Prince Edward Island Energy Efficiency Potential Study:

A Comprehensive Assessment of Energy Efficiency and Demand Response Opportunities 2021-2030

(Volume I: Final Results)

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About Dunsky

Dunsky provides strategic analysis and counsel in the areas of energy efficiency, renewable energy, and clean mobility. We support our clients – governments, utilities, and others – through three key services: we **assess** opportunities (technical, economic, market); **design** strategies (programs, plans, policies); and **evaluate** performance (with a view to continuous improvement).

Dunsky's 35+ experts are wholly dedicated to helping our clients accelerate the clean energy transition, effectively and responsibly.

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List of Acronyms

AMF	Advanced metering functionality
ASHP	Air source heat pump
BAU	Business as Usual
BYOD	Bring your own device
DCV	Demand control ventilation
DEEP	Dunsky Energy Efficiency Potential model
DER	Distributed energy resource
DLC	Direct load control
DMSHP	Ductless mini-split heat pump
DR	Demand response
DSM	Demand side management
EE	Energy efficiency
EMS	Energy management system
EUL	Effective useful life
GDP	Gross domestic product
GHG	Greenhouse gas
GWh	Gigawatt-hour
HER	Home energy report
HPWH	Heat pump water heater
HVAC	Heating, ventilation, and air conditioning
LED	Light-emitting diode
MW	Megawatt
O&M	Operation and maintenance
PAC	Program Administrator Cost test
tCO_2e	Tons of carbon-dioxide equivalent
TLED	Tubular light-emitting diode
TOU	Time of use rate
TRC	Total Resource Cost test

Definitions

Term	Definition
Achievable potential	The savings from cost-effective opportunities once market barriers have been applied, resulting in an estimate of savings that can be achieved through demand-side management programs. For each module, three achievable potential scenarios are modeled to examine how varying factors such as incentive levels and market barrier reductions impact uptake.
Cumulative savings	A rolling sum of all new savings that will affect energy sales, cumulative savings exclude measure re-participation (i.e., savings toward a measure are counted only once, even if customers can participate again after the measure has reached the end of its useful life) and provide total expected grid-level savings.
Economic potential	The savings opportunities available should customers adopt all cost-effective savings, as established by screening measures against the Total Resource Cost Test (TRC), without consideration of market barriers or adoption limitations.
Enabling activities	Enabling activities or strategies help participants overcome barriers to participating in efficiency programs and include but are not limited to direct install programs, contractor training and support, upstream programs, targeted marketing, building and home energy labeling requirements, and financing programs.
Energy end-use	In this study, energy end-uses refer to grouping of energy saving measures related to specific building component (i.e., water heating, HVAC, lighting etc.).
Demand Side Management	The use of programs that offer financial incentives, education, and other support to encourage the efficient use of energy both in terms of the amount and timing of the energy used.
Incremental annual savings	Savings from measures incentivized through programs in a given year expressed in terms of savings in the first year of each measure's life. Incremental annual savings include savings attributable to measure re-participation (i.e., when a customer in incentivized to participate in a program again after the original measure has reached the end of its useful life).
Incremental lifetime savings	Savings from measures incentivized through programs in a given year expressed in terms of savings expected over the lifetime of each measure. Incremental lifetime savings include savings attributable to measure re-participation (i.e., when a customer in incentivized to participate in a program again after the original measure has reached the end of its useful life).
Market sector	The market of energy using customers on Prince Edward Island is broken down into four sectors based on the primary occupants in the building: residential (including single family and multi-family buildings), low-income residential, commercial, and industrial.
Market segment	Within each sector, market segments are defined to capture key differences in energy use and savings opportunities that are governed by building use and configuration.
Measure re-participation	The re-participation of a customer in a program after the original incentivized measure has reached the end of its useful life. Re-participation is counted in program savings (i.e. incremental lifetime savings and incremental annual savings), but it does not impact cumulative savings since the customer's net consumption is not impacted by replacing an efficient technology with an equally efficient technology.
Program Savings	Savings from measures incentivized through programs in a given year. Program savings include measure re-participation and are generally expressed in terms of incremental lifetime savings or incremental annual savings.
Annual Peak	The annual peak demand refers to the hour in each year that exhibits the highest system demand in MW, on a system-wide basis not accounting for local constraints.

Executive Summary

Introduction

The Government of Prince Edward Island (PEI) has established a province-wide electricity savings goal of reducing annual consumption by 2% per year. efficiencyPEI's programs are ramping up to achieve this target while at the same time helping to lower customer and electric system costs, improve grid resiliency, and achieve other public policy goals.

The Prince Edward Island Energy Efficiency Potential Study ("the Potential Study") assesses the degree to which efficiencyPEI's Demand Side Management (DSM) programs can reduce electricity use on PEI, covering both Maritime Electric Corporation and Summerside Electric customers. The study quantifies the consumption savings (expressed in kWh) that are achievable from energy efficiency (EE) programs as well as peak load reductions (expressed in kW) resulting from Demand Response (DR) programs. It includes adoption forecasts of all commercially viable efficiency technologies, supported by program incentives and associated strategies over the ten-year period spanning from 2021 to 2030.

This Potential Study is intended to inform province-wide energy efficiency and peak demand reduction targets, and support program design strategies for the coming DSM program planning periods. As such it includes a comprehensive assessment of program costs and benefits, providing a comparison among the various program options and their relative cost-effectiveness, as expressed from the utilities' perspective.

Energy Efficiency Potential

The energy efficiency potential was assessed under three program investment levels, for which customer incentives and rebates were varied from the current levels (referred to in the "business as usual" scenario) to an upper end limit where the program incentives would eliminate all additional costs to customers for installing efficiency equipment (referred to in the "maximum" scenario), as outlined below:

BAU	Mid	Max
A lower bounds scenario meant to reflect a **Business as Usual (BAU)** approach by applying existing efficiencyPEI incentives, enabling activities, and costs while at the same time expanding to new measures and adding three new programs (Home Energy Reports, Appliance Recyling and the newly launched Community Energy Solutions Program).	A scenario where incentive levels are increased above current levels to cover at least 75% of the extra costs of installing a more efficient piece of equipment in comparison to a standard option. (Example: if a more efficient piece of equipment was $100 more expensive, then a $75 rebate would be provided.)	An upper bound scenario that eliminates all extra costs associated with installing energy efficient equipment for the consumer. Under this scenario, incentives cover 100% of the additional cost of installing energy savings technologies in comparison to standard equipment.

The impact of enabling activities (e.g., direct install programs, contractor training and support) were explored through sensitivities to the Mid scenario

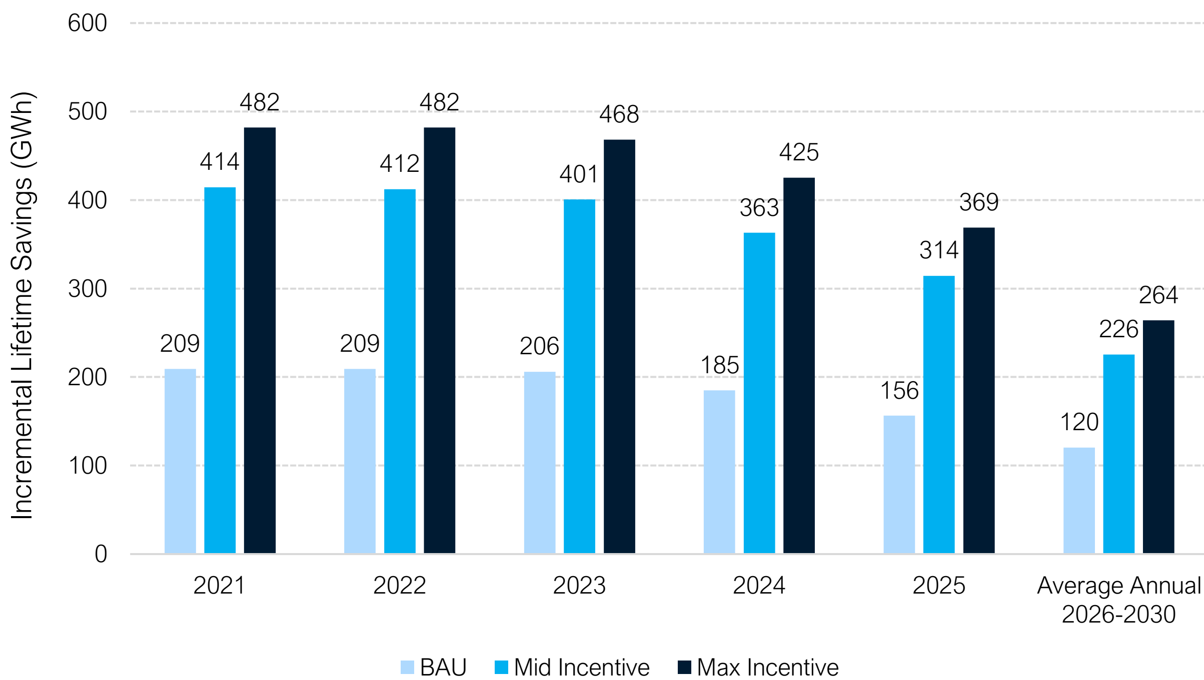
Efficiency Program Savings Results

Dunsky's Demand and Energy Efficiency Potential (DEEP) model was used to test the impact of different incentive levels and program strategies on the overall potential achievable electric efficiency savings opportunity as well as the associated impact on peak demand. Throughout the report the achievable savings results are broken down by measure type, end-use, segment, and sector.

The Impact of Increased Incentives over the Current (BAU) Levels

The potential study shows that under all scenarios, PEI customers can significantly reduce the amount of energy consumed while still receiving the same quality of service. Over efficiencyPEI's next three-year program planning cycle (2021-2023), Figure E-1 shows that energy efficiency programs have the potential to deliver, on average, between 208 GWh to 477 GWh of lifetime savings per year. Lifetime savings refer to the savings that will accumulate over the lifetime of a measure installed in a given year. The BAU results in this study are higher than the 2019/20 program results primarily due to the recent expansion of the range of incentivized efficiency technologies offered under efficiencyPEI's commercial and institutional programs.

Figure E-1. New Lifetime Electricity Savings by Year (All Scenarios)



The study found that while efficiency savings in the initial years are quite high, they are projected to decline in the later years. This is largely the result of the successful transition from inefficient incandescent and halogen lighting to solid state (LED) lighting that is taking place in the market. For example, it is predicted that by 2026 LED bulbs will become the norm for almost all PEI homes. For businesses, the transition to LED linear lighting will occur steadily over the study period, slowly drawing down the number of new customers who can be encouraged to switch to high efficiency LED linear lights.

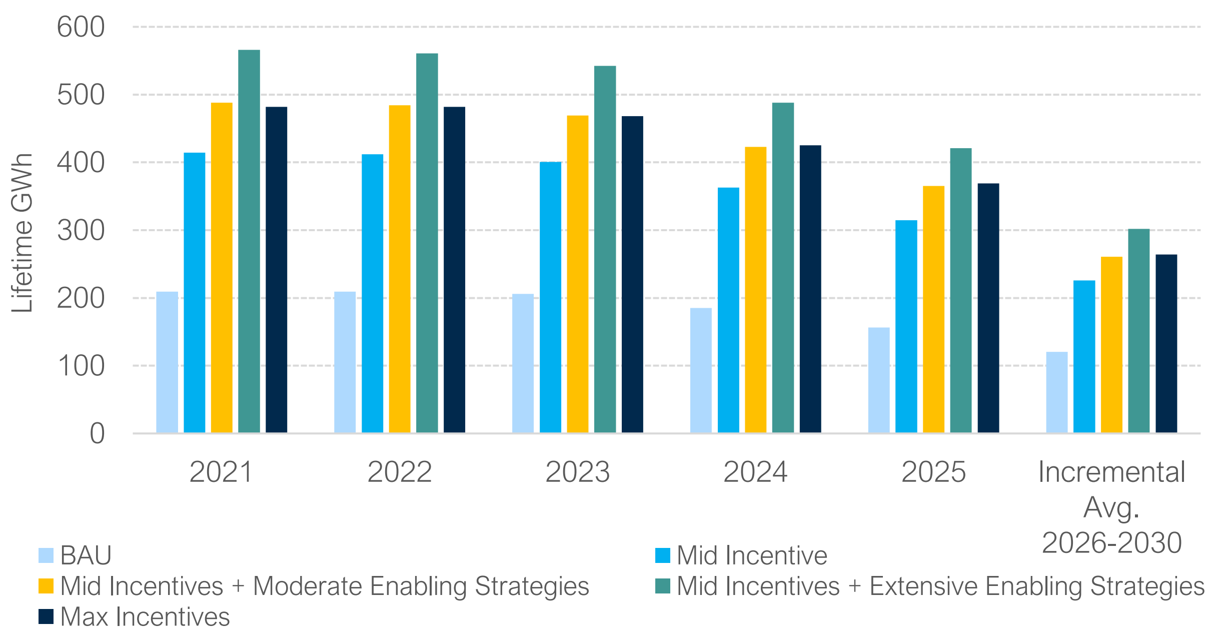
There is also a projected decline in the number of home and business retrofits (such as adding roof or basement insulation) conducted in each year over the study period, as more and more buildings become insulated and the opportunity becomes saturated. The steepness of this decline will depend largely on how successful efficiencyPEI programs can be in the initial years, and in reality, these savings could be more equally distributed across all years in the study, depending on program goals and designs.

The Impact of Program Strategies that Reduce Customer Friction

Beyond simply raising customer incentives, the study also explored the potential impact of efficiencyPEI's investment in strategies that reduce market friction and enable customers to adopt efficient technologies. This could include strategies such as enhanced marketing; contractor training; encouraging home and building energy reporting and disclosure that helps to value efficient properties in the sales and rental markets; pursuing "direct install" type programs that deliver simple-to-install technologies such as lightbulbs, efficient shower heads and air-sealing directly to the customer's doors; or providing "upstream" incentives to suppliers and distributors that help to reduce the cost of efficient equipment at the point of sale without requiring customers to apply for rebates. Given that efficiencyPEI's programs are still relatively new, there are many options that could be pursued, and the study results indicate that these enabling strategies can help increase achievable savings significantly.

As shown in Figure E-2, adding a moderate level of enabling strategies alongside the Mid scenario incentives increases savings levels to, on average, 480 GWh of lifetime savings (2021-2023) – roughly the level of savings achieved under the Maximum incentive scenario. Moreover, investing in extensive enabling strategies brings the Mid scenario above the Max with 556 GWh of average lifetime savings over the first three years.

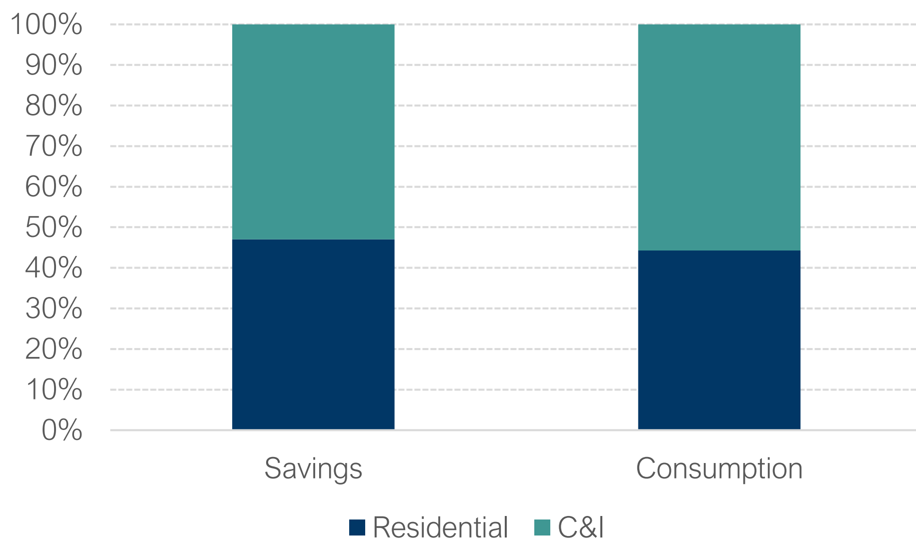
Figure E-2. Lifetime Savings for Enabling Strategies Compared to Varied Incentive Levels



Savings by Market Sector and Segment

Savings are essentially evenly split between the residential sector (47 percent) and the commercial and industrial (C&I) sector (53 percent) over the first three-year period of the study. The savings breakdown closely tracks the consumption breakdown between the sectors as shown in Figure E-3. This suggests that both sectors are both important and that efficiencyPEI should invest in both equally.

Figure E-3. Comparison of Lifetime Savings under Mid Scenario and Baseline Consumption Breakdown (% of Total) by Sector



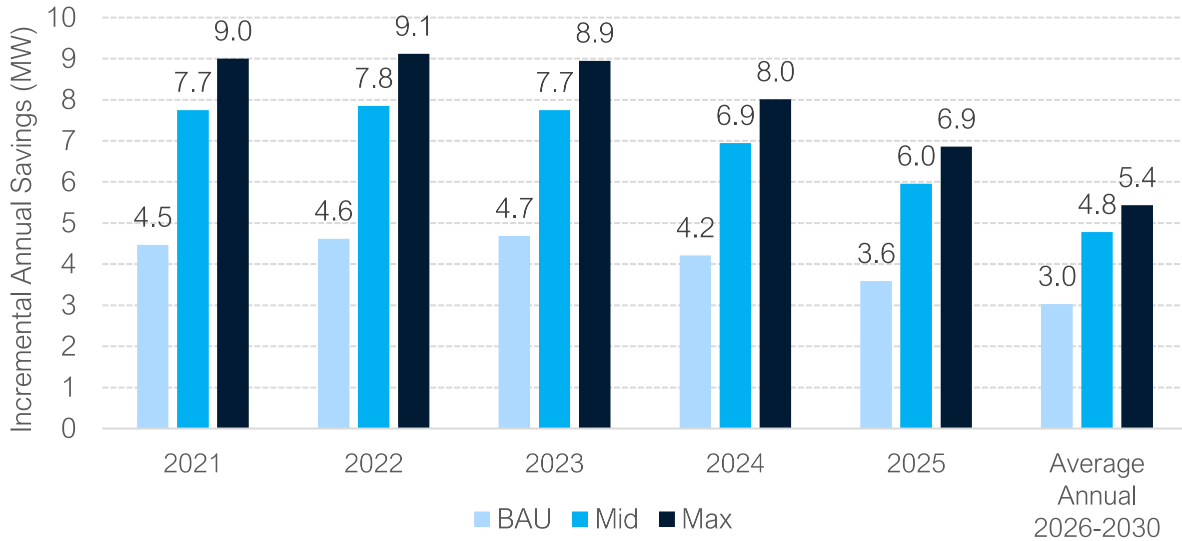
Overall, the single family, industrial/agriculture, and office market segments represent the bulk of electric energy efficiency savings, accounting for approximately 75% of the savings, and therefore should be the focus of efficiency programs on PEI. Low-income homes and the retail market round out the top five segments, representing 85% of total savings.

It should be noted that for the purposes of this study agricultural customers were considered C&I and grouped with industrial accounts due to a lack of data and information that would allow Dunsky to model a stand-alone segment at this time. Section 2.5 of the report provides an overview of agricultural electric efficiency measures and benchmarks agricultural savings to results from potential studies in other jurisdictions. While there are some limitations due to available sector-specific information and data, the high-level review shows that the savings targets in this study are likely reasonable for the agricultural sector and useful for program planning purposes.

Peak Load Reduction from Efficient Technologies

Energy efficient technologies can also reduce the peak demand on the electricity network, which can help to increase system reliability or avoid/defer investments in electricity distribution infrastructure, thereby saving costs for all customers on PEI. Figure E-4 shows that annual reductions in the peak demand vary from 4.2 MW (BAU) to 9.1 MW (Max), over the 2022-2024 period, and decline slowly from those levels in the later years of the study.

Figure E-4. Annual Electric Demand Savings from Efficiency Measures by Year (All Scenarios)



Note: The above figure represents passive demand reductions from efficiency measures and does not include demand response programs, which are covered in the next section.

Efficiency Program Cost-Effectiveness

The study only considered savings from efficiency measures and programs that are cost-effective from the utility perspective. Measures were screened out of the results using the Program Administrator's Cost (PAC) Test, which provides a ratio of the energy savings benefits to the utilities (in the form of the avoided costs of electricity supply), over the incentive costs to encourage customers to adopt the measures. These account for program additionality, by removing savings from program free-riders (i.e. those who would take the rebates even though they would have installed the measure without it).

Table E-1 below shows the cost-effectiveness results for the residential and C&I programs. A PAC ratio greater than 1.0 is considered cost-effective, and the higher the ratio the more cost effective the programs are expected to be. This is reflected in the cost per kWh saved over the lifetime of the installed measures, which at 2.8 to 5.0 cents per kWh are cheaper than the costs of supply on PEI (at the time this report was written, tier one residential rates were 14.92 cents per kWh and tier one general service commercial rates were $18.31 cents per kWh).

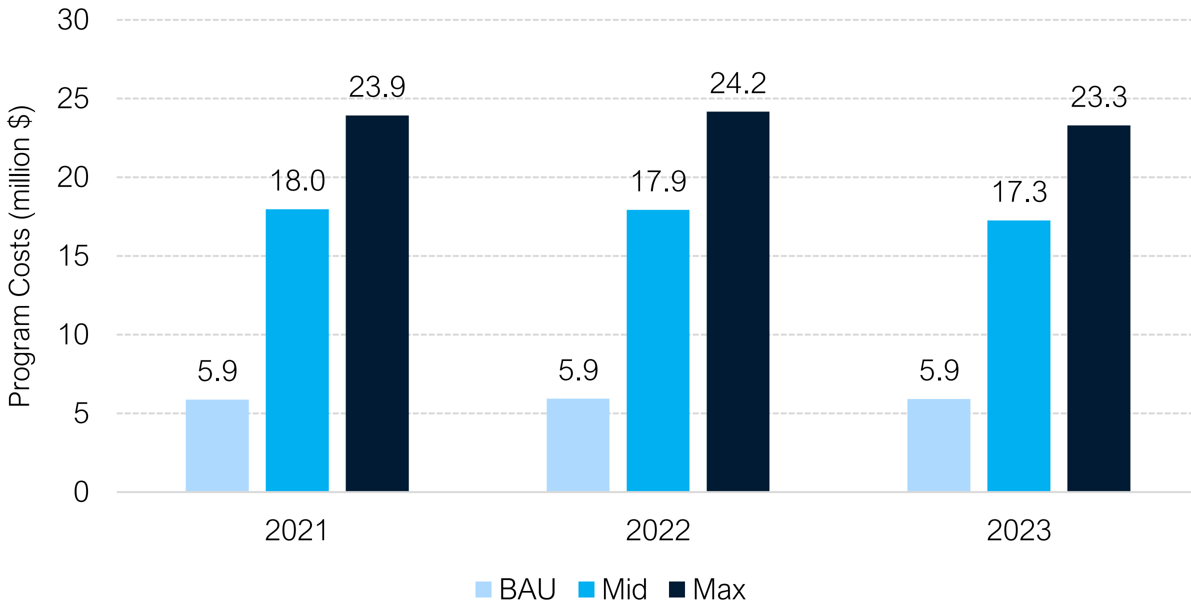
Table E-1. Average Estimated Savings Unit Cost (2021-23; All Scenarios)

Metric	BAU	Mid	Max
$ per Incremental Lifetime kWh	0.028	0.048	0.050
Residential Portfolio PAC ratios	1.8	1.3	1.2
C&I Portfolio PAC ratios	6.2	2.4	1.8

The resulting efficiency program costs are assessed to range between $5.9 (BAU) to $23.8 (Max) million dollars on average per year over the first three years of the programs as shown in Figure E-5. This is in comparison to efficiencyPEI's approved budget of $4.7 million in 2019/20 (in actuality, efficiencyPEI spent

$2.6 million in 2019/20 for reasons outlined in its annual plan). It should be noted that program cost assessments in this study represent an upper end estimate and have not accounted for optimization strategies that can be applied in effective program design.

Figure E-5. Estimated Program Costs by Year (2021-2023; All Scenarios)



Note: Electric portfolio costs include incentive and administration (fixed and variable costs)

Efficiency Programs Key Takeaways

Based on the energy efficiency potential analysis, the following key findings emerge:

1. **Increasing program investments can unlock a significant amount of cost-effective new savings.** Expanding current programs to a broader range of measures and increasing investments in incentives and enabling strategies can significantly increase savings for PEI homes and businesses. Moving from the BAU to Mid incentive scenario increases average (2021-2023) incremental lifetime savings by 97% and by 130% under the Max incentive scenario. However, these increased savings require notably higher annual portfolio budgets, which can be contained to a degree by strategically applying increased incentives and investing in new enabling strategies.

2. **Program strategies that can help reduce customer barriers to energy efficiency can be employed to drive further savings and also help optimize program investments.** Enhancing program designs by applying further enabling activities that help address customer barriers to energy efficiency can play a key role in helping efficiencyPEI meet its targets. The results show that when moderate enabling strategies are added alongside the Mid scenario incentives, the resulting lifetime savings (2021-2023) increase by 16 percent, which is approximately equal to the savings under the Max scenario but are achieved at a budget that is $2 million lower than the Max scenario program costs. This suggests that focusing on enabling activities may be a more effective way to pursue higher savings than simply raising

incentives alone. Program design strategies that focus on enabling strategies, alongside targeted adjustments to incentive levels, can help to optimize program impacts and cost-effectiveness.

3. **Focusing on envelope measures on PEI homes is a key opportunity alongside HVAC measures, in particular high-efficiency heat pumps:** Single family homes represent a major portion of the saving potential. Because PEI has a high penetration of electric heating and a high growth rate in new home starts, high efficiency new construction along with envelope improvement measures such as adding attic and basement insulation to existing homes offer the largest opportunity for reducing energy consumption on PEI homes. Higher performing building envelopes also help contractors to right-size heating equipment, such as high efficiency heat pumps, which combined with optimized use of the systems can further reduce equipment and energy costs for PEI homeowners.

4. **There is significant opportunity to derive further electricity savings on PEI's businesses and institutions.** This study shows that there are significant savings opportunities within PEI's businesses and institutions (equal to roughly the same amount of savings potential as that on PEI homes). The program scenarios show notably higher savings in the C&I market than were delivered in 2019/20 by efficiencyPEI's commercial sector programs. The introduction of efficiencyPEI's new Community Energy Solutions program, along with adding new measures, using targeted incentives, and applying new enabling strategies, can play a key role in tapping into the savings opportunities in the C&I market.

Demand Response Potential

The study assessed the potential for reducing utility peak loads by curtailing electricity usage on PEI homes and buildings, either through adjusting customer energy use behaviour, or by the utility centrally controlling energy using equipment. Programs that enlist customers to participate in peak reduction strategies are referred to as Demand Response (DR) programs. DR opportunities were assessed using Dunsky's Demand Reduction Optimized Potential (DROP) model, which analyses the ability for each measure to reduce the province-wide electricity demand peak, and accounts for the possibility that shifting energy use to another time may create new demand peaks. The model assesses all measures together, accounting for their cumulative interaction on the utility load curve and gives priority to the most cost-effective measures.

To determine the program achievable potential, the DROP model accounts for the propensity of customers to participate in DR programs, based on the financial incentives offered, utility marketing investments, and level of intervention that each DR measure entails (i.e., does it require equipment to be installed? how many peak reduction events will be called in a given year? etc.). The achievable potential for DR programs was assessed under three scenarios, each representing a different utility strategy to reduce peak demand: 1) Customer Incentives, 2) Customer Incentives as well as engaging large C&I Interruptible rates customers in DR events,[1] and 3) via the application of Time of Use (TOU) electricity rates that carry higher prices during peak demand hours (i.e., winter mornings and evenings) and reduced rates during lower use hours (i.e.,

[1] MECL offers some large C&I customers a lower electricity rate in return for them agreeing to curtail their usage during system reliability events. This scenario assesses the impact of expanding those agreements to include curtailment during peak demand events as well.

middle of the day and overnight). For new programs and measures, program set-up costs and ramp-up factors were applied to account for the time and investments needed to enroll customers.

Figure E-6. Demand Response Program Scenario Descriptions

BASE CASE

CUSTOMER INCENTIVES

DR programs with event-based incentives set at levels commonly used in other jurisdictions. This scenario excludes C&I interruptible customers.

- Sensitivity with increased spending (double incentives) is applied to this scenario.

CUSTOMER INCENTIVES + INTERRUPTIBLE RATES

Applies the Customer Incentives scenario measures and programs, along with the impact of enrolling large C&I interruptible rates customers to participate in DR events.

TOU RATES

Assessment of the impact of TOU Rates for both residential and C&I customers (beginning in 2025).

Demand Response Program Savings

Overall, the results indicate there is significant potential to reduce province-wide peak electricity demand on PEI. By 2030, the total achievable savings range from 10.7 MW (via TOU Rates) to 31 MW (via Customer Incentives and Interruptible Rates), which represents between 3.1% to 8.8% of the overall forecasted electricity demand peak in 2030 (see Table 3-2, below).

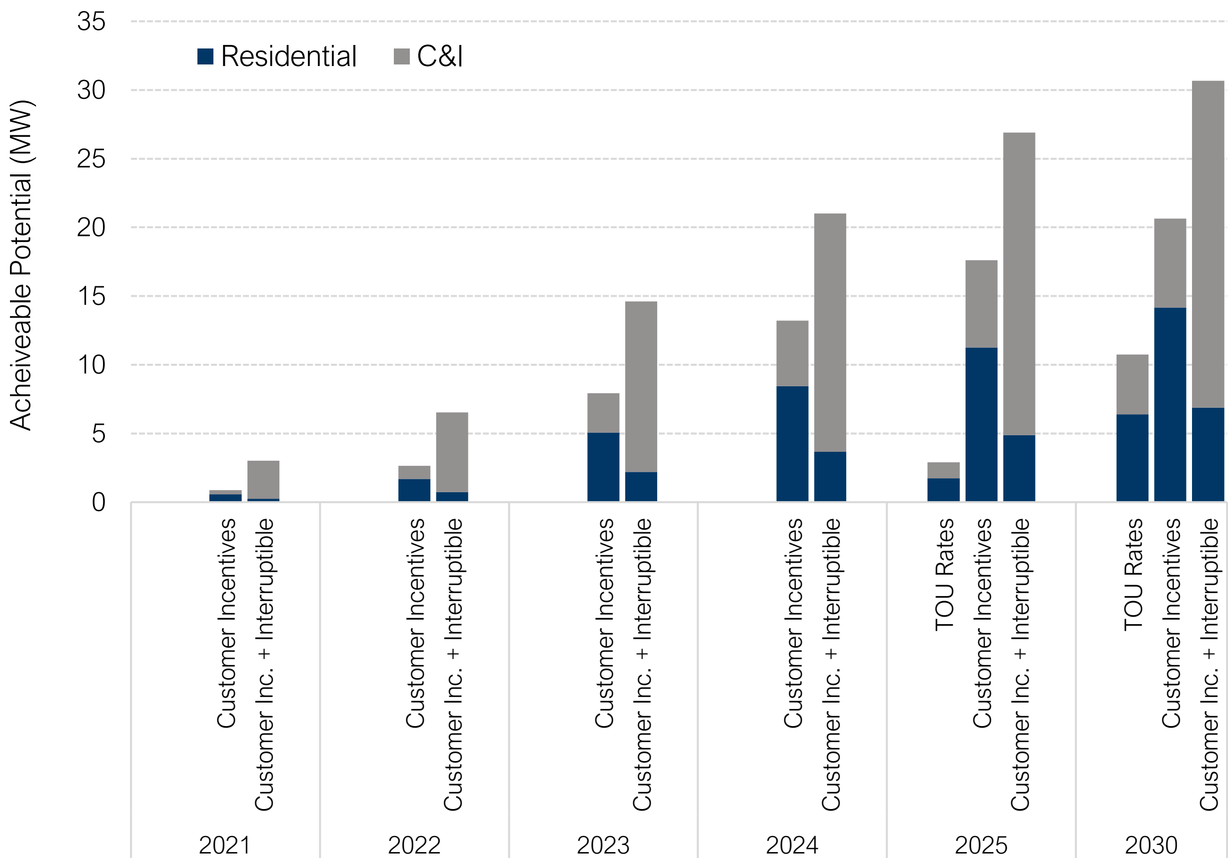
Table E-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and TOU scenarios

Scenarios	Customer Incentives Scenario	Customer Incentives & Interruptible Rates Scenario	TOU Rates Scenario
Achievable Potential (MW)	21	31	10.7
% of System Peak in 2030	5.9%	8.8%	3.1%

Figure E-7, below, provides the annual peak reduction potential from DR programs under each scenario. The chart also indicates the relative contributions from Residential and C&I sector programs, which reveals that the inclusion of Interruptible Rate customers in DR events, could offer significant peak reduction potential. Conversely, if it is not possible to engage Interruptible Rate customers[2] in DR events, then Residential programs offer the greatest potential for peak load reduction under either the Customer Incentives scenario or the TOU Rates scenario.

[2] Interruptible Rate customers refer to those large industrial customers that are on a reduced rate in exchange for the ability to reduce or interrupt the customers' electric service during reliability events (i.e., emergency events).

Figure E-7. Demand Response Achievable Potential

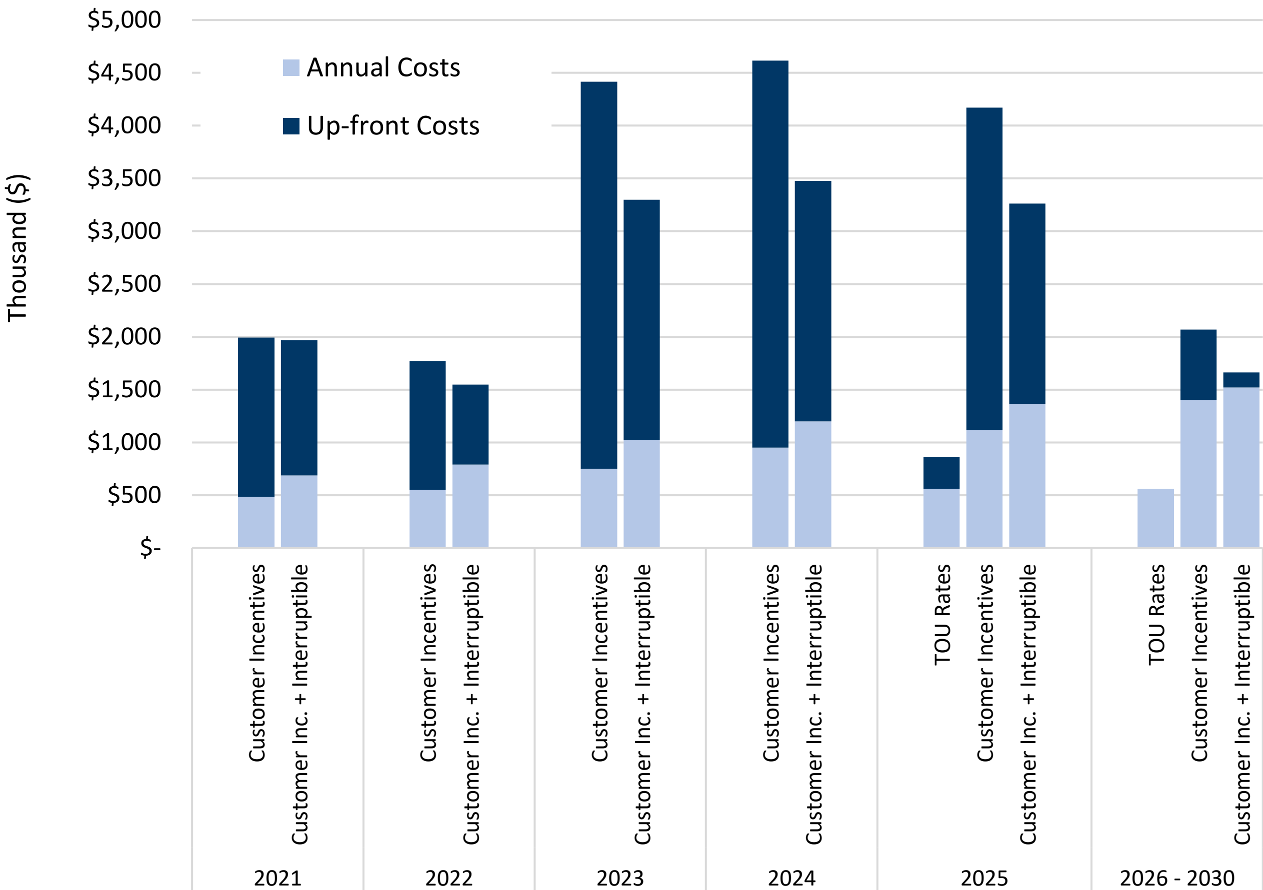


Demand Response Program Cost-Effectiveness

In Figure E-8, below, the annual DR program costs are provided. The dark portion of the cost bars represent the up-front costs associated with investments in program set-up, customer enrollment, and installing controls and equipment. The lighter blue portion represents the on-going annual costs associated with running the program, marketing, and customer incentives. It is important to note the DR program savings only persist for as long as the programs remain active, and new programs typically require a significant initial set up investment, followed by an ongoing period of annual – and relatively lower – costs to maintain participation.

In both the Customer Incentives and Customer Incentives & Interruptible Rates scenarios, the results show significant up-front costs in the initial years (~$2M to $4.5M), followed by lower annual costs over the 2025-2030 period. For the TOU Rates scenario, the costs are much lower and are concentrated largely on costs associated with running the program and marketing. It should be noted that the TOU Rates scenario costs do not include the cost of establishing smart-meter (advance metering infrastructure) capabilities, as it is assumed that these will be in place before the TOU Rates program begins.

Figure E-8. Demand Response Program Costs per Year (2021-2025) and Average Annual for 2026-2030



A cost-effectiveness assessment was conducted to determine if the value of the peak load benefits to the utilities would exceed the cost of setting up and running the programs. The PAC test is applied, and the results for each scenario are presented in Table 3-3. These account for total benefits and costs over the 2021-2030 period. A PAC ratio greater than 1.0 indicates that the benefits out-weigh the costs, and from these results it is clear that all scenarios pass this cost-effectiveness screen.

Table E-3. Demand Response PAC Test Results

Scenario	PAC Ratio
Customer Incentives	1.3
Customer Incentives & Interruptible Rates	1.8
TOU Rates	8.7

The TOU Rates scenario is by far the most cost-effective option, but as is noted above, it delivers only a fraction of the peak savings compared to the other scenarios. That said, it should be noted that it may be possible to optimise an eventual DR program design by combining TOU rates with other peak reducing measures such as heating system and water heater controls devices and energy storage.

Demand Response Program Key Takeaways

Based on the DR program potential analysis, the following key findings emerge:

1. **There is significant potential to reduce peak loads via DR programs on PEI:** Even with a relatively flat load curve, there is up to 31 MW of peak reduction potential by 2030 via a combination of Customer Incentives and engaging Interruptible Rate customers in DR events. Alternatively, the TOU Rates could deliver 10.7 MW of peak reduction potential by leveraging the upcoming AMI investments, and this could be combined with strategic selection of other targeted customer incentive measures to create an optimized DR program portfolio.

2. **The key to success will be to focus DR program design on optimized measure mixes:** There is significant cost-effective peak reduction potential on PEI and focusing on a few key programs can provide the most savings while optimizing the overall cost-effectiveness. Overall, most of the potential can be achieved through the following measures:

    a. Load reducing measures that do not experience a bounce-back effect (i.e., an increase in demand following a DR event that may create a new peak) such as medium & large commercial customer load curtailment, dual fuel systems, and battery energy storage that strictly reduce peak demand.

    b. Residential thermal energy storage and electric storage water heaters.

    c. Smart thermostats connected to electric heating systems, which offer additional benefit by integrating efficiency and peak reduction programs.

3. **Enrolling Interruptible Rates customers in DR events should be a priority:** Expanding the current interruptible rates agreement with large C&I customers to include peak demand events, could yield up to 18MW of peak load reduction potential. This is the largest single measure for reducing system peaks and could be combined with other customer incentive measures and/or TOU rates to deliver a significant amount of cost-effective peak load reduction potential. Exploring the ability to make this adjustment to the interruptible rates agreements should be an initial step in an eventual DR program design.

Combined System Impacts

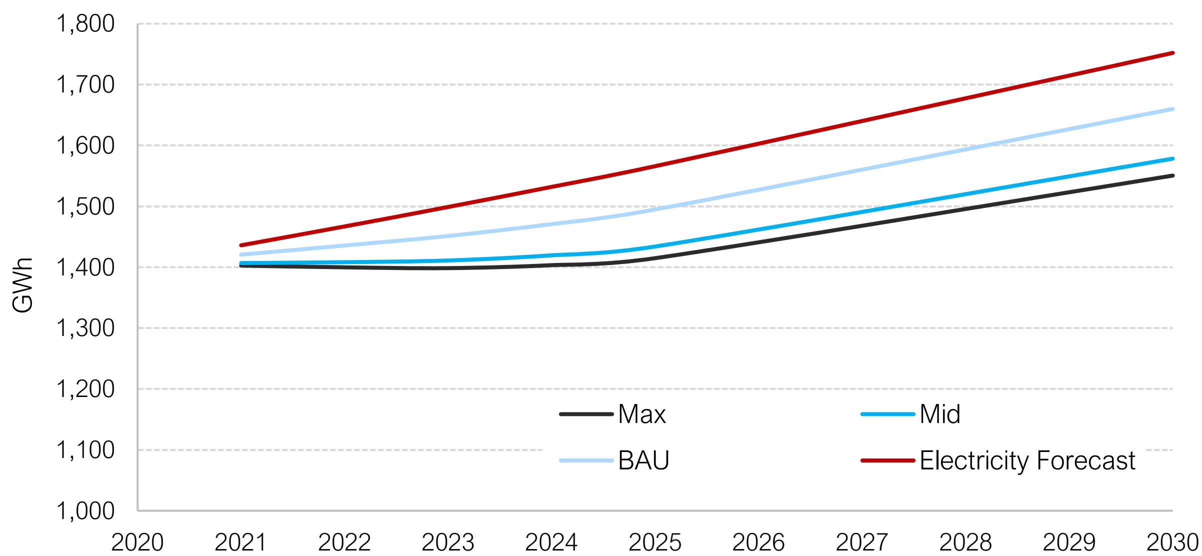
The following presents the *cumulative* impact on electricity consumption on PEI resulting from efficiency and demand response programs. These results provide a rolling sum of all new savings from measures that are incentivized by efficiency and demand response programs. Cumulative savings provide the total expected impact on electricity sales and annual peak demand and can be used to help plan for the province's long-term energy needs.

Electricity Consumption Impacts

By 2030, achievable electric efficiency savings could reduce annual electricity consumption by a total of 92 GWh (BAU scenario) to 200 GWh (Max scenario). This translates into a 5% to 11% reduction in electricity sales by 2030 relative to the province-wide consumption forecast in the absence of efficiency programs, as shown Figure E-9.

Overall, the study indicates that energy efficiency programs can effectively flatten electricity consumption in the province over the 2021-2025 period by offsetting projected growth. However, as the new savings opportunities decline in the later years of the study period, the programs are less able to offset consumption growth.

Figure E-9. Impact of Electric EE Program Savings on Forecasted Electricity Sales (2021-2030; Program Scenarios)



Note: Y-axis in above figure does not begin at zero.

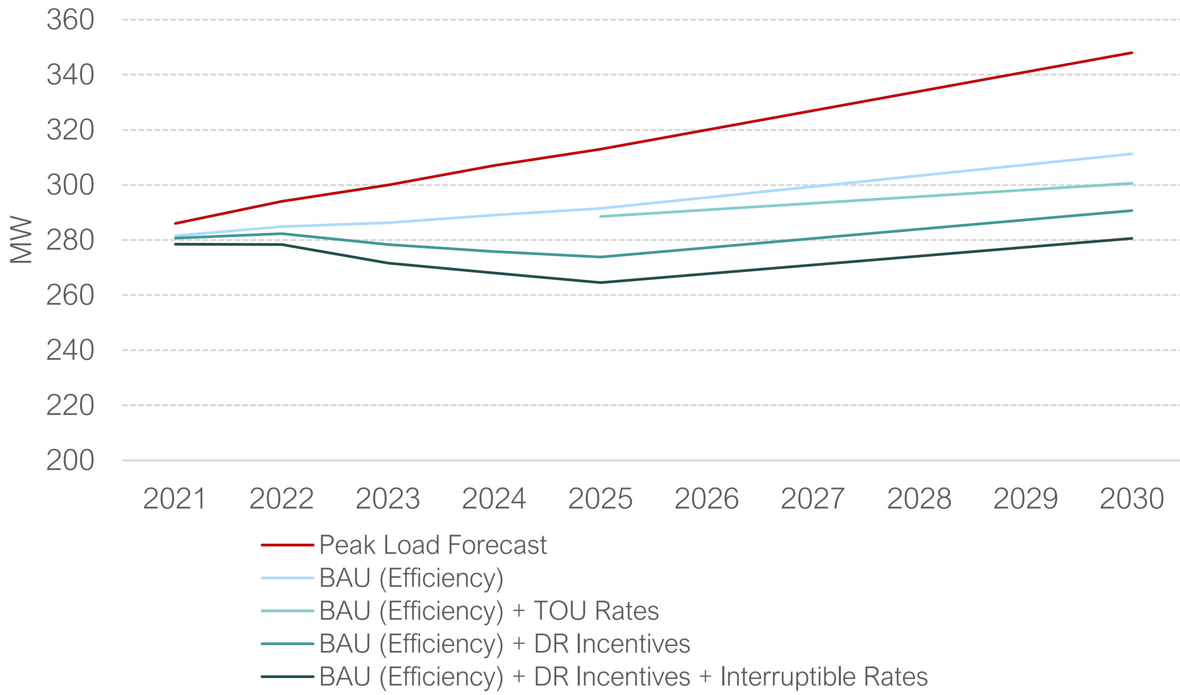
Over the first three years (i.e., 2021-2023), the average achievable electric efficiency savings are equivalent to reducing forecasted electricity sales by 1.0 percent (BAU scenario) to 2.2 percent (Max scenario) per year and represent an increase over efficiencyPEI's 2019/20 program savings which were approximately 0.5 percent of electricity sales in that year. To note, the Province has set an annual electricity reduction target of 2% of consumption. The results of this study show that the target is achievable under the higher scenarios, especially when enabling activities are deployed alongside incentives.

Annual Peak Electricity Demand Impacts

Efficiency and demand response programs can also help reduce the programs annual peak demand for electricity, which is important to maintaining system reliability, and can help defer or avoid costly expansions to electricity transmission and distribution infrastructure.

Figure E-10 provides the forecasted growth in annual peak demand for electricity (red line) and compares this to the projected annual peak demand when the potential impacts of DSM programs are considered (blue and green lines). The efficiency program BAU scenario (blue line) shows the potential to keep annual peak demand relatively stable for the 2021-2025 period, after which a steady increase occurs as customer growth impacts outstrip peak savings from efficiency programs. When DR program impacts are added alongside efficiency programs, the annual peak load is reduced further, staying within the range of 260MW – 300MW for most of the study period. The impact of TOU Rates is introduced in 2025, and while the impact is not as pronounced as with the other scenarios, it does result in a 3% reduction in peak in 2030.

Figure E-10. Impact of DSM Programs on Forecasted Utility Annual Peak Load (2021-30; All Program Scenarios)



Note: Y-axis in above figure does not begin at zero.

Key Takeaways

Overall, the Potential Study shows that there is significant potential for efficiencyPEI's DSM programs to curtail the projected growth in electricity consumption in the province over the coming decade.

1. **PEI's electricity energy efficiency savings targets are achievable**: While current energy efficiency programs do not appear sufficient to meet the provincial government's goal of 2% electricity savings per year, there is a reasonable path to that target, albeit at higher costs and covering a broader range of eligible measures coupled with a greater focus on enabling activities. In addition, Demand Response offers a new opportunity to engage the Island community to help mitigate the growing annual peak in the province and reduce overall system costs.

2. **Efficiency and Demand Response programs can help manage electric system peak demand growth:** Over the first half of the study period, energy efficiency and DR programs can flatten and even bend forecasted load growth downward. This can help maintain system reliability, and possibly allow the utilities to defer or avoid expansion of the transmission and distribution infrastructure over the coming decade.

1 Introduction

1.1 Study Overview

This report presents the results of the Prince Edward Island Energy Efficiency Potential Study ("the Potential Study"). The Potential Study includes two modules covering the following savings streams:

- Electric energy efficiency (EE),
- Electric demand response (DR),

The Potential Study includes electric savings measures only and covers the ten-year period spanning the calendar years 2021 to 2030. Included are electric energy efficiency savings, electric demand reduction savings associated with the energy efficiency measures, and active demand response savings as well as the costs and cost-effectiveness ratios associated with these savings. Secondary fuel savings, such as oil or propane savings, associated with the electric efficiency measures are assessed to determine benefits, but are not quantified in this report. The study covers the entire province of Prince Edward Island, which is served by Maritime Electric and Summerside Electric.[3]

1.1.1 Uses for the Potential Study

The Potential Study is a high-level assessment of electric savings opportunities on Prince Edward Island over the next ten years. The main purpose of this study is to quantify the cost-effective savings opportunities for energy efficiency and demand response. In addition to this objective, the Potential Study can support:

- Resource planning
- Program planning
- Provincial policy and strategies

While the Potential Study provides granular information such as savings for specific measures in specific building segments, the study is not a program design document meant to accurately forecast and optimize savings and spending through efficiency programs in a given future year. The Potential Study is meant to quantify the total universe of opportunities that exist under specific parameters as defined under each program scenario and the cost-effectiveness test used.

1.2 Data Sources and Uses

The Potential Study leverages Prince Edward Island specific data to populate the models used to estimate market potential. Where Prince Edward Island specific data is not available or insufficient, data from nearby jurisdictions is leveraged to fill gaps and produce a more robust representation of market parameters in the

[3] Maritime Electric serves approximately 90% of electric customers on the Island and the City of Summerside's electric utility serves approximately 10%.

province. Table 1-1 provides an overview of the key data sources used in the study. A more detailed description of the sources, inputs, and assumptions can be found in Appendix C.

Table 1-1. Study Data Sources and Uses

Data source	Application in study
Utility customer data	Anonymized utility customer data from Maritime Electric and Summerside Electric is used to determine the number of customers and overall consumption in each market segment.
PEI market baseline survey data	As part of this study, Ad Hoc Research conducted a phone survey to establish equipment penetration and saturations in the model for select end-uses.
Program evaluation reports	Program data from recently completed program evaluations is used to characterize programs for model input (e.g., incentive levels, administrative costs) and used to benchmark results.
PEI Home Heating Survey	Results from the most recent Home Heating Survey was used to supplement the primary research and refine equipment penetration and saturation levels as well as inform our barriers assessment.
Maritime Electric's historical load	Historical hourly load data from 2019 was used to assess peak demand and evaluate demand response potential.
Dunsky's Market Archetype	Where Island specific baseline data is not available (or was based on a low number of observations), baseline data from neighboring jurisdictions, in particular New Brunswick and Newfoundland is leveraged and adjusted for PEI specific attributes wherever possible.
Measure Characterizations	Measure savings algorithms, estimated lives, incremental costs and specifications are derived from technical reference manuals published in analogous jurisdictions and are adjusted to reflect PEI program evaluation results.

1.3 Market Segmentation

Based on an analysis of anonymized customer data from Maritime Electric and Summerside Electric, the Potential Study segments the electric customers into two sectors with the Residential sector split into three market segments and the Commercial and Industrial (C&I) sector split into nine as presented in Table 1-2.

Table 1-2. Study Market Sectors and Segments

Sector / Segment	Number of Customers
Residential	75,021
Single Family	*47,699*
Multi-Family[4]	*16,070*
Low-Income	*11,253*
Commercial & Industrial	6,989
Office	*2,411*
Retail	*724*
Food Service	*311*
Healthcare & Hospitals	*168*
Campus & Education	*75*
Warehouse	*120*
Lodging	*294*
Other Commercial	*883*
Industrial/Agriculture	*2,002*
Total	82,010

It should be noted that all agricultural accounts are included in the Industrial/Agriculture market segment. While most agricultural accounts are currently under a residential rate tariff, for the purposes of this study these customers were considered C&I and grouped with industrial accounts as there is no market characterization specific to the agricultural sector on PEI nor a market archetype that would allow Dunsky to model a stand-alone segment at this time. Section 2.5 provides an overview of agricultural electric efficiency measures and benchmarks agricultural savings to results from potential studies in other jurisdictions. While this high-level review shows that the savings targets in this study are likely reasonable for the agricultural sector, as a result of the limited sector-specific data, the measure level details may differ from market reality.

1.4 Achievable Scenarios and Sensitivities

As is standard practice in potential studies, the study assesses potential at the technical, economic, and program achievable levels. For each module, the study explores three program achievable scenarios (as well as sensitivities) to determine how various levels of incentives and enabling activities can impact achievable savings. In general, achievable potential is the focus of this analysis.

Figure 1-1 provides general descriptions for each achievable energy efficiency scenario. The Demand Response scenarios and more detailed descriptions are provided for each module in their respective chapters.

[4] The multi-family population count represents individual residential units within multi-family buildings. This segment includes apartments, condos, and duplexes.

Figure 1-1. Achievable Program Scenario Descriptions[5]

BAU — Applies incentives, enabling activities and costs that are in line with ePEI's 2019/20 programs – plus the addition of **three new programs** – to simulate business as usual.

Focus of Reporting

Mid Incentive — Incentives are raised to a minimum of 75%, and enabling activities kept at BAU levels.

MAX Incentive — Incentives are raised to 100% to completely eliminate costs and show the full potential of incentives to increase participation.

Dunsky explored **increased enabling activities** *(above and beyond current levels)* **through sensitivities to the Mid scenario.** This approach allows us to isolate and report on the impact of incentives vs. enabling activities, which can be helpful from the perspective of program design.

The study tests various modules against multiple sensitivity scenarios as summarized in Table 1-3.

Table 1-3. Sensitivity Scenario Descriptions

Sensitivity Scenario	Baseline	Sensitivity
Enabling Activities	Adoption barrier levels are set to reflect current program enabling activities.	For the Mid energy efficiency scenario, barrier levels are reduced by a half step and a full step impacted adoption under enhanced enabling activities.[6]
Retail Rates	Retail electricity rates are forecasted in line with current best information.	Forecasted retail electricity rates are increased/decreased by 10% impacting bill savings associated measures that impact energy consumption.
Avoided Costs	Energy and capacity avoided costs are forecasted in line with current best information.	Forecasted avoided energy costs are increased/decreased by 10% to account for possible new spending or reduced future energy and/or capacity costs.

[5] efficiencyPEI's programs (and reported costs and savings) are for the 2019/20 fiscal year (April 1, 2019 through March 31, 2020). They are used to calibrate the BAU scenario in the model, which provides results based on a calendar year.
[6] A half step barrier reduction reflects a notable investment in enabling strategies (e.g., contractor training, direct install measures) to reduce non-economic market barriers to participation. A full step would represent an absolute limit of what could be achieved by applying a full range of strategies. See Section 2.4 and Appendix A for additional detail.

1.5 Baseline Energy and Demand Forecasts

To help discern the impact of the various measures analyzed in the Potential Study on overall energy consumption and demand on PEI, the study establishes baseline energy and demand forecasts for the study period. The electric consumption forecast was developed using anonymized consumption data from Maritime Electric which was then scaled to account for Summerside Electric customers.[7] The first year of the study forecast (2021) was then compared to the 2021 electricity sales forecast in Maritime Electric's 2018 rate case filing.[8] After adjusting Maritime Electric's rate case forecast upward by 10% to include the Summerside service territory, the study's year one (2021) forecast – based on actual historical consumption – was comparable to the 2021 forecast in the rate filing.[9] Moreover, the study's forecast through 2025 is reasonably in-line with the sales forecast in Maritime Electric's 2020 Integrated System Plan.

The demand forecast is based on the peak load forecast included in the 2016/17 PEI Energy Strategy.[10] A more detailed description of the approach used to derive these forecasts is included in Appendix C. As with the energy forecast, the study demand forecast was compared to Maritime Electric's 2020 Integrated System Plan and found to be in-line with that forecast through 2025.

Figure 1-2 presents the baseline forecasts for electricity sales and peak demand. Electricity consumption as well as electric peak demand are expected to increase over the study period at annualized rates of 2%. These forecasts are used to illustrate the cumulative impacts of savings within each study module chapter as well as overall system impacts in Chapter 2.

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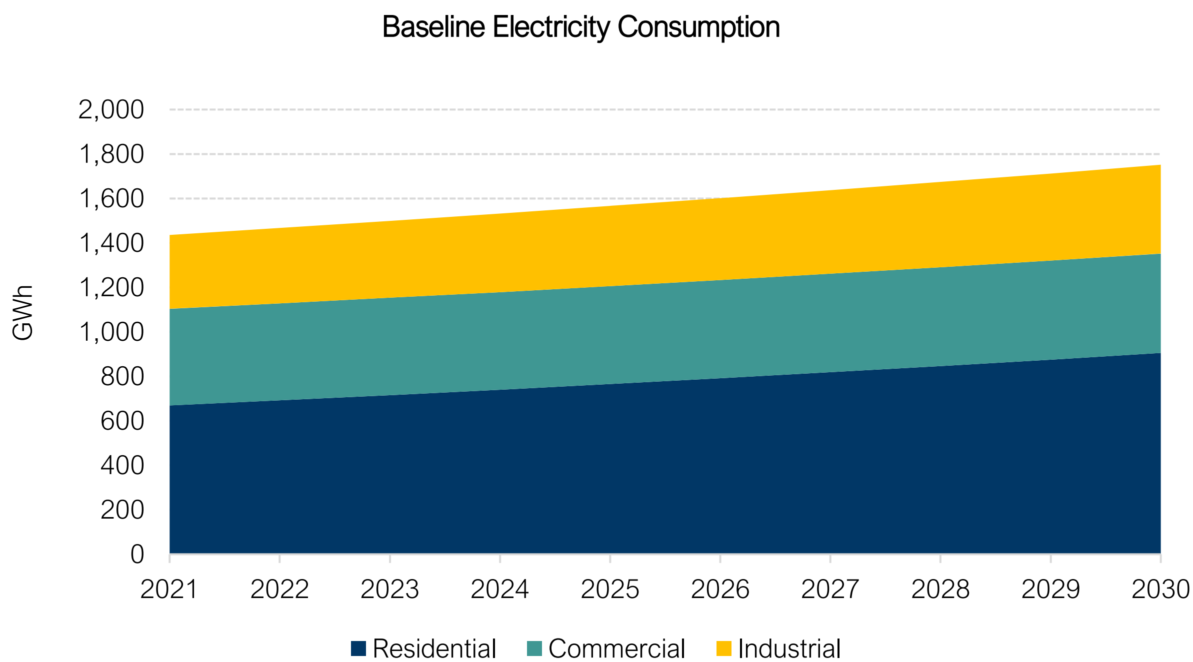
[7] Summerside Electric's overall electricity consumption is roughly 10% that of Maritime Electric. Consumption by sector is also approximately equal, and therefore a 10% adder to Maritime Electric's forecasts is an appropriate proxy for determining total electricity consumption (and demand) for PEI.

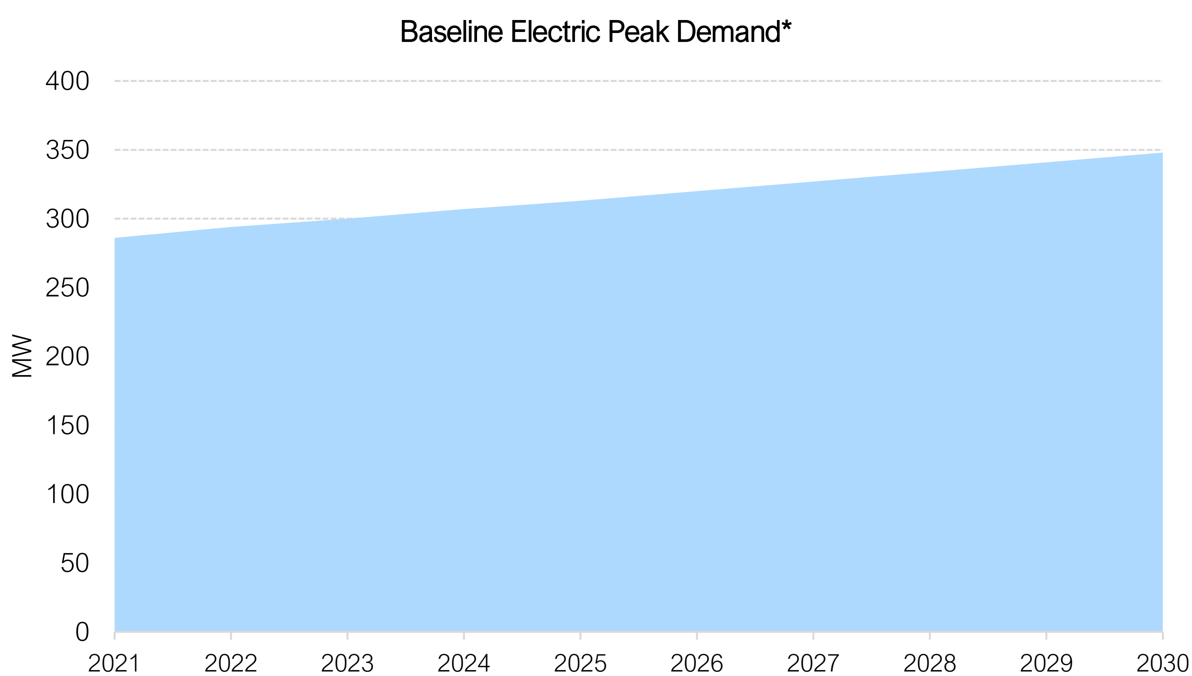
[8] Maritime Electric 2019 General Rate Application (November 2018). Schedule 7-3. Available at: https://www.maritimeelectric.com/media/1424/2019-general-rate-application-filed-november-30-2018.pdf

[9] Maritime Electric 2020 Integrated System Plan. Available at: http://www.irac.pe.ca/infocentre/documents/Electric-MECL-2020_Integrated_System-093020.pdf. To note, the forecasts (energy and demand) do not include energy efficiency savings.

[10] Prince Edward Island Provincial Energy Strategy 2016/17 (March 2017). Table 1. Comparison of PEI Peak Load to Existing Available Resources. Available at: https://www.princeedwardisland.ca/sites/default/files/publications/pei_energystrategymarch_2017_web.pdf. This forecast was also compared to Maritime Electric's most recent IRP and found to be roughly in-line with that forecast.

Figure 1-2. Baseline Energy and Peak Demand Forecasts





*Forecasted peak demand was not disaggregated by sector.

1.6 Savings Terminology

This report expresses results in terms of *cumulative savings* and *program savings*.

Cumulative savings are a rolling sum of all new savings from measures that are incentivized by efficiency programs that will affect energy sales. Cumulative savings provide the total expected impact on energy sales and electric peak demand and are used to determine the impact of efficiency programs on long-term energy consumption and peak demand. Where applicable, cumulative savings are adjusted to account for mid-life baseline adjustments and the retirement of efficiency equipment that has reached the end of its effective useful life (EUL).

Program savings provide the level of savings from measures that are incentivized by efficiency programs *in a given year*. Efficiency targets and plans are generally expressed in terms of program savings – i.e., the amount of savings programs procure in a given year.

Incremental annual savings are expressed in terms of savings achieved in the first year of all measures incentivized through efficiency programs.

Incremental lifetime savings are expressed in terms of the savings expected over the entire useful lives of all measures incentivized through efficiency programs.

2 Energy Efficiency

2.1 Overview

The following chapter presents results for the energy efficiency (EE) module of the Prince Edward Island Potential Study. The EE module estimates energy savings for electricity measures as well as peak demand savings (i.e., passive demand reductions) for electric measures. It does *not* include savings from demand response (DR), which is discussed in the subsequent chapter, nor does it include savings or consumption impacts from heating electrification, electric vehicles, or customer-sited solar, which were not within the scope of this study.

The chapter first briefly summarizes key results, the approach used to estimate EE potential, and the program scenarios explored in the analysis. A full description of the methodology can be found in Appendix A. A more detailed analysis of results is then presented in the following order:

- **Program savings.** Savings are presented in terms of incremental lifetime savings achieved during the study period for electricity. Where warranted, incremental annual savings are also presented for comparison purposes.
- **Portfolio metrics.** The benefits and costs of efficiency savings are presented at the portfolio-level.
- **Sensitivity analysis.** The impact of various sensitivities scenarios on program savings and portfolio metrics are presented.
- **System impacts.** Savings are presented in terms of *cumulative* savings to provide an assessment of system-level impacts of efficiency savings.

2.1.1 Approach

The market potential for EE is assessed using the Dunsky's Demand and Energy Efficiency Potential (DEEP) model. DEEP employs a bottom-up modelling approach that assesses thousands of "measure-market" combinations, applying program impacts (e.g., incentives and enabling activities that reduce customer barriers) to assess energy savings potentials across multiple scenarios. Rather than estimating potentials based on the portion of each end-use that can be reduced by energy saving measures and strategies (often referred to as a "top-down" analysis), the DEEP's approach applies a highly granular calculation methodology to assess the energy savings opportunity for each measure-market segment opportunity in each year.

DEEP estimates interactive effect impacts for measures that may have material impacts on secondary fuel usage (e.g., the installation of LEDs leading to increased fuel oil usage from space heating systems since LEDs produce less heat than incandescent or halogen bulbs). Interactive effect impacts are included within each fuel-specific savings stream (i.e., electric savings from measures that indirectly increase or decrease electricity consumption are accounted for under electric program savings). The interactive effect impacts can be found in Appendix D, which provides detailed results for measures at the end-use level for each savings stream. A more detailed description of the methodology can be found in Appendix A.

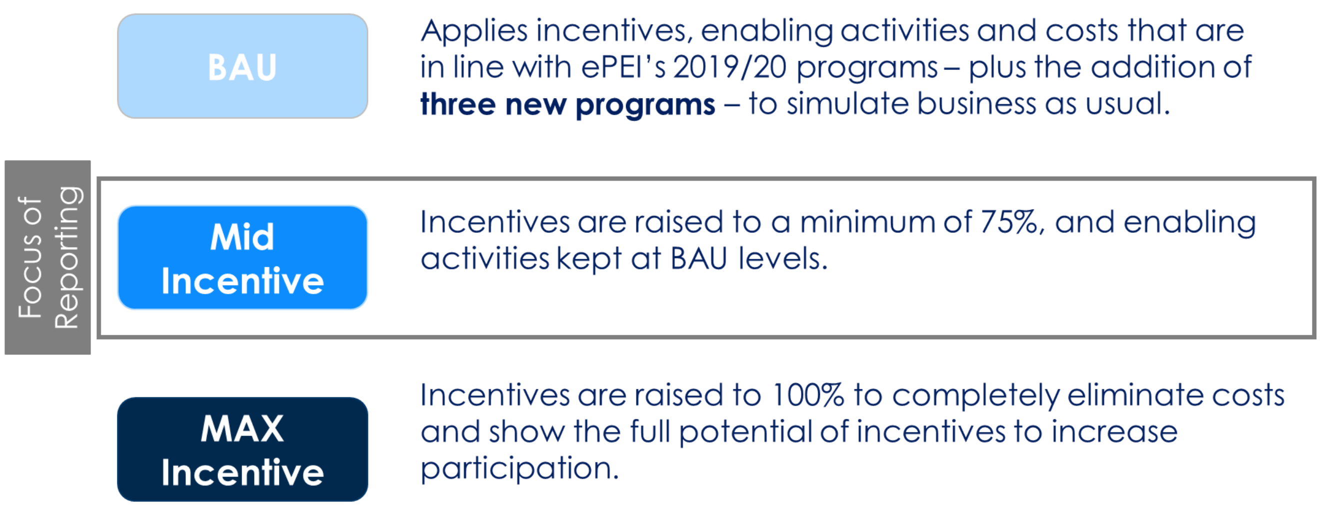
Benchmarking EE Results

To provide additional context to the study results, this chapter compares results to savings achieved by efficiency PEI in program year 2019/20, which are taken from a recent set of program evaluation reports. These reports provide final efficiency savings achieved for the entire 2019/20 program year.

2.1.2 Program Scenarios

The EE module explores three achievable program scenarios as described in Figure 2-1. In many areas of the report the Mid incentive scenario is the focus as it represents a reasonable level of growth for programs on PEI.

Figure 2-1. EE Module Program Scenario Descriptions



The BAU scenario is designed to emulate savings that may be achieved under incentive levels and enabling activities indicative of efficiency PEI's current programs albeit with measures and technologies that may not be currently offered by existing programs. In addition, the BAU scenario includes three additional programs not previously offered in efficiencyPEI's portfolio: Home Energy Reports, Appliance Recycling, and the recently established Community Energy Solutions program. The Mid scenario increases average incentive levels to at least 75% of incremental costs[11] for all programs but maintains the same level of enabling

[11] Incentives are applied to the incremental cost of a new, more efficiency measure. The incremental cost is the difference between the baseline technology and the new measure.

activities (see Chapter 1 for more information on program enabling activities). Finally, the Max scenario increases incentives to 100% of incremental costs so that customers do not pay any additional cost for efficient technologies while maintaining the same enabling activities assumed in the BAU scenario.

As noted, enabling activity impacts are treated as a sensitivity, which allows for a high-level assessment of the savings, and associated costs, resulting by applying enhanced enabling activities. See Section 2.4 for more details and the results of the comparative analysis.

For a more complete description of program characterization and assumptions underlying each scenario, please see Appendix C.

2.2 Program Savings

Figure 2-2 presents cumulative savings over the first three-year period of the study (2021-2023). Cumulative savings over the entire 10-year study period are included in the figure, below, and in Appendix D. The study estimates that, over the initial study period, the achievable scenarios capture approximately 23% (BAU) to 48% (Max) of the economic potential.[12] This is reasonable given what is seen in other jurisdictions and suggests that there is room to grow programs to realize a larger portion of the economic savings. It is important to note:

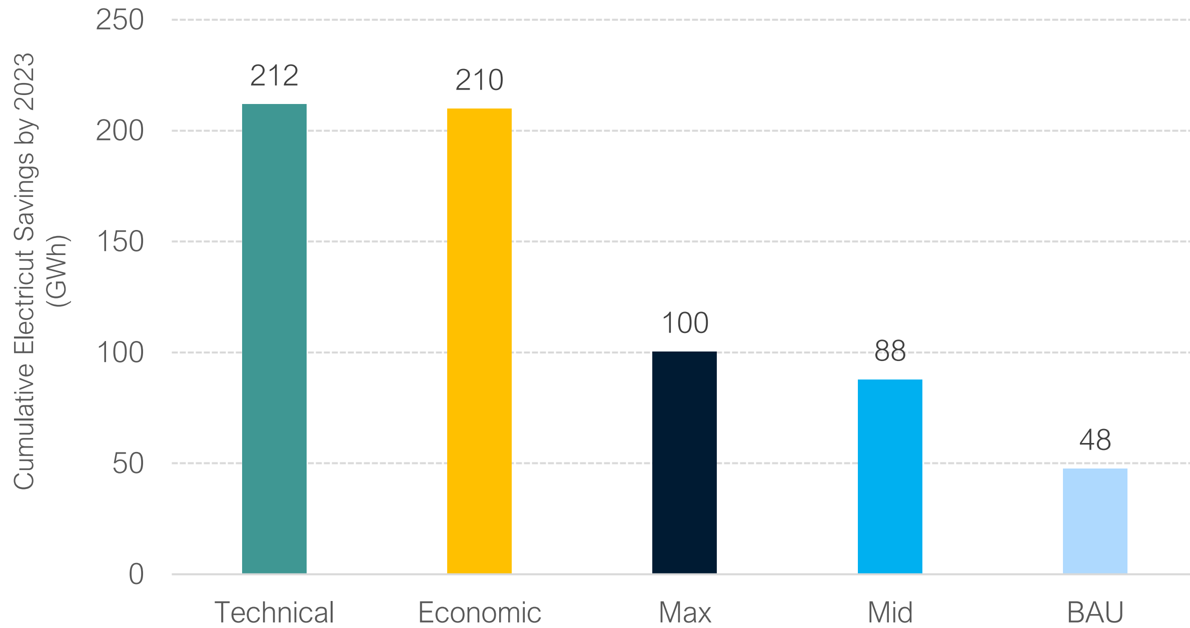
- These are incentive-only scenarios – As discussed above, enabling activities have been held constant at current program levels. The addition of enabling activities above business as usual – explored in the sensitivity analysis in section 2.4 – further drives adoption and increases energy savings by 17% under the Mid Incentive + Enabling (half step) and 36% under the Mid Incentive + Enabling (full step) on average over the first three years.

- Max incentives under a PAC screen does not necessarily result in max savings – Using the PAC test to screen for cost-effectiveness with 100% incentives reduces the number of measures that pass the cost-effectiveness screen. This approach does not optimize potential achievable savings. For this reason – and diminishing returns from higher incentives – we see a Mid and Max scenario that are close in terms of total savings.

- Economic savings at 99% of technical savings: Most measures pass the cost-effectiveness screen. This close agreement is somewhat an artifact of the study parameters, where only measures that are commercially viable were characterized for the model.

[12] See Appendix A (section A.4.1) for a discussion of technical and economic potential.

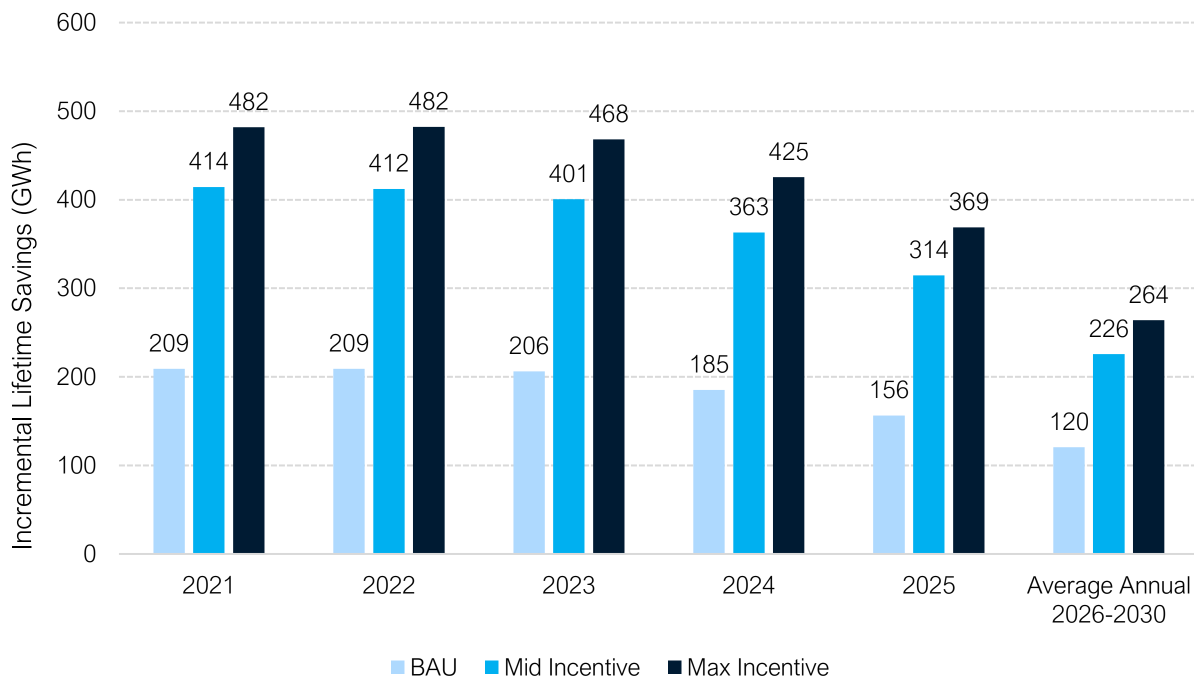
Figure 2-2. Cumulative Electric Savings by 2023 (All Scenarios)



As shown in Figure 2-3, below, the study estimates that efficiency programs can procure an average of 208 GWh (BAU) to 477 GWh (Max) of incremental lifetime savings per year over the first three years (2021-2023) or an average of 157 GWh (BAU) to 355 GWh (Max) of incremental lifetime savings each year over the entire ten-year study period. As shown in Figure 2-3, incremental lifetime savings remain relatively stable across the first three years of the study period – fluctuating by ~ 0.5-2.5% year-over-year.[13] Starting in 2024, incremental lifetime savings begin to decline more rapidly for reasons explored below. To note the second five-year period (2026-2030) is reported as average incremental lifetime savings over that period.

[13] The average increment lifetime savings over the first three years of the study ranges from 250 GWh (BAU) to 529 GWh (Max).

Figure 2-3. Electric Incremental Lifetime Savings by Year (All Scenarios)



The decline in savings – which is also true for incremental annual savings – is being primarily driven by the fact that the lighting market is transforming. By 2026, it is assumed that all residential lighting opportunities will become exhausted, as LED bulbs become the baseline technology option. In the C&I sector, as the market becomes more saturated with LEDs there are fewer opportunities to generate new savings from replacing T8 and T12 linear lights.

In addition to lighting, we also see a degree of decline over time in savings from retrofit measures that are added to buildings, such as insulation. This is primarily an artifact of the model diffusion curve, that reflects the ability of programs to aggressively pursue these additional opportunities in the initial years. In reality, these savings could be equally distributed across all years in the study, depending on program goals and designs.

Table 2-1, below, summarizes the incremental lifetime and annual savings over the first three years of the study period, as well as the 2021-2023 averages. As a percent of annual sales, these scenarios represent, on average over this period, a 1.0% reduction (BAU), 1.9% reduction (Mid), and a 2.2% reduction (Max) in electricity use. As a point of reference, efficiencyPEI achieved a 0.3% and 0.5% reduction in electricity use as a percent of sales in program years 2018/19 and 2019/20. To note, the C&I sector is driving the difference between the BAU scenario and evaluated 2019/20 results due to: 1) the addition of new measures not currently in or going through existing programs; 2) new savings opportunities beyond current programs; and 3) the addition of the Community Energy Solutions program.

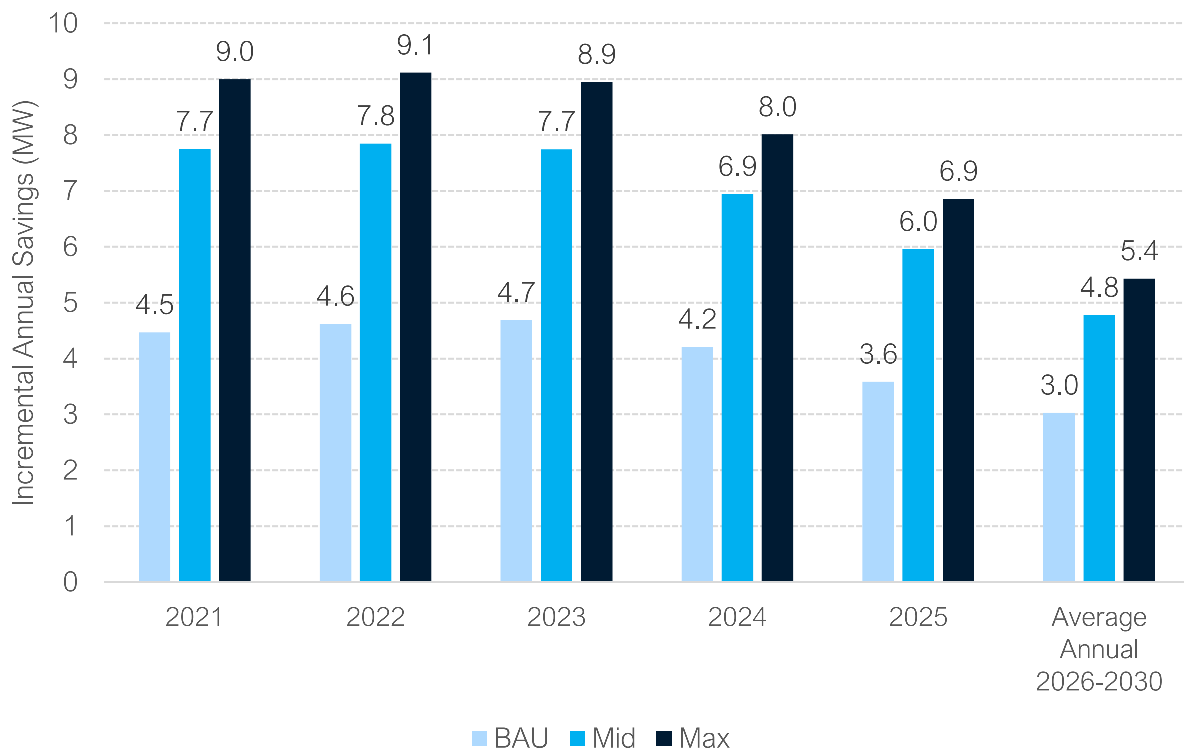
The higher savings scenarios approach or exceed PEI's goals of 2% annual electricity savings, and as demonstrated in Section 2.4, the addition of enabling activities delivers even more savings thus allowing efficiencyPEI to achieve the provincial policy target under the Mid scenario.

Table 2-1. Electric EE Incremental Lifetime Savings, Incremental Annual Savings, and Incremental Annual Savings as Percentage of Overall Sales by Year (All Scenarios, 2021-2023)

Program Savings	Scenario	2021	2022	2023	Average
Incremental Lifetime Savings (GWh)	BAU	209.1	209.1	206.1	208.1
	Mid	414.4	412.2	400.6	409.1
	Max	481.9	482.1	468.3	477.4
	Mid + Enabling	565.8	561.0	542.3	556.4
Incremental Annual Savings (GWh)	BAU	15.3	16.0	16.4	15.9
	Mid	29.1	29.6	29.2	29.3
	Max	33.3	33.9	33.3	33.5
	Mid + Enabling	39.3	39.6	38.6	39.2
% of Annual Sales	BAU	1.0%	1.0%	1.0%	1.0%
	Mid	1.9%	1.9%	1.9%	1.9%
	Max	2.2%	2.2%	2.1%	2.2%
	Mid + Enabling	2.6%	2.6%	2.4%	2.5%

In terms of peak demand reduction stemming from efficiency measures, incremental annual savings range from an average of 4.5 MW (BAU) to 9.0 MW (Max) across the first three years as shown in Figure 2-4. The cumulative annual demand savings by 2023 are approximately equal to 4.6% to 9.0% of the 300 MW of forecasted load in 2023.

Figure 2-4. Electric Demand Incremental Annual Savings from Efficiency Measures by Year (All Scenarios)



Note: The above figure represents passive demand reductions from EE measures and does not include active demand response.

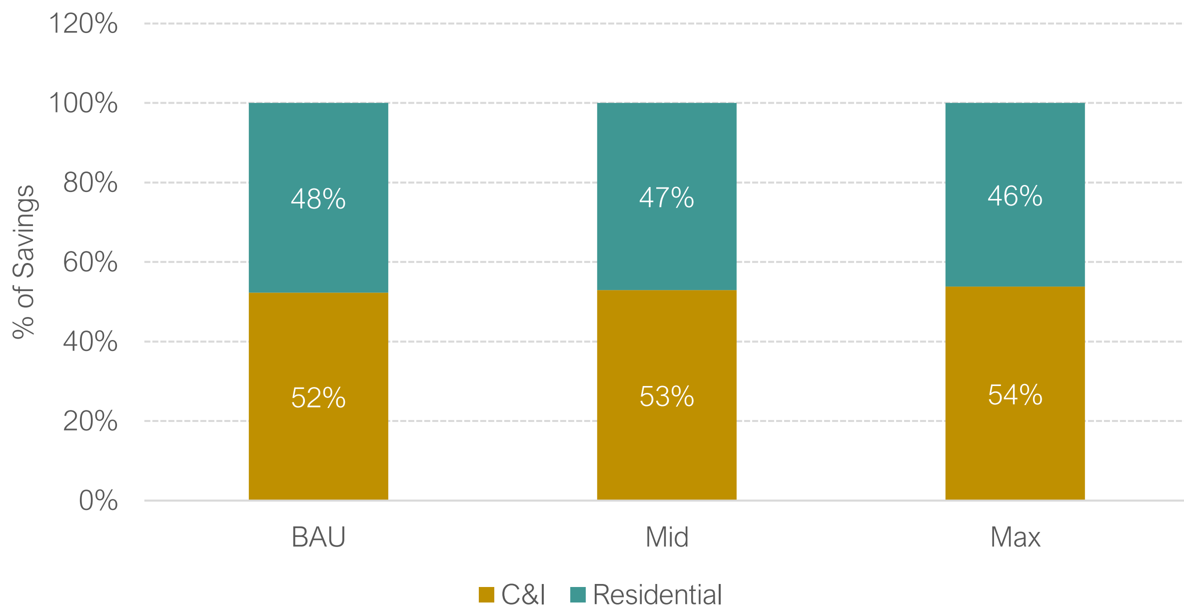
2.2.1 Program Savings by Market Sector

Based on incremental lifetime savings, the C&I sector accounts for on average 53% of savings across all scenarios, as shown in Figure 2-5, while the residential sectors accounts for approximately 47% of savings over the first three-year period. The savings breakdown closely tracks the sectors' relative portion of overall electricity consumption on the Island, which was forecast to be roughly 50/50 in 2021.[14]

There is essentially no difference when the share of overall electric savings by sector is measured in terms of incremental annual savings – commercial sector BAU scenario is 47%, Mid is 52%, and Max 54%.

[14] Maritime Electric 2019 General Rate Application (November 2018). Schedule 7-3. Available at: https://www.maritimeelectric.com/media/1424/2019-general-rate-application-filed-november-30-2018.pdf

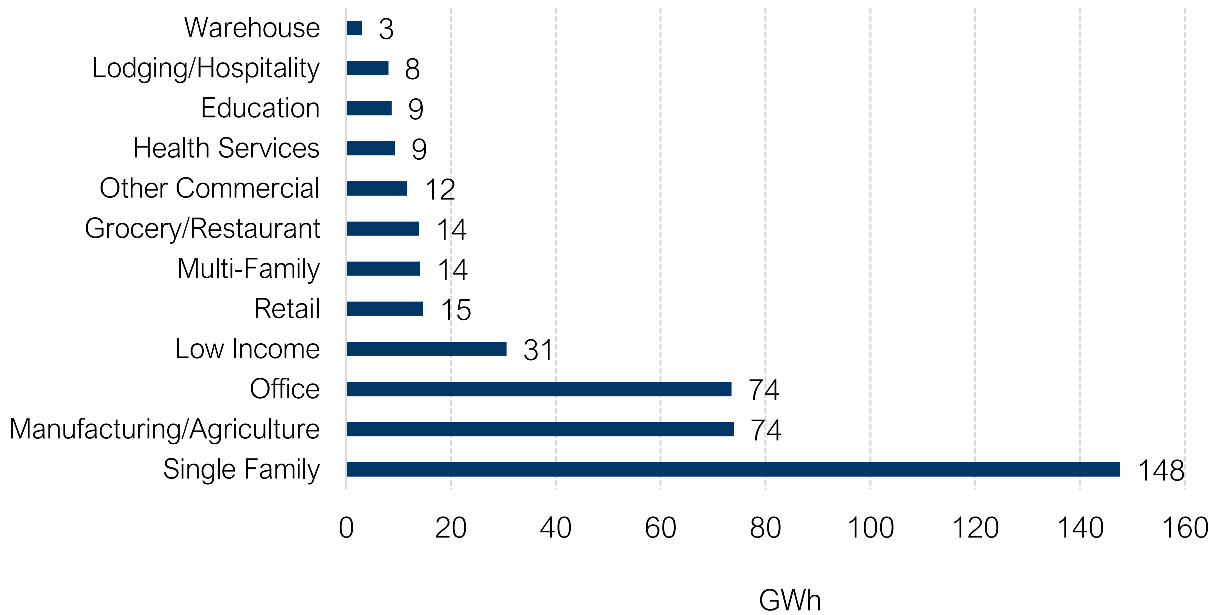
Figure 2-5. Proportion of Electric EE Savings by Sector (Average Incremental Lifetime Savings (2021-2023; All Scenarios)



At the segment level, the single family, industrial/agriculture, and office segments represent the bulk of electric EE savings. Under the Mid scenario, nearly 75% of all electric energy efficiency savings come from these three segments (see Figure 2-6). Low income and retail round out the top five segments for electric EE savings and represent 85% of total savings.

To note, these results are indicative of general trends. There were some challenges mapping consumption data to segments based on the data received and thus a level of uncertainty with respect to the balance of savings between the various segments. As such the savings by segment should be considered directional and not absolute.

Figure 2-6. Electric EE Savings by Segment (Average Incremental Lifetime Savings (2021-2023); Mid Scenario; GWh)



2.2.2 Residential Program Savings by End-use

In the residential sector, the single-family segment dominates with a 70% share of the savings, followed by low-income (21%) and multi-family (9%).

Figure 2-7. Residential Electric Average Lifetime Savings (2021-2023) by Segment, All Scenarios

Table 2-2 presents the savings breakdown by program and scenario. Where possible, the savings are compared to evaluated results from efficiency PEI's current programs. The primary takeaway is that insulation, equipment, and new constructure are emerging opportunities. The following is also noteworthy:

- Energy Efficient Equipment sees a reduction in savings in the BAU scenario compared to evaluated results since evaluated savings used baseboards as the baseline whereas this study uses a mix of baseboards and heat pumps in the baseline. In addition, the BAU, Mid and Max scenarios are essentially the same as we have held heat pump incentives constant between the scenarios based on discussions with efficiencyPEI.
- The Instant Energy Savings program is approximately 97% lighting and returns lower BAU savings on account of a much lower NTG ratios used in this study compared to the evaluation.
- Winter Warming and Home Comfort all have 100% incentives starting in the BAU scenario, which explains why the savings levels are the same between the scenarios (as incentives are the only variables in these scenarios). Moreover, we applied full distribution for the Home Energy Report measure under all scenarios.

Table 2-2. Residential Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, All Scenarios, GWh

	2019-20 Results (GWh)	BAU (GWh)	Mid (GWh)	Max (GWh)
Energy Efficient Equipment	38	21	20	22
Home Insulation Rebates	16	18	35	36
Instant Energy Savings	21	16	31	29
New Home Construction	24	23	70	100
Winter Warming	4	7	7	7
Home energy report	-	5	5	5
Appliance recycling	-	0	14	13
Home Comfort	-	9	9	9

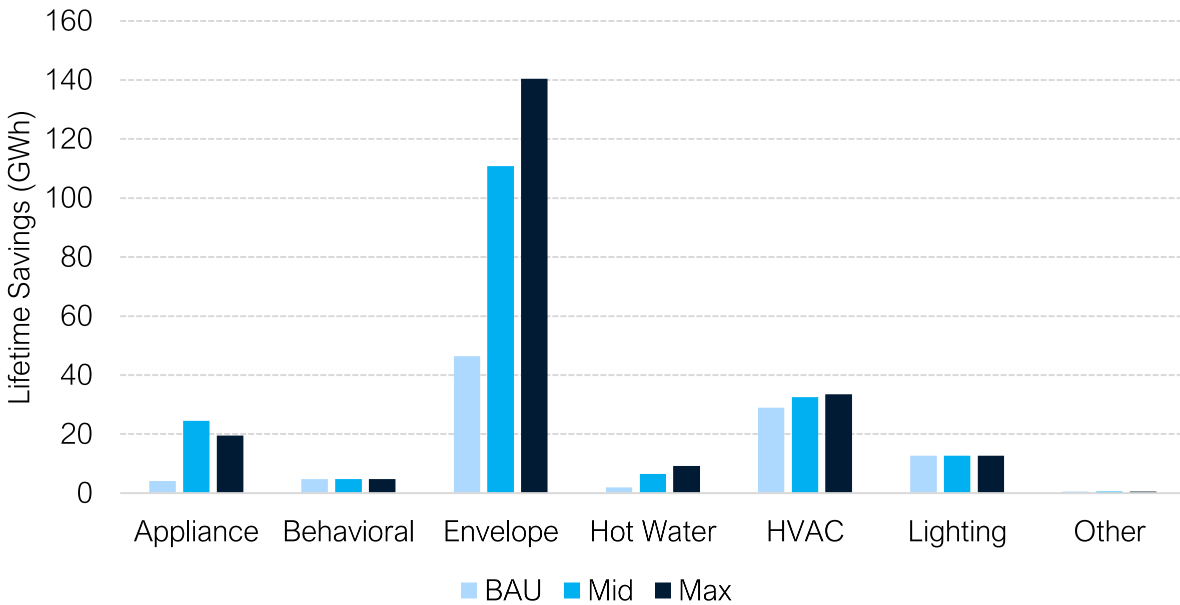
For the residential sector, incremental lifetime savings are distributed among multiple end-uses with over half (58%) coming from envelope measures (of which roughly 70% is new construction) under the Mid scenario. The bulk of the remaining saving come from HVAC (17%) and appliances (13%) – although as seen in Figure 2-8, the measures contribution to total savings varies depending on the scenario. To note, lighting savings do not change among the scenarios as the measure is already covered by 100% incentive starting in the BAU scenario.

With respect to New Home Construction, the relatively high level of savings reflects the recent and rapid trend in population growth and new housing starts on the Island.[15,16] However, a slowdown in new

[15] PEI 46th Annual Statistical Review (2019). "The Canada Mortgage and Housing Corporation (CMHC) estimate that there were 1,504 new housing starts on Prince Edward Island in 2019. This is up by 415, or 38.1%, from 2018 and the largest number of housing starts since 1927."
[16] The residential growth rate used in the model is 1.23% per year applied to 2019 base year consumption data provided by Maritime Electric.

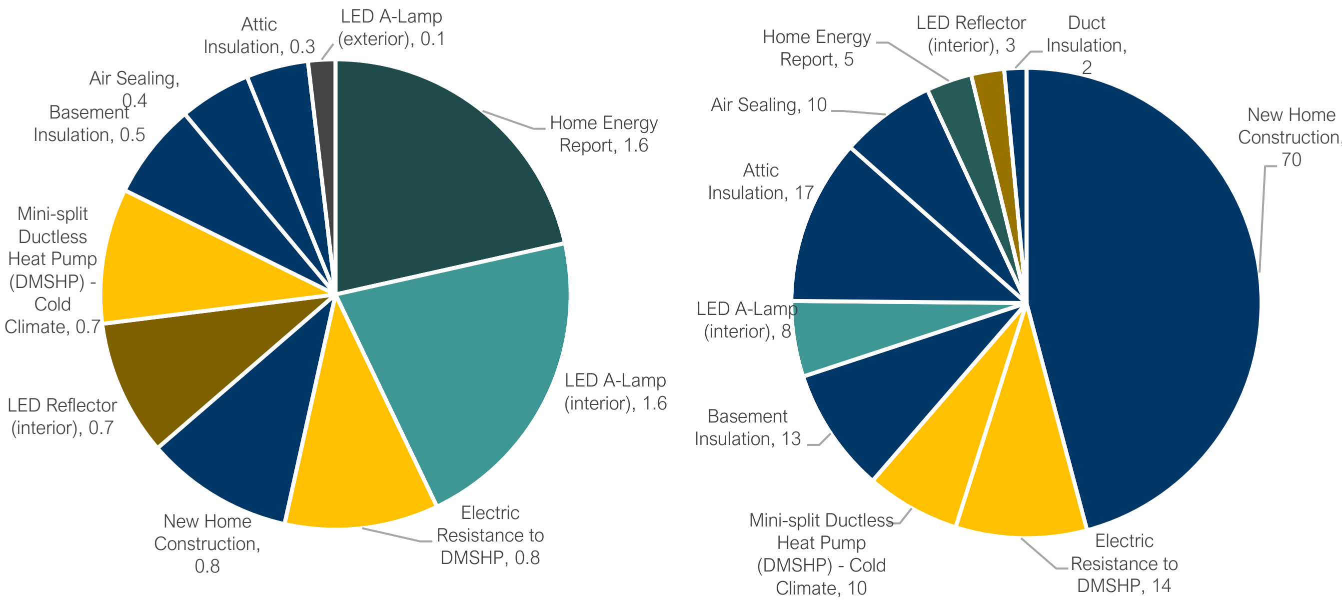
construction would lead to a reduction in savings potential. It is also worth noting that a slowdown in housing starts would have an impact on other measures that have an adjustment factor based on new construction. In general, the results signal a strong response from incentives, but we note that this program will likely also benefit from an investment in enabling activities to overcome other non-economic market barriers.

Figure 2-8. Residential Electric EE Savings by End-use Average Incremental Lifetime Savings (2021-2023; All Scenarios)



The following provides a breakdown of the top ten measures in terms of average annual and lifetime savings under the Mid scenario. As can be seen, there are important differences between looking at savings from the perspective of annual versus lifetime. For example, new home construction and other longer lasting envelop measures (shaded in blue) are much more prominent when considered on a lifetime basis.

Figure 2-9. Top 10 Residential Measures – Avg. Annual (left pie) and Lifetime (right pie) (2021-2023; Mid Scenario; GWh)



Note: Envelope measures and DMSP measures are grouped by the same colours.

Home Energy Reports

This behavioral measure provides an outsized proportion of residential incremental annual savings relative to their portion of residential incremental lifetime savings. The reason for this difference is that savings from home energy reports only persist for one to three years under the assumption that savings would dissipate in the event the program is discontinued. For other technologies, such as efficient furnaces or air conditioners, savings incentivized through a program will continue to exist even if the program is discontinued later.

It is also important to note that while home energy reports generate direct savings through behavioral changes, they are also an effective enabling strategy to drive uptake of other efficiency measures, which is not explicitly quantified in this study.

The prevalence of envelope measures – new construction as well as insulation and air sealing – in the top ten measures suggest an important opportunity for Prince Edward Island. As noted above, a significant amount of the potential is predicated on the continuation of the current growth in new housing. There is also an opportunity for continued savings by incentivizing the use of high-efficiency ductless mini-split heat pumps (DMSHP) at current levels. Heating systems such as DMSHP have long useful lives, therefore incentivizing the purchase and optimal use of more efficient systems results in significant incremental lifetime savings.

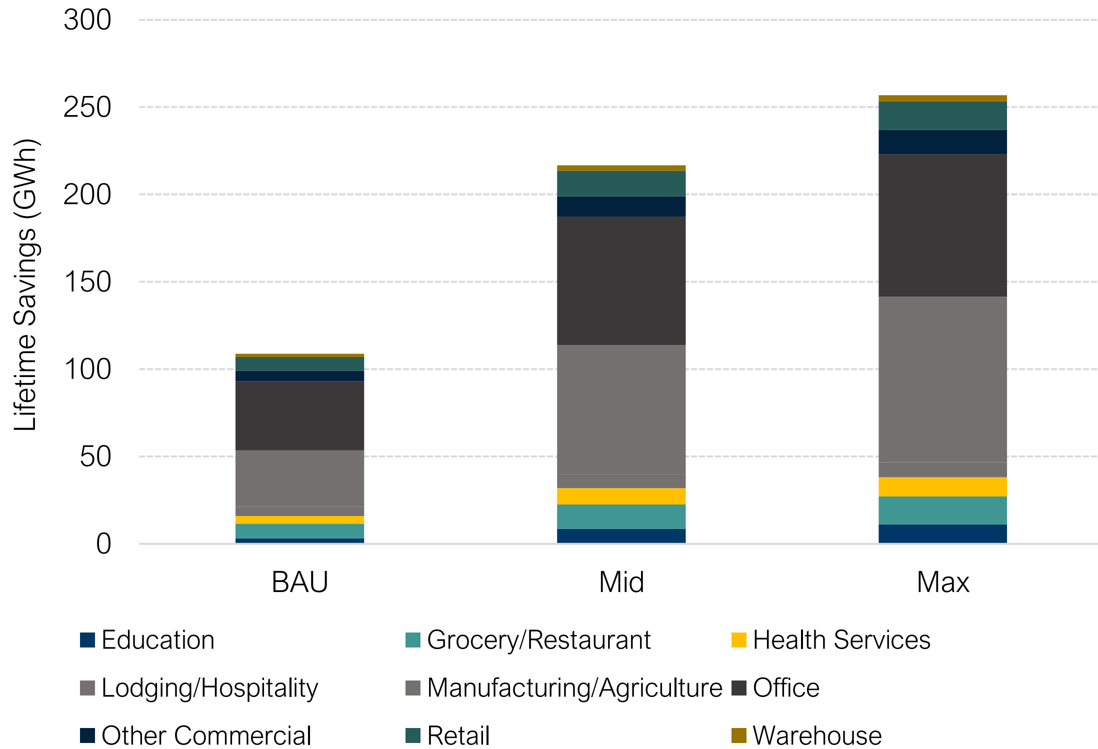
Table 2-3. Residential Top 10 Electric EE Measures (Average Incremental Lifetime Savings (2021-2023); Mid Scenario)

Measure	Description	GWh
New Home Construction	The construction of new homes that achieve ENERGY STAR certification, or R2000 certification.	70
Electric Resistance Heating to DMSHP	The installation of a DMSHP to displace heating from an electric resistance heating system (baseboards)	14
Attic Insulation	The installation of additional insulation in the attic/ceiling	10
Basement Insulation	The installation of additional insulation to basement walls	13
Air Sealing	Thermal shell air leaks are sealed through strategic use and location of air-tight materials	8
Ductless Mini-split Heat Pump (DMSHP) – Cold Climate	The installation of a high efficiency cold-climate DMSHP instead of a standard DMSHP in a) homes with existing DMSHP, or b) homes that were planning on installing a standard DMSHP.	17
LED A-Lamp (Interior)	The installation of LED A-lamps instead of incandescent or CFL lamps.	10
Home Energy Report	A report sent to customers that displays home energy consumption in comparison with peers and prompts energy conserving behavior	5
LED Reflector (Interior)	The installation of LED reflectors instead of incandescent lamps.	3
Duct Insulation	The addition of insulation to uninsulated ducts located in unconditioned space.	2

2.2.3 C&I Program Savings by End-use

In the C&I sector, industrial/agriculture and offices are the most important segments. Under the Mid scenario, industrial/agriculture and offices both account for 34% of average lifetime savings per year. These are followed by retail (7%), grocery/restaurant (6%), and other commercial (5%). In general, the savings are driven by lighting and motors although building envelope and HVAC also provide important contributions.

Figure 2-10. C&I Electric Average Lifetime Savings (2021-2023) by Segment, All Scenarios



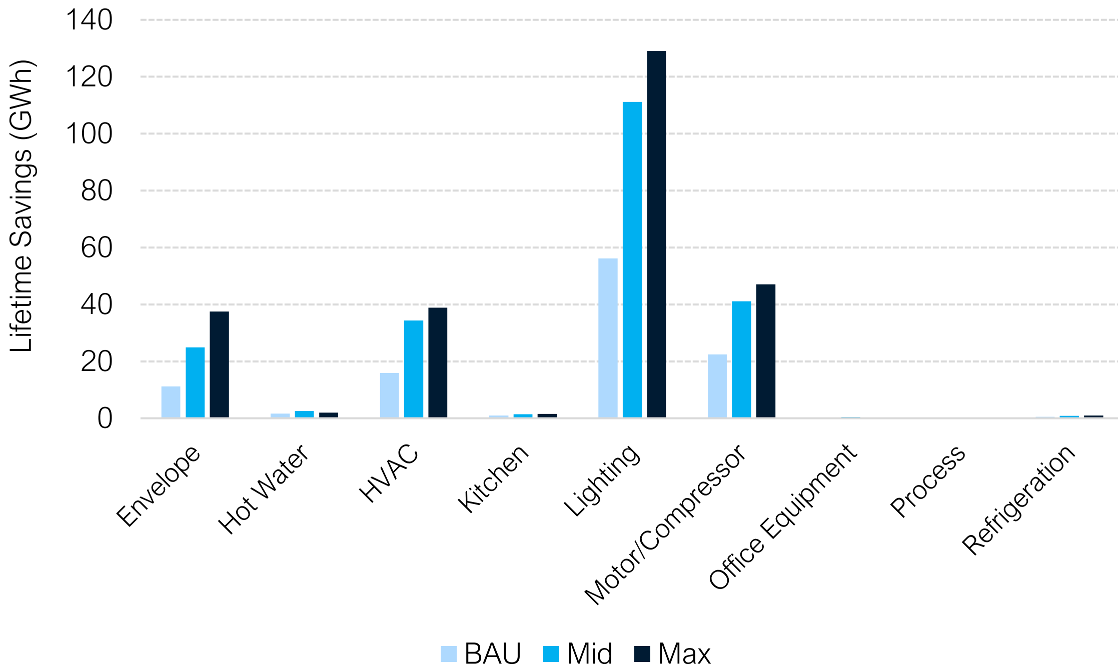
In general, the results of this study show that there is significant potential in the C&I sector in both the existing Business Energy Rebate and the planned Community Energy Solutions programs. This is responsible in large part for the significant difference between the 2019/20 evaluated results and the BAU scenarios (see Table 2-4).

Table 2-4. C&I Electric Evaluated Results and Average Lifetime savings (2021-2023) by Program, All Scenarios

	2019-20 Results (GWh)	BAU (GWh)	Mid (GWh)	Max (GWh)
Business Energy Rebates	19	63	123	142
Community Energy Solutions	-	46	93	115

Approximately half of average incremental lifetime electric efficiency savings over the first three years come from lighting measures (see Figure 2-11). Motors and compressors also offer meaningful potential, driven largely by the industrial/agricultural segment.

Figure 2-11. C&I Electric EE Savings by End-use Average Incremental Lifetime Savings (2021-2023; All Scenarios)



Noteworthy from these results:

- **C&I lighting remains by far the largest opportunity, both in terms of annual and lifetime savings.** While Tubular LEDs (TLEDs) are becoming a more and more important commercial lighting technology, there has not yet been the same level of market transformation as has been seen with A-Lamps and specialty bulbs. As a result, programs that incentivise efficient commercial lighting technologies are expected to continue to offer significant potential over the study period.

  However, C&I lighting is saturating and therefore there is lower turnover per year as LEDs have longer EULs. It is likely that future evaluation reports may show declining NTGs as Linear LEDs become the norm in the market.

- **Refrigeration is low due to availability of data.** The model includes a small number of prescriptive measures that target refrigeration. This study does not include any custom HVAC measures because these are quite dependent on the jurisdiction, and without in-depth market research or historical data to leverage, there would be high uncertainty around the measure. It is likely that, for example the addition of agriculture specific refrigeration measures, would further increase savings in this end use.

Lighting and lighting control measures are four of the top ten C&I electric efficiency measures as shown in Figure 2-12. The remaining six measures in the top 10 list relate to a mix of end uses, including HVAC, motor controls, and envelope.

Figure 2-12. Top 10 C&I Measures – Avg. Annual and Lifetime (2021-2023; Mid Scenario; GWh)

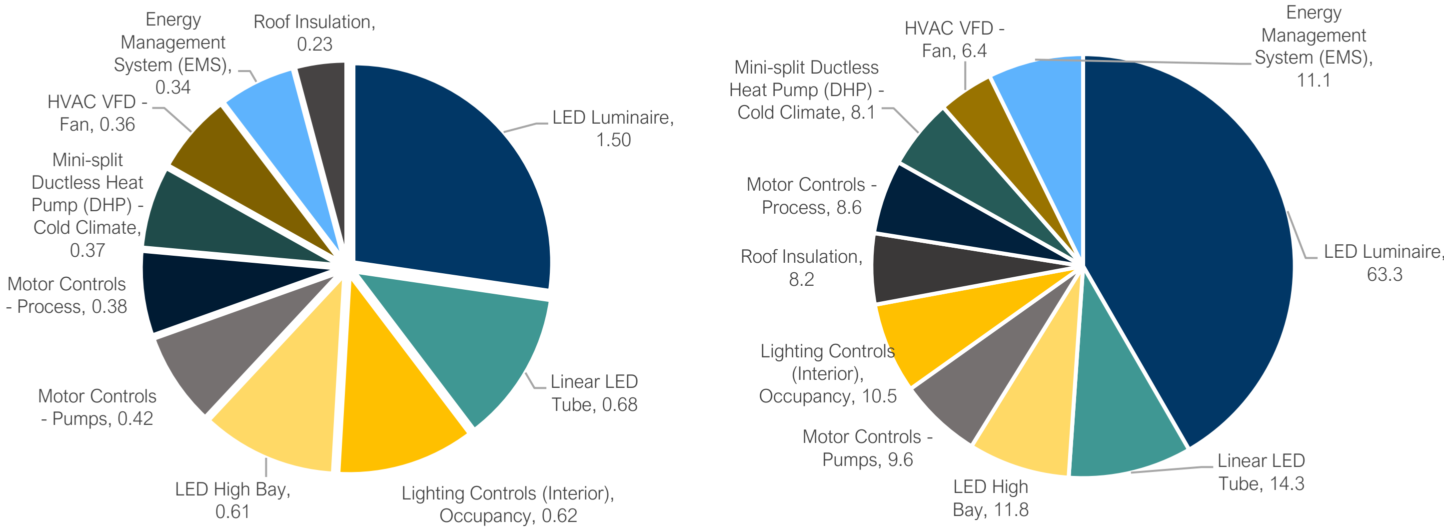


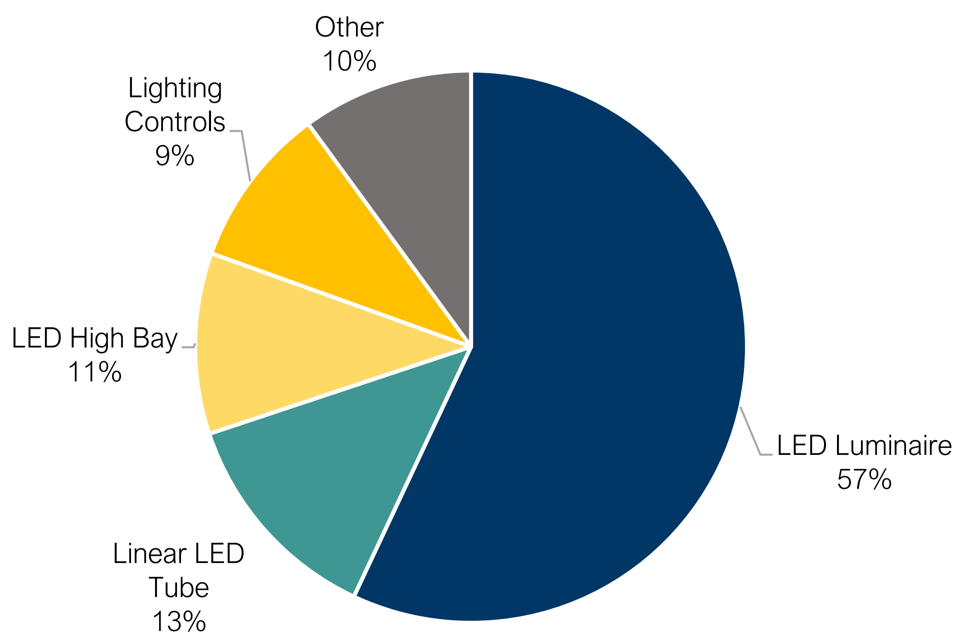
Table 2-5. Top 10 C&I Electric EE Measures (Average Incremental Lifetime Savings; Mid Scenario)

Measure	Description	GWh
LED Luminaire	The installation of an LED in a luminaire lighting fixture	63
Linear LED Tube	The installation of an LED in a linear tube lighting fixture	14
LED High Bay	The installation of an LED in a high bay lighting fixture	12
Energy Management System (EMS)	The installation of system to more efficiently manage energy consuming equipment and activities within a building	11
Lighting Controls (Interior), Occupancy	The installation of a device to turn lights on/off in the presence/absence of room occupants	10
Motor Controls – Pump	The installation of VFDs and synchronous belts for motors used for hydraulics.	10
Motor Controls – Process	The installation of direct digital controls and synchronous belts for motors used for other processes.	9
Roof Insulation	The installation of additional insulation to a flat roof.	8
Mini-split Ductless Heat Pump (DHP) – Cold Climate	The installation of a high efficiency cold-climate DMSHP instead of a standard DMSHP in a) buildings with existing DMSHP, or b) buildings that were planning on installing a standard DMSHP.	8
HVAC VFD – Fan	The installation of VFD on an HVAC fan.	6

Lighting will continue to play an important role in C&I programs over the study period. These savings are concentrated among four measure groups – LED Luminaires, Linear LED Tubes, LED High Bays, and Lighting Controls – as shown in Figure 2-13.

While markets are shifting for luminaires and tubes toward more common adoption of TLEDs, advanced lighting controls, including networked lighting, is a growing opportunity as new technologies and products integrate efficiency savings with increased functionality and non-energy benefits. These offer an emerging opportunity that also faces notable challenges including limited cross-compatibility among products from different manufacturers, limited customer awareness of the options and benefits, and timing re-lamping efforts with controls change-outs. Achieving the potential savings from advanced lighting controls will likely require investment to identify the most effective delivery strategies and tracking product development and roll out.

Figure 2-13. Proportion of C&I Lighting Savings by Measure Type (2021-23 Average Incremental Lifetime Savings; Mid Scenario)



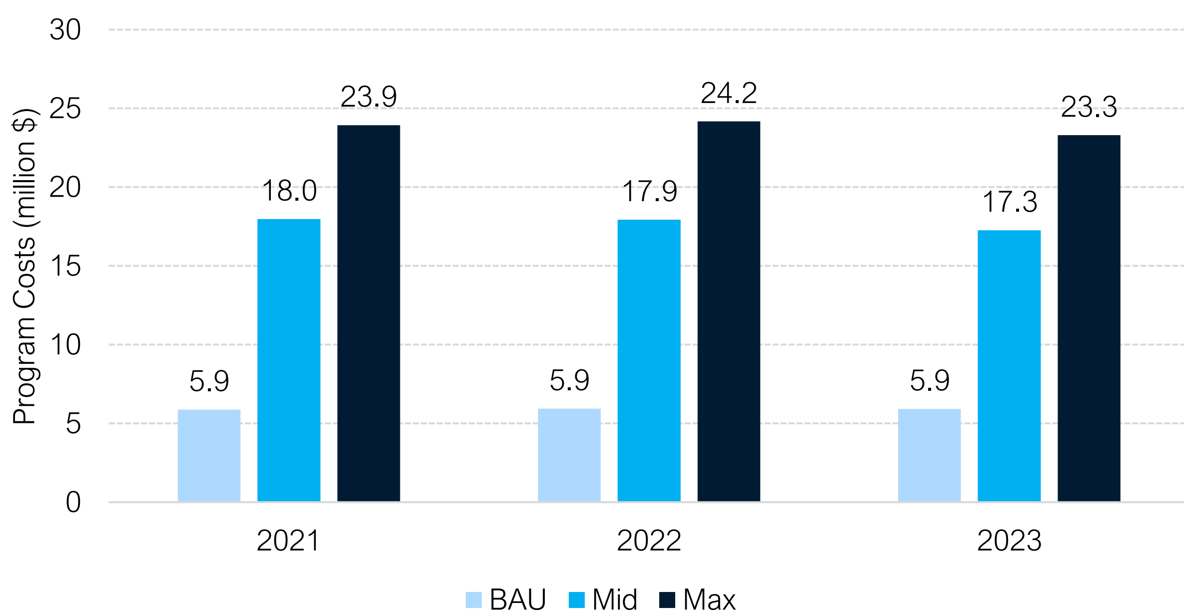
2.3 Portfolio Metrics

Overall, the study shows there is significant potential for energy efficiency on Prince Edward Island. As A-Lamps and specialty lighting markets transform, the heat pump market becomes more saturated, and efficiencyPEI ramps up efforts in new areas, program delivery, costs, and impacts will be affected. This section provides high-level estimated cost and benefit projections for the achievable potential scenarios. While these projections may offer a valuable directional assessment of program opportunities and the associated costs over the study period, these are largely informed by past program designs and performance on PEI. However, as the efficiency technology mix evolves, and new delivery approaches are required, the actual costs and program balances could vary significantly from these projections and could be higher or lower.

2.3.1 Program Costs

The study estimates that efficiency program costs will range between an average of $5.9 (BAU) to $23.8 (Max) million dollars per year over the first three years of the programs.[17] Under these incentive-only scenarios, program costs rise steeply between the achievable scenarios. We note that efficiencyPEI's budgets come from multiple sources, including ratepayers, the Province, and increasingly from federal funds such as the Low Carbon Economy Fund.

Figure 2-14. Estimated Program Costs by Year (2021-2023; All Scenarios)



Note: Electric portfolio costs include incentive and administration (fixed and variable costs).

[17] efficiencyPEI's approved budget for the 2019/20 fiscal year was $4,660,785, including Enabling Strategies and Evaluation. This is for all fuel types. A total of $2,630,281 was actually spent in that year due to lower-than-expected participation in two programs and because two of three commercial programs were not launched.

Table 2-6, below, provides a budget breakdown by sector and scenario over the first three years.

Table 2-6. Estimated Sector Costs by Year (All Scenarios)

Portfolio	Scenario	2021	2022	2023	Average
Residential	BAU	4.4	4.5	4.5	4.4
	Mid	10.4	10.4	10.1	10.3
	Max	12.6	12.6	12.	12.5
C&I	BAU	1.5	1.5	1.4	1.5
	Mid	7.5	7.5	7.2	7.4
	Max	11.3	11.6	11.1	11.3
Total	*BAU*	5.9	5.9	5.9	5.9
	Mid	18.0	17.9	17.3	17.7
	Max	23.9	24.2	23.3	23.8

The average unit cost of savings increases as well under the Mid and Max scenarios as presented in Table 2-7. Marginal costs per unit savings grow substantially between BAU to Mid and to a lesser extent between Mid and Max. Under the BAU scenario, first-year costs are $0.379 per annual kWh and increase to $0.605 and $0.710 per kWh under the Mid and Max scenarios, respectively. For comparison, efficiencyPEI's first year portfolio level costs were $0.325 per annual kWh for the 2019/20 fiscal year. The cost per lifetime kWh saved (i.e., the cost of the energy efficiency savings over the lifetime of the measures) is much lower - $0.028 per kWh (BAU), $0.048 per kWh (Mid), and $0.050 (Max).

Table 2-7. Average Estimated Savings Unit Cost (2021-23; All Scenarios)

Metric	BAU	Mid	Max
$ per Annual kWh (First year cost)	0.379	0.605	0.710
$ per Lifetime kWh	0.028	0.048	0.050

These results are to be expected as costs will typically increase as incentives are raised and more customers participate in programs under the Mid and Max scenarios. The unit cost of savings will increase as well for two primary reasons. First, raising incentives increases the cost not just for newly acquired savings, but also for savings that would have been obtained under lower incentive levels and thus at a lower per unit cost. Second, the higher incentives may drive more uptake of measures with higher unit savings costs associated with their lower savings to incremental cost ratios. However, the precise magnitude of cost increases under these scenarios should be interpreted with the following caveats:

- **Cost estimates are based on historical cost data.** Fixed and variable program cost inputs were developed based on historical spending data for efficiencyPEI's efficiency programs in 2018/19 and 2019/20. These inputs do not vary over the study period to account for factors that may increase costs (e.g., higher labor or technology costs as programs increased demand for specific services and/or equipment drives up prices) or decrease costs (e.g., lower program implementation costs as programs mature and become more efficient or employ new delivery strategies). For example, program administrators have historically placed emphasis on creating cost-effective lighting programs as this is where the majority of savings were found. However, as lighting savings decrease, programs administrators will likely begin focusing more on programs offering non-lighting savings, which will impact program implementation effectiveness and costs relative to current implementation practices today.

- **The program scenarios are not optimized for program spending.** For each achievable scenario in the DEEP model, incentives levels are set at the program level as a portion of the incremental costs for each eligible measure in the program. However, a real-world program design would likely set unique incentive levels for each measure, applying higher incentive levels for measures that may have had limited uptake in the past, and maintaining or lowering incentive levels for measures that meet their expected adoption. The text box below describes how a more granular approach to incentive setting could lead to significantly lower program spending at minimal expense of reducing savings.

The exception in this is analysis is DMSHPs. Based on discussions with efficiencyPEI it was determined that current DMSHP incentive levels already cover a high portion of the incremental cost of efficient heat pumps (and there has been rapid penetration of the measure to date). Dunsky therefore held these incentive levels constant at current levels among all scenarios.[18].

In addition, as discussed elsewhere in the report, the budgets reflect incentive-only scenarios. Program design optimization – increasing enabling activities along with targeting incentive to key measures – can help right-size program budgets.

DEEP's Adoption Methodology and Optimizing Program Savings

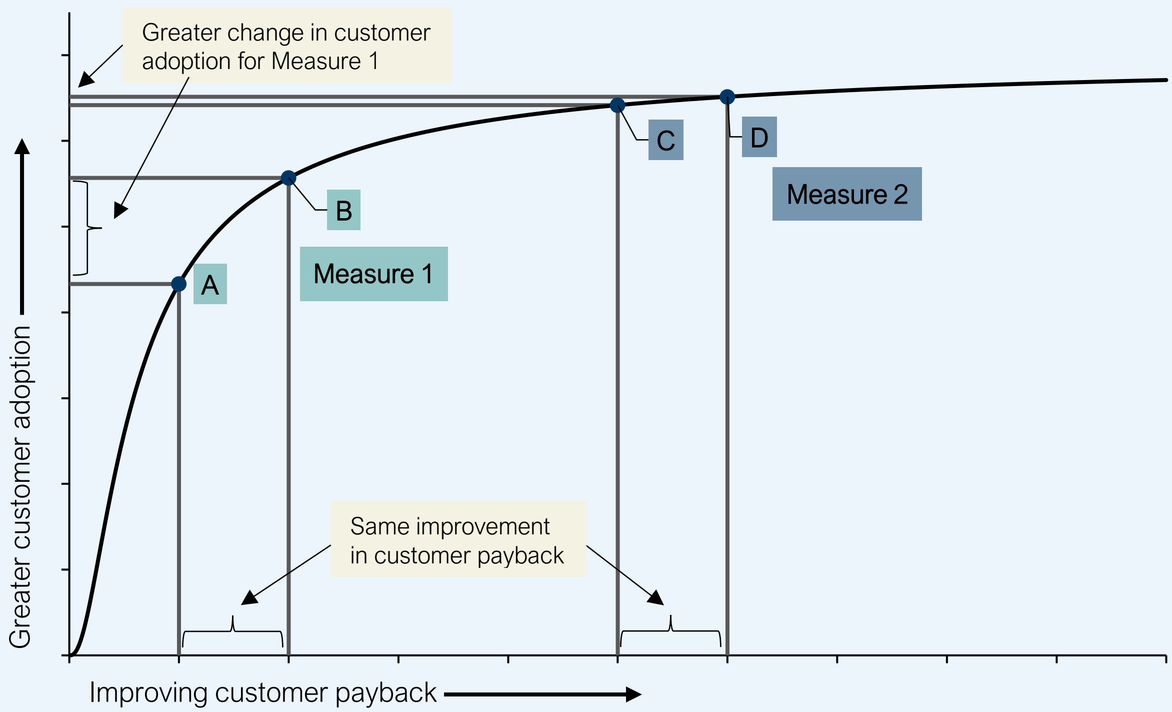
The DEEP model calculates market adoption as a function of customer payback and a technology's underlying market barrier level. Increasing incentives will improve the customer payback, pushing a measure further to the right along the adoption curve. However, because the adoption curve is not linear, the degree of market reaction will depend on where the measure sits on its allocated adoption curve. This means increasing incentives for measures on the lower end of the adoption curve will result in much greater proportional increase in adoption compared to measures at the higher end of the adoption curve.

Figure 2-15 illustrates this effect. In this example, consider two theoretical measures, Measure 1 and Measure 2. Both are offered within the same program and share the same barrier level assignment, meaning they follow the same adoption curve. Due to differences in the relationship between the incremental costs and the energy savings of the two measures, each sits at a different point on the adoption curve. Measure 1 starts at point A, indicating that the customer payback is not sufficient to drive the majority of potential customers to adopt this technology. Measure 2 has a much higher ratio of energy savings to incremental costs, and thus it sits at point C, wherein most customers will likely adopt the efficient option.

[18] While comprehensive, potential studies are high-level in nature and do not account for different equipment between manufacturers. It is possible that the incremental costs of efficiency DMSHPs may vary significantly among manufacturers, and further market research could reveal opportunities to adjust incentive levels in future program designs.

As incentives are increased for both measures, the customer payback is increased, and moving both measures up and to the right along the adoption curve (to Points B and D for Measures 1 and 2, respectively). As can be seen from the figure, this results in a significant increase in adoption for measure 1, which is in the steep part of the adoption curve. However, for Measure 2 the incremental change in adoption is minimal, despite the increased incentives. Ideally, an optimized program design would target Measure 1 for an increased incentive but may not change incentive levels for Measure 2 and would prioritize driving incremental savings from Measure 2 through enabling strategies, marketing, and/or novel delivery pathways rather than through additional incentives.

Figure 2-15. Schematic Example of Adoption Theory



In this study, the impact of this non-linear relationship between incentive costs and savings achievement described above will be particularly pronounced under the Max scenario. Since all measures receive a 100% incentive under the Max scenario, every measure will traverse the higher-end of the adoption curve where incremental increases in incentive payments will induce progressively smaller incremental increases in customer adoption and savings. For this reason, cost estimates under the Max scenario in particular likely significant overstate the cost per unit of savings that could be achieved under an optimized portfolio approach.

2.3.2 Cost-Effectiveness

Table 2-8 presents the PAC ratios at the end of the three-year period (2023) by program and scenario. All programs are cost effective under each of the savings except for the lighting portion of the Instant Energy Savings program. It should be noted, however, that Instant Energy Savings – lighting does pass the TRC test under all scenarios with a benefits/cost ratio of 1.27, which suggests that there may still be a rationale for including residential lighting measures in the portfolio.

Table 2-8. Program PAC Test Benefit-Cost Ratios in 2023 (All Scenarios)

Sector	Program	BAU	Mid	Max
Residential	Energy Efficient Equipment	2.8	2.6	2.6
	Energy Efficient Equipment - Low Income	1.7	1.6	1.2
	Home Insulation Rebates	1.6	1.1	1.3
	Home Insulation Rebates - Low Income	1.2	1.2	1.2
	Instant Energy Savings - lighting	0.5	0.5	0.5
	Instant Energy Savings - other	3.5	1.1	1.0
	New Home Construction	2.7	1.4	1.1
	Winter Warming	2.4	2.4	2.4
	Home energy report	2.4	2.4	2.4
	Appliance recycling	4.1	1.3	1.2
	Home Comfort	1.4	1.4	1.4
Commercial and Industrial	Business Energy Rebates	7.9	2.8	2.1
	Community Energy Solutions	4.7	1.9	1.5

2.4 Sensitivity Analysis

The sensitivity of the efficiency potential results is tested against three key factors as described in Table 2-9. The first sensitivity assesses the impact of investing further in enhanced enabling activities on program savings and costs. The other sensitives explore the impact of economic factors on the achievable potential by assessing the impact of increases or decreases in retail electricity rates and avoided cost forecasts. Each sensitivity is tested against the Mid scenario, but the impacts under the BAU and Max scenarios is expected to be similar in relative magnitude.

Table 2-9. EE Module Sensitivity Descriptions

Sensitivity Scenario	Baseline	Sensitivity
Enabling Activities	Adoption barrier levels are set to reflect current program enabling activities.	For the Mid energy efficiency scenario, barrier levels are reduced by a half step and a full step impacted adoption under enhanced enabling activities.
Retail Rates	Retail electricity rates are forecasted in line with current best information.	Forecasted retail electricity rates are increased/decreased by 10% impacting bill savings associated measures that impact energy consumption.
Avoided Costs	Energy and capacity avoided costs are forecasted in line with current best information.	Forecasted avoided energy costs are increased/decreased by 10% to account for possible new spending or reduced future energy and/or capacity costs.

2.4.1 Enabling Activities

Up to this point, the achievable potential scenarios in this study have explored the impact of increased incentive levels to drive further savings from the efficiency programs. However, efficiencyPEI's programs have been offered for only a few years, and there is an ongoing interest adapt and enhance its program strategies, which suggests that there may be opportunities to incorporate further enabling strategies into the programs to help drive further savings.

Enabling strategies that help overcome participant barriers to participating in efficiency programs include, but are not limited to:

- Direct install programs
- Contractor training and support
- Upstream programs
- Targeted marketing
- Building and home energy labeling requirements
- Financing programs

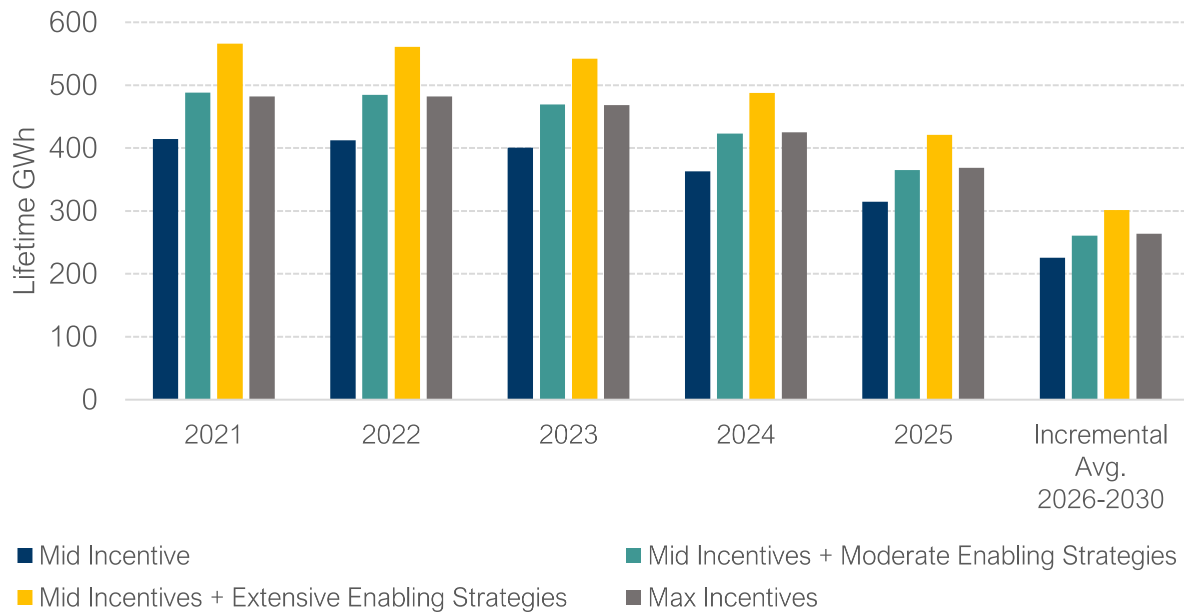
The program scenarios assessed in this study capture the impact of current program strategies applied by efficiencyPEI by calibrating the BAU scenario achievable potentials to current portfolio savings. The potential impact of investing further in enabling strategies is assessed under this sensitivity scenario, using the Mid incentive scenario.

Where possible, barrier level reductions are applied to capture the impact of additional enabling activities not already included incurrent efficiencyPEI programs. While the potential study does not identify the specific enabling strategies engaged or the associated barriers addressed, the results are intended to provide a quantitative assessment of additional savings that can be unlocked through enabling strategies.

Two sensitivities were tested, 1) moderate enabling strategies – represented by a half step barrier reduction, and 2) extensive enabling strategies – represented by a full step barrier level reduction.[19] In terms of the cost of the enabling strategies sensitivities, for the moderate enabling strategies variable program administration costs were increased by 25% and fixed costs by 15%. For the extensive enabling strategies scenario, variable program administration costs were increased by an additional 5% and fixed costs by an additional 10%.[20] More detail on program characterization and enabling activities can be found in Appendix C.

The addition of enabling strategies further drives achievable scenarios, with the half step reduction in barriers increases the Mid scenario to be nearly equivalent to the savings achieved under the Max Incentive scenario (i.e., 2.2% of sales over the first three-year period). The full step reduction in barriers brings the Mid scenario above the Max, and translates into approximately 2.5% of sales, on average, over the first three years.

Figure 2-16. Incremental Lifetime Savings Compared to Baseline Mid and Max Incentive Scenarios



As shown in Table 2-10, the $ per annual kWh saved is higher in the sensitivities compared to the Mid Incentive scenario, but lower than the Max Incentive scenario. By increasing the enabling activities and reducing barriers by a half step, PEI can access more savings at lower cost – i.e., achieve just over the Max scenario but with $1.9M less investment. Increasing enabling activities further and reducing barriers by a full step surpasses the Max scenario in terms of savings as well as budget. While the marginal costs

[19] A half step barrier reduction reflects a move to a higher adoption curve and thus assumed level of participant uptake. This would be a notable investment in enabling strategies, and a full step – moving to an even higher adoption curve – would represent a reasonable limit of what could be achieved by applying a full range of enabling strategies. See Appendix A for additional details. ePEI's programs are relatively new and therefore it is reasonable to assume that additional enabling activated can be leveraged. As noted above, the assessment does not consider specific enabling activities, but these may include direct install programs, contractor training and support and/or the others listed on the previous page.

[20] The full step reduction requires a highly targeted approach, including working more closely with the industry conducting the retrofits. In this case there is a stronger link to volume as opposed to setting things up (i.e., general marketing, structure for a trade ally network, etc.) and thus variable costs increase more than fixed.

for the Mid Incentive + Extensive Enabling Strategies are lower, because the scenario is achieving that much more savings the resulting budget is higher than the incentive-only scenario.

Table 2-10. Average Annual Investment, Average Annual Savings, and Cost per First Year Savings under the Achievable Scenarios and Sensitivities (2021-2023)

Scenario	Average Annual Cost ($Million)	Average Annual Savings (GWh)	Average Annual Cost per Savings ($ per annual GWh)
BAU	5.9	15.9	0.37
Mid	17.7	29.3	0.60
Mid + Enabling (half step)	21.9	34.1	0.64
Mid + Enabling (full step)	26.5	39.2	0.68
Max	23.8	33.5	0.71

2.4.2 Electric Rates & Avoided Costs

In theory higher electricity rates will drive greater participation in efficiency programs, while lower electricity rates should reduce participation. This change is participation is driven entirely by the change in the financial attractiveness of efficiency measures for customers due to more (or less) expensive retail electricity rates. The change in retail rates impacts bill savings and the cost-effectiveness test used to calculate adoption.

Higher avoided costs will also lead to greater achievable potential as energy savings become more cost-effective, increasing benefits, and therefore resulting in more measures passing the cost-effectiveness test screen. Conversely, lower avoided costs will likely screen out more measures, thus reducing potential participation and savings. However, since almost all measure pass the PAC test and the +/-10% adjustment will only impact a limited number of measures, the impact from the avoided cost sensitivity should be less pronounced than that of changes to rates.

Figure 2-17 shows the change in *average lifetime electric savings* (2021-2023) relative to the Mid scenario baseline savings value (409 GWh) under the rate and avoided cost sensitivity scenarios. Reducing electricity rates by 10% resulted in a reduction in savings of 12 GWh while a 10% increase in rates increased savings by 11 GWh. The avoided cost sensitivity had less of an impact; 3 GWh fewer savings under lower avoided costs, although a comparatively larger impact – 8 GWh more savings – when avoided costs are raised by 10%.

Figure 2-17. Impact of Electric Rate and Avoided Cost Sensitivities on Average Incremental Lifetime Savings Compared to Baseline (2021-2023; Mid Scenario; GWh)

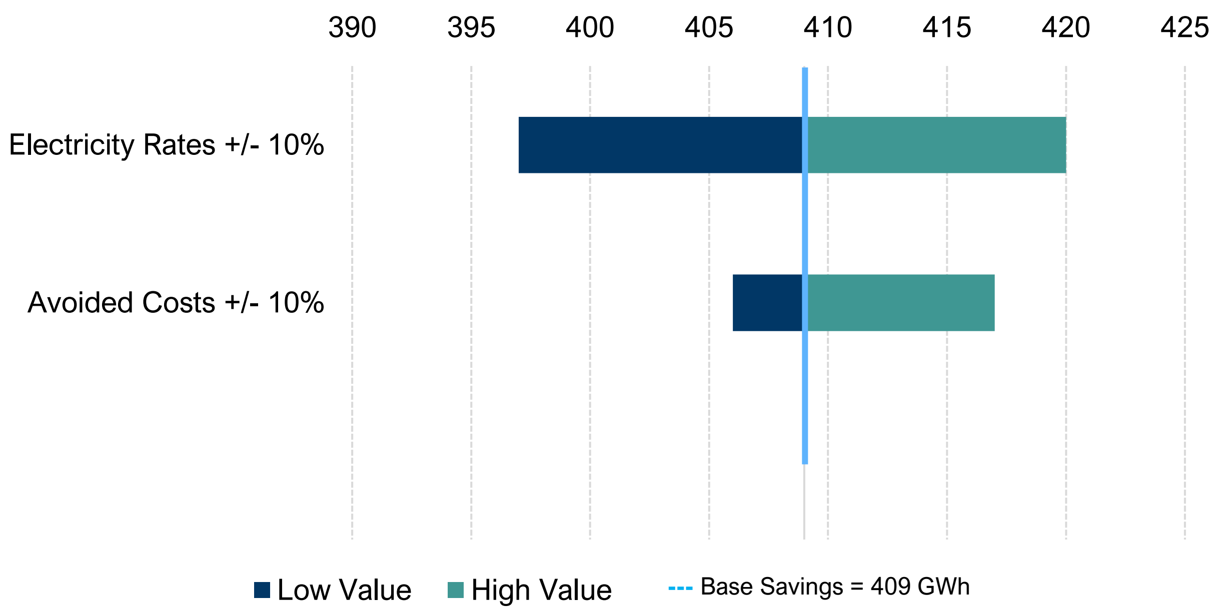


Figure 2-18 shows the impact on *average annual savings* (2021-2023) relative to the Mid scenario baseline. Each figure includes the impact from a 10% increase or decrease in rates as well as a 10% increase or decrease in avoided costs. The Mid scenario base savings level (GWh) is included as a reference point. The results follow a similar trend to the lifetime savings impacts above.

Figure 2-18. Impact of Electric Rate and Avoided Cost Sensitivities on Average Incremental Annual Savings Compared to Baseline (2021-2023; Mid Scenario; GWh)

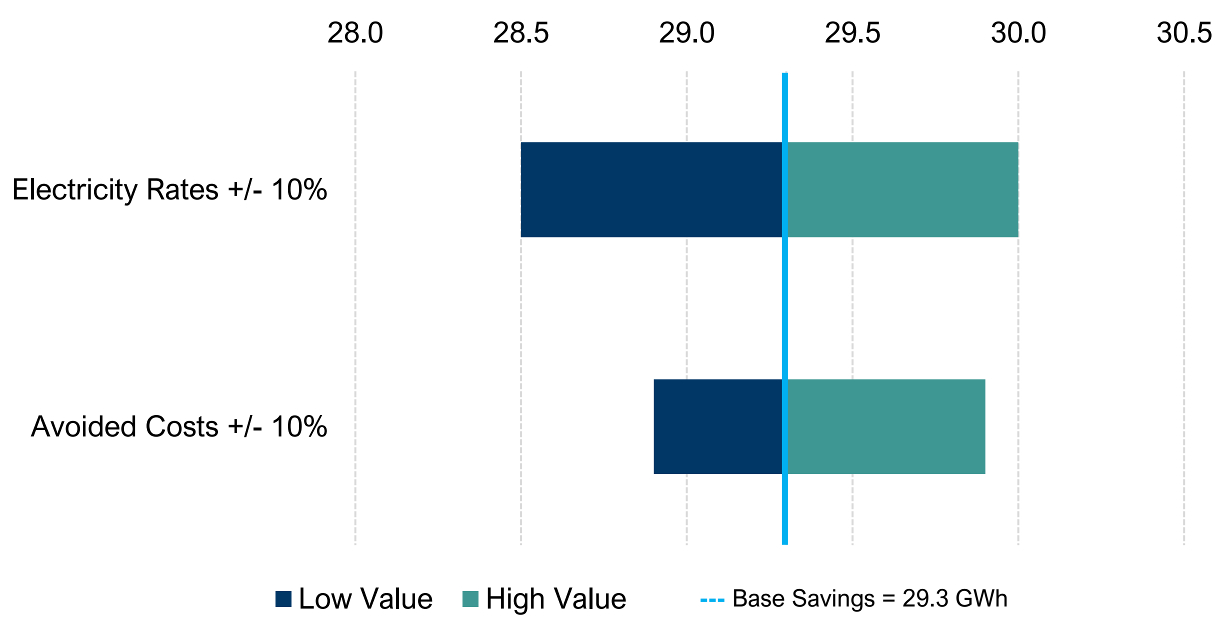


Table 2-11 includes the values for average annual lifetime and annual savings (2021-2023) under the rate and avoided cost sensitivities as well as the percent difference relative to the Mid scenario.

Table 2-11. Impact on Average Lifetime and Annual Savings (2021-2023) in Mid Scenario under +/- 10% Rate and Avoided Costs Sensitivities

	Average Lifetime Savings, 2021-2023 (GWh)				Average Annual Savings, 2021-2023 (GWh)		
	Mid	Low Value (-10%)	High Value (+10%)		Mid	Low Value (-10%)	High Value (+10%)
Electricity Rates Sensitivity	409	397	420		29.3	28.5	30.0
% Difference	--	-3%	+3%		--	-3%	+2%
Avoided Costs Sensitivity	409	406	417		29.3	28.9	29.9
% Difference	--	-0.7%	+2.0%		--	-1.4%	+2.0%

The results indicate that increasing or decreasing electricity rates or avoided costs does lead to the expected increase or decrease in electricity savings, program costs, and customer benefits. Changing customer rates has a larger impact as the economics become more or less favourable for potential participants and impact adoption. Avoided costs have less of an impact, especially since most of the measures included in the model are likely to already be cost effective. The results indicate that a limited number of measures are on the margin (i.e., have benefits costs ratios around 0.90 to 0.99).

2.5 Agricultural Sector Savings

Representing approximately 43% of the Prince Edwards Island's land-use, the agricultural sector is an integral part of PEI's economy and many Islanders' livelihoods. The size and nature of the industry also makes it a significant consumer of energy. Energy is consumed in every stage of agricultural production: from lighting greenhouses to running tractors to heating and cooling buildings.

Reducing the amount of energy consumed by the sector can reduce operating costs, increase local profits, and reduce greenhouse gas emissions. This can be accomplished by increasing the adoption of energy-efficient equipment upgrades (e.g., motors, pumping, and HVAC system). Yet despite the potential benefits, the agricultural sector is often subject to substantial market barriers to energy efficiency and as a result this sector is typically underserved by efficiency programs. These include a lack of awareness of energy-efficient technology, underestimating equipment lifetime energy costs, and limited access to the capital needed to implement efficiency upgrades.

While it was beyond the scope of this Potential Study to perform a detailed bottom-up assessment of energy efficiency measures on PEI's agricultural sector, this assessment shows that this sector offers significant potential for efficiency program savings. This chapter is intended to offer initial insights that can be leverage for future work by efficiencyPEI and others, including in the design of comprehensive energy efficiency programs for farms of all sizes and configurations.

A high-level review of energy efficiency measures in the agricultural sector is provided based on a literature review of leading agricultural efficiency programs in other jurisdictions. Moreover, a comparison of the achievable savings assessed in this study, where the Industrial and Agricultural sectors were modelled together as a single market segment, are compared to results from potential assessments that included a dedicate agricultural segment in the analysis. This is intended to give a directional indication of whether the combined Industrial/Agriculture segment savings provide valid savings targets for PEI's agricultural sector.

2.5.1 Limitations to the Agricultural Sector Assessment

There are several important limitations that impacted our ability to assess the potential in the agricultural sector:

1. No baseline study was performed for the agricultural sector, and efficiencyPEI does not currently have energy savings characterizations for agricultural measures.

2. There is a limited amount of background research available on energy efficiency in the agricultural sector compared to other sectors. Therefore, it was necessary to use findings from other jurisdictions, some of which exhibit notably different markets and climates from that of PEI (e.g., California).

3. The potential study is covers electric savings measures only, and while some measures may also provide fossil fuel savings these impacts are not captured here.

As a result, the bottom-up potential assessment detailed in this report, modeled the Industrial and Agricultural sectors as a combined market, and hence it was not possible to differentiate the specific savings attributable to the agricultural sector electric customers in the DEEP model.

2.5.2 Agricultural Market Characterization

The PEI agricultural sector is large, diverse and consists of many different agricultural products, including potatoes, grains and oilseeds, fruits and honeybees, and vegetables. The sector utilized close to 595,000 acres of land and contributed ~ $278.1 million dollars to the Island GDP in 2019.[21, 22] As a percentage of sales, potatoes make up the majority of crop sales (75%), and a significant amount of total agricultural sales (49%).[23] Therefore, special attention should be given to this crop when performing energy efficiency potential modeling and program design in the agricultural sector.

It is also worth noting that under Maritime Electric's current rate structure the majority of farms – regardless of size – are classified as residential customers. The Island Regulatory and Appeals has requested that Maritime Electric revisit this classification, which will mean many if not most farms will fall under a commercial tariff in the near future.

To best understand the agricultural sector's potential energy efficiency savings, we first split PEI's agricultural sector into segments and end-uses. Energy efficiency measures and programs are often designed to specific segments and end-uses, which will allow for more efficient program delivery and evaluation. See Table 2-12 below for a list of segments and typical agricultural products in those segments. These can be applied in future program designs to target agricultural measures and programs.

Table 2-12. PEI Agriculture Segments and Products by Segment

Segments	PEI Products in Segment
Dairy and Livestock	Poultry, Hogs, Beef and Dairy
Greenhouses	Vegetables, Fruits
Farm Crops	Potatoes[24], Grains and Oilseeds, Fruit Production and Honeybees, Vegetables

2.5.3 Specialized Agricultural Saving Measures

The agricultural sector applies a range of specialized equipment, much of which offers unique energy savings opportunities for Agricultural Sector focussed efficiency programs. Table 2-13, below, outlines the specific measures identified that may apply to PEI's key agricultural market segments and end-uses.

Many of these overlap with the standard efficiency measures applied in the DEEP model assessment of the combined Industrial/Agricultural segment, but further refinement of these measures to the specific characteristics and usage paters for agricultural applications may reveal further savings in agricultural programs.

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21 https://www.princeedwardisland.ca/en/publication/annual-statistical-review
22 https://www.princeedwardisland.ca/sites/default/files/publications/af_stat_tab4.pdf. Note GDP in chained 2012 dollars.
23 https://www.princeedwardisland.ca/sites/default/files/publications/af_stat_tab4.pdf
24 While this list aggregates all farm crops together, due to its size, the potato segment might justify its own segment due to the importance of the product on the market.

Table 2-13. Suggested End-Uses and Technologies[25]

End-Use	Technology Category	Example Technologies / Behaviors
Lighting	High-Efficiency LEDs and HPS Upgrades	• Indoor and Linear Fixtures • Specialty Lamps • Exterior Bulbs • Single-ended HPS to double-ended HPS or single metal halide
	Lighting Controls	• Occupancy Sensors • Daytime Controls • Sunlight Optimization
Motor / Drives	Pumps	• Pump Retrofits • VFDs • High to Low-Pressure Irrigation • Pump Scheduling/Controls
	Air Compressors	• Leak repair • Controls • VFDs • Operation and Maintenance
	Other Motors	• Other Motor Upgrades / VFDs • Waterer Upgrades
HVAC and Water Heating	Ventilation System Upgrades	• High-Speed Fans • Circulation Fans • Exhaust Fans • Variable Speed Drive Fans • High Volume; Low-Speed Fans • Optimized Fan Placement
	Electric Water Heating	• Water Heater Maintenance • Efficient Hot Water Heaters Upgrades • Heat Recovery Unit
	HVAC	• Optimization and Maintenance • Replacing or Adding Insulation Air Sealing • Night Curtains (Green Houses) • Electronic Thermostats / Humidity Controls • Plant Trees (West or Southwest planting for Greenhouses) • Natural Ventilation Systems (Greenhouses) • Combined Heat & Power (CHP) Systems
	Other	• Block Heater Timers
Process Heating and Refrigeration	Process Heating	• Process Controls • Efficient Drying • Heat Recovery Units • Natural Drying
	Process Refrigeration	• Efficient Milk Cooling/Harvesting: (e.g., Plate Heat Exchanger; Well Water Pre-Cooler; Scroll Compressors; Heat Recovery Units) • Cold Water Pre-Cooling • Refrigeration Maintenance/Tune-Up
	Cold Storage Improvements	• Floating Head Pressure Controls • Evaporator Fan Controls • Evaporator Fan Economizers

[25] This list was vetted and adapted with expert advice given by the EnSave. They provided details to supplement available information found via published secondary sources.

It is important to note that the savings will vary by measure, and that some measures are segment-specific (such as livestock waterers or night curtains) while others have broad applicability throughout all segments (e.g., pumps). It is expected that a few measures will offer particularly importance savings, including VFDs for motors, variable speed fans for drying and air circulation, and block heat timers for tractors and other farm machinery. As noted above, a more detailed review of these measures and the market is needed to enable program design or bottom-up energy efficiency potential modelling.

2.5.4 Benchmarking Agriculture Sector Savings

Table 2-14 below compares the average annual achievable savings from the Industrial/Agricultural segment in the PEI potential study to the achievable savings in agriculture segments in other potential studies. These are compared on the basis of annual savings as a portion of annual consumption in the sector.

Table 2-14. Jurisdictional Scan of Potential Savings

Jurisdiction	Period	Average Annual Savings (GWh/year)	Annual Savings as % of Electricity Consumption in Sector
PEI: Combined Industrial/Agriculture	2021-2023	2.4 – 7.4	0.72% - 2.23%
Iowa	2018-2037	15.0	3.4%
Wisconsin	2019-2030	19.3	0.78% - 1.28%
Ontario	2019-2023	22.5	0.5% - 0.78%

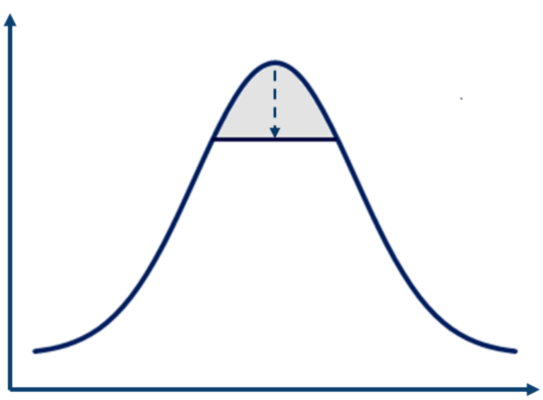
This assessment shows that the notable efficiency potential on PEI's Industrial/Agricultural sector is aligned with savings assessed in other jurisdictions, and therefore may offer a reasonable range for setting targets for future Agricultural electric efficiency programs on PEI. To design an effective agricultural sector program, further research may be of benefit, including further market research, characterizing specialized measure savings and costs for agricultural applications, and developing enabling strategies that target the specific barriers faced in the agricultural sector.

3 Demand Response

The following chapter presents results for the demand response (DR) module of the Potential Study. The active peak demand reduction potential, herein referred to as DR potential, is assessed by analyzing the ability of behavioral measures, equipment controls and industrial and commercial curtailment to reduce the system-wide annual peak demand.[26] A dynamic rate-specific scenario is also included to assess the impact of Time-of-Use (TOU) rates that would be enabled by the possible roll out of advanced metering functionality (AMF) beginning in 2025.

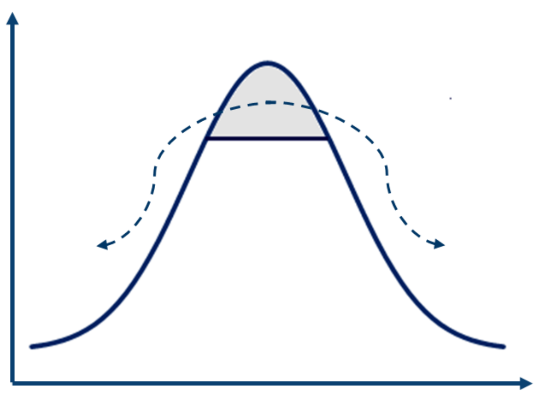
Annual DR potential is modelled over the study period (2021-2030), and the results represent a **net impact** considering all measure interactions with the hourly load curve. The most cost-effective measures are given priority ranking in the DR measure "queue." Once a cost-effective measure is selected by the model, all associated potential for that measure is incorporated before moving on to the next most cost-effective measure. This continues until the DR window peaks cannot be further reduced or shifted without creating new peaks elsewhere on the curve. This has the effect of crowding out some DR measures that are less cost-effective. As we will discuss in the results section, the shape of a jurisdictions' curve has an important impact on the measures pursued and how much DR potential can be captured.

Depending on the demand reduction goal, program design, and technologies used, demand response can have a varying impact on load. In this study we consider measures that either **reduce peak** or **shift consumption** from the peak period to off-peak hours, as outlined in the visual, below.



Peak Reduction

- Reduce system peak with no bounce back
- Measures include dual fuel systems, emergency generators, curtailment (e.g. interruption of processes)



Peak Shifting

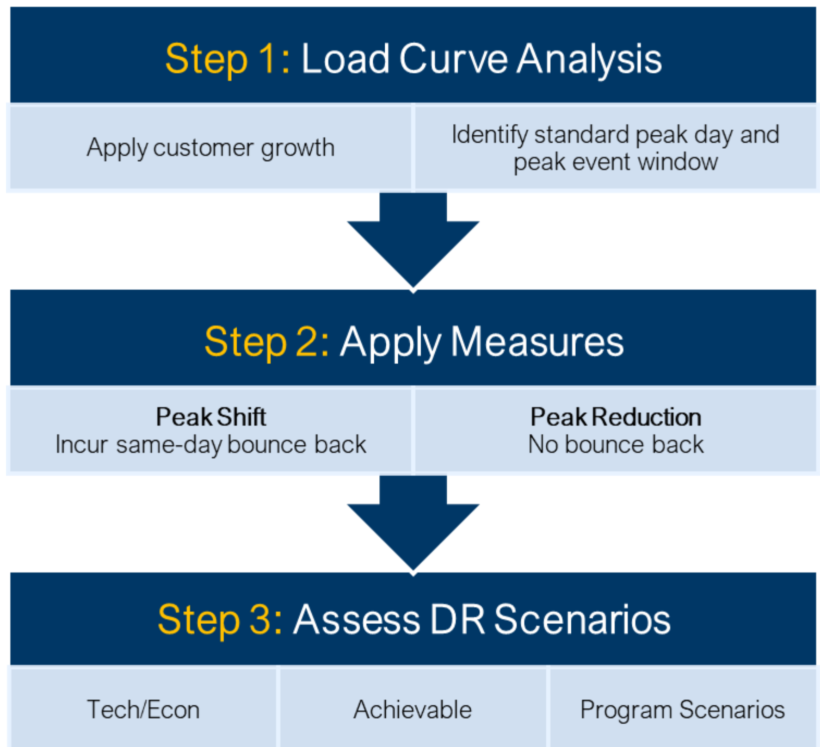
- Shifting load from on-peak to off-peak periods; overall consumptions stays ~ the same
- Measures such as direct load control Wi-Fi thermostats (to preheat with system compensating when event is over)

[26] In all cases in this report, the annual peak demand refers to the hour in the year that exhibits the highest system peak demand in MW. It is assessed on a system-wide basis, not accounting for local constraints across the transmission and distribution system.

3.1 Approach

We applied Dunsky Demand Reduction Optimized Potential (DROP) model to assess the DR potential on PEI. Figure 3-1 provides an overview of the steps applied in this study.

Figure 3-1. Demand Response Potential Assessment Approach



Step one in the DR potential analysis is to define the standard peak day load curve and apply the impacts of load growth projections. The standard peak day curve is based on Maritime Electric's historic system hourly (8,760) load curve and annual peak demand.[27] Establishing a standard peak day curve allows the model to assess each measure's net reduction in the annual peak, considering that the new annual peak may occur on a different day or hour than the initial peak due to the way that DR measures alter the utility load curve.

In some cases, this may lead to results that are contrary to initial expectations, especially when DR programs such as dynamic rates or equipment direct load control (DLC) measures are looked at only from the perspective of how they may impact individual customer peak loads at the originally identified peak hour. A more detailed description of the DR modeling approach applied in this study can be found in Appendix C.

The standard peak day utility load curve is then used to characterize measures and assess the measure-specific peak demand reduction potentials at the technical and economic potential levels. This includes applying **peak shift** (or Type 1) measures such as direct load control water heaters to baseline use and defining the control schemes and adjusted load curves. This also includes applying **peak reduction** (or Type 2) measures such as C&I curtailment wherein curtailable loads are identified and constraints (e.g., number of events per year, event duration) are applied. The optimizer function then determines the overall net impact on annual peak demand.

The final step in the process is to assess the DR scenarios. Similar to energy efficiency, we consider the technical, economic, achievable potential and achievable potential under specific program scenarios. The box on the following page provides a description of each type of potential.

[27] Maritime Electric's 8760 load curve from 2019 was scaled by 10% to include Summerside Electric's service territory.

Technical, Economic, and Achievable DR Potential

Technical potential is estimated as the total possible coincident peak load reduction for each individual measure multiplied by the saturation of the measure or opportunity in each market segment.

Economic potential is estimated as the net demand reduction possible from each individual measure when assessed against the utility load curve. It accounts for the difference between the utility peak load before and after the measure is applied, when examining the 24-hour peak day curve and the 8,760 annual hourly curve accounting for individual measure bounce-back impacts or peak time shift impacts.

Depending on the shape of the peak day curve these impacts may create new peaks. For example, a load curve with a relatively high/distinct peak over a few hours (a) offers more opportunity to reduce and shift load without creating a new peak whereas a flatter curve (b) requires targeted measures and can limit DR potential.

(a)

The measures are then screened against the PAC Test, and only those that pass the threshold are retained for inclusion in the achievable potential scenarios. [28]

Achievable potential is assessed under three scenarios by applying mixes of all cost-effective measures and programs, giving priority to the most cost-effective measures first. For each year, the DR potential is assessed accounting for existing programs from previous years, as well as new measures or programs starting in that year. Unlike many efficiency measures, the DR peak savings only persist as long as the program is active. For new and expanded programs, ramp-up factors were applied to account for the time required to recruit participants.

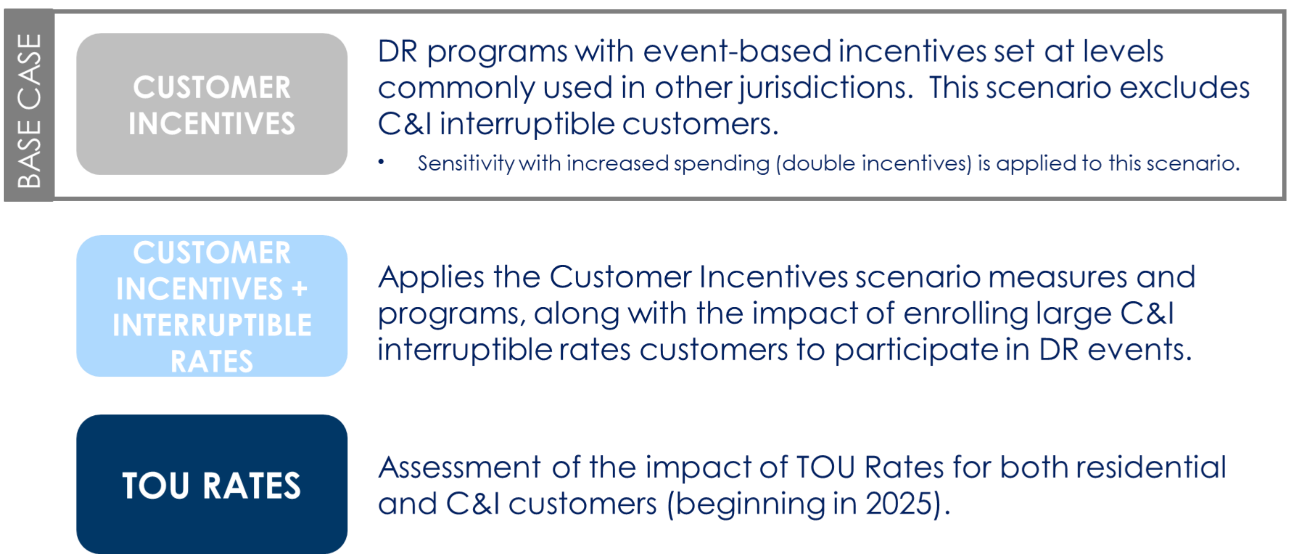
Because DR measures interact via their effects on the utility load curve, technical and economic DR potentials are not considered to be additive and are therefore not presented in aggregate in this report. To ensure that the combined achievable potential results were truly additive in their ability to reduce annual peak loads, combinations of programs were assessed against the hourly load curve to capture inter-program interactions that could affect the net impact of each program. Further details of this approach are provided in Appendix C.

[28] For energy efficiency the benefit-cost threshold was set below 1.0 (at 0.8) for low-income programs which is supported by the fact that energy efficiency offers direct customer benefit which LI customer should have access to even though these programs are typically more expense. For DR, there is less direct customer benefit – although all ratepayers benefit from reduced system costs – and thus the same justification for reducing the LI threshold for DR is not supported.

3.1.1 Achievable Scenarios

The achievable potential is assessed under three scenarios corresponding to varied DR approaches or strategies as outlined below. The scenarios in this study include: 1) Customer Incentives, 2) Customer Incentives + Interruptible Rates, and 3) Time of Use (TOU) Rates. Figure 3-2 provides an overview of each achievable scenario and further details on the specific programs and the related inputs for each scenario are provided in Appendix C.

Figure 3-2. Demand Response Program Scenario Descriptions

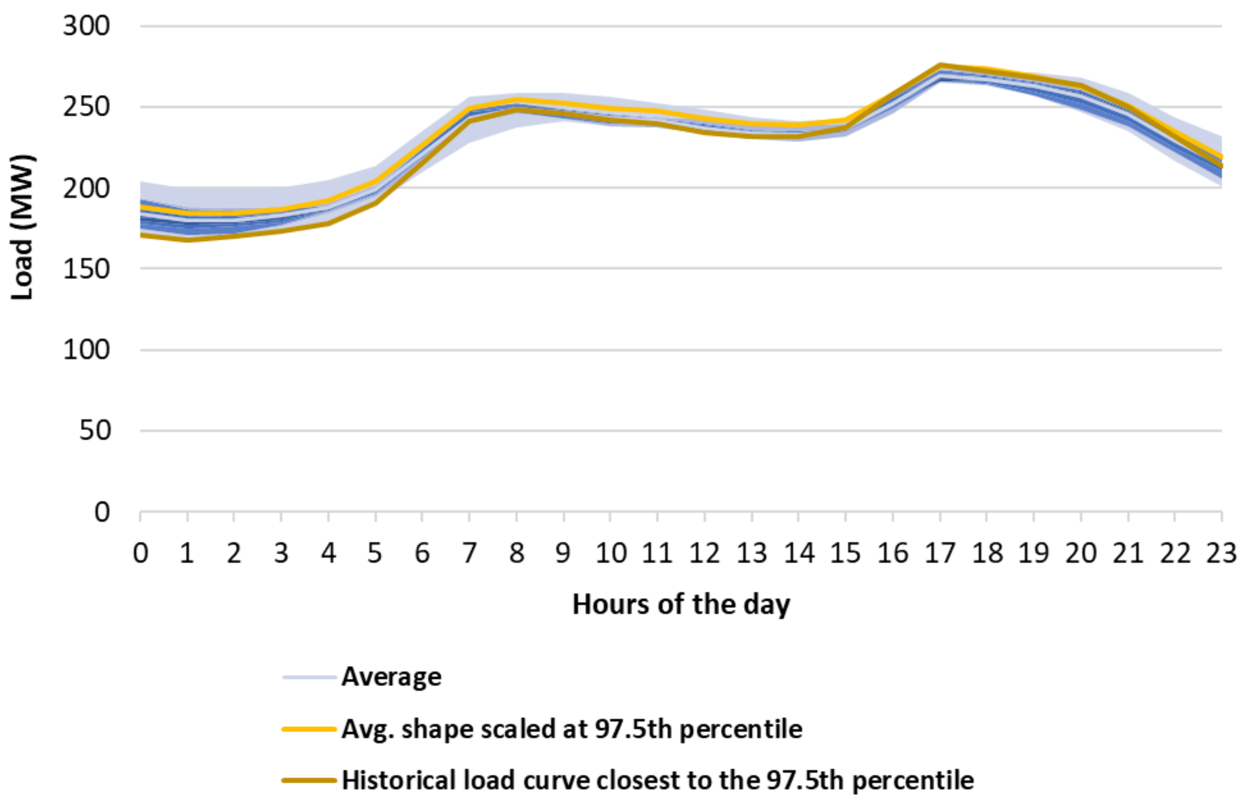


3.1.2 Load Curve Analysis

The standard peak day load curve for the electric system is defined by taking an average of the load shape from each of the top ten peak days in the historical hourly load data provided (Figure 3-3).[29] The average shape of the peak day is scaled to align with the 97.5th percentile peak to generate a standard peak day load shape for the PEI system.

[29] For this study, one year of historical data, from 2019, was used to establish the standard peak day load curve.

Figure 3-3. Standard Peak Day Load Shape with Percentile Distribution



The shape of the peak day is then maintained over the study period, but the curve is projected forward such that the daily peak is equal to the Island's forecasted annual peak in each of the study years (2021-2030), resulting in the peak load listed in Table 3-1 below.

Table 3-1. Peak load forecast for PEI (2021-2030)[30]

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Demand (MW)	286	294	300	307	313	320	327	334	341	348

The analysis finds that **PEI's system has a relatively flat load curve with an evening peak as well as a second peak in the morning**, which is not uncommon in winter-peaking jurisdictions with a significant penetration of electric heating. The duration and steepness of the peak curve indicate that measures with significant bounce-back or pre-charge effects close to the peak will likely have limited potential to reduce the annual peak as they risk creating new peaks by shifting load from one hour to another. In addition, the shape of

[30] The peak demand forecasted is based on the load forecast in the 2016/17 PEI Energy Strategy. It was then compared to Maritime Electric's 2020 Integrated System Plan and is in-line with that forecast through 2025. It is important to note that the forecast does not include energy efficiency savings from efficiencyPEI's 2018/19 or 2019/20 programs or future years, which are estimated to contribute 10 MW of savings by 2025. But while the demand forecast used in this study is higher than the ISP + DSM forecast in early years, the two essentially align when the ISP + DSM forecast is projected out from 2025 to 2030. It should also be noted that it is unclear to what extent heat pump and EV adoption is incorporated into the ISP forecasts.

PEI's peak day load curve suggests that targeting DR measures that can be used to address an evening and/or morning peak would be beneficial for the province.

It should also be noted that increasing penetration of electric space heating in general, heat pumps and electric vehicles will have an impact on the system peak load and shape. The trend on PEI toward increasing dependence on electricity for space heating could have the effect of increasing system peaks, which may increase the opportunity for, and value of, DR. Heat pumps alone introduce the potential to shift from an evening to morning peak, which has been seen in other jurisdictions. With respect to electric vehicles, we would expect adoption to be driven by passenger vehicles over the study period. This will have an impact on morning and evening peak with a greater emphasis on the evening; however, there is also an opportunity for load control and shifting for EVs

While not part of this assessment, heat pump and EV forecast studies would provide additional insights into how the timing of the peak may shift (more likely towards the end of the study period and onward) as a result of increased adoption.

3.2 Achievable Potential Results

The DR potential study provides numerous insights which can be used to inform DR program design on PEI. This section presents overall and scenario-by-scenario results for each achievable potential scenario. Key takeaways from the analysis are also included below.

Overall, the results indicate there is significant DR potential on Prince Edward Island. By 2030, the total achievable savings range from 10.7 MW (TOU Rate) to 31 MW (Customer Incentives + Interruptible Rate), which is approximately 3.1% to 8.8% of the forecasted system peak in 2030 (see Table 3-2, below).

Table 3-2. Customer Incentives scenario compared to the Customer Incentives + Interruptible Rate and TOU Rates scenarios

Scenarios	Customer Incentives Scenario	Customer Incentives + Interruptible Rate Scenario	TOU Rate Scenario
Achievable Potential (MW)	21	31	10.7
% of System Peak in 2030	5.9%	8.8%	3.1%

The C&I sector, in particular large interruptible customers, could represent a significant opportunity as shown by the Customer Incentives + Interruptible Rate scenario in Figure 3-4. In the absence of interruptible customers, residential measures become more prominent and take a larger share of the cost-effective DR savings potential under the Customer Incentives scenario and the TOU Rate scenario.

Figure 3-4. Demand Response Achievable Potential[31]

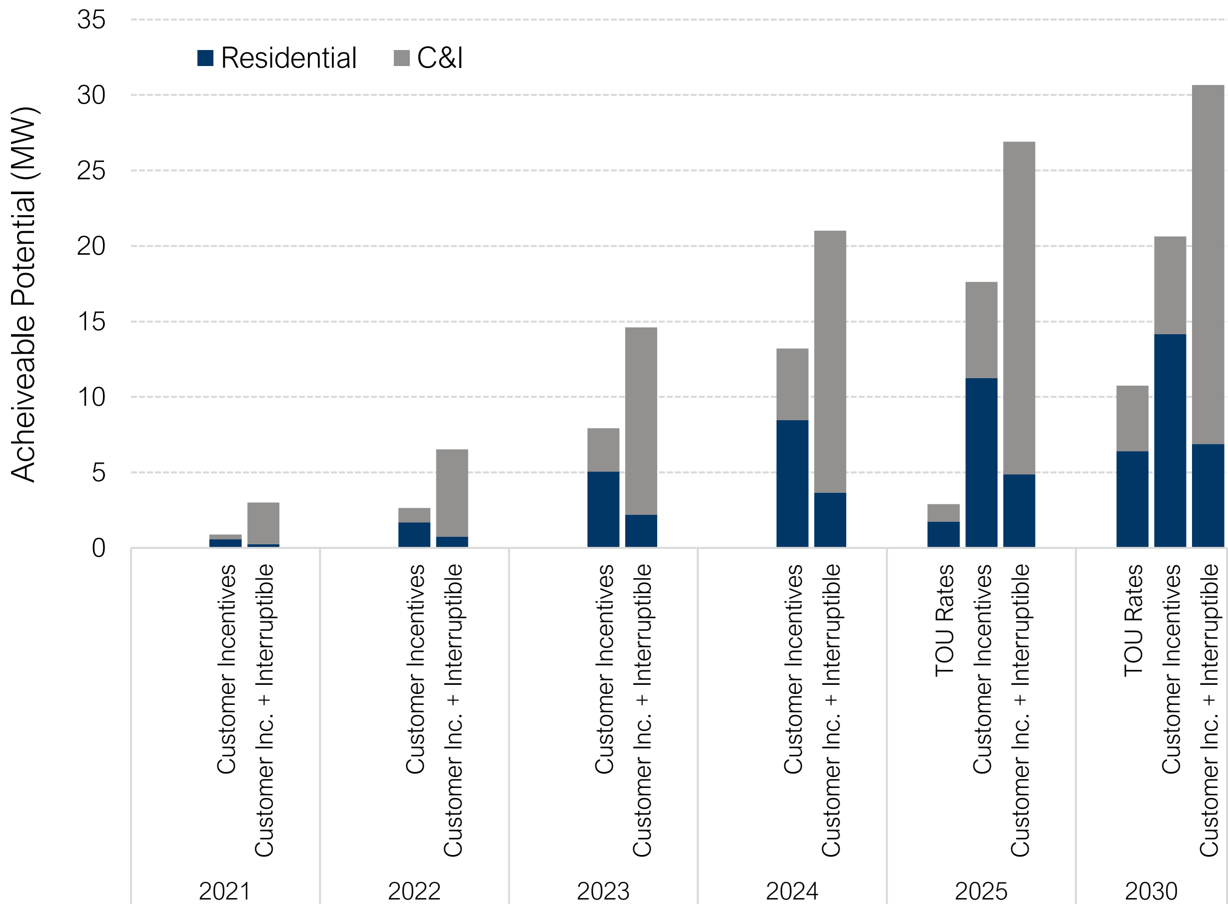


Figure 3-5, below, provides the program costs for each scenario, broken down between upfront costs and annual running costs. Upfront costs (dark blue bars) include customer enrollment incentives as well as controls and equipment installation costs. Annual costs (light blue bars) include annual incentive to maintain participation as well as recurring program administration costs.

In both the Customer Incentives and Customer Incentives + Interruptible Rate scenarios, the results show significant up-front costs in the initial years (~$2M to $4.5M). In these scenarios, **we assume all new programs are deployed,**[32] which involves enrolling new customers in the programs and putting in-place new equipment and control systems. These initial investments are followed by greater emphasis in the later years on incentives to maintain participation in the programs. To note, for the TOU Rate

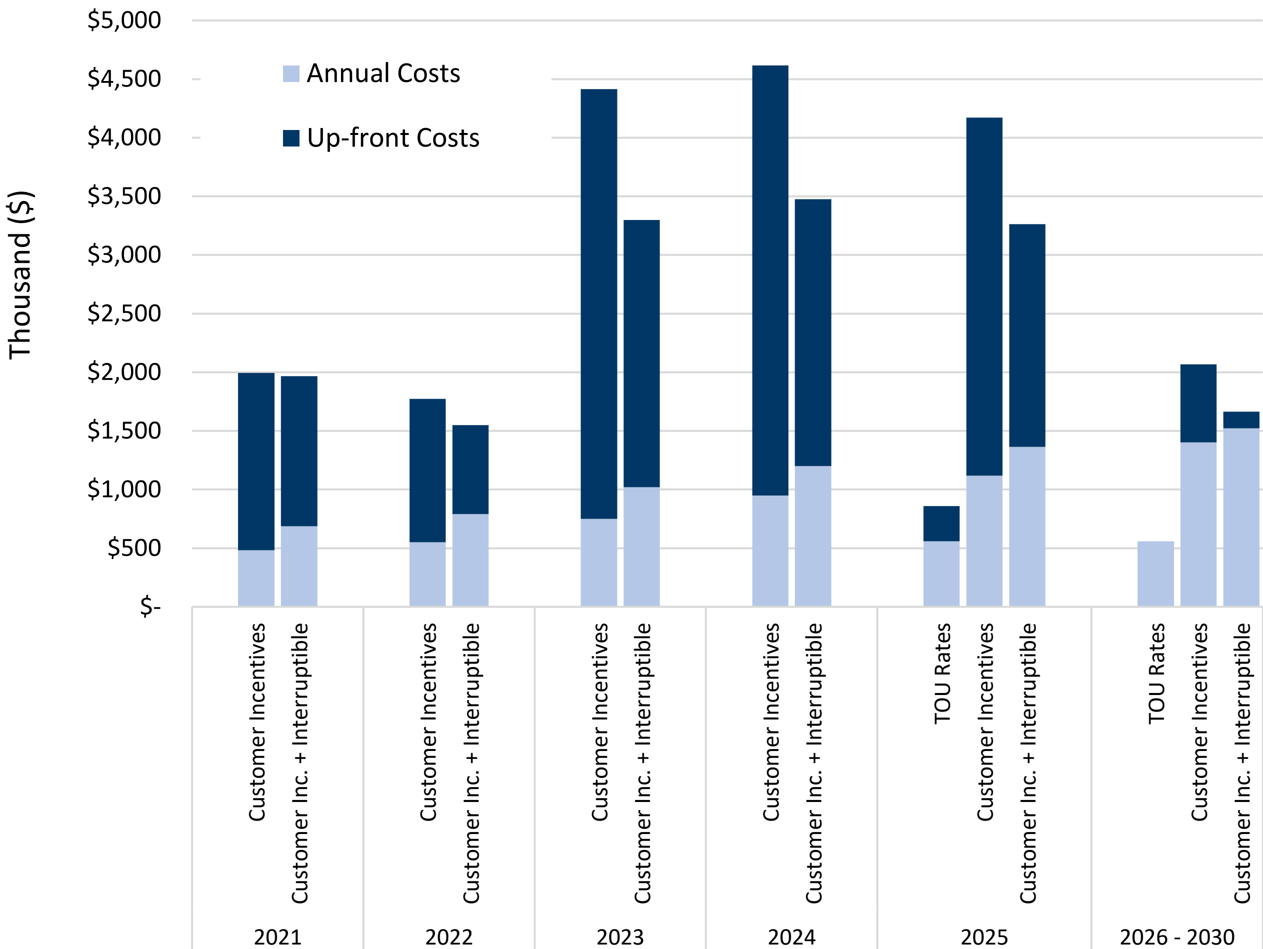
[31] The total achievable potential in each year for each scenario reflects the overall peak load reduction potential when all the constituent programs are assessed together against the utility load curve, accounting for the combined interactions among programs, and reasonable ramp-up schedules for new measures and programs.

[32] While this is the underlying modeling assumption, our analysis and discussion in the following sections suggest that PEI has an opportunity to focus its efforts on a few impactful measures. Program design optimization can help reduce actual program costs.

scenario, the costs only include those that are incremental to the AMI investment. It is assumed that the rates will be designed to achieve revenue neutral benefits.

It is important to note that while the DR programs require significant up-front costs in early years of the programs, the demand savings persist for on average nine years (with annual incentives to help maintain participation levels). Thus, investments made within the study period (e.g., 2025 or 2030) will continue to provide load reduction savings and system benefits into the future.

Figure 3-5. Demand Response Program Costs



Under all scenarios the benefits of the DR programs outweigh the costs at the portfolio level. The Program Administrator Cost (PAC) Test was applied to assess cost-effectiveness a benefit-cost ratio of 1.0 as the cut-off threshold for all measures and assuming a 9-year program life. Table 3-3 below provides the cumulative average cost-effectiveness results for each scenario, accounting for the costs and benefits for newly added demand reduction program capacity between 2021 and 2030.

Table 3-3. Demand Response PAC Test Results

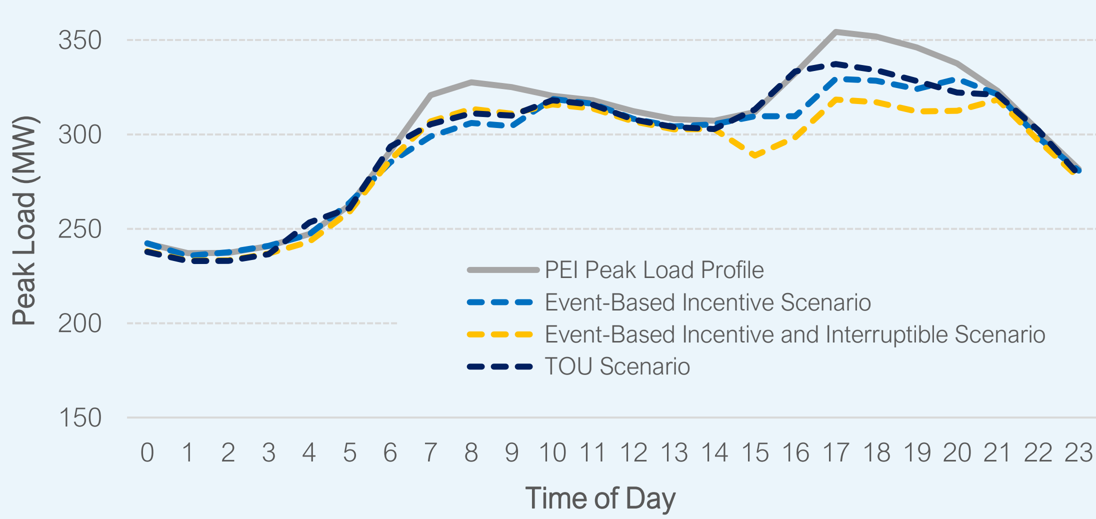
Scenario	
Customer Incentives	1.3
Customer Incentives + Interruptible Rate	1.8
TOU Rates	8.7

PEI's Flat Load Curve is the Primary Constraint

The analysis reveals that the shape of PEI's current load curve is the limiting factor in terms of the overall DR potential. In other words, DR potential is not constrained by cost-effectiveness or customer participation in DR programs, but a relatively flat load profile which limits the potential by creating a new peak outside the targeted peak hour.

Figure 3-6 demonstrates this phenomenon, by providing the resulting utility load profiles under the each of the three achievable scenarios. The varying load curve shapes result from the measure mix in each scenario. In each case, the programs are successful in decreasing demand at the peak hours, but peaks emerge at new times which become the limiting factor. A more detailed optimization and program design may be able to somewhat further reduce load at the new peak hours, but that level of analysis was beyond the scope of this study.

Figure 3-6. Peak Load Profile (2030)

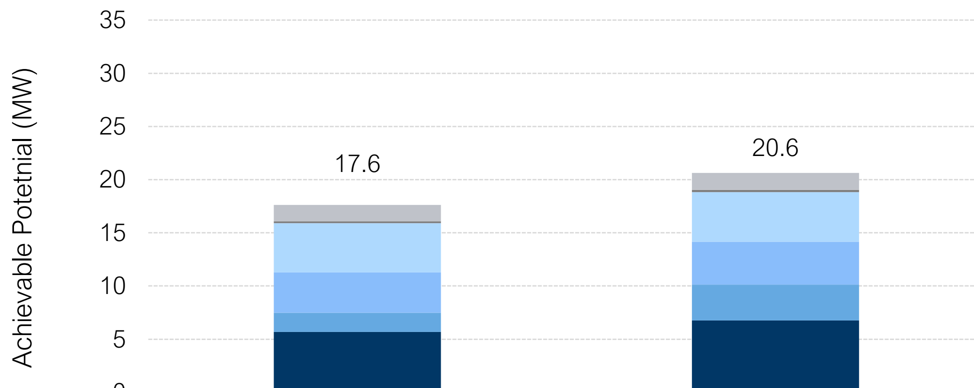


3.2.1 Customer Incentives Scenario

The Customer Incentives scenario captures the DR potential from developing a variety of DR programs under basic incentive levels and delivery approaches.[33] Figure 3-7, below, shows that PEI can achieve up to 21 MW by 2030. This comes primarily from the residential programs with a combined potential of 14 MW by 2030. The C&I programs offer an additional 6.5 MW reduction potential, mainly through a curtailment program targeting mid-sized customers.

It is important to note that large C&I customers already enrolled in the interruptible rates program were not included in this scenario which explains the absence of potential from these customers.[34] Large C&I customers were excluded from this DR scenario because it is unclear whether they will in fact be able or willing to participate in DR events under their current interruptible rates contracts. The Customer Incentives scenario offers insights that can be used for program design if large C&I customers who are on the interruptible rate do not participate. Large C&I customers are however included in the second scenario – Customer Incentives + Interruptible Rate to show how they impact the overall savings and mix of measures.

Figure 3-7. Customer Incentives Scenario – Achievable Potential by Program



	2025	2030
Total	17.61	20.63
C&I Energy Storage	1.52	1.58
Commercial DLC	0.18	0.22
Medium & Large C&I Curtailment	4.65	4.68
Dual Fuel Program	3.78	4.01
Residential Energy Storage	1.82	3.39
Residential DLC	5.67	6.75

Table 3-4, below, provides the measure-level savings for the 2025 and 2030 DR potentials[35] along with each program cost-effectiveness results over an assumed 9-year usable program life span. The results show that the largest potential comes from the residential sector with a few measures offering notable opportunities.

[33] Delivery approaches refer to different program delivery strategies. For example, Bring-Your-Own-Device versus a DLC program where the device is provided and installed by the program administrator.

[34] As shown in the Customer Incentives + Interruptible Rate, when included, large C&I customers under an interruptible rate captures a significant portion of the achievable potential; however, it is unclear how many of these customers would actually be available for DR events, and under what conditions. For this reason, we included a scenario without large interruptible customers so that ePEI would have visibility regarding other opportunities for program design.

[35] Diesel back-up generators were excluded from this study as they do not align with other public policy considerations.

On the C&I side, medium and large customers provide most of the potential with little contribution from the small C&I customers.

Table 3-4. Customer Incentives Scenario - Measures

Measures	Achievable Potential 2025 (MW)	Achievable Potential 2030 (MW)	PACT Results
Medium & Large C&I Curtailment	4.6	4.7	2.3
Medium C&I Curtailment	*4.0*	*4.1*	
Large C&I Curtailment	*0.6*	*0.6*	
Residential Energy Storage	1.8	3.4	1.4
Thermal Energy Storage	*1.7*	*3.3*	
Residential Battery Energy Storage - BYOD	*0.10*	*0.13*	
Residential DLC	5.7	6.8	1.4
Residential Wi-Fi Thermostat	*2.2*	*2.4*	
Residential Wi-Fi Thermostat (Heat Pump)	*0.5*	*1.0*	
Residential Storage Water Heater	*2.8*	*3.0*	
Residential Other Smart Appliances	*0.2*	*0.4*	
Commercial DLC	0.18	0.22	0.2
C&I Wi-Fi Thermostat	*0.17*	*0.20*	
Storage Water Heater	*0.01*	*0.02*	
C&I Commercial Battery Storage - BYOD	1.5	1.6	1.4
Dual Fuel System	3.8	4.0	1.1
TOTAL	17.6	20.6	1.3

Key observations:

- **Residential thermal energy storage systems and electric storage water heaters achieve 3.3 MW and 3.0 MW of peak reduction potential, respectively.** Both measures benefit from their capacity to target the peak hour while managing the bounce back effect through their storage capacity. These measures are also extremely promising because they offer the flexibility to reduce the load for several hours without impacting the participant's level of comfort,[36] which can be a limiting factor for other measures such as Wi-Fi thermostats.

- **Wi-Fi thermostats paired with central electric heating systems** also show potential through different delivery approaches – by enrolling customers who already own their device ("Bring-Your-Own-Device" program (BYOD)) and by enrolling customers who would require their installation as part of the program[37]. To note, it is possible that an integrated efficiency and DR incentive delivery

[36] Provided that the program strategies are carefully designed.
[37] BYOT program customers are assumed to receive sign-up incentives to join the program while customers without devices are considered not eligible to sign-up incentives.

approach for Wi-Fi thermostats could yield higher adoption rates, thereby increasing the BYOD potential relative to the direct install opportunity.

- **In the C&I sector, the mid-sized commercial and industrial curtailment measures show the largest potential.** These programs tend to be very cost-effective programs when customers leverage their own building management systems. Additionally, there is also potential to enroll installed commercial battery storage capacity in the DR programs as the study progresses.

- **Under the Customer Incentives scenario, almost all programs pass the PACT threshold once the programs ramp up**. The exception is the commercial DLC program, likely due to the limited achievable potential available to the program relative to the set-up and equipment costs. Details on each measure potential and cost-effectiveness by segment are provided in Appendix E.

The analysis also reveals that **dual fuel systems** can effectively reduced the peak load by as much as 4 MW by 2030. This measure considers the replacement of electric central heating systems such as an electric furnace with dual fuel systems that can switch fuel during peak events. While this measure is useful to reduce the peak demand, an integrated approach to leverage current dual fuel systems (heat pump with combustible fuel fired back-up heating) could potentially achieve meaningful impacts and help mitigate growth in winter peak loads that are expected to result from increased electrification of residential heating in the province.

Enhance Incentive Sensitivity Analysis

To assess the impact of incentives on DR adoption and achievable potential, Dunsky conducted a sensitivity analysis wherein incentive levels were doubled for all measures included in the Customer Incentives scenario.

Key results and observations:

- Achievable potential did not increase because most of the measures were already constrained by the load shape (i.e., would create a new peak) rather than by program potential participation.

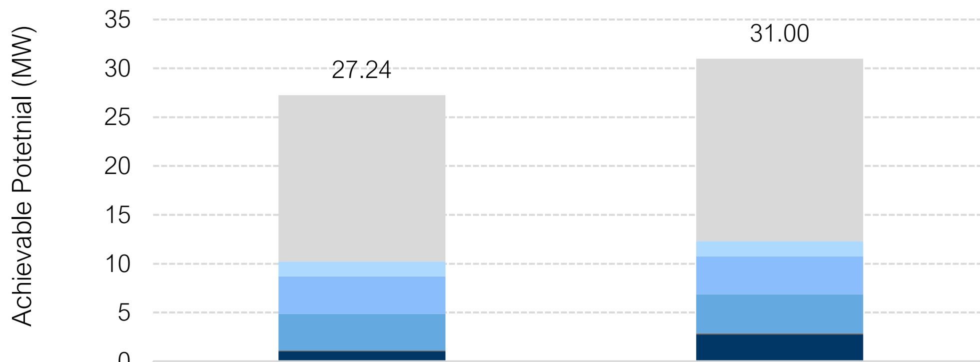
- The only difference between the sensitivity and the base scenario is that the most cost-effective measures (such as C&I curtailment) were able to capture slightly more of the achievable potential due to higher market adoption on account of the increased incentives. This reduced the available potential for other cost-effective measures (i.e., crowded them out), and ultimately reducing their overall contribution in the final measure mix.

- Doubling incentives in this scenario significantly increased program costs but had little to no effect on increasing the DR potentials. This implies that if PEI is to implement a suite of DR programs, the focus should be on selecting an optimized combination of programs and measures, and to provide attractive, yet moderate participation incentives.

3.2.2 Customer Incentives + Interruptible Rate Scenario

Under the Customer Incentives + Interruptible Rate scenario, DR programs from the base scenario are assessed in combination with expanding the large C&I interruptible rates program to include DR events. Under this scenario, the potential is assessed for calling DR events among PEI customers who are currently enrolled in their interruptible rates program that is currently used only for system reliability events, not peak reduction per se[38]. Since these customers are already enrolled in an interruptible rate, the cost of the preferential rate is not accounted for in the DR assessment. As detailed in Figure 3-8 below, the overall achievable potential increases, with large interruptible customers driving significant DR potentials. In this scenario, DR program incentives were kept at the same levels as in the base scenario, and a $30 per kW additional incentive was offered to existing IR customers.

Figure 3-8. Customer Incentives + Interruptible Rate Scenario – Achievable Potential



	2025	2030
Total	27.24	31.00
Large Interruptible	17.01	18.68
C&I Energy Storage	1.52	1.58
Commercial DLC	0.00	0.00
Medium & Large C&I Curtailment	3.82	3.85
Dual Fuel Program	3.78	4.01
Residential Energy Storage	0.10	0.13
Residential DLC	1.00	2.74

The measure and program potentials under this scenario are provided in Table 3-5 below as well as each program cost-effectiveness over a 9-year program lifetime. Because the interruptible rates for large C&I customers are so cost-effective, they capture most of the potential, thereby leaving less opportunity for the DR program measures to further flatten load curve.

[38] In 2017, PEI had 15 MW of curtailment enrolled under large C&I Interruptible Rate programs, this was considered to be fully available for DR events, and was scaled up to account for market growth over the study period.

Table 3-5. Customer Incentives + Interruptible Rate Scenario – Measures

Measures	Achievable Potential 2025 (MW)	Achievable Potential 2030 (MW)	PACT Results
Medium & Large C&I Curtailment	3.8	3.9	2.2
Medium C&I Curtailment	*3.3*	*3.4*	
Large C&I Curtailment	*0.5*	*0.5*	
Residential Energy Storage	0.1	0.13	0.1
Thermal Energy Storage	*0*	*0*	
Residential Battery Energy Storage - BYOD	*0.10*	*0.13*	
Residential DLC	1.0	2.7	1.0
Residential Wi-Fi Thermostat	*0.9*	*1.5*	
Residential Wi-Fi Thermostat (Heat Pump)	*0*	*0*	
Residential Storage Water Heater	*0*	*1.1*	
Residential Other Smart Appliances	*0.1*	*0.1*	
Commercial DLC	0	0	0
C&I Wi-Fi Thermostat	*0*	*0*	
Storage Water Heater	*0*	*0*	
C&I Commercial Battery Storage - BYOD	1.5	1.6	1.4
Dual Fuel System	3.8	4.0	1.1
Large Interruptible	17	18.7	4.7
TOTAL	27.2	31.0	1.8

Key observations:

- **Interruptible rates for large C&I customers** generate most of the potential with 18.7 MW by 2030. This measure assumes that interruptible rate customers could be called on to respond to reduce their load over a 6-hour event window during peak time. To proceed to designing an interruptible rate DR program, a deeper analysis would be needed to determine the degree to which interruptible rates customers would be willing to participate in DR event calls under their existing contracts with the PEI utilities.

- **Medium and large commercial curtailment** can further increase the potential by up to 3.9 MW, which is slightly lower than the first scenario. Leveraging C&I battery storage can add an additional 1.6 MW of potential to the mix.

- **Residential DLC** is significantly lower in this scenario, with up to 2.7 MW total divided between storage water heater (1.1 MW) and Wi-Fi thermostat (1.5 MW). This is because these measures compete against the others and were ultimately crowded out.

- **Dual fuel systems** achieve up to 4 MW by 2030 (as in the Customer Incentives scenario). Since this measure is not constraint by any bounce back effect, its potential is cumulative to the large interruptible one.

It is worth recalling that the modelling methodology follows a cost-effectiveness priority ranking in order to provide realistic scenarios, as described in the methodology. Moreover, all measures are assessed based on their ability to reduce the peak load during the defined DR event windows. However, program optimization may reveal further potential from measures that fall lower down the cost-effectiveness list in this analysis in two ways.

First, it may identify measures that can address the new peaks that emerge outside of the current DR windows, caused by load shifting from the more cost-effective measures.

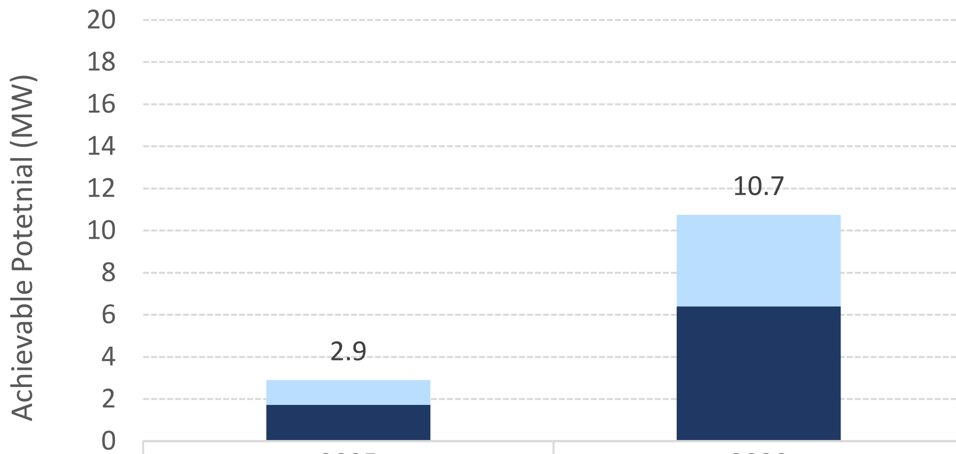
Second a change to the program designs in some cases can shift upfront costs from the program to the customer, thereby improving the program cost-effectiveness. For example, for thermal energy storage, the study considers the initial costs of equipment as a utility initial incentive. However, by offering a well-designed rate structure such as Summerside, these costs can be transferred to the customers which could significantly increase the program cost-effectiveness. These variations should be carefully studied during the program design stage to find the best optimisation scenario.

While the portfolio cost-effectiveness has increased due to the large contribution of the large interruptible measure, some of the other programs result less cost-effective. This is due to the fact that the program development and fixed costs are applied to a smaller pool of participants.

3.2.3 TOU Rate Scenario

The TOU Rate scenario analyses the achievable potential if PEI were to implement dynamic rates (specifically, Time-of-Use rates) to encourage customer behaviour that reduces peak time usage. The analysis focused on a two-tier, 3:1 peak-to-off-peak TOU rate ratio, that is applied to all customers, but with an opt-out option. This rate was applied across all residential and commercial customers and the savings are presented in Figure 3-9. When compared to the Customer Incentives and Customer Incentives + Interruptible Rate scenario, the TOU scenario offers limited peak reduction reaching 10.7 MW of potential by 2030 (equal to 3.1% of the system peak). The majority of the achievable peak reduction potential comes from the residential sector (60%).

Figure 3-9. TOU Rates Scenario Achievable Potential



	2025	2030
Total	2.9	10.7
Commercial and Industrial	1.2	4.3
Residential	1.7	6.4

Key observations:

- While TOU can be an effective approach to leverage AMI and achieve peak demand reductions, its effectiveness can be further increased by combining it with other strategies, such as rate enabled devices (i.e. Wifi Thermostats) or critical peak pricing during DR events. Critical peak pricing rates combined with TOU have proven to be effective on residential customers while peak time rebates tend to be more attractive for commercial customers. While an optimization exercise is not within the scope of this study, it should be considered if PEI proceeds to consider dynamic rates in the future.

- Our analysis shows that the C&I sector is less responsive than the residential customers to TOU rates, especially small C&I customers.

3.3 Key Takeaways

Using Dunsky's DROP model, DR program potentials were assessed using three scenarios, each representing a different DR program strategy (DR equipment, interruptible rates, and time of use rates). Based on these results, the following key findings emerge.

1. Significant DR Load Reduction Potential is Available under Each Scenario

Overall, these results show that there is a significant amount of cost-effective DR potential on PEI. Even with a relatively flat load curve, there is up to 31 MW of demand response potential by 2030 under the Customer Incentives + Interruptible Rate scenario, representing about 8.8% of the system peak. Alternatively, the TOU Rates scenario suggests that 10.7 MW of potential is achievable by leveraging the upcoming AMI infrastructure for the residential and commercial customers. The Customer Incentives scenario realizes 21 MW of load reduction by 2030.

Table 3-6. Demand Response PAC Test Results

Scenario	
Customer Incentives	1.3
Customer Incentives + Interruptible Rate	1.8
TOU Rates	8.7

As discussed early, customer participation is not the limiting factor in terms of achievable potential – PEI's relatively flat load curve constrains the level of peak load reduction that is possible without creating new peaks outside of the DR windows.

2. Focus on Optimizing a Few Key DR Programs

There is significant cost-effective potential on PEI but focusing on a few key programs can provide the most savings while improving overall cost-effectiveness. By focussing on a few key equipment-based measures, PEI can capture most of the peak load reduction potential and by including DR events in the interruptible rates program for large C&I customers a higher total reduction can be achieved. Overall, most of the potential is achievable through the following measures:

- Load reducing measures that do not experience a bounce back effect are particularly well suited for PEI. This includes adding DR event calls to the large C&I interruptible rates program, (representing up to 18 MW of potential under this approach alone). Other potential load shift measures include medium & large curtailment, dual fuel systems, and battery energy storage.
- Other key measures are residential thermal energy storage and electric storage water heaters that can provide up to 6.3 MW of cost-effective potential.
- Smart thermostats can also provide additional potential. To increase the cost-effectiveness of this measure, efficiencyPEI could explore an integrated EE/DR approach that offers combined incentives

for participants to deliver both EE and DR savings or that allows EE incentive takers to be pre-enrolled in the DR program.

In general, our analysis shows that a combination of interruptible rates strategies with equipment-based DR programs can provide the highest DR potential. Further potential may be possible by optimizing the combination of measures to introduce further measures that can target the new peaks that emerge outside of the modeled DR windows. The program design stage will be crucial to achieve the most savings while improving overall cost effectiveness.

3. Results for PEI are In-line with Other Winter-Peaking Jurisdictions

Table 3-7, below, benchmarks the achievable DR potential from all scenarios to DR potential study findings in other jurisdictions. Overall, these show that the PEI DR potential is similar to other winter peaking jurisdictions, which indicates that the assessment has captured the majority of the available peak load reduction potential from DR programs.

Table 3-7. Benchmarking of the achievable DR Potential (Mid Scenario) to other summer peaking Jurisdictions

	PEI (2021)	Newfoundland & Labrador (2020)	Northwest Power & Cons. Council (2015)	Nova Scotia (2019)	New Brunswick (2019)
Portion of Peak Load	3.1% - 8.8% (2030)	12% (winter peak)	8.8% (winter peak)	4.1% – 5.7% (winter peak)	6%-7% (winter peak)
Avoided Costs	$200 / kW	$430 / kW	n/a	$160-$200 / kW	$0-$108 / kW

4 Conclusion

The concluding section of this report presents overall system impacts in terms of energy and demand savings followed by a summary of our key takeaways from the Potential Study assessment.

4.1 Combined Consumption and Peak Load Impacts

The following presents the *cumulative* system-wide impacts resulting from efficiency and demand response programs. As described in Chapter 1, cumulative savings are a rolling sum of all *new* savings from measures that are incentivized by efficiency and demand response programs. Cumulative savings provide the total expected impact on energy sales and electric peak demand overtime and are used to determine the impact of efficiency programs on long-term energy consumption and peak demand.

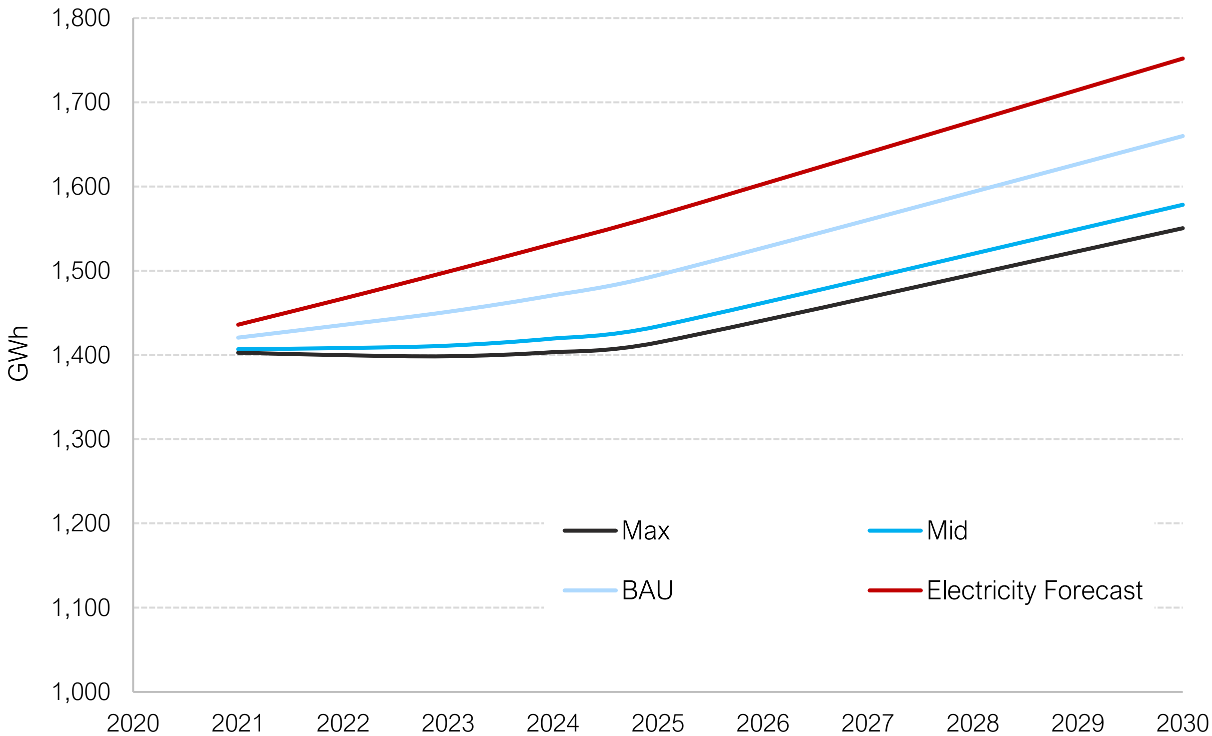
This section also provides cumulative results for technical and economic potential in addition to achievable scenario potential. There are two key caveats for understanding the technical and economic potential as presented in this section.

First, the DEEP model estimates all potentials (technical, economic, and achievable) on an annual phased-in basis. The model assumes that most efficient measures are not eligible for deployment until the existing equipment it is replacing reaches the end of its useful life or becomes a viable early replacement measure. For retrofit addition measures, the model applies a diffusion curve to release the market in a phased-in manner as well. This limits the number of opportunities available for efficiency upgrades each year. For this reason, technical and economic potential will increase each year of the study as more baseline equipment is eligible to be replaced.

Second, technical potential in the EE module represents all savings from *commercially viable* measures as opposed to all *technologically possible* savings. As explained further in Appendix A, the efficiency measures included in this study were limited to currently commercially viable options, and those that may become commercially viable over the study period (based on Dunsky's professional experience). In some cases, Dunsky excluded measures that were highly unlikely to pass the PAC cost-effectiveness test in the study period due to relatively low savings and/or high incremental costs or measures that have extremely low market penetration.

By 2030, achievable electric efficiency savings could reduce annual electric consumption by approximately 92 GWh (Low) to 200 GWh (Max). This would reduce annual electricity sales by between 5% (BAU) and 11.0% (Max) of forecasted levels in 2030 as shown in Figure 4-1. If all economic savings were captured, electricity consumption would decline by approximately 643 GWh (37% of forecasted 2030 sales), and if all technical savings were captured, electricity consumption would decline by 726 GWh (41% of sales).

Figure 4-1. Impact of Electric EE Savings on Forecasted Electricity Sales (2021-2030; Technical, Economic, and Program Scenarios)



Note: Y-axis in above figure does not begin at zero.

From these results, the following observations can be made:

- **Technical and economic potential are nearly the same.** Cumulative economic potential for electric EE in 2026 is approximately 99% of cumulative technical potential. As previously described, the initial exclusion of measures that are not currently commercially viable and are not expected to become viable within the study period screens out technologically possible savings that would be unlikely to pass economic screening (see Appendix C for the full measure list).[39] This reduces overall technical potential without reducing economic potential.
- **Up to a third of the economic potential can be captured by the achievable scenarios.** The achievable scenarios capture between 14% (BAU) and 31% (Max) of economic savings in 2030. This suggests that market barriers for efficient technologies are relatively high on PEI, which likely reflect the relatively recent ramp-up in energy efficiency efforts in the province. We see additional potential captured when enabling activities that further reduce market barriers are included.
- **Achievable savings are relatively clustered together.** As can be seen in Figure 4-1, there achievable savings potentials under all scenarios helps offset some of the forecasted load growth. The spread among the achievable scenarios is relatively narrow, especially between the Mid and Max scenarios. This is primarily due to the fact that many of efficiencyPEI's programs already offer high or 100%

[39] Commercial availability and viability of measures was assessed through a review of available secondary sources such as technical resource manuals as well as Dunsky's professional judgment.

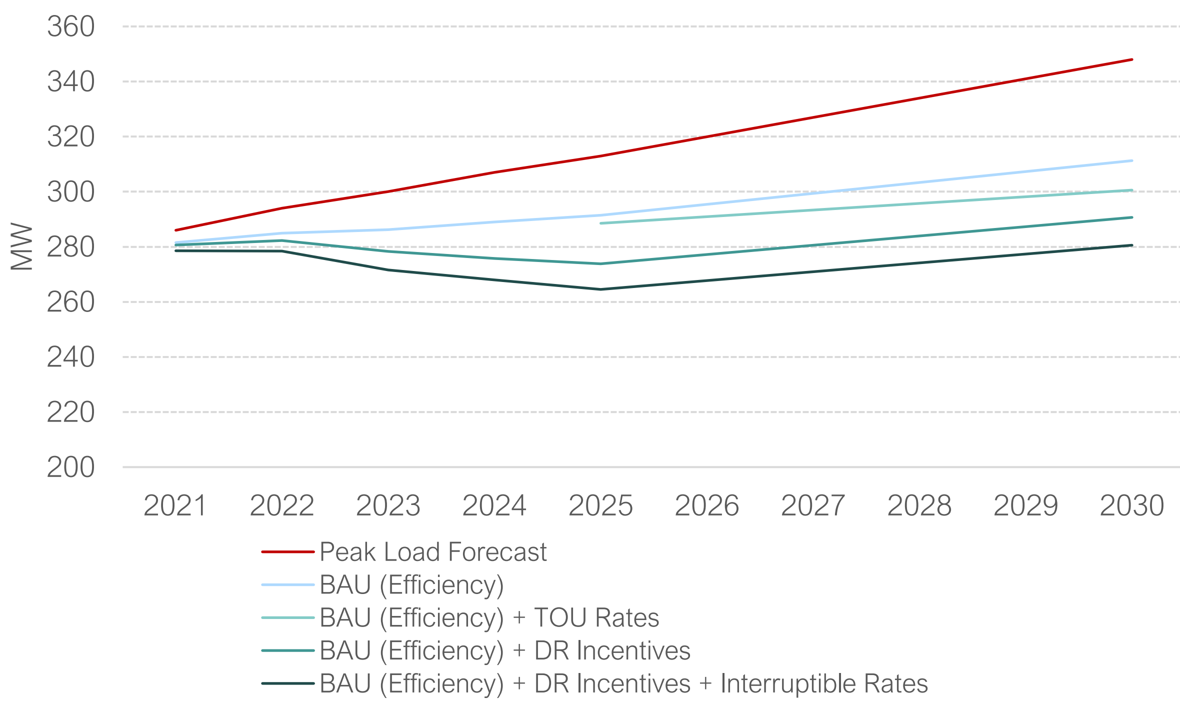
incentives and therefore there is less opportunities to induce additional savings through enhanced incentives – especially between the Mid and Max scenarios.

- **Programs flatten projected growth in electricity sales in early years.** Figure 4-1 also shows that the energy efficiency programs significantly reduce and even flatten the energy forecast in the first three years. Starting in 2024, however, none of the scenarios are able to prevent the anticipated growth in consumption in the province.

In addition to reducing electricity consumption, EE and DR programs can reduce province-wide peak electric demand. As shown in Figure 4-2, demand savings from the BAU energy efficiency scenario essentially flattens projected load growth in the first three years. When DR programs are included, the BAU EE scenario plus the Customer Incentives and Customer Incentives + Interruptible Rate scenarios result in a significant reduction in peak load compared to the demand forecast. The impact of TOU Rates as modeled are introduced in 2025, and while the impact is not as pronounced as with the other scenarios, on its own it does result in a 3% reduction in peak in 2030.

To note, technical and economic savings are not shown here as they are assessed at the measure level and are not considered to be realistically additive across the system. It is also noteworthy that even the energy efficiency demand savings and highest DR scenario only keep peak load steady until 2024, after which there is notable growth in the annual peak demand.

Figure 4-2. Impact of Electric EE Demand Reduction on Forecasted Peak Load (2021-30; All Program Scenarios)



Note: Y-axis in above figure does not begin at zero.

4.2 Key Takeaways

Based on the results presented in this report, the following key take-aways emerge:

1. **PEI's electricity energy efficiency savings targets are achievable.** While current energy efficiency programs do not appear sufficient to meet the provincial government's targe of 2% electricity savings per year, there is a reasonable path to that target, albeit at higher costs and covering a broader range of eligible measures as well as a greater focus on enabling activities. Demand Response offers a new opportunity to engage the Island community to help mitigate the growing annual peak in the province and reduce overall system costs.
2. **Increasing program incentives can unlock a significant amount of cost-effective new savings**. Expanding current programs to a broader range of measures and increasing incentives (and budgets) can significantly increase savings in the residential and commercial sectors. Moving from the BAU to Mid incentive scenario increases average (2021-2023) incremental lifetime savings by 97% and by 130% under the Max incentive scenario. However, these increasing savings come at notably higher annual portfolio budgets. In particular between BAU and Max (the PAC screening tests limits a meaningful increase in savings between the higher savings scenarios and thus budgets.) It should be noted that the potential assessment applied "blanket" incentive level increases in the Mid and Max scenarios, which may not be representative of program costs after strategies and optimisations are applied in program designs.
3. **Focusing on barrier-reducing enabling activities can deliver further potential and help optimize program design and costs.** Enhancing program designs by applying further enabling activities that help address customer barriers to energy efficiency can play a key role in helping efficiencyPEI meet it targets. The results show that when moderate enabling strategies are added alongside the Mid scenario incentives, the resulting lifetime savings (2021-2023) increase by 16% to approximately the Max savings levels, but for $2 million less. This suggests that focusing on enabling activities may be a more effective way to pursue higher savings than simply raising incentives alone. Program design strategies that focus on enabling strategies, alongside targeted adjustments to incentive levels, can help to optimize program impacts and cost-effectiveness.
4. **Focusing on envelope measures in the residential sector is a key opportunity**. The single-family segment is critical to the portfolio given the achievable savings potential. New construction and other envelope measures such as adding attic and basement insulation are the largest opportunity in terms of lifetime energy savings within the sector. Higher performing building envelopes also help to right-size equipment, such as high efficiency heat pumps, which continue to be an important energy savings opportunity going forward.
5. **The commercial sector offers a key opportunity for expansion.** The results of this assessment show that there is also significant opportunity within the commercial sector (equal to roughly the same amount of savings potential as that of the residential sector). In all cases the achievable scenarios showed notably higher savings than are currently accessed by the existing commercial sector programs. The introduction of the new Community Energy Solutions program, introducing new enabling activities as well as targeted incentives and new measures can play a key role in tapping into this potential.