untracked or incomplete items. Incomplete items include product model and SKU numbers.
b. Compile the number of units and use that value to calculate program-level electricity savings by multiplying it by the unitary savings values recommended in this evaluation report and the proportion of units generating electrical savings (percentage claimed for EE&C).
c. Consolidate the various spreadsheets into a single database, thus providing a standardized and easy-to-use tracking system. If that is not possible, another option would be to use the same template so that data can be easily merged.
d. Remove unused columns to simplify program tracking.

Subsections 4.1 and 4.2 of this report provide additional information on the findings that led to these sub-recommendations.

APPENDIX I
PARTICIPANT INTERCEPT SURVEY QUESTIONNAIRE

Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Intercept survey
Estimated Time to Complete	5 minutes
Target Audience	LED purchasers
Expected Number of Completions	70
Fielding Firm	Vision Research

To be adapted by Econoler **[Blue text]**

Import variables from database **< LIKE THIS >**

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

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

A. Introduction and Eligibility

Hello, my name is _____and I am with Vision Research. Today we are conducting a short survey about energy efficiency. We are gathering information from customers who just purchased L-E-D energy efficient light bulbs.

[NOTE FOR THE HOME DEPOT STORE LOCATIONS: Please know that this survey was commissioned by efficiencyPEI, not the Home Depot, but that the results will be shared with the Home Depot Canada in all confidentiality.]

A1. Did you purchase L-E-Ds today? **[CODE ONE ONLY]**

1. Yes
2. No **[THANK AND TERMINATE]**
98. (Don't Know) **[ASK AGAIN. IF STILL DK, THANK AND TERMINATE]**
99. (Refused) **[THANK AND TERMINATE]**

[NOTE FOR THE HOME DEPOT STORE LOCATION: SKIP TO A3, DO NOT ASK A2]

A2. **[IF A1=1]** Would you mind showing me the L-E-Ds you bought today**? [CODE ONE ONLY]**

[CONFIRM VISUALLY THAT THE PRODUCT BOUGHT BY RESPONDENTS IS L-E-DS. IF NO, THANK AND TERMINATE.]

1. Product is L-E-D **[CONTINUE]**
2. Other type of bulbs/products **[THANK AND TERMINATE]**
99. Refused **[CONTINUE]**

A3. **[IF A1=1]** 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]**

A4. 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 B1]**
2. No **[THANK AND TERMINATE]**

B. Purchase and Installation

B1. Are there any L-E-Ds currently installed at your home? **[CODE ONE ONLY]**

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

B2. 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)
99. (Refused) **[THANK AND TERMINATE]**

[IF B2=0 OR DON'T KNOW, GO TO B2A]

B2a. Earlier you stated that you did purchase L-E-D bulbs. Can you confirm if you purchased L-E-D bulbs today?

1 Yes [GO TO B2_LEDconfirm]
2 No [THANK AND TERMINATE]

B2_confirm. 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

B3. **[IF B2 OR B2_CONFIRM=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 halogen bulb
4. To replace a standard incandescent bulb—those bulbs typically have wattages of 40, 60 or 100 Watts
5. To replace an efficient incandescent bulb—those bulbs look the same as incandescent bulbs but typically have wattages of 29, 43 or 72 Watts
6. Into a new lamp or light fixture

96. (Other [SPECIFY__________________])
98. (Don't Know)
99. (Refused)

B4. **[IF B3<> 5].** 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

96. (Other [SPECIFY__________________])

(Don't Know)

(Refused)

B5. **[IF B2>1]** For which of the following reasons did you buy these **[INSERT NUMBER OF LEDS FROM B2]** L-E-D bulbs? How many, if any, of these **[OF THE [INSERT NUMBER OF LEDS FROM B2]** L-E-D bulbs will be installed… [**TOTAL NUMBER OF BULBS RECORDED CAN'T BE HIGHER THAN COUNT IN B2]** [***SHOW PICTURES TO ALL RESPONDENTS***] NOTE TO INTERVIEWER – ALL CATEGORIES NEED A NUMBER, ADD IN ZEROS FOR ANY THAT WERE NOT SELECTED.

b. To replace another L-E-D bulb

c. To replace a CFL bulb

d. To replace a halogen bulb

e. To replace a standard incandescent bulb—those bulbs typically have wattages of 40, 60 or 100 Watts

f. To replace an efficient incandescent bulb—those bulbs look the same as incandescent bulbs but typically have wattages of 29, 43 or 72 Watts

g. Into a new lamp or light fixture

h. For some other reason? Please specify:________

___ Response ___98 Don't Know ___99 Refused

B6. **[IF B5A OR B5B OR B5C OR B5D OR B5E >0].** Concerning the bulbs that you will use to replace existing 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

96. (Other [SPECIFY__________________])

98. (Don't Know)

99. (Refused)

C. Awareness

C1. Have you ever heard of the efficiencyPEI program that offers instant rebates at the cash register for the purchase of energy efficient products such as L-E-D light bulbs, programmable thermostats and smart power bars? **[CODE ONE ONLY]**

1. Yes [**GO TO C2]**
2. No [**GO TO D1]**
98. (Don't Know) [**GO TO D1]**
99. (Refused) [**GO TO D1]**

C2. **[ASK ONLY IF C1=1]** How did you find out about this program? **[DON'T READ; ALLOW MULTIPLE RESPONSE BUT DO NOT PROBE FOR MULTIPLE]**

1. (Radio ads)
2. (Newspaper ads)
3. (In-store promotions)
4. (Store flyer)
5. (Store personnel)
6. (efficiencyPEI website)
7. (Facebook or other social media)
8. (Word of mouth)
9. (Through an efficiencyPEI representative during an in-store event)
96. (Other [SPECIFY____________________])
98. (Don't know)
99. (Refused)

C3. **[ASK IF C1=1]** Besides the L-E-D bulbs that you purchased today, are you aware of any other energy efficiency products that are discounted by efficiencyPEI? **[CODE ONE ONLY]**

1. Yes **[GO TO C4]**
2. No [**GO TO D1]**
98. (Don't Know) [**GO TO D1]**
99. (Refused) [**GO TO D1]**

C4. **[ASK IF C3=1]** What are those products? Any others? **[DO NOT READ RESPONSES – CODE AS MANY AS APPLY]**

1. (Heat pumps)
2. (Clotheslines)
3. (Dehumidifiers)
4. (Dimmers)
5. (Motion sensors)
6. (Faucet aerators)
7. (Programmable thermostats)
8. (Smart thermostats)
9. (Refrigerators)
10. (Showerheads)
11. (Toilets)
12. (Washing machines)
96. (Other, SPECIFY: __________________)
98. (Don’t Know)
99. (Refused)

D. Free-Ridership

D1. You bought L-E-Ds today. EfficiencyPEI is currently offering rebates on packages of L-E-Ds. Before paying at the cash register, were you aware that a rebate was offered on the purchase of L-E-Ds? **[CODE ONE ONLY]**

1. Yes **[GO TO D3]**
2. No **[GO TO D2]**
98. (Don’t Know) **[GO TO D2]**
99. (Refused) **[GO TO D2]**

D2. **[ASK IF NOT AWARE OF THE REBATE (D1=2, DK, REF)]** I just want to make sure I understand - You did not know about the rebate on packages of L-E-Ds before paying at the register? **[CODE ONE ONLY]**

1. Yes, I knew about the rebate
2. No, I did not know about the rebate **[GO TO SECTION E]**
98. (Don’t know) **[GO TO SECTION E]**
99. (Refused) **[GO TO SECTION E]**

D3. **[ASK IF D1=1 or D2=1]** Before the beginning of the rebate campaign, which began on September 27th, were you aware that rebates on L-E-Ds would be offered this fall?

1. Yes **[GO TO D4]**
2. No **[SKIP TO D5]**
98. (Don't Know) **[SKIP TO D5]**
99. (Refused) **[SKIP TO D5]**

D4. **[ASK IF YES IN D3]** Did you postpone your purchase of L-E-Ds to take advantage of the rebate?

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

D5. How did you learn about the rebates offered on the purchase of specific packages of L-E-Ds? **[DO NOT READ RESPONSES – CODE AS MANY AS APPLY]**

1. (Radio ads)
2. (Newspaper ads)
3. (In-store promotions)
4. (Store flyer)
5. (Store personnel)
6. (efficiencyPEI website)
7. (Facebook or other social media)
8. (Word of mouth)
9. (Through an efficiencyPEI representative during an in-store event)
96. (Other [SPECIFY___________________])
98. (Don't know)
99. (Refused)

D6. Did you see in-store signage (stickers, shelf signs or posters) in the light bulbs section of the store promoting the rebates offered on L-E-Ds? **[CODE ONE ONLY]**

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

D7. You mentioned that you were aware, before paying at the cash register, that a rebate 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)

D8. If the rebate on L-E-Ds had NOT been offered today, what would you have bought today? Would you have… **[READ, CODE ONE ONLY]**

1. Bought L-E-Ds anyway **[SKIP TO D10]**
2. Bought other type of bulbs **[GO TO D9]**
3. Not bought any bulbs **[SKIP TO D10]**
98. (Don't know) **[SKIP TO D10]**
99. (Refused) **[SKIP TO D10]**

D9. **[ASK IF D8=2]** 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)

D10. 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

D11. If the rebate 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 D4=1]** Earlier than 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 E SERIES]**
98. (Don't Know)
99. (Refused)

D12. Without the rebate, 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)

E. Demographics

These final questions are asked for statistical purposes only. The information collected is strictly confidential.

E1. What type of residence do you live in? **[READ FIRST SEVEN RESPONSES; SELECT ONE RESPONSE]**

1. Detached single-family house
2. Semi-detached house or duplex (2 dwellings attached)
3. Townhouse or row house with shared adjacent walls (3 or more dwellings attached)
4. Mobile home or house trailer
5. Apartment or condo building that has fewer than five stories
6. Apartment or condo building that has five or more stories

96. (Other [SPECIFY: ________________________])
98. (Don't know)
99. (Refused)

E2. Do you own or rent this residence? **[CODE ONE ONLY]**

1. Own/buying **[GO TO END]**
2. Rent/lease **[GO TO E3]**

96. (Other (Describe)) __________________ **[GO TO E3]**
99. (Refused) **[GO TO E3]**

E3. 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)

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. **[INCLUDE SIGNATURE LINE IN PROGRAMMING TO NOTE RECEIPT OF INCENTIVE].**

APPENDIX II
UNITARY SAVINGS DETAILED CALCULATIONS

This appendix presents the detailed calculations and assumptions used to establish the unitary savings values for the key product categories that cover at least 80% of the program savings for 2019/2020. The six following product categories combined generated 91% of program savings.

- LED A-type Lamps
- LED Non-A-type Lamps (R, BR and Decorative)
- LED Non-A-type Lamps (Excluding R, BR and Decorative)
- Solid-State LED Recessed Downlight Fixtures
- Solid-State LED Fixtures without Motion Sensor
- Solid-State LED Fixtures with Motion Sensor

Moreover, the Evaluator established the unitary savings values of the following product categories since they were missing in the database.

- Dehumidifiers
- Low-Flow Showerheads
- Faucet Aerators

LED Lamps

Distinct unitary savings values were calculated for LED A-type lamps, LED R, BR and decorative lamps and other LED non-A-type lamps sold through the IES program, based on the assumption 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 (CFLs). The three unitary savings values were determined using the general lighting equation below Equation (1).

$$\boldsymbol{Annual\ Unitary\ Savings}\left[\frac{\boldsymbol{kWh}}{\boldsymbol{yr}}\right]=\frac{\boldsymbol{Displaced\ Wattage}\,[W]\times\boldsymbol{HOU}\left[\frac{\boldsymbol{h}}{\boldsymbol{day}}\right]\times\boldsymbol{365}\left[\frac{\boldsymbol{day}}{\boldsymbol{yr}}\right]}{\boldsymbol{1{,}000}\left[\frac{\boldsymbol{W}}{\boldsymbol{kW}}\right]} \quad (1)$$

The Evaluator established the displaced wattage and the hours of use (HOU) values for each LED lamp type. No in-service rate was included in the equation. The Evaluator presents the reasoning for that in the corresponding sub-section further below.

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)[16] to better represent the real baseline wattages of LED lamps.

Questions were included in the 2019 fall campaign 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 establish the baselines which correspond to the least efficient lamps that would have been used if the program component had not been offered.

The respondents' answers are summarized in Table 19.

Table 19: Results of the Intercept Survey for Establishing the LED A-type Lamp Baselines

Question	Number of Respondents	Number of Lamps	Percentage of Lamps
Do you plan on installing these LED lamps…[17]			
To replace lamps once they burn out?	27	186	43%
To replace lamps that are still working?	36	251	57%
For respondents who are replacing working lamps: How many, if any, of these LED lamps will be used to replace…[18]			
Standard incandescent lamps	14	115	55%
Efficient incandescent lamps	0	0	0%
CFLs	8	63	30%
LED lamps	8	33	16%
Total	**30**	**211**	**100%**[19]

[16] National Renewable Energy Laboratory, *Uniform Methods Protocol Chapter 6: Residential Lighting Evaluation Protocol*, February 2014, pp. 6-20.

[17] Eight participants, or 11% of total respondents, answered, "Don't know" or did not answer. Their answers were excluded from the calculations.

[18] Eight lamps 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. Moreover, LED lamps purchased to replace halogen lamps (32) were excluded from the calculation since it is unlikely that A-type lamps replace this type of lamp.

[19] Sum of answers may not add up to 100% due to rounding.

In light of these findings, two types of baselines were defined.

Early Replacement Baseline: The survey revealed that 57% 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 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 IES, thereby resulting in a displaced wattage of 0 W.

The Evaluator assumed that LED lamps replacing LED lamps were A-type lamps since it is unlikely that non-A-type lamps reached the end of their life given their recent appearance on the market. In addition, no other technology than incandescent and LED is available to replace R, BR and decorative lamps; hence, 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. Moreover, considering the significantly higher proportion of A-type lamps purchased in comparison to non-A-type lamps, 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 20.

Table 20: 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 Replaced Lamp Wattage[20]
		Average Wattage	%	Average Wattage	%	Average Wattage	%	Average Wattage	%	Average Wattage	%	
LED A-type Lamps	8.8	58.7	55%	42.1	0%	12.7	30%	-	-	8.8	16%	37.2
LED Non-A-Type Lamps (R, BR and Decorative)	7.3	56.6	100%	-	-	-	-	-	-	-	-	56.6
LED Non-A-Type Lamps (excluding R, BR and Decorative)	7.0	-	-	-	-	-	-	52.2	100%	-	-	52.2

Based on the above calculations, the baseline wattages for the early replacement scenario were established at 37.2 W for LED A-type, 56.6 W for R, BR and decorative lamps and 52.2 W for the other LED non-A-type lamps.

Replace On Burn-Out Baseline: For the 43% of LED lamps that replaced burned-out lamps, it was assumed that participants would purchase 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 minimum efficiency lamp was defined, which was in turn used to calculate the weighted average equivalent wattage for each lamp category.

[20] Represents the average replaced lamp wattage weighted by the proportion of lamps replaced by type, based on survey responses. For LED A-type lamps, the average replaced lamp wattage = [(58.7×55%)+(42.1×0%)+(12.7×30%)+(8.8×16%)]/(55%+30%+16%) = 37.2.

To determine the wattage of equivalent minimum efficiency lamps, the Evaluator considered the current federal regulation on general service lamps.[21] 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 outlined in Table 21.

Table 21: 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 42.1 W for A-type lamps.

Table 22 outlines the overall displaced wattages for all categories of LED lamps.

Table 22: Calculations for Displaced Wattages

	Proportion	Baseline Wattage (W)	LED Lamp Wattage (W)	Displaced Wattage (W)
LED A-type Lamps				
Early Replacement Scenario	57%	37.2	8.8	28.4
Replace On Burn-Out Scenario	43%	42.1	8.8	33.3
Total LED A-type Lamps	**100%**	**39.3**	**8.8**	**30.5**
LED Non-A-type Lamps (R, BR and Decorative)				
Early Replacement Scenario	57%	56.6	7.3	49.3
Replace On Burn-Out Scenario	43%	56.6	7.3	49.3
Total LED Non-A-type Lamps (R, BR and Decorative)	**100%**	**56.6**	**7.3**	**49.3**
LED Non-A-type Lamps (excluding R, BR and Decorative)				
Early Replacement Scenario	57%	52.2	7.0	45.1
Replace On Burn-Out Scenario	43%	52.2	7.0	45.1
Total LED Non-A-type Lamps (Excluding R, BR and Decorative)	**100%**	**52.2**	**7.0**	**45.1**

[21] Natural Resources Canada, *General Service Lamps*, http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869 (Last accessed November 1, 2018).

Hours of Use

The Residential Lighting Evaluation Protocol of the UMP recommends that each jurisdiction conduct a metering study to determine their specific HOUs. In the absence of a specific value for PEI, the Evaluator based the daily HOUs on the Northeast Residential Lighting Hours-of-Use (NERHOU) Study,[22] which found that the average usage is 2.9 hours per day for efficient bulbs without the snapback effect.[23]

According to UMP criteria, the NERHOU Study remains the most reliable source for the following reasons: (1) it takes into account the proportion of efficient bulbs installed inside and outside the house; (2) it is based on a large sample size; and (3) it includes a very detailed analysis of the variations in HOUs by bulb type (including LEDs), geographical location, and household type. For these reasons, it is the most relevant study and is used to establish the hours for the IES program.

The NERHOU Study concludes that the HOUs are 2.7 hours/day for all types of bulbs, while the HOUs are 3.0 hours/day for efficient bulbs. In other words, a variation of 0.3 hours/day between both HOU values is observed. Three theories have been put forward to explain why efficient bulbs are used over a greater number of hours, as follows.

- Differential socket selection: the assumption is that the most used sockets in a household are selected to install efficient bulbs;
- Shifting usage: the assumption is that once an efficient bulb is installed, it is favoured over other sockets containing inefficient bulbs;
- Snapback effect: the assumption is that there is a tendency to use an efficient product more than a replaced inefficient product.

Since there is no indication that one theory overrides the others, the Evaluator considers that each theory represents an additional usage of 0.1 hours per day. Two theories, differential socket selection and shifting usage, apply to bulbs purchased as part of the IES program since participants are likely to buy only a limited quantity of bulbs rather than changing every bulb in the house. As for the snapback effect, it is not taken into account in the HOU assessment since this usage would not have occurred if an incandescent or halogen (base case) had been installed in the absence of the program. To avoid overestimating savings by making calculations based on higher operating hours than those of the base case, the Evaluator included an additional usage of 0.2 hours in the daily HOU value determined in the NERHOU Study for all bulb types, thereby increasing the HOUs from 2.7 hours to 2.9 hours per day.

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[22] NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.
[23] The snapback effect is an increase in usage following the installation of an efficient product because the operating cost is lower.

In-Service Rate

The UMP Residential Lighting Evaluation Protocol mentions that in-service rates are particularly important in upstream or giveaway programs through which participants are responsible for installing lamps. This is because it is likely that some of the lamps are not installed until a few years later when the base case has changed, resulting in full savings not being achieved. The UMP provides some examples wherein the first-year in-service rates were applied to six LED upstream programs in the United States; those in-service rates varied between 84% and 99%, with four being 95% or higher.

The UMP also identifies three key factors causing the in-service rate to be below 100%: (1) deeply discounted prices; (2) inclusion of LED multipacks; and (3) consumers commonly waiting until a lamp burns out before replacing it.

Since these factors vary from one program to another, it is difficult to find the most appropriate in-service rates applicable to the IES program. Furthermore, the Evaluator considers unlikely that most LED lamps purchased are left unused since more than half of participants (51%) interviewed during the 2019 fall campaign intercept survey mentioned that they purchased lamps to replace lamps that still work.

However, first-year in-service rates mean that the LED bulbs will be installed later, not that they will not be installed at all. Therefore, if an in-service rate is applied to LED bulb savings, a discount rate should also be applied on the savings to claim the future savings that will occur. The Evaluator believes that the savings deduction is too small to be considered.

For the abovementioned reasons, the Evaluator decided not to apply an in-service rate to LED bulbs and to claim all savings in the year during which the LED bulbs were purchased.

Unitary Savings

The unitary savings values for each LED lamp category were established using the general lighting equation and are presented in Table 23.

Table 23: LED Lamps Unitary Savings Values

Lighting Product Category	Displaced Wattage (W)	HOUs	Unitary Savings Value (kWh)
LED A-type	30.5	2.9	32.3
LED Non-A-type (R, BR and Decorative)	49.3	2.9	52.2
LED Non-A-type (Excluding R, BR and Decorative)	45.1	2.9	47.8

Solid-State Recessed Downlight Fixtures

The unitary savings value for LED recessed downlight fixtures sold through IES was obtained by using the general lighting equation (Equation 1), as with LED lamps.

To establish the displaced wattage of each category of LED recessed downlight fixture offered under IES, the Evaluator identified the 10 best-selling models listed in the 2019 campaign databases. The wattage value data and the incandescent or halogen wattage equivalents for these models were then gathered from participating retailer websites (as recommended by manufacturers). These values were then converted into wattage values that meet the current Canadian energy efficiency regulation for general-service lamps.

Most fixtures house reflector lamps for which the baseline is a halogen lamp. Some LED recessed downlight fixtures house E27 type lamps; because 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 11.2 W and the average equivalent wattage for the replaced halogen and incandescent lamps is 61.6 W. As a result, the displaced wattage was established at 50.4 W.

By using the general lighting equation and applying the displaced wattage value of 50.4 W and the HOU value of 2.9 hours per day, the unitary savings value for LED recessed downlight fixtures was established at 53.3 kWh per year, as listed in Table 24 below.

Table 24: LED Recessed Downlight Fixtures Unitary Savings Value

Lighting Product Category	Displace Wattage (W)	HOUs (Hours)	Unitary Savings Value (kWh)
Solid-State LED Recessed Downlight Fixtures	50.4	2.9	53.3

Solid-State LED Fixtures Without Motion Sensor

The unitary savings value associated with LED fixtures without a motion sensor was obtained using the general lighting equation (Equation 1).

The Evaluator selected the 10 most popular models from the 2019/2020 campaigns to establish the displaced wattage. 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 retailer websites. The other selected fixtures served to replace general-use lamps. For some of these fixtures, information concerning the equivalent wattage was not available. The Evaluator therefore used the light output measured in lumens found on ENERGY STAR or manufacturer websites and used a table from the ENERGY STAR website to establish equivalent incandescent wattages (see Table 25). Then, the equivalent incandescent wattages were converted by using the current Canadian Energy Efficiency Regulation requirements for general service lamps.

Table 25: 2019 ENERGY STAR Certified Lamp Light Output Equivalency to Incandescent Lamp Wattage[24]

Old Incandescent Lamps (W)	ENERGY STAR Certified Lamp Light Output (Lumens)
40	450
60	800
75	1,100
100	1,600
150	2,600

The analysis indicated that the average efficient wattage value was 19.8 W and the corresponding average baseline wattage was 64.8 W for new LED fixtures without a motion sensor. Thus, the average displaced wattage was established at 44.9 W.

Using the displaced wattage value of 44.9 W and the HOUs of 2.9 hrs/day, the unitary savings value for LED fixtures without motion sensor was revised to 47.5 kWh per year, as listed in Table 26 below.

Table 26: LED Fixtures Without Motion Sensor Unitary Savings Values

Lighting Product Category	Displace Wattage (W)	HOUs (Hours)	Unitary Savings Value (kWh)
Solid-State LED Fixtures Without Motion Sensor	44.9	2.9	47.5

Solid-State LED Fixtures with Motion Sensor

To determine the unitary savings value associated with LED fixtures with a motion sensor, the Evaluator adapted the general lighting equation (Equation 1) by taking into account the specific HOUs, as expressed as follows:

$$\boldsymbol{Annual\ Unitary\ Savings}\left[\frac{\boldsymbol{kWh}}{\boldsymbol{yr}}\right] = \frac{\left(\boldsymbol{Wattage_{old}}\,[W]\times\boldsymbol{HOU_{old}}\left[\frac{\boldsymbol{hrs}}{\boldsymbol{day}}\right] - \boldsymbol{Wattage_{new}}\,[W]\times\boldsymbol{HOU_{new}}\left[\frac{\boldsymbol{hrs}}{\boldsymbol{day}}\right]\right)\times\boldsymbol{365}\left[\frac{\boldsymbol{day}}{\boldsymbol{yr}}\right]}{\boldsymbol{1,000}\left[\frac{\boldsymbol{W}}{\boldsymbol{kW}}\right]}$$

[24] ENERGY STAR, *Learn About Brightness,* https://www.energystar.gov/products/lighting_fans/light_bulbs/learn_about_brightness (Last accessed December 21, 2018).

The Evaluator analyzed all the models of LED fixtures with a motion sensor sold through the IES program. It was found that 10% of these fixtures housed lamps that replaced halogen lamps, while 90% of them replaced incandescent lamps. The methodology used for determining the equivalent wattage for this product category was the same as for LED fixtures without motion sensor.

The analysis led to the conclusion that the average wattage value for new LED fixtures was 12.5 W and the average equivalent wattage was 51.9 W. Using these values, the average displaced wattage was established at 39.4 W.

As for the HOUs, the operating time tend to differ between fixtures installed indoor and those installed outdoor. Therefore, the Evaluator applied an old operating time of 4.75 hours per day and a new operating time of 2.95 hours per day for outdoor fixtures with motion sensor, following the guidelines provided in the “OPA 2011 Prescriptive Measures and Assumptions” document.[25] For indoor LED fixtures with motion sensor, the values for the old and new operating times are 2.7 hours and 1.24 hours per day respectively.[26] These values are consistent with the NERHOU study previously mentioned in the LED lamps section. Because of the use of a motion sensor, the HOUs are not increased compared with the usage of typical-efficiency bulbs. The Evaluator calculated the average hours-of-operation values for the new and old fixtures by applying the weight based on the proportions of models installed indoor and outdoor, as shown in Table 27 below.

Table 27: LED Fixtures with Motion Sensor HOUs

Location	HOUs of New Fixtures (hrs/day)	HOUs of Old Fixtures (hrs/day)	Percentage	Average HOUs of New Fixtures (hrs/day)	Average HOUs of Old Fixtures (hrs/day)
Indoor	1.24	2.7	90%	1.42	2.91
Outdoor	2.95	4.75	10%		

Using the aforementioned wattage and HOU values, the unitary savings for the LED fixtures equipped with a motion sensor was established at 48.7 kWh, as shown in Table 28 below.

Table 28: LED Fixtures with Motion Sensor Unitary Savings Value

Lighting Product Category	New Wattage (W)	New HOUs	Old Wattage (W)	Old HOUs	Unitary Savings Value (kWh)
Solid-State LED Fixtures with Motion Sensor	12.5	1.42	51.9	2.91	48.7

[25] Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions Version 1*, March 2011.
[26] Ibid.

Smart Thermostats

There is currently only one Instant Savings eligible smart thermostat, Mysa, which is compatible with electrical baseboards. The Mysa thermostat operates by connecting to a single baseboard as opposed to a central heating system.

To calculate the revised unitary savings value for smart thermostats (electrical baseboard), the Evaluator used the following equation:

$$Unitary\ Savings\ (kWh) = \frac{Heating\ Energy \times \%Savings}{Number\ of\ Rooms}$$

Where:

- *Heating Energy* is the average space heating energy consumption of a home in kWh.
- *%Savings* is the percentage of heating load saved by smart thermostats.
- *Number of rooms* is the average number of rooms per dwelling unit.

Since no substantial data is available about PEI residential heating energy consumption, the Evaluator used the average space heating energy consumption of a home established through the evaluation of the Nova Scotia Home Energy Assessment (HEA) program in 2019.[27] The energy consumption per household was estimated at 17,430 kWh based on the average space heating energy consumption for all 2019 HEA participants who primarily use electrical heating and do not have a heat pump. This value includes an overestimation ratio of 19%, which was applied to adjust the modelled HOT2000 energy consumption value.[28]

The Evaluator conducted a literature review to determine the percentage of heating energy consumption saved by smart thermostats for electrical baseboards, but no studies specific to smart thermostats connected to electrical baseboards were identified. Since Mysa smart thermostats have essentially the same features as non-baseboard smart thermostats (e.g. Nest, Ecobee), the Evaluator based the calculation of the unitary savings value on available studies for smart thermostats with adjustments made for characteristics of electrical resistance heating, notably that a unique smart thermostat is installed per baseboard.

[27] Econoler, *2019 DSM Evaluation Reports*, report prepared for EfficiencyOne, https://www.efficiencyone.ca/dsm/, (last accessed June 12, 2020).
[28] This value is based on the average heating electricity consumption of HEA participants both before and after their home retrofit, as per the October 2018 tracking sheet. Only 100% electrically heated households without heat pumps were considered so that the electricity consumption value could be used as the heating load.

As presented in Table 29, the Evaluator found two billing analyses conducted for Nest smart thermostats installed on electrical heating systems (rather than natural gas or oil heating systems). Both analyses assessed the savings for smart thermostats installed to replace both programmable and non-programmable thermostats, which is a reasonable baseline for Instant Savings. In both studies, heating consumption savings were evaluated for central air source heat pumps. Since a central air source heat pump system is the closest heating system to electrical baseboard among Nest compatible systems, the Evaluator applied a *%Savings* value of 12%.

Table 29: 2019 Billing Analysis Savings Results for Smart Thermostats on Electrical Heating Systems

Jurisdiction	Measure	Sample Size	Heating Consumption Savings
Oregon[29]	Nest thermostats	185	12% (for ASHP)
Bonneville Power Administration[30]	Nest thermostats	176	12% (for ASHP)

As previously mentioned, electrical baseboards are individually paired to a unique Mysa smart thermostat. Therefore, the Evaluator divided the savings by the average number of electrical baseboards within a dwelling unit, assuming there is one baseboard per room. Table 30 presents the variables used for the unitary savings calculation.

Table 30: 2019 Unitary Savings Calculation for Smart Thermostats

Parameter	Symbol	Value	Source
Average heating energy consumption of a home [kWh/year]	*Heating Energy*	17,431	Calibrated heating energy consumption of 2019 Nova Scotia HEA participants
Percentage of heating load saved by smart thermostats	*%Savings*	12%	Literature review of billing analyses
Average number of rooms per dwelling	*No. of rooms*	6.5	Census Profile 2016[31]
Unitary Savings [kWh/year]	**-**	**322**	**Calculation**

Using the aforementioned equation and the variable values in Table 30, the Evaluator established a unitary savings value of 322 kWh for smart thermostats (electrical baseboards).

[29] Apex Analytics LLC, *Energy Trust of Oregon Nest Thermostat Heat Pump Control Pilot Evaluation*, October 10, 2014, 123 p.
[30] Bonneville Power Administration, *Nest Learning Thermostat Pilot Program Savings Assessment Bonneville Power Administration & Franklin Public Utility District*, November 16, 2016.
[31] Statistics Canada, Census Profile, 2016 Census, https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/Page.cfm?Lang=E&Geo1=PR&Code1=12&Geo2=&Code2=&Data=Count&SearchType=Begins&SearchPR=01&B1=All (last accessed December 3, 2019)

Dehumidifiers

For dehumidifiers, the unitary savings value was determined by using the following equation:

$$
\begin{aligned}
&\mathit{Unitary\ Savings}\left[\frac{kWh}{year}\right] \\
&\quad = \left(\mathit{Average\ Water\ Removal\ Volume}\left[\frac{L}{day}\right] \times \mathit{Average\ Operating\ Days}\left[\frac{days}{year}\right]\right) \\
&\quad \times \left(\frac{1}{\mathit{Energy\ Factor\ Standard\ Dehumidifier}} \right. \\
&\quad \left. - \frac{1}{\mathit{Energy\ Factor\ ENERGY\ STAR\ Dehumidifier}}\right)\left[\frac{kWh}{L}\right]
\end{aligned}
$$

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 Ontario Power Authority (OPA) Prescriptive Measures and Assumptions report.[32] Since these input values were established based on field activities such as metering, they are considered more appropriate than others based on theoretical studies.

Based on the models purchased through the IES program during the 2019/2020 fiscal year and the list of ENERGY STAR labelled products[33] (which provides the energy factor of these products), a weighted average water removal capacity[34] of 23.8 L/day was established. Since October 2012, Canadian regulations[35] 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 as the standard unit energy factor. The efficient unit energy factor was established at 2.0 L/kWh based on the specifications of the most sold models through the IES program.

Table 31 lists the parameters and corresponding values used to establish the unitary savings values for dehumidifiers installed through the IES program and the resulting unitary savings value.

[32] Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions, Released Version 1*, March 2011.
[33] ENERGY STAR, *Certified Products – Find and Compare Products – Dehumidifiers*, https://www.energystar.gov/productfinder/product/certified-dehumidifiers/ (Last accessed December 20, 2018).
[34] The average water removal capacity refers to the amount of water 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 OPA.
[35] Natural Resources Canada, *Regulations and Standards – Dehumidifiers*, http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6889 (Last accessed December 20, 2018).

Table 31: Unitary Savings Value for ENERGY STAR Dehumidifiers

Parameter	Value	Source
Average Water Removal Volume [L/day]	3.87	OPA 2011[36]
Average Operating Days [days/year]	168	OPA 2011
Energy Factor of Standard Dehumidifier [L/kWh]	2.0	Minimal performance criteria for ENERGY STAR dehumidifiers[37]
Energy Factor of ENERGY STAR Dehumidifier [L/kWh]	1.6	Natural Resources Canada[38]
Unitary Savings [kWh/year]	**81.3**	**Calculation**

Low-Flow Showerheads

The annual unitary savings value for low-flow showerheads is established by the difference between base and efficient domestic hot water consumption, as illustrated in Equations (2) and (3).

$$Water\ Savings\left[\frac{L}{year}\right] =$$

$$(\mathrm{q_{base}} - \mathrm{q_{low}})\left[\frac{L}{min}\right] \times \mathrm{n_{people}}[\mathrm{person}] \times \mathrm{t_{shower}}\left[\frac{\mathrm{min}}{\mathrm{shower}}\right] \times \mathrm{n_{shower}}\left[\frac{\mathrm{shower}}{\mathrm{day{\cdot}person}}\right] \times \frac{1}{\mathrm{n_{showerheads}}} \times 365\left[\frac{days}{year}\right] \quad (2)$$

$$\text{Annual Unitary Savings}\left[\frac{kWh}{year}\right] = \frac{Water\ Savings\left[\frac{L}{year}\right] \times \%_{\mathrm{DHW}} \times Cp_{H_2O}\left[\frac{kJ}{kg^{\circ}C}\right] \times \rho_{H_2O}\left[\frac{kg}{L}\right] \times \Delta T_{H_2O}[^{\circ}C] \times \frac{1}{3{,}600}\left[\frac{kWh}{kJ}\right]}{\eta} \quad (3)$$

Table 32 below lists the parameters and corresponding values used to establish the unitary savings values for low-flow showerheads installed through the IES program and the resulting unitary savings value.

[36] Ontario Power Authority (OPA), *2011 Prescriptive Measures and Assumptions, Released Version 1*, March 2011.
[37] ENERGY STAR, *ENERGY STAR® Program Requirements Product Specification for Dehumidifiers – Eligibility Criteria V4.0*, https://www.energystar.gov/sites/default/files/ENERGY%20STAR_Dehumidifiers_V4%200_Specification_Final_1.pdf (Last accessed June 12, 2020).
[38] Natural Resources Canada, *Regulations and Standards – Dehumidifiers*, http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6889 (Last accessed December 20, 2018).

Table 32: Unitary Savings Value for Low-Flow Showerheads

Parameter	Symbol	Value	Source
Baseline Flow Rate	q_{base}	7.6 L/min (2.0 gpm)	Based on the average flow rates of standard products sold at retailers
Low-Flow Rate [gpm]	q_{low}	6.3 L/min (1.7 gpm)	Average flow-rate of top 10 models rebated under the IES program
Number of People per Household	n_{people}	2.3 persons	PEI 45th Annual Statistical Review 2018[39]
Average Number of Showers per Day per Person	n_{shower}	0.69 shower/day /person	DeOreo & al. 2016[40]
Number of Showerheads per Household	$n_{showerheads}$	1.4 showerheads	Assumption and PEI 45th Annual Statistical Review 2018. See details in Table 33 below
Average Shower Time per Person [min/shower]	t_{shower}	7.8 min/shower	DeOreo & al. 2016
Percentage of Hot Water Used in Showers	$\%_{DHW}$	63%	DeOreo & al. 2016[41]
Specific Heat of Water	Cp_{H2O}	4.18 kJ/kg°C	Convention
Density of Water	ρ_{H2O}	1 kg/L	Convention
Temperature Rise in Electrical Water Heater	ΔT_{H2O}	54 °C (98 °F)	Based on the difference between water mains weighted average yearly temperature for the City of Charlottetown (5°C or 42°F) and 140°F (or 60°C, the standard water temperature in water heaters).
Electrical Water Heater Efficiency	η	98%	Typical electric water heater efficiency used by many TRMs, such as the Pennsylvania TRM[42]
Water Savings	-	**4195 L/year**	**Calculation**
Unitary Savings	**-**	**169 kWh/year**	**Calculation**

[39] Province of Prince Edward Island, Forty-Fifth Annual Statistical Review, 2018, p. 37.
[40] DeOreo & 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.
[41] Obtained based on the total domestic water consumption through showers per household (28.1 gpd) and the hot water use through showers (17.8 gpd) in DeOreo & 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.
[42] State of Pennsylvania. (2016). *Technical Reference Manual*, p. 121.

To establish the number of showerheads per home, the Evaluator used the results of on-site visits conducted in 2017 in Nova Scotia, which revealed that single-family homes had on average 1.5 showerheads.[43] The Evaluator assumed that apartments each have one showerhead and weighted this assumption with the proportion of each type of dwelling in the province based on PEI statistics. As a result, the average number of showerheads per home was established at 1.4.

Table 33: Average Number of Showerheads per Home in PEI

Dwelling Type	Proportion in PEI[44]	Number of Showerheads per Home[45]
Single-Attached or Single-Detached	79%	1.5
Apartments	17%	1
Other	4%	1.25
Weighted Average		**1.4**

Faucet Aerators

Equation (4) is used to calculate the annual unitary savings value for faucet aerators installed through the IES program. The parameters and corresponding values are presented in Table 34 further below.

$$\text{Annual Unitary Savings}\left[\frac{kWh}{year}\right] = \frac{Water\ Savings\left[\frac{L}{year}\right] \times \%_{\text{DHW}} \times Cp_{H_2O}\left[\frac{kJ}{kg\text{º}C}\right] \times \rho_{H_2O}\left[\frac{kg}{L}\right] \times \Delta T_{H_2O}[\text{º}C] \times \frac{1}{3{,}600}\left[\frac{kWh}{kJ}\right]}{\eta} \quad (4)$$

The base domestic water consumption value (DW_{base}) is calculated by multiplying the consumption of domestic water per person (DW_{person}) by the number of people per household (n_{people}) and then dividing the resulting value by the number of faucet aerators per household ($n_{faucets}$), as expressed in Equation (5) below.

$$DW_{base}\left[\frac{L}{day}\right] = \frac{DW_{person}\left[\frac{L}{day \cdot person}\right] \times n_{people}[person]}{n_{aerators}} \quad (5)$$

[43] Econoler. (2018). *Existing Residential Program: 2017 DSM Evaluation. Efficiency Nova Scotia.*
[44] Province of Prince Edward Island, Forty-Fifth Annual Statistical Review, 2018, p. 37.
[45] Assumptions made by the Evaluator.

The efficient domestic water consumption value ($DW_{efficient}$) is calculated by applying the baseline flow rate (q_{base}), the low-flow rate (q_{low}), and the base domestic water consumption value, as expressed in Equation (6) below.

$$DW_{efficient}\left[\frac{L}{day}\right] = DW_{base}\left[\frac{L}{day}\right] \times \left(1 - \frac{q_{base} - q_{low}}{q_{base}}\right) \tag{6}$$

The annual water savings are obtained by determining the difference between the base case and the efficient domestic water consumption values, as expressed in Equation (7) below.

$$Water\ Savings\left[\frac{L}{year}\right] = (DW_{base} - DW_{efficient})\left[\frac{L}{day}\right] \times 365\left[\frac{day}{year}\right] \tag{7}$$

Table 34 below lists the parameters and values applied in Equations (4), (5) and (6) for faucet aerators installed through the IES program and the resulting unitary savings values.

Table 34: Unitary Savings Value for Faucet Aerators

Parameter	Symbol	Value	Source
Baseline Flow Rate	q_{base}	5.3 L/min (1.39 gpm)	DeOreo & al. in *Residential End Uses of Water Study Update*, as cited in Illinois Commerce Commission (2016)[46,47]
Low-Flow Rate]	q_{low}	3.6 L/min (0.94 gpm)	DeOreo & al. in *Residential End Uses of Water Study Update*, as cited in Illinois Commerce Commission (2016)[48]
Number of People per Household	n_{people}	2.3 persons	PEI 45th Annual Statistical Review 2018[49]
DW Used per Person	DW_{person}	37.5 L/day.person (9.9 gpd/person)	DeOreo et al. 2016[50]
Number of Aerators per Household	$n_{aerators}$	3.3	Assumption
Specific Heat of Water	Cp_{H2O}	4.18 kJ/kg°C	Convention
Density of Water	ρ_{H2O}	1 kg/L	Convention
Temperature Rise in Electric Water Heater	ΔT_{H2O}	54 °C (98 °F)	Based on the difference between water mains weighted average yearly temperature for the City of Charlottetown (5°C or 42°F) and 140°F (or 60°C, the standard water temperature in water heaters).
Electric Water Heater Efficiency	η	98%	Typical electric water heater efficiency used by many TRMs, such as the Pennsylvania TRM[51]
Percentage of Hot Water Used by Faucet Aerators	$\%_{DHW}$	59%	DeOreo & al. 2016[52]
Water Savings	**-**	**3,060 L/year**	Calculation
Unitary Savings	**-**	**115 kWh/year**	**Calculation**

[46] DeOreo & al. (2016). *Residential End Uses of Water, Version 2: Executive Report*, published by the Water Research Foundation, http://www.waterrf.org/PublicReportLibrary/4309A.pdf (March 16, 2017), pp. 5-8.
[47] Illinois Commerce Commission (2016). *Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 5.0 – Volume 3: Residential Measures*, p. 175.
[48] *Ibid.*
[49] Province of Prince Edward Island, Forty-Fifth Annual Statistical Review, 2018, p. 37.
[50] 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 & al. (2016). *Residential End Uses of Water, Version 2: Executive Report*, published by the Water Research Foundation, http://www.waterrf.org/PublicReportLibrary/4309A.pdf (March 16, 2017), pp. 5-8.
[51] State of Pennsylvania. (2016). *Technical Reference Manual*, p. 121.
[52] Obtained based on the total domestic water consumption through faucets per household (26.3 gpd) and the hot water use through faucets (15.4 gpd) in DeOreo & 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.

Low-Flush Toilets

Although low-flush toilets do not generate energy savings, this product category generates substantial water savings that can be accounted as non-energy benefits.

The annual water savings value for low-flush toilets is established by determining the difference between base and efficient domestic water consumption values, as expressed in the following equation.

$$Water\ Savings\ \left[\frac{L}{yr}\right] = (q_{base} - q_{low})[Lpf] \times n_{people}[person] \times n_{flush}[\frac{flush}{day \cdot person}] \times \frac{1}{n_{toilets}} \times 365\ [\frac{days}{yr}]$$

Table 35 below lists the parameters and corresponding values used to establish the water savings value for low-flush toilets installed through the IES program and the resulting water savings value.

Table 35: Unitary Savings Value for Low-Flush Toilets

Parameter	Symbol	Value	Source
Baseline Flush Volume [Lpf]	q_{base}	6.0	Based on the toilets with highest flush volumes sold by retailers.
Partial Flush Volume [Lpf]	q_{low}	4.1	Average flow-rate of top 10 models rebated under IES
Number of People per Household [people]	n_{people}	2.3	PEI 45th Annual Statistical Review 2018[53]
Average Number of Partial Flushes per Day per Person [flush/day/person]	n_{flush}	2.5	Assumption based on DeOreo & al.[54]
Number of Toilets per Household [Toilets]	$n_{toilets}$	1.8	Assumption
Water Savings [L/yr]	**-**	**2,215**	**Calculation**

[53] Province of Prince Edward Island, Forty-Fifth Annual Statistical Review, 2018, p. 37.
[54] DeOreo & al. (2016). *Residential End Uses of Water, Version 2: Executive Report*, published by the Water Research Foundation, http://www.waterrf.org/PublicReportLibrary/4309A.pdf (March 16, 2017), p. 9.

APPENDIX III
LIGHTING INTERACTIVE EFFECTS DETAILED CALCULATIONS

The Evaluator developed a methodology to calculate the interactive effects factors of lighting products. The steps of the methodology are presented below.

Literature Review of Interactive Effects Studies

To establish interactive effects values, the Evaluator conducted a literature review of the latest TRMs and evaluation reports.

Since only a small percentage of houses are heated with electricity in Canada and in the Northeastern U.S., it was found that few jurisdictions, other than Hydro-Québec, calculated the impact of interactive effects on electric heating. The State of New York is the only other jurisdiction where interactive effects factors for electrically heated buildings were provided.[55] Although the interactive effects factors are provided for various buildings and heating and cooling types in the New York State TRM, no explanation is provided about how they were calculated. Hence, the Evaluator decided not to use this source.

The evaluation of the interactive effects factors associated with lighting products was therefore based on a study conducted by ADS Groupe-conseil Inc. in 1992 for Hydro-Québec. Although not a recent study, it was found to be the most relevant and applicable to PEI. That study involved modifying certain parameters in simulations for an average home in the Province of Quebec to determine the impacts that these changes had on interactive effects. The simulations were focused on homes heated entirely with electricity and were performed with the DOE-2 software[56] to analyze three interactive effects scenarios: low, moderate and high interactive effects. The Evaluator finally chose the scenario with the lowest level of interactive effects for the calculation of interactive effects in this Instant Rebates evaluation because it reflects the evolution of homes since 1992. The following subsections explain the Evaluator's rationale for choosing to use the findings of the ADS study to assess interactive effects for Instant Rebates.

Verification of Climate Data Validity

To ensure that the ADS study findings were valid and applicable to PEI, the Evaluator first compared PEI's climate characteristics with those of Quebec.

[55] New York State Department of Public Service, *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential, Multi-Family, and Commercial/Industrial Measures*, Version 6, April 16, 2018, pp. 439- 445.
[56] DOE-2 is a widely used and accepted building energy analysis software tool developed with funding from the U.S. Department of Energy.

This analysis was conducted based on the assumption that internal heating gains (from lighting, domestic hot water or appliances) reduce the heating load as long as the outdoor temperature is below the balance temperature of the building (and it is the opposite during the cooling season). This would mean that the most significant variable involved in calculating the interactive effects factors is the duration of the heating and cooling seasons rather than just the total heating degree days (HDD) and cooling degree (CDD) days.

The following figures show the normal HDDs and CDDs[57] per month in Trois-Rivières and Charlottetown respectively. Trois-Rivières was chosen as the reference city in the Province of Quebec for this analysis. Since this city is located about halfway between Montreal and Quebec City (which were the two cities considered in the ADS study), it is representative of the climate data used in the ADS study.

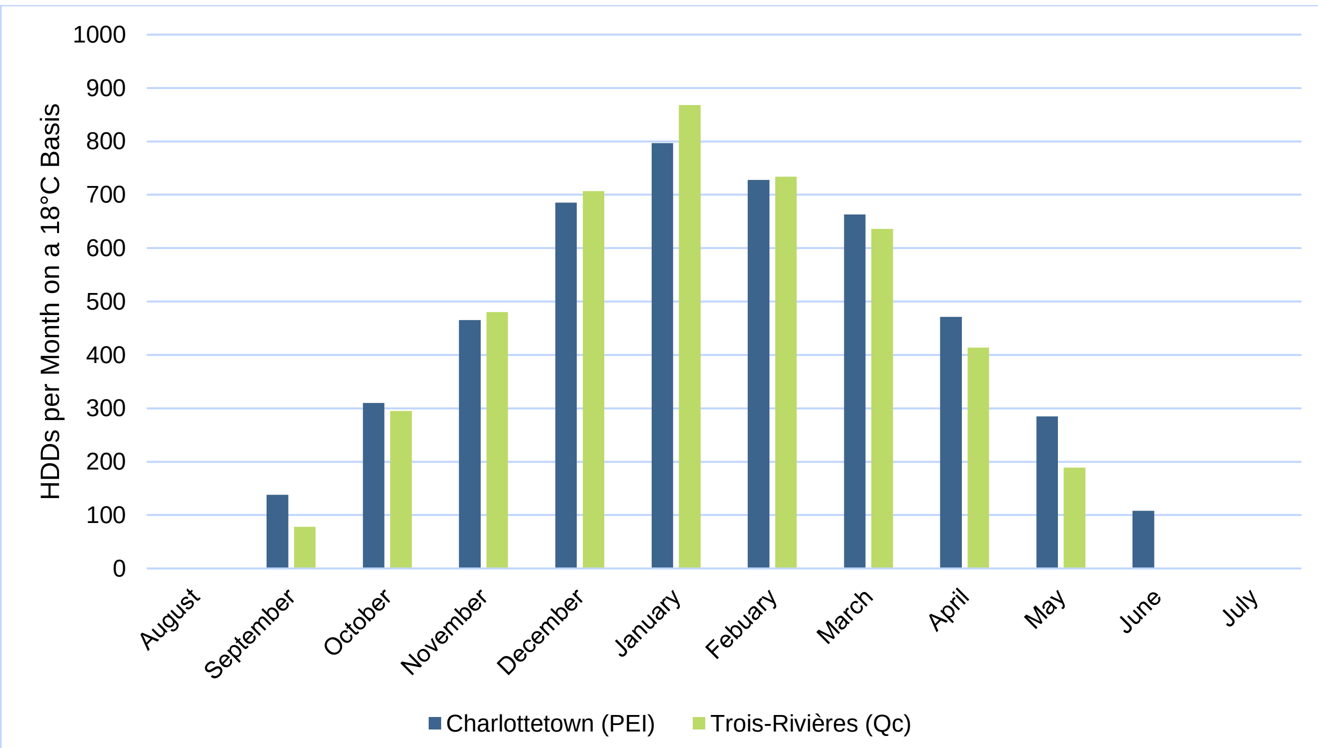

Figure 6: HDDs per Month in Charlottetown and Trois-Rivières

[57] RETScreen Climate Database. RETScreen Expert, 2019.

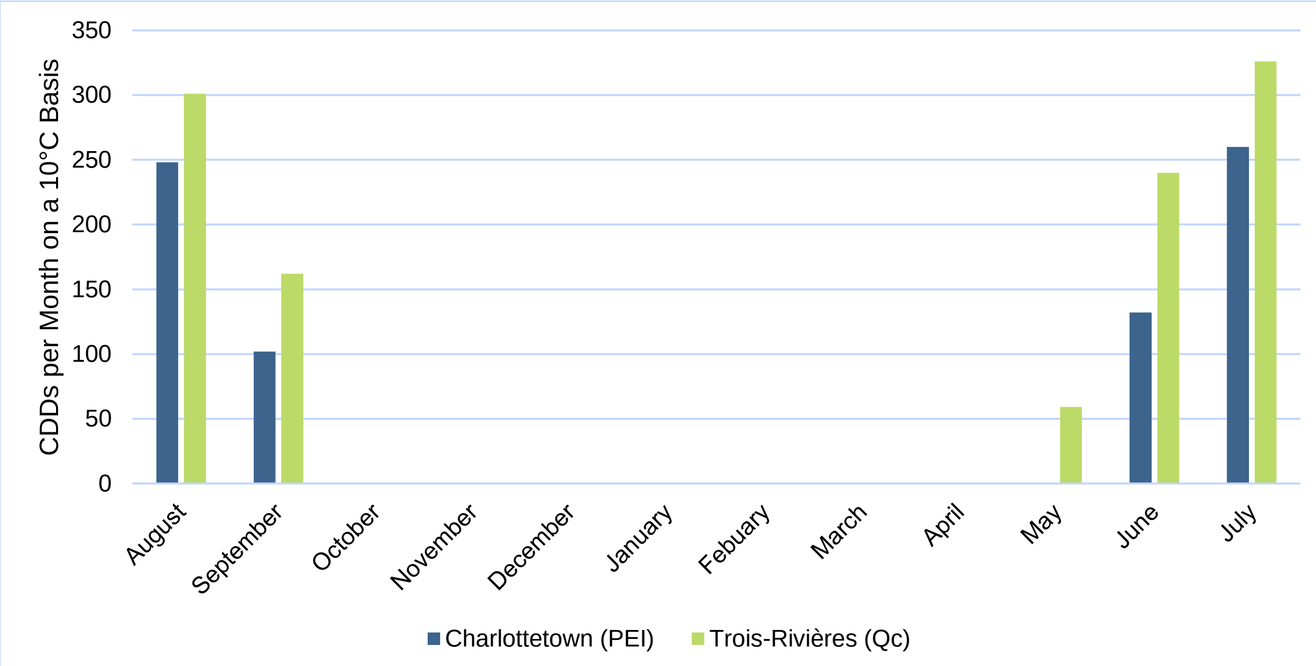

Figure 7: CDDs per Month in Charlottetown and Trois-Rivières

Figure 6 and Figure 7 illustrate that the heating season is slightly shorter in Trois-Rivières than in Charlottetown and that the cooling season in Trois-Rivières is longer and warmer than in Charlottetown. Overall, the number of HDDs of the two cities is somewhat similar, whereas the number of CDDs of the cooling season is much higher in Trois-Rivières. This means that the interactive effects factors based on the ADS study slightly overestimate the positive interactive effects occurring during the cooling season in PEI; however, because of the very small impact of cooling on interactive effects (3.6% according to the ADS study), the overestimation is considered negligible. Therefore, the Evaluator believes that the ADS study findings are still applicable.

Review of Interactive Effects Factor Equations

The ADS study provided the raw data needed to calculate the interactive effects associated with specific measures but did not include all the information required to convert the raw-data values into interactive effects factors. Hence, the equations for calculating the interactive effects factors were drawn from a Hydro-Québec report.[58] The Evaluator revised the equations presented therein to improve the precision of the overall interactive effects factors calculated for the IES program.

[58] ADS ASSOCIÉS, *Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale*, report submitted to Hydro-Québec, 1992.

The Hydro-Québec report states that efficient lighting in electrically heated single-family homes without air-conditioning in the Province of Quebec results in an interactive effects factor of -58%. To determine the impact on an electrically heated home with air-conditioning, the Evaluator adapted the equation used by Hydro-Québec as follows:

$$Interactive\ Effects\ Factor_{heating+cooling} = -58\% + \frac{22\%}{COP} \times \%\ Home\ Area\ Conditioned$$

In the above equation, the 22% value represents the proportion of energy savings that occurs during the cooling period and affects the cooling load. The percentage of the home area air-conditioned was added because it was found through market research that most participating homes had window air-conditioning units that only conditioned a portion of the home. Therefore, many efficient lighting measures installed in non-conditioned areas resulted in nil air-conditioning interactive effects. It was impossible to extract the exact values used for the coefficient of performance (COP) and the percentage of home area conditioned, but the Evaluator found that using a COP of 2.5 and a 40% home area yielded results very close to the value of -54.4% used by Hydro-Québec. The Evaluator finds these values reasonable to be used for PEI in this evaluation. Hence, they were also used to calculate the interactive effects factor for homes that are non-electrically heated but are air-conditioned; as a result, this factor is maintained at the initial level of 3.6%, used by Hydro-Québec.

The Evaluator also established an interactive effects factor for houses electrically heated with a heat pump, which account for 13% of households in PEI.[59] Since the interactive effects calculation in the ADS study is based on a heating system efficiency of 100%, an adjustment was applied by dividing the interactive effects factor for heating (-58.0%) by the COP of a heat pump. This COP was estimated based on a heating seasonal performance factor Region V of 10.4, which is the weighted average value of the heat pumps rebated through the ePEI Energy Efficient Equipment Rebates (EEER) program. As a result, the interactive effects factor for heating was divided by a COP of 3.0 and, when added to the cooling only interactive effects factor of 3.6%, yields an overall interactive effects factor of -15.7% for houses electrically heated with a heat pump.

During the peak demand period, which occurs during the heating period, it is assumed that 100% of the heat emitted by incandescent lamps is now generated by the heating system. However, based on the ADS study, it is assumed that 10% of the heat is released through exterior walls and ceilings and does not contribute to interactive effects. As a result, the peak demand interactive effects factor in electrical heated houses is estimated at -90.0%. For houses electrically heated with a heat pump, the Evaluator used a COP of 2.0, based on the weighted average COP at -15°C for the heat pumps rebated through the EEER program. Therefore, the peak demand interactive effects factor for heat pumps was divided by 2.0, yielding an overall factor of -45% for houses electrically heated with a heat pump.

[59] MQO Research, PEI Home Energy Survey: Results Summary, October 2018.

It should be noted that, for houses electrically heated with a heat pump, the Evaluator assumed that the heat pumps installed would have the same characteristics as those installed through the EEER program, which tend to indicate that most heat pumps in PEI are recently installed cold-climate heat pumps.

Calculation of Interactive Effects Factors for Energy Savings

Table 36 below lists the interactive effects factors from the ADS study for each heating and cooling situation. The respective percentages of PEI homes using electricity for heating and using air-conditioning as documented by PEI and Statistics Canada were used to establish the average interactive effects factor for the program.

Table 36: Interactive Effects Calculation for Energy Savings

Parameter	% of Homes[60][61]	Interactive Effects Factors[62]	Peak Demand Interactive Effects Factor
Heat pump heating, with air-conditioning	13% × 100% = 13.0%	-15.7%	-45.0%
Electric heating, with air-conditioning	19% × 25% = 4.8%	-54.4%	-90.0%
Electric heating, without air-conditioning	19% × 75% = 14.3%	-58.0%	-90.0%
No electric heating, with air-conditioning	68% × 25% = 17%	3.6%	0.0%
With neither electric heating nor air-conditioning	68% × 75% = 51%	0.0%	0.0%
Weighted Interactive Effects Factor	**100%**	**-12.3%**	**-23.0%**

These interactive effects occur only when products are installed inside a house. Since LED lamps installed through the program can also be used for outdoor lighting, the interactive effects factors for these products were adjusted to take this into account. For LED lamps, the percentages of those installed indoor and outdoor were derived from the 2019 EfficiencyOne DSM Evaluation Report, based on a socket study conducted in Nova Scotia. As for LED fixtures, the percentages of those installed indoor and outdoor were determined based on the specifications of the top 10 models sold through IES during the 2019 campaigns.

[60] The proportions of homes that are electrically heated were drawn from MQO Research, PEI Home Energy Survey: Results Summary, October 2018.
[61] The proportions of homes that are air-conditioned were drawn from Natural Resources Canada, Table 27 Cooling System Stock by Type, New Unit Efficiencies, Stock Efficiencies and Unit Capacity Ratio in the Residential Sector in Prince Edward Island, August 2018.
[62] ADS ASSOCIÉS, *Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale*, report submitted to Hydro-Québec, 1992.

Table 37: Proportions of Lighting Products Installed Indoor and Outdoor and Adjusted Interactive Effects

Product Category	% Indoor	% Outdoor	Energy Interactive Effects Factor Calculation	Peak Demand Interactive Effects Factor Calculation
LED A-type Lamps	92%	8%	-11.3%	-21.1%
LED Non-A-type Lamps (R, BR and Decorative)	92%	8%	-11.3%	-21.1%
LED Non-A-type Lamps (excluding R, BR and Decorative)	92%	8%	-11.3%	-21.1%
Solid-State LED Recessed Downlight Fixtures	100%	0%	-12.3%	-23.0%
LED Fixtures without Motion Sensor[63]	100%	0%	-12.3%	-23.0%
Solid-State LED Fixtures with Motion Sensor	90%	10%	-11.0%	-20.6%
Dimmer Switches	100%	0%	-12.3%	-23.0%
Indoor Motion Sensors	100%	0%	-12.3%	-23.0%
Indoor Occupancy Sensors with Dimmer	100%	0%	-12.3%	-23.0%

[63] According to the database review.

APPENDIX IV
LAMP AND FIXTURE EUL DETAILED CALCULATIONS

This appendix presents the details on how the equivalent EUL values were calculated for lighting products that cover at least 80% of total program savings for 2019/2020. An equivalent EUL corresponds to number of years by which the first year savings need to be multiplied to obtain the lifetime savings.

The Evaluator first calculated the equipment life for each type of lamps, as presented in Table 38 below. The equipment life was calculated as the ratio between the manufacturer rated lifetime hours for the most popular models of lamps installed under the program and the annual HOU values used to calculate unitary savings values.

Table 38: EUL Value of Each LED Lighting Product Category

LED Lighting Product Category	Average Rated Lifetime Hours (Hours)[64]	Annual HOU (Hours/Year)[65]	Equipment Useful Life (Years)
LED A-type Lamps	15,000	1,059	14
LED Non-A-type Lamps (R, BR and Decorative)	20,141	1,059	19
LED Non-A-type Lamps (Excluding R, BR and Decorative)	24,450	1,059	23
Solid-State LED Recessed Downlight Fixtures	39,946	1,059	38
LED Fixtures without Motion Sensor	45,714	1,059	43
Solid-State LED Fixtures with Motion Sensor	49,630	1,059	47

The LED lamps market is evolving rapidly and driven by government regulations. LED lamps installed today are likely to become the baseline before the end of their rated life since LED technologies are developing quickly and prices are falling. Some jurisdictions have already applied a reduced equivalent EUL to their residential lighting savings by adopting a higher baseline to represent savings in future years. In other words, their baseline increases over the lifetime of the product, which in turns reduces the equivalent EUL that is applied to first-year savings to obtain lifetime energy savings. That is the case for Illinois where savings for LED lamps are considered nil after 10 years, and baselines are adjusted throughout the product lifetime to match changes in regulations. For instance, a 60 W incandescent baseline is raised to a 43 W halogen incandescent after the end of the incandescent lamp remaining useful life and will be raised again to the planned minimum efficiency CFL level required by the Energy Independence and Security Act (EISA) 2020 effective in 2021.[66]

[64] Based on the manufacturer specification sheets for the most popular models installed under Instant Energy Savings.
[65] Based on the unitary savings review.
[66] Illinois Energy Efficiency Stakeholder Advisory Group, *Illinois Statewide Technical Reference Manual for Energy Efficiency Version 8.0, Volume 3*, October 2019, p. 258.

Massachusetts also uses a similar methodology and has set the equivalent EUL value at eight to nine years for LED lamps, which takes into account baseline increases that will occur because of EISA 2020.[67] While the US government has recently decided to eliminate the EISA 2020 backstop on inefficient lighting products,[68] Illinois and Massachusetts have not since made changes to their equivalent EUL methodology. One reason mentioned by the US government not to enforce the backstop is that the market is already changing toward LED products, which suggests the current methodology used by these jurisdictions will remain valid.

However, the Evaluator considered that limiting the EUL to 10 years, as done by Illinois, was too conservative and used the equipment life of LED A-type lamps as the EUL, thereby avoiding capping since it is uncertain when LED lamps will become the baseline technology on the Canadian market. Like the approach used in Illinois and Massachusetts, the Evaluator applied a triple baseline for LED A-type lamps over their 14-year EUL to establish their equivalent EUL that accounts for the following factors:

› **First baseline:** The replaced incandescent light lamps have an estimated remaining useful life of one year. Incandescent light lamps have a typical rated life expectancy of 1,000 to 2,000 hours.[69] The remaining useful life of replaced functional incandescent light lamps is assumed to be half the rated life expectancy. By applying a remaining useful life of 1,000 hours and 2.9 HOUs per day, the period over which savings are calculated when an incandescent baseline has been established at one year.

› **Second baseline:** The current Canadian regulation bans imports on 60 W, 75 W and 100 W light lamps, imposes a minimum efficiency to be achieved by efficient incandescent light lamps (also called halogen incandescent light lamps)[70] and reflects U.S. federal legislation (as outlined in the three tables further below). After the first year over which incandescents remain the baseline, the baseline is increased to halogen incandescent lamps.

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[67] Massachusetts Electric and Gas Energy Efficiency Program Administrators, *Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures, 2016-2018 Program Years – Plan Version*, October 2015, p. 151.
[68] Apex Analytics, *DOE Issues Final Rule Designed to Eliminate EISA Backstop: Analysis of the Rule and Implications for Energy Efficiency Programs*, 2019.
[69] 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 19, 2018).
[70] 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 19, 2018).

› **Third baseline:** The EISA 2020 was expected to impose an efficiency level of 45 lumens per watt in 2020,[71] as outlined in the three tables further below. As mentioned previously, the US government has recently decided to eliminate the EISA 2020 backstop on inefficient lighting products.[72] However, one reason mentioned by the US government for not enforcing the backstop is that the market is already changing toward LED products. Considering that Canada's residential lighting market is also evolving rapidly and closely follows trends in the U.S. market, the Evaluator considers it advisable to establish the baseline wattage based on the planned U.S regulation. Furthermore, Natural Resources Canada intends to update the general service bulb minimum energy performance requirement in Amendment 17, which is planned for preconsultation in 2019[73] (and should therefore be applied within a few years thereafter). Since a Canadian regulation matching the requirements of the EISA 2020 specification would effectively ban the import and fabrication of efficient incandescent light lamps, it is expected that these incandescent light lamps would still be available in retail outlets before stocks are depleted for up to two years after the legislation is implemented.

It should be noted that using the minimum efficiency levels of EISA 2020 starting in 2024 might be optimistic. Since LED lamps rapidly gain popularity while CFL market share declines, it is possible that the baseline for lamps covered by the legislation will be LED lamps by 2024.[74] In that case, savings would occur over a maximum of five years. However, since it is difficult to determine this with certainty, the Evaluator preferred using the efficiency levels set in the proposed American legislation until the end of the EUL of A-type lamps.

The Evaluator established lifetime energy savings values for early replacement and replace on burn-out scenarios, as well as for the different types of lamps replaced. The displaced wattage values used to obtain the lifetime energy savings of each scenario are summarized in Table 39 and Table 40 below.

[71] US EPA, *"Summary of the Energy Independence and Security Act. Public Law 110-140 (2007)",* www.epa.gov/laws-regulations/summary-energy-independence-and-security-act (Last accessed January 19, 2018).
[72] Apex Analytics, *DOE Issues Final Rule Designed to Eliminate EISA Backstop: Analysis of the Rule and Implications for Energy Efficiency Programs*, 2019.
[73] Natural Resources Canada, *"Forward Regulatory Plan 2019-21,"* https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-regulations/forward-regulatory-plan-2019-2021/18318 (Last accessed April 1, 2020).
[74] Barclay, D., von Trapp, K. and Miziolek C.,
Party Like It's 2020: EISA Phase 2 – An Examination of DOE Rulemaking and Implications for Programs, poster presented at the 2017 International Energy Program Evaluation Conference, Baltimore, MD, 2017.

Table 39: Equivalent EUL Calculation Summary for LED A-Type Lamps Replaced Early

Type of Lamp Replaced	Incandescent Baseline		Halogen Incandescent Baseline – Canadian Legislation[75,76]		CFL Equivalent Baseline – American Legislation[77]		Lifetime Energy Savings (kWh)	% of Lamps Replaced	Average Lifetime Energy Savings (kWh)
	1 Year (2019)		4 Years (2020-2023)		9 Years (2024-2032)				
	Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	Baseline Wattage [78]	Displaced Wattage			
Standard Incandescent	58.7	49.9	42.1	33.3	17.3	8.5	275	55%	167
Efficient Incandescent	42.1	33.3	42.1	33.3	17.3	8.5	257	0%	
CFL	12.7	3.9	12.7	3.9	12.7	3.9	58	30%	
LED	8.8	0	8.8	0.0	8.8	0.0	0.0	16%	

For replaced lamps that are already CFLs or LED lamps, the changing energy efficiency regulation has no impact on the baseline that remains the same throughout the entire EUL of the measure.

[75] 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 20, 2018).
[76] Also equivalent to Incandescent Equivalent 1st Tier EISA 2007.
[77] As proposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.
[78] Baseline wattage values were established based on the minimum efficiency level of 45 lumen/watts dictated by the EISA regulation and on the assumed level of 778 lumens established from a weighted average of the 10 most popular models.

Table 40: Equivalent EUL Calculation Summary for LED A-Type Lamps Replaced on Burn-Out

Halogen Incandescent Baseline – Canadian Legislation		CFL Equivalent Baseline – American Legislation		Lifetime Energy Savings (kWh)
5 Years (2019-2023)		9 Years (2024-2032)		
Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
42.1	33.3	17.3	8.5	257

The lifetime energy savings values in Table 39 and Table 40 were weighted by the proportion of each scenario (57% early replacement and 43% replaced on burn-out) to obtain an average lifetime energy savings value for A-type lamps (205 kWh), which was then divided by the average first year energy savings for LED A-type lamps (32.3 kWh/yr) to obtain an equivalent EUL for LED A-type lamps of 6.4 years.

A similar analysis was conducted for LED non-A-type lamps that mostly include 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 would have been affected by the requirements of EISA 2020. Starting in 2024, the baseline wattage is therefore increased to match the minimum efficiency level of 45 lumens/watt. As outlined in Table 41 and Table 42 below, an equivalent EUL of 6.6 years was established for R, BR and decorative lamps, while an equivalent EUL of 6.7 years was established for the other LED non-A-types.

Table 41: Equivalent EUL Calculation Summary for LED Non-A-Types (R, BR and Decorative Lamps)

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline – Canadian Legislation 5 Years (2019-2023)		CFL Equivalent Baseline – American Legislation[79] 14 Years (2024-2037)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage[80]	Displaced Wattage		
56.6	7.3	56.6	49.3	13.1	5.8	347.1	6.6

[79] As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.
[80] Baseline wattage values were established based on the minimum efficiency level of 45 lumen/watts dictated by the EISA regulation and on the assumed level of 600 lumens established from a weighted average of the 10 most popular models.

Table 42: Equivalent EUL Calculation Summary for LED Non-A-Types (Except R, BR and Decorative Lamps)

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline – Canadian Legislation 5 Years (2019-2023)		CFL Equivalent Baseline – American Legislation[81] 18 Years (2024-2041)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage[82]	Displaced Wattage		
52.2	7.0	52.2	45.1	11.4	4.4	322.4	6.7

For LED fixtures, the Evaluator considered that their equivalent EUL could be analyzed the same way as 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 generate savings throughout their entire equipment life considering factors such as early replacement.

Using the rated life of products sold under the LED Recessed Downlight Fixtures category, the equipment useful life was established at 38 years. However, the EUL was capped at 25 years and the equivalent EUL for LED recessed downlight fixtures was set at 7.0 years, as shown in Table 43.

Table 43: Equivalent EUL Calculation Summary for LED Recessed Downlight Fixtures

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline – Canadian Legislation 5 Years (2019-2023)		CFL Equivalent Baseline – American Legislation[83] 20 Years (2024-2043)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage		
61.6	11.2	61.6	50.4	16.1	4.9	370.5	7.0

For LED fixtures without motion sensor, the baseline for 65% of the 10 most popular models is mostly one, two or three general-service halogen incandescent lamps, with four models replacing linear fluorescent lamps. Therefore, the same methodology as applied for A-type lamps was used, as shown in Table 44 below. The equivalent EUL for LED fixtures without motion sensor was thus established at 12.8 years.

[81] As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.
[82] Baseline wattage values were established based on the minimum efficiency level of 45 lumen/watts dictated by the EISA regulation and on the assumed level of 506 lumens established from a weighted average of the 10 most popular models.
[83] As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.

Table 44: Equivalent EUL Calculation Summary for LED Fixtures Without Motion Sensor

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline – Canadian Legislation 5 Years (2019-2023)		CFL Equivalent Baseline – American Legislation[84] 20 Years (2024-2043)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Displaced Wattage	Baseline Wattage[85]	Displaced Wattage		
64.8	19.8	64.8	44.9	37.3	17.5	608	12.8

For LED fixtures with motion sensor, the Evaluator calculated the lifetime energy savings by calculating the annual unitary savings for each baseline. The baseline for LED fixtures with motion sensor is incandescent lamps for most of the units sold (90%). Therefore, the Evaluator applied the same methodology as for A-type lamps, but used the annual unitary savings instead of the displaced wattage to consider the specific HOUs due to the motion sensor, as shown in Table 45 below.

Table 45: Lifetime Energy Savings for LED Fixtures with Motion Sensor – Reduced Wattage

Average Replaced Lamp (W)	Average Wattage of Efficient Lamp (W)	Halogen Incandescent Baseline – Canadian Legislation 5 Years (2019-2023)		CFL Equivalent Baseline – American Legislation[86] 20 Years (2024-2043)		Lifetime Energy Savings (kWh)	Equivalent EUL (years)
		Baseline Wattage	Annual Unitary Savings	Baseline Wattage[87]	Annual Unitary Savings		
51.9	12.5	51.9	48.7	21.9	16.8	580	11.9

By dividing the total lifetime energy savings value of 580 kWh by the first-year savings value of 48.7 kWh, the equivalent EUL was established at 11.9 years.

[84] As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.
[85] The baseline wattage values were established based on the minimum efficiency level of 45 lumen/watts set by the EISA regulation and the assumed level of 2,487 lumens established from a weighted average of the 10 most popular models.
[86] As imposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.
[87] The baseline wattage values were established based on the minimum efficiency level of 45 lumen/W, as set by the EISA.

APPENDIX V
FREE-RIDERSHIP ALGORITHM

The figures below present the algorithm for calculating the free-ridership level of LED lamps. The participant survey questionnaire included questions designed to assess the planning, quantity, efficiency, period, cost, and influence of the program. 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.

Section 1 – Free-ridership level for customers who were unaware of discount before paying	
D1. Before paying at the cash register, were you aware that a rebate was offered on the purchase of L-E-Ds?	IF Yes : GO TO Section 2 IF No OR REF: GO TO D2
D2. [ASK IF D1=2, DK, REF)] I just want to make sure I understand - You did not know about the rebate on packages of L-E-Ds before paying at the register?	IF Yes: : GO TO Section 2 IF No OR REF: D2 = 100%
Free-Ridership Level for those who were unaware of discount before paying	**D2 OTHERWISE: GO TO Section 2**
Section 2 – Free-ridership level for customers who postponed their purchase because of the program	
D3. Before the beginning of the rebate campaign, which began on September 27th, were you aware that rebates on L-E-Ds would be offered this fall?	IF Yes : GO TO D4 IF No OR REF: GO TO Section 3
D4. [ASK IF D3=1] Did you postpone your purchase of LEDs to take advantage of the rebate?	IF Yes: GO TO D11 IF No OR REF: GO TO Section 3
D11. If the rebate had NOT been offered, when would you have purchased the L-E-Ds that you purchased today? Would it have been…? 1. [ASK IF D4=1] Earlier 2. Definitely today 3. Probably today 4. Probably at a later date 5. Definitely at a later date 96. (Would not have purchased them at all) 99. (Don't know / Refused)	IF 1: D11 = 100% OTHERWISE: GO TO Section 3
D12. Without the rebate, 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: D12 = 100% IF 2: D12 = 50% IF 3: D12 = 25% IF 4. : D12 = 0% IF 99. : D12 = 0%
Free-Ridership Level for those who postponed their purchase because of the program	**MEAN VALUE OF (D11;D12) OTHERWISE GO TO Section 3**

Section 3 – Free-ridership level for regular participants (aware of discount, did not postpone purchase)	
D10. 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)	D10 = Answer x 10% IF 98 OR 99. D10 = EMPTY
D8. If the rebate 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: D8 = 100% IF 2: D8 = Use D9 IF 3: D8 = 0% IF 99: D8 = EMPTY
D9. [ASK IF D8=2] Which type of bulb would you have purchased instead today? 1. Incandescent 2. Halogen 3. CFLs 96. Other 99. (Don't know / Refused)	IF 1 OR 2: D9 = 0% IF 3: D9 = 50% IF 96: D9 = EMPTY IF 99: D9 = EMPTY
Preliminary Score:	**MEAN VALUE OF (D10 ; D8 OR D9)**
D11. If the rebate had NOT been offered, when would you have purchased the L-E-Ds that you purchased today? Would it have been…? 2. Definitely today 3. Probably today 4. Probably at a later date 5. Definitely at a later date 96. (Would not have purchased them at all) – SKIP FR5 99. (Don't know / Refused)	IF 2: D11 = 100% IF 3: D11 = 50% IF 4: D11 = 25% IF 5. : D11 = 0% IF 96. : D11 = 0% IF 99. : D11 = 0%
D12. 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: D12 = 100% IF 2: D12 = 50% IF 3: D12 = 25% IF 4. : D12 = 0% IF 99. : D12 = 0%
Inconsistency Test #1	IF D10 ≥ 70% AND D8 OR D9 = 0%: Preliminary Score = EMPTY
Inconsistency Test #2	IF Preliminary Score ≤ 30% AND D12 ≥ 50% D12 = EMPTY
Free-Ridership Level (after inconsistency tests) for regular participants	**MEAN VALUE OF: (Prelim Score ; D11 ; D12)**
Influence Check D7. You mentioned that you were aware, before paying at the cash register, that a rebate was offered on the purchase of L-E-Ds. Did knowing this play a part in your decision to buy L-E-Ds today?	IF D7 = Yes AND MEAN (Prelim Score;D11;D12) ≥ 50% Revised FR = MEAN (Prelim Score;D11;D12) / 2
Free-Ridership Level (after influence check) for regular participants	**Revised FR**

ECONOLER

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2018/2019 AND 2019/2020 NEW HOME CONSTRUCTION PROGRAM EVALUATION

EFFICIENCYPEI

Final Report

June 26, 2020

ECONOLER

ACRONYMS

DSM	Demand-side management
EA	Energy Advisor
EE&C	Electricity Efficiency and Conservation
ePEI	efficiencyPEI
ERS	EnerGuide Rating System
EUL	Effective useful life
HIR	Home Insulation Rebates (program)
IPC	Incremental product cost
NBC	National Building Code
NHC	New Home Construction (program)
NPV	Net Present Value
NTGR	Net-to-gross ratio
PAC	Program Administrator Cost (test)
PEI	Prince Edward Island
SO	Service Organization
TRC	Total Resource Cost (test)

DEFINITIONS

Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
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.
Evaluated savings	Gross and net savings calculated by the Evaluator using parameters (installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process.
Free-ridership	Percentage of 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 energy efficiency program, regardless of why they participated.
Interactive effects	Interactive effects occur when the installation of an energy efficiency measure has an impact on the energy consumption of other elements in the building such as heating and cooling.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for 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.
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 between the net energy savings and gross energy savings that includes effects, such as free ridership and spillover, that positively or negatively affect the energy savings generated by a program.
Peak demand-to-energy ratio	The ratio between peak demand savings and energy savings.
Peak demand savings	The demand savings that coincide in time with the peak demand of the electricity system.
Program Administrator Cost test	This test compares program administrator costs to utility resource savings.

Sample size	The number of observations or replicates included in a statistical sample.
Spillover	Savings attributable to participants who continue to implement the energy efficiency measures introduced by a program after participating in it once, without participating in the program a second time.
Total Resource Cost test	This test compares program administrator and participant costs to utility resource savings and in some cases, other resource savings and program benefits accrued by participants, such as non-energy benefits.
Tracked savings	Gross and net savings calculated by the utility in its internal tracking, based on various parameters such as number of participants, installation rates, interactive effects, and 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).

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EXECUTIVE SUMMARY

This report presents the evaluation results of the efficiencyPEI (ePEI) New Home Construction (NHC) program. The program encourages homeowners and builders to implement energy efficient features in their new builds by providing customized energy efficiency recommendations through a review of house plans and financial incentives. House plans are evaluated by energy advisors (EAs) who work for Service Organizations (SOs) responsible for delivering the program in the province. The HOT2000 software is used to model the energy efficiency of the home based on recommendations made by EAs. Program energy efficiency requirements consist of a certification (ENERGY STAR® Canada or R2000) or an improvement beyond the 2015 National Building Code (NBC) minimum requirements. The program includes two incentive tiers: (1) $2,000 for participants who achieve an energy use level 20% better than required by the 2015 NBC; and (2) $5,000 for participants who achieve an energy use level 50% better than required by the 2015 NBC.

Summary of Evaluation Assignment

ePEI hired Econoler (hereinafter the Evaluator) to evaluate the program and achieve the following key objectives:

- Establish the gross electricity energy and peak demand savings generated by the program;
- Establish the net electricity energy and peak demand savings generated by the program;
- Assess whether the program is cost-effective;
- Assess the effectiveness of program processes and implementation.

The evaluation addresses the program savings and cost-effectiveness results associated with equipment that displace electricity usage only.

The evaluation was carried out based on a review of the program database and documentation, a participant survey, literature review, engineering calculations and cost-effectiveness analyses based on the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests.

The evaluation covers the 2019/2020 fiscal year. Based on the parameters established through the evaluation, this report also presents results for the 2018/2019 fiscal year.

Summary of Evaluation Results

This subsection presents the key findings of the evaluation.

Participation Level

A total of 103 NHC program projects were completed during the 2019/2020 fiscal year, 95 of which were completed by participants who use electricity as their main heating source. In 2018/2019, 40 projects were completed, with 36 being in electrically-heated homes.

Satisfaction with the Program

Participant satisfaction with the program is high, with most aspects receiving high average satisfaction scores. The aspect of the program that received the lowest average satisfaction rating is the rebate amount. Participants recommended that rebates be increased and that the incentive structure be reviewed to include more tiers.

Survey results also indicated that reviewing program recommendations and choosing energy efficiency features are the two aspects of the program that participants found most challenging during the participation process. Those who struggled with reviewing the recommendations and choosing energy efficiency features mentioned that the information provided to them after the home plan review was not well laid out to them and that they would have needed more consultation and discussion with the EA to better understand. Another recommendation from participants was to plan for more time and consultation with EAs at the time of the review of home plans to discuss and understand the recommendations. Participants also highlighted issues with finding a builder, mentioning a lack of builders in the province to meet construction demand.

Program Data Tracking

The program database contained most of the basic participant data. The Evaluator identified a few key participant and project data types that should be tracked, such as the project status and dates, as well as the applicant type (builder or homeowner). The Evaluator also found that information used to calculate and compile energy and demand savings was not always tracked or tracked incompletely, including the primary and secondary heating system types and other simulation data. The Evaluator also identified opportunities to improve the clarity of the database column header names.

Gross Savings

Since NHC program savings are mainly generated by reduced heating needs and increased heating system efficiency, the Evaluator only attributed electricity savings to participating homes for which the primary heating fuel type was tracked as electric in the database. During the review of gross electricity energy savings, the Evaluator determined the following:

- Recent evaluations of similar programs in other Canadian provinces have indicated that the HOT2000 software is known to overestimate the consumption of simulated buildings. Based on the results of a billing analysis conducted in Nova Scotia and the heating system types of a sample of NHC program participants in 2019/2020, the Evaluator established overestimation ratios of 5.6% and 9.0% to be applied to as-built and to-code modelled EnerGuide Rating System (ERS) simulation scores respectively.
- Since the selected overestimation ratios impact only building heating consumption rather than the whole building consumption, the Evaluator established the as-built heating consumption of each participant by subtracting a baseload consumption from the as-built ERS scores provided in the program database.

Net Savings

A net-to-gross ratio (NTGR) is used to determine net savings based on program gross savings. The Evaluator established the NTGR for the program using free-ridership; spillover was considered to be nil. Based on the participant survey, the Evaluator determined free-ridership to be 38%, resulting in a NTGR of 0.62.

Cost-Effectiveness

The Evaluator assessed the cost-effectiveness of the Electricity Efficiency and Conservation portion of the program by performing specific cost-effectiveness tests, namely the TRC and PAC tests. When performing these tests, ratios greater than 1 are desired because they indicate that program benefits outweigh costs.

The evaluation revealed that the program was very cost-effective in both 2018/2019 and 2019/2020, with PAC and TRC results all higher than 3.0.

Summary of Savings and Cost-Effectiveness Results

Table 1 summarizes the key results of the program savings and cost-effectiveness evaluations for 2019/2020 and 2018/2019, as well as participation levels and program targets.

Table 1: Summary of Program Savings and Cost-Effectiveness Targets and Evaluated Results

Parameters	2018/2019 Targets	2018/2019 Evaluation Results	2019/2020 Targets	2019/2020 Evaluation Results
Program Participation				
Number of Participants	20	36	20	95
Gross Electricity Savings at the Generator				
Gross Electricity Energy Savings (GWh)	-	0.401	-	1.277
Gross Lifetime Electricity Savings (GWh)	-	12.035	-	38.305
Gross Peak Demand Savings (MW)	-	0.119	-	0.378
Net Electricity Savings at the Generator				
NTGR	-	0.62	-	0.62
Net Electricity Energy Savings (GWh)	0.1	0.249	0.2	0.792
Net Lifetime Electricity Savings (GWh)	-	7.462	-	23.749
Net Peak Demand Savings (MW)	0.0	0.074	0.0	0.234
Cost-Effectiveness				
PAC Test	3.1	4.51	3.2	7.56
TRC Test	1.2	3.27	1.2	4.00

- In 2018/2019 and 2019/2020, the evaluated net electrical energy savings considerably exceeded program targets by 149% and 296% respectively. The evaluated peak demand savings also exceeded program targets since they were nil for the NHC program. This was mainly due to participation levels being better than expected, notably in 2019/2020 with over four times more participants than anticipated.
- The PAC and TRC tests revealed that the program was very cost-effective from both perspectives and for both fiscal years. The evaluated effective useful life and incremental product cost values likely explain why the evaluated TRC and PAC results are higher than targets.

Recommendations

In light of these findings, the Evaluator issues the following recommendations.

Recommendation 1: Use the evaluation parameters established through this evaluation for program savings tracking going forward.

Recommendation 2: Update program tracking to implement the following:

- Continue tracking current items and try collecting data on currently untracked or incomplete items. The latter items include the project status, applicant type, primary and secondary heating system types, overestimation ratios, modelled to-code ERS scores, as well as gross and net electrical energy and peak demand savings.
- Identify the projects that generate electrical savings to calculate program gross and net electrical savings.
- Collect and track builder contact information (names, emails, phone numbers). This would enable the Evaluator to conduct interviews with builders to not only assess their experience with the program, but also collect information to enhance the NTGR assessment, i.e. free-ridership and spillover levels, and further improve the savings calculation and evaluation methodologies going forward.
- Clearly and consistently name program database columns to avoid interpretation as well as facilitate overall understanding of the information tracked and data collection sampling.

Recommendation 3: Consider having SOs and EAs spend more time with participants to ensure they have all the information they need to go forward with their project and make the best energy efficiency decisions.

Recommendation 4: Consider updating the program incentive structure. The Evaluator recommends exploring the following: (1) increasing the first tier to encourage more energy efficient projects while also (2) providing more tiers to ensure that participants who do not anticipate being able to meet the existing second tier (50%) have an alternate option, 30% or 40% for example.

INTRODUCTION

Under the Government of Prince Edward Island (PEI), efficiencyPEI (ePEI) is responsible for administering Electricity Efficiency and Conservation (EE&C) programs in the province. The programs are meant to help Islanders not only improve the energy efficiency and conservation of energy in their homes and workplaces by installing high-efficiency equipment and products, but also change behaviours. Econoler was commissioned by ePEI to evaluate its EE&C program portfolio comprised of five residential programs and three commercial programs.

One of the five residential programs is the New Home Construction (NHC) program, which provides builders and homeowners with recommendations and rebates to encourage them to build new homes that exceed the energy efficiency levels of the building code.

The evaluation of the NHC program is focused on assessing program processes, implementation and cost-effectiveness, as well as providing evaluated gross and net energy and peak demand savings. The evaluation covers the 2019/2020 fiscal year. Based on the parameters established through the evaluation, this report also presents results for the 2018/2019 fiscal year. This report presents the program EE&C results, namely the savings and cost-effectiveness results associated with equipment that displace electrical usage only. Evaluation activities were carried out considering both electrically heated and non-electrically heated participants to assess program processes and implementation, but certain sections of the report reference only subsets of the total participants included in the evaluation, depending on the topic assessed.

To complete this evaluation, Econoler worked with Vision Research, a PEI-based market research firm, on a participant survey. Throughout this report, the team of Econoler and Vision Research is referred to as the Evaluator.

1 PROGRAM OVERVIEW

The ePEI NHC program is meant to encourage homeowners and builders to exceed energy efficiency building code requirements in new homes.

Homeowners and builders who wish to participate in the program must start by scheduling a review of home plans with one of the two program Service Organizations (SOs) hired by ePEI to deliver the program. House plans are reviewed before the house is built to provide customized energy efficiency recommendations and inform participants on the expected energy efficiency levels of their homes if they incorporate these recommendations into their builds. House plans are evaluated by energy advisors (EAs) who work for the SOs. The HOT2000 software is used to model the energy efficiency of the home based on recommendations made by EAs. Program energy efficiency requirements consist of a certification (ENERGY STAR® Canada or R2000) or an improvement beyond the 2015 National Building Code (NBC) minimum requirements.

Participants have 12 months from the date of the review of home plans to complete their build and schedule a follow-up home energy assessment; extensions are available for participants who request them. A blower door test is completed by an EA to verify energy efficiency performance and determine a final energy efficiency level for the home. Participants are charged a $99 + tax fee for the review of home plans and follow-up home energy assessment, while ePEI subsidizes more than 80% of the cost.

The following incentives are available to NHC program participants:

- An incentive of $2,000 is provided for homes that achieve: (1) ENERGY STAR certification; or (2) an energy use level 20% better than required by the 2015 NBC;
- An incentive of $5,000 is provided for homes that achieve: (1) R2000 certification; or (2) an energy use level 50% better than required by the 2015 NBC.

While the program has mainly included homeowner applicants, it aims to have more builders register homes.

2 EVALUATION APPROACH

The main objectives of the NHC program evaluation are as follows:

- Establish the gross electricity energy and peak demand savings generated by the program;
- Establish the net electricity energy and peak demand savings generated by the program;
- Assess whether the program is cost-effective;
- Assess the effectiveness of program processes and implementation.

The Evaluator identified key research questions aimed at achieving the aforementioned objectives. The following table outlines the evaluation objectives and maps them to the research questions and methods. Each method is described further below.

Table 2: Evaluation Approach

<table>
<tr><th>Evaluation Objective</th><th>Research Question</th><th>Method</th></tr>
<tr><td rowspan="5">Gross energy and peak demand savings</td><td>What overestimation ratios should be applied to program gross savings?</td><td rowspan="5">Program savings analysis</td></tr>
<tr><td>What formula should be used to calculate gross savings?</td></tr>
<tr><td>What is the average peak demand-to-energy ratio for the program?</td></tr>
<tr><td>What are the appropriate upgrade effective useful life (EUL) values?</td></tr>
<tr><td>What are the evaluated annual and lifetime gross energy savings and peak demand savings?</td></tr>
<tr><td rowspan="2">Net energy and peak demand savings</td><td>What is the free-ridership level for the program?</td><td rowspan="2">Participant survey</td></tr>
<tr><td>What are the evaluated annual and lifetime net energy savings and peak demand savings?</td></tr>
<tr><td rowspan="2">Program cost-effectiveness</td><td>In addition to the other cost-effectiveness calculation parameters already collected (e.g. EUL values, net savings), what is the average incremental cost of program projects?</td><td rowspan="2">Cost-effectiveness analysis</td></tr>
<tr><td>Is the program cost-effective from the perspective of the program administrator and participants?</td></tr>
<tr><td rowspan="8">Program processes and implementation</td><td>Is program tracking effective, complete, consistent and clear?</td><td>Program database review</td></tr>
<tr><td>How did participants hear about the program?</td><td rowspan="7">Participant survey</td></tr>
<tr><td>How involved are participants in the decision to participate in the program, versus builders?</td></tr>
<tr><td>Why did participants want to participate in the program?</td></tr>
<tr><td>What is the level of participant satisfaction with the program?</td></tr>
<tr><td>What issues or challenges, if at all, did participants encounter during their participation?</td></tr>
<tr><td>What prevented participants from implementing certain features into their builds?</td></tr>
<tr><td>What recommendations do participants have to improve the program?</td></tr>
</table>

The Evaluator first conducted an in-depth interview with program staff to learn about program processes, discuss program performance and identify evaluation objectives. Then, specific evaluation methods were undertaken as described in the following subsections.

Program Savings and Cost-Effectiveness Analyses

The Evaluator analyzed the program database, conducted a literature review and performed engineering calculations to provide evaluated savings calculation values and parameters, including the parameters used in calculating project incremental costs, gross and net energy and peak demand savings, as well as the EUL values used for the lifetime energy savings calculations. As part of the literature review, the Evaluator consulted technical reference manuals and public evaluation reports of jurisdictions similar to ePEI, with a focus on the most recent and accurate sources.

The Evaluator also performed two cost-effectiveness tests, namely the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests.

Participant Survey

In February 2020, the Evaluator conducted a telephone survey with 20 program participants. The average length of the survey was 18 minutes. A sample of 20 participants yields a margin of error of 17.1% at a 90% confidence level. The survey questionnaire is provided in Appendix I.

Program Database Review

The Evaluator reviewed the program database to: (1) assess tracking practices and processes and whether they meet program needs; (2) identify any gaps in tracked data to better inform program savings calculations, management and evaluation; and (3) assess the consistency and organization of tracked data.

3 PROGRAM SAVINGS AND COST-EFFECTIVENESS

This section presents the evaluation results related to program gross and net electrical energy and peak demand savings, as well as cost-effectiveness for the fiscal year 2019/2020. The parameters used to obtain these results were also used to calculate program savings and cost-effectiveness results for the 2018/2019 fiscal year. The section opens with an overview of program participation in 2018/2019 and 2019/2020.

3.1 Program Participation

As presented in Figure 1 below, 103 projects were completed under the NHC program during the 2019/2020 fiscal year, which represent an increase of 61% compared to the 40 projects completed in the 2018/2019 fiscal year. Of the total projects completed in 2019/2020 and 2018/2019, 95 and 36 respectively were completed by participants who used electricity as their main heating source, which represent more than 90% of the projects.

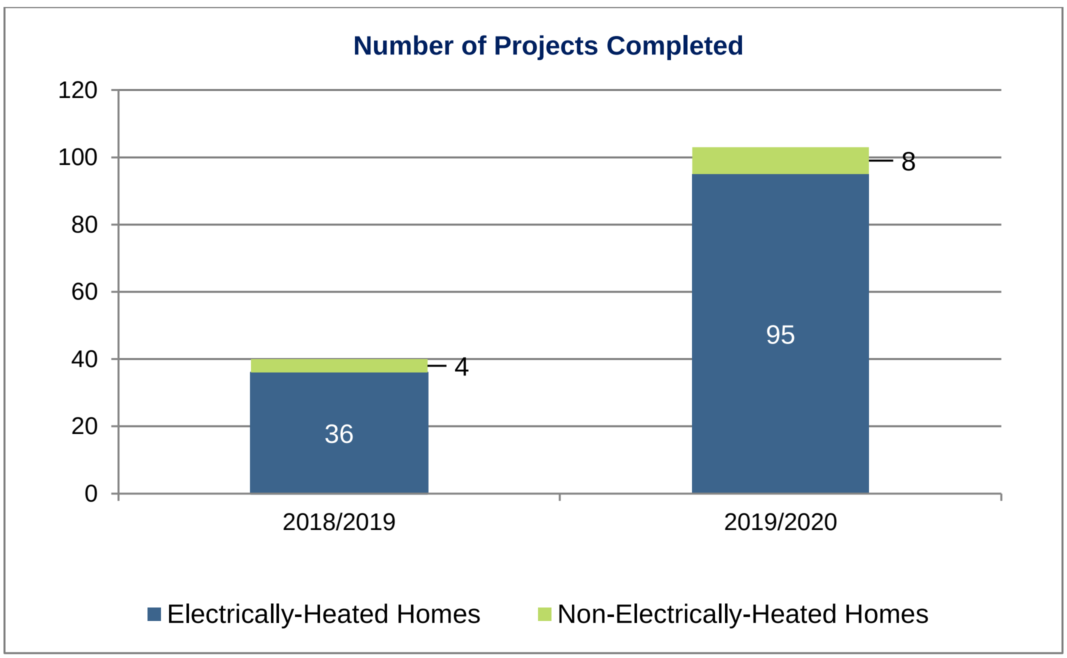

Figure 1: Summary of NHC Program Participation

The following figure illustrates in which better-than-code improvement level fell the 2018/2019 and 2019/2020 participants. As can be seen, 78% of the NHC program projects resulted in an improved home performance of at least 30%, which is 10% more than the first program tier, and 36% of projects resulted in an improved home performance of at least 50% (the second program tier).

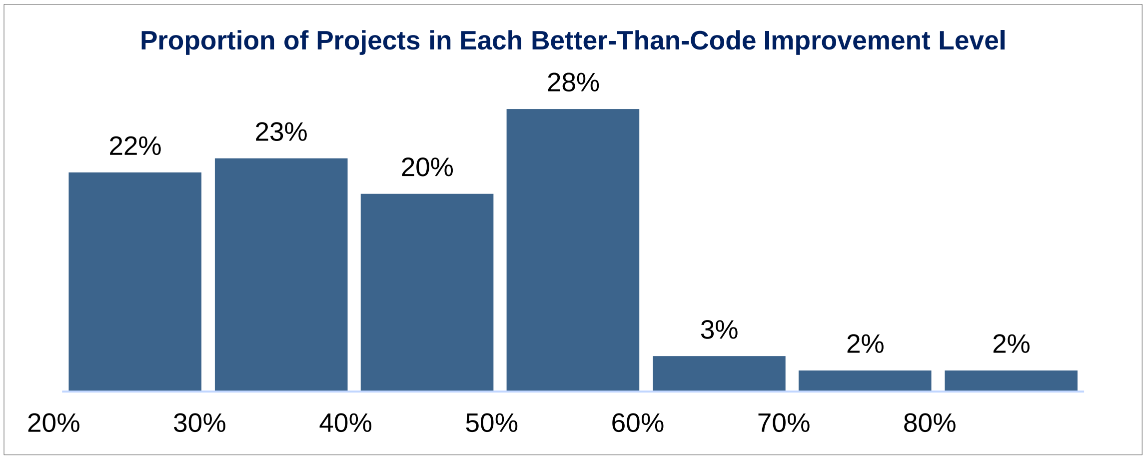

Figure 2: Summary of NHC Improvement Levels Reached by Participants

3.2 Gross Savings

Gross savings correspond to the change in energy consumption that results from actions taken by participants regardless of their reasons for participating in a program. For the NHC program, gross energy savings are determined on a project basis by comparing the modelled energy consumption of a home with an equivalent home meeting minimum building code requirements. Lifetime gross energy savings are then obtained by multiplying the annual gross energy savings by the average EUL value associated with a given NHC project.

3.2.1 Percentage of Projects Claimed for EE&C

NHC program savings are mostly generated from reduced heating needs and increased heating system efficiency. Therefore, the Evaluator only attributed electricity savings, which correspond to the savings claimed for EE&C, to participating homes for which the primary heating system was tracked as electric in the database.

3.2.2 Energy Savings Calculation

For the NHC program, ePEI tracks each participant's as-built modelled EnerGuide Rating System (ERS) score resulting from a HOT2000 simulation conducted after construction. An ERS score corresponds to building energy consumption in GJ and is used to estimate energy savings. ePEI also tracks how the ERS score compares to the 2015 NBC using a percentage of energy use reduction compared to code. Based on recent evaluations of similar programs in other Canadian provinces, the HOT2000 software is known to overestimate the consumption of simulated buildings. Depending on which equipment is included in the HOT2000 simulation and the mix of cooling and heating systems of each region, different overestimation ratios have been calculated as part of those recent evaluations. Similarly, the Evaluator decided to apply an overestimation ratio to the modelled ERS scores to establish the savings of NHC projects.

The overestimation ratios were established based on a literature review. The Evaluator first identified two jurisdictions that have similar programs designed around the use of HOT2000, namely Nova Scotia (through EfficiencyOne) and New Brunswick (through NB Power). Both jurisdictions established overestimation ratios by comparing simulation results to actual building consumption data of participants. The Evaluator chose to use the EfficiencyOne overestimation ratios to be consistent with the ePEI Home Insulation Rebates (HIR) program evaluation for which an overestimation ratio assessment was also conducted. While the EfficiencyOne overestimation ratios are applicable to space heating consumption only, their application is justified by the fact that the majority of the savings achieved through the NHC program is generated by measures affecting space heating consumption.

The most recent overestimation ratios used by EfficiencyOne were based on heating system type, more precisely whether the building had a heat pump or not. By comparing the simulations to actual consumption data, overestimation ratios of 19% for buildings without a heat pump and 0% for buildings with a heat pump were found. Additionally, an overestimation ratio of 9% for buildings built to-code was determined, and it was assumed that to-code buildings include neither a heat pump nor a secondary heating system such as a wood or pellet stove.

Table 3: Overestimation Ratio Values

Scenario	Overestimation Ratio
To-code Model – **With Neither** Heat Pump Nor Wood/Pellet Stove	9%
As-built Model – **With** Heat Pump	0%
As-built Model – **Without** Heat Pump	19%

Since the NHC program database did not include details on heating systems, the Evaluator analyzed the simulation outputs of a sample of 34 projects to adapt the EfficiencyOne ratios to the ePEI NHC program and concluded that 71% of the projects had a heat pump. Thus, an overestimation of 5.6% was applied to all as-built ERS scores, which corresponds to a weighted average of the two as-built overestimation ratios applied by EfficiencyOne, and an overestimation ratio of 9% applied to all to-code ERS scores.

Since the selected overestimation ratios impact only building heating consumption rather than the whole building consumption, the Evaluator established the as-built heating consumption of each participant by subtracting a baseload consumption from the as-built ERS scores provided in the program database. The baseline consumption is a fixed value of 7,118 kWh in HOT2000 version 11 which was the version used by all participants in the simulation output sample. For the to-code heating consumption, the Evaluator first calculated the to-code ERS value by using the as-built ERS value and the percentage of how the building is better than the code, and then subtracted the same baseline consumption. The equation below summarizes how the evaluated energy savings were obtained.

$$\text{Gross Energy Savings} = \left(\frac{\text{ERS}_{\text{As-built}}}{\text{\% Better Than Code}} - BC\right) \times (1 - \text{OR}_{\text{To-code}}) - (\text{ERS}_{\text{As-built}} - BC) \times (1 - \text{OR}_{\text{As-built}})$$

Where:

- *ERS* corresponds to the building energy consumption in GJ obtained for all energy sources from HOT2000 simulation models.
- *BC* is the baseload consumption of 7,118 kWh.
- *OR* refers to the overestimation ratios used to adjust the ERS values.
- *% Better Than Code* is the parameter tracked in the database, which serves to establish the to-code modelled energy consumption.

3.2.3 Peak Demand Savings

Electricity peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The peak demand period in PEI occurs between 5 p.m. and 7 p.m. from mid-December through early March inclusively, on any day when maximum temperature is -10° C or lower.

For the NHC program, the Evaluator relied on the peak demand-to-energy ratios established for Nova Scotia, as presented in the EfficiencyOne 2019 DSM evaluation reports.[1] Although the Nova Scotia peak demand period occurs during weekdays only, the Evaluator considered that Nova Scotia and PEI peak demand periods are sufficiently similar to use the Nova Scotia peak demand-to-energy ratios.

Thus, peak demand savings were calculated using a peak demand-to-energy ratio of 0.283 MW/GWh.

3.2.4 Interactive Effects

Interactive effects occur in a home when the implementation of energy efficiency equipment has an impact on the energy consumption of other systems, most commonly heating and cooling systems. In the case of the NHC program, the simulation models encompass the total energy consumption of the house; therefore, interactive effects are already considered in the savings calculations.

3.2.5 Effective Useful Life

EUL values are used to determine the energy savings occurring throughout the lifetime of installed measures. For the NHC program, the EUL depends on the measures installed in each specific project. Since the program database did not include details about installed measures, the Evaluator used an average EUL. Other jurisdictions, such as Nova Scotia, also use an average EUL usually between 20 and 30 years.

[1] Econoler, 2019 DSM Evaluation Reports, report prepared for EfficiencyOne, March 2020.

The Evaluator relied on the EUL value of 30 years used in the EfficiencyOne 2019 New Home Construction program evaluation report.[2] This value was calculated by considering the EUL values of the different measures known to be frequently installed in program projects along with their estimated weights on total savings. The Evaluator considers that the new home construction market in PEI is similar to that of Nova Scotia and believes that the 30-year average EUL value is appropriate for the ePEI NHC program.

3.2.6 Summary of Gross Savings

The annual gross electricity energy savings for the NHC program during the 2018/2019 and 2019/2020 fiscal years are presented in Table 4. Savings at the generator were obtained by applying line loss factors of 1.120 for energy and 1.171 for peak demand, as provided by Maritime Electric, the electricity utility.

Table 4: Gross Energy and Peak Demand Savings for 2018/2019 and 2019/2020

	2018/2019	2019/2020
Number of Projects	40	103
Number of Projects Claimed for EE&C	36	95
Energy Savings		
Gross Energy Savings – at the Meter (GWh)	**0.358**	**1.140**
Line Loss Factor	1.120	1.120
Gross Energy Savings – at the Generator (GWh)	**0.401**	**1.277**
Effective Useful Life (years)	30.0	30.0
Gross Lifetime Energy Savings – at the Generator (GWh)	**12.035**	**38.305**
Peak Demand Savings		
Peak Demand-to-Energy Ratio (MW/GWh)	0.283	0.283
Gross Peak Demand Savings – at the Meter (MW)	**0.101**	**0.323**
Line Loss Factor	1.171	1.171
Gross Peak Demand Savings – at the Generator (MW)	**0.119**	**0.378**

3.3 Net Savings

Net savings are defined as the energy use reductions specifically attributable to the NHC program. Effects that positively or negatively affect the energy savings generated by a program, namely free-ridership and spillover, are generally considered. They are then combined into a net-to-gross ratio (NTGR) that is applied to gross energy savings.

[2] Econoler, 2019 DSM Evaluation Reports, report prepared for EfficiencyOne, March 2020.

For the NHC program, the Evaluator assessed the free-ridership level using the participant survey. As for participant spillover, this effect was not measured and considered to be nil since it is unlikely that measures not included in a recently built home would be implemented shortly after construction. While non-participant spillover in the form of market effects is often assessed in this type of program through builder interviews, the program has focused on and included mostly homeowner applicants, therefore limiting the ability to conduct such data collection.

3.3.1 Free-Ridership

Free-ridership occurs when participants would have still implemented the energy efficiency measures in the absence of the program. The 20 surveyed participants were asked questions about all applicable variables of the decision-making process, including planning, efficiency and cost. Another set of questions was used to assess the influence of various program factors on participant decisions to implement energy efficiency measures, including program financial incentives, expert information or advice from program EAs, recommendations received through the review of home plans, as well as promotion by ePEI or previous participation in an ePEI program.

The feedback collected from the participant survey was converted into a free-ridership level using the algorithm presented in Appendix II. The resulting overall free-ridership level is a weighted average based on the revised energy savings for each participant.

As outlined in Table 5, the Evaluator calculated a free-ridership level of 38% for the program.

Table 5: Average Free-Ridership Level

Average Free-Ridership Level	Sample Size	Population Size	Margin of Error
38%	20	143[3]	7.2%

Although 60% of respondents mentioned that their home design already included all the energy efficiency features identified through the NHC program before participating, the program and previous experience with ePEI had a great influence on participant decisions. Indeed, respondents provided an average score of 7.5 out of 10, where 1 means “No influence” and 10 means “Great Influence”, when asked to rate the importance of program aspects (incentive, information by EA, etc.) in their decision to build or buy a house with a high level of energy efficiency.

[3] Due to the low number of program participants, the Evaluator sampled participants from both 2018/2019 and 2019/2020 for the survey to meet the target sample size of 20. Therefore, the free-ridership calculation was conducted using the total populations of 2018/2019 and 2019/2020 participants, not just the 2019/2020 participant population.

3.3.2 Net-to-Gross Ratio Calculations

The NTGR is calculated using the following equation:

$$NTGR = (1 - \%\ Free\text{-}Ridership)$$

By using the free-ridership level presented above, a NTGR ratio of 0.62 was established for the NHC program.

3.3.3 Summary of Net Savings

Net savings are determined by applying the NTGR to evaluated gross savings using the following equation:

$$Net\ Savings = Evaluated\ Gross\ Savings \times NTGR$$

The detailed net electricity energy savings results for 2018/2019 and 2019/2020 are summarized in Table 6 below.

Table 6: Net Energy and Peak Demand Savings for 2018/2019 and 2019/2020

	2018/19	2019/20
Energy Savings		
Gross Energy Savings – at the Meter (GWh)	0.358	1.140
NTGR	0.62	0.62
Net Energy Savings – at the Meter (GWh)	**0.222**	**0.707**
Line Loss Factor	1.120	1.120
Net Energy Savings – at the Generator (GWh)	**0.249**	**0.792**
Effective Useful Life (years)	30.0	30.0
Net Lifetime Energy Savings – at the Generator (GWh)	**7.462**	**23.749**
Peak Demand Savings		
Gross Peak Demand Savings – at the Meter (MW)	0.101	0.323
NTGR	0.62	0.62
Net Peak Demand Savings – at the Meter (MW)	**0.063**	**0.200**
Line Loss Factor	1.171	1.171
Net Peak Demand Savings – at the Generator (MW)	**0.074**	**0.234**

3.4 Cost-Effectiveness

The Evaluator assessed program cost-effectiveness by performing specific cost-effectiveness tests, namely the TRC and the PAC tests. When performing these tests, ratios greater than 1 are desired because they indicate that program benefits outweigh costs. This subsection presents the calculations performed to assess the cost-effectiveness of the EE&C portion of the program.

Various values and parameters were necessary to conduct these tests:

- The gross and net electrical savings as well as the EUL were drawn from the results presented in Subsections 3.2 and 3.3 of this report. To quantify the economic value of those savings (i.e. the program benefits), the Evaluator used the unitary avoided costs of electrical energy savings and peak demand savings provided by the electricity utility, Maritime Electric. Total program costs, broken down into administrative and incentive costs, were provided by ePEI. The Evaluator estimated the proportion of those costs allocated to EE&C based on the ratio of electrical and non-electrical savings[4] generated by the program in 2019/2020. The incremental product cost (IPC) associated with projects generating electrical savings were estimated by the Evaluator and are described in further detail in Subsection 3.4.1 below.
- The Net Present Value (NPV) calculation of all cash flows (costs and benefits) considered in the cost-effectiveness tests were performed using the ePEI discount rate (3.2%) and inflation rate (2%).

3.4.1 Incremental Product Costs

IPCs are defined as the difference between the costs of energy efficient products offered by a program and the costs of base case products that would have been installed in the absence of the program over the life cycle of a product or upgrade.

For the NHC program, the base case is a house meeting minimum code requirements. Therefore, the IPCs are the difference between the efficient houses built through the program and their equivalent to-code houses.

Since the NHC program database includes no project costs, the Evaluator relied on a literature review to establish IPCs for NHC projects. First, the Evaluator relied on values from Statistics Canada about buildings permits to establish the average cost of a new house in PEI.[5] Using the house values included in permits issued for all residential single-dwelling buildings over the 2019/2020 period and the corresponding number of permits, the average cost of a new house was established at $228,900.

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[4] Although the quantification of non-electrical energy savings was outside of the scope of the evaluation, the Evaluator used the number of projects generating non-electrical savings in the database as well as their energy savings to produce a high-level estimate of the non-electrical savings for the NHC program and compared that value to electrical energy savings to obtain a percentage of savings attributed to EE&C activities.

[5] Statistics Canada. *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 May 5, 2020).

Then, the Evaluator applied percentages of incremental costs based on a report prepared for NRCan, which mentions that home performance improvements of 25% and 50% represent cost increases of about 3% and 6% respectively.[6] Although NHC included projects with improvements below 25%, the Evaluator believes that using an average IPC value of 3% for projects with less than 50% improvement and a value of 6% for projects with 50% or more represent reasonable estimations.

Table 7 summarizes the IPC values used for the NHC program evaluation.

Table 7: IPC Values

Average Cost of a New House in PEI	Improvement Level	Percentage of IPC	IPC per Project
$228,900	Less than 50%	3%	**$6,900**
	50% or more	6%	**$13,700**

These IPC values were then multiplied by the number of projects claimed for EE&C to obtain overall IPC values of $282,400 and $954,700 for the EE&C portion of the 2018/2019 and 2019/2020 program years respectively.

3.4.2 Cost-Effectiveness Tests

This subsection presents the equations used for the PAC and TRC tests. For each test, benefits are at the numerator and costs at the denominator, and they both need to be NPVs.

PAC Test

The PAC test measures the net economic benefit of a program from the program administrator perspective using the equation presented below:

$$PAC = \frac{NPV\ (Avoided\ Costs)}{NPV\ (Total\ Gross\ Program\ Admnistrator\ Costs)}$$

- **Avoided costs** are the avoided supply costs achieved by the net electrical energy and peak demand savings generated by the program. The avoided unitary costs, in $/kWh and $/kW saved, were multiplied by the electrical energy and peak demand savings.
- **Total gross program administrator costs** are the program costs incurred by the program administrator. Program administrator costs include costs related to program planning, design, marketing, implementation and evaluation, as well as incentives. Incentives represent the amounts that the program administrator offers to participating customers for the upgrades they implement. The program costs were provided by ePEI and only the proportion attributable to EE&C savings was considered since the PAC test is performed for the EE&C portion of the program.

[6] Bfreehomes. *Path to Net-Zero Energy Homes: Cost Optimization Study of Progressively Improving Energy Efficiency of Homes in Canada*, retrieved from http://bfreehomes.com/wp/wp-content/uploads/2014/02/Path_NZE_Report.pdf.

TRC Test

The TRC test reveals the total net benefits of a program from the perspective of both the utility and participants. It is not necessary to know who realizes the benefits and bears the costs.

The TRC test is calculated based on the following formula:

$$TRC = \frac{NPV\ (Avoided\ Costs + Customer\ Benefits)}{NPV\ (Net\ Tech.\ Costs + Gross\ Program\ Administrator\ Non{-}Incentive\ Costs)}$$

- The **avoided costs** are the same as those of the PAC test.
- **Customer benefits** are participants' non-energy benefits such as water savings and improved comfort or safety. For the NHC program, no customer benefits were included.
- **Net technical costs** correspond to the IPCs discussed in Subsection 3.4.1.
- The **gross program administration non-incentive costs** are the same costs as in the PAC test, except that they exclude incentives. Incentives are excluded because they are financial transfers between ePEI and participants, thus not representing an expense.

3.4.3 Cost-Effectiveness Results

Table 8 and Table 9 present the cost-effectiveness results for the 2019/2020 and 2018/2019 periods respectively. The NHC program was cost-effective in both years from the program administrator perspective. The TRC test, which accounts for all benefits and costs, also indicates that the program was cost-effective.

Table 8: 2019/2020 Cost-Effectiveness Results

Cost-Effectiveness Test	Ratio	Benefits	Costs
PAC Test	**7.56**	$2,893,466	$382,549
TRC Test	**4.00**	$2,893,466	$723,303

Table 9: 2018/2019 Cost-Effectiveness Results

Cost-Effectiveness Test	Ratio	Benefits	Costs
PAC Test	**4.51**	$909,121	$201,367
TRC Test	**3.27**	$909,121	$278,175

3.5 Summary of Program Savings and Cost-Effectiveness Results

Table 10 summarizes the key results from the program savings and cost-effectiveness evaluations and compares these results to program targets.

Table 10: Summary of Program Savings and Cost-Effectiveness Targets and Evaluated Results

Parameters	2018/2019 Targets	2018/2019 Evaluation Results	2019/2020 Targets	2019/2020 Evaluation Results
Program Participation				
Number of Participants	20	36	20	95
Gross Electricity Savings at the Generator				
Gross Electricity Energy Savings (GWh)	-	0.401	-	1.277
Gross Lifetime Electricity Savings (GWh)	-	12.035	-	38.305
Gross Peak Demand Savings (MW)	-	0.119	-	0.378
Net Electricity Savings at the Generator				
NTGR	-	0.62	-	0.62
Net Electricity Energy Savings (GWh)	0.1	0.249	0.2	0.792
Net Lifetime Electricity Savings (GWh)	-	7.462	-	23.749
Net Peak Demand Savings (MW)	0.0	0.074	0.0	0.234
Cost-Effectiveness				
PAC Test	3.1	4.51	3.2	7.56
TRC Test	1.2	3.27	1.2	4.00

- In 2018/2019 and 2019/2020, the evaluated net electrical energy savings considerably exceeded program targets by 149% and 296% respectively. The evaluated peak demand savings also exceeded program targets since they were nil for the NHC program. This was mainly due to participation levels being better than expected, notably in 2019/2020 with over four times more participants than anticipated.
- The PAC and TRC tests revealed that the program was very cost-effective from both perspectives and for both fiscal years. The evaluated EUL and IPC values likely explain why the evaluated TRC and PAC results are higher than targets.

4 PROGRAM PROCESSES AND IMPLEMENTATION

This section includes the evaluation results related to program processes and implementation. Specifically, it presents the Evaluator's findings related to program data tracking and participant feedback about their experience with the program.

4.1 Program Data Completeness

Figure 3 presents the important data types for the NHC program and their status in the NHC program database.

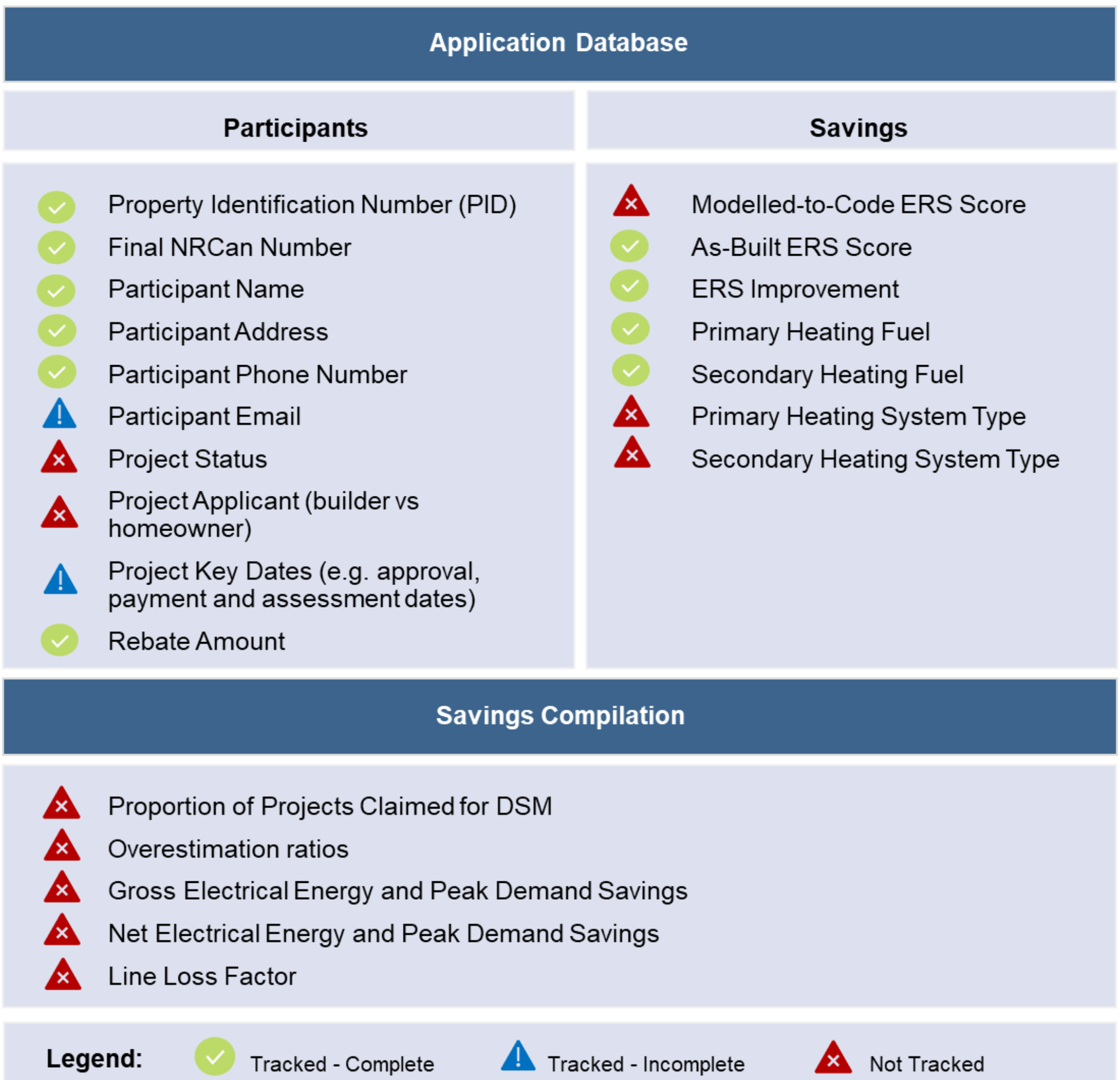

Figure 3: Summary of NHC Program Data Tracking

The program database includes the basic participant data types such as names, addresses and phone numbers, with the exception of some incomplete fields related to emails. In a context where both builders and homeowners may apply for the program, it is important to systematically track who the applicant is to facilitate project follow-up, if needed, and evaluation data collection such as surveys. Tracking a clear status for each project, along with key project dates, including the dates of the review of home plans and follow-up assessments, also facilitates these same elements.

The key items missing from the program database pertain to how savings are calculated and then compiled. Overestimation ratios are used to adjust the modelled energy consumption values generated by HOT2000 since the software tends to overestimate those values. Since the heating systems in place and the presence of mini-split heat pumps are the factors that tend to affect the overestimation ratios the most, tracking the primary and secondary heating fuels and types is noted as key for the NHC program. The 2019/2020 database includes primary and secondary heating fuels but not heating system types.

Additionally, the 2019/2020 database included the as-built ERS scores in GJ, along with the ERS improvement over code, but did not include the modelled-to-code ERS scores. For the evaluation, the Evaluator was able to deduce the modelled-to-code ERS scores but recommends that this information be tracked for both clarity and the correct application of overestimation ratios.

The program database should include gross and net electrical energy and peak demand savings values for each project so that tracked savings are available to program staff and the Evaluator. Also, it should be clearly indicated whether the savings values are at the meter or at the generator. If they are at the generator, the line loss factor should be included in the database.

Recommendation: Continue tracking current items and try collecting data on currently untracked or incomplete items.

Recommendation: Identify the projects that generate electrical savings to calculate program gross and net electrical savings.

Recommendation: To further improve the savings calculation and evaluation methodologies going forward, the Evaluator also suggests collecting and tracking builder contact information (names, emails, phone numbers). This would enable the Evaluator to conduct interviews with builders to not only assess their experience with the program, but also collect information to enhance the NTGR assessment, i.e. free-ridership and spillover levels.

4.2 Program Data Organization

The Evaluator identified the following opportunity to improve the organization of the NHC program database:

› Some of the column header names are unclear. For example, energy savings information is labelled "GJ Rating", but it is unclear if this rating is the modelled-to-code rating or the as-built rating. Also, the NRCan simulation number is tracked under a column named ''Final ERS Number''.

  Recommendation: All columns should be clearly and consistently named to avoid interpretation, as well as facilitate overall understanding of the information tracked and data collection sampling.

Data tracking and reporting are crucial for program management and evaluation. The Evaluator understands that ePEI is interested in acquiring a data management system that would allow program tracking to be centralized rather than being performed in multiple individual tracking sheets. The Evaluator supports ePEI's goal to improve data management, which would contribute not only to the implementation of the data-completeness and data-organization recommendations in this report, but also ensure that program data is up to date and easy to use, for program management.

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4.3 Participant Awareness and Motivations

Participants learned about the NHC program from various sources, with a home show being the main source, followed closely by the ePEI website and word of mouth.

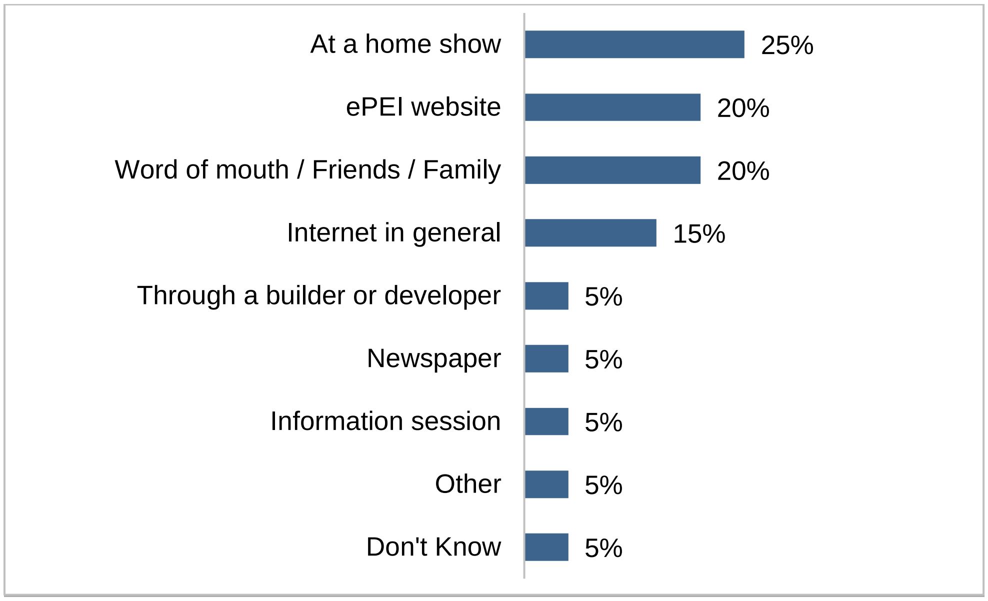

Figure 4: Primary Source of Awareness about the Program

Participants were interested in participating in the program mainly to make their new home more energy efficient and save money through program rebates or a reduction in their energy bills.

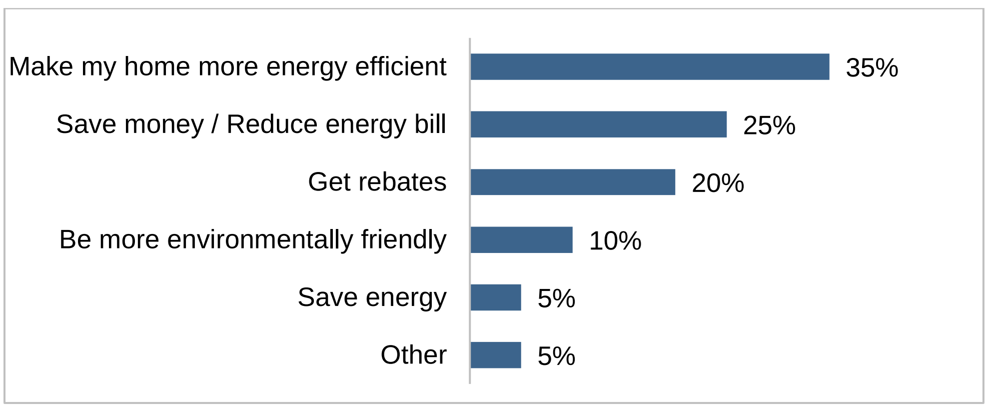

Figure 5: Primary Motivation for Participating in the Program

All surveyed participants said that they were involved in the decision to participate in the program, as opposed to the builder making the decision. Additionally, all but one of the 20 surveyed participants indicated that they were involved in their NHC project from the initial planning and design stage. The remaining participant became involved after the home plans were finalized but was still involved in the choice of energy efficient features.

4.4 Participation Processes

Participants were asked to rate their experience with various program steps according to a 0 to 10 scale where 0 means “very difficult” and 10 means “very easy”. Survey results indicate that finding a builder as well as reviewing program recommendations and choosing energy efficiency features are the two aspects of the program that participants found most challenging. Participants who struggled to find a builder mentioned a lack of builders in the province to meet construction demand. Those who struggled with reviewing the recommendations and choosing energy efficiency features mentioned that the information provided to them after the home plan review was not well laid out to them and that they would have needed more consultation and discussion with the EA to better understand.

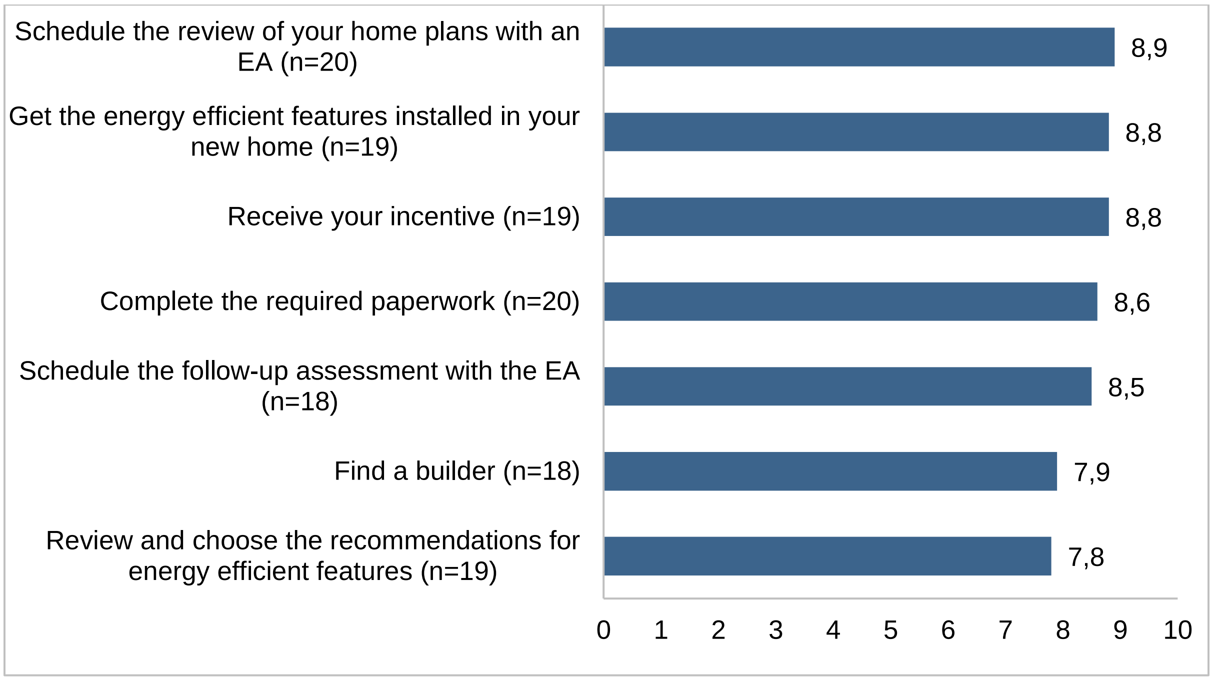

Figure 6: Ease of Completing Program Steps

4.5 Barriers to Incorporating Energy Efficient Features into Builds

Ten of the 20 surveyed participants indicated that there were features that had been recommended to them through the program that they chose not to incorporate into their builds. The main features that participants did not install were:

- Insulation (n=4);
- Ventilation or heat recovery ventilator (n=3);
- Windows, doors or skylights (n=3).

Not being able to afford the features was mentioned as the main reason for not incorporating the features into the builds.

4.6 Participant Satisfaction and Recommendations for Improvement

Participant satisfaction with the program is high, with most aspects receiving high average satisfaction scores. The main aspect of the program that received the lowest average satisfaction rating is the rebate amount.

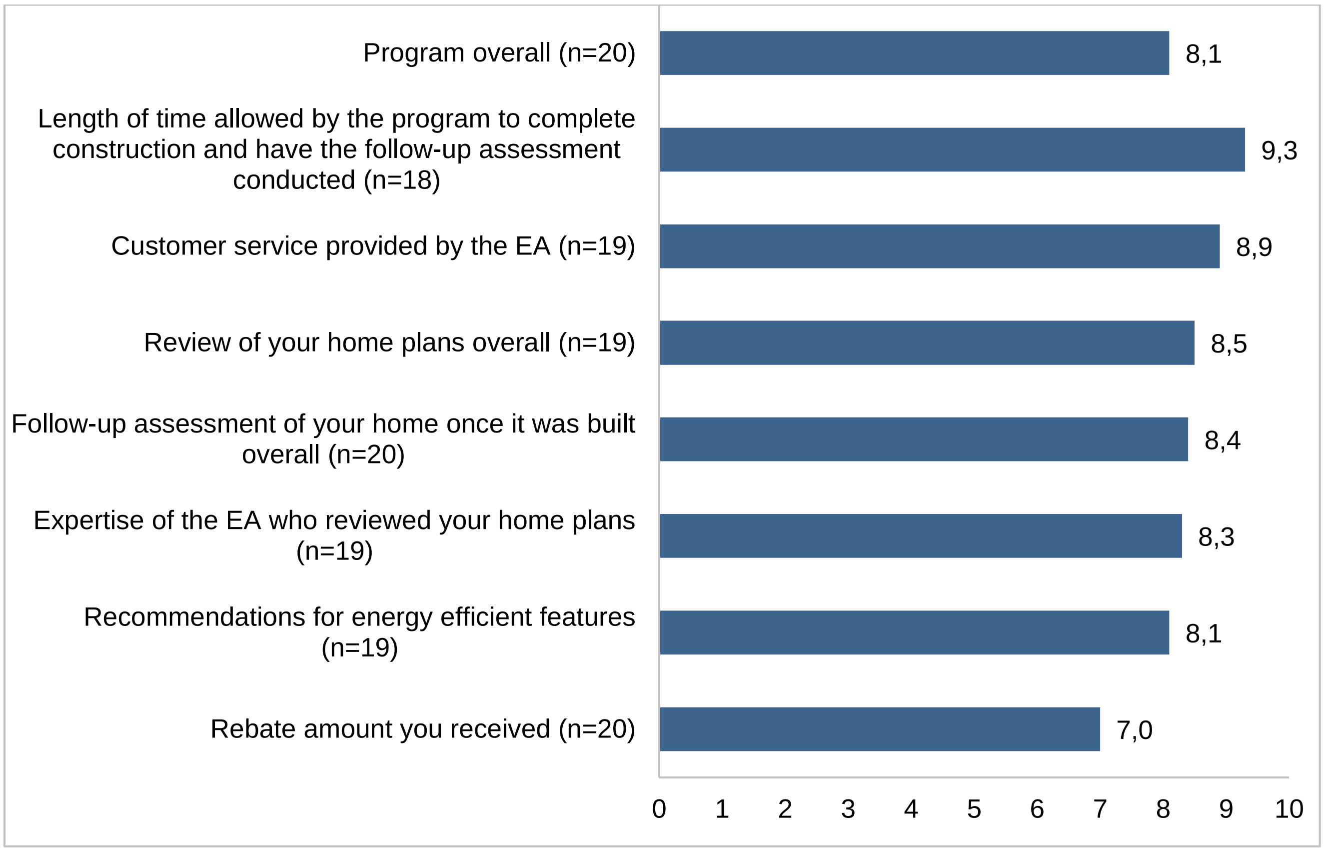

Figure 7: Participant Satisfaction Levels

Participants provided various recommendations to improve the program:

- One quarter of surveyed participants (n=5) asked that rebates be increased;
- Another key recommendation was to include more tiers in the rebate structure or offer participants more rebate options (n=3);
- Another recommendation involved favouring more consultation between EAs and participants at the time of home plan reviews to ensure that recommendations meet participant expectations and that they are well understood (n=3).

These recommendations are in line with the satisfaction ratings provided in the figure above and explain some of the somewhat lower ratings.

CONCLUSIONS AND RECOMMENDATIONS

The evaluation of the NHC program was conducted to achieve the following objectives:

› Establish the gross electricity energy and peak demand savings generated by the program;
› Establish the net electricity energy and peak demand savings generated by the program;
› Assess whether the program is cost-effective;
› Assess the effectiveness of program processes and implementation.

This section provides the Evaluator's conclusions and recommendations related to program processes, implementation, cost-effectiveness, as well as electricity energy and peak demand savings.

The program reached its energy savings, peak demand savings and cost-effectiveness targets.

For 2018/2019 and 2019/2020 respectively, net electricity energy savings targets of 0.1 GWh and 0.2 GWh had been set for the NHC program. The program achieved 0.249 GWh and 0.792 GWh in net electricity energy savings in 2018/2019 and 2019/2020 respectively, thereby greatly surpassing targets due to higher-than-expected participation levels. Despite having no peak demand savings targets, the program generated peak demand savings of 0.074 MW and 0.234 MW in 2018/2019 and 2019/2020 respectively. On another positive note, the program was very cost-effective during both fiscal years, based on the PAC and TRC tests.

To establish these program results, the Evaluator assessed various program savings calculation parameters such as the overestimation ratios, NTGR and EUL values.

Recommendation 1: Use the evaluation parameters established through this evaluation for program savings tracking going forward.

There are opportunities to improve the completeness and organization of program tracking data.

The Evaluator reviewed the program database and identified the important data types that should be collected and tracked to effectively manage and evaluate the program and accurately calculate savings.

Recommendation 2: Update program tracking to implement the following:

› Continue tracking current items and try collecting data on currently untracked or incomplete items. The latter items include the project status, applicant type, primary and secondary heating system types, overestimation ratios, modelled to-code ERS scores, as well as gross and net electrical energy and peak demand savings.
› Identify the projects that generate electrical savings to calculate program gross and net electrical savings.

› Collect and track builder contact information (names, emails, phone numbers). This would enable the Evaluator to conduct interviews with builders to not only assess their experience with the program, but also collect information to enhance the NTGR assessment, i.e. free-ridership and spillover levels, and further improve the savings calculation and evaluation methodologies going forward.
› Clearly and consistently name program database columns to avoid interpretation as well as facilitate overall understanding of the information tracked and data collection sampling.

Subsections 4.1 and 4.2 of this report provide additional information on the findings that led to these sub-recommendations.

Participant satisfaction with the program is high. Aspects of the program participation process that participants found the most challenging include the incentive levels and understanding program recommendations.

Participants provided overall positive feedback about the program and its aspects. The aspect of the program that received the lowest average satisfaction rating is the rebate amount. Participants suggested that rebates be increased and that the incentive structure be reviewed to include more tiers.

Survey results also indicated that reviewing program recommendations and choosing energy efficiency features are among the program aspects that participants found most challenging during their participation process.

Recommendation 3: Consider having SOs and EAs spend more time with participants to ensure they have all the information they need to go forward with their project and make the best energy efficiency decisions.

The program free-ridership level is slightly high, and the majority of participants reached an energy efficiency level above the first program tier (20% above code).

The Evaluator calculated a free-ridership level of 38% for the program, which is slightly high. This means that the program had limited impact on the energy efficiency decisions of a portion of participants. Some of them also expressed a desire for the incentive structure to be reviewed, as mentioned above.

Additionally, the Evaluator found that the vast majority of 2018/2019 and 2019/2020 participants, regardless of their main fuel source, reached an energy efficiency level of at least 30%, which is higher than the first tier.

Other jurisdictions, such as Nova Scotia and New Brunswick, use more stringent program criteria than PEI. For example, the first tier of the Nova Scotia new home construction program requires participants to have an energy use level at least 30% better than code, and New Brunswick’s first program tier has recently been updated to require that new homes perform at least 55% better than then reference house of the 2015 NBC.

Recommendation 4: Consider updating the program incentive structure. The Evaluator recommends exploring the following: (1) increasing the first tier to encourage more energy efficient projects while also (2) providing more tiers to ensure that participants who do not anticipate being able to meet the existing second tier (50%) have an alternate option, 30% or 40% for example.

APPENDIX I
PARTICIPANT SURVEY QUESTIONNAIRE

Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Telephone survey
Estimated Time to Complete	15 minutes
Target Audience	Participants who completed New Home Construction program projects
Expected Number of Completions	20
Contact List Source	efficiencyPEI
Fielding Firm	Vision Research
Estimated Timeline for Fielding	February 2020

Research Objectives and Associated Questions

Research Objectives	Questions
How did participants learn about the program?	B1
Why did participants want to participate in the program?	B2-B3
How satisfied were participants with the program and its aspects?	C1-C3
Did participants encounter issues or challenges with the program?	C4-C5
What prevented participants from installing certain energy efficient features?	D1-D3
What was the free-ridership level?	E series
What recommendations did participants have to improve the program?	F1

Import variables from database **< LIKE THIS >**
Skip pattern or programming instructions **[LIKE THIS]**
Black text**:** instructions for interviewer **[NOTE:** xxxx **] / [PROBE:** xxxx **]**

INTRODUCTION

Hello may I please speak with **<INSERT NAME>**?

1. Yes **[GO TO INTRODUCTION]**
2. No **[SAY "PERHAPS YOU CAN HELP ME ANYWAY." GO TO INTRODUCTION]**

Hello, my name is *** and I am with Vision Research, a PEI-based survey research company. We are performing an evaluation of energy efficiency programs and services provided by efficiencyPEI. Our records indicate that you or your household recently participated in efficiencyPEI's New Home Construction program. This program encourages homeowners to improve the energy efficiency of their new home by having an energy advisor review their home plans and provide them with customized energy efficiency recommendations. Then, a follow-up assessment of the new home is conducted once it is built to determine its efficiency.

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

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

A. Verification and Recall

A1. We understand you participated in the New Home Construction program. Is that correct?

1. Yes **[CONTINUE]**
2. No, does not recall participating **[PROMPT**: "An energy advisor would have reviewed your new home plans before you built and provided you with customized energy efficiency recommendations to make your new home more comfortable and efficient. They might have talked about the possibility of you getting rebates to cover some of the cost of recommended energy efficient features."] **[IF PERSIST AS NO, THANK, TERMINATE AND RECORD]**
3. Don't know/Refused [**PROBE**: "Is there someone else in the household who would know about having participated in the New Home Construction program?"] **[IF YES, ASK TO SPEAK TO THE APROPRIATE PERSON AND RESTART AT INTRODUCTION. IF PERSISTS AS NO, THANK, TERMINATE AND RECORD.] [IF REFUSED, ASK "CAN WE SCHEDULE A MORE CONVENIENT TIME FOR YOU TO CONDUCT THIS SURVEY?"] [SCHEDULED, IF NECESSARY, FOR: ________________________________]**

A2. Are you in the business of building and/or selling homes?

1. Yes **[THANK, TERMINATE AND RECORD]**
2. No **[CONTINUE]**
98. (Don't know) **[THANK, TERMINATE AND RECORD]**
99. (Refused) **[THANK, TERMINATE AND RECORD]**

A3. Did you personally take part in the decision to participate in the New Home Construction program? **[DO NOT READ. ACCEPT ONE]**

1. (Yes)
2. (No/The Builder made the decision)
98. (Don't know)
99. (Refused)

A4. Which of the following statements best describes when you became involved in the decisions about the energy efficiency of your home? Would you say …: **[READ STATEMENTS IN ORDER – CODE ONE ONLY]**

1. You were involved from <u>the initial planning and design stage</u>. This is when your home existed only on paper.
2. You were involved <u>after the plans for your home were finalized</u> but had the option to choose energy efficient features.
3. You were involved <u>after the energy efficiency features were installed</u> but before the final review of your completed home, or
4. You were not involved in any of these decisions, or you bought the home after it was completed.
98. (Don't know)
99. (Refused)

B. Program Awareness and Reasons for Participation

B1. How did you first learn about the New Home Construction program? **[DO NOT READ; ALLOW MULTIPLE RESPONSES BUT DO NOT PROBE FOR MULTIPLE]**

1. **efficiencyPEI** website
2. Through a builder or developer
3. At a home show
4. Word of mouth / Friends / Family
5. Facebook or other social media
6. Power bill insert
7. Through participation in another efficiencyPEI program
8. Newspaper
9. Radio ad
10. Television ad
11. Community event
12. Internet in general
13. Information session

96. Other [SPECIFY: _______________]
98. Don't know

B2. What was the SINGLE most important reason you were interested in participating in the program? **[DO NOT READ – CODE ONE ONLY]**

1. Save money / Reduce energy bill
2. Save energy
3. Get rebates
4. Be more environmentally friendly
5. Make my home more energy efficient
6. Increase comfort in my home
7. Increase value of my home

96. Other [SPECIFY________________]
98. Don't know

B3. Were there any other reasons? **[SAME LIST AS IN B2] [DO NOT READ. ACCEPT MULTIPLE RESPONSES]**

C. Satisfaction with Program

C1. 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]**

C2. **[IF C1<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)
99. (Refused)

C3. On the same scale of 0 to 10, where 0 is ‘not at all satisfied’ and 10 is ‘completely satisfied’, how satisfied were you with each of the following aspects of the New Home Construction program? **[DO NOT RANDOMIZE] [97 = NOT APPLICABLE, 98 = DON’T KNOW/DON’T RECALL, 99 = REFUSED]**

a. The review of your home plans overall ***[IF SCORE IS 7 OR LESS, ASK:** What about the review of home plans could have been improved?**] RECORD VERBATIM***
b. The recommendations for energy efficient features ***[IF SCORE IS 7 OR LESS, ASK:** What about the recommendations could have been improved?**] RECORD VERBATIM***
c. The follow-up assessment of your home once it was built overall ***[IF SCORE IS 7 OR LESS, ASK:** What about this assessment could have been improved?**] RECORD VERBATIM***
d. The expertise of the energy advisor who reviewed your home plans ***[IF SCORE IS 7 OR LESS, ASK:** What about the energy advisor’s expertise could have been improved?**] RECORD VERBATIM***
e. The customer service provided by the energy advisor ***[IF SCORE IS 7 OR LESS, ASK:** What about the energy advisor’s customer service could have been improved?**] RECORD VERBATIM***
f. The rebate amount you received
g. Length of time allowed by the program to complete construction and have the follow-up assessment conducted

C4. Using a scale of 0 to 10, where 0 is ''very difficult'', and 10 is ''very easy'', how easy was it for you to complete each of the following program steps: **[READ] [DO NOT ROTATE STATEMENTS] [0 TO 10 SCALE, 97=NOT APPLICABLE, 98 = DON'T KNOW/DON'T RECALL THIS STEP]**

a. Schedule the review of your home plans with the energy advisor
b. Review and choose the recommendations for energy efficient features
c. Find a builder
d. Get the energy efficient features installed in your new home
e. Schedule the follow-up assessment with the energy advisor
f. Complete the required paperwork
g. Receive your incentive
98. (Don't know)
99. (Refused)

C5. **[FOR EACH C4A-G ≤ 7] [DO NOT ASK IF DON'T KNOW OR REFUSED]** What was difficult about completing this program step? **[VERBATIM BOX]**

D. Barriers

[ASK IF A4=1, 2 OR 3]

D1. Were there any energy efficiency equipment or features recommended to you during the New Home Construction program review of home plans that you chose <u>not</u> to install in your new home?

1. Yes
2. No
98. (Don't recall)

D2. **[ASK IF D1=1] WHAT RECOMMENDED EQUIPMENT OR FEATURES DID YOU DECIDE NOT TO INSTALL IN YOUR NEW HOME?**

1. Space heating system
2. Water heating system
3. Insulation
4. Air tightness
5. Windows, doors or skylights
6. Lighting
7. Appliances
8. Ventilation or heat recovery ventilation
96. Other: ______
98. Don’t know

D3. **[ASK FOR EACH RESPONSE IN D2]** Why did you decide not to install this equipment? **[DO NOT READ. ACCEPT MULTIPLE]**

1. Couldn’t afford this equipment
2. Couldn’t find the time to put in the equipment
3. Lack of interest
4. Not having enough information on the equipment
5. Not convinced that installing this equipment was worth the money
6. Couldn’t find a builder or installer for this equipment
7. Equipment was unavailable in Atlantic Canada
8. Cost-benefit analysis did not justify installing the equipment
96. Other:_______
98. Don’t know

E. Free-Ridership

[ASK IF A3=1 OR A4=1, 2 OR 3]

Moving along to another topic now….

E1. As part of your participation in the New Home Construction program, an energy advisor reviewed your home plans. Did the review of your home plans identify energy efficiency features that had not been included in your original home plans?

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

E2. **[IF E1=NO]** I just want to make sure I understand - Before you participated in the New Home Construction program, your home design already included all the energy efficient features that were identified in the New Home Construction program review of your home plans?

1. Yes, my home design already included all the energy efficient features
2. No
98. (Don’t know)
99. (Refused)

E3. **[ASK IF REBATE>0]** Thinking of all the energy efficient features you decided to incorporate into your build, how much would you estimate the total cost of these features to be before any financial incentives from efficiencyPEI? **[RECORD TOTAL COST IN DOLLARS. PROBE TO AVOID ACCEPTING A RANGE.]**

___ Response ___98 Don’t Know ___99 Refused

E4. **[ASK IF REBATE>0]** EfficiencyPEI gave you a financial incentive of $**<REBATE>** for the energy efficiency level that you achieved in your new house. If you had not received the incentive from efficiencyPEI, would you have paid for the full cost to reach this energy efficiency level? 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]**

96. ___ Response
97. (Did not receive that incentive)
98. (Don’t Know)
99. (Refused)

E5. **[ASK IF REBATE=$0]** EfficiencyPEI funded about 80% of the review of home plans and follow-up assessment that were performed by the energy advisor as part of the program. If efficiencyPEI had not reduced the cost of the review of home plans and follow-up assessment, would you have paid for the full cost, which is $600? 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]**

96. ___ Response
97. (Did not receive that incentive)
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 New Home Construction 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 E6-E7 SEQUENCE IN ORDER/DO NOT RANDOMIZE]**

E6. If the program or its rebate had <u>not been</u> offered, what is the likelihood that you would have built or bought a house with the exact same level of efficiency?

___ Response ___98 Don't Know ___99 Refused

E7. If the program or its rebate had <u>not been</u> offered, what is the likelihood that you would have built or bought a standard house, designed to code, instead of a house with a high level of efficiency?

___ Response ___98 Don't Know ___99 Refused

E8. Next, I'm going to ask you to rate the importance of factors that might have influenced your decision to build or buy a house with a high level of energy efficiency. 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 build or buy a house with a high level of energy efficiency. **[DO NOT ACCEPT A RANGE]**

Factor (READ AND RANDOMIZE)	Responses
a. **[ASK IF REBATE>0]** The program financial incentive	___ Response ___98 Don't Know ___99 Refused
b. Expert information or advice provided by the program energy advisor	___ Response ___98 Don't Know ___99 Refused
c. The recommendations received through the review of your home plans	___ Response ___98 Don't Know ___99 Refused
d. Promotion done by efficiencyPEI or a previous participation in an efficiencyPEI program	___ Response ___98 Don't Know ___99 Refused

F. Recommendations for Program Improvement

F1. Do you have any recommendations for improving the New Home Construction program? [**PROBE**: Anything else]? **[DO NOT READ. ACCEPT MULTIPLE]**

1. (Complete the review of home plans faster)
2. (Offer more information on the equipment/features recommended)
3. (Increase the time given to complete construction)
4. (Advertise the program more or in a better way)
5. (Simplify participation process)
6. (Increase rebates)
7. (No recommendation)
8. (Favour more consultation between energy advisors and participants during and after the review of home plans)
9. (Ensure recommended equipment are readily available)
10. (Include more tiers/Offer participants more rebate options)
11. (Increase energy advisor knowledge of recommended equipment)
12. (Speed up the time to receive the report)
13. (Encourage the Passive House energy efficiency level)

96. (Other [SPECIFY_______________])
98. (Don't know)
99. (Refused)

G. Demographic Characteristics

These final questions are asked for statistical purposes only. The information collected is strictly confidential.

G1. What type of residence do you live in? **[READ RESPONSES 1-5, SELECT ONE RESPONSE]**

1. Detached single-family house
2. Semi-detached house
3. Mobile home or house trailer
4. Townhouse or duplex that shares adjacent walls
5. Row house

96. (Other [SPECIFY: ________________________])

98. (Don't know)
99. (Refused)

G2. How many bedrooms are in your home? **[98=DK; ENTER ZERO FOR A STUDIO APARTMENT WITH NO BEDROOMS]**

G3. Is your home occupied year round, or is it a seasonal home?

1. Year round residence
2. Seasonal / vacation home

96. (Other Specify _______)
98. (Don't Know)
99. (Refused)

G4. Including yourself, how many people live in this residence on a full-time basis?

Number of people: ______________

G5. In what age category do you fall? 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)

G6. 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)
98. (Don't know)
99. (Refused)

G7. Which of the following income categories best describes your total annual household income before taxes in 2018? 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
98. (Don't know)
99. (Refused)

This completes the survey. Your responses are very important to efficiencyPEI. We appreciate your participation and thank you for your time. Have a good [evening/day].

APPENDIX II
FREE-RIDERSHIP ALGORITHM

The figure below presents the algorithm for calculating the free-ridership level for the NHC program. The participant survey questionnaire included questions designed to assess the planning, efficiency and cost parameters of the project, as well as the influence of the program. Participants' responses to each group of questions were converted into a value indicating the level of program attribution, and this value was used to calculate the free-ridership level associated with each participant.

E1. As part of your participation in the New Home Construction program, an Energy Advisor reviewed your home plans. Did the review of your home plan identify energy efficiency features that had not been included in your original home plans?	IF Yes OR DK OR REF: E1 = 0% IF No: Use E2
E2. [IF E1=NO] I just want to make sure I understand - **Before** you participated in the New Home Construction program, your home design already included all the energy efficient features that were identified in the review of your home plans?	IF Yes: E1 = 100% IF No OR DK OR REF : E1 = 0%
Planning Score:	**E1**
E4orE5. If you had not received the incentive from efficiencyPEI or efficiencyPEI had not reduced the cost of the review of home plans and follow-up assessment, would you have paid for the full cost to reach this energy efficiency level? (Scale 0 to 10)	E4orE5 = Answer x 10% IF DK OR REF: E4orE5 = EMPTY
E6. If the program or its rebate had not been offered, what is the likelihood that you would have built or bought a house with the exact same level of efficiency? (Scale 0 to 10)	E6 = Answer x 10% IF DK OR REF: E6 = EMPTY
Cost and Efficiency Score:	**MEAN VALUE OF: (E4orE5; E6)**
INTENTION Score:	**MEAN VALUE OF: (Planning; Cost and Efficiency)**
E8. Level of influence of four factors (Scale 0 to 10) **a.** The program financial incentive **b.** Expert information or advice provided by the program energy advisor **c.** The recommendations received through the review of your home plans **d.** Promotion done by ePEI or a previous participation in an ePEI program	E8 = MAX(a; b; c; d)
INFLUENCE Score:	**(10 − E8) x 10%**
Inconsistency Test #1	IF E2 = 100% AND E4orE5 <70% Planning Score = EMPTY
Inconsistency Test #2	IF E7 > 70% Cost and Efficiency Score = MEAN VALUE OF: (E4orE5; E6) /2
Inconsistency Test #3	IF B2 = 3 INFLUENCE = 0%
Free-Ridership	**MEAN VALUE OF: (INTENTION; INFLUENCE)**

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2018/2019 AND 2019/2020 WINTER WARMING PROGRAM EVALUATION

EFFICIENCYPEI

Final Report

June 29, 2020

ECONOLER

ACRONYMS

CDD	Cooling degree days
CFL	Compact fluorescent lamp
COP	Coefficient of performance
DHW	Domestic hot water
DSM	Demand-side management
EE&C	Electricity Efficiency and Conservation
EISA	Energy Independence and Security Act
ePEI	efficiencyPEI
EUL	Effective useful life
HDD	Heating degree days
HOU	Hours of use
IES	Instant Energy Savings (program)
IPC	Incremental product cost
LED	Light-emitting diode
NERHOU	Northeast Residential Lighting Hours-of-Use (study)
NTGR	Net-to-gross ratio
OPA	Ontario Power Authority
PAC	Program Administrator Cost (test)
PEI	Prince Edward Island
TRC	Total Resource Cost (test)
TRM	Technical reference manual
UMP	Uniform Methods Project
WW	Winter Warming (program)

DEFINITIONS

Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
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.
Evaluated savings	Gross and net savings calculated by the Evaluator using parameters (installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process.
Free-ridership	Percentage of 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 energy efficiency program, regardless of why they participated.
Interactive effects	Interactive effects occur when the installation of an energy efficiency measure has an impact on the energy consumption of other elements in the building such as heating and cooling.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for 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.
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 between the net energy savings and gross energy savings that includes effects, such as free ridership and spillover, that positively or negatively affect the energy savings generated by a program.
Peak demand-to-energy ratio	The ratio between peak demand savings and energy savings.
Peak demand savings	The demand savings that coincide in time with the peak demand of the electricity system.
Program Administrator Cost test	This test compares program administrator costs to utility resource savings.

Sample size	The number of observations or replicates included in a statistical sample.
Spillover	Savings attributable to participants who continue to implement the energy efficiency measures introduced by a program after participating in it once, without participating in the program a second time.
Total Resource Cost test	This test compares program administrator and participant costs to utility resource savings and in some cases, other resource savings and program benefits accrued by participants, such as non-energy benefits.
Tracked savings	Gross and net savings calculated by the utility in its internal tracking, based on various parameters such as number of participants, installation rates, interactive effects, and 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).

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EXECUTIVE SUMMARY

This report presents the evaluation results of the efficiencyPEI (ePEI) Winter Warming (WW) program. The program provides low to moderate-income Islanders with free-of-charge direct installation of energy efficient products, such as weatherization products, as well as light bulbs, low-flow showerheads and programmable thermostats. ePEI contracts two service providers to provide this service across the province and carry out product installation.

Summary of Evaluation Assignment

ePEI hired Econoler (hereinafter the Evaluator) to evaluate the program and achieve the following key objectives:

- Establish the gross electricity energy and peak demand savings generated by the program;
- Establish the net electricity energy and peak demand savings generated by the program;
- Assess whether the program is cost-effective;
- Assess the effectiveness of program processes and implementation.

The evaluation addresses the program savings and cost-effectiveness results associated with equipment that displace electricity usage only.

The evaluation was carried out based on a review of the program database and documentation, a paper form review combined with site visits, literature review, engineering calculations and cost-effectiveness analyses based on the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests.

The evaluation covers the 2019/2020 fiscal year. Based on the parameters established through the evaluation, this report also presents results for the 2018/2019 fiscal year.

Summary of Evaluation Results

This subsection presents the key findings of the evaluation.

Participation Level

A total of 699 participants took part in the WW program during the 2019/2020 fiscal year, while 528 participated in 2018/2019. Almost all participants had LED lamps, low-flow showerheads and smart power bars installed as part of the program. A majority of participants had at least one weatherization product installed, while about half of participants received a programmable thermostat.

Satisfaction with the Program

Satisfaction with the program was very high among 2019/2020 participants. Participants were also very satisfied with the products they had installed and the installer who performed the work.

The less-satisfied participants mainly mentioned being dissatisfied because the contractor did not install all the products; some were left for the homeowners to install. The installation of weatherization products in particular is important to ensure that it was carried out appropriately and that savings occur. Other issues encountered by participants included wanting more information on the decision to install certain specific products and not to install others, believing the products installed did not meet their needs, and finding the thermostat installed inappropriate for heating conditions.

Although most participants did not have any recommendation and appreciated their experience with the program, a few participants suggested advertising the program more, not limiting the number of products installed, and installing more types of products.

Program Data Tracking

The program database was generally well organized and included most information required for the evaluation. Nonetheless, the Evaluator identified a few improvement areas that would allow for better managing and evaluating the program and calculating savings. Some of these tracking-related findings are supported by site visit observations.

- It was sometimes unclear if the quantities tracked in the database reflected the quantities installed in participant homes or the quantities used by the service providers. In addition, site visits revealed that some products were left behind for future installation.
- Along the same line, the information tracked was often inconsistent with the way to calculate unitary savings. For example, for caulking, spray foam and weatherstripping, the number of tubes or cans were tracked while it would have been more relevant and accurate to track the number of windows and doors sealed as well as the perimeter.
- Although the program has offered three different types of light-emitting diode (LED) lamps since January 2020, LED lamp types and wattages were not tracked.
- More than one heating source was often included under the primary heating system column, making it impossible to identify the actual primary source.
- The income level of each participant (low or moderate) was not included in the database.

Gross Savings

The Evaluator established savings calculation parameters for all product categories offered through the WW program, although it should be mentioned that caulking and spray foam were combined. To do so, the Evaluator established a unitary energy savings value for each product category based on a literature review and engineering calculations, supported by program data and findings from the site visits.

Table 1 below lists the unitary energy savings value for each product category.

Table 1: Unitary Energy Savings Values

Product Category	Unitary Energy Savings Value	Source
Weatherization Products		
Caulking and Spray Foam	325 kWh/participant	Established by the Evaluator
Weatherstripping	314 kWh/participant	Established by the Evaluator
Electrical Outlet Gaskets	6.56 kWh/unit	Established by the Evaluator
Door Sweeps and Bumpers	126 kWh/unit	Established by the Evaluator
Attic Hatch Insulation	91.9 kWh/unit	Established by the Evaluator
Window Insulation Film	-	Assumed to be negligible
Plug Covers	-	Assumed to be negligible
Energy Efficient Products		
LED Lamps	31.2 kWh/unit	Established by the Evaluator
Low-Flow Showerheads	322 kWh/unit	Established by the Evaluator
Programmable Thermostats	-	Not defined because 100% of the units are assumed to generate non-electrical energy savings.
Smart Power Bars	207 kWh/unit	Established by the Evaluator

Net Savings

A net-to-gross ratio (NTGR) is used to determine net savings based on program gross savings. Evaluation standards assume that free-ridership and spillover are nil among low-income participants. Although the WW program accepts both low- and moderate-income participants, the Evaluator considered that the NTGR assumption for low-income was reasonable for this first evaluation of the WW program, considering the program delivery model and types of products installed. Therefore, the NTGR was established at 1.00.

Cost-Effectiveness

The Evaluator assessed the cost-effectiveness of the Electricity Efficiency and Conservation (EE&C) portion of the program by performing specific cost-effectiveness tests, namely the TRC and PAC tests. When performing these tests, ratios greater than 1 are desired because they indicate that program benefits outweigh costs.

The evaluation revealed that the program was very cost-effective in both 2018/2019 and 2019/2020, with PAC and TRC results all being higher than 4.0.

Summary of Savings and Cost-Effectiveness Results

Table 2 summarizes the key results of the program savings and cost-effectiveness evaluations for 2019/2020 and 2018/2019, as well as participation levels and program targets.

Table 2: Summary of Program Savings and Cost-Effectiveness Targets and Evaluated Results

Parameters	2018/2019 Targets	2018/2019 Evaluation Results	2019/2020 Targets	2019/2020 Evaluation Results
Program Participation				
Number of Participants	350	528	350	699
Gross Electricity Savings at the Generator				
Gross Electricity Energy Savings (GWh)	-	0.349	-	0.462
Gross Lifetime Electricity Savings (GWh)	-	3.035	-	4.031
Gross Peak Demand Savings (MW)	-	0.044	-	0.058
Net Electricity Savings at the Generator				
NTGR	-	1.00	-	1.00
Net Electricity Energy Savings (GWh)	0.3	0.349	0.3	0.462
Net Lifetime Electricity Savings (GWh)	-	3.035	-	4.031
Net Peak Demand Savings (MW)	0.1	0.044	0.1	0.058
Cost-Effectiveness				
PAC Test	2.1	4.47	2.0	4.56
TRC Test	2.2	5.45	2.1	5.65

› The 2018/2019 and 2019/2020 evaluated net electricity energy savings exceeded program targets by 16% and 54% respectively. This was mainly due to participation levels being higher than expected, with 51% and 100% more participants in 2018/2109 and 2019/2020 respectively.

- The 2018/2019 and 2019/2020 evaluated net peak demand savings did not achieve program targets by 56% and 42% respectively. Although the participation level was higher than expected, the average peak demand savings per participant were considerably lower than anticipated at the time of setting the targets.
- The PAC and TRC tests revealed that the program was very cost-effective from both perspectives and reached the cost-effectiveness targets for both fiscal years.

Recommendations

In light of these findings, the Evaluator issues the following recommendations.

Recommendation 1: Develop guidelines for service providers to improve and ensure consistency in program delivery and reporting. These guidelines should clearly indicate which products need to be installed by service providers and which ones, if any, can be left behind. Also, the guidelines should specify what information should be collected to ensure the other above-mentioned recommendations are followed.

Recommendation 2: Ensure to collect the relevant information for establishing the unitary savings value of each product category.

- For caulking, spray foam and weatherstripping, it would be important to collect information at least on the number of windows and doors sealed and, if possible, the perimeter sealed, to establish unitary savings values more precisely or calculate savings on a per-foot basis rather than on a per-participant basis. Similarly, for electrical outlet gaskets, more information on the number of units installed on outdoor walls would allow for more precise unitary savings value calculations.
- For LED lamps, the installed LED lamp type and wattage should be tracked now because the program offers three different types of LED lamps. In addition, tracking the type and wattage of the replaced lamps would allow for better savings estimation.

Recommendation 3: Update program tracking to implement the following:

a. Continue tracking current items and try collecting data on currently untracked or incomplete items. The latter items include the primary heating system types, line loss factor, as well as gross and net electrical unitary energy and peak demand savings.
b. Add a field for the proportion of units that generate electrical savings (claimed for EE&C) and ensure this value is multiplied by the total number of units installed.
c. Always track quantities and ensure that upgrade types and quantities are tracked in different columns.
d. Track the income level of each participant (low or moderate) to enable an assessment of free-ridership in the future. Given the longevity of the program, some of the site visit observations and the fact that the program includes moderate-income participants (not just low-income participants), the Evaluator believes that free-ridership should be assessed in the future.

INTRODUCTION

Under the Government of Prince Edward Island (PEI), efficiencyPEI (ePEI) is responsible for administering Electricity Efficiency and Conservation (EE&C) programs in the province. The programs are meant to help Islanders not only improve the energy efficiency and conservation of energy in their homes and workplaces by installing high-efficiency equipment and products, but also change behaviours. Econoler was commissioned by ePEI to evaluate its EE&C program portfolio comprised of five residential programs and three commercial programs.

One of the five residential programs is the Winter Warming (WW) program, which provides low to moderate income Islanders with free-of-charge direct installation of energy efficient products, such as weatherization products, as well as light bulbs, low-flow showerheads and programmable thermostats.

The evaluation of the WW program is focused on assessing program processes, implementation and cost-effectiveness, as well as providing evaluated gross and net energy and peak demand savings. The evaluation covers the 2019/2020 fiscal year. Based on the parameters established through the evaluation, this report also presents results for the 2018/2019 fiscal year. This report presents the program EE&C results, namely the savings and cost-effectiveness results associated with equipment that displace electrical usage only. Evaluation activities were carried out considering both electrically-heated and non-electrically heated participants to assess program processes and implementation, but certain sections of the report reference only subsets of the total participants included in the evaluation, depending on the topic assessed.

To complete this evaluation, Econoler worked with Darren Matheson, a local contractor, who completed on-site visits at participating homes. Throughout this report, the team of Econoler and Darren Matheson is referred to as the Evaluator.

1 PROGRAM OVERVIEW

The WW program provides low to moderate income Islanders with free-of-charge direct installations of weatherization and energy efficient products. To be eligible, homeowners must have an annual household income of $50,000 or less. ePEI contracts two service providers to provide this service across the province.

Products available for installation through the WW program are:

Weatherization Products

- Caulking
- Spray foam
- Weatherstripping (v-strip or foam strip)
- Electrical outlet gaskets
- Door sweeps and bumpers
- Attic hatch insulation
- Window insulation film
- Plug covers

Energy Efficient Products

- Light-emitting diode (LED) lamps
- Low-flow showerheads (usually only one per home)
- Programmable thermostats (only one per home)
- Smart power bars (only one per home)

Participants can also receive a voucher for a free heating system cleaning.

The number of LED lamps offered to participants changed during the 2019/2020 fiscal year. Until the end of December 2019, participants were each allowed six LEDs, all of the same type. Starting from January 2020, the program has allowed all existing lamps to be replaced, including three different types of lamps.

2 EVALUATION APPROACH

The main objectives of the WW program evaluation are as follows:

- Establish the gross electricity energy and peak demand savings generated by the program;
- Establish the net electricity energy and peak demand savings generated by the program;
- Assess whether the program is cost-effective;
- Assess the effectiveness of program processes and implementation.

The Evaluator identified key research questions aimed at achieving the aforementioned objectives. The following table outlines the evaluation objectives and maps them to the research questions and methods. Each method is described further below.

Table 3: Evaluation Approach

Evaluation Objective	Research Question	Method
Gross energy and peak demand savings	What are the unitary savings by product?	› Program savings analysis › Paper form review and site visits
	What are the installation rates of the program products?	
	What are the product peak demand-to-energy ratios?	
	What are the appropriate product effective useful life (EUL) values?	
	What are the evaluated annual and lifetime gross energy savings and peak demand savings?	
Net energy and peak demand savings	What are the evaluated annual and lifetime net energy savings and peak demand savings?	Program savings analysis
Program cost-effectiveness	In addition to the other cost-effectiveness calculation parameters already collected (e.g. EUL values, net savings), what is the incremental product cost (IPC) of each program product type?	Cost-effectiveness analysis
	Is the program cost-effective from the perspective of the program administrator and participants?	
Program processes and implementation	Is program tracking effective, complete, consistent and clear?	Program database review
	How did participants hear about the program?	Paper form review and site visits
	What is the level of participant satisfaction with the program?	
	What issues or challenges, if at all, did participants encounter during their participation?	
	What recommendations do participants have to improve the program?	

The Evaluator first conducted an in-depth interview with program staff to learn about program processes, discuss program performance and identify evaluation objectives. Then, specific evaluation methods were undertaken as described in the following subsections.

Paper Form Review and Site Visits

In February and March 2020, the Evaluator carried out on-site visits in a total of 30 homes that had benefitted from the program during the 2019/2020 fiscal year to confirm product installation and collect participant feedback on their participation in the program. Due to the pandemic, seven of the 30 assessments were conducted over the phone rather than on site. The Evaluator used paper forms completed by the service providers after product installation to determine the categories of products that needed to be verified. The homes were sampled to ensure that projects from both program service providers would be visited. Additionally, the Evaluator selected homes that had received multiple products to maximize site visit results. The site visit protocol used to conduct the visits is provided in Appendix I.

Program Savings and Cost-Effectiveness Analyses

The Evaluator analyzed the program database, conducted a literature review and performed engineering calculations to revise the savings calculation values and parameters used by ePEI, including the assumptions used in calculating IPCs, gross and net energy and peak demand savings, as well as the EUL values used for the lifetime energy savings calculations. As part of the literature review, the Evaluator consulted technical reference manuals (TRMs) and public evaluation reports of jurisdictions similar to ePEI, with a focus on the most recent and accurate sources.

The Evaluator also performed two cost-effectiveness tests, namely the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests.

Program Database Review

The Evaluator reviewed the program database to: (1) assess tracking practices and processes and whether they meet program needs; (2) identify any gaps in tracked data to better inform program savings calculations, management and evaluation; and (3) assess the consistency and organization of tracked data.

3 PROGRAM SAVINGS AND COST-EFFECTIVENESS

This section presents the evaluation results related to program gross and net electrical energy and peak demand savings, as well as cost-effectiveness for the fiscal year 2019/2020. The parameters used to obtain these results were also used to calculate program savings and cost-effectiveness results for the 2018/2019 fiscal year. The section opens with an overview of program participation in 2018/2019 and 2019/2020.

3.1 Program Participation

Over the 2019/2020 fiscal year, 699 participants took part in the WW program, which was an increase of 32% compared to the 2018/2019 fiscal year, over which 528 participants had products installed as part of the program. Figure 1 below shows the number of participants who had each product category installed in the 2019/2020 fiscal year. The same kind of information for the 2018/2019 fiscal year was not tracked.

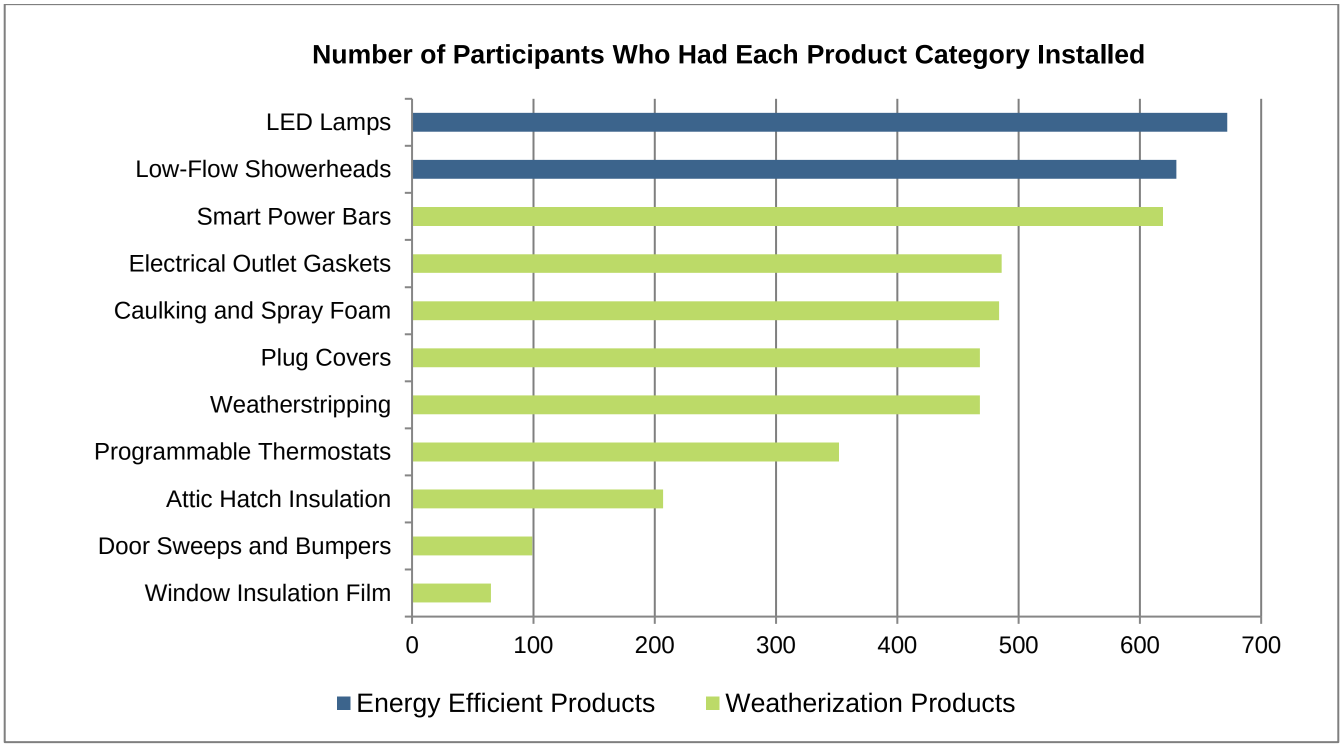

Figure 1: Summary of 2019/2020 WW Program Participation

Almost all participants had LEDs, low-flow showerheads and smart power bars installed as part of the program. Most participants had at least one weatherization product installed, while about one-half of participants received a programmable thermostat.

3.2 Gross Savings

Gross savings correspond to the change in energy consumption that results from actions taken by participants regardless of their reasons for participating. For the WW program, gross savings are determined by multiplying the proportion of units generating electricity savings (percentage claimed for EE&C) with the number of units installed (including the installation rate) for each product category, the energy or peak demand savings value, and the interactive effects factor, using the following equation:

$$\textit{Gross Savings} = \textit{Percentage Claimed for EE\&C} \times \textit{Number of Units} \times \textit{Installation Rate} \times \textit{Unitary Savings} \times \textit{Interactive Effects Factor}$$

Lifetime gross energy savings are then obtained by multiplying the annual gross energy savings with the EUL value associated with each product category.

The Evaluator established savings calculation parameters for all product categories offered through the WW program, although it should be mentioned that caulking and spray foam as well as door sweeps and bumpers were combined, and that no savings were associated with window insulation film or plug covers, as explained further in Subsection 3.2.2.

3.2.1 Percentage of Units Claimed for EE&C

The WW program provides direct installation of weatherization and energy efficient products to eligible homeowners, regardless of the source of energy used for space heating or water heating. Therefore, some product categories only generate electricity savings if they are used with electric space or water heating systems. This is the case for weatherization products, low-flow showerheads and programmable thermostats. The Evaluator determined the proportion of units generating electricity savings for each of these product categories, which corresponds to the percentage claimed for EE&C.

For weatherization products, the Evaluator used the proportion of homes with an electric heating system used as the main heating source to determine the percentage of products generating electricity savings. Based on the results from the PEI Home Energy Survey[1], the proportion of weatherization products generating electricity savings was established at 32%.

For low-flow showerheads, because no information was available on the water heating systems of the program participants in the program database or the PEI Home Energy Survey, the Evaluator assumed that 21% of PEI houses are equipped with an electric water heater, based on 2017 statistics from Natural Resources Canada.[2]

[1] MQO Research, PEI Home Energy Survey: Results Summary, October 2018.
[2] Natural Resources Canada, Single Detached and Single Attached Water Heater Stock by Energy Source, https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=pei&rn=29&page=0 (last accessed March 20, 2020)

For programmable thermostats, the model offered through the program is compatible with heating systems controlled with low-voltage thermostats. Low-voltage thermostats are designed to control central heating systems. Although a few models are available for baseboard heating systems, these models do not seem to be commonly installed. Considering that central electric heating systems, namely central heat pumps, electric furnaces or electric boilers, represent a small proportion of the home heating systems in PEI based on the PEI Home Energy Survey, electric baseboards with a low-voltage thermostat seem rare, and that, of the 30 sites visited, all programmable thermostats were installed on non-electric heating systems, the Evaluator assumed that 0% of the programmable thermostats generated electricity savings.

For other products, namely LED lamps and smart power bars, the proportion of units generating electricity savings is assumed to be 100% because they are directly connected to the electricity grid.

Table 4 below summarizes the percentage claimed for EE&C for each product category.

Table 4: Percentage Claimed for EE&C

Product Category	Proportion of Units	Source
Weatherization Products	32%	PEI Home Energy Survey[3]
LED Lamps	100%	Assumption
Low-Flow Showerheads	21%	Natural Resources Canada, 2017[4]
Programmable Thermostats	0%	Based on the model installed through the WW program only compatible with central heating systems which are less likely to be electric and confirmed during site visits.
Smart Power Bars	100%	Assumption

3.2.2 Installation Rates

Installation rates represent the proportion of products recorded in the database that were installed in participants' homes. The Evaluator established installation rates based on the results of the site visits.

[3] MQO Research, PEI Home Energy Survey: Results Summary, October 2018.
[4] Natural Resources Canada, Single Detached and Single Attached Water Heater Stock by Energy Source, https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=res&juris=pei&rn=29&page=0 (last accessed March 20, 2020).

Weatherization Products

For caulking, spray foam, and weatherstripping, the installation rate was considered to be 100% whether the product was installed or left behind. The Evaluator included the left-behind units in the installation rate because the unitary savings, which were established on a per-participating home basis, were based on a consideration of the average quantity of products installed per home (e.g., 3 windows sealed with caulking or foam on average).

For electrical outlet gaskets, the unitary savings were established on a per-unit basis. Although the number of electrical outlet gaskets installed on exterior walls could not be validated through the site visits, the Evaluator applied an installation rate of 50% for this product since it is unlikely that all gaskets were installed on exterior walls based on the high number of units installed in many participating houses.

Door sweeps, door bumpers, and attic hatch insulation also have unitary savings values established on a per-unit basis. In the small number of visited homes that included these products, the Evaluator was able to observe that the products were installed in most cases. Indeed, only one participant did not have his door sweeps installed yet because the house was still in renovation.

Although the number of visited houses that received window insulation film was small (3), the Evaluator observed a very low installation rate for this product. Indeed, only one of the visited houses had the product installed and almost one-half of it did not last the winter.

As for plug covers, no installation rate was established because the savings for this product is assumed to be negligible.

Energy Efficient Products

For LED lamps, the site visits revealed that a pack of six lamps was provided to each participant, but not all LED lamps were installed by the service providers. Nonetheless, the Evaluator decided to use an installation rate of 100% for the LED lamps provided by the WW program based on the following two assumptions: (1) the Evaluator confirmed during the site visits that a proportion of the left-behind lamps had been installed since the visit of the service provider; (2) for the remaining ones, the Evaluator assumed that they would be installed in the near future and that any discounted savings would be small. It is worth mentioning that the displaced wattage value used in the unitary savings calculation for LED lamps takes into account the different replacement scenarios. Moreover, site visits were made to those participants who had participated before the program made the change to allow service providers to replace all existing lamps. The Evaluator also assumed an installation rate of 100% for lamps installed through this new installation approach, which represents a minority of 2019/2020 participants (22%), because it is believed that this change in delivery process should result in few or no lamps left behind in the future. However, this parameter should be validated in a future evaluation, once the transition to the new installation approach and data tracking is completed.

For low-flow showerheads and power bars, the installation rates of 87% and 63% were established respectively based on the actual numbers of units found installed on site. It should be mentioned that, since LED lamps are now directly installed by the service provider, power bars are the only product left behind.

The Evaluator also confirmed the installation of programmable thermostats during the site visits.

Table 5 below lists the installation rate established for each product category.

Table 5: Installation Rates

Product Category	Installation Rate	Number of Participants with this Product	Unitary Savings Basis
Weatherization Products			
Caulking and Spray Foam	100%	24	Per participant
Weatherstripping	100%	23	Per participant
Electrical Outlet Gaskets	50%	25	Per unit
Door Sweeps and Bumpers	100%	5	Per unit
Attic Hatch Insulation	100%	8	Per unit
Window Insulation Film	Assumed to generate no savings due to a low installation rate	3	N/A
Plug Covers	Assumed to generate no savings	22	N/A
Energy Efficient Products			
LED Lamps	100%	30	Per unit
Low-Flow Showerheads	87%	29	Per unit
Programmable Thermostats	100%	20	Per unit
Smart Power Bars	63%	30	Per unit

3.2.3 Unitary Energy Savings

The Evaluator established a unitary energy savings value for each WW program product category based on a literature review and engineering calculations, supported by program data and findings from the site visits. Appendix II provides a detailed description of the parameters and unitary energy savings calculations used for each product category.

Table 6 below lists the unitary energy savings value[5] for each product category.

[5] All unitary savings values were calculated at the meter. Line loss factors were added to obtain savings at the generator in the gross savings compilation table (see Table 9).

Table 6: Unitary Energy Savings Values

Product Category	Unitary Energy Savings Value	Source
Weatherization Products		
Caulking and Spray Foam	325 kWh/participant	Established by the Evaluator
Weatherstripping	314 kWh/participant	Established by the Evaluator
Electrical Outlet Gaskets	6.56 kWh/unit	Established by the Evaluator
Door Sweeps and Bumpers	126 kWh/unit	Established by the Evaluator
Attic Hatch Insulation	91.9 kWh/unit	Established by the Evaluator
Window Insulation Film	-	Assumed to be negligible
Plug Covers	-	Assumed to be negligible
Energy Efficient Products		
LED Lamps	31.2 kWh/unit	Established by the Evaluator
Low-Flow Showerheads	322 kWh/unit	Established by the Evaluator
Programmable Thermostats	-	100% of the units are assumed to generate non-electrical energy savings.
Smart Power Bars	207 kWh/unit	Established by the Evaluator

3.2.4 Unitary Peak Demand Savings

Electricity peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The peak demand period in PEI occurs between 5 p.m. and 7 p.m. from mid-December through early March inclusively, on any day when maximum temperature is -10°C or lower.

To calculate the unitary peak demand savings values for each product category, the Evaluator used peak demand-to-energy ratios. These ratios were multiplied to the unitary energy savings values established in the previous section to obtain unitary peak demand savings values. For LED lamps, the Evaluator applied a value of 0.162 W/kWh drawn from the Northeast Residential Lighting Hours-of-Use (NERHOU) Study[6]. As for other product categories, the Evaluator relied on peak demand-to-energy ratios established for Nova Scotia for various types of energy efficiency measures, as found in EfficiencyOne's 2019 evaluation reports.[7] Although the Nova Scotia peak demand period occurs during weekdays only, the Evaluator considered that Nova Scotia and PEI peak demand periods are sufficiently similar to use the Nova Scotia peak demand-to-energy ratios.

[6] NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014.
[7] Econoler, 2019 DSM Evaluation Reports, prepared for EfficiencyOne, March 2020.

Table 7 lists the peak demand-to-energy ratio used for each product category and the resulting unitary peak demand savings values.

Table 7: Unitary Peak Demand Savings Values

Product Category	Peak Demand-to-energy Ratio [W/kWh]	Unitary Peak Demand Savings	Source
Weatherization Products			
Caulking and Spray Foam	0.156	50.7 W/participant	EfficiencyOne 2019 DSM Evaluation Reports
Weatherstripping		49.0 W/participant	
Electrical Outlet Gaskets		1.02 W/unit	
Door Sweeps and Bumpers		19.7 W/unit	
Attic Hatch Insulation		14.3 W/unit	
Window Insulation Film	-	-	Assumed to be negligible
Plug Covers	-	-	Assumed to be negligible
Energy Efficient Products			
LED Lamps	0.162	5.05 W/unit	Northeast Residential Lighting Hours-of-Use Study
Low-Flow Showerheads	0.162	52.2 W/unit	EfficiencyOne 2019 DSM Evaluation Reports
Programmable Thermostats	-	-	Not defined because 100% of the units are assumed to generate non-electrical energy savings.
Smart Power Bars	0.000	0.0 W/unit	EfficiencyOne 2019 DSM Evaluation Reports

3.2.5 Interactive Effects

Interactive effects occur in a home 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 the WW program, no interactive effects occur for weatherization products and programmable thermostats because the savings result from heating and cooling reduction directly. Also, the Evaluator considered the interactive effects for smart power bars and low-flow showerheads to be negligible.

However, replacing inefficient lighting products with LED lamps causes an increase in the heating load in winter and a decrease in the cooling load in summer. The Evaluator established energy and peak demand interactive effects factors based on a study conducted by ADS Groupe-conseil Inc. for Hydro-Québec,[8] and adjusted them to account for the proportions of electric heating and cooling systems in PEI and lamps installed indoor. The methodology and detailed calculations for establishing the interactive effects factors are presented in Appendix III. Following this methodology, the Evaluator established interactive effects factors of -11.3% and -21.1% for energy and peak demand respectively.

3.2.6 Effective Useful Life

The EUL values of products correspond to the number of years over which savings are expected to be realized. They are used to determine the energy savings throughout product lifetimes.

For LED lamps, an equivalent EUL value was calculated since this lamp type is expected to experience increased baselines during its lifetime, which reduces its EUL. An equivalent EUL corresponds to the number of years by which the first-year savings need to be multiplied to obtain the lifetime savings. The calculation methodology is presented in more detail in Appendix IV. For other products, the EUL values were established based on a literature review.

Table 8 below lists the EUL value for each product category.

Table 8: EUL Values

Product Category	EUL Value (Years)	Source
Weatherization Products		
Caulking and Spray Foam	15.0	GDS Measure Life Report
Weatherstripping	15.0	GDS Measure Life Report
Electrical Outlet Gaskets	15.0	GDS Measure Life Report
Door Sweeps and Bumpers	15.0	GDS Measure Life Report
Attic Hatch Insulation	25.0	GDS Measure Life Report
Window Insulation Film	-	Not defined because the savings are assumed to be negligible.
Plug Covers	-	Not defined because the savings are assumed to be negligible.
Energy Efficient Products		
LED Lamps	6.1	Evaluator's Calculation
Low-Flow Showerheads	10.0	DEER 2014 EUL Table
Programmable Thermostats	11.0	DEER 2014 EUL Table
Smart Power Bars	4.0	David Rogers, Power Smart Engineering

[8] ADS ASSOCIÉS, *Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale*, report submitted to Hydro-Québec, 1992.

3.2.7 Summary of Gross Savings

The annual gross savings for each product category that generated electrical energy savings in 2019/2020 are listed in Table 9 below. Savings at the generator were obtained by applying line loss factors of 1.120 for energy and 1.171 for demand, as provided by Maritime Electric, the electricity utility.

Table 9: Gross Energy and Peak Demand Savings for 2019/2020

Product Category	Weatherization Products							
	Caulking and Spray Foam	Weather-Stripping	Electrical Outlet Gaskets	Door Sweeps and Bumpers	Attic Hatch Insulation	Window Insulation Film	Plug Covers	Subtotal
Number of Units								
Total Number of Units	**484**	**468**	**6478**	**145**	**207**	**65**	**468**	**643**
Percentage Claimed for EE&C	32%	32%	32%	32%	32%	32%	32%	32%
Number of Units Claimed for EE&C	**155**	**150**	**2073**	**46**	**66**	**21**	**150**	**206**
Installation Rate	100%	100%	50%	100%	100%	-	-	-
Number of Units Installed	**155**	**150**	**1037**	**46**	**66**	**-**	**-**	**-**
Energy Savings								
Unitary Savings Value (kWh)	325	314	6.56	126	91.9	-	-	564
Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
Gross Energy Savings – at the Meter (GWh)	**0.050**	**0.047**	**0.007**	**0.006**	**0.006**	**0.000**	**0.000**	**0.116**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120	-
Gross Energy Savings – at the Generator (GWh)	**0.056**	**0.053**	**0.008**	**0.006**	**0.007**	**0.000**	**0.000**	**0.130**
Effective Useful Life (years)	15.0	15.0	15.0	15.0	25.0	-	-	-
Gross Lifetime Energy Savings – at the Generator (GWh)	**0.846**	**0.791**	**0.114**	**0.097**	**0.170**	**0.000**	**0.000**	**2.019**
Peak Demand Savings								
Unitary Savings Value (W)	50.7	49	1.02	19.7	14.3	-	-	87.9
Interactive Effects Factor	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-
Gross Peak Demand Savings – at the Meter (MW)	**0.008**	**0.007**	**0.001**	**0.001**	**0.001**	**0.000**	**0.000**	**0.018**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171	-
Gross Peak Demand Savings – at the Generator (MW)	**0.009**	**0.009**	**0.001**	**0.001**	**0.001**	**0.000**	**0.000**	**0.021**

Table 9: Gross Energy and Peak Demand Savings for 2019/2020 (Continued)

Product Category	Energy Efficient Products				Total
	LED Lamps	Low-Flow Showerheads	Programmable Thermostats	Smart Power Bars	
Number of Units					
Total Number of Units	**6260**	**705**	**352**	**619**	**699**
Percentage Claimed for EE&C	100%	21%	100%	100%	-
Number of Units Claimed for EE&C	**6260**	**148**	**0**	**619**	**-**
Installation Rate	100%	87%	-	63%	-
Number of Units Installed	**6260**	**129**	**0**	**392**	**-**
Energy Savings					
Unitary Savings Value (kWh)	31.2	322	-	207	590
Interactive Effects Factor	-11.3%	0.0%	0.0%	0.0%	
Gross Energy Savings – at the Meter (GWh)	**0.173**	**0.042**	**0.000**	**0.081**	**0.412**
Line Loss Factor	1.120	1.120	1.120	1.120	
Gross Energy Savings – at the Generator (GWh)	**0.194**	**0.047**	**0.000**	**0.091**	**0.462**
Effective Useful Life (years)	6.1	10.0	11.0	4.0	8.7
Gross Lifetime Energy Savings – at the Generator (GWh)	**1.184**	**0.465**	**0.000**	**0.364**	**4.031**
Peak Demand Savings					
Unitary Savings Value (W)	5.05	52.2	-	0	71.2
Interactive Effects Factor	-21.1%	0.0%	0.0%	0.0%	-
Gross Peak Demand Savings – at the Meter (MW)	**0.025**	**0.007**	**0.000**	**0.000**	**0.050**
Line Loss Factor	1.171	1.171	1.171	1.171	-
Gross Peak Demand Savings – at the Generator (MW)	**0.029**	**0.008**	**0.000**	**0.000**	**0.058**

Because the 2018/2019 program database did not include details about the products installed in participating homes, the Evaluator calculated the average savings value per participant based on the 2019/2020 evaluation results and applied this value to the 2018/2019 participants. The average energy and peak demand savings values per participant were established at 590 kWh and 71.2 kW respectively. The annual gross electricity savings for 2018/2019 are shown in Table 10 below.

Table 10: Gross Energy and Peak Demand Savings for 2018/2019

	Evaluation Results for 2018/2019
Number of Units	
Total Number of Participants	528
Energy Savings	
Average Electricity Savings per Participant (kWh/participant)	590
Gross Energy Savings – at the Meter (GWh)	**0.312**
Line Loss Factor	1.120
Gross Energy Savings – at the Generator (GWh)	**0.349**
Effective Useful Life (years)	8.7
Gross Lifetime Energy Savings – at the Generator (GWh)	**3.035**
Peak Demand Savings	
Average Peak Demand Savings per Participant (W/participant)	71.2
Gross Peak Demand Savings – at the Meter (MW)	**0.038**
Line Loss Factor	1.171
Gross Peak Demand Savings – at the Generator (MW)	**0.044**

3.3 Net Savings

Net savings are defined as the energy use reductions specifically attributable to a program. Effects that positively or negatively affect the energy savings generated by a program, namely free-ridership and spillover, are generally considered. They are then combined into a net-to-gross ratio (NTGR) that is applied to gross energy savings.

3.3.1 Net-to-gross Ratio Calculations

Evaluation standards assume that free-ridership and spillover are nil among low-income participants. Although the WW program accepts both low- and moderate-income participants, the Evaluator considered that the NTGR assumption for low-income was reasonable for this first evaluation of the WW program considering the program delivery model and types of products installed. Therefore, the NTGR was established at 1.00.

3.3.2 Summary of Net Savings

Net savings are determined by applying the NTGR to evaluated gross savings using the following equation:

$$\textit{Net Savings} = \textit{Evaluated Gross Savings} \times \textit{NTGR}$$

Since the NTGR is assumed to be 1.00, net savings are equal to gross savings for the WW program. The detailed net savings results for 2019/2020 and 2018/2019 are summarized below in Table 11 and Table 12 respectively.

Table 11: Net Energy and Peak Demand Savings for 2019/2020

Product Category	Weatherization Products						
	Caulking and Spray Foam	Weather-stripping	Electrical Outlet Gaskets	Door Sweeps and Bumpers	Attic Hatch Insulation	Window Insulation Film	Plug Covers
Energy Savings							
Gross Energy Savings – at the Meter (GWh)	0.050	0.047	0.007	0.006	0.006	0.000	0.000
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net Energy Savings – at the Meter (GWh)	**0.050**	**0.047**	**0.007**	**0.006**	**0.006**	**0.000**	**0.000**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120	1.120
Net Energy Savings – at the Generator (GWh)	**0.056**	**0.053**	**0.008**	**0.006**	**0.007**	**0.000**	**0.000**
Effective Useful Life (years)	15.0	15.0	15.0	15.0	25.0	-	-
Net Lifetime Energy Savings – at the Generator (GWh)	**0.846**	**0.791**	**0.114**	**0.097**	**0.170**	**0.000**	**0.000**
Peak Demand Savings							
Gross Peak Demand Savings – at the Meter (MW)	0.008	0.007	0.001	0.001	0.001	0.000	0.000
NTGR	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Net Peak Demand Savings – at the Meter (MW)	**0.008**	**0.007**	**0.001**	**0.001**	**0.001**	**0.000**	**0.000**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171	1.171
Net Peak Demand Savings – at the Generator (MW)	**0.009**	**0.009**	**0.001**	**0.001**	**0.001**	**0.000**	**0.000**

Table 11: Net Energy and Peak Demand Savings for 2019/2020 (Continued)

Product Category	Energy Efficient Products				Total
	LED Lamps	Low-Flow Showerheads	Programmable Thermostats	Smart Power Bars	
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.173	0.042	0.000	0.081	0.412
NTGR	1.00	1.00	1.00	1.00	-
Net Energy Savings – at the Meter (GWh)	**0.173**	**0.042**	**0.000**	**0.081**	**0.412**
Line Loss Factor	1.120	1.120	1.120	1.120	-
Net Energy Savings – at the Generator (GWh)	**0.194**	**0.047**	**0.000**	**0.091**	**0.462**
Effective Useful Life (years)	6.1	10.0	11.0	4.0	8.7-
Net Lifetime Energy Savings – at the Generator (GWh)	**1.184**	**0.465**	**0.000**	**0.364**	**4.031**
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.025	0.007	0.000	0.000	**0.050**
NTGR	1.00	1.00	1.00	1.00	-
Net Peak Demand Savings – at the Meter (MW)	**0.025**	**0.007**	**0.000**	**0.000**	**0.050**
Line Loss Factor	1.171	1.171	1.171	1.171	-
Net Peak Demand Savings – at the Generator (MW)	**0.029**	**0.008**	**0.000**	**0.000**	**0.058**

Table 12: Net Energy and Peak Demand Savings for 2018/2019

	Evaluation Results for 2018/2019
Energy Savings	
Gross Energy Savings – at the Meter (GWh)	0.312
NTGR	1.00
Net Energy Savings – at the Meter (GWh)	**0.312**
Line Loss Factor	1.120
Net Energy Savings – at the Generator (GWh)	**0.349**
Effective Useful Life (years)	8.7
Net Lifetime Energy Savings – at the Generator (GWh)	**3.035**
Peak Demand Savings	
Gross Peak Demand Savings – at the Meter (MW)	0.038
NTGR	1.00
Net Peak Demand Savings – at the Meter (MW)	**0.038**
Line Loss Factor	1.171
Net Peak Demand Savings – at the Generator (MW)	**0.044**

3.4 Cost-Effectiveness

The Evaluator assessed program cost-effectiveness by performing specific cost-effectiveness tests, namely the TRC and the PAC tests. When performing these tests, ratios greater than 1 are desired because they indicate that program benefits outweigh costs. This section presents the calculations performed to assess the cost-effectiveness of the EE&C portion of the program.

Various values and parameters were necessary to conduct these tests:

- The gross and net electrical savings as well as the EUL were drawn from the results presented in Subsections 3.2 and 3.3 of this report. To quantify the economic value of those savings (i.e. the program benefits), the Evaluator used the unitary avoided costs of electrical energy savings and peak demand savings that were provided by the electricity utility, Maritime Electric. Total program costs, broken down by administrative and incentive costs, were provided by ePEI. The Evaluator estimated the proportion of those costs allocated to EE&C based on the ratio of electrical and non-electrical savings[9] generated by the program in 2019/2020. The IPCs associated with products generating electrical savings were estimated by the Evaluator and is described in further detail in Subsection 3.4.1 below.
- The Net Present Value (NPV) calculations of all cash flows (costs and benefits) considered in the cost-effectiveness tests were performed using the ePEI discount rate (3.2%) and inflation rate (2%).

3.4.1 Incremental Product Costs

IPCs are defined as the difference between the costs of the energy efficient products offered by a given program and the costs of the base case products that would have been installed in the absence of said program. For direct install programs such as the WW program, IPCs also include installation costs.

For all products except LED lamps, the base case is to not install the efficient product. Therefore, the IPC equals the full cost of the product and the installation.

For LED lamps, the IPC cannot simply be the difference between the cost of a standard product and the cost of a LED lamp. Although LED products are more expensive, their useful life is much longer than that of halogen incandescent lamps or fluorescent lamps. The rated life of typical LED lamps is between 15,000 and 25,000 hours (or between 15 and 25 years if used in residential applications), whereas halogen incandescent lamps only last about 1,000 to 2,000 hours. Other types of lamps last longer (halogen reflector lamps last up to 4,000 hours and CFLs up to 10,000 hours), but they do not last as long as LEDs. Therefore, to provide a service life equivalent to that of one LED product, many standard lamps have to be purchased. Since IPCs are used to calculate lifetime cost-to-benefit ratios of energy efficiency measures, they must reflect the true lifetime difference in cost. In this context, some jurisdictions calculate a negative IPC for LED products, such as the Ontario Independent Electricity System Operator. However, applying a negative IPC to cost-effectiveness tests is challenging. For instance, if a negative IPC exceeds the program costs, the denominator of the TRC test ratio will be negative, resulting in a negative ratio. To avoid overestimating cost-effectiveness test results, certain jurisdictions such as Manitoba and Nova Scotia use a nil value as the IPC of LED products. The Evaluator considered this a reasonable assumption and applied it to the LED products installed through the WW program.

[9] Although the quantification of non-electrical energy savings was outside of the scope of the evaluation, the Evaluator used the number of products, listed in the database, generating non-electrical savings as well as estimates of the unitary energy savings of each product to produce a high-level estimate of the non-electrical savings for the WW program and compared that value to electrical energy savings to obtain a percentage of savings attributed to EE&C activities.

Since the WW program is a direct-install program, there are no incentives, unlike in other energy efficiency programs. However, for the purpose of the cost-effectiveness assessment, product and installation costs are included as incentives. Given this and the IPC conclusions above, the only difference between the total IPCs and the incentives is the cost of the LED lamps. Hence, the Evaluator established the total incremental costs of the WW program by deducting the cost of LED lamps from the total incentive amount. As per the information provided by ePEI, the LED lamps provided through the program are worth $2.30 each.

Table 13 below shows the resulting IPCs per participant for the 2019/2020 period.

Table 13: IPC Values

Product Category	IPC Definition	IPC	Source
LED Lamps	0% of full cost	$0	Assumption
Other Products	100% of full cost	$302	Cost provided by ePEI without costs for LED lamps

For the 2018/2019 period, the Evaluator used the same approach, i.e., using the incentive amount provided by ePEI and subtracting the cost of LED lamps. The Evaluator assumed that each participant received six LED lamps because product quantities were not available in the 2018/2019 database.

Because this IPC value is for all participants regardless of their savings being electrical or not, the Evaluator estimated the proportion of those costs allocated to EE&C based on the ratio of electrical and non-electrical savings generated by the program in 2019/2020. This resulted in overall IPCs of $53,433 and $56,922 for the 2018/2019 and 2019/2020 program years respectively.

3.4.2 Cost-Effectiveness Tests

This subsection presents the equations used for the PAC and TRC tests. For each test, benefits are at the numerator and costs at the denominator, and they both need to be NPVs.

PAC Test

The PAC test measures the net economic benefit of a program from the program administrator perspective using the equation presented below:

$$PAC = \frac{NPV\ (Avoided\ Costs)}{NPV\ (Total\ Gross\ Program\ Admnistrator\ Costs)}$$

- **Avoided costs** are the avoided supply costs achieved by the net electrical energy and peak demand savings generated by the program. The avoided unitary costs in $/kWh and $/kW saved were multiplied by the electrical energy and peak demand savings respectively.
- **Total gross program administrator costs** are the program costs incurred by the program administrator. Program administrator costs include costs related to program planning, design, marketing, implementation and evaluation, as well as incentives. Incentives typically represent the amounts that the program administrator offers participating customers for the upgrades they implement; for the WW program, incentives include the product and installation costs. The program costs were provided by ePEI and only the proportion attributable to EE&C savings was considered since the PAC test is performed for the EE&C portion of the program.

TRC Test

The TRC test reveals the total net benefits of a program from the perspective of both the utility and participating customers. It is not necessary to know who realizes the benefits and bears the costs.

The TRC test is calculated based on the following formula:

$$TRC = \frac{NPV\ (Avoided\ Costs + Customer\ Benefits)}{NPV\ (Net\ Tech.\ Costs + Gross\ Program\ Administrator\ Non{-}Incentive\ Costs)}$$

- For the TRC test, the **avoided costs** are the same as those of the PAC test.
- **Customer benefits** are participant non-energy benefits such as water savings and improved comfort or safety. For the WW program, only water savings from low-flow showerheads were included, as presented in Appendix II, along with the unitary energy savings value associated with these water savings.
- **Net technical costs** correspond to the IPCs discussed in subsection 3.4.1.
- The **gross program administration non-incentive costs** are the same costs as in the PAC ratio denominator, except that they exclude incentives. Incentives are excluded because they are financial transfers between ePEI and participating customers, thus not representing an expense.

3.4.3 Cost-Effectiveness Results

Table 14 and Table 15 present the cost-effectiveness results for the 2019/2020 and 2018/2019 periods respectively. As outlined in these tables, the WW program was cost-effective in both years, based on both the PAC and TRC results.

Table 14: 2019/2020 Cost-Effectiveness Results

Cost-Effectiveness Test	Ratio	Benefits	Costs
PAC Test	**4.56**	$424,961	$93,143
TRC Test	**5.65**	$504,589	$89,256

Table 15: 2018/2019 Cost-Effectiveness Results

Cost-Effectiveness Test	Ratio	Benefits	Costs
PAC Test	**4.47**	$321,164	$71,881
TRC Test	**5.45**	$381,312	$69,913

3.5 Summary of Program Savings and Cost-Effectiveness Results

Table 16 summarizes the key results from the program savings and cost-effectiveness evaluations and compares these results to program targets.

Table 16: Summary of Program Savings and Cost-Effectiveness Targets and Evaluated Results

Parameters	2018/2019 Targets	2018/2019 Evaluation Results	2019/2020 Targets	2019/2020 Evaluation Results
Program Participation				
Number of Participants	350	528	350	699
Gross Electricity Savings at the Generator				
Gross Electricity Energy Savings (GWh)	-	0.349	-	0.462
Gross Lifetime Electricity Savings (GWh)	-	3.035	-	4.031
Gross Peak Demand Savings (MW)	-	0.044	-	0.058
Net Electricity Savings at the Generator				
NTGR	-	1.00	-	1.00
Net Electricity Energy Savings (GWh)	0.3	0.349	0.3	0.462
Net Lifetime Electricity Savings (GWh)	-	3.035	-	4.031
Net Peak Demand Savings (MW)	0.1	0.044	0.1	0.058
Cost-Effectiveness				
PAC Test		4.47	2.0	4.56
TRC Test	2.2	5.45	2.1	5.65

› The 2018/2019 and 2019/2020 evaluated net electricity energy savings exceeded program targets by 16% and 54% respectively. This was mainly due to participation levels being higher than expected, with 51% and 100% more participants in 2018/2109 and 2019/2020 respectively.

› The 2018/2019 and 2019/2020 evaluated net peak demand savings did not achieve program targets by 56% and 42% respectively. Although the participation level was higher than expected, the average peak demand savings per participant were considerably lower than anticipated at the time of setting the targets.

› The PAC and TRC tests revealed that the program was very cost-effective from both perspectives and reached the cost-effectiveness targets for both fiscal years.

4 PROGRAM PROCESSES AND IMPLEMENTATION

This section includes the evaluation results related to program processes and implementation. Specifically, it presents the Evaluator's findings of the paper form review and site visits regarding program tracking, implementation and participant experience, as well as the findings regarding overall program data completeness and organization.

4.1 Paper Form Review and Site Visit Observations

In preparation for the site visits, the Evaluator was provided with the original paper forms filled in by the service providers for each site to be visited, and first compared the data in these forms to the data in the program database to ensure that no data entry errors had occurred. The Evaluator found only one minor tracking discrepancy, where the quantity of electrical gaskets tracked in the program database was off by one unit compared to the paper form.

The Evaluator did notice, however, that for some products, the quantities reported as installed differed considerably between the two service providers. For example, one service provider reported an average of 3.0 tubes of caulking per participant while the other had an average of 1.3 tubes per participant. This situation was even more obvious for foam weatherstripping, for which one service provider provided an average of 52.8 feet of stripping and the other, an average of 18.8 feet. These results highlight differences in installation habits and potentially product preferences between the two service providers.

Although the WW program is designed to offer direct installation of products by the service providers, the site visits revealed that some products were left behind to be installed by participants, specifically weatherization products and LEDs. The Evaluator saw uninstalled weatherization products in six homes. The installation of weatherization products by service providers is important to ensure that it was carried out appropriately and that savings occur. Also, at least a portion of the LED lamps were left behind most of the time. It should be noted, however, that all visited participants had received their products before the program change in December 2019, which allows the service providers to replace all existing lamps. The Evaluator believes that this change in delivery process should result in few or no lamp left behind in the future but recommends monitoring this.

4.2 Program Data Completeness

Figure 2 presents the important data types for the WW program and their status in the 2019/2020 WW program database.

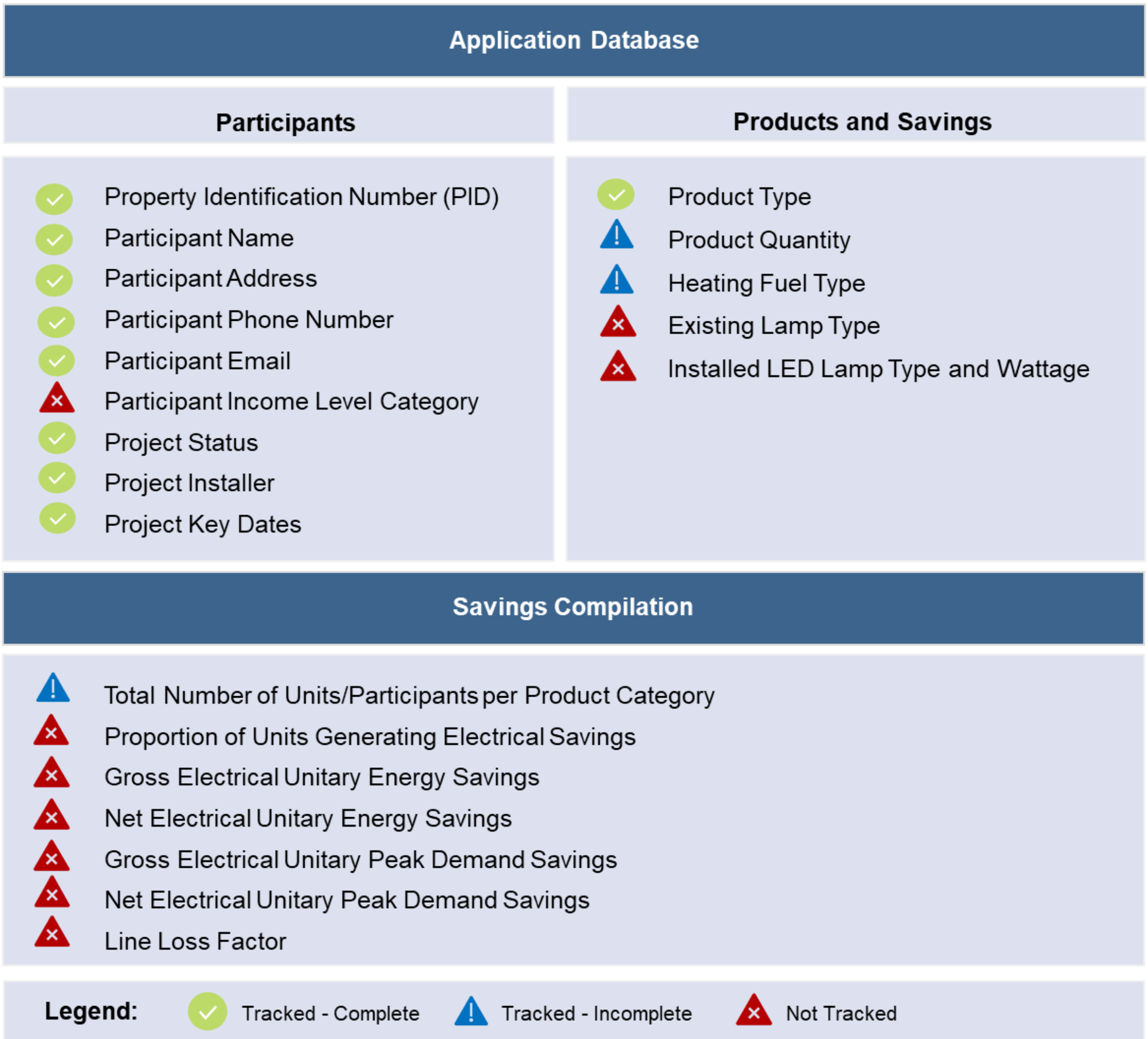

Figure 2: Summary of WW Program Data Tracking

Data tracking for the WW program is performed in a dedicated spreadsheet. The database is generally complete and well-organized. There are few unused or incomplete columns, data fields are used consistently, and most information required for evaluation is available. The database includes mostly complete and consistent information for participants and products. The Evaluator has nonetheless identified the following improvement areas.

Evaluation findings have led the Evaluator to assume that, although the program includes low-income participants that are typically assumed not to be free-riders, there may be some free-ridership in the program. For example, the Evaluator found that many participants already had LEDs in their homes. Additionally, the program has been operating for almost 15 years, which might indicate that the low-income market is becoming saturated, thereby leading to a greater proportion of moderate-income participants being registered for the program and a lesser proportion of low-income participants. With this in mind, the Evaluator believes that the next evaluation should include an assessment of free-ridership among moderate-income participants. For this, the database should include which participants are low income vs moderate income.

The database indicates in which participant home each weatherization product was installed. In another column, a unit of measure is tracked, which sometimes refers to a number of units (e.g. door sweeps, electrical outlet gaskets), the material used (e.g. tubes, cans) or the length of material used (e.g. ft). It is sometimes unclear whether these quantities are the ones that were actually installed in participant homes or the ones that the installer used. In addition, some products were left behind for future installation. These two findings render the calculation of unitary savings values challenging. In some cases, the unitary savings values were calculated on a per-participant basis, based on site observations and assumptions on the number of windows or doors sealed. This situation applies to caulking, spray foam and weatherstripping.

The database includes fields for primary and secondary heating systems, but more than one heating source is often included under the primary heating system column, making it impossible to identify the actual primary source. The program database should also include unitary energy and peak demand savings values so that tracked savings can be calculated. Also, it should be clearly indicated whether the savings values are at the meter or at the generator. If they are at the generator, the line loss factor should be included in the database.

The Evaluator recommends tracking the existing lamps replaced by LEDs along with the types and wattage of the LEDs installed because the program now offers the replacement of all existing lamps using three different types of LEDs.

Recommendation: Continue tracking current items and try collecting data on currently untracked or incomplete items. These untracked or incomplete items include the primary heating system types, gross and net electrical unitary energy and peak demand savings, as well as the income level to enable an assessment of free-ridership in the future.

Recommendation: Ensure to collect the relevant information for establishing the unitary savings value of each product category.

For caulking, spray foam and weatherstripping, it would be important, in the future, to collect information at least on the number of windows and doors sealed and, if possible, the perimeter sealed, to establish unitary savings values more precisely or calculate savings on a per-foot basis rather than on a per-participant basis. Similarly, for electrical outlet gaskets, more information on the number of units installed on outdoor walls would allow for a more precise unitary savings value calculations. As for door sweeps and attic hatch insulation, the information tracked in the database was sufficient and seemed accurate.

Recommendation: Add a field for the proportion of units that generate electrical savings (claimed for EE&C) and ensure this value is multiplied by the total number of units installed.

4.3 Program Data Organization

The Evaluator identified the following opportunity to improve the organization of the WW program database:

› Product quantities are tracked in different columns than product types, which is good practice; however, this is not the case for low-flow showerheads. When more than one showerhead is installed, the quantity is tracked in brackets next to the product name. Additionally, quantities are not tracked at all for smart power bars. The Evaluator understands that most homes should receive only one power bar, but tracking quantities would avoid any ambiguity.

Recommendation: Always track quantities and ensure that upgrade types and quantities are tracked in different columns.

The Evaluator found other minor opportunities to improve the organization and clarity of the WW program database:

› Participant names are tracked in a single column. Tracking first and last names in separate columns would slightly improve searchability.
› The column heading “Spouse/Partner” does not account for common relationships such as son/daughter, niece/nephew, etc. Adjusting the heading to “Secondary Contact” or something similar would improve inclusiveness.
› The Postal Code column is not adjacent to other participant address fields.
› Some PIDs are seven digits while others are 10 digits.

Data tracking and reporting are crucial for program management and evaluation. The Evaluator understands that ePEI is in the process of acquiring a data management system that would allow program tracking to be centralized rather than being performed in multiple individual tracking sheets. The Evaluator supports ePEI’s goal to improve data management, which would contribute not only to the implementation of the data-completeness and data-organization recommendations in this report, but also ensure that program data is up to date and easy to use, for program management.

4.4 Participant Awareness of the Program

Participants learned about the program in various ways, with word of mouth being the primary source of awareness for 30% of participants visited. ePEI initiatives were also key in informing participants about the program. Four in 10 participants learned about the program through ePEI initiatives, including past program participation and experience with ePEI staff, as well as advertising such as radio, television, newspapers and Facebook. Another 10% of participants learned about the program through their heat pump contractor.

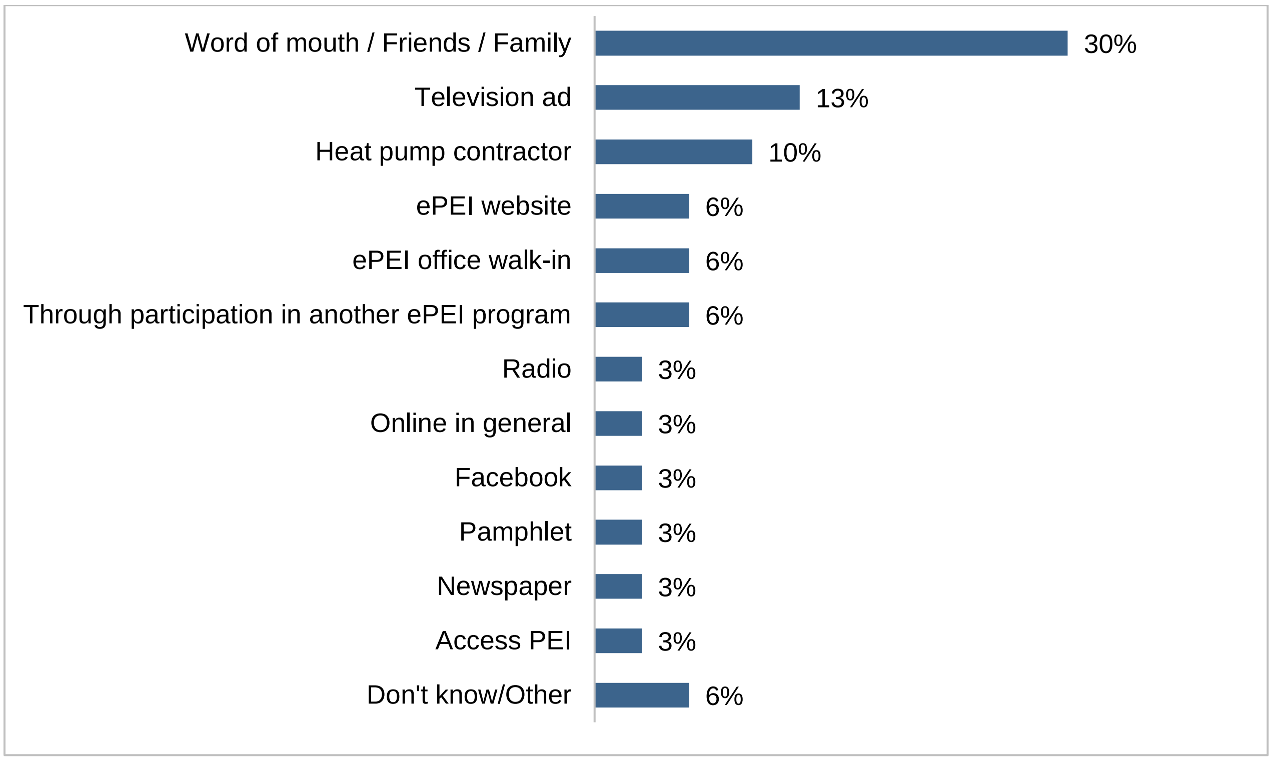

Figure 3: Primary Source of Awareness About the Program

4.5 Satisfaction with the Program

As presented in the figure below, participant satisfaction with the program was very high. Participants were also very satisfied with the products they had installed and the installer who performed the work. The satisfaction ratings were provided according to a 0 to 10 scale where 0 meant "not at all satisfied" and 10 meant "completely satisfied".

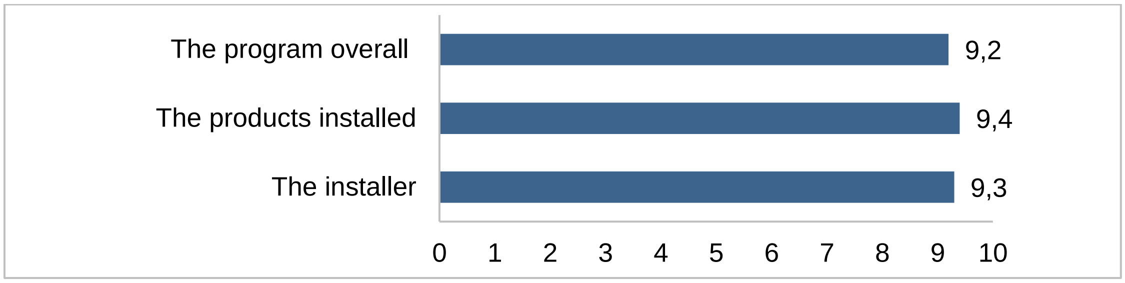

Figure 4: Participant Satisfaction

What follows is feedback from those participants who provided satisfaction ratings below 8.

› **The program overall:** Only two of the 30 respondents who were visited provided ratings below 8. One said that they expected more savings while the other mentioned that she was dissatisfied that the installer did not install most of the products; they were left with her.
› **The products installed:** Only one participant provided a rating below 8 because they were hoping the program would include more products. A few other participants who provided higher ratings did mention that despite being satisfied with the products installed, they struggled with using their thermostat or power bar. A couple of other participants also critiqued the quality of the power bar.
› **The installer:** Four of the 30 participants provided ratings below 8 when asked to express their satisfaction with the installer who came to their home. All four mentioned that they were dissatisfied because the contractor did not install all the products; some were left with the homeowners for installation. One participant also added that the visit felt rushed.

4.6 Participant Issues with the Program

When asked if they encountered issues or challenges during program participation, four of the 30 visited participants said that they did, as follows:

› Similar to the section above, one participant reiterated that she would have needed help with installing the products since some of them were not installed.
› Another participant would have liked more information on the information that was collected about their home and the decision to install certain specific products.
› One participant did not agree with the products that were installed. They said that the products did not meet their needs.
› The remaining participant mentioned that the thermostat installed was not appropriate for the heating conditions of their house and now finds their home colder and less comfortable.

4.7 Areas for Program Improvement

Participants were asked to provide recommendations to improve the program. Most of them did not have any recommendations and appreciated their experience with the program and want it to continue.

Among the remaining participants, the main areas for improvement were to:

- Advertise the program more
- Not limit the number of products installed (e.g. showerheads)
- Install more types of products

CONCLUSIONS AND RECOMMENDATIONS

The evaluation of the WW program was conducted to achieve the following objectives:

› Establish the gross electricity energy and peak demand savings generated by the program;
› Establish the net electricity energy and peak demand savings generated by the program;
› Assess whether the program is cost-effective;
› Assess the effectiveness of program processes and implementation.

This section provides the Evaluator's conclusions and recommendations related to program processes, implementation, cost-effectiveness, as well as electricity energy and peak demand savings.

The program reached its energy savings and cost-effectiveness targets, but not its peak demand savings targets.

For 2018/2019 and 2019/2020 respectively, net electricity energy savings targets of 0.3 GWh and 0.3 GWh had been set for the WW program. The program achieved 0.349 GWh and 0.462 GWh in net electricity energy savings in 2018/2019 and 2019/2020 respectively, therefore surpassing targets due to higher-than-expected participation. However, the average peak demand savings per participant were considerably lower than anticipated, which prevented the program from achieving its peak demand savings targets. Nonetheless, the program was very cost-effective in both fiscal years, based on the PAC and TRC tests.

Participant satisfaction with the program is high. Nonetheless, program delivery and reporting processes could be improved.

Participants provided overall positive feedback about the program and its aspects. Among the less-satisfied participants, the main reason for dissatisfaction was that not all the products had been installed by the service providers; some were left for the homeowners to install. The installation of weatherization products by service providers is important to ensure that it was carried out appropriately and that savings occur.

Recommendation 1: Develop guidelines for service providers to improve and ensure consistency in program delivery and reporting. These guidelines should clearly indicate which products need to be installed by service providers and which ones, if any, can be left behind. Also, the guidelines should specify what information should be collected to ensure the other above-mentioned recommendations are followed.

There are opportunities to improve the completeness and organization of program tracking data.

The Evaluator reviewed the program database and concluded that the database includes mostly complete and consistent information about participants and products. This was the case for door sweeps, attic hatch insulation, low-flow showerheads and smart power bars. Nonetheless, for other products, the Evaluator identified important data types that should be collected and tracked to effectively manage and evaluate the program and accurately calculate savings.

Recommendation 2: Ensure to collect the relevant information for establishing the unitary savings value of each product category.

› For caulking, spray foam and weatherstripping, it would be important to collect information at least on the number of windows and doors sealed and, if possible, the perimeter sealed, to establish unitary savings values more precisely or calculate savings on a per-foot basis rather than on a per-participant basis. Similarly, for electrical outlet gaskets, more information on the number of units installed on outdoor walls would allow for more precise unitary savings value calculations.

› For LED lamps, the installed LED lamp type and wattage should be tracked now because the program offers three different types of LED lamps. In addition, tracking the type and wattage of the replaced lamps would allow for better savings estimation.

Recommendation 3: Update program tracking to implement the following:

a. Continue tracking current items and try collecting data on currently untracked or incomplete items. The latter items include the primary heating system types, line loss factor, as well as gross and net electrical unitary energy and peak demand savings.
b. Add a field for the proportion of units that generate electrical savings (claimed for EE&C) and ensure this value is multiplied by the total number of units installed.
c. Always track quantities and ensure that upgrade types and quantities are tracked in different columns.
d. Track the income level of each participant (low or moderate) to enable an assessment of free-ridership in the future. Given the longevity of the program, some of the site visit observations and the fact that the program includes moderate-income participants (not just low-income participants), the Evaluator believes that free-ridership should be assessed in the future.

Subsections 4.2 and 4.3 of the report provide additional information on the findings that led to these sub-recommendations.

APPENDIX I
SITE VISIT PROTOCOL

HOUSEHOLD INFORMATION					
Applicant Name:				PID:	
Person met on-site				Telephone:	
Civic Address :				Postal Code:	
City:				Date of the visit:	
HEATING SYSTEMS					
	Tracked Fuel type	**Tracked Heating System type**	**On-site Fuel type**	**On-site Heating System type**	**Which one would you say is used as the main heating system?**
Heating system #1					
Heating system #2					
MEASURE VERIFICATION					
	Tracked	**On-site Verification**	**Observations On-site**		
Heating Measures					
Programmable Thermostat Installed:	Yes □ No □	Yes □ No □ Quantity: ___	Which heating system does it control? Is it programmed?		
Heating System Tune-up Coupon Received:	Yes □ No □	Yes □ No □	Was it used?	Yes □ No □	
Window and Door Air Sealing Measures					
Caulking:	Nb of tubes:	Nb of windows/doors:	<u>Was some removed?</u> If YES: How much was removed (less than 50%, 50% or more, all)? When (month)? Why?		
Foam Stripping:	Length:	Nb of windows/doors:			
Door Sweeps:	Nb of doors:	Nb of doors:			
Shrink Wrap:	Nb of rolls:	Nb of windows/doors:			
V-Weather Strip:	Length:	Yes □ No □			
Other Measures					
LED Bulbs Installed:	Tracked Nb:	On-site Nb:	If nb on-site is smaller, please investigate why (removal, burn-out, no explanation so seems to be a data entry error, etc.).		
			If nb on-site is higher, just confirm that the participant installed some LEDs by themselves, and note if it was done before or after participating in the program.		
Low-flow Shower Head Installed:	Yes □ No □ Quantity: ___	Yes □ No □ Quantity: ___	If different, investigate why:		
Smart Power Bar:	Yes □ No □	Yes □ No □	<u>Is it currently used?</u> If NO: Why? If YES: What is the main device on the power bar? How many devices does it control / are plugged in?	Yes □ No □ TV □ Computer □ Other □ Nb of controlled devices: ________	
Electrical Outlet Gaskets installed:	Nb:	Nb:	Only ask verbally if really installed. If so, count the number of electrical outlet on exterior walls.		
Plug Covers Installed:	Nb:	Nb:			
Spray Foam Applied:	Nb of Cans:	Yes □ No □	Only ask verbally if really installed		
Attic Hatch insulation installed:	Yes □ No □	Yes □ No □	Only ask verbally if really installed		

Questions on Participants' Experience with the Program:

Q1. How did you first learn about the Winter Warming Program?

Q2. On a scale from 0 to 10 where 0 means "Not at all satisfied" and 10 means "Completely satisfied", how satisfied are you with the Winter Warming Program overall?

Q2a. **[IF RATING IS 7 OR LESS, ASK]** Why are you not more satisfied?

Q3. On the same scale from 0 to 10, how satisfied are you with the products installed in your home?

Q3a. **[IF RATING IS 7 OR LESS, ASK]** Why are you not more satisfied?

Q4. On the same scale from 0 to 10, how satisfied are you with the contractor who installed the products in your home?

Q4a. **[IF RATING IS 7 OR LESS, ASK]** Why are you not more satisfied?

Q5. Did you face any issues or challenges during your participation in the program? If so, what were they?

Q6. Do you have any recommendations to improve the Winter Warming Program?

APPENDIX II
UNITARY ENERGY SAVINGS DETAILED CALCULATIONS

This appendix presents the detailed calculations and assumptions used to establish unitary energy savings values.

Weatherization Products

Weatherization products include caulking, spray foam, weatherstripping, electrical outlet gaskets, door sweeps and bumpers, attic hatch insulation, window insulation film, and plug covers.

The Evaluator consulted the TRMs of other jurisdictions offering similar programs and found that most jurisdictions base their savings calculations on results of door blower tests or pre- and post-installation R-values, neither of which is available. However, the Connecticut TRM[10] provides unitary savings values based on the results of an evaluation, conducted by KEMA in 2010, of a residential weatherization program. In its evaluation, KEMA conducted post-retrofit blower door tests to measure the amount of air infiltration in sampled homes. The baseline infiltration was determined with the information collected during site visits as well as ASHRAE assumptions. The energy savings were determined using DOE-2 energy simulations. Among the various sources consulted in the literature review, the Evaluator found the KEMA evaluation report to be the most robust in terms of the methodology employed to establish average savings values for these types of products.

The KEMA evaluation report provides per-foot unitary savings values for caulking (caulking and sealing), weatherstripping (window and door weatherization), as well as per-unit unitary savings for electric outlet gaskets and door sweeps.

To establish the average unitary savings value for each category of product, the Evaluator made the following assumptions based on the information in the database and the site visit findings, where possible.

- For the purpose of this evaluation, caulking and spray foam were combined because both products are used to seal the perimeter of windows or doors and, with the information provided in the database, it was not possible to determine whether or not they were installed on the same windows and doors. In the KEMA study, a single unitary savings value was established for caulking and sealing measures, by length of window or door perimeter caulked or sealed. To establish the unitary savings value for the caulking and spray foam installed through the WW program, the Evaluator assumed that an average of 45 ft of window or door frame was caulked for each participant that received at least one unit of either product. This length approximately corresponds to three windows with all the perimeters caulked.

[10] United Illuminating Company and Connecticut Light & Power Company, *Connecticut Program Savings Document, 15th Edition for 2019 Program Year*, March 2019.

- For weatherstripping, the Evaluator assumed that participants installed 37.5 ft of weatherstripping products on average if they received either foam or v-strip weatherstripping. This length approximately corresponds to two and a half windows with all the perimeters sealed.
- For electrical outlet gaskets, the Evaluator used the number of units from the database, to which an installation rate of 50% was applied (see Section 3.2.2 for more details).
- For door sweeps and bumpers, the Evaluator used the number of units directly from the database.

The only measures that were not included in the KEMA study were attic hatch insulation, door bumpers, window insulation film, and plug covers.

- Since the KEMA evaluation does not include attic hatch insulation, the unitary savings value for this product was drawn directly from the Connecticut TRM.[11]
- The Evaluator attributed no savings for window insulation film for the following reasons. First, from the three visited participants that received this product, only one installed some and almost half of the product did not last the winter. Second, the information in the literature was very limited. Where the information was available, such as in the Canadian Niagara Power Residential Direct Mail Pilot evaluation report,[12] the savings were calculated for the air sealing improvement associated with the installation of the window film. However, the Evaluator believes that the reduction of air leaks through the windows of WW participants is already captured in the savings associated with the other weatherization products. Third, window films were not widely distributed as part of the WW program compared with other weatherization products.
- For electrical outlet covers, the Evaluator estimates that the savings are likely negligible and found no jurisdiction that claims savings for this product. Therefore, the Evaluator did not attribute any savings for this product.

Adjustment Factor for Heating System Efficiency

The energy savings from weatherization products come from reducing the space heating load in homes. Therefore, only homes with electric space heating can generate electricity savings. Because the unitary savings values in Table 18 were established for homes with standard electric heating systems, homes heated with a heat pump generate lower savings. Thus, the Evaluator calculated an adjustment factor based on the proportion of heating systems in PEI and the average efficiencies associated with the different technologies.

$$Adjustment\ Factor\ for\ Heating\ System\ Efficiency = \frac{1}{COP_{Standard}} \times \%_{Standard} + \frac{1}{COP_{Heat\ Pump}} \times \%_{Heat\ Pump}$$

[11] Ibid.
[12] The Cadmus Group Inc. *Canadian Niagara Power: Draft Final Residential Direct Mail Pilot Evaluation*, August 2017, prepared for the Independent Electricity System Operator.

Table 17 below lists the parameters and corresponding values applied in the equation.

Table 17: Adjustment Factor for Heating System Efficiency

Parameter	Symbol	Value	Source
Coefficient of performance (COP) of a standard electric heating system	$COP_{Standard}$	1	Electric baseboards, boilers and furnaces are assumed to have a 100% efficiency, which corresponds to a COP of 1.
Percentage of the electric heating systems in PEI that are standard electric heating systems.	$\%_{Standard}$	59.4%	MQO Research, PEI Home Energy Survey: Results Summary, October 2018.
Average COP of a standard heat pump	$COP_{Heat\ Pump}$	3.0	Average COP of heat pumps rebated through the ePEI Energy Efficient Equipment Rebates program
Percentage of the electric heating systems in PEI that are heat pumps	$\%_{Heat\ Pump}$	40.6%	MQO Research, PEI Home Energy Survey: Results Summary, October 2018.
Adjustment Factor for Heating System Efficiency	**kWh/kWh**	**0.729**	

Summary of Unitary Energy Savings Values for Weatherization Products

Table 18 below lists the parameters used to establish the unitary savings values for the WW program evaluation.

Table 18: Unitary Savings Values for Weatherization Products

Product	Connecticut TRM Unitary Savings Values	Assumption	Adjustment Factor	Annual Unitary Savings Value
Caulking and Spray Foam	9.9 kWh/ft	45.0 ft/part.	0.729	**325 kWh/participant**
Weatherstripping	11.5 kWh/ft	37.5 ft/part.		**314 kWh/participant**
Electrical Outlet Gaskets	9 kWh/unit	-		**6.56 kWh/unit**
Door Sweeps and Bumpers	173 kWh/unit	-		**126 kWh/unit**
Attic Hatch Insulation	126 kWh/unit	-		**91.9 kWh/unit**
Window Insulation Film	-	-		**-**
Plug Cover	-	-		**-**

As mentioned above, most jurisdictions base their savings calculations on the results of door blower tests or pre- and post-installation R-values and calculate the full weatherization-related savings. When using separate unitary savings values for products impacting the same system (in this case, the space heating and cooling systems), caution should be taken in adding up those values. In comparison, a WW participant with all types of weatherization products installed[13] would have savings of 902 kWh and the average weatherization savings value per participant for the WW program was 564 kWh, which is a value falling within a similar range of the savings values claimed for this type of product by other jurisdictions. For example, the values of 501 kWh, 1,616 kWh and 2,013 kWh can be respectively found in the TRMs of Massachusetts,[14] Rhode Island,[15] and Maine.[16]

LED Lamps

The Evaluator used the equation below to calculate the unitary savings value for LED lamps installed through the program.

$$Unitary\ Savings\ \left[\frac{kWh}{yr}\right] = \frac{(Displaced\ Wattage)[W] \times HOU\left[\frac{h}{day}\right] \times 365\left[\frac{day}{yr}\right]}{1{,}000\left[\frac{W}{kW}\right]}$$

Although the LED lamps delivery approach changed in January 2020, the Evaluator established the unitary savings value based the initial approach of providing a pack of six LED lamps to each participant because this was the case for 78% of participants. For the remaining 22%, ePEI indicated that three different types of lamps were installed to replace existing lamps, but no information was tracked on the type installed. Moreover, no wattage information on the replaced existing lamps was collected through either approach. Therefore, the Evaluator considers it acceptable to use a unitary savings value established for a baseline consisting of a mix of different types of lamps.

Displaced Wattage

The displaced wattage corresponds to the difference between the baseline and the efficient wattages. To establish the baseline wattage, the Evaluator used the information collected through an intercept survey conducted as part of the ePEI Instant Energy Savings (IES) program evaluation. The Evaluator decided to use the IES value because no wattage information on the replaced lamps was tracked for the WW program and, more importantly, the site visits revealed that the LED lamps were often left behind rather than installed by the service provider, which implies a similar decision-making process about installing the lamps.

[13] Based on one door sweep, one attic hatch insulation, and the average number of electrical outlet gaskets on exterior walls (6.8).
[14] Massachusetts Electric and Gas Energy Efficiency Program Administrators, *Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures, 2016-2018 Program Years – Plan Version*, October 2015, p. 44.
[15] National Grid, *Rhode Island Technical Reference Manual for Estimating Savings from Energy Efficiency Measures – 2018 Program Year*, November 2018, p. M-31.
[16] Efficiency Maine, *Retail/Residential Technical Reference Manual Version 2019.1,* July 2018, p. 67.

As recommended in the principles of the Uniform Methods Project (UMP),[17] the Evaluator considered two types of baselines: the early-replacement baseline and the replace on burn-out baseline. Based on the IES program survey results, 54% of the LED lamps replace lamps that are still working and 46% replace burned-out lamps. For early-replacement lamps, the IES survey identified the proportions by which LED lamps replace different technologies. The assumed wattage for each technology was also drawn from the IES program evaluation report because these values were considered reasonable for the WW program as well. The baseline wattage calculation details are presented in Table 19 below.

Table 19: Wattage Calculations for the Early Replacement Baseline

	Standard Incandescent	Efficient Incandescent	CFL	LED	Average Baseline Wattage
Average Wattage	58.7	42.1	12.7	8.8	**37.2**
Proportion	55%	0%	30%	16%	

For LED lamps replacing a burned-out lamp, it was assumed that participants would have purchased lamps meeting the current Canadian federal energy efficiency regulation on general-service lamps.[18] For A-type lamps such as those installed through the WW program, the current regulation results in the baseline being efficient incandescent lamps. Using this baseline resulted in an average wattage of 42.1 W for lamps replaced on burn-out.

For the new wattage, the Evaluator used a value 10 W based on the wattage of the model installed by the service providers, as provided by ePEI.

Table 20 below shows the displaced wattages for LED lamps installed through the WW program.

Table 20: Calculations for Displaced Wattages

	Proportion	Baseline Wattage (W)	LED Lamp Wattage (W)	Displaced Wattage (W)
LED A-type Lamps				
Early Replacement Scenario	54%	37.2	10	27.2
Replace on Burn-out Scenario	46%	42.1	10	32.1
Total LED A-type Lamps	**100%**	**39.5**	**10**	**29.5**

[17] National Renewable Energy Laboratory, *Uniform Methods Protocol Chapter 6: Residential Lighting Evaluation Protocol*, February 2014, pp. 6-20.
[18] Natural Resources Canada, *General Service Lamps*, http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869 (Last accessed November 1, 2018).

Hours of Use

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 the absence of a specific value for PEI, the Evaluator based the daily HOU value on the Northeast Residential Lighting Hours-of-Use Study (NERHOU)[19], which found that the average usage is 2.9 hours per day for efficient lamps without the snapback effect.[20]

According to the UMP criteria, the NERHOU Study remains the most reliable source for the following reasons: (1) it takes into account the proportion of efficient lamps installed inside and outside the house; (2) it has a large sample size; and (3) it includes a very detailed analysis of the variations in HOU by bulb type (including LED lamps), geographical location, and household type. For these reasons, it is the most relevant study and was used to establish the HOU of the WW program.

The NERHOU Study concludes that the HOU value is 2.7 hours/day for all types of lamps, while the HOU value is 3.0 hours/day for efficient lamps. In other words, a difference of 0.3 hours/day between the two HOU values was observed. The following three theories have been put forward to explain why efficient lamps are used over a greater number of hours:

› Differential socket selection: the assumption is that the most used sockets in a household will be selected to install efficient lamps.
› Shifting usage: the assumption is that once an efficient bulb is installed, it will be favoured over other sockets containing inefficient lamps.
› Snapback: the assumption is that there is a tendency to use an efficient product more than the replaced inefficient product.

Because there is no indication that one theory overrides the other, the Evaluator considers that each theory represents an additional usage of 0.1 hours per day. Two theories, differential socket selection and shifting usage, apply to lamps installed through the WW program because participants only have a limited quantity of lamps to install rather than changing every bulb in their house. As for the snapback effect, it was not taken into account in the HOU assessment because this usage would not have occurred if an incandescent or halogen (base case) had been installed in the absence of the program. To avoid overestimating the savings by making calculations based on operating hours higher than those of the base case, the Evaluator included an additional usage of 0.2 hours in the daily HOU value determined in the study for all bulb types, thereby increasing the HOU from 2.7 hours to 2.9 hours per day.

[19] NMR Group Inc. and DNV GL, *Northeast Residential Lighting Hours-of-Use Study*, May 5, 2014, p. 69.
[20] The snapback effect is an increase in usage following the installation of an efficient product because the operating cost is lower.

Unitary Energy Savings

Table 21 below shows the calculation parameters and the resulting unitary savings value for LED lamps installed through the WW program.

Table 21: Unitary Energy Savings Values for LED Lamps

Baseline Wattage	New Wattage	Hours of Use (hrs/day)	Unitary Saving Value (kWh/yr)
39.5	10	2.9	**31.2**

Low-Flow Showerheads

The annual unitary savings value for low-flow showerheads is established by the difference between base and efficient domestic hot water consumption, as illustrated in the following two equations.

$$\mathit{Water\ Savings}\left[\frac{L}{year}\right] = (\mathrm{q_{base}} - \mathrm{q_{low}})[\frac{L}{min}] \times \mathrm{n_{people}}[\mathrm{person}] \times \mathrm{t_{shower}}[\frac{\mathrm{min}}{\mathrm{shower}}] \times \mathrm{n_{shower}}[\frac{\mathrm{shower}}{\mathrm{day \cdot person}}] \times \frac{1}{\mathrm{n_{showerheads}}} \times 365\left[\frac{days}{year}\right]$$

$$\mathrm{Annual\ Unitary\ Savings}\left[\frac{kWh}{year}\right] = \frac{\mathit{Water\ Savings}\left[\frac{L}{year}\right] \times \%_{\mathrm{DHW}} \times Cp_{H_20}\left[\frac{kJ}{kg\text{º}C}\right] \times \rho_{H_2O}\left[\frac{kg}{L}\right] \times \Delta T_{H_2O}[\text{º}C] \times \frac{1}{3{,}600}\left[\frac{kWh}{kJ}\right]}{\eta}$$

Table 22 lists the parameters and corresponding values used to establish the unitary energy savings value for low-flow showerheads installed through the WW program and the resulting unitary energy savings values.

Table 22: Unitary Energy Savings Value for Low-Flow Showerheads

Parameter	Symbol	Value	Source
Baseline Flow Rate	q_{base}	9.5 L/min (2.5 gpm)	Assumption based on the most encountered baseline in EfficiencyOne Efficient Product Installation program[21]
Low-Flow Rate	q_{low}	6.8 L/min (1.8 gpm)	Installed model specifications
Number of People per Household	n_{people}	2.3 persons	PEI 45th Annual Statistical Review 2018[22]
Average Number of Showers per Day per Person	n_{shower}	0.69 shower/day /person	DeOreo & al. 2016[23]
Number of Showerheads per Household	$n_{showerheads}$	1.5 showerheads	Assumption based on on-site visits conducted in 2017 in Nova Scotia.[24]
Average Shower Time per Person	t_{shower}	7.8 min/shower	DeOreo & al. 2016
Percentage of Hot Water Used in Showers	$\%_{DHW}$	63%	DeOreo & al. 2016[25]
Specific Heat of Water	Cp_{H2O}	4.18 kJ/kg°C	Convention
Density of Water	ρ_{H2O}	1 kg/L	Convention
Temperature Rise in Electrical Water Heater	ΔT_{H2O}	54 °C (98 °F)	Based on the difference between water main weighted average yearly temperature for the City of Charlottetown (5°C or 42°F) and 60°C (the standard water temperature in water heaters, 140°F).
Electrical Water Heater Efficiency	η	98%	Typical electric water heater efficiency used by many TRMs, such as Pennsylvania TRM [26]
Water Savings	**-**	**7982 L/year**	**Calculation**
Unitary Savings	**-**	**322 kWh/year**	**Calculation**

Programmable Thermostats

The on-site visits revealed that the programmable thermostats provided through the WW program were all installed on non-electrical heating systems. Therefore, this product generates no electrical energy savings.

[21] Econoler (2020), *2019 DSM Evaluation Reports, Final Report*, Prepared for EfficiencyOne.
[22] Province of Prince Edward Island, Forty-Fifth Annual Statistical Review, 2018, p.40
[23] 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.
[24] Econoler. (2018). *Existing Residential Program: 2017 DSM Evaluation.* Prepared for Efficiency Nova Scotia.
[25] Obtained based on the total domestic water consumption through showers per household (28.1 gpd) and the hot water use through 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), pp. 5-8.
[26] Pennsylvania Public Utility Commission, *Technical Reference Manual*, State of Pennsylvania, June 2013, p. 174.

Smart Power Bars

Based on a literature review, the unitary savings value associated with the use of smart power controllers was established at 207 kWh per year based on a metering study, published in 2019, of 133 households across Massachusetts.[27] This value was used because this study represents the most up-to-date research, using treatment and control sites, with a significantly larger sample size than previous studies.

[27] NMR Group Inc., *RLPNC 17-3: Advanced Power Strip Metering Study,* March 18, 2019.

APPENDIX III
LIGHTING INTERACTIVE EFFECTS DETAILED CALCULATIONS

The Evaluator developed a methodology to calculate the interactive effects factors of lighting products. The steps of the methodology are presented below.

Literature Review of Interactive Effects Studies

To establish interactive effects values, the Evaluator conducted a literature review of the latest TRMs and evaluation reports. Since only a small percentage of houses are heated with electricity in Canada and in the Northeastern U.S., it was found that few jurisdictions, other than Hydro-Québec, calculated the impact of interactive effects on electric heating. The State of New York is the only other jurisdiction where interactive effects factors for electrically-heated buildings were provided.[28] Although the interactive effects factors are provided for various buildings and heating and cooling types in the New York State TRM, no explanation is provided about how they were calculated. Hence, the Evaluator decided not to use this source.

The evaluation of the interactive effects factors associated with lighting products was therefore based on a study conducted by ADS Groupe-conseil Inc. in 1992 for Hydro-Québec. Although not a recent study, it was found to be the most relevant and applicable to PEI. That study involved modifying certain parameters in simulations for an average home in the Province of Quebec to determine the impacts that these changes had on interactive effects. The simulations were focused on homes heated entirely with electricity and were performed with the DOE-2 software[29] to analyze three interactive effects scenarios: low, moderate and high interactive effects. The Evaluator finally chose the scenario with the lowest level of interactive effects for the calculation of interactive effects because it reflects the evolution of homes since 1992. The following subsections explain the Evaluator’s rationale for choosing to use the findings of the ADS study to assess interactive effects.

To ensure that the ADS study findings were valid and applicable to PEI, the Evaluator first compared PEI’s climate characteristics with those of Quebec.

This analysis was conducted based on the assumption that internal heating gains (from lighting, domestic hot water or appliances) reduce the heating load as long as the outdoor temperature is below the balance temperature of the building (and it is the opposite during the cooling season). This would mean that the most significant variable involved in calculating the interactive effects factors is the duration of the heating and cooling seasons rather than just the total heating degree days (HDD) and cooling degree (CDD) days.

[28] New York State Department of Public Service, *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential, Multi-Family, and Commercial/Industrial Measures*, Version 6, April 16, 2018, pp. 439- 445.
[29] DOE-2 is a widely used and accepted building energy analysis software tool developed with funding from the U.S. Department of Energy.

The following figures show the normal HDDs and CDDs[30] per month in Trois-Rivières and Charlottetown respectively. Trois-Rivières was chosen as the reference city in the Province of Quebec for this analysis. Since this city is located about halfway between Montreal and Quebec City (which were the two cities considered in the ADS study), it is representative of the climate data used in the ADS study.

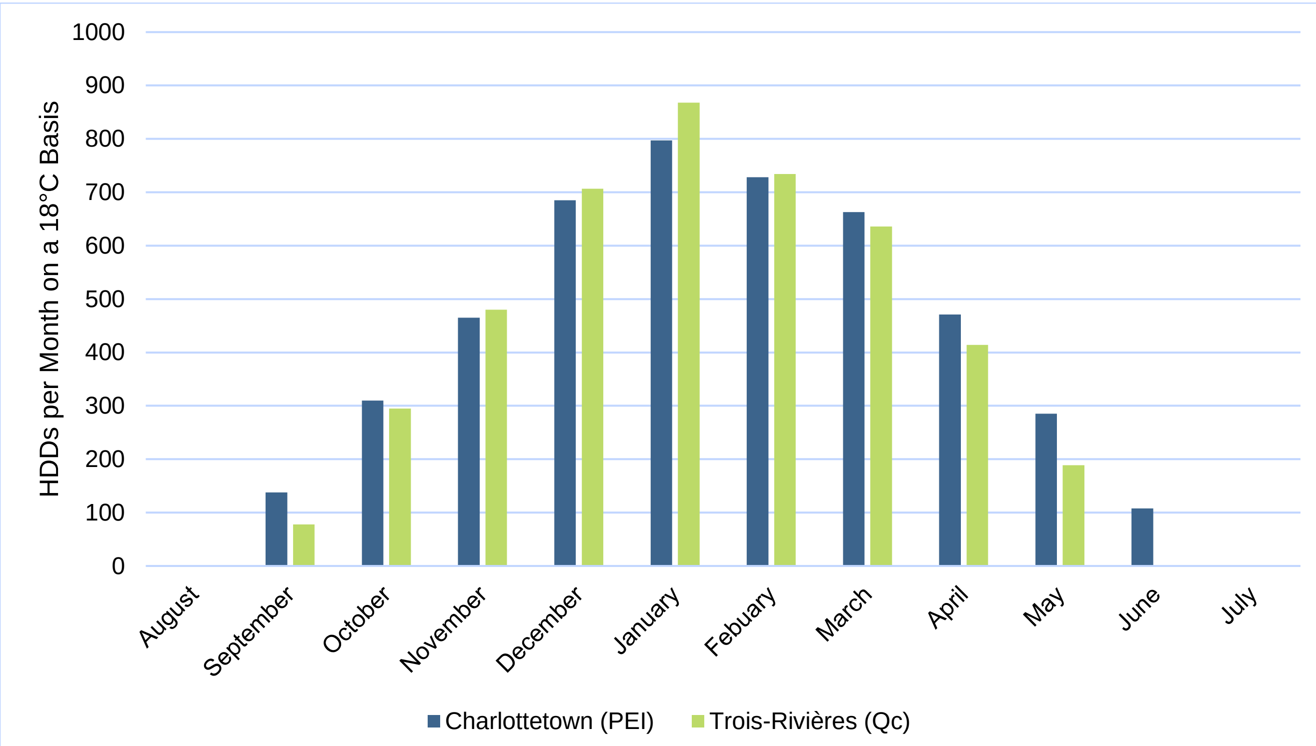

Figure 5: HDDs per Month in Charlottetown and Trois-Rivières

[30] RETScreen Climate Database. RETScreen Expert, 2019.

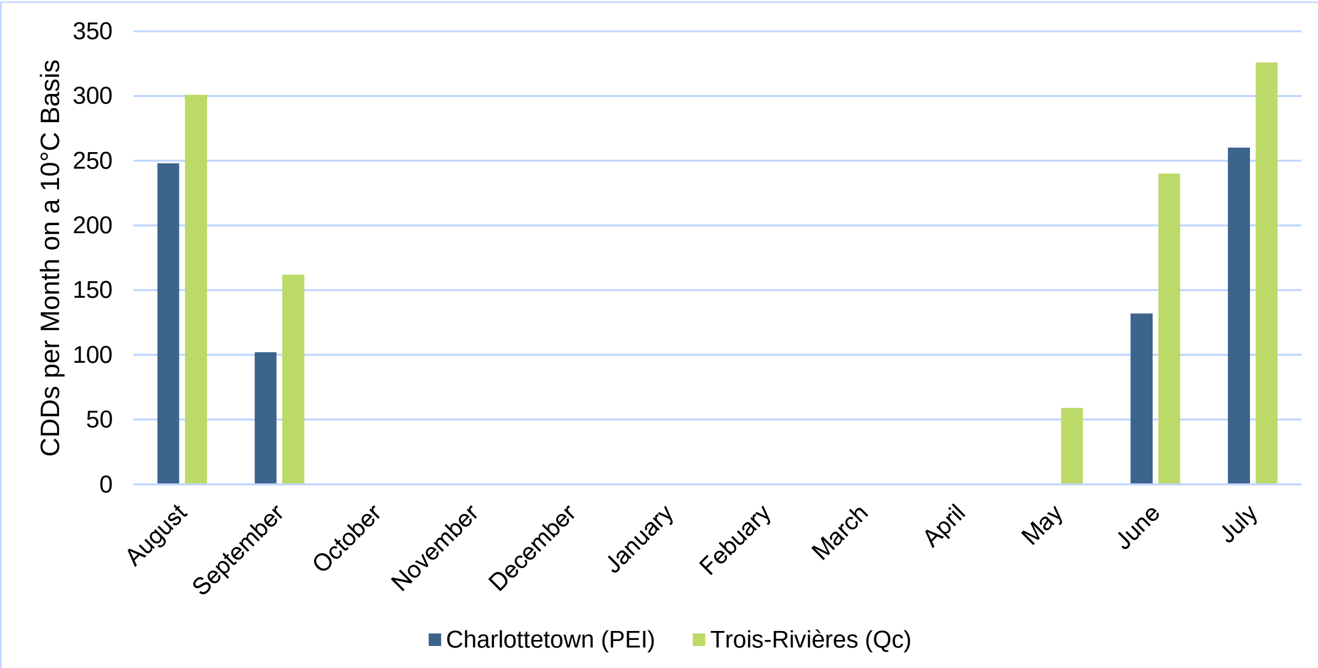

Figure 6: CDDs per Month in Charlottetown and Trois-Rivières

Figure 5 and Figure 6 illustrate that the heating season is slightly shorter in Trois-Rivières than in Charlottetown and that the cooling season in Trois-Rivières is longer and warmer than in Charlottetown. Overall, the number of HDDs of the two cities is somewhat similar, whereas the number of CDDs of the cooling season is much higher in Trois-Rivières. This means that the interactive effects factors based on the ADS study slightly overestimate the positive interactive effects occurring during the cooling season in PEI; however, because of the very small impact of cooling on interactive effects (3.6% according to the ADS study), the overestimation is considered negligible. Therefore, the Evaluator believes that the ADS study findings are still applicable.

Review of Interactive Effects Factor Equations

The ADS study provided the raw data needed to calculate the interactive effects associated with specific products but did not include all the information required to convert those raw-data values into the interactive effects factors. Hence, the equations for calculating the interactive effects factors were taken from a Hydro-Québec report. [31] The Evaluator reviewed these equations to improve the precision of the overall interactive effects factor calculated for the WW program.

[31] ADS ASSOCIÉS, *Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale*, report submitted to Hydro-Québec, 1992.

The Hydro-Québec report states that efficient lighting in electrically heated single-family homes without air-conditioning in the Province of Quebec results in an interactive effects factor of -58%. To determine the impact on an electrically heated home with air-conditioning, the Evaluator adapted the equation used by Hydro-Québec as follows:

$$Interactive\ Effects\ Factor_{heating+cooling} = -58\% + \frac{22\%}{COP} \times \%\ Home\ Area\ Conditioned$$

In the above equation, the value of 22% represents the proportion of the energy savings that occurs during the cooling period and affects the cooling load. The percentage of the home area air-conditioned was added because it was found through market research that most participating homes had window air-conditioning units that only conditioned a portion of the home. Therefore, many efficient lighting products installed in a non-conditioned area resulted in nil air-conditioning interactive effects. It was impossible to extract the exact values used for the COP and the percentage of home area conditioned, but the Evaluator found that using a COP of 2.5 and a percentage of home area of 40% yielded results very close to the value of -54.4% used by Hydro-Québec. The Evaluator finds these values reasonable to be used for PEI in this evaluation. Hence, they were also used to calculate the interactive effects factor for homes that are non-electrically heated but are air-conditioned; as a result, this factor is maintained at its initial level of 3.6%, used by Hydro-Québec.

The Evaluator also established an interactive effects factor for houses electrically heated with a heat pump, which account for 13% of households in PEI.[32] Since the interactive effects calculation in the ADS study is based on a heating system efficiency of 100%, an adjustment was applied by dividing the interactive effects factor for heating (-58.0%) by the COP of a heat pump. This COP was estimated based on a heating seasonal performance factor Region V of 10.4, which is the weighted average value of the heat pumps rebated through ePEI Energy Efficient Equipment Rebates program. As a result, the interactive effects factor for heating was divided by a COP of 3.0 and, when added to the cooling only interactive effects factor of 3.6%, yields an overall interactive effects factor of -15.7% for houses electrically heated with a heat pump.

During the peak demand period, which occurs during the heating period, it is assumed that 100% of the heat emitted by incandescent lamps is now generated by the heating system. However, based on the ADS study, it is assumed that 10% of the heat is released through exterior walls and ceilings and does not contribute to interactive effects. As a result, the peak demand interactive effects factor in electrical heated houses is estimated at -90.0%. For the houses electrically heated with a heat pump, the Evaluator used a COP of 2.0, based on the weighted average COP at -15°C of the heat pumps rebated through the Energy Efficient Equipment program. Therefore, the peak demand interactive effects factor for heat pumps was divided by 2.0, yielding an overall factor of -45% for the houses electrically heated with a heat pump.

[32] MQO Research, PEI Home Energy Survey: Results Summary, October 2018.

It should be mentioned that, for houses electrically heated with a heat pump, the Evaluator assumed that the heat pumps installed would have the same characteristics as those installed through the Energy Efficient Equipment program, considering the high participation level for this program compared to the total number of households in PEI, which would indicate that most heat pumps in PEI are recently installed cold-climate heat pumps.

Calculation of Interactive Effects Factors for Energy Savings

Table 23 below lists the interactive effects factors from the ADS study for each heating and cooling situation. The respective percentages of PEI homes using electricity for heating and using air-conditioning as documented by PEI and Statistics Canada were used to establish the average interactive effects factor for the program.

Table 23: Interactive Effects Calculation for Energy Savings

Parameter	% of Homes[33][34]	Interactive Effects Factors[35]	Peak Demand Interactive Effects Factor
Heat pump heating, with air-conditioning	13% × 100% = 13.0%	-15.7%	-45.0%
Electric heating, with air-conditioning	19% × 25% = 4.8%	-54.4%	-90.0%
Electric heating, without air-conditioning	19% × 75% = 14.3%	-58.0%	-90.0%
No electric heating, with air-conditioning	68% × 25% = 17%	3.6%	0.0%
With neither electric heating nor air-conditioning	68% × 75% = 51%	0.0%	0.0%
Weighted Interactive Effects Factor	**100%**	**-12.3%**	**-23.0%**

[33] The proportions of homes that are electrically heated were drawn from MQO Research, PEI Home Energy Survey: Results Summary, October 2018.
[34] The proportions of homes that are air-conditioned were drawn from Natural Resources Canada, Table 27 Cooling System Stock by Type, New Unit Efficiencies, Stock Efficiencies and Unit Capacity Ratio in the Residential Sector in Prince Edward Island, August 2018.
[35] ADS ASSOCIÉS, *Évaluations des effets énergétiques combinés des mesures d'économies d'énergie – résidence unifamiliale*, report submitted to Hydro-Québec, 1992.

These interactive effects occur only when the products are installed inside a house. Because the lamps received through the program can also be used for outdoor lighting, the interactive effects factor for this product was adjusted to take this into account. Because no information specifically about PEI was available, the proportion of LED light lamps installed indoor compared with those installed outdoor was based on the findings of a socket study conducted in Nova Scotia.[36] Table 24 below shows the interactive effects factors that the Evaluator has calculated for lighting.

Table 24: Interactive Effects Factors

% Indoor	% Outdoor	Interactive Effects Factor Calculation	Peak Demand Interactive Effects Factor Calculation
92%	8%	92% × -12.3% + 8% × 0% = **-11.3%**	92% × -23.0% + 8% × 0% = **-21.1%**

[36] Corporate Research Associates Inc., *2016 Socket Study,* Final Report Prepared for Efficiency Nova Scotia, December 2016.

APPENDIX IV
LED LAMPS EUL DETAILED CALCULATIONS

This appendix presents the details on how the equivalent effective useful life (EUL) value was calculated for LED lamps. An equivalent EUL corresponds to the number of years over which the first-year savings need to be multiplied to obtain the lifetime savings.

The Evaluator first calculated the equipment life, as shown in Table 25 below. The equipment life was calculated as the ratio between the manufacturer rated lifetime hours for the model of lamp installed through the WW program and the annual HOU value used to calculate the unitary savings values.

Table 25: Equipment Life Value for LED Lamps

Average Rated Lifetime Hours (Hours)	Annual HOU (Hours/Year)	Equipment Life (Years)
15,000	2.9 x 365 = 1,059	14

The LED lamps market is evolving rapidly and driven by government regulations. LED lamps installed today are likely to become the baseline before the end of their rated life since LED technologies are developing quickly and prices are falling. Some jurisdictions have already applied a reduced equivalent EUL to their residential lighting savings by adopting a higher baseline to represent savings in future years. In other words, their baseline increases over the lifetime of the product, which in turns reduces the equivalent EUL that is applied to first-year savings to obtain lifetime energy savings. That is the case for Illinois where savings for LED lamps are considered nil after 10 years, and baselines are adjusted throughout the product lifetime to match changes in regulations. For instance, a 60 W incandescent baseline is raised to a 43 W halogen incandescent after the end of the incandescent lamp remaining useful life and will be raised again to the planned minimum efficiency CFL level required by the Energy Independence and Security Act (EISA) 2020 effective in 2021.[37] Massachusetts also uses a similar methodology and has set the equivalent EUL value at eight to nine years for LED lamps, which takes into account baseline increases that will occur because of EISA 2020.[38] While the US government has recently decided to eliminate the EISA 2020 backstop on inefficient lighting products,[39] Illinois and Massachusetts have not since made changes to their equivalent EUL methodology. One reason mentioned by the US government not to enforce the backstop is that the market is already changing toward LED products, which suggests the current methodology used by these jurisdictions will remain valid.

[37] Illinois Energy Efficiency Stakeholder Advisory Group, *Illinois Statewide Technical Reference Manual for Energy Efficiency Version 8.0, Volume 3*, October 2019, p. 258.
[38] Massachusetts Electric and Gas Energy Efficiency Program Administrators, *Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures, 2016-2018 Program Years – Plan Version*, October 2015, p. 151.
[39] Apex Analytics, *DOE Issues Final Rule Designed to Eliminate EISA Backstop: Analysis of the Rule and Implications for Energy Efficiency Programs*, 2019.

However, the Evaluator considered that limiting the EUL to 10 years, as done by Illinois, was too conservative and used the equipment life of LED A-type lamps as the EUL, thereby avoiding capping since it is uncertain when LED lamps will become the baseline technology on the Canadian market. Like the approach used in Illinois and Massachusetts, the Evaluator applied a triple baseline for LED A-type lamps over their 14-year EUL to establish their equivalent EUL that accounts for the following factors:

- **First baseline:** The replaced incandescent light lamps have an estimated remaining useful life of one year. Incandescent light lamps have a typical rated life expectancy of 1,000 to 2,000 hours.[40] The remaining useful life of replaced functional incandescent light lamps is assumed to be half the rated life expectancy. By applying a remaining useful life of 1,000 hours and 2.9 HOUs per day, the period over which savings are calculated when an incandescent baseline has been established at one year.
- **Second baseline:** The current Canadian regulation bans imports on 60 W, 75 W and 100 W light lamps, imposes a minimum efficiency to be achieved by efficient incandescent light lamps (also called halogen incandescent light lamps)[41] and reflects U.S. federal legislation (as outlined in the three tables further below). After the first year over which incandescents remain the baseline, the baseline is increased to halogen incandescent lamps.
- **Third baseline:** The EISA 2020 was expected to impose an efficiency level of 45 lumens per watt in 2020,[42] as outlined in the three tables further below. As mentioned previously, the US government has recently decided to eliminate the EISA 2020 backstop on inefficient lighting products.[43] However, one reason mentioned by the US government for not enforcing the backstop is that the market is already changing toward LED products. Considering that Canada's residential lighting market is also evolving rapidly and closely follows trends in the U.S. market, the Evaluator considers it advisable to establish the baseline wattage based on the planned U.S regulation. Furthermore, Natural Resources Canada intends to update the general service bulb minimum energy performance requirement in Amendment 17, which is planned for preconsultation in 2019[44] (and should therefore be applied within a few years thereafter). Since a Canadian regulation matching the requirements of the EISA 2020 specification would effectively ban the import and fabrication of efficient incandescent light lamps, it is expected that these incandescent light lamps would still be available in retail outlets before stocks are depleted for up to two years after the legislation is implemented.

[40] 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 19, 2018).
[41] 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 19, 2018).
[42] US EPA, *"Summary of the Energy Independence and Security Act. Public Law 110-140 (2007)",* www.epa.gov/laws-regulations/summary-energy-independence-and-security-act (Last accessed January 19, 2018).
[43] Apex Analytics, *DOE Issues Final Rule Designed to Eliminate EISA Backstop: Analysis of the Rule and Implications for Energy Efficiency Programs*, 2019.
[44] Natural Resources Canada, *"Forward Regulatory Plan 2019-21,"* https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-regulations/forward-regulatory-plan-2019-2021/18318 (Last accessed April 1, 2020).

It should be noted that using the minimum efficiency levels of EISA 2020 starting in 2024 might be optimistic. Since LED lamps rapidly gain popularity while CFL market share declines, it is possible that the baseline for lamps covered by the legislation will be LED lamps by 2024.[45] In that case, savings would occur over a maximum of five years. However, since it is difficult to determine this with certainty, the Evaluator preferred using the efficiency levels set in the proposed American legislation until the end of the EUL of A-type lamps.

The Evaluator established lifetime energy savings values for early replacement and replace on burn-out scenarios, as well as for the different types of lamps replaced. The displaced wattage values used to obtain the lifetime energy savings of each scenario are summarized in Table 26 and Table 27 below.

Table 26: Equivalent EUL Calculation Summary for LED A-Type Lamps Replaced on Burn-Out

Halogen Incandescent Baseline – Canadian Legislation		CFL Equivalent Baseline – American Legislation		Lifetime Energy Savings (kWh)
5 years (2019-2023)		9 years (2024-2032)		
Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	
42.1	32.1	17.3	7.3	239

[45] Barclay, D., von Trapp, K. and Miziolek C., *Party Like It's 2020: EISA Phase 2 – An Examination of DOE Rulemaking and Implications for Programs*, poster presented at the 2017 International Energy Program Evaluation Conference, Baltimore, MD, 2017.

Table 27: Equivalent EUL Calculation Summary for LED A-Type Lamps Replaced Early

Type of Lamp Replaced	Incandescent Baseline		Halogen Incandescent Baseline – Canadian Legislation[46,47]		CFL Equivalent Baseline – American Legislation[48]		Lifetime Energy Savings (kWh)	% of Lamps Replaced	Average Lifetime Energy Savings (kWh)
	1 year (2019/20)		4 years (2020/21-2023/24)		9 years (2024/25-2032/33)				
	Baseline Wattage	Displaced Wattage	Baseline Wattage	Displaced Wattage	Baseline Wattage [49]	Displaced Wattage			
Standard Incandescent	58.7	48.7	42.1	32.1	17.3	7.3	257	55%	152
Efficient Incandescent	42.1	32.1	42.1	32.1	17.3	7.3	239	0%	
CFL	12.7	2.7	12.7	2.7	12.7	2.7	40	30%	
LED	8.8	0	8.8	0	8.8	0	0	16%	

For replaced lamps that are already CFLs or LED lamps, the changing energy efficiency regulation has no impact on the baseline which remains the same throughout the entire EUL of the product.

The lifetime energy savings values in Table 27 and Table 26 were weighted by the proportion of each scenario (57% early replacement and 43% replaced on burn-out) to obtain an average lifetime energy savings value for LED lamps (189 kWh), which was then divided by the average first year energy savings for LED lamps (31.2 kWh/yr) to obtain an equivalent EUL of 6.1 years.

[46] 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 20, 2018).
[47] Also equivalent to Incandescent Equivalent 1st Tier EISA 2007.
[48] As proposed by U.S. federal legislation. Incandescent Equivalent 2nd Tier EISA 2007.
[49] Baseline wattage values were established based on the minimum efficiency level of 45 lumen/watts dictated by the EISA regulation and on the assumed level of 778 lumens established from a weighted average of the 10 most popular models.

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2018/2019 AND 2019/2020 BUSINESS ENERGY REBATES PROGRAM EVALUATION

EFFICIENCYPEI

Final Report

June 29, 2020

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ACRONYMS

AHRI	Air-Conditioning Heating and Refrigeration Institute
BER	Business Energy Rebates (program)
COP	Coefficient of performance
DLC	DesignLights Consortium
DSM	Demand-side management
ECM	Electronically-commutated motor
EE&C	Electricity Efficiency and Conservation
ePEI	efficiencyPEI
EUL	Effective useful life
HOU	Hours of use
HVAC	Heating, ventilation and air-conditioning
IPC	Incremental product cost
LED	Light-emitting diode
MSHP	Mini-split heat pump
NTGR	Net-to-gross ratio
PAC	Program Administrator Cost (test)
PCF	Peak coincidence factor
PEI	Prince Edward Island
PID	Project identification (number)
PTHP	Packaged terminal heat pump
TRC	Total Resource Cost (test)
TRM	Technical reference manual

DEFINITIONS

Confidence interval	The estimated range of values which is likely to include the unknown population parameters.
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.
Evaluated savings	Gross and net savings calculated by the Evaluator using parameters (installation rates, interactive effects, net-to-gross ratio, etc.) validated or measured during the evaluation process.
Free-ridership	Percentage of 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 energy efficiency program, regardless of why they participated.
Interactive effects	Interactive effects occur when the installation of an energy efficiency measure has an impact on the energy consumption of other elements in the building such as heating and cooling.
Lifetime energy savings	The energy savings that occur over the lifetime of an energy efficiency measure. Lifetime energy savings account for 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.
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 between the net energy savings and gross energy savings that includes effects, such as free ridership and spillover, that positively or negatively affect the energy savings generated by a program.
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-to-energy ratio	The ratio between peak demand savings and energy savings.
Peak demand savings	The demand savings that coincide in time with the peak demand of the electricity system.

Program Administrator Cost test	This test compares program administrator costs to utility resource savings.
Sample size	The number of observations or replicates included in a statistical sample.
Spillover	Savings attributable to participants who continue to implement the energy efficiency measures introduced by a program after participating in it once, without participating in the program a second time.
Total Resource Cost test	This test compares program administrator and participant costs to utility resource savings and in some cases, other resource savings and program benefits accrued by participants, such as non-energy benefits.
Tracked savings	Gross and net savings calculated by the utility in its internal tracking, based on various parameters such as number of participants, installation rates, interactive effects, and 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).

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EXECUTIVE SUMMARY

This report presents the evaluation results of the efficiencyPEI (ePEI) Business Energy Rebates (BER) program. BER provides commercial, industrial and agricultural customers with rebates for qualified high-efficiency products such as lighting, controls and heat pumps.

Summary of Evaluation Assignment

ePEI hired Econoler (hereinafter the Evaluator) to evaluate the BER program and achieve the following objectives:

- Establish the gross electricity energy and peak demand savings generated by the program;
- Establish the net electricity energy and peak demand savings generated by the program;
- Assess whether the program is cost-effective;
- Assess the effectiveness of program processes and implementation.

The evaluation addresses program savings and cost-effectiveness results associated with equipment that displace electrical usage only.

The evaluation was carried out based on a review of the program database and documentation including participant applications, participant survey, literature review, engineering calculations and cost-effectiveness analyses based on the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests.

The evaluation covers the 2019/2020 fiscal year. Based on the parameters established through the evaluation, this report also presents results for the 2018/2019 fiscal year.

Summary of Evaluation Results

This subsection presents the key findings of the evaluation.

Participation Level and Measure Mix

The BER program supported the successful completion of 240 projects that generated electricity savings in PEI businesses in 2019/2020, and 114 projects in 2018/2019. In both fiscal years, the majority of projects included heating, ventilation and air-conditioning (HVAC) measures, mostly mini-split heat pumps (MSHPs), but the proportion of lighting projects was higher in 2019/2020 compared to 2018/2019.

Lighting measures represented 81% of BER program gross energy savings in 2019/2020, while HVAC measures represented 19%. In 2018/2019, lighting represented 53% of BER gross energy savings, while HVAC measures—including only MSHPs—made up 47%.

Satisfaction with the Program

BER participants were satisfied with the program overall. Surveyed participants awarded particularly high satisfaction scores to the work performed by the contractor or installer and the measures installed as part of the program. One negative issue cited by multiple respondents (8 of the 30 surveyed) was the rebate amount – half of them were disappointed because their contractors had provided an estimated rebate amount that was higher than the amount they received from the BER program. Others would have liked the rebate cap to be higher.

The same proportion of participants mentioned that they thought program processes and requirements were unclear, requiring them to seek the help of their contractor.

Program Data Tracking

The BER program application database included all the essential fields, and most fields were complete for each application. Currently, the database does not include any field for tracking the proportion of measures that achieve electrical energy savings. While the database is adequate for the current approach to calculating energy savings, it will have limitations if and when ePEI updates the unitary energy savings values. Indeed, the technical information on measures, such as the wattage of lighting products and model numbers, was very limited.

Gross Savings

The Evaluator established savings calculation parameters for key eligible measures to cover at least 80% of program savings. The participant survey results indicated that 50% of the MSHPs installed through the BER program save electricity and the remaining half reduce the usage of non-electrical heating fuels. The Evaluator therefore considered the proportion of BER program participants with an electrical heating baseline at 50% and used this parameter to calculate the number of MSHP units that reduce the use of electricity rebated through the program. The same parameter was applied to PTHPs. As for the other BER measure categories, all the measures save electricity; so, all the rebated units were considered in the gross savings calculations.

Since no technical data on lighting measures was collected in the ePEI program database, the Evaluator could not rely on engineering calculations to calculate unitary savings values specific to the products installed through the BER program. The Evaluator therefore used the most up-to-date unitary savings values from the 2019 program evaluation of the EfficiencyOne BER Instant Rebates service to establish evaluated lighting unitary savings values, with the exception of high-bay fixtures, for which the unitary savings values established in the 2016 EfficiencyOne BER Mail-in service were used.

Net Savings

A net-to-gross ratio (NTGR) is used to determine net savings based on program gross savings. The Evaluator assessed the free-ridership level using the participant survey and assumed the spillover level to be nil. Based on the Evaluator's experience with similar programs, spillover is usually low for programs like BER, especially when participants are allowed to install multiple units. The Evaluator determined the free-ridership level for BER key eligible lighting measures at 30% and assumed a nil free-ridership level for MSHPs, yielding respective NTGRs of 0.70 and 1.00. For MSHP, the Evaluator did not deduct free-ridership since the baseline established for calculating gross savings is a new standard efficiency heat pump and not the existing heating and cooling system. The gross savings of MSHPs therefore already excluded the portion of savings related to the efficiency increase provided by the replacement of the existing system with the MSHP. Therefore, no further adjustment was needed at the net savings level. However, a certain level of free-ridership is attributable to the decision of purchasing a high-efficiency MSHP instead of a standard-efficiency MSHP, but the Evaluator assumed it would be negligible.

Cost-Effectiveness

The Evaluator assessed the cost-effectiveness of the Electricity Efficiency and Conservation (EE&C) portion of the program by performing specific cost-effectiveness tests, namely the TRC and PAC tests. When performing these tests, ratios greater than 1 are desired because they indicate that program benefits outweigh costs.

The evaluation determined that BER was very cost-effective in both 2018/2019 and 2019/2020, with PAC and TRC results significantly higher than the program targets.

Summary of Savings and Cost-Effectiveness Results

Table 1 below summarizes the key results of the program savings and cost-effectiveness evaluation for 2019/2020 and 2018/2019, as well as participation levels and program targets.

Table 1: Summary of Program Savings and Cost-Effectiveness Targets and Evaluated Results

Parameters	2018/2019 Targets	2018/2019 Evaluation Results	2019/2020 Targets	2019/2020 Evaluation Results
Program Participation				
Number of Projects	-	114	-	240
Number of Measures Claimed for EE&C	4,100	1,727	5,300	5,460
Gross Electricity Savings				
Gross Electricity Energy Savings – at the Generator (GWh)	-	0.239	-	1.455
Gross Lifetime Electricity Savings – at the Generator (GWh)	-	3.211	-	25.364
Gross Peak Demand Savings – at the Generator (MW)	-	0.192	-	0.483
Net Electricity Savings				
NTGR	-	0.86	-	0.76
Net Electricity Energy Savings – at the Generator (GWh)	0.9	0.205	1.1	1.106
Net Lifetime Electricity Savings – at the Generator (GWh)	-	2.812	-	18.979
Net Peak Demand Savings – at the Generator (MW)	0.1	0.187	0.2	0.430
Cost-Effectiveness				
PAC Test	2.6	17.22	2.8	11.71
TRC Test	1.1	16.43	1.2	17.98

- The 2018/2019 evaluated net electricity energy savings were lower than the program targets by 77%, mainly because the number of products rebated was lower than expected. Indeed, the program was launched later than initially planned and therefore did not operate for the full 2018/2019 fiscal year. For 2019/2020, the evaluated results were 1% higher than the program targets; the number of products rebated was 3% higher than expected.
- The evaluated peak demand savings exceeded the program targets by 87% and 115% for 2018/2019 and 2019/2020, respectively.
- The PAC and TRC tests revealed that the program was very cost-effective from both perspectives and reached the cost-effectiveness targets set for both fiscal years. The evaluated incremental product cost values, especially that of lighting, likely explain why the evaluated TRC and PAC results are higher than the targets.

Recommendations

In light of these findings, the Evaluator makes the following recommendations.

Recommendation 1: Establish a strategy to collect participant and measure information to ensure that the savings calculation inputs more accurately reflect the actual conditions in PEI. One approach may be to utilize program application forms to collect key information on measure performance, baseline conditions, and business operations.

Recommendation 2: Until more specific data are collected from program participants, use the evaluation parameters established through this evaluation to calculate program gross savings. These parameters include NTGRs and unitary savings values.

Additionally, the Evaluator analyzed program data organization and completeness and identified the data types that should be tracked by ePEI regardless of the strategy developed to collect additional key information on participant facilities and measures. The Evaluator found that basic participant data was complete and consistent, but the proportion of units that generate electrical savings is not currently considered for the few measures where it is relevant (i.e., heat pumps); hence, the database includes all BER program units in savings results, with the same electrical unitary savings being applied to all of them.

Recommendation 3: Update program tracking to implement the following:

a. Continue tracking current items and try collecting data on currently untracked or incomplete items.
b. In the compilation tab, add a field for the proportion of units that generate electrical savings for heat pump measures and ensure this value is multiplied by the total number of units rebated.

INTRODUCTION

Under the Government of Prince Edward Island (PEI), efficiencyPEI (ePEI) is responsible for administering Electricity Efficiency and Conservation (EE&C) programs in the province. The programs are meant to help Islanders not only improve the energy efficiency and conservation of their homes and workplaces by installing high-efficiency equipment and products, but also change behaviours. Econoler was commissioned by ePEI to evaluate its EE&C program portfolio comprised of five residential programs and three commercial programs.

One of the three commercial programs is the Business Energy Rebates (BER) program, which provides commercial, industrial and agricultural customers with rebates for qualified high-efficiency products such as lighting, controls and heat pumps.

The evaluation of the BER program is focused on assessing program processes, implementation and cost-effectiveness, as well as providing evaluated gross and net energy and peak demand savings. The evaluation covers the 2019/2020 fiscal year. Based on the parameters established through the evaluation, this report also presents results for the 2018/2019 fiscal year. This report presents the program EE&C results, namely the savings and cost-effectiveness results associated with equipment that displace electrical usage only. Evaluation activities were carried out considering both electrically-heated and non-electrically-heated participants to assess program processes and implementation, but certain sections of the report reference only subsets of the total participants included in the evaluation, depending on the topic assessed.

To complete this evaluation, Econoler worked with Vision Research, a PEI-based market research firm, on a participant survey. Throughout this report, the team of Econoler and Vision Research is referred to as the Evaluator.

1 PROGRAM OVERVIEW

The ePEI BER program provides financial incentives to business, non-profit and institutional organizations as well as industrial and agricultural facilities in PEI to foster upgrades to energy efficient products. For businesses, energy efficient products can result in a better customer experience or increased employee productivity in addition to reduced operating costs. The following equipment and products are offered through the program.

› Light-emitting diode (LED) lighting products: indoor and outdoor bulbs, fixtures and occupancy sensors
› Heat pumps: mini-split heat pumps (MSHPs) and packaged terminal heat pumps (PTHPs)
› Refrigeration: electronically-commutated motors (ECMs) for walk-in and stand-alone coolers, lighting, conversion from open to closed cooler

To be eligible, products must meet the specific criteria for a given product category. Either ENERGY STAR® or DesignLights Consortium (DLC) performance levels are required for most products. Rebates are provided on a per-unit basis after the purchase and installation of energy efficient products. The maximum rebate payment must not exceed 50% of the product purchase price. ePEI must preapprove projects that have an expected rebate amount of at least $5,000.

Participants are invited to work with a wholesaler or contractor to identify upgrade opportunities for their organization. ePEI's Network of Excellence provides participants with a list of contractors in their area.

Throughout this report, the Evaluator uses the term measure to refer to the lighting products and other equipment offered through the BER program.

2 EVALUATION APPROACH

The main objectives of the BER program evaluation are as follows:

- Establish the gross electricity energy and peak demand savings generated by the program;
- Establish the net electricity energy and peak demand savings generated by the program;
- Assess whether the program is cost-effective;
- Assess the effectiveness of program processes and implementation.

The Evaluator identified key research questions aimed at achieving the aforementioned objectives. The following table outlines the evaluation objectives and maps them to the research questions and methods. Each method is described further below.

Table 2: Evaluation Approach

Evaluation Objective	Research Question	Method
Gross energy and peak demand savings	In what state were the existing lighting products when they were upgraded?	Participant survey
	How are program MSHPs being used?	
	What are the product unitary savings values?	› Application form review › Program savings analysis
	What are the product peak demand-to-energy ratios?	
	What are the product effective useful life (EUL) values?	
	What are the evaluated annual and lifetime gross energy savings and peak demand savings?	
Net energy and peak demand savings	What is the free-ridership level for the program?	Participant survey
	What are the evaluated annual and lifetime net energy savings and peak demand savings?	
Program cost-effectiveness	In addition to the other cost-effectiveness calculation parameters already collected (e.g. EUL values, net savings), what are the equipment incremental product costs (IPCs)?	Cost-effectiveness analysis
	Is the program cost-effective from the perspective of the program administrator and participants?	
Program processes and implementation	Is program tracking effective, complete, consistent and clear?	Program database review
	How did participants hear about the program?	Participant survey
	Why did participants want to install MSHPs or lighting products?	
	What is the level of participant satisfaction with the program?	
	What issues or challenges, if at all, have participants had with their MSHPs?	
	Which energy efficient upgrades did participants make outside the BER program in the last two years, if at all and why did they not participate in the program?	
	What energy efficient products do participants intend on installing in the next two years, if at all? If not, what is keeping them from making upgrades?	
	What recommendations do participants have to improve the program?	

The Evaluator first conducted an in-depth interview with program staff to learn about program processes, discuss program performance and identify evaluation objectives. Then, specific evaluation methods were undertaken as described in the following subsections.

Participant Survey

In February 2020, the Evaluator conducted a telephone survey with 30 program participants: 12 who had installed lighting products and 18 who had installed one or more MSHPs. The average length of the survey was 27 minutes. A sample of 30 participants yields a margin of error of 14.0% at a 90% confidence level. The survey questionnaire is provided in Appendix I.

Application Form Review

The Evaluator reviewed 30 application forms, including project receipts and invoices, to verify that rebated measures met program eligibility criteria and inform certain parameters of program savings and cost-effectiveness assessments, such as unitary savings and IPCs. The 30 application forms included 18 MSHP applications and 12 lighting applications, with some applications including multiple measures.

Program Savings and Cost-Effectiveness Analyses

The Evaluator analyzed the program database, conducted a literature review and performed engineering calculations to provide evaluated savings calculation values and parameters, including the parameters used in calculating IPCs, gross and net energy and peak demand savings, as well as EUL values used for lifetime energy savings calculations. As part of the literature review, the Evaluator consulted technical reference manuals (TRMs) and public evaluation reports of jurisdictions similar to ePEI, with a focus on the most recent and accurate sources.

The Evaluator also performed two cost-effectiveness tests, namely the Program Administrator Cost (PAC) and Total Resource Cost (TRC) tests.

Program Database Review

The Evaluator reviewed the program database to: (1) assess tracking practices and processes and whether they meet program needs; (2) identify any gaps in tracked data to better inform program savings calculations, management and evaluation; and (3) assess the consistency and organization of tracked data.

3 PROGRAM SAVINGS AND COST-EFFECTIVENESS

This section presents the evaluation results related to program gross and net electrical energy and peak demand savings, as well as cost-effectiveness for the fiscal year 2019/2020. The parameters used to obtain these results were also used to calculate program savings and cost-effectiveness results for the 2018/2019 fiscal year. The section opens with an overview of program participation in 2018/2019 and 2019/2020.

3.1 Program Participation

In the 2019/2020 fiscal year, 240 BER projects generating electricity savings were completed in PEI businesses, representing an increase of 111% compared to the 114 projects that generated electricity savings in the 2018/2019 fiscal year.

Figure 1 below illustrates the numbers of projects that included each eligible measure category, namely HVAC, lighting, motors and lighting controls.[1] In both fiscal years, the majority of projects included HVAC measures, with MSHPs being the most popular measure installed. That said, the proportion of lighting projects increased in 2019/2020 compared to 2018/2019.

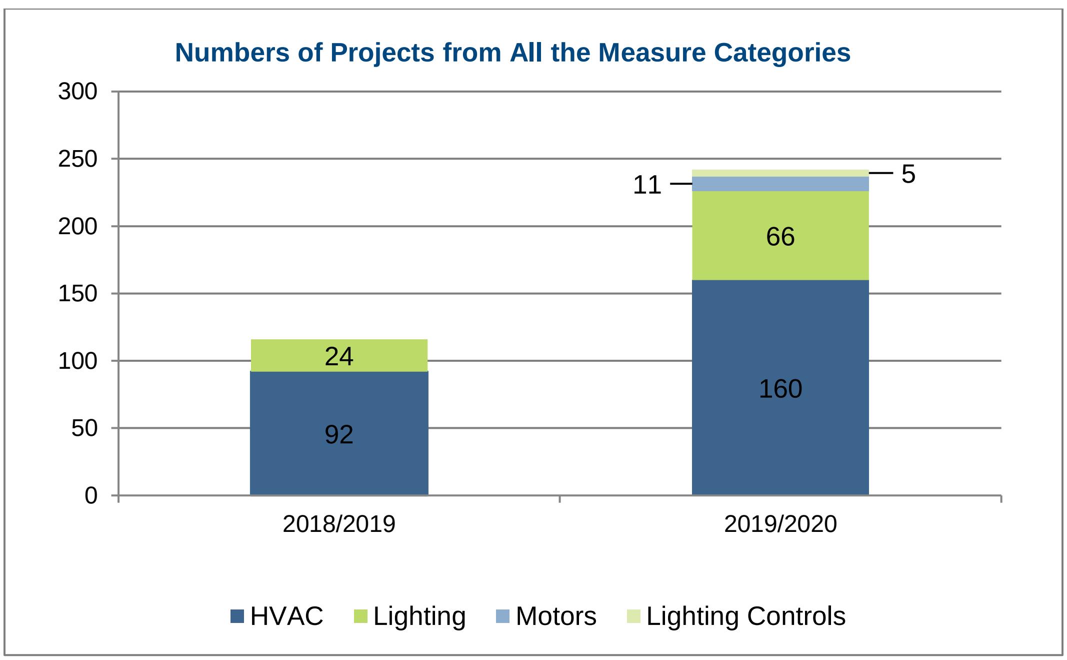

Figure 1: Summary of BER Program Participation

[1] The differences between the total numbers of projects and the values in the figure are due to a few participants installing more than one measure category in their projects.

3.2 Gross Savings

Gross savings correspond to the change in energy consumption that results from actions taken by participants regardless of their reasons for participating. For the BER program, gross savings are determined by multiplying the proportion of units generating electricity savings (percentage claimed for EE&C) by the number of units installed for each measure category and the energy or peak demand savings value. The following equation is used.

Gross Savings = Percentage Claimed for EE&C × Number of Units × Unitary Savings x In-Service Rate x (1 + Interactive Effects Factor)

Lifetime gross energy savings are then obtained by multiplying annual gross energy savings with the EUL value associated with each measure category.

The Evaluator established savings calculation parameters for key eligible measures to cover at least 80% of program savings, based on the ePEI program database.

Table 3 below presents the measure categories selected for the evaluation and their proportion of gross energy savings for 2019/2020. For the other measures, the Evaluator used the savings values established as part of program design and derived from the results presented in the EfficiencyOne 2016 demand-side management (DSM) Evaluation Report of the Business Energy Rebates (BER) program.[2]

Table 3: Key Eligible Measure Categories for the Program Evaluation

Measure Category	Proportion of Gross Energy Savings
MSHPs	30%
High Bay Luminaires	42%
Linear Fixtures	8%
Linear Lamps	7%
Total	**87%**

3.2.1 Percentage Claimed for EE&C

The participant survey results indicate that 50% of MSHPs installed through the BER program save electricity and the remaining half reduce the usage of non-electrical heating fuels, mainly oil, wood and propane. The Evaluator therefore considered that the proportion of BER program participants who have an electrical heating baseline is 50% and used this proportion to calculate the number of MSHP units that reduce the use of electricity rebated through the program. The same proportion was applied to PTHPs. The other measure categories, which include lighting and ECMs, only save on electricity usage so all rebated units were considered.

[2] Econoler, *2016 DSM Evaluation Reports*, report prepared for EfficiencyOne, https://www.efficiencyone.ca/dsm/ (last accessed January 30, 2020).

3.2.2 Unitary Energy Savings

This subsection presents how the Evaluator established the unitary savings values for the key eligible measures.[3]

MSHPs

The participant survey was used to determine the appropriate space heating system baseline. Among participants with electrical heating, a significant proportion already had heat pumps and a great majority of facilities were already air-conditioned. Therefore, the baseline was defined as a standard efficiency heat pump that provides heating and cooling.

The Evaluator reviewed the literature to establish the most appropriate method to calculate unitary savings for MSHPs. The literature indicated that the equation used by the EfficiencyOne BER program Mail-in service, upon which ePEI bases heat pump unitary savings, is valid.

The equation to calculate MSHP electrical unitary savings is as follows.

$$Energy\ Savings_{kWh} = 0.001 * \left[\left(HC * \left[\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{ee}} \right] * EFLH_h \right) + \left(CC * \left[\frac{1}{SEER_{base}} - \frac{1}{SEER_{ee}} \right] * EFLH_c \right) \right]$$

The variables used in this equation are defined in Table 4. Since the technical information on MSHPs is not collected in the database, the Evaluator used the weighted average heat pump performance data (*HC, CC,* $HSPF_{ee}$ and $SEER_{ee}$) based on the sample of 18 projects for which application forms were reviewed. This sample included 72 MSHP units and was considered representative of the mix of measures installed through the ePEI BER program. The application form review also served to establish the mix of facility types in the program. Since the referenced TRMs recommend that EFLH values have different values per facility type, the Evaluator used the sample to establish a weighted average specific to PEI.

[3] All unitary savings values were calculated at the meter. Line loss factors were added to obtain savings at the generator in the gross savings compilation table (see **Erreur ! Source du renvoi introuvable.**).

Table 4: Calculation of Electrical Unitary Energy Savings for MSHPs

Acronym	Variable	Value/Unit	Source
-	Conversion factor from W·h to kWh	0.001 kWh/W·h	Convention
HC	Rated heating capacity of the new heat pump	14,335 BTU/h	Weighted average value based on the application form review (data extracted for each model from the Air-Conditioning, Heating and Refrigeration Institute [AHRI] directory).[4]
CC	Rated cooling capacity of the new heat pump	12,710 BTU/h	Weighted average value based on the application form review (data extracted for each model from AHRI).
$HSPF_{base}$	Heating seasonal performance factor (Region V) for the baseline measure	7.1 BTU/W·h	Energy efficiency regulation for split system heat pumps[5]
$HSPF_{ee}$	Rated heating seasonal performance factor (Region V) for the new heat pump	9.75 BTU/W·h	Weighted average value based on the application form review (data extracted for each model from AHRI).
$EFLH_h$	Full heating load hours	2,070 h/year	Weighted average value based on the $EFLH_h$ values from the Minnesota TRM,[6] facility types in the application form review and participant survey (n=36).
$EFLH_c$	Full cooling load hours	350 h/year	Weighted average value based on the $EFLH_c$ values from the Minnesota TRM, the facility types in the application form review and participant survey (n=36).
$SEER_{base}$	Seasonal energy efficiency ratio for the baseline measure	14 BTU/W·h	Energy efficiency regulation for split system heat pumps
$SEER_{ee}$	Seasonal energy efficiency ratio for the new heat pump	22.8 BTU/W·h	Weighted average value based on the application form review (data extracted for each model from AHRI).
Electrical Energy Savings		**1,259 kWh**	**Calculation**

[4] AHRI, *Directory of Certified Product Performance*, https://www.ahridirectory.org/Search/SearchHome (Last accessed April 10, 2020).
[5] 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 February 18, 2020).
NRCan specifies that the HSPF for climate Region V has been obtained by dividing the value for Region IV by 1.15.
[6] Minnesota Department of Commerce – Division of Energy Resources, *State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs* – Version 3.0, Effective January 10, 2019.

Lighting Measures

Since no technical data on lighting measures are collected in the ePEI program database, the Evaluator could not rely on engineering calculations to calculate unitary savings values specific to the products installed through the BER program. The application form review also did not allow to capture the average wattages of the main lighting categories. Given the multiple lighting measure categories and various lighting products within each category, a very large sample would have been required to obtain a representative mix of the program.

With this in mind, the Evaluator sought to use average unitary savings values from the most similar program possible. The EfficiencyOne BER program includes two services, namely Mail-in and Instant Rebates. The Mail-in service requires participants to mail in their program application and include technical information about the baseline and efficient equipment, which is then used to calculate project-specific savings. The Instant Rebates service is delivered through a network of distributors who offer program rebates at their point-of-purchase and do not collect project-specific information on replaced lighting products. Instead, Instant Rebates calculates savings based on baseline efficiency levels that are consistent with standard products currently offered on the market. The EfficiencyOne BER Instant Rebates service is the most similar to the ePEI BER program for lighting since it does not collect information on such replaced products. In addition, the eligibility criteria for products are the same.

The Evaluator therefore used the most up-to-date unitary savings values from the 2019 program evaluation of the EfficiencyOne BER Instant Rebates service to establish evaluated lighting unitary savings values. EfficiencyOne obtained these savings based on the following equation, whose variables are defined in Table 5.

$$Energy\ Savings_{kWh} = \frac{HOU}{1{,}000} * (\mathrm{W}_{\mathrm{base}} - W_{ee})$$

Table 5: Parameters Used in Unitary Energy Savings Calculations for Lighting Measures

Acronym	Variable	Value/Unit	Source
-	Conversion factor from W·h to kWh	1,000 W·h/kWh	Convention
HOU	Annual hours of use	4,410 or 4,380 h/year	4,410 for indoor lighting and 4,380 for outdoor lighting
W_{base}	Wattage for the baseline measure	Varies per measure type (W)	Baseline wattage defined for each fixture type, based on the Duke Energy Fixture Wattage table[7]
W_{ee}	Wattage for the new measure	Varies per measure type (W)	Wattage for the specific measure and model number in DLC database[8]

[7] Duke Energy, Fixture Wattage Table, http://www.ahutton.com/LED/Progress%20wattages.pdf (Last accessed March 31, 2020).
[8] DLC Bringing Efficiency to Light, https://www.designlights.org/ (Last accessed March 31, 2020).

The unitary energy savings for each measure type, drawn from the EfficiencyOne BER Instant Rebates 2019 Evaluation Report, are listed further below in Table 6.

High bay luminaires, the most popular lighting product in the ePEI BER program, are not eligible for the EfficiencyOne BER Instant Rebates service – it is instead offered through their Mail-in service. Since BER Mail-in relies on semi-prescriptive savings algorithms, no average unitary savings are published. The Evaluator was able to confirm that the values defined by ePEI upon program design, outlined in Table 6 below, were consistent with the 2016 evaluation results of the EfficiencyOne BER Mail-in service and that they included interactive effects. Therefore, these values were maintained as the evaluated unitary savings in the absence of more recent data.

Table 6: Unitary Energy Savings for Lighting Measures

Measure	Unitary Energy Savings (kWh)
Linear Fixtures	202
Linear Lamps	58.8
High Bay Luminaires - [10,000 - 19,999 lm]	1,047
High Bay Luminaires - [20,000 - 29,999 lm]	1,340
High Bay Luminaires - [40,000 – 54,999 lm]	3,147
High Bay Luminaires - Other Lumen Ranges	1,625

Summary of All Eligible Measures

The unitary savings values for each measure are presented in Table 7 below. The Evaluator established the unitary savings values for MSHPs and certain lighting measures, while the unitary savings values of other measures were defined as part of program design.

Table 7: Electrical Unitary Energy Savings Values

Category	Measure Name	Unitary Energy Savings (kWh)	Source
HVAC	MSHPs	1,259	Established by the Evaluator
	PTHPs	2,596	Defined by program design
Lighting	Linear Fixtures	202	Established by the Evaluator
	Linear Lamps	58.8	Established by the Evaluator
	High Bay Luminaires - [10,000 - 19,999 lm]	1,047	Defined by program design and maintained by the Evaluator
	High Bay Luminaires - [20,000 - 29,999 lm]	1,340	Defined by program design and maintained by the Evaluator
	High Bay Luminaires - [40,000 - 54,999 lm]	3,147	Defined by program design and maintained by the Evaluator
	High Bay Luminaires – Other Lumen Ranges	1,625	Defined by program design and maintained by the Evaluator
	Low Bay Luminaires - [5,000 - 9,999 lm]	217	Defined by program design
	Downlight Luminaires - [400 - 999 lm]	129	Defined by program design
	Downlight Luminaires - [1,000 - 2,999 lm]	210	Defined by program design
	Full-Cutoff Wall-Mounted Area Luminaires - [300 - 1,999 lm]	124	Defined by program design
	Full-Cutoff Wall-Mounted Area Luminaires - [2,000 - 4,999 lm]	237	Defined by program design
	Outdoor Pole/Arm Mounted Area Luminaires - [10,000 - 24,999 lm]	1,244	Defined by program design
	General Use Lamps	111	Defined by program design
	Reflector (Directional) Lamps - [Large (>20 lm)]	143	Defined by program design
	Flood and Spot Luminaires - [1,000 - 4,000 lm]	259	Defined by program design
Lighting Controls	Occupancy Sensors - Wall-Switch or Fixture Mounted	205	Defined by program design
	Controls	72.0	Defined by program design
Motors	ECMs for Walk-In Coolers	1,029	Defined by program design

3.2.3 Unitary Peak Demand Savings

Electricity peak demand savings correspond to the demand savings that coincide in time with the peak demand period of the electricity system. The peak demand period in PEI occurs between 5 p.m. and 7 p.m. from mid-December through early March inclusively, on any day when maximum temperature is -10 °C or lower.

MSHPs

Peak demand savings occur for MSHP participants who have an electrical heating system baseline, which was previously defined as a standard efficiency heat pump. The Evaluator analyzed temperature data to determine that, on average, outdoor temperature of -14 °C is likely to occur between 5 p.m. and 7 p.m. on days when maximum temperature is -10 °C or lower. At -14 °C, the Evaluator deemed the baseline system operates with an efficiency of 100% (coefficient of performance [COP] of 1) which is equivalent to an electrical resistance heating system. For installed efficient MSHPs, the Evaluator used the COP and heating capacity values at -15 °C (the closest available data point) of models included in the application form review to calculate peak demand savings with the equation below. The Evaluator assumed a COP of 1 for one model whose specifications at -15 °C were not available and thus did not consider peak demand savings for this model .[9]

$$Peak\ Demand\ Savings_W = \frac{HC_{-15°C}}{3.412} \times \left(\frac{1}{COP_{base-15°C}} - \frac{1}{COP_{ee\,-15°C}}\right)$$

The parameters in this equation are described in Table 8.

Table 8: Calculation of Peak Demand Savings for MSHPs

Acronym	Variable	Value/Unit	Source
$HC_{-15°C}$	Rated maximal heating capacity of the new heat pump at an outdoor air temperature of - 15 °C	14,365 BTU/h	Weighted average value based on the application form review (data extracted for each model from NEEP)[10]
-	Conversion factor for BTU/h to W	3.412 BTU/h/W	Convention
$COP_{base-15°C}$	COP for the assumed base case (standard heat pump) at an outdoor air temperature of -15 °C	1 kW/kW	Assumption that a standard heat pump system operates at -15 °C with a COP equivalent to an electrical resistance heater
$COP_{ee-15°C}$	COP at maximal capacity for the new heat pump at an outdoor air temperature of – 15 °C	1.77 kW/kW	Weighted average value based on the application form review (data extracted for each model from NEEP)
Unitary Peak Demand Savings		**1,832 W**	**Calculation**

[9] Out of a total of 72 units, 20 units of this model were included in the sample of MSHPs reviewed, thus impacting considerably the weighted average COP value.

[10] NEEP, *Cold Climate Air Source Heat Pump (ccASHP) Specification*, https://neep.org/ASHP-Specification#Listing%20Products (last accessed March 25, 2020).

Lighting

Peak demand savings for lighting correspond to the reduction in wattage between the baseline and the efficient lighting fixtures or lamps multiplied by a peak coincidence factor (PCF). The PCF represents the proportion of the peak demand period during which full wattage reduction is achieved. It is also expressed in the following formula:

$$PCF = \frac{Average\ Wattage\ Reduction\ Over\ Peak\ Demand\ Period}{Maximum\ Wattage\ Reduction}$$

The Evaluator used the PCF results from EfficiencyOne's BER Instant Rebates 2019 Evaluation Report since EfficiencyOne's peak demand period is the closest to ePEI's. The two periods are not identical however; while in Nova Scotia the peak occurs from December to February on weekdays between 5 p.m. and 7 p.m., in PEI, the peak period includes weekend days as well. The PCF obtained from EfficiencyOne is therefore likely to be overestimated, based on the assumption that fewer businesses are open on weekend evenings than on weekdays. This PCF therefore carries significant uncertainty when applied to PEI results. Again, for high bay luminaires, updated values were not available because the EfficiencyOne 2019 Evaluation Report does not present results specific to this measure. The Evaluator was able to confirm that, in the absence of more recent data, the unitary peak demand savings values established as part of program design and derived from the 2016 evaluation of EfficiencyOne's BER Mail-in service were appropriate and could be maintained as the evaluated unitary peak demand savings value.

Table 9: Peak Demand Savings Calculation for Lighting Measures

Measure	Unitary Wattage Reduction (W)	PCF	Unitary Peak Demand Savings (W)
Linear LED Fixtures	45.9	0.648	29.7
Linear LED Lamps	13.3	0.648	8.62
High Bay Luminaires - [10,000 - 19,999 lm]	-	-	155
High Bay Luminaires - [20,000 - 29,999 lm]	-	-	211
High Bay Luminaires - [40,000 – 54,999 lm]	-	-	386
High Bay Luminaires - Other Lumen Ranges	-	-	241

Summary of All Eligible Measures

The unitary peak demand savings values of key eligible evaluated measures are presented in Table 10, as well as the values for other measures that the Evaluator maintained since they had been defined through program design.

Table 10: Unitary Peak Demand Savings Values

Category	Measure Name	Unitary Peak Demand Savings (W)	Source
HVAC	MSHPs	1,832	Established by the Evaluator
	PTHPs	0	Defined by program design
Lighting	Linear Fixtures	29.7	Established by the Evaluator
	Linear Lamps	8.62	Established by the Evaluator
	High Bay Luminaires - [10,000 - 19,999 lm]	155	Defined by program design and maintained by the Evaluator
	High Bay Luminaires - [20,000 - 29,999 lm]	211	Defined by program design and maintained by the Evaluator
	High Bay Luminaires - [40,000 – 54,999 lm]	386	Defined by program design and maintained by the Evaluator
	High Bay Luminaires - Other Lumen Ranges	241	Defined by program design and maintained by the Evaluator
	Low Bay Luminaires - [5,000 - 9,999 lm]	38.2	Defined by program design
	Downlight Luminaires - [400-999 lm]	22.4	Defined by program design
	Downlight Luminaires - [1,000-2,999 lm]	36.3	Defined by program design
	Full-Cutoff Wall-Mounted Area Luminaires - [300-1,999 lm]	28.3	Defined by program design
	Full-Cutoff Wall-Mounted Area Luminaires - [2,000-4,999 lm]	54.2	Defined by program design
	Outdoor Pole/Arm Mounted Area Luminaires - [10,000 - 24,999 lm]	221	Defined by program design
	General Use Lamps	19.0	Defined by program design
	Reflector (Directional) Lamps - [Large (>20 lm)]	24.4	Defined by program design
	Flood and Spot Luminaires - [1000-4000 lm]	59.2	Defined by program design
Lighting Controls	Occupancy Sensors - Wall-Switch or Fixture Mounted	42.4	Defined by program design
	Controls	1.40	Defined by program design
Motors	ECMs for Walk-In Coolers	117	Defined by program design

3.2.4 In-Service Rates

Research indicates that a percentage of measures purchased through instant rebate programs (where there are no data collected on the measures installed and what they are replacing, i.e. their baseline) might be stored for later use. As previously mentioned, the Evaluator found that the lighting portion of the ePEI BER program resembles an instant rebate program rather than a mail-in program given the limited data that are collected. The Evaluator conducted a literature review to establish in-service rates using data from other jurisdictions with similar programs. Based on a study conducted by DNV GL for the Massachusetts Energy Efficiency Program Administrators, an in-service rate of 85% was applied to LED lamps,[11] which corresponds to the proportion of in-service fluorescent and LED lighting technologies installed three years after their purchase through an instant rebates program. The Evaluator maintained the in-service rate of 100% for fixtures, occupancy sensors and other non-lighting measures because their higher price points discourage stocking in large quantities.

3.2.5 Interactive Effects

Interactive effects occur when the implementation of energy efficiency measures has an impact on the energy consumption of other elements such as heating and cooling. For the ePEI BER program, interactive effects only occur with indoor lighting measures.

Lighting Measures

The Evaluator used interactive effects factors calculated for similar commercial programs offered in Nova Scotia by EfficiencyOne. They were calculated based on the building types and associated heating and cooling systems for a sample of participants in their Small Business Energy Solutions and BER Mail-In programs.[12] It should be noted that those factors are specific to the mix of heating, ventilation and air-conditioning (HVAC) systems and fuel types encountered in businesses in Nova Scotia; however, in the absence of data on the heating and cooling systems of BER participants in the ePEI database and in application forms, the Evaluator chose to use the results from Nova Scotia.

[11] An in-service rate of 85% had to be applied for linear lamps only since the unitary savings of the other lamp types, namely general-use and reflector lamps that were maintained as defined by program design, already include this in-service rate.
[12] Econoler, *2016 DSM Evaluation Reports*, report prepared for EfficiencyOne, https://www.efficiencyone.ca/dsm/ (Last accessed January 30, 2020).

The average overall interactive effects factors were established at -4.0% for energy savings and -8.9% for peak demand savings for indoor fixtures. Additionally, a factor of 57%[13] was applied to interactive effects factors to take into account the limited contribution of recessed fixtures to heat gains. The Evaluator used the factors calculated for the EfficiencyOne BER Instant Rebates service, for which a recessed factor of 57% was applied to the proportion of savings generated by recessed fixtures and lamps. Finally, since high bay luminaire unitary savings already include interactive effects, no interactive effects factor was applied.[14] Interactive effects factors for the reviewed key lighting measures are summarized in Table 11.

Table 11: Interactive Effects Factors for Lighting Measures

Measure	Interactive Effects Factor for Energy Savings	Interactive Effects Factor for Peak Demand Savings
Linear Fixtures	-3.4%	-7.5%
Linear Lamps	-3.4%	-7.5%
High Bay Luminaires	0%	0%

Interactive effects factors were only reviewed for key eligible measures. It should, however, be noted that the unitary savings values used in program design already include interactive effects despite the interactive effects factors in the gross savings compilation table (Table 13 below) being set to 0%.

3.2.6 Effective Useful Life

The Evaluator performed a literature review to establish the EUL values of key eligible measures. For MSHPs, a period of 15 years was deemed appropriate because it is currently used in recent TRMs and available public evaluation reports. For instance, this value is reported in the GDS Measure Life Report,[15] which is commonly stated in TRMs. For high bay luminaires, linear luminaires and linear lamps, the Evaluator used the values determined through the evaluation of EfficiencyOne's BER program, which considers the evolution of the baseline due to changes in energy efficiency regulations over the lifespan of efficient lighting products. The EUL calculations for those measures are detailed in Appendix II. The EUL values for the other eligible measures were maintained as defined by program design.

Table 12 below lists the EUL value of each measure category.

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[13] Chantrasrisalai, C., & Fisher, D. E. (2006). *Lighting Heat Gain Parameters: Experimental Method*, HVAC&R Research, 13(2).

[14] High bay fixtures are typically installed in spaces where ceilings are too high to have a real impact on heating and cooling, so it is expected that the interactive effects would be negligible even if they had not already been included in the unitary savings value.

[15] GDS Associates. *Measure Life Report. Residential and Commercial/Industrial Lighting and HVAC Measures*, June 2007, p. A-5.

Table 12: EUL Values

Category	Measure Name	EUL (years)	Source
HVAC	MSHPs	15.0	Established by Econoler
	PTHPs	18.0	Defined by program design
Lighting	Linear Fixtures	11.3	Established by Econoler
	Linear Lamps	11.3	Established by Econoler
	High Bay Luminaires	22.7	Established by Econoler
	Low Bay Luminaires	13.6	Defined by program design
	Downlight Luminaires	14.2	Defined by program design
	Full-Cutoff Wall-Mounted Area Luminaires	18.0	Defined by program design
	Outdoor Pole/Arm Mounted Area Luminaires	8.0	Defined by program design
	General Use Lamps	13.6	Defined by program design
	Reflector (Directional) Lamps	13.6	Defined by program design
	Flood and Spot Luminaires	15.0	Defined by program design
Lighting Controls	Occupancy Sensors and Controls	10.0	Defined by program design
Motors	ECMs for Walk-In Coolers	9.0	Defined by program design

3.2.7 Summary of Gross Savings

The annual gross savings for each measure category that generated electrical energy savings in the 2019/2020 program period are listed in Table 13 below. Results for 2018/2019 are presented in Table 14. Savings at the generator were obtained by applying line loss factors of 1.120 for energy and 1.171 for peak demand, as provided by Maritime Electric, the electricity utility.

Table 13: Gross Energy and Peak Demand Savings for 2019/2020

Measure	HVAC		Lighting		
	MSHPs	PTHPs	Linear Fixtures	Linear Lamps	High Bay Luminaires - [10,000 - 19,999 lm]
Number of Measures	272	4	753	3,226	210
Percentage Claimed for EE&C	50%	50%	100%	100%	100%
Number of Measures Claimed for EE&C	136	2	753	3,226	210
Energy Savings					
Unitary Energy Savings (kWh)	1,259	2,596	202	58.8	1,047
In-Service Rate	100%	100%	100%	85%	100%
Energy Interactive Effects Factor	0%	0%	-3.4%	-3.4%	0%
Gross Energy Savings – at the Meter (GWh)	**0.171**	**0.005**	**0.147**	**0.156**	**0.220**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120
Gross Energy Savings – at the Generator (GWh)	**0.192**	**0.006**	**0.165**	**0.174**	**0.246**
Effective Useful Life (years)	15.0	18.0	11.3	11.3	22.7
Gross Lifetime Energy Savings – at the Generator (GWh)	**2.877**	**0.105**	**1.860**	**1.971**	**5.590**
Peak Demand Savings					
Unitary Peak Demand Savings (W)	1,832	0	29.7	8.62	155
In-Service Rate	100%	100%	100%	85%	100%
Peak Demand Interactive Effects Factor	0%	0%	-7.5%	-7.5%	0%
Gross Peak Demand Savings – at the Meter (MW)	**0.249**	**0.000**	**0.021**	**0.022**	**0.033**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171
Gross Peak Demand Savings – at the Generator (MW)	**0.292**	**0.000**	**0.024**	**0.026**	**0.038**

Table 13: Gross Energy and Peak Demand Savings for 2019/2020 (Continued)

Measure	Lighting				
	High Bay Luminaires - [20,000 - 29,999 lm]	High Bay Luminaires - [40,000 – 54,999 lm]	High Bay Luminaires - Other Lumen Ranges	Low Bay Luminaires - [5,000 - 9,999 lm]	Downlight Luminaires [400-999 lm]
Number of Measures	139	44	54	52	182
Percentage Claimed for EE&C	100%	100%	100%	100%	100%
Number of Measures Claimed for EE&C	139	44	54	52	182
Energy Savings					
Unitary Energy Savings (kWh)	1,340	3,147	1,625	217	129
In-Service Rate	100%	100%	100%	100%	100%
Energy Interactive Effects Factor	0%	0%	0%	0%	0%
Gross Energy Savings – at the Meter (GWh)	**0.186**	**0.138**	**0.088**	**0.011**	**0.023**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120
Gross Energy Savings – at the Generator (GWh)	**0.209**	**0.155**	**0.098**	**0.013**	**0.026**
Effective Useful Life (years)	22.7	22.7	22.7	13.6	14.2
Gross Lifetime Energy Savings – at the Generator (GWh)	**4.735**	**3.520**	**2.231**	**0.172**	**0.373**
Peak Demand Savings					
Unitary Peak Demand Savings (W)	211	386	241	38.2	22.4
In-Service Rate	100%	100%	100%	100%	100%
Peak Demand Interactive Effects Factor	0%	0%	0%	0%	0%
Gross Peak Demand Savings – at the Meter (MW)	**0.029**	**0.017**	**0.013**	**0.002**	**0.004**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171
Gross Peak Demand Savings – at the Generator (MW)	**0.034**	**0.020**	**0.015**	**0.002**	**0.005**

Table 13: Gross Energy and Peak Demand Savings for 2019/2020 (Continued)

Measure	Lighting					
	Downlight Luminaires [1,000-2,999 lm]	Full-Cutoff Wall-Mounted Area Luminaires [300-1,999 lm]	Full-Cutoff Wall-Mounted Area Luminaires [2,000-4,999 lm]	Outdoor Pole/Arm Mounted Area Luminaires - [10,000 - 24,999 lm]	General Use Lamps	Reflector (Directional) Lamps
Number of Measures	63	1	4	1	377	98
Percentage Claimed for EE&C	100%	100%	100%	100%	100%	100%
Number of Measures Claimed for EE&C	63	1	4	1	377	98
Energy Savings						
Unitary Energy Savings (kWh)	210	124	237	1,244	111	143
In-Service Rate	100%	100%	100%	100%	100%	100%
Energy Interactive Effects Factor	0%	0%	0%	0%	0%	0%
Gross Energy Savings – at the Meter (GWh)	**0.013**	**0.000**	**0.001**	**0.001**	**0.042**	**0.014**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120
Gross Energy Savings – at the Generator (GWh)	**0.015**	**0.000**	**0.001**	**0.001**	**0.047**	**0.016**
Effective Useful Life (years)	14.2	18.0	18.0	8.0	13.6	13.6
Gross Lifetime Energy Savings – at the Generator (GWh)	**0.210**	**0.002**	**0.019**	**0.011**	**0.637**	**0.213**
Peak Demand Savings						
Unitary Peak Demand Savings (W)	36.3	28.3	54.2	221	19.0	24.4
In-Service Rate	100%	100%	100%	100%	100%	100%
Peak Demand Interactive Effects Factor	0%	0%	0%	0%	0%	0%
Gross Peak Demand Savings – at the Meter (MW)	**0.002**	**0.000**	**0.000**	**0.000**	**0.007**	**0.002**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171
Gross Peak Demand Savings – at the Generator (MW)	**0.003**	**0.000**	**0.000**	**0.000**	**0.008**	**0.003**

Table 13: Gross Energy and Peak Demand Savings for 2019/2020 (Continued)

Measure	Lighting	Lighting Controls		Motors	Total
	Flood and Spot Luminaires [1,000-4,000 lm]	Occupancy Sensors - Wall-Switch or Fixture Mounted	Controls	ECMs for Walk-In Coolers	
Number of Measures	2	43	3	70	5,598
Percentage Claimed for EE&C	100%	100%	100%	100%	--
Number of Measures for Claimed EE&C	2	43	3	70	5,460
Energy Savings					
Unitary Energy Savings (kWh)	259	205	72.0	1,029	-
In-Service Rate	100%	100%	100%	100%	-
Energy Interactive Effects Factor	0%	0%	0%	0%	-
Gross Energy Savings – at the Meter (GWh)	**0.001**	**0.009**	**0.000**	**0.072**	**1.299**
Line Loss Factor	1.120	1.120	1.120	1.120	-
Gross Energy Savings – at the Generator (GWh)	**0.001**	**0.010**	**0.000**	**0.081**	**1.455**
Effective Useful Life (years)	15.0	10.0	10.0	9.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	**0.009**	**0.099**	**0.002**	**0.726**	**25.364**
Peak Demand Savings					
Unitary Peak Demand Savings (W)	59.2	42.4	1.40	117	-
In-Service Rate	100%	100%	100%	100%	-
Peak Demand Interactive Effects Factor	0%	0%	0%	0%	-
Gross Peak Demand Savings – at the Meter (MW)	**0.000**	**0.002**	**0.000**	**0.008**	**0.412**
Line Loss Factor	1.171	1.171	1.171	1.171	-
Gross Peak Demand Savings – at the Generator (MW)	**0.000**	**0.002**	**0.000**	**0.010**	**0.483**

Table 14: Gross Energy and Peak Demand Savings for 2018/2019

Measure	HVAC	Lighting			
	MSHPs	Linear Fixtures	Linear Lamps	Downlight Luminaires [400-999 lm]	Full-Cutoff Wall-Mounted Area Luminaires [2,000-4,999 lm]
Number of Measures	159	103	1,437	74	1
Percentage Claimed for EE&C	50%	100%	100%	100%	100%
Number of Measures Claimed for EE&C	80	103	1,437	74	1
Energy Savings					
Unitary Energy Savings (kWh)	1,259	202	58.8	129	237
In-Service Rate	100%	100%	85%	100%	100%
Energy Interactive Effects Factor	0%	-3.4%	-3.4%	0%	0%
Gross Energy Savings – at the Meter (GWh)	**0.101**	**0.020**	**0.069**	**0.010**	**0.000**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120
Gross Energy Savings – at the Generator (GWh)	**0.113**	**0.023**	**0.078**	**0.011**	**0.000**
Effective Useful Life (years)	15.0	11.3	11.3	14.2	18.0
Gross Lifetime Energy Savings – at the Generator (GWh)	**1.692**	**0.254**	**0.878**	**0.152**	**0.005**
Peak Demand Savings					
Unitary Peak Demand Savings (W)	1,832	29.7	8.62	22.4	54.2
In-Service Rate	100%	100%	85%	100%	100%
Peak Demand Interactive Effects Factor	0%	-7.5%	-7.5%	0%	0%
Gross Peak Demand Savings – at the Meter (MW)	**0.147**	**0.003**	**0.010**	**0.002**	**0.000**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171
Gross Peak Demand Savings – at the Generator (MW)	**0.172**	**0.003**	**0.011**	**0.002**	**0.000**

Table 14: Gross Energy and Peak Demand Savings for 2018/2019 (Continued)

Measure	Lighting			Total
	Full-Cutoff Wall-Mounted Area Luminaires [5,000-14,999 lm]	Flood and Spot Luminaires [1,000-4000 lm]	Flood and Spot Luminaires [5,000-14,999 lm]	
Number of Measures	6	23	3	1,806
Percentage Claimed for EE&C	100%	100%	100%	-
Number of Measures Claimed for EE&C	6	23	3	1,727
Energy Savings				
Unitary Energy Savings (kWh)	826	259	796	-
In-Service Rate	100%	100%	100%	-
Energy Interactive Effects Factor	0%	0%	0%	-
Gross Energy Savings – at the Meter (GWh)	**0.005**	**0.006**	**0.002**	**0.213**
Line Loss Factor	1.120	1.120	1.120	-
Gross Energy Savings – at the Generator (GWh)	**0.006**	**0.007**	**0.003**	**0.239**
Effective Useful Life (years)	18.0	15.0	15.0	-
Gross Lifetime Energy Savings – at the Generator (GWh)	**0.100**	**0.100**	**0.040**	**3.221**
Peak Demand Savings				
Unitary Peak Demand Savings (W)	189	59.2	182	-
In-Service Rate	100%	100%	100%	-
Peak Demand Interactive Effects Factor	0%	0%	0%	-
Gross Peak Demand Savings – at the Meter (MW)	**0.001**	**0.001**	**0.001**	**0.164**
Line Loss Factor	1.171	1.171	1.171	-
Gross Peak Demand Savings – at the Generator (MW)	**0.001**	**0.002**	**0.001**	**0.192**

3.3 Net Savings

Net savings are defined as the energy use reductions specifically attributable to the BER program. Effects that positively or negatively affect the energy savings generated by a program, namely free-ridership and spillover, are generally considered. They are then combined into a net-to-gross ratio (NTGR) that is applied to gross energy savings.

For the BER program, the Evaluator assessed the free-ridership level using the participant survey and assumed the spillover level to be nil. Based on the Evaluator's experience with similar programs, spillover is usually low for programs like BER, especially when participants are allowed to install multiple units.

3.3.1 Free-Ridership

For the BER program, free-ridership occurs when participants would still have implemented the energy efficiency measures in the absence of the program. All applicable variables in the decision-making process were considered in the free-ridership questions, including planning, efficiency level, timing, quantity and cost.

For MSHP, the Evaluator did not deduct free-ridership since the baseline established for calculating gross savings is a new standard efficiency heat pump and not the existing heating and cooling system. The gross savings of MSHPs therefore already excluded the portion of savings related to the efficiency increase provided by the replacement of the existing system with the MSHP. Therefore, no further adjustment was needed at the net savings level. However, a certain level of free-ridership is attributable to the decision of purchasing a high-efficiency MSHP instead of a standard-efficiency MSHP, but the Evaluator assumed it would be negligible.

For key eligible lighting measures, the feedback collected from the participant survey was converted into a free-ridership level using the algorithm presented in Appendix III. The Evaluator established the free-ridership level of key eligible lighting measures at 30% with a margin of error of ±9.9%.

The answers collected revealed that almost half (42%) of the participants who installed lighting measures had already decided (intention variable) to implement energy efficient measures in their facility before they heard about the program. On the other hand, participants were influenced by the program rebates as well as information provided and promotion, demonstrating that the BER program still had a great influence on participants' final decisions. Furthermore, the rebates provided by ePEI proved to be the most influential factor for participants. Since the overall free-ridership level is calculated considering both intention and influence levels, the influence factor significantly lowered the free-ridership level associated with intention, resulting in a 30% average free-ridership level.

Table 15 below summarizes the average free-ridership level for key eligible measures as well as for the other program measures. The Evaluator maintained the free-ridership levels of the other measures, as per program design, since they were not assessed through the survey.

Table 15: Free-Ridership Levels

Measure	Free-Ridership Level	Margin of Error
MSHPs	**0%**	N/A
Linear Fixtures	**30%**	9.9%
Linear Lamps		
High Bay Luminaires		
Others	**16%**	N/A

3.3.2 Net-to-Gross Ratio Calculations

The NTGR was calculated using the following equation:

$$NTGR = (1 - \%\ \text{Free-Ridership})$$

Table 16 summarizes the NTGRs for key eligible measures as well as for the other measures.

Table 16: 2019 NTGRs

Measure	Free-Ridership Level	NTGR
MSHPs	0%	**1.00**
Linear Fixtures	30%	**0.70**
Linear Lamps		
High Bay Luminaires		
Others	16%	**0.84**

3.3.3 Summary of Net Savings

Net savings are determined by applying the NTGRs to evaluated gross savings using the following equation.

$$\textit{Net Savings} = \textit{Evaluated Gross Savings} \times \textit{NTGR}$$

The detailed net savings results for 2019/2020 and 2018/2019 are summarized in Table 17 and Table 18 respectively.

Table 17: Net Energy and Peak Demand Savings for 2019/2020

Measure	HVAC		Lighting		
	MSHPs	PTHPs	Linear Fixtures	Linear Lamps	High Bay Luminaires - [10,000 - 19,999 lm]
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.171	0.005	0.147	0.156	0.220
NTGR	1.00	0.84	0.70	0.70	0.70
Net Energy Savings – at the Meter (GWh)	**0.171**	**0.004**	**0.103**	**0.109**	**0.154**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120
Net Energy Savings – at the Generator (GWh)	**0.192**	**0.005**	**0.115**	**0.109**	**0.172**
Effective Useful Life (years)	15.0	18.0	11.3	11.3	22.7
Net Lifetime Energy Savings – at the Generator (GWh)	**2.877**	**0.088**	**1.302**	**1.380**	**3.913**
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.249	0.000	0.021	0.022	0.033
NTGR	1.00	0.84	0.70	0.70	0.70
Net Peak Demand Savings – at the Meter (MW)	**0.249**	**0.000**	**0.014**	**0.015**	**0.023**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171
Net Peak Demand Savings – at the Generator (MW)	**0.292**	**0.000**	**0.017**	**0.018**	**0.027**

Table 17: Net Energy and Peak Demand Savings for 2019/2020 (Continued)

Measure	Lighting				
	High Bay Luminaires - [20,000 - 29,999 lm]	High Bay Luminaires - [40,000 – 54,999 lm]	High Bay Luminaires - Other Lumen Ranges	Low Bay Luminaires - [5,000 - 9,999 lm]	Downlight Luminaires [400-999 lm]
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.186	0.138	0.088	0.011	0.023
NTGR	0.70	0.70	0.70	0.84	0.84
Net Energy Savings – at the Meter (GWh)	**0.130**	**0.097**	**0.061**	**0.009**	**0.020**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120
Net Energy Savings – at the Generator (GWh)	**0.146**	**0.109**	**0.069**	**0.011**	**0.022**
Effective Useful Life (years)	22.7	22.7	22.7	13.6	14.2
Net Lifetime Energy Savings – at the Generator (GWh)	**3.315**	**2.464**	**1.562**	**0.144**	**0.314**
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.029	0.017	0.013	0.002	0.004
NTGR	0.70	0.70	0.70	0.84	0.84
Net Peak Demand Savings – at the Meter (MW)	**0.021**	**0.012**	**0.009**	**0.002**	**0.003**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171
Net Peak Demand Savings – at the Generator (MW)	**0.024**	**0.014**	**0.011**	**0.002**	**0.004**

Table 17: Net Energy and Peak Demand Savings for 2019/2020 (Continued)

Measure	Lighting					
	Downlight Luminaires [1,000-2,999 lm]	Full-Cutoff Wall-Mounted Area Luminaires [300-1,999 lm]	Full-Cutoff Wall-Mounted Area Luminaires [2,000-4,999 lm]	Outdoor Pole/Arm Mounted Area Luminaires - [10,000 - 24,999 lm]	General Use Lamps	Reflector (Directional) Lamps
Energy Savings						
Gross Energy Savings – at the Meter (GWh)	0.013	0.000	0.001	0.001	0.042	0.014
NTGR	0.84	0.84	0.84	0.84	0.84	0.84
Net Energy Savings – at the Meter (GWh)	**0.011**	**0.000**	**0.001**	**0.001**	**0.035**	**0.012**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120	1.120
Net Energy Savings – at the Generator (GWh)	**0.012**	**0.000**	**0.001**	**0.001**	**0.039**	**0.013**
Effective Useful Life (years)	14.2	18.0	18.0	8.0	13.6	13.6
Net Lifetime Energy Savings – at the Generator (GWh)	**0.177**	**0.002**	**0.016**	**0.009**	**0.535**	**0.179**
Peak Demand Savings						
Gross Peak Demand Savings – at the Meter (MW)	0.002	0.000	0.000	0.000	0.007	0.002
NTGR	0.84	0.84	0.84	0.84	0.84	0.84
Net Peak Demand Savings – at the Meter (MW)	**0.002**	**0.000**	**0.000**	**0.000**	**0.006**	**0.002**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171	1.171
Net Peak Demand Savings – at the Generator (MW)	**0.002**	**0.000**	**0.000**	**0.000**	**0.007**	**0.002**

Table 17: Net Energy and Peak Demand Savings for 2019/2020 (Continued)

Measure	Lighting	Lighting Controls		Motors	Total
	Flood and Spot Luminaires [1,000-4,000 lm]	Occupancy Sensors - Wall-Switch or Fixture Mounted	Controls	ECMs for Walk-In Coolers	
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.001	0.009	0.000	0.072	1.299
NTGR	0.84	0.84	0.84	0.84	-
Net Energy Savings – at the Meter (GWh)	**0.000**	**0.007**	**0.000**	**0.061**	**0.988**
Line Loss Factor	1.120	1.120	1.120	1.120	-
Net Energy Savings – at the Generator (GWh)	**0.000**	**0.008**	**0.000**	**0.068**	**1.106**
Effective Useful Life (years)	15.0	10.0	10.0	9.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	**0.007**	**0.083**	**0.002**	**0.610**	**18.979**
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.000	0.002	0.000	0.008	0.412
NTGR	0.84	0.84	0.84	0.84	-
Net Peak Demand Savings – at the Meter (MW)	**0.000**	**0.002**	**0.000**	**0.007**	**0.367**
Line Loss Factor	1.171	1.171	1.171	1.171	-
Net Peak Demand Savings – at the Generator (MW)	**0.000**	**0.002**	**0.000**	**0.008**	**0.430**

Table 18: Net Energy and Peak Demand Savings for 2018/2019

Measure	HVAC	Lighting			
	MSHPs	Linear Fixtures	Linear Lamps	Downlight Luminaires [400-999 lm]	Full-Cutoff Wall-Mounted Area Luminaires [2,000-4,999 lm]
Energy Savings					
Gross Energy Savings – at the Meter (GWh)	0.101	0.020	0.069	0.010	0.000
NTGR	1.00	0.70	0.70	0.84	0.84
Net Energy Savings – at the Meter (GWh)	**0.101**	**0.014**	**0.049**	**0.008**	**0.000**
Line Loss Factor	1.120	1.120	1.120	1.120	1.120
Net Energy Savings – at the Generator (GWh)	**0.113**	**0.016**	**0.054**	**0.009**	**0.000**
Effective Useful Life (years)	15.0	11.3	11.3	14.2	18.0
Net Lifetime Energy Savings – at the Generator (GWh)	**1.692**	**0.178**	**0.615**	**0.128**	**0.004**
Peak Demand Savings					
Gross Peak Demand Savings – at the Meter (MW)	0.147	0.003	0.010	0.002	0.000
NTGR	1.00	0.70	0.70	0.84	0.84
Net Peak Demand Savings – at the Meter (MW)	**0.147**	**0.002**	**0.007**	**0.001**	**0.000**
Line Loss Factor	1.171	1.171	1.171	1.171	1.171
Net Peak Demand Savings – at the Generator (MW)	**0.172**	**0.002**	**0.008**	**0.002**	**0.000**

Table 18: Net Energy and Peak Demand Savings for 2018/2019 (Continued)

Measure	Lighting			Total
	Full-Cutoff Wall-Mounted Area Luminaires [5,000-14,999 lm]	Flood and Spot Luminaires [1,000-4,000 lm]	Flood and Spot Luminaires --- [5,000-14,999 lm]	
Energy Savings				
Gross Energy Savings – at the Meter (GWh)	0.005	0.006	0.002	0.213
NTGR	0.84	0.84	0.84	-
Net Energy Savings – at the Meter (GWh)	**0.004**	**0.005**	**0.002**	**0.183**
Line Loss Factor	1.120	1.120	1.120	-
Net Energy Savings – at the Generator (GWh)	**0.005**	**0.006**	**0.002**	**0.205**
Effective Useful Life (years)	18.0	15.0	15.0	-
Net Lifetime Energy Savings – at the Generator (GWh)	**0.084**	**0.084**	**0.034**	**2.818**
Peak Demand Savings				
Gross Peak Demand Savings – at the Meter (MW)	0.001	0.001	0.001	0.164
NTGR	0.84	0.84	0.84	-
Net Peak Demand Savings – at the Meter (MW)	**0.001**	**0.001**	**0.000**	**0.159**
Line Loss Factor	1.171	1.171	1.171	-
Net Peak Demand Savings – at the Generator (MW)	**0.001**	**0.001**	**0.001**	**0.187**

3.4 Cost-Effectiveness

The Evaluator assessed program cost-effectiveness by performing specific cost-effectiveness tests, namely the TRC and the PAC tests. When performing these tests, ratios greater than 1 are desired because they indicate that program benefits outweigh costs. This section presents the calculations performed to assess the cost-effectiveness of the EE&C portion of the program.

Various values and parameters were necessary to conduct these tests:

- The gross and net electrical savings as well as the EUL were drawn from the results presented in Subsections 3.2 and 3.3 of this report. To quantify the economic value of those savings (i.e. the program benefits), the Evaluator used the unitary avoided costs of electrical energy savings and peak demand savings that were provided by the electricity utility, Maritime Electric. Total program costs, broken down by administrative and incentive costs, were provided by ePEI. The Evaluator estimated the proportion of those costs allocated to EE&C based on the ratio of electrical and non-electrical savings[16] generated by the program in 2018/19 and 2019/2020. The IPCs associated with products generating electrical savings were estimated by the Evaluator and is described in further detail in Subsection 3.4.1 below.
- The Net Present Value (NPV) calculations of all cash flows (costs and benefits) considered in the cost-effectiveness tests were performed using the ePEI discount rate (3.2%) and inflation rate (2%).

3.4.1 Incremental Product Costs

For the BER program, IPCs represent the difference in cost between the energy efficient product rebated by the program and what would have been purchased in the absence of the program (baseline scenario), regardless of who pays.

The baseline scenario for the IPC of MSHPs is a standard efficiency heat pump. Based on a literature review of TRMs and publicly available evaluation reports, the Evaluator determined that the most appropriate and recent source to establish the IPC between this base case and a higher efficiency MSHP was the 2019 evaluation of the EfficiencyOne Green Heat program. Although this program is offered to the residential sector, eligible MSHPs for both the ePEI BER and EfficiencyOne Green Heat programs are the same type and have similar capacities. Although the performance requirements vary slightly between the two programs (Both programs require a similar HSPF, but EfficiencyOne's Green Heat has an additional minimum requirement for COP at - 15°C.), the Evaluator considered that the IPC from Nova Scotia was the most representative, given the proximity of the two markets. In the 2019 evaluation of the Green Heat program, interviews with distributors in Nova Scotia were conducted to

[16] Although the quantification of non-electrical energy savings was outside of the scope of the evaluation, the Evaluator used the number of products, listed in the database, generating non-electrical savings as well as estimates of the unitary energy savings of each product to produce a high-level estimate of the non-electrical savings for the BER program and compared that value to electrical energy savings to obtain a percentage of savings attributed to EE&C activities.

establish an average IPC of $590 (or 12% of the total installed cost) between a standard efficiency heat pump and an efficient unit with a capacity of 12,000 BTU/h. The Evaluator established the IPC by applying this value of 12% to the average cost of the units installed through the BER program, which resulted in $414/unit.

For key eligible lighting measures, the baseline scenario was defined as standard products currently available on the market, such as fluorescent or halogen-incandescent technologies. In the evaluation reports of commercial lighting programs consulted by the Evaluator, notably from Manitoba and New Brunswick,[17] the IPC value of LED lighting measures was set at $0. The rationale behind this is that although LED lamps are more expensive than standard products, their rated life span is much longer than that of fluorescent or halogen-incandescent lamps. This means that to offer the same service as LED lamps, standard products would have to be purchased multiple times. In other words, for the same effective useful life span, it is more expensive for participants to purchase standard-efficiency products than efficient products. In this context, some jurisdictions set negative IPCs for LED products, such as Ontario's Independent Electricity System Operator. However, applying negative IPCs to cost-effectiveness tests is challenging since it can result in a negative TRC ratio. To avoid overestimating the cost-effectiveness test results, certain jurisdictions such as Manitoba and New Brunswick use a nil value as the IPC of LED products. The Evaluator considered this a reasonable assumption and decided to set the IPC at $0 for all lighting measures of the BER program, even for lighting products that had not been identified as key eligible measures.

For the other measure types offered by the program, namely lighting controls and motors, the Evaluator kept the IPC values as they had been established during program design.

Table 19 below lists the IPC values for each of the program measure categories rebated in 2019/2020.

[17] Econoler, *2015/16 Commercial Lighting Program Evaluation*, report prepared for Manitoba Hydro, June 29, 2017. Econoler, *2018/2019 Small Business Lighting Program Impact Evaluation*, report prepared for New Brunswick Power, September 30, 2019.

Table 19: IPC Values

Measure Category	Measure Name	IPC per Unit	Source
HVAC	MSHPs	$414	Established by Econoler
	PTHPs	$3,500	Defined by program design
Lighting	Linear Fixtures	$0	Established by Econoler
	Linear Lamps	$0	Established by Econoler
	High Bay Luminaires	$0	Established by Econoler
	Low Bay Luminaires	$0	Established by Econoler
	Downlight Luminaires	$0	Established by Econoler
	Full-Cutoff Wall-Mounted Area Luminaires	$0	Established by Econoler
	Outdoor Pole/Arm Mounted Area Luminaires	$0	Established by Econoler
	General Use Lamps	$0	Established by Econoler
	Reflector (Directional) Lamps	$0	Established by Econoler
	Flood and Spot Luminaires	$0	Established by Econoler
Lighting Controls	Occupancy Sensors	$30.30	Defined by program design
	Controls	$50	Defined by program design
Motors	ECMs for Walk-In Coolers	$515	Defined by program design

The unitary IPC values were multiplied by the number of units claimed for EE&C, resulting in an overall IPC of $100,807 for the EE&C portion of the BER program.

3.4.2 Cost-Effectiveness Tests

This subsection presents the equations used for the PAC and TRC tests. For each test, benefits are at the numerator and costs at the denominator, and they both need to be NPVs.

PAC Test

The PAC test measures the net economic benefit of a program from the program administrator perspective using the equation presented below:

$$PAC = \frac{NPV\ (Avoided\ Costs)}{NPV\ (\ Total\ Gross\ Program\ Admnistrator\ Costs)}$$

- **Avoided costs** are the avoided supply costs achieved by the net electrical energy and peak demand savings generated by the program. The avoided unitary costs in $/kWh and $/kW saved were multiplied by the electrical energy and peak demand savings respectively.

- **Total gross program administrator costs** are the program costs incurred by the program administrator. Program administrator costs include costs related to program planning, design, marketing, implementation and evaluation, as well as incentives. Incentives typically represent the amounts that the program administrator offers participating customers for the upgrades they implement. The program costs were provided by ePEI and only the proportion attributable to EE&C savings was considered since the PAC test is performed for the EE&C portion of the program.

TRC Test

The TRC test reveals the total net benefits of a program from the perspective of both the utility and participating customers. It is not necessary to know who realizes the benefits and bears the costs.

The TRC test is calculated based on the following formula:

$$TRC = \frac{NPV\ (Avoided\ Costs + Customer\ Benefits)}{NPV\ (Net\ Tech.\ Costs + Gross\ Program\ Administrator\ Non{-}Incentive\ Costs)}$$

- For the TRC test, the **avoided costs** are the same as those of the PAC test.
- **Customer benefits** are participant non-energy benefits such as water savings and improved comfort or safety. For the BER program, no customer benefits were included.
- **Net technical costs** correspond to the IPCs discussed in Subsection 3.4.1 above.
- The **gross program administration non-incentive costs** are the same costs as in the PAC ratio denominator, except that they exclude incentives. Incentives are excluded because they are financial transfers between ePEI and participating customers, thus not representing an expense.

3.4.3 Cost-Effectiveness Results

Table 20 and Table 21 present the cost-effectiveness results for the 2019/2020 and 2018/2019 periods respectively. The BER program was cost-effective in both years based on the PAC and TRC test results.

Table 20: 2019/2020 Cost-Effectiveness Results

Cost-Effectiveness Test	Ratio	Benefits	Costs
PAC Test	**11.71**	$2,806,067	$239.705
TRC Test	**17.98**	$2,806,067	$156,029

Table 21: 2018/2019 Cost-Effectiveness Results

Cost-Effectiveness Test	Ratio	Benefits	Costs
PAC Test	**17.22**	$733,818	$42,618
TRC Test	**16.43**	$733,818	$44,656

3.5 Summary of Program Savings and Cost-Effectiveness Results

Table 22 summarizes the key results from the program savings and cost-effectiveness evaluations and compares these results to program targets.

Table 22: Summary of Program Savings and Cost-Effectiveness Targets and Evaluated Results

Parameters	2018/2019 Targets	2018/2019 Evaluation Results	2019/2020 Targets	2019/2020 Evaluation Results
Program Participation				
Number of Projects	-	114	-	240
Number of Measures Claimed for EE&C	4,100	1,727	5,300	5,460
Gross Electricity Savings at the Generator				
Gross Electricity Energy Savings (GWh)	-	0.239	-	1.455
Gross Lifetime Electricity Savings (GWh)	-	3.211	-	25.364
Gross Peak Demand Savings (MW)	-	0.192	-	0.483
Net Electricity Savings at the Generator				
NTGR	-	0.86	-	0.76
Net Electricity Energy Savings (GWh)	0.9	0.205	1.1	1.106
Net Lifetime Electricity Savings (GWh)	-	2.818	-	18.979
Net Peak Demand Savings (MW)	0.1	0.187	0.2	0.430
Cost-Effectiveness				
PAC Test	2.6	17.22	2.8	11.71
TRC Test	1.1	16.43	1.2	17.98

- The 2018/2019 evaluated net electricity energy savings were lower than the program targets by 77%, mainly because the number of products rebated was lower than expected. Indeed, the program was launched later than initially planned and therefore did not operate for the full 2018/2019 fiscal year. For 2019/2020, the evaluated results were 1% higher than the program targets; the quantity of products rebated was 3% higher than expected.
- The evaluated peak demand savings exceeded the program targets by 87% and 115% for 2018/2019 and 2019/2020, respectively.
- The PAC and TRC tests revealed that the program was very cost-effective from both perspectives and reached the cost-effectiveness targets set for both fiscal years. The evaluated IPC values, especially that of lighting, likely explain why the evaluated TRC and PAC results are higher than the targets.

4 PROGRAM PROCESSES AND IMPLEMENTATION

This section includes the evaluation results related to program processes and implementation. Specifically, it presents the Evaluator's findings related to program data tracking and participant feedback about their experience with the program.

4.1 Program Data Completeness

BER program data tracking is stored in two places: in a combined database with three other programs; and in a stand-alone database. The Evaluator used the stand-alone database as the point of reference for this review because, based on the Evaluator's understanding following discussions with ePEI, the stand-alone database was more comprehensive.

Figure 2 presents the important data points for the BER program and their status in the BER program database.

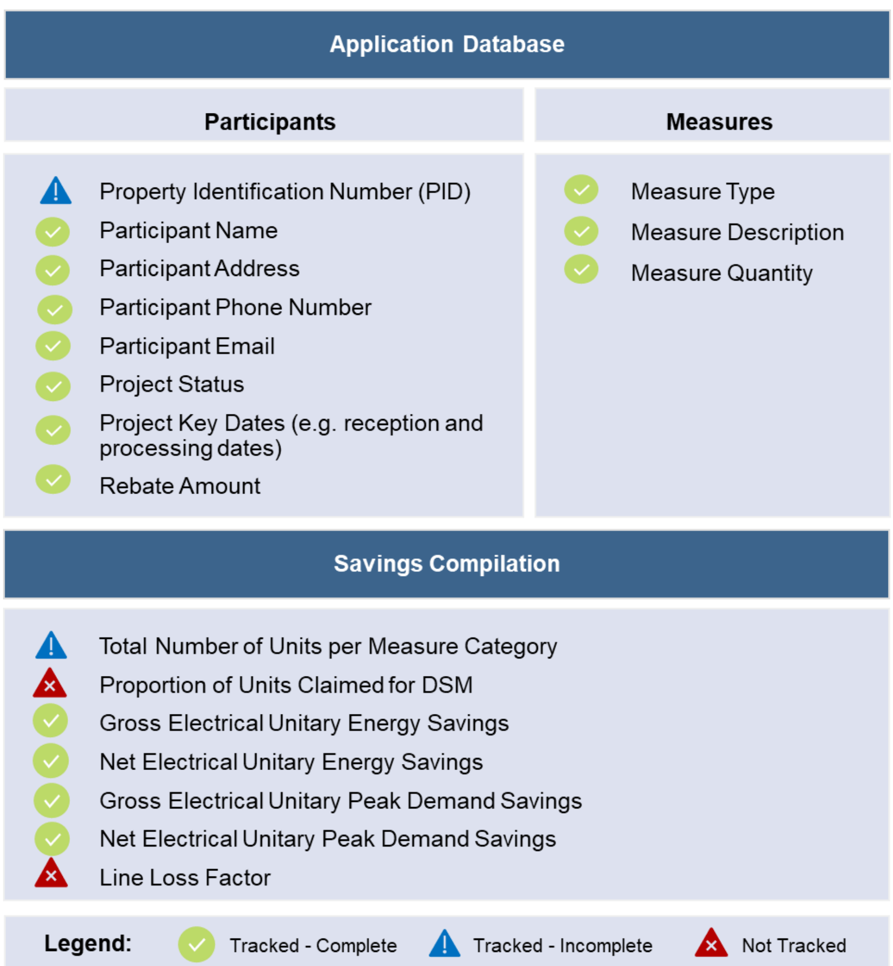

Figure 2: Summary of BER Program Data Tracking

The BER program application database includes all essential fields, and a vast majority of those fields are completed for each application. Each application corresponds to one line; one column identifies the measure types included in the application (e.g. LED lights or air source heat pump), and each measure is identified with a precise description and an associated quantity in separate columns (“Upgrade 1” to “Upgrade 5”). The only field with data missing for a handful of applications was the PID.

The Status field is also filled out for each application; the database includes applications that are still in progress or considered not eligible and, for the latter cases, upgrade descriptions and associated quantities are left empty to avoid counting them in the compilation of program savings.

Savings are compiled in another tab using the sum of quantities for each measure. The Evaluator observed that the proportion of units that generate electrical savings is not currently considered for the few measures where it is relevant (i.e. heat pumps); hence, the database includes all BER program units in savings results, with the same electrical unitary savings being applied to all of them.

Also, it should be clearly indicated whether the savings values are at the meter or at the generator. If they are at the generator, the line loss factors should be included in the database.

Recommendation: Continue tracking current items and try collecting data on currently untracked or incomplete items.

Recommendation: In the compilation tab, add a field for the proportion of units that generate electrical savings for heat pump measures and ensure this value is multiplied by the total number of units rebated.

The Evaluator notes that the data tracking system is appropriate for the current savings calculation methodology, but will have limitations once unitary savings values need to be updated. Indeed, while the measure description field includes sufficient information to associate the appropriate unitary savings value to each measure, the technical information on measures is very limited. For instance, no wattage information is available on lighting fixtures and lamps. Measure model numbers are also not tracked. Given the large number of lighting measures offered through the program, review of invoices and specification sheets for a sample of projects is impractical to obtain enough information to validate and adjust the unitary savings values that are drawn from EfficiencyOne evaluation reports.

Recommendation: Ensure that the information collected in the data-tracking system is aligned with ePEI’s strategy for updating the unitary savings values of BER program measures.

On a related note, the Evaluator was able to verify the eligibility of all but two of the 18 MSHP and 12 lighting applications that were reviewed as part of the application form review. The eligibility of the lighting products of two of the 12 lighting applications could not be confirmed due to missing information, with one of these projects having a significant incentive amount.

Data tracking and reporting are crucial for program management and evaluation. The Evaluator understands that ePEI is in the process of acquiring a data management system that would allow program tracking to be centralized rather than being performed in multiple individual tracking sheets.

The Evaluator supports ePEI's goal to improve data management, which would contribute not only to the implementation of the data-completeness and data-organization recommendations in this report, but also ensure that program data is up to date and easy to use, for program management.

4.2 Participant Awareness and Motivations

One third of surveyed participants first learned about the BER program via word of mouth or from another business. Other common sources of awareness were contractors and via participation in another ePEI program. Direct marketing – radio, newspapers, television advertisements, and the ePEI website – was the source of awareness for 30% of surveyed participants.

Survey respondents also mentioned the "other" category, which includes diverse unique responses that could not be grouped including having heard about the program at a home show or family show, or through online research or a business inspection.

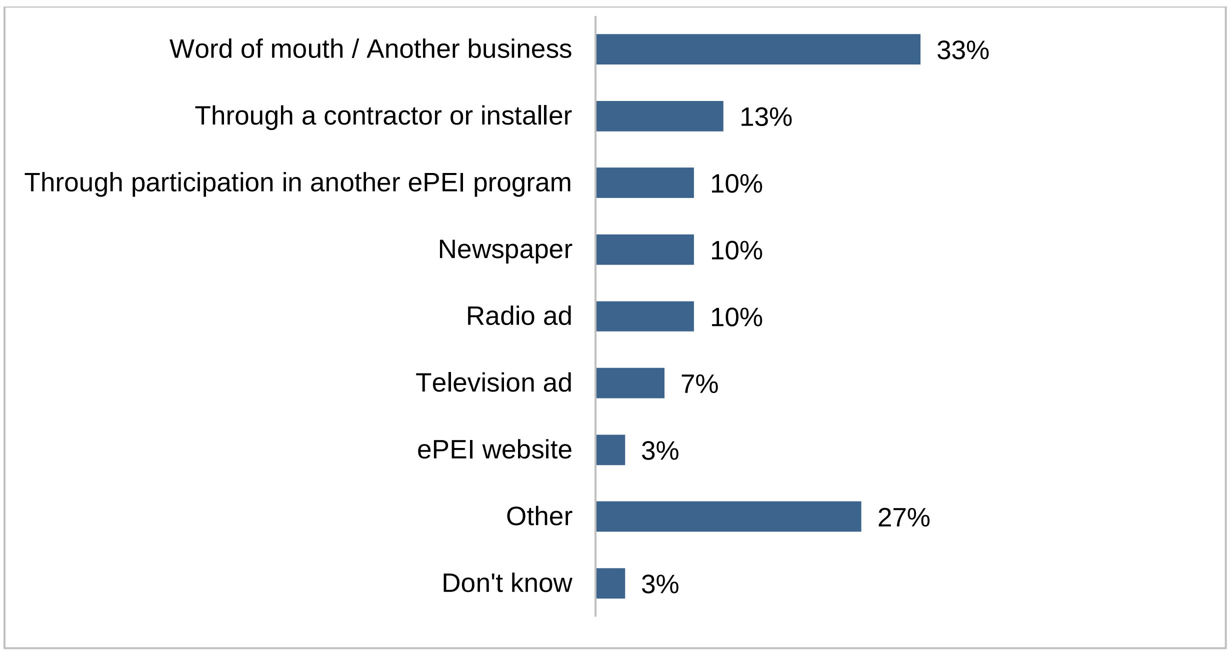

Figure 3: Primary Source of Awareness About the Program

The most common motivations for participating in the BER program among surveyed participants were saving money, saving energy and improving heating. Combined, these motivations are shared by nearly two thirds of all surveyed participants.

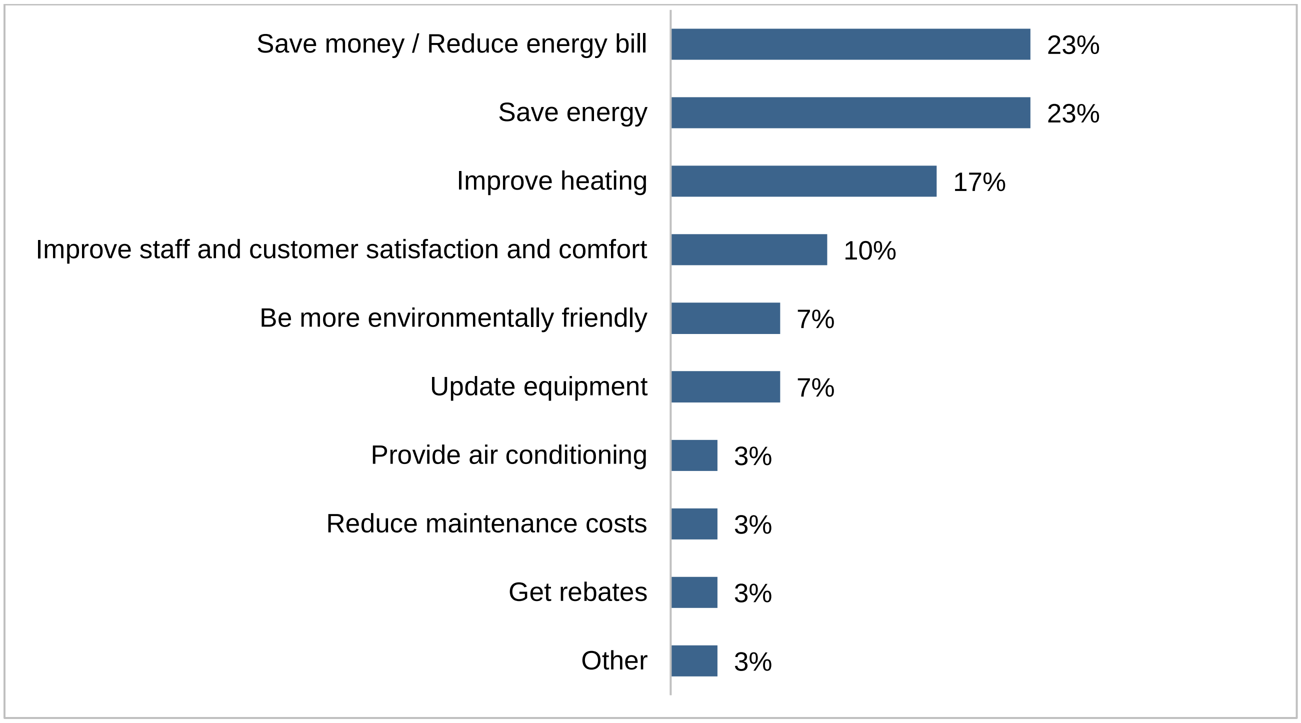

Figure 4: Primary Reason for Participating in the Program

4.3 Satisfaction with the Program

Surveyed participants were satisfied with the BER program overall. Surveyed participants awarded particularly high satisfaction scores to the work performed by the contractor or equipment installer and the new equipment installed. Only one program aspect – the rebate amount – received an average satisfaction score lower than 8 on a scale from 0 to 10 where 0 means “not at all satisfied” and 10 means “completely satisfied”.

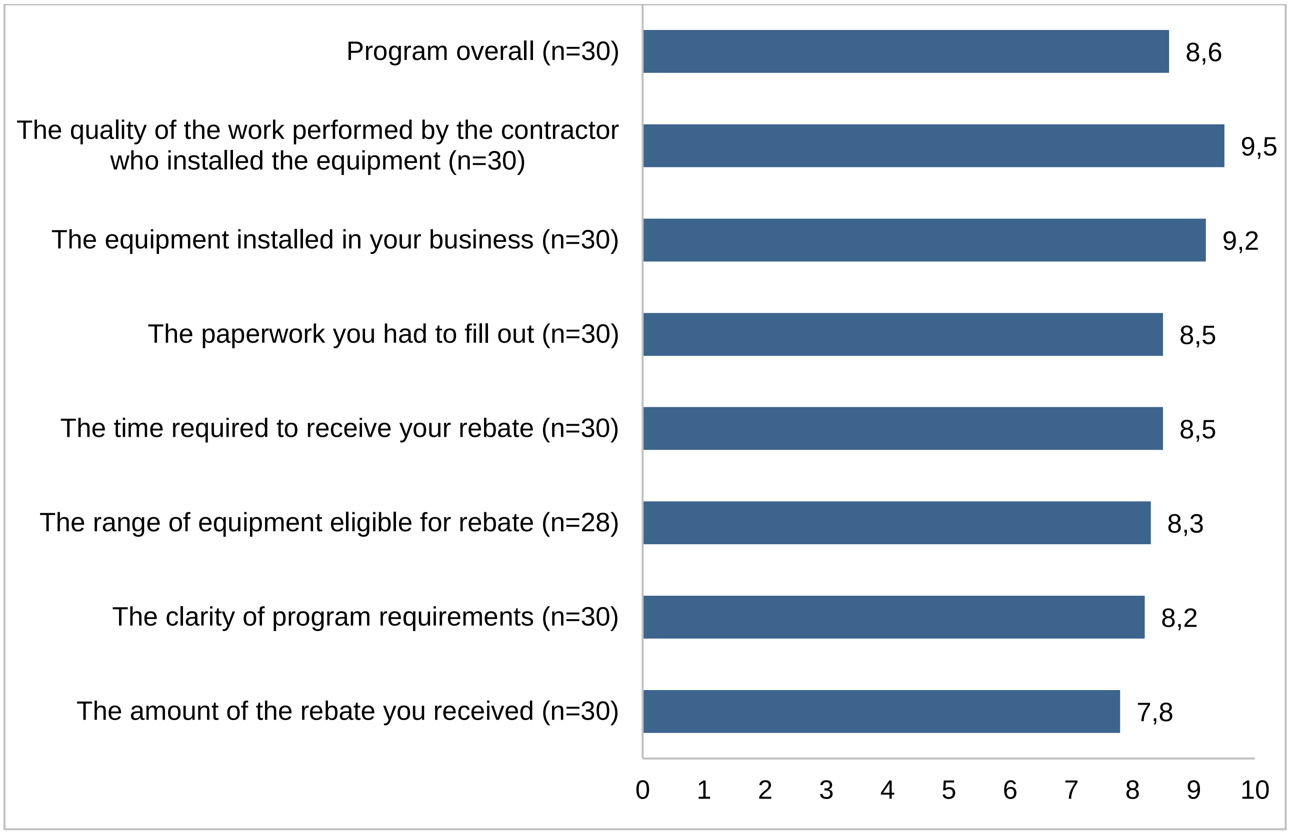

Figure 5: Participant Satisfaction Levels

The Evaluator asked participants to explain any satisfaction scores of 7 or less. The list below summarizes participants' explanations of program aspects for which at least five respondents provided scores of 7 or less.

› **BER program overall**: All five respondents indicated that they were disappointed in the rebate amounts they received. Four of the five respondents indicated that they had received an estimate from their contractor and were unhappy when they received less than the estimated amount.

› **Clarity of program requirements**: Eight respondents provided scores of 7 or less regarding the clarity of program requirements. Most indicated that they found the requirements or processes unclear and sought the help of their electrical contractor or had issues with rebates.

› **Rebate amount**: Eight respondents provided scores of 7 or less regarding the rebate amount they received. Five of them were dissatisfied at receiving less than the amount they were expecting, as mentioned above. Two participants indicated that they would like the rebate cap to be higher. One respondent said they would like to see non-profit organizations be eligible for a higher rebate amount.

› **Range of eligible equipment**: Six participants provided a score of 7 or less for the range of equipment eligible for the BER program. Two requested that support be expanded for electric vehicles and charging stations. No other technology was mentioned by more than one participant.

4.4 Energy Efficiency Activity Outside the ePEI Program

The Evaluator asked participants about upgrades to their organization in the past two years without support from the BER program or another ePEI program, as well as any plans to make upgrades in the next two years.

Slightly more than half of surveyed participants indicated that they had made upgrades to their equipment in the past two years without support from an ePEI program. Approximately two thirds of these upgrades were lighting, while approximately one third were upgrades to building envelope, and one quarter upgraded HVAC systems; the total is greater than 100% because several participants upgraded more than one system. Nearly half of those who implemented upgrades in the past two years indicated that they did not participate in the program because they did not need program support since they would have implemented the upgrade regardless. Others were unaware of the program or were ineligible to participate.

Regarding plans for the next two years, more than three quarters of surveyed participants intend to complete further upgrades to their buildings. The systems most commonly mentioned by these respondents were HVAC (11 respondents), lighting (10 respondents), and building envelope (7 respondents).

4.5 Areas for Program Improvement

More than half of surveyed participants offered recommendations to improve the BER program. The most common suggestions were to increase the rebate amount and advertise more effectively.

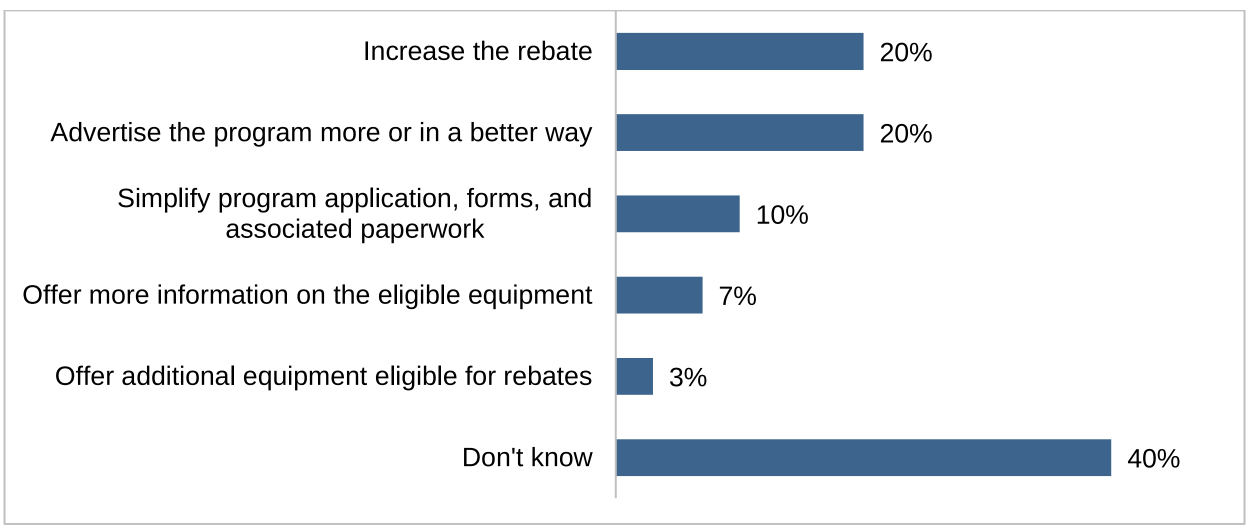

Figure 6: Main Recommendations for Improving the Program

CONCLUSIONS AND RECOMMENDATIONS

The evaluation of the BER program was intended to achieve the following objectives:

- Establish the gross electricity energy and peak demand savings generated by the program;
- Establish the net electricity energy and peak demand savings generated by the program;
- Assess whether the program is cost-effective;
- Assess the effectiveness of program processes and implementation.

This section provides the Evaluator's conclusions and recommendations related to program processes, implementation, cost-effectiveness, as well as energy and peak demand savings.

The BER program achieved the targets for 2019/2020 but fell short of the targets set for participation and energy savings for 2018/2019.

In 2019/2020, BER exceeded the target levels for both participation and energy savings by 3% and 1%, respectively. The program also exceeded the peak demand savings target by 115% and achieved the cost-effectiveness targets based on both the PAC and TRC tests.

Participation and energy savings fell short of the targets in 2018/2019, in large part because very few lighting measures were completed through BER in that program year. Nevertheless, BER exceeded the peak demand savings target in 2018/2019 by 87% and achieved the cost-effectiveness targets.

Lighting represented the majority of gross energy savings in 2019/2020. MSHPs made up nearly all HVAC savings.

Lighting measures represented 81% of BER program gross energy savings in 2019/2020, while HVAC measures, mainly MSHPs, represented 19%. In 2018/2019, lighting represented 53% of BER gross energy savings, while HVAC measures—including only MSHPs—made up 47%.

Current BER program tracking may not be sufficient to improve the accuracy and granularity of energy savings calculations.

The Evaluator did not have access to key technical information used in calculating gross savings and, in several instances, relied on the parameters established by recent evaluation results in Nova Scotia. Examples of assumed parameters include unitary savings for lighting measures, interactive effects, and peak coincidence factor. Nova Scotia was selected as the most representative jurisdiction because of similarities in program design, climate, and economy. While the assumed values represent the best available information, in some cases they may not be an accurate reflection of the realities in PEI.

Recommendation 1: Establish a strategy to collect participant and measure information to ensure that the savings calculation inputs more accurately reflect the actual conditions in PEI. One approach may be to utilize program application forms to collect key information on measure performance, baseline conditions, and business operations.

Recommendation 2: Until more specific data are collected from program participants, use the evaluation parameters established through this evaluation to calculate program gross savings. These parameters include NTGRs and unitary savings values.

Additionally, the Evaluator analyzed program data organization and completeness and identified the data types that should be tracked by ePEI regardless of the strategy developed to collect additional key information on participant facilities and measures. The Evaluator found that basic participant data was complete and consistent, but the proportion of units that generate electrical savings is not currently considered for the few measures where it is relevant (i.e., heat pumps); hence, the database includes all BER program units in savings results, with the same electrical unitary savings being applied to all of them.

Recommendation 3: Update program tracking to implement the following:

a. Continue tracking current items and try collecting data on currently untracked or incomplete items.
b. In the compilation tab, add a field for the proportion of units that generate electrical savings for heat pump measures and ensure this value is multiplied by the total number of units rebated.

Participant satisfaction with BER is high.

Participants were very satisfied with BER overall and awarded particularly high satisfaction scores to the work performed by the contractor or installer and their new equipment.

Some contractors appear to misunderstand BER rebate amounts or equipment eligibility.

Four participants out of the 30 surveyed reported that they were dissatisfied with the rebate they received from BER because they had been told by a contractor that they would receive a higher amount. This may indicate the need to educate contractors and trade allies about program rebates and requirements.

APPENDIX I
PARTICIPANT SURVEY QUESTIONNAIRE

Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Participant Survey
Estimated Time to Complete	15 minutes
Target Audience	Participants who installed mini-split heat pumps and/or lighting as part of the program
Expected Number of Completions	30 (18 mini-split heat pumps and 12 lighting)
Contact List Source	efficiencyPEI
Fielding Firm	Vision Research
Estimated Timeline for Fielding	February 2020

Research Objectives and Associated Questions

Research Objectives	Section
How did participants learn about the program?	B1
Why did participants want to participate in the program?	B2-B3
In what state were the participants' lighting products when they chose to replace them through the program?	B4
Are the program heat pumps used for cooling?	B5-B6
How satisfied are participants with the program and its aspects?	C1-C3
Did participants have any issues with their equipment or its installation?	C4-C5
What is the free-ridership level for mini-split heat pumps and lighting?	D series
Did participants make upgrades outside of the program in the last two years; if so, what are these upgrades?	E1-E3
Do participants intend to make other upgrades in the next two years? If so, what are these upgrades and if not, why?	E4-E6
What recommendations do participants have to improve the program?	F1

Import variables from database **< LIKE THIS >**

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

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

INTRODUCTION

Could I speak with **<INSERT NAME>**?

1. Yes **[CONTINUE]**
2. No **[SAY "PERHAPS YOU CAN HELP ME ANYWAY." CONTINUE]**

Hello, my name is *** and I am with Vision Research, a PEI-based survey research company. We are performing an evaluation of energy efficiency programs and services provided by efficiencyPEI. Our records indicate that your business recently participated in efficiencyPEI's Business Energy Rebates program. The program provides a rebate for the installation of lighting products or equipment such as mini-split heat pumps.

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

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

A. Verification

A1. Our records indicate that your business would have received a mail-in rebate for energy efficiency measures that were installed at your facility located at **<FACILITY ADDRESS>** in **<FACILITY CITY>**, as part of efficiencyPEI's Business Energy Rebates Program. Is this correct?

1. Yes **[CONTINUE]**
2. No [PROBE: **IS THERE SOMEONE ELSE IN YOUR BUSINESS WHO WOULD KNOW ABOUT HAVING PARTICIPATED IN THE BUSINESS ENERGY REBATES PROGRAM]?**

A2. Are you the person in your business who is most knowledgeable about your experience with the Business Energy Rebates program?

1. Yes **[IF YES GO TO A4]**
2. No

A3. We would like to talk to the person who is the most knowledgeable about your business' 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.)

A4. According to our information, you installed **<NUMBER> <MEASURE CATEGORY>** products at your facility located at **<FACILITY ADDRESS>** in **<FACILITY CITY>** in **<DATE>**, and received a rebate of **<REBATE>**. When answering the survey questions, please take into account this specific application for **<MEASURE CATEGORY>** products.

B. Program Awareness and Reasons for Participation

B1. How did you first learn about the Business Energy Rebates program? **[DO NOT READ; ALLOW MULTIPLE RESPONSES BUT DO NOT PROBE FOR MULTIPLE]**

1. efficiencyPEI website
2. Through a contractor or installer
3. Through a vendor or distributor
4. Word of mouth / Another business
5. Facebook or other social media
6. Power bill insert
7. Through participation in another efficiencyPEI program
8. Newspaper
9. Radio ad
10. Television ad
96. Other [SPECIFY: ______________]
98. Don't know

B2. What was the SINGLE most important reason you were interested in installing **<MEASURE CATEGORY>**? **[DO NOT READ – CODE ONE ONLY]**

1. Save money / Reduce energy bill
2. Save energy
3. Get rebates
4. Be more environmentally friendly
5. Reduce maintenance costs
6. Update equipment
7. Provide air conditioning
8. Improve heating
9. Improve staff and customer satisfaction and comfort
96. Other [SPECIFY_______________]
98. Don’t know

B3. Were there any other reasons? **[SAME LIST AS IN B2] [DO NOT READ. ACCEPT MULTIPLE RESPONSES]**

B4. **[ASK IF MEASURE CATEGORY=LIGHTING]** In what state were your existing fixtures or lamps when you decided to purchase your new lighting products? Were they… **[READ. CODE ONLY ONE. DO NOT RANDOMIZE]**

1. Working but at the end of their useful life
2. Working and <u>not</u> close to the end of their useful life
3. Broken
96. **[DO NOT READ]** Other, please specify
98. Don’t know
99. Refused

B5. **[ASK IF MEASURE CATEGORY=MINI-SPLIT HEAT PUMPS]** Before participating in the Business Energy Rebates program, did you use an air conditioner at your facility?

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

B6. **[ASK IF MEASURE CATEGORY= MINI-SPLIT HEAT PUMPS]** Do you use the heat pump(s) installed as part of the Business Energy Rebates program to provide cooling for your facility?

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

C. Satisfaction with Program

C1. 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]**

C2. **[IF C1<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)
99. (Refused)

C3. On the same scale of 0 to 10, where 0 is 'not at all satisfied' and 10 is 'completely satisfied', how satisfied were you with each of the following aspects of the Business Energy Rebates program? **[DO NOT RANDOMIZE] [97 = NOT APPLICABLE, 98 = DON'T KNOW/DON'T RECALL, 99 = REFUSED]**

a. The clarity of program requirements ***[IF SCORE IS 7 OR LESS, ASK:*** *What about the program requirements was unclear?* ***] RECORD VERBATIM***
b. The paperwork you had to fill out ***[IF SCORE IS 7 OR LESS, ASK:*** *What about the paperwork could be improved?* ***] RECORD VERBATIM***
c. The amount of the rebate you received ***[IF SCORE IS 7 OR LESS, ASK:*** *What rebate amount would you have liked to receive?* ***] RECORD VERBATIM***
d. The time required to receive your rebate ***[IF SCORE IS 7 OR LESS, ASK:*** *How long did it take to receive your rebate* ***] RECORD VERBATIM***
e. The equipment installed in your business ***[IF SCORE IS 7 OR LESS, ASK:*** *Why aren't you more satisfied with the equipment?* ***] RECORD VERBATIM***
f. The quality of the work performed by the contractor who installed the equipment ***[IF SCORE IS 7 OR LESS, ASK:*** *What about the contractor's work could have been improved?* ***] RECORD VERBATIM***
g. The range of equipment eligible for rebate ***[IF SCORE IS 7 OR LESS, ASK:*** *What equipment would you like to see eligible under the program?* ***] RECORD VERBATIM***

C4. **[ASK IF MEASURE IN SAMPLE IS MINI-SPLIT HEAT PUMPS]** Did you have any issues with the heat pump(s) that was/were installed as part of the Business Energy Rebates program, whether it be with the equipment installed or how it was installed? **[DO NOT READ – CODE ONE ONLY]**

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

C5. **[ASK IF C4=1]** Can you describe the issue? **[*RECORD VERBATIM]***

D. Free-Ridership

D1. Had your business ***already*** decided to install energy efficient **<MEASURE CATEGORY>** ***before*** you heard about the Business Energy Rebates program?

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

D2. **[ASK IF D1= YES]** I just want to make sure I understand - Before you decided to participate in the Business Energy Rebate program, you had already made the decision to install energy efficient **<MEASURE CATEGORY>**?

1. Yes, I had already made the decision
2. No, I had not made the decision
98. (Don’t know)
99. (Refused)

D3. EfficiencyPEI paid your business **$<REBATE VALUE BY CATEGORY>** for the energy efficient **<MEASURE CATEGORY>**. If your business had not received the rebate from efficiencyPEI, would you have paid the full cost of the energy efficient **<MEASURE CATEGORY>**? 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

D4. **[ASK IF MEASURE CATEGORY=LIGHTING]** Were you aware that the lighting products rebated through the Business Energy Rebates program are premium products certified by Design Light Consortium or ENERGY STAR?

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

[READ FIRST TIME THROUGH ONLY] Now I would like to ask you to consider which actions your business 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 D5 TO D8 SEQUENCE IN ORDER/DO NOT RANDOMIZE]**

D5. **[ASK IF MEASURE CATEGORY <> LIGHTING]** If the program rebate had not been offered, what is the likelihood that you would have installed exactly the same energy efficient heat pumps that you purchased through the Business Energy Rebates program?

___ Response ___98 Don't Know ___99 Refused

D6. **[ASK IF MEASURE CATEGORY=LIGHTING]** If the program rebate had not been offered, what is the likelihood that you would have installed the exact same model of lighting products?

___ Response ___98 Don't Know ___99 Refused

D7. **[ASK IF MEASURE CATEGORY = LIGHTING AND MEASURE CATEGORY QTY>1]** If the program rebate had not been offered, what is the likelihood that you would have installed exactly the same quantity of lighting products that you installed through the program?

___ Response ___98 Don't Know ___99 Refused

D8. **[IF D3≥5]** If the program rebate had not been offered, what is the likelihood that you would have postponed installing the **<MEASURE CATEGORY>** by at least one year?

___ Response ___98 Don't Know ___99 Refused

D9. 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 business' decision to install energy efficient **<MEASURE CATEGORY>**.

Factor (READ AND RANDOMIZE)	Responses
a. The program rebate	___ Response ___98 Don't Know ___99 Refused
b. Information received from efficiencyPEI	___ Response ___98 Don't Know ___99 Refused
c. The information and recommendations on energy efficiency measures provided by a contractor before learning about the Business Energy Rebates program	___ Response ___98 Don't Know ___99 Refused
d. Promotion done by efficiencyPEI or a previous participation in an efficiencyPEI program	___ Response ___98 Don't Know ___99 Refused

E. Barriers and Intentions

E1. In the last two years, did your business make any upgrades without support or incentives from an efficiencyPEI program?

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

E2. **[ASK IF E1=1]** What types of upgrades did you make? **[DO NOT READ, CODE ALL THAT APPLY]**

1. Lighting
2. Heating, ventilation and air conditioning (HVAC)
3. Water heating
4. Kitchen equipment
5. Building shell
6. Compressed air
96. Other (please specify:____________)
98. (Don't know)
99. (Refused)

E3. **[ASK IF E1=1]** Why did you make upgrades without using an efficiencyPEI 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 efficiencyPEI programs at the time I made the upgrades
4. The upgrades were not eligible
5. We would have done the upgrades anyway
6. We did not think the program was available
7. Other (please specify:_________)

98. (Don't know)
99. (Refused)

E4. In the next two years, are you or your business planning to make any upgrades?

1. Yes
2. No

98. (Don't know)
99. (Refused)

E5. **[ASK IF E4 = 1]** What types of upgrades will you be making? [**DO NOT READ, ALLOW MULTIPLE RESPONSE]**

1. Lighting
2. Heating, ventilation and air conditioning (HVAC)
3. Water heating
4. Kitchen equipment
5. Building shell
6. Compressed air
7. Solar panels

Other (please specify:__________)

98. (Don't know)
99. (Refused)

E6. **[ASK IF E4=2]** Which of the following statements best reflects why you are not considering making efficiency upgrades 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 or 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_________)
98. (Don't know)
99. (Refused)

F. Recommendations for Program Improvements

F1. Do you have any recommendations for improving the Business Energy Rebates program? PROBE: Anything else? **[DO NOT READ. ACCEPT MULTIPLE]**

1. (Increase the rebate)
2. (Offer additional equipment eligible for rebates)
3. (Offer more information on the eligible equipment)
4. (Simplify program application, forms, and associated paperwork)
5. (Advertise the program more or in a better way)

97. (No recommendation)
96. (Other [SPECIFY_______________])
98. (Don't know)
99. (Refused)

G. Demographics

These final questions are asked for statistical purposes only. The information collected is strictly confidential.

G1. Do you own or rent your space?

1. Own
2. Rent
3. Other (____________)
98. (Don't know)
99. (Refused)

G2. What is the main heating source of your facility? Is it…

1. Electricity
2. Natural gas
3. Propane
4. Oil
5. Wood
6. Or something else? (Please describe_______)
98. (Don't know)
99. (Refused)

G3. What is the main activity of your business? **[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. (Ice skating rink)
19. (Automotive repair)
20. (Child care)
21. (Construction)
96. (Other (SPECIFY: ___________)
98. (Don’t know)
99. (Refused)

G4. Approximately how many full-time equivalent workers does your business employ at all locations within PEI? **[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)

G5. Is your business independent, or part of a larger organization?

1. Independent
2. Part of a larger company/organization
96. Other (____________)
98. (Don't know)
99. (Refused)

G6. How many locations does your business have in PEI? **[RECORD A NUMBER 1-99; 998 = DON'T KNOW, 999 = REFUSED]**

This completes the survey. Your responses are very important to efficiencyPEI. We appreciate your participation and thank you for your time. Have a good [evening/day].

APPENDIX II
LAMP AND FIXTURE EUL DETAILED CALCULATIONS

This appendix presents the revised equivalent EUL values of the key lighting measures reviewed as part of this evaluation. These equivalent EUL values for lighting were obtained by dividing the rated life in hours by the annual hours of use (HOU) to represent the number of years products are expected to last. Rated life values were obtained from the EfficiencyOne 2019 BER Evaluation Report; as part of that evaluation, the rated life values were validated to ensure they were representative of the most popular products within each measure type. Since this reference was used for unitary savings calculations for the ePEI BER program evaluation, the Evaluator considered the rated life values valid as well. Equivalent EULs are EULs that have been modified to take into account baseline changes during the EUL of energy savings due to expected or potential changes in energy efficiency regulations.

The Evaluator analyzed current and projected Canadian regulations for lighting energy efficiency. The only major upcoming change in regulation is for general-service lamps. However, none of the key lighting products presented in Table 23 are affected by this regulation change, so all equivalent EUL values are the same as EUL values.

Table 23: Equivalent Effective Useful Life Values by Lighting Measure

Measure	Rated Life (hours)	Annual HOU	EUL (years)	Revised Equivalent EUL (years)
Linear LED Fixtures	50,000	4,410	11.3	11.3
Linear LED Lamps	50,000	4,410	11.3	11.3
High Bay Luminaires	100,000	4,410	22.7	22.7

APPENDIX III
FREE-RIDERSHIP ALGORITHM

The figure below presents the algorithm for calculating the free-ridership level for the key lighting measures rebated through the BER program. The participant survey questionnaire included questions designed to assess the planning, quantity, efficiency, period and cost parameters of the project, as well as the influence of the program. Participants' responses to each group of questions were converted into a value indicating the level of program attribution, and this value was used to calculate the free-ridership level associated with each participant.

Key Lighting Measures: Linear Fixtures, Linear Lamps, and High Bay Luminaires	
D1. Had your business ***already*** decided to install energy efficient <MEASURE CATEGORY> ***before*** you heard about the Business Energy Rebates program?	IF 1. Yes: Use D2 IF 2. No OR DK OR REF: D1 = 0%
D2. [ASK IF D1=1] I just want to make sure I understand - before you decided to participate in the Business Energy Rebates program, you had already made the decision to install energy efficient <MEASURE CATEGORY>?	IF 1. Yes: D1 = 100% IF 2. No OR DK OR REF: D1 = 0%
PLANNING Score	**D1**
D3. If your business had not received the rebate from efficiencyPEI, would you have paid the full cost of the energy efficient <MEASURE CATEGORY>? (Scale 0 to 10)	D3 = Answer x 10% IF DK OR REF: D3 = EMPTY
D4. [ASK IF MEASURE CATEGORY = LIGHTING] Were you aware that the lighting products rebated through the Business Energy Rebates program are premium products certified by Design Light Consortium or ENERGY STAR?	IF 1. Yes: Use D6 IF 2. No OR DK OR REF: D6 = 0%
D6. [ASK IF MEASURE CATEGORY = LIGHTING] If the program rebate had <u>not been</u> offered, what is the likelihood that you would have installed the exact same model of lighting products? (Scale 0 to 10)	D6 = Answer x 10% IF DK OR REF: D6 = EMPTY
Cost & EE Level Score	**MEAN (D3; D6)**
D7. [ASK IF MEASURE CATEGORY = LIGHTING AND MEASURE CATERGORY QTY>1] If the program rebate had <u>not been</u> offered, what is the likelihood that you would have installed exactly the same <u>quantity</u> of lighting products that you installed through the program? (Scale 0 to 10)	D7 = Answer x 10% IF DK OR REF: D7 = EMPTY
Quantity Score	**D7**

D8. [IF D3≥5] If the program rebate had <u>not been</u> offered, what is the likelihood that you would have postponed Installing the <MEASURE CATEGORY> by at least one year? (Scale 0 to 10)	D8 = (10 – Answer) x 10% IF DK OR REF: D8 = EMPTY
Timing Score	**D8**
Inconsistency Test #1	IF D1 = 100% AND D3 < 70%: Planning = EMPTY
Inconsistency Test #2	IF ABS (D3 - D6) ≥ 50%: Cost & EE Level = MIN (D3; D6)
Inconsistency Test #3	IF D3 < 70%: Quantity = EMPTY
INTENTION Score	**IF MIN (Quantity; Timing) < MEAN (Planning; Cost & EE Level): INTENTION = MEAN (Planning; Cost & EE Level; MIN (Quantity; Timing)) OTHERWISE: INTENTION = MEAN (Planning; Cost & EE Level)**
D9. Level of influence of the program (Scale 0 to 10) a. The program rebate b. Information received from efficiencyPEI c. The information and recommendations on energy efficiency measures provided by a contractor before learning about the Business Energy Rebates program d. Promotion done by efficiencyPEI or a previous participation in an efficiencyPEI program	D9 = MAX(a; b; c; d)
INFLUENCE Score	**(10 – D9) x 10%**
Free-Ridership	**FR = MEAN (INTENTION; INFLUENCE)**

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To: efficiencyPEI

From: Econoler

Date: June 26, 2020

Subject: 2019/2020 Small Business Energy Solutions and Custom Programs Assessment

Introduction

efficiencyPEI (ePEI) is in the process of launching two new programs for commercial, industrial, institutional, agricultural and municipal customers in Prince Edward Island (PEI), namely the Small Business Energy Solutions (SBES) and Custom programs.

The programs provide financial incentives to encourage energy efficiency measures and include an energy audit to provide eligible customers with energy efficiency recommendations adapted to their facility needs.

Although these programs are in their early stages, the Evaluator wanted to conduct a preliminary assessment to ensure they follow best practices. Specifically, the Evaluator's assessment was meant to accomplish the following:

› To review program tracking to ensure that the information about projects and participants is complete and clear for program management and evaluation purposes.

› To perform a qualitative review of audit reports to ensure (1) their clarity and consistency across auditors, (2) the adequacy of the recommended measures and (3) that they include sufficient documentation and details about the technical aspects of existing and recommended measures.

› To ensure the use of appropriate savings calculation methodologies to allow for accurate savings estimates and impact evaluation.

Methodology

To achieve these objectives, the Evaluator conducted a desk review, using the program database and a sample of audit reports and associated savings calculation files, to assess the completeness and soundness of the audit reports, savings calculations methodology and program tracking. The sample included 12 SBES and four Custom projects. The Evaluator also conducted a more in-depth analysis using the RETScreen savings calculations files for three of the sampled SBES projects and two of the sampled Custom projects.

The sample was designed to include different energy consumption levels, facility types, audit tiers, and service providers.

Results

Program Data Tracking

The Evaluator first reviewed the program database and found that it contained useful participant information for program management and evaluation purposes, such as contact information, facility information, and audit information. The database columns related to the measures were empty, except for one participant. For this participant, the column “Measure Category” was filled out with “Lighting”, but the column “Measure Description” indicated the project contained “LED Retrofit and attic insulation”. Since there is only one column for the savings and cost values, it might be unclear if the savings and costs correspond to those estimated at the audit stage or after project implementation. To avoid confusion and ensure that all pertinent information is recorded, the Evaluator recommends that ePEI add columns to record savings values at the audit and implementation stages separately as well as for each measure separately (e.g., attic insulation and lighting measures in different rows).

Audit Reports

The Evaluator examined the 16 sampled audit reports and found that their format was consistent across participants and easy to understand. The audit template includes helpful information, such as the subsequent participation steps, the suggested type of contractor for each proposed measure (e.g., “electrician”) and auditor contact information.

Only two auditors have completed audit reports so far, with the large majority having been completed by one of them. The auditor who completed the most reports provided very little information in the audit report about the existing equipment and proposed measures compared to the other auditor.

The audit reports could be improved by providing more details about the proposed energy efficiency measures, which would also provide guidance to participants on what is required to achieve the estimated energy savings. For example, the audit reports could specify that to achieve the estimated savings associated with installing a heat pump, participants would need to install an ENERGY STAR certified heat pump or cold-climate heat pump. Similarly, for building envelope measures, it would be helpful if the audit report included the necessary R-value to achieve estimated energy savings.

The Evaluator found that auditors recommended LED lighting to all but one participant, for which the report specified that the majority of existing lighting had already been converted to LED. This indicates that auditors are adequately identifying energy savings opportunities related to lighting. HVAC measures were recommended to all but three participants. For two of these participants, the audit report provided no information on the existing HVAC equipment and thus assessing if there is any lost opportunity to achieve savings is difficult. As for the remaining participant, the audit report indicated that the facility already had a geothermal system, heat pumps and an HRV in place.

While the sampled audit reports included estimated electrical and non-electrical energy savings for all project files, the peak demand savings were not included, even in cases where the measure was specifically included to achieve a peak demand reduction. It can be challenging for auditors to calculate peak demand savings and therefore, the Evaluator recommends that ePEI provide guidelines to auditors on how to do so and require that they provide an estimate for peak demand savings for the proposed measures.

Savings Calculation Methodology

Since the audit reports contained little information on how savings were determined, the Evaluator examined the RETScreen files for five project files to glean better insights. The RETScreen files were only available for the auditor who completed the bulk of the audits. The sampled projects contained a variety of measures, including lighting, HVAC, building envelope, controls, refrigeration as well as motors and drives.

The Evaluator found that the auditor used RETScreen Version 4, which is an old version of RETScreen that is no longer supported by Natural Resources Canada, its developer. RETScreen Version 4 uses Excel, and it appears that it does not support the latest version of Excel very well, making it challenging to open and consult files. Furthermore, RETScreen Version 4 does not allow energy auditors as much flexibility as the latest version in terms of what measures can be modelled and how. Therefore, the Evaluator recommends that ePEI require that auditors use RETScreen Expert to ensure that files are easy to open so that ePEI and future evaluators will be able to consult them as well as improving the accuracy of energy savings estimates.

The Evaluator found that measures were often modelled by reducing the equipment load or increasing efficiencies – potentially because of the limitations of RETScreen Version 4. Although these are acceptable means of estimating energy savings, the auditor did not provide supporting documentation or notes explaining the hypotheses made. Also, some recommended measures were not found in the RETScreen files. Requiring that auditors provide savings calculation documentation, including the rationales and hypotheses, for both modelled and non-modelled measures will help ePEI and future evaluators ensure that energy savings are accurate.

The Evaluator found several cases where the impact of implementing several measures at the same time was not considered in the energy savings calculations. For example, when installing both a heat pump and building envelope measures, the building envelope measure savings are overestimated if we assume the old heating equipment is still in use. Similarly, the Evaluator found that interactive effects of lighting on cooling were not always included when a heat pump was recommended. This is acceptable at the audit stage, but ePEI should ensure that this is taken into account after the implementation of the project when determining the final project savings and incentives.

Recommendations

To summarize, the Evaluator suggests that ePEI make the following adjustments to audit reports, savings calculations, and program tracking.

- Improve the database to record information on measures at the audit and implementation stages separately (e.g., different columns for the audit and post-implementation stages) and to record information on each measure separately (e.g., different rows for different measures).
- Ask auditors to include more specific information about the proposed measures to help participants understand what they need to install to achieve the estimated energy savings.
- Require that auditors provide savings calculation documentation, including the rationales and hypotheses, for both modelled and non-modelled measures to help ePEI and future evaluators ensure that energy savings are accurate.
- Provide guidelines to auditors on how to calculate peak demand savings and ask auditors to include estimated peak demand savings in the audit reports.
- Require auditors to use an up-to-date version of RETScreen to ensure that files are accessible by ePEI staff and future evaluators as well as to allow for more accurate energy savings estimation.
- To make accurate energy savings calculations, ensure that all measures installed are considered and that interactive effects on heating and cooling loads are considered, where appropriate.