Prince Edward Island Energy Efficiency Potential Study:

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

(Volume II: Appendices)

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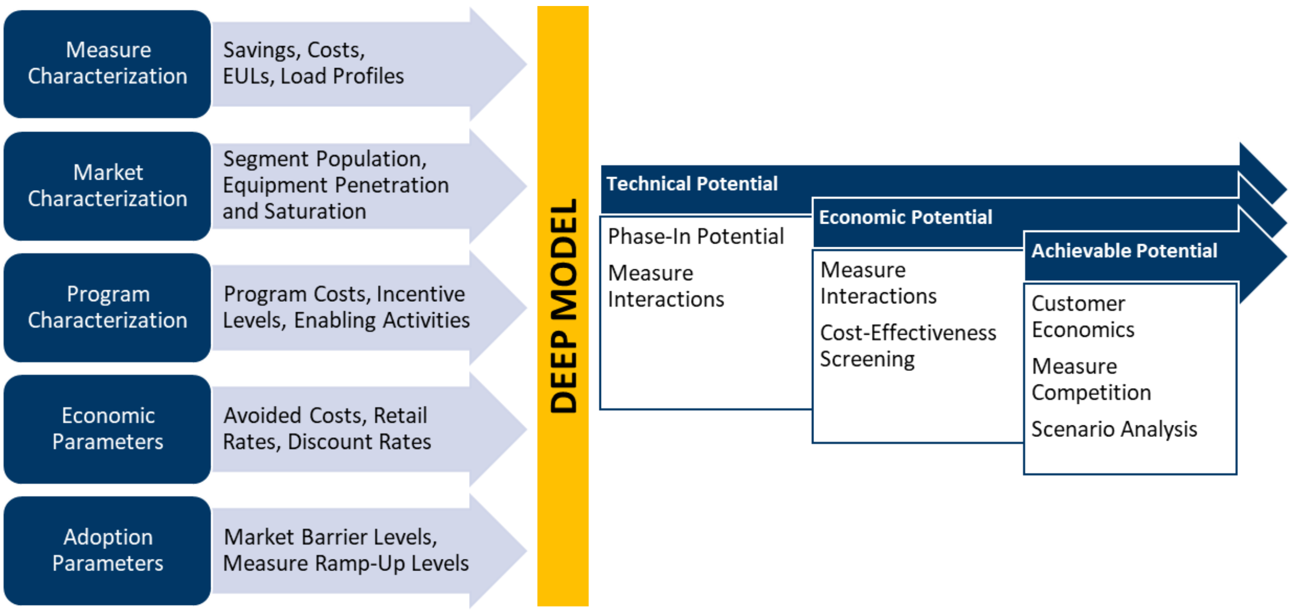
A. Energy Efficiency Methodology

A.1 Overview

The market potential for energy efficiency was estimated using the Dunsky Energy Efficiency Potential (DEEP) model. DEEP employs a multi-step process to develop a bottom-up assessment of the technical, economic and achievable potentials. This appendix describes DEEP's modeling approach, the process of developing DEEP model inputs and the underlying calculations employed to assess energy efficiency potential.



A.2 The Dunsky Energy Efficiency Potential Model

DEEP's bottom-up modelling approach assesses thousands of "measure-market" combinations, applying program impacts (e.g., incentives and barrier reducing enabling activities) 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. Key features of this assessment include:

- **Measure-Market Combinations:** Energy saving measures are applied on a segment-by-segment basis using segment-specific equipment saturations, utility customer counts, and demographic data to create unique segment-specific "markets" for each individual measure. The measure's impact and market size are unique for each measure-market segment combination, which increases the accuracy of the results.

- Phase-In Potential: DEEP assesses the phase-in technical, economic, and achievable potential by applying a measure's expected useful life (EUL) and market growth factors to determine the number of energy savings opportunities for each measure-market combination each year. This provides an important time series for each energy savings measure upon which estimated annual achievable program volumes (measure counts and savings) can be calculated in the model, as well as phase-in technical and economic potentials.

- Annual and Cumulative Savings: For each measure-market combination in each year, DEEP calculates the annual and cumulative savings accounting for mid-life baseline adjustments and program re-participation where appropriate.[1] This provides a read on the cumulative savings (above and beyond natural uptake), as well as the annual savings that will pass through DSM portfolios.

Key Limitations

The key limitations for estimating energy efficiency potential in this study are the availability of market data.

The ability to forecast results is connected to the availability of market data and past market behavior. Where this data is not available, secondary sources and professional judgement must be employed. As discussed in more detail in Appendix C, this study utilizes Prince Edward Island specific information wherever possible, but in many cases alternative data sources were used to fill data gaps.

A.3 DEEP Model Inputs

DEEP requires an extensive set of model inputs related to energy savings measures, markets, economic factors, and adoption parameters to accurately assess energy efficiency potential. These inputs are developed through several concurrent processes that include measure characterization, market characterization, program characterization, economic parameter development and adoption parameter development. The remainder of this section outlines each process.

A.3.1 Measure Characterization

Measure characterization is the process of determining the costs, savings, and lifetimes of potential energy-saving technologies and services and their baseline equivalents that will then be used as inputs to the DEEP model. The measure characterization process begins by developing a comprehensive list of energy saving measures.

In this study, an initial measure list was proposed based on the full range of existing measures in efficiencyPEI's energy efficiency programs as well as a number of emerging opportunities. Measures 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

[1] Mid-life baseline adjustments are required for early retirement measures after the useful life of the existing equipment expires and new equipment (at a more efficient baseline) would have been purchased. Program re-participation occurs when a customer may receive an incentive for a new efficient measure to replace an efficient measure previously received through the program at the end of its life, which results in *program* savings but no additional *cumulative* savings.

were highly unlikely to pass the Program Administrator Cost Test in the study period due to relatively low savings and/or high incremental costs or measures that have extremely low market penetration due to existing baselines. The measure list was vetted and approved by efficiencyPEI finalized prior to measure characterization. Appendix C provides the full measure list.

Measure characterization is accomplished by compiling primary and secondary data (as available) on the efficient and baseline (e.g., non-efficient) energy-consuming equipment available in a given jurisdiction. Measures are characterized using segment-specific inputs when available yielding segment specific characterizations for each measure-market combination.

Measures are characterized in terms of their **market unit** such as savings per widget, savings per square foot, or savings per ton of cooling capacity. Each measure in the measure list was characterized by defining a range of specific parameters. Table A-1 describes these parameters.

Table A-1. DEEP Measure Characterization Parameters

Parameter	Description
Market unit	The unit in which the measure is characterized and applied to the market (e.g., per widget, per building, per square foot, etc.)
Measure type	The measure type, which can be at least one of the following: • Replace on Burn-out • Early Replacement • Additional Measures • New Construction/Installation
Annual gross savings	The annual gross savings of the measure per market unit in terms of both energy (e.g., kWh, MMBtu), demand (e.g., kW) and other factors (e.g., water) as applicable
Measure costs	The incremental cost of the measure (e.g., the difference in cost between the baseline technology and the efficient technology)
Measure life	The effective useful life (EUL) and/or remaining useful life (RUL) of both the efficient measure and the baseline technology
Impact factors	Any factors affecting the attribution of gross savings including net-to-gross adjustments, in-service factors, persistence factors and realization rates.
Load factors	Any factors affecting modulating gross savings including summer and winter peak coincidence factors as well as seasonal savings distributions.
Program allocation	The program(s) to which the measure applies – in some instances, measures will be allocated to multiple programs on a pro-rated basis if the measure is offered through multiple programs

As PEI does not currently have a Technical Resource Manual (TRM), measures were characterized using other best in class TRMs from other jurisdictions. See Appendix C for the complete measure list and accompanying TRM sources used in this study.

Measure Types

DEEP incorporates four types of measures – replace on burnout, early replacement, addition, and new construction/installation. DEEP treats each of these measure types differently in determining the maximum annual market available for phase-in potential. Table A-2 provides a guide as to how each measure type is defined and how the replacement or installation schedule is applied within the study to assess the phase-in potentials each year.

Table A-2. DEEP Measure Type Descriptions

Measure Type	Description	Yearly Units Calculation
Replace on Burnout (ROB)	An existing unit is replaced by an efficient unit after the existing unit fails. *Example: Replacing burned out bulbs with LEDs*	The eligible market is the number of existing units divided by EUL.[2]
Early Replacement (ER)[3]	An existing unit is replaced by an efficient unit before the existing unit fails. These measures are generally limited to measures where savings are sufficient enough to motivate a customer to replace existing equipment earlier than its expected lifespan. *Example: Replacing a functional, but inefficient, furnace*	The eligible market is assumed to be a subset of the number of existing units based on a function of the equipment's EUL and remaining useful life (RUL)
Addition (ADD)	A measure is applied to existing equipment or structures and treated as a discretionary decision that can be implemented at any moment in time. *Example: Adding controls to existing lighting systems, adding insulation to existing buildings*	The eligible market is distributed over the estimated useful life of the measure using an S-curve function.
New Construction/ Installation (NEW)	A measure that is not related to existing equipment. *Example: Installing a heat-pump in a newly constructed building.*	The eligible market is measure-specific and defined as new units per year.

A.3.2 Market Characterization

Market characterization is the process of defining the size of the **market** available for each characterized measure. Primary and secondary data are compiled to establish a **market multiplier**, which is an assessment of the market baseline that details the current penetration (e.g., the number of lightbulbs) of energy-using equipment and saturation of energy efficiency equipment (e.g., the percentage of lightbulbs that are LEDs) in each market sector and segment. The market multiplier is applied to each market segment's **population** to establish each measure's market. The market multiplier can be understood as the average number of opportunities per customer within the market segment in terms of the measure's market unit.

[2] The EUL is set at a minimum of 3 years to spread installations over the potential study period. Note: Home Energy Reports are a special case with an EUL of one year.
[3] Early replacement measures are limited to measures where energy savings are sufficient enough to motivate a customer to replace existing equipment prior to the end of its expected lifespan.

This study characterized markets by leveraging anonymized Maritime Electric and Summerside Electric customer data, Prince Edward Island specific baseline data, and market data from other jurisdictions in the region. Residential and C&I baseline information was received through primary data collection via telephone surveys conducted by Ad Hoc Research in summer 2020. This data was supplemented by the 2020 PEI Home Energy Survey. When Prince Edward Island specific baseline data was not available (or was based on a low number of observations), baseline data from neighboring jurisdictions in the region – namely New Brunswick and Newfoundland – was leveraged and adjusted for PEI specific attributes wherever possible.

A.3.3 Program Characterization

Program characterization is the process of estimating the average administrative program costs in terms of fixed and variable costs, incentive levels, and enabling activity impacts of existing efficiency programs. Inputs generated through the program characterization process include:

- **Fixed costs** are the portion of non-incentive administrative costs that are independent of the amount of savings attributable to the program.
- **Variable costs** are the portion of non-incentive administrative costs that change in magnitude with the amount of savings attributable to the program.
- **Incentives** are the portion of the measure's incremental costs that are covered by the program. Incentive levels vary by program scenario.
- **Enabling activities** are strategies employed by programs to reduce market barriers (e.g., effective marketing and delivery processes, contractor training, etc.). For details on the enabling strategies considered in this study please refer to Appendix F.

This study characterized programs through an extensive review of recently completed evaluation reports and accompanying spreadsheets for each of efficiencyPEI's current programs as well as conversations with efficiencyPEI's program specialists to develop initial estimates of program costs, incentives, and enabling activities across all programs. The initial program characterization was reviewed by efficiencyPEI and subsequent updates were made. Appendix C provides more information on the specific inputs resulting from program characterization.

A.3.4 Economic Parameter Development

DEEP harnesses key economic parameters such as avoided costs, retail energy rates, and discount rates to assess measure cost-effectiveness and customer adoption. Appendix C outlines the development of these inputs, which were used across all modules of this study.

A.3.5 Adoption Parameter Development

DEEP requires several key inputs to determine achievable measure adoption including market barrier levels and measure ramp-up levels.

- **Market barrier levels** define maximum adoption rates and are assigned for each measure-market combination based on market research and professional experience. Different end-uses and segments exhibit different barriers. Barrier levels may change over time if market transformation effects are anticipated.

- **Measure ramp-up levels** modify the initial uptake of measures not offered by existing programs and/or offered at lower levels than expected given the market context to account for ramping up new programs and measure marketing. In this study, measures that represent significant savings and are not currently offered by existing programs (i.e., Home Energy Reports) have ramp rates of 33%, 66%, and 100% applied in the first three years of the study, respectively.

A.4 Assess Potential

Using the comprehensive set of model inputs, DEEP assesses three levels of energy savings potential: technical, economic, and achievable. In each case, these levels are defined based on the governing regulations and practice in the modeled jurisdiction, such as applying the appropriate cost-effectiveness tests, and applying the relevant benefit streams and net-to-gross (NTG) ratios to ensure consistency with evaluated past program performance. Table A-3 provides a summary of how DEEP treats each potential type.

Table A-3. DEEP Treatment of Technical, Economic, and Achievable Potential

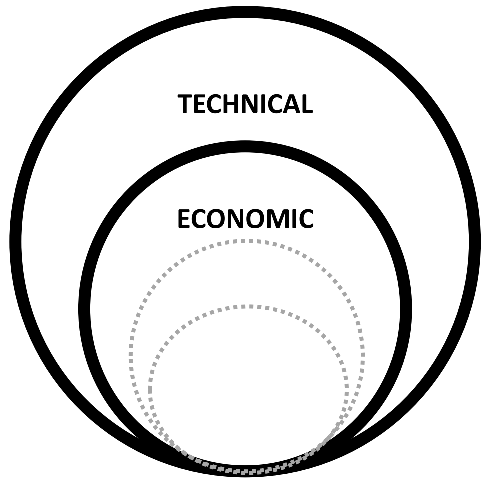
APPLIED CALCULATION	TECHNICAL POTENTIAL	ECONOMIC POTENTIAL	ACHIEVABLE POTENTIAL
1. ECONOMIC SCREENING	No Screen	Cost-Effectiveness (Program Administrator Cost Test)	Cost-Effectiveness (Program Administrator Cost Test)
2. MARKET BARRIERS	No Barriers (100% Inclusion)	No Barriers (100% Inclusion)	Market Barriers (Adoption Curves)
3. COMPETING MEASURES	Winner takes all	Winner takes all	Competition Groups Applied
4. MEASURES INTERACTIONS	Chaining Adjustment	Chaining Adjustment	Chaining Adjustment
5. NET SAVINGS	Not Considered	Not Considered	Program Net-to-Gross Ratios (NTGR)

For each level of potential, DEEP calculates annual and cumulative potential:

- **Annual potential** is the incremental savings attributable to program activities in the study year. It includes re-participation in programs (e.g., when a customer may receive an incentive for a new LED lightbulb to replace a burnt-out LED lightbulb previously received through the program). DEEP expresses annual potential both in terms of incremental lifetime savings and incremental annual savings. This is the most appropriate measure for annual program planning and budgeting.

- **Cumulative potential** is the total savings attributable to program activities from the beginning of the study period to the relevant study year. It accounts for mid-life baseline adjustments to measures implemented in previous years, as well as the retirement of savings for measures reaching their end of life. As such it does not include new savings for re-participation in programs, thereby providing an assessment of the cumulative impact of the measure/program (e.g., the reduction in energy sales). This is the most appropriate measure for resource planning.

A.4.1 Technical and Economic Potential



Technical potential is all theoretically possible energy savings stemming from the applied measures. Technical potential is assessed by combining measure and market characterizations to determine the maximum amount of savings possible for each measure-market combination without any constraints such as cost-effectiveness screening, market barriers, or customer economics. This excludes early replacement and retirement opportunities, which are to be addressed in the subsequent achievable potential analysis. Technical potential is calculated for each year in the study period.

DEEP's calculation of technical potential accounts for markets where multiple measures compete. In these instances, the measure procuring the greatest energy savings is selected while all other measures are excluded to avoid double counting energy savings while maximizing overall technical energy savings (see description of measure competition below for additional detail).

Additionally, the calculation of technical potential also accounts for measures that interact and impact the savings potential of other measures (see description of measure interactions below for additional detail).

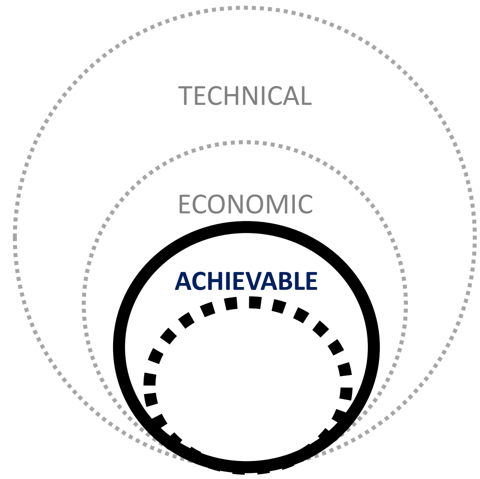
Economic potential is a subset of technical potential that only includes measures that pass cost-effectiveness screening. Economic screening is performed at the measure level and only includes costs related to the measure. All benefits and costs applied in the cost-effectiveness screening are multiplied by their corresponding cumulative discounted avoided costs to derive a present value ($) of lifetime benefits. All benefits and costs are adjusted to real dollars expressed in the first year of the study. Economic screening does not include general program costs. Like technical potential, the calculation of economic potential also accounts for measure competition and interaction.

This study screened measures based on the Program Administrator Cost Test ("PAC Test"). The PAC test assesses the net costs (including incentives) from the perspective of the program administrator.[4] For energy efficiency, measures that had a benefit-cost ratio above 1.0 were included in the economic potential, except for low-income measures where a benefit-cost threshold of 0.8 or higher was used.

[4] As defined by the California Standard Practice Manual. Benefits include avoided energy and demand, avoided T&D, avoided capacity. Costs include fixed and variable program administration costs, incentive costs, and any other related cost borne by the program administrator.

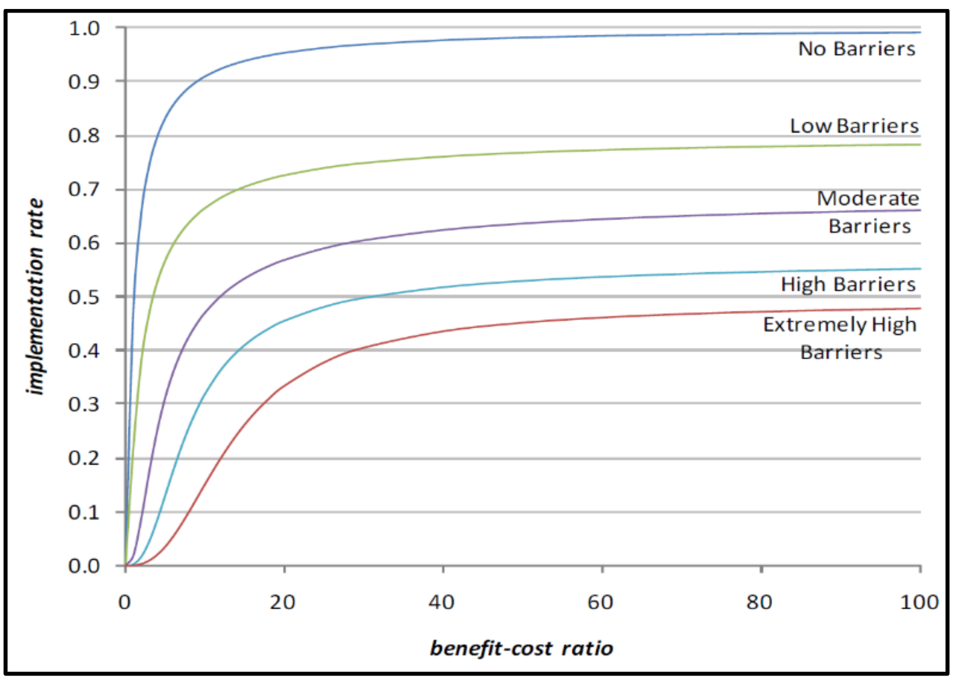
A.4.2 Achievable Potential and Scenario Modeling

Achievable potential is the energy savings stemming from the customer adoption of energy-savings measures. Rooted in the United States' Department of Energy (U.S. DOE) adoption curves,[5] DEEP defines annual adoption rates based on a combination of customer cost-effectiveness and market barrier levels. Customer cost-effectiveness is calculated within the model based on inputs from measure and program characterization as well as economic and adoption parameters. Figure A-1 presents a representative example of the resulting adoption curves.



While this methodology is rooted in the U.S. DOE's extensive work on adoption curves, it applies two important refinements as described below:

Figure A-1. Representative Example of Adoption Curves



Refinement #1: Choice of the cost-benefit criteria. The DOE model assumes that participants make their decisions based on a benefit-cost ratio calculated using discounted values. While this may be true for a select number of large, more sophisticated customers, experience shows that most consumers use simpler estimates, including simple payback periods. This has implications for the choice and adoption of measures, since payback period ignores the time value of money as well as savings after the break-even point. The model converts DOE's discount rate-driven curves to equivalent curves for payback periods and applies

[5] The USDOE uses this model in several regulatory impact analyses. An example can be found in http://www.regulations.gov/contentStreamer?objectId=090000648106c003&disposition=attachment&contentType=pdf, section 17-A.4.

simple and discounted payback periods based on sector. Generally, DEEP assumes residential customers assess cost-effectiveness by considering a measure's simple payback period, while commercial customers assess cost-effectiveness by considering a discounted payback period.

Refinement #2: Ramp-up. Two key factors – measure awareness and program delivery structure – can limit program participation, especially during the first few years after a program's launch or redesign and result in lower participation than DOE's achievable rates would suggest. For example, a new home retrofit program that requires the enrollment and training of skilled auditors and contractors by program vendors could take some time to achieve the uptake assumed using DOE's curves. As described under adoption parameter development, this study adjusts adoption rates on a case-by-base basis where appropriate.

Scenario Modeling

Multiple levels of achievable potential are modeled within DEEP by applying varying incentive and market barrier levels, which impact the degree of customer adoption. Additional details on parameters for each scenario can be found in Appendix C.

Varying levels of achievable adoption will also impact program spending by modulating incentive payments and variable program costs. As part of program characterization, variable program costs may be adjusted between scenarios to account for increased program expenses for providing additional enabling activities above current program levels.

It is important to note that program cost estimates are based on historical budgets and DEEP does not consider dynamic impacts on program budgets resulting from internal (to the program) and external factors impacting program and incremental costs. For example, the variable cost of delivering programs may decline overtime as program learnings are applied to future administrative and delivery practices within a program or incentive costs may decline if incremental costs decline over time. Likewise, program costs may increase if factors lead to increasing measure costs, for example, the lack of enough contractors to deploy high adoption measures leading to an increase in overall labor costs.

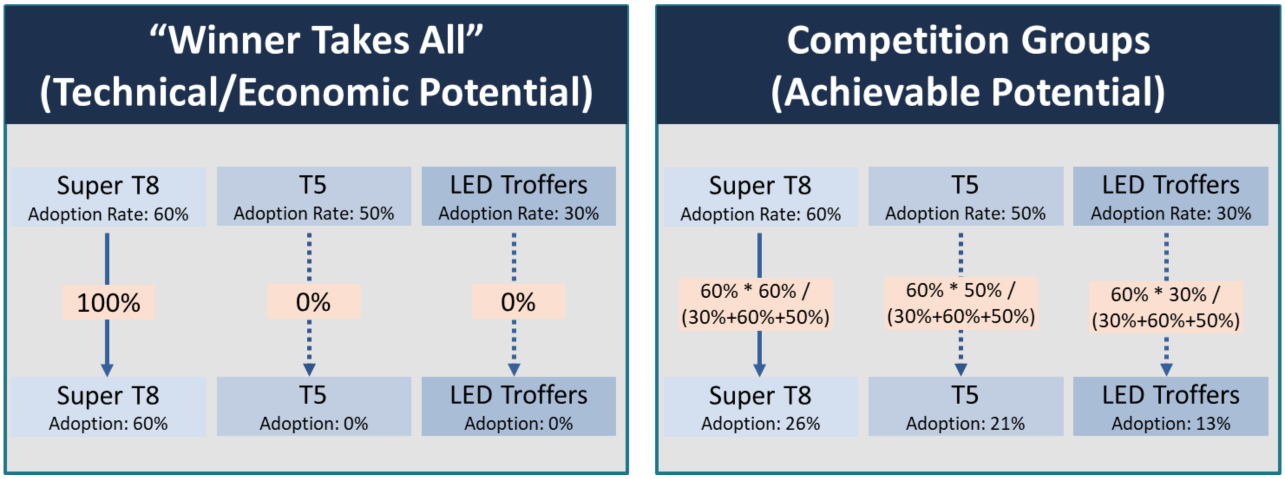
A.4.3 Measure Competition

Measure competition occurs when measures share the same market opportunity but are mutually exclusive. For example, LED troffers, T5 lamps and Super T8 lamps can all serve the same market opportunity but will not be simultaneously adopted. In these cases, DEEP assesses the market potential for each measure as follows:

- **Technical Potential**: 100% of the market is applied to the measure with the highest savings.
- **Economic Potential:** 100% of the market is applied to the measure with the highest savings that passes cost-effectiveness screening.
- **Achievable Potential**: The market is split between all cost-effective measures by pro-rating the achievable adoption rate based on the maximum adoption rate and each of the measures' respective adoption rates.

Figure A-2 presents an example where three measures compete: LED troffers, Super T8 and T5 lamps. First, the adoption rate is calculated for each measure independent of any competing measures, as outlined in the figure below. Based on this assessment, the maximum adoption rate is 60%, corresponding to the measure with the highest potential adoption. Next, the adoption of each measure is pro-rated based on their relative adoption rates to arrive at each measure's share of the 60% total adoption rate. As a result, the total adoption rate is still 60%, but it is shared by three different measures.

Figure A-2. Example of DEEP Measure Competition

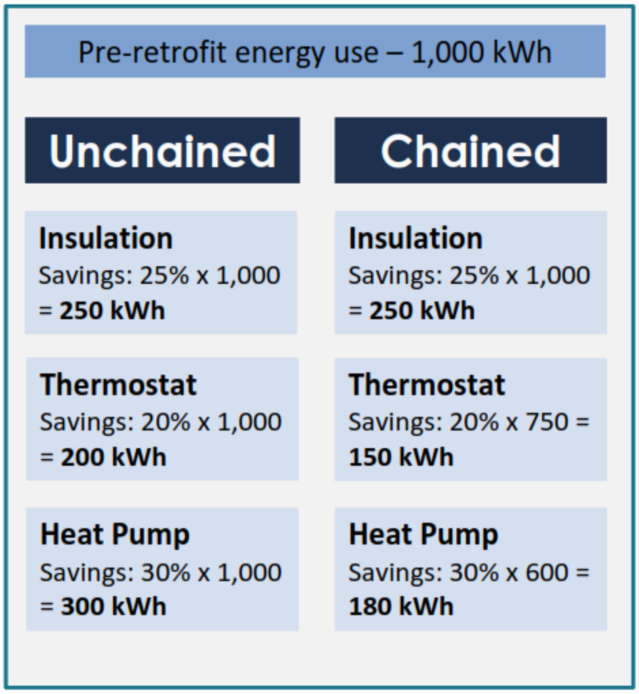


A.4.4 Measure Interactions (Chaining)

Measure interactions occur when the installation of one measure will impact the savings of another measure. For example, the installation of more efficient insulation will reduce the savings potential of subsequently installing a smart thermostat. In DEEP, measures that interact are "chained" together and their savings are adjusted when other chained measures are adopted in the same segment. Chaining is applied at all potential levels and these interactive effects are automatically calculated according to measure screening and uptake at each potential level.

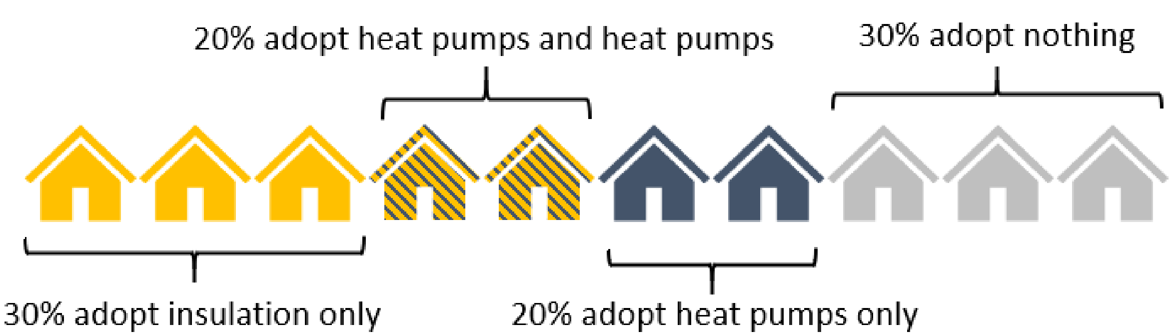
DEEP applies a hierarchy of measures in the chain reducing the savings from each measure that is lower down the chain. The model adjusts the chained measures' savings for each individual measure, with the final adjustment calculated based on the likelihood that measures will be chained together (determined by their respective adoption rates) and the collective interactive effects of all measures higher in the chain. Figure A-3 provides an example of the calculations used to determine the interactive savings effects for a customer where insulation is added in addition to a smart thermostat and a heat pump.

Figure A-3. Example of Savings Calculation for DEEP Chained Measures



The model estimates the number of customers adopting chained measures based on the relative adoption rates of each measure. In an example where insulation has a 50% adoption rate and heat pumps have a 40% adoption rate in isolation, when chaining is considered, the model might assume 40% of customers adopting insulation will also install a heat pump, which means 50% of customers adopting a heat pump will also improve their installation levels. This segments the market into customers adopting only one of the measures, customers adopting both measures, and customers adopting none of the measures as shown in Figure A-4.

Figure A-4. Representative Example of Adoption for DEEP Chained Measures



Note: The above figure is representative of the DEEP model's treatment of chained measures only and not representative of any actual program or measure inputs. In many cases, efficiency programs require weatherization prior to the incentivization of a heat pump.

B. Demand Response Methodology

B.1 Overview

The following sections outline Dunsky's Demand Response Model methodology, used to assess the technical, economic and achievable peak-hour demand savings from electric demand response programs. The strength of Dunsky's approach to analyzing demand response (DR) potential, is that it takes into account two specific considerations that differentiate it from energy efficiency potential assessments.

1. DR Potential is Time-Sensitive

- DR measures are often subject to constraints based on when the affected demand can be reduced and for how long.
- DR measure "bounce-back" effects (caused by shifting loads to another time) can be significant, creating new peaks that limit the achievable potential.
- DR measures impact one another by modifying the System Load Shape – thus the entire pool of measures (at all sites) must be assessed together to capture these interactive effects and provide a true estimate of the achievable potential impact on the system peak.

2. Many DR Measures Offer Little or no Direct Economic Benefits to Customers

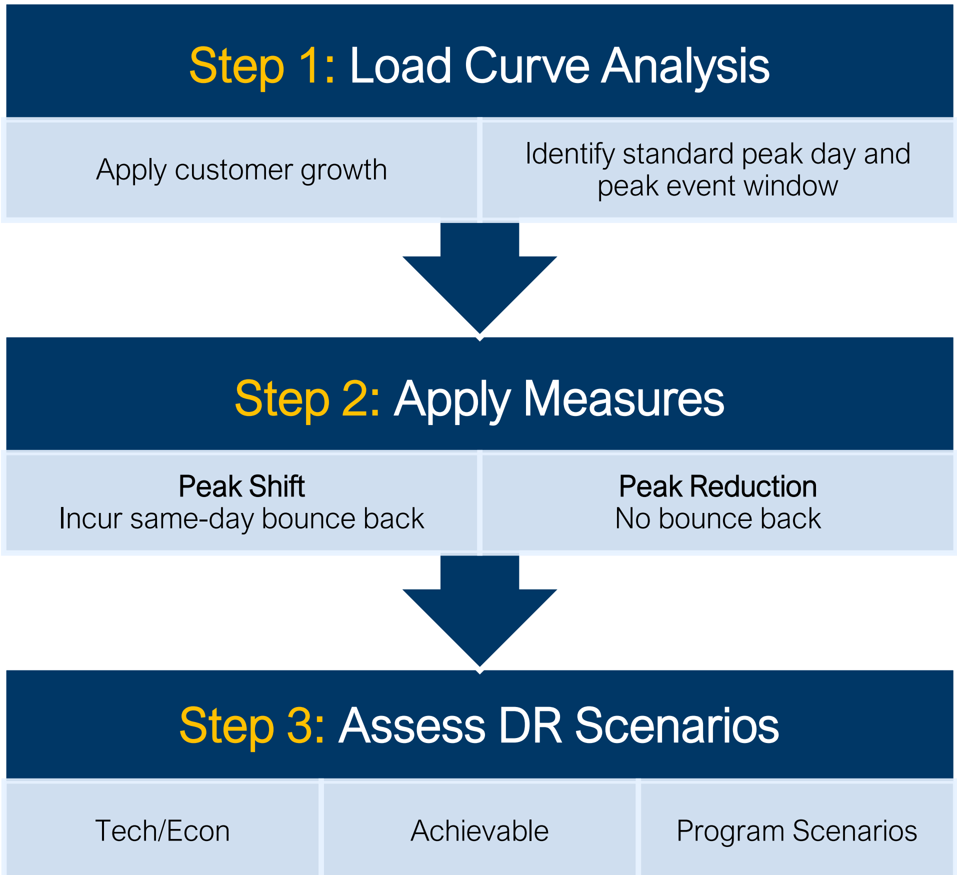
- Participants must receive an incentive over and above simply covering the incremental cost associated with installing the DR equipment.[6]
- Incentives can be based on an annual payment basis, a rebate/reduced rate based on a participant agreement to curtail load, or through time-dependent rates that send a price signal encouraging load reduction during anticipated system peak hours.
- Savings are expected to persist only as long as programs remain active.

A limitation of the methodology is that it may not be consistent with how utilities quantify their DR impacts, which may focus on reducing demand only at certain pre-determined peak hours, regardless of how load may vary at other hours, or if a new peak emerges outside of the targeted hours.

Figure B-1 presents an overview of the analysis steps applied to assess the DR potential in this study. For each step, system-specific inputs are identified and incorporated into the model. Each step is described below.

[6] This study did not account for reductions in customer peak demand charges that may arise from DR program participation. Since DR events are typically called for a small number of days each month, the impact on commercial monthly peak demand charges is assumed to be minimal.

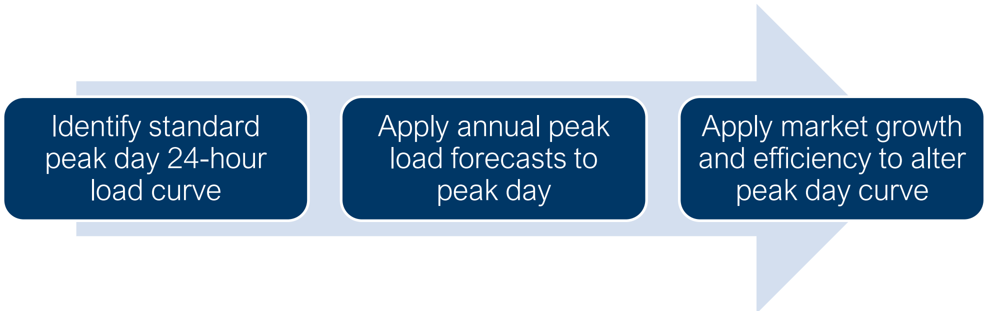
Figure B-1. Demand Response Assessment Steps



B.2 Load Curve Analysis

The first step in Dunsky's modelling approach is to define the baseline load forecast and determine the key parameters of the utility load curve that influence the DR potential. The process begins by conducting a statistical analysis of historical utility data to determine the 24-hour load curve for the "Standard Peak Day" against which DR measure impacts are assessed. The utility peak demand forecast period is then applied to adjust the amplitude of the standard peak day curve over the study period. Finally, relative market sector growth factors are applied to further adjust the peak day load curve (growth factors used in the study can be referenced in Appendix C.2.3).

Figure B-2. Load Curve Analysis Tasks



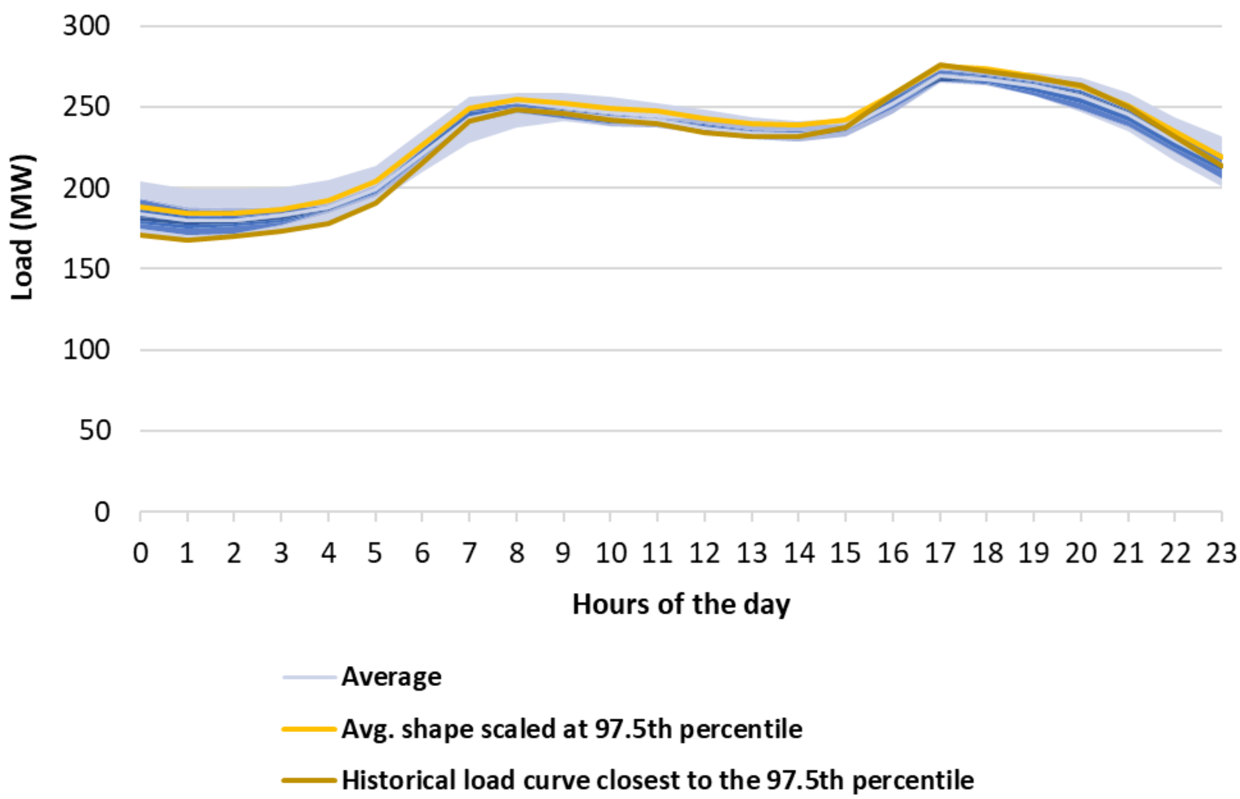
Once complete, the load curve analysis provides a tool which can assess the individual measure, and combined program impacts against a valid utility peak baseline curve that evolves to reflect market changes over the study period. The sub-section below presents the initial Standard Peak Day for Prince Edward Island.

B.2.1 Identify Standard Peak Day

The **Standard Peak Day** is assessed through an analysis of historical hourly annual load curves. For each provided year, a sample of the peak days are identified (e.g., 10 top peak demand days in each year that historical data is available) and a pool of peak days is established[7]. From this the average peak day shape is established as from the pool of peak day hourly shapes. The standard peak day load curve is then defined by raising the average peak day load curve such that the peak moment matches the projected annual peak demand (keeping the shape consistent with the average curve) as shown in Figure B-3, below.

[7] The analysis is based on the 8760-load curve for year 2019 provided by MECL.

Figure B-3. Standard Peak Day Load Curve



Note: Each blue shading area represents a 10-percentile gradient.

From the standard peak day curve, two DR windows were identified – evening peak as well as a second peak in the morning – which represents an overall 7-hour time period in which to capture the highest demand hours. These are used to characterize certain DR measures, providing guidance on which hours to target for time-of-use (TOU) high-rate tiers, customer driven curtailment periods, and to create pre-charge/reduction/re-charge curves for equipment control measures, as described in the next step.

B.3 DR Measures Characterization

DR potential is assessed drawing on Dunsky's database of specific demand reducing measures developed from a review of commonly applied approaches in DR programs across North America, and emerging opportunities such as battery storage.[8] Measures are characterized with respect to the local customer load profiles, and the technical and economic DR potentials are assessed for each individual measure.

Figure B-4. Measure Characterization Tasks

Once complete, the measure-specific economic potential is loaded into the model to assess the achievable potential scenarios when all interactive load curve effects are considered.

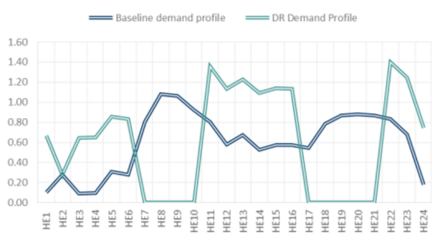
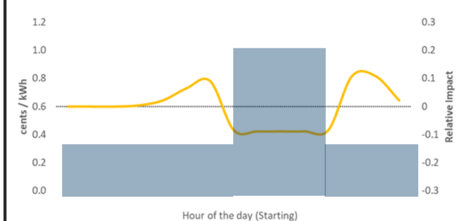
B.3.1 Measure Specific Model Inputs

Measures are developed covering all customer segments and end-uses, and can be broadly categorized into two groups:

- Type 1 DR Measures (typically constrained by demand bounce-back and/or pre-charging):
    - These measures exhibit notable pre-charging or bounce-back demand profiles within the same day as the DR event is called. This can create new peaks outside of the DR window and may lead to significant interaction effects among measures when their combined impact on the utility peak day curve is assessed.
    - Typically, Type 1 measures can only be engaged for a limited number of hours before causing participant discomfort or inconvenience. This is reflected in the DR measure load curves developed for each measure-segment combination. (example: direct load control of a residential water heater)
    - **Dynamic Rates (Time-of-Use or TOU)** are a sub-category of measures developed independently than the others. These measures are designed to alter customer behaviour with time and cannot be engaged by the utility to respond to a specific DR event but must be set in place and exert a prolonged effect on the utility load curve shape.

[8] A detailed list of measures applied in this study is provided in Appendix C.5.

- Type 2 DR Measures (unconstrained by load curve):
    - These measures do not exhibit a demand bounce-back and are therefore not constrained by the addressable peak.
    - Some of them can be engaged at any time, for an unlimited duration. (example: back-up generator at a commercial facility)

Peak Shift *(Type 1 measures)*	Peak Reduction *(Type 2 measures)*	Dynamic Rates *(TOU)*
Example: DLC Water heaters • Applies baseline use to define Direct Load Control (DLC) strategy and adjust load curve. • Multiple control schemes 	Example: C&I Curtailment • Assume loads are shifted outside of 24hr period. • Identify curtailable loads from load curve observation. • Apply constraints (events per year, max hours per year, event duration) • Optimizer determines overall net impact on annual peak demand	Example: TOU opt out program • Define on and off-peak pricing to maintain average annual billing. • Redistribute shifted loads. • Account for efficiency savings (approx. 2% of shifted kWh) 

Dunsky's existing library of applicable DR measure characterizations was then applied and adjusted to reflect hourly end-use energy profiles for each applicable segment. Key metrics of the characterization are:

1. **Load Shape:** Each measure characterization relies on defined 24-hour load shape both before and after the demand response event. The load shapes are based on the population of measures within each market segment and are defined as the average aggregate load in each hour across the segment.
2. **Effective Useful Life (EUL):** Effective useful life of the installed equipment/control device.
3. **Costs:** At measure level, the costs include the initial cost of the installed equipment (i.e., controls devices and telemetry) and the annual operational cost (program administration, customer incentives etc.).
4. **Constraints:** Some measures are subject to specific constraints such as the number of hours per day or year, maximum number of events per year and event durations.

Once the measures are adapted to the utility customer load profiles and markets, the technical and economic potentials are assessed for each measure independently as outlined below. Because these are assessed independently (i.e., not considering interactions among measures), the technical and economic potentials are not considered to be additive, but instead provide important measure characterization inputs to assess the collective achievable potential when measures are analyzed together in step 3.

B.3.2 Technical Potential (Measure Specific)

The technical potential represents a theoretical assessment of the total universe of controllable loads that could be applicable to a DR program. It is defined as the technically feasible load (kW) impact for each DR measure considering the impact on the controlled equipment power draw coincident with the utility annual peak.

More specifically, the technical potential is calculated from the maximum hourly load impact during a DR event multiplied by the applicable market of the given measure. It is important to note that the technical potential assessment does not consider the utility load curve constraints, such as the impact that shifting load to another hour may have on the overall annual peak.

B.3.3 Economic Potential (Measure Specific)

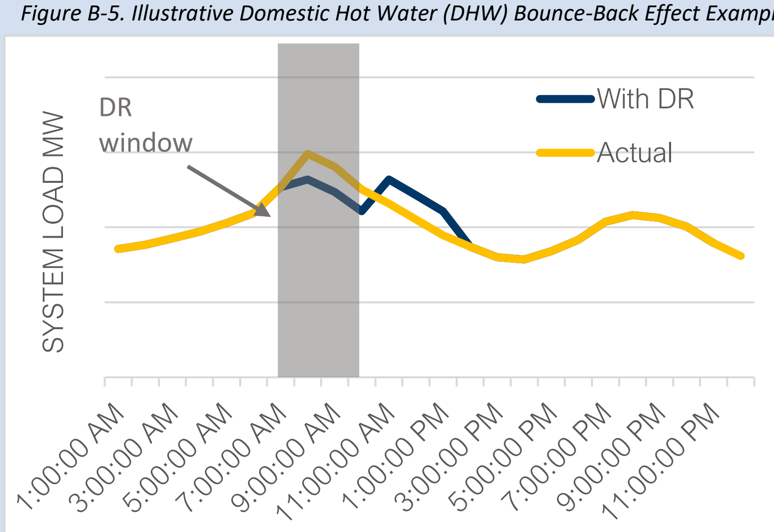
The assessment of each measure's economic potential is conducted in three key steps: adjustment of the technical potential, screening for cost-effectiveness, and adjusting for market adoption limitations.

1. **Net Technical Potential Adjustment:** The measure's hourly load curve impact is applied to the utility standard peak day load curve, to assess the net impact after pre-charge and bounce-back effects are accounted for. For each individual measure, an optimization algorithm that assesses various control schemes and market portions is applied to arrive at the maximum number of participants and impact for the given measure, without creating a new system peak, either during the standard peak day, or over the sample annual hourly load profile.

Net Impact Determination:

By considering the bounce-back effect associated with water heaters recharging their reservoirs after the evening DR window has passed, Figure B-5 illustrates how adding too many water heaters to the DR program would risk creating a new peak outside of the DR window. This new peak is used to assess the net impact of the measures, which is determined as the difference between the peak before the DHW controls were applied and the new peak after the DHW controls were applied.

Figure B-5. Illustrative Domestic Hot Water (DHW) Bounce-Back Effect Example



2. **Cost-Effectiveness Screening:** Once each measure's net impact on the peak is assessed, measures are screened using the applicable cost-effectiveness test, considering installation costs and baseline incentive costs.[9] It is important to note the customer incentives are not treated as a pass through cost for DR programs because they typically do not cover a portion of the customers' own equipment incremental costs (i.e. customers typically have no direct equipment costs, unlike in efficiency programs where the incentives provided cover a portion of the participant's incremental costs for the efficiency upgrade).

Table B-1. DR Benefits and Costs Included in Determination of the PACT

Benefits	Costs
Avoided Capacity Costs Other ancillary benefits (as applicable)	Controls and equipment installation Controls and equipment Operations and Maintenance (O&M) (if required) Annual incentives ($/ participant) Peak reduction incentives ($/kW contracted)

3. **Market Adoption Adjustment**: The market for a given DR program or measure may be constrained either by the impact on the load curve, or by the expected participation (or adoption) among utility customers.

   In the first case, the economic potential assessment (described above) determines the number of devices needed to achieve the measure's maximum impact on the utility peak load. Adding any further participation will come at a cost to the utility, but with little or no DR impact benefits.

   In the second case, the model determines the expected maximum program participation based on the incentive offered, the need to install controls equipment, the level of marketing, and the total number of eligible customers, by applying DR program propensity curves (described in the call out box below) developed by the Lawrence Berkeley National Laboratory.[10]

   The DR model assesses both the utility curve economic potential market and the maximum adoption at the resulting incentive levels, then constrains the market (maximum number of participants) to the lower of the two. This is then applied as a measure input for the achievable potential assessment described in the next step.

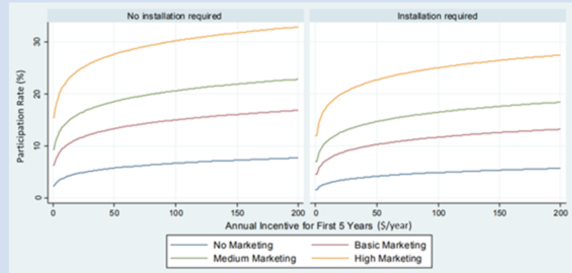
[9] Any measure that cannot achieve a PAC Test > 1 is not retained for further consideration in the model.
[10] Lawrence Berkeley National Laboratory, March 2017. 2025 California Demand Study Potential Study, Phase 2 Appendix F. Retrieved at: http://www.cpuc.ca.gov/General.aspx?id=10622

Demand Response Propensity Curves

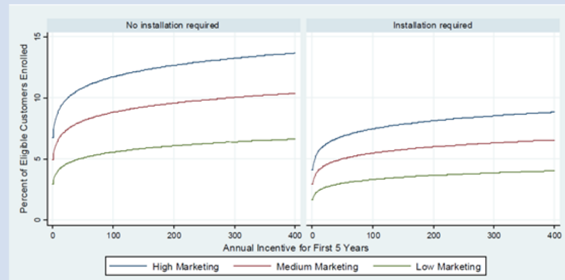
For each measure the propensity curve methodology, as developed by the Lawrence Berkeley National Laboratory to assess market adoption under various program conditions, is applied. The curves represent achievable enrollment rates as a function of incentive levels, marketing strategy, number of DR calls per year, and the need for controls equipment. Their development is based on empirical studies, calibrated to actual enrollment from utility customer data. Specific curves are available for each sector.

Sector	Inputs
Residential	• Annual incentives ($/yr.), • Marketing (low, mid, high), • Installed equipment (yes/no)
Small Business	
Large C&I	• Annual incentive ($/kW-yr.) • # of events (hours per yr.)

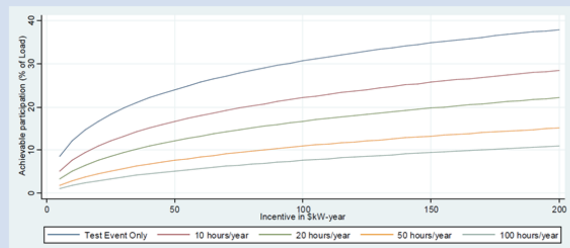
Residential



Small Business



Large C&I



B.4 Assessment of Achievable Potential Scenarios

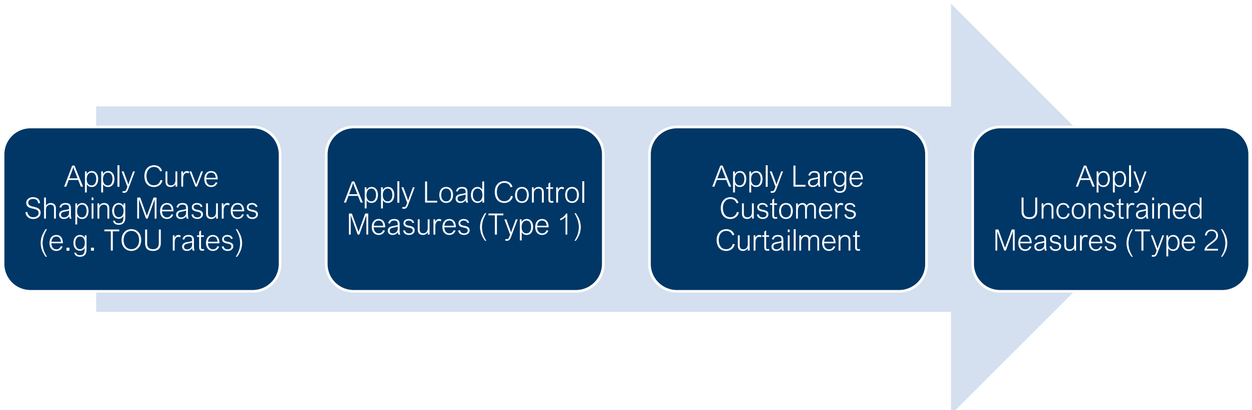
The achievable potential is determined through an optimization process that considers market adoption constraints, individual measure constraints, and the combined inter-measure impacts on the utility load curve.

Scenarios are developed to assess the combined impact of selected programs and measures. For example, one scenario may assess the achievable potential of the impact of applying TOU rates and industrial curtailment, while another may assess the combined potential from direct load control of customer equipment and industrial curtailment. This approach recognizes that there can be various strategies to access the DR potentials from the same pool of equipment (i.e., TOU rates can exert a reduction in residential water heating peak demand, thereby reducing or eliminating the potential from a water heater DLC program). The scenarios are assembled from logical combinations of programs and measures designed to test various strategies to maximize the achievable peak load reduction.

B.4.1 Assessing Achievable Potential

For each scenario, measures are applied in groups in order starting with the least flexible/most constrained measures and progressing to the measures/groups that are less and less constrained, as per the order illustrated in figure below.

Figure B-6. Achievable Potential Assessment Tasks



- **Curve Shaping:** Rates Based Measures (such as time of use rates) are typically applied first as these are designed to alter customer behaviour with time, and are considered the least flexible (i.e., with the exception of critical peak pricing, they cannot be engaged by the utility to respond to a specific DR event but must be set in place and exert a prolonged effect on the utility load curve shape). Curve shaping can also include passive demand reduction via increased adoption of efficiency measures.

- **Type 1 - Load Control Measures:** Direct control of connected loads such as water heaters and thermostats, and customer controlled shut-off or ramp down of commercial HVAC loads are applied next. These are typically constrained to specific times of day based on the utility peak load shape, and the controlled equipment load shape (i.e., turning of residential water heaters at midday may be feasible but deliver next to no savings as there is minimal hot water demand at that hour). These are assessed against the load curve altered by any shaping measures, and measures that may double count savings are eliminated. A new aggregate utility load curve is then created, applying the achievable load control peak reductions, and bounce-back effect.

- **Industrial / Commercial Curtailment:** Next customer curtailment is applied, which typically carries constraints related to the number of curtailment hours per day (consecutive and total), the number of events per year, and in some cases the time of day that curtailment can be applied (but does not carry same-day bounce-back effects). These are applied to the adjusted load curve to assess the potential impact of large industrial and commercial curtailment measures on the magnitude and timing of the overall annual peak.

- **Type 2 - Unconstrained Measures:** Finally, the Type 2 measures that have less constraints on the duration, frequency or timing of their application are applied. These may include measures such as dual-fuel heating and back-up generators which can be engaged as needed and whose potential is not impacted by the shape of the utility load curve.

B.4.2 DR Programs and Scenarios

Dunsky has developed a set of best-in-class program archetypes based on a review of programs in other jurisdictions. For each program, development, marketing and operating costs are estimated and applicable measures are mapped to the corresponding program, applying key features from the program archetypes, and taking into account current programs offered by the utility.

The model first determines the achievable DR potential of the combined measures within all programs, and then assesses the program level cost-effectiveness, summing all program and measure costs, as well as applicable measure benefits. A 9-year delivery period is assumed for each program, except where the program is based on control devices with a longer EUL, in which case the program is assumed to cover the entire device life. In cases where DR device EULs are shorter than 9 years, preparticipation / re-installation costs are applied. This approach allows the model to fairly assess the programs costs and benefits for an on-going program.

New measure and program ramp-up: Where applicable, new programs and measures can be ramped up accounting for the time needed to enroll customers and install controls equipment to reach the full achievable potential. Ramp up trajectories applied to the achievable potential markets after all interactive effects (i.e., new peaks created or program interactions that affect the net impact of any other program) have been assessed. An S-curve ramp-up over a five-year period is applied in this study. In addition, given the limited number of existing DR initiatives in the province, all programs were treated as new and thus up-front costs were applied to each.

Based on these steps the achievable DR potential for each measure, program and scenario are developed, along with an appropriate assessment of the measure, program and scenario level cost-effectiveness.

C. Study Inputs and Assumptions

The following appendix describes the key inputs used in this study and how they were derived.

C.1 Measure Characterization

C.1.1 Energy Efficiency Measure List

The following tables lists the energy efficiency measures and characterization sources used in this study. Table C-1 lists the various Technical Resource Manuals (TRM) and other sources used to characterize measures.

Table C-1. Measure Characterization Sources

Jurisdiction/TRM Name	Version
Commercial Measures	
Iowa - Volume 3: Nonresidential Measures	Version 2 (July 12th, 2017)
Illinois - Volume 2: Commercial and Industrial Measures	Versions 8.0 (Oct. 17th, 2019), 7.0 (Sep. 28th, 2018) and 6.0 (Feb. 8th, 2017)
Massachusetts Technical Reference Manual	Plan Versions 2019-2021 and 2016-2018
Maine – Commercial/Industrial/Multifamily	Version 2018.3
NB Power TRM	September 2017 version
Mid-Atlantic (Northeast Energy Efficiency Partnerships (NEEP))	Version 8.0 (May 2018)
New York - Residential, Multi-Family, and Commercial/Industrial Measures	Version 5 (July 17th, 2017)
OEB TRM	Version 3.0, December 3rd 2018
Pennsylvania TRM	June 2015 version
Efficiency PEI 2018-20 Evaluation Reports	2020
PSEG Long Island	2019 Version, June 14, 2018
Residential Measures	
Efficiency PEI 2018-20 Evaluation Reports	2020
Mid-Atlantic (Northeast Energy Efficiency Partnerships (NEEP))	Version 8.0 (May 2018)
Massachusetts – 2019 Plan- Year Report Version	May 2020
Iowa - Volume 2: Residential Measures	Version 2 (July 12th, 2017)
Illinois - Volume 3: Residential Measures	Version 8.0 (Oct. 17th, 2019)
Maine - Retail/Residential	Version 2018.3
New York - Residential, Multi-Family, and Commercial/Industrial Measures	Version 7 (April 15th, 2019)
California Public Utility Commission appliance recycling program impact evaluation, 2014	2014

Table C-2 and Table C-3 list each residential and C&I energy efficiency measure included in this study along with the TRM source from which the measure was characterized. These typically reference the source of the algorithms used to determine the measures savings and impacts, which were then applied to the PEI specific market, equipment saturations, climate, and customer consumption data used as inputs to the study.

Table C-2. Residential Energy Efficiency Measures

Class	Measure	Source
Appliance	Air Purifier	ENERGY STAR
Appliance	ENERGY STAR Clothes Dryers	NEEP, 2018
Appliance	Clothes Washer	NEEP, 2018
Appliance	Dehumidifier	PEI, 2020
Appliance	Dehumidifier Recycle	MA. 2019
Appliance	Dishwasher	NEEP, 2018
Appliance	Freezer	NEEP, 2018
Appliance	Freezer Recycle	California, 2014
Appliance	Heat Pump Clothes Dryers	NEEP, 2018
Appliance	Refrigerator	NEEP, 2018
Appliance	Refrigerator Recycle	California, 2014
Behavioral	Home Energy Report	PEI, 2020
Envelope	Air Sealing	IA, 2018
Envelope	Attic Insulation	IL, 2019
Envelope	Basement Insulation	PEI, 2020
Envelope	Efficient Windows	IA, 2018
Envelope	New Home Construction	PEI, 2020
Hot Water	Faucet Aerator	PEI, 2020
Hot Water	Heat Pump Water Heater (HPWH)	NY, 2019
Hot Water	Low Flow Shower Head	PEI, 2020
Hot Water	Thermostatic Restrictor Shower Valve	NEEP, 2018
HVAC	Air Source Heat Pump (ASHP) Tune Up	IA, 2017
HVAC	Duct Insulation	ME, 2018
HVAC	Duct Sealing	IA, 2018
HVAC	ENERGY STAR Ceiling Fan	NEEP, 2018
HVAC	Ground Source Heat Pump (GSHP)	NEEP, 2018
HVAC	Heat Recovery Ventilator	ENERGY STAR
HVAC	Electric Resistance to DMSHP	PEI, 2020
HVAC	Mini-split Ductless Heat Pump (DMSHP) - Cold Climate	MA, 2019
HVAC	Mini-split Ductless Heat Pump (DMSHP) - Cold Climate	MA, 2019

HVAC	Mini-split Ductless Heat Pump (DMSHP) - Cold Climate	MA, 2019
HVAC	Mini-split Ductless Heat Pump (DMSHP) - Cold Climate	MA, 2019
HVAC	Thermostat Programmable	NEEP, 2018
HVAC	Thermostat Wi-Fi	PEI, 2020
HVAC	Thermostat Wi-Fi	PEI, 2020
Lighting	LED A-Lamp (exterior)	PEI, 2020
Lighting	LED A-Lamp (interior)	PEI, 2020
Lighting	LED Linear Tube	NEEP, 2018
Lighting	LED Reflector (exterior)	PEI, 2020
Lighting	LED Reflector (interior)	PEI, 2020
Other	Advanced Smart Strips	MA, 2017

Table C-3. C&I Energy Efficiency Measures

Class	Measure	Source
Envelope	Building Shell Air Sealing	IA, 2017
Envelope	Roof Insulation	NB, 2017
Envelope	LEED Certified	Custom
Envelope	Net-Zero Ready	Custom
Envelope	Attic Insulation	IL, 2019
Hot Water	Heat Pump Water Heaters	PA, 2015
Hot Water	Heat Pump Water Heaters	PA, 2015
Hot Water	Faucet Aerator	IA, 2017
Hot Water	Low Flow Shower Head	NB, 2017
Hot Water	Pre-Rinse Spray Valve	NY, 2017
Hot Water	Thermostatic Restrictor Shower Valve	NEEP, 2018
Hot Water	Recirculation Pump with Demand Controls	IA, 2017
Hot Water	Circulator Pump EC Motor	ME, 2018
HVAC	Mini-split Ductless Heat Pump (DHP) - Cold Climate	NEEP, 2018
HVAC	Mini-split Ductless Heat Pump (DHP) - Cold Climate	NEEP, 2018
HVAC	Mini-split Ductless Heat Pump (DHP) - Cold Climate	NEEP, 2018
HVAC	Mini-split Ductless Heat Pump (DHP) - Cold Climate	NEEP, 2018
HVAC	Air Source Heat Pumps (ASHP) - Cold Climate	NEEP, 2018
HVAC	Air Source Heat Pumps (ASHP) - Cold Climate	NEEP, 2018
HVAC	Air Source Heat Pumps (ASHP)	NEEP, 2018
HVAC	Ground Source Heat Pump	NB, 2017
HVAC	Ground Source Heat Pump	NB, 2017
HVAC	Water Cooled Chiller, Centrifugal	PSEGLI, 2019

Class	Measure	Source
HVAC	Air Cooled Chiller	PSEGLI, 2019
HVAC	Energy Recovery Ventilator (ERV)	OEB, 2018
HVAC	HVAC EC Motor	MA, 2016-18
HVAC	Demand Control Ventilation (DCV)	IL, 2017
HVAC	Kitchen Demand Control Ventilation	IL, 2017
HVAC	Dual Enthalpy Economizer Controls	NB, 2017
HVAC	Energy Management System (EMS)	Custom
HVAC	Guest Room Energy Management	IA, 2017
HVAC	Advanced Thermostat (Wi-Fi Thermostat)	MA, 2016-18
HVAC	Refrigeration Heat Recovery	Custom
HVAC	Retro-commissioning Strategic Energy Manager (RCx SEM)	Custom
Kitchen	Dishwasher	IA, 2017
Kitchen	Fryer	MA, 2016-18
Kitchen	Oven	MA, 2016-18
Kitchen	Steamer	MA, 2016-18
Lighting	LED Bulbs	PEI, 2020
Lighting	Linear LED Tube	PEI, 2020
Lighting	LED Luminaire	PEI, 2020
Lighting	LED High Bay	PEI, 2020
Lighting	LED Exit Sign	NB, 2017
Lighting	LED Parking Garage (Exterior)	ME, 2018
Lighting	LED Pole Mounted (Exterior)	NB, 2017
Lighting	LED Wall Pack (Exterior)	ME, 2018
Lighting	LED Refrigerated Case Lighting	PSEGLI, 2019
Lighting	Lighting Controls (Interior), Daylighting	NB, 2017
Lighting	Lighting Controls (Interior), Occupancy	NB, 2017
Motor/Compressor	HVAC VFD - Cooling Tower	NB, 2017
Motor/Compressor	HVAC VFD - Fan	NB, 2017
Motor/Compressor	HVAC VFD - Pump	NB, 2017
Motor/Compressor	High Efficiency Air Compressor	PSEGLI, 2019
Motor/Compressor	High Efficiency Air Compressor	PSEGLI, 2019
Motor/Compressor	Air Receiver for Load/No Load Compressor	PSEGLI, 2019
Motor/Compressor	Air Receiver for Load/No Load Compressor	PSEGLI, 2019
Motor/Compressor	Low Pressure Drop Filters	IL, 2018
Motor/Compressor	Zero Loss Condensate Drain	NB, 2017
Motor/Compressor	Refrigerated Air Dryer	PSEGLI, 2019
Motor/Compressor	Motor Controls - Process	Custom
Motor/Compressor	Motor Controls - Conveyors	Custom

Class	Measure	Source
Motor/Compressor	Motor Controls - Pumps	Custom
Office Equipment	Advanced Smart Strips	MA, 2019-20
Office Equipment	Advanced Smart Strips	MA, 2019-20
Refrigeration	Refrigerated Case Anti-Sweat Door Heaters	PSEGLI, 2019
Refrigeration	Refrigerated Case Anti-Sweat Door Heaters	PSEGLI, 2019
Refrigeration	Refrigerated Case Door Gaskets	NY, 2017
Refrigeration	Refrigerated Case Door Gaskets	NY, 2017
Refrigeration	Refrigerated Case Night Cover	MA, 2016-18
Refrigeration	ENERGY STAR Ice Maker	MA, 2016-18
Refrigeration	Refrigerated Case EC Motor	PSEGLI, 2019
Refrigeration	Refrigerated Walk-ins EC Motor	PSEGLI, 2019
Refrigeration	Refrigerated Walk-ins Evaporator Fan Control	PSEGLI, 2019

Measure Ramp-Up

Home Energy Report measures represent significant savings and are not currently offered by existing programs, so ramp rates of 33%, 67%, and 100% are applied in the first three years of the study, respectively.

C.1.2 Lighting Standards and market evolution

At the time of this study, Natural Resources Canada has announced a revision of lighting standards; however, no date has been set. Lighting standards are typically done in step with the U.S. DOE standard setting process, but again the timing has not yet been confirmed. Irrespective of potential new lighting standards, the lighting market has been evolving towards LEDs becoming the baseline for bulbs. As such, Dunsky is using a net-to-gross (NTG) of 0.3 for bulbs in both the residential and C&I sectors.

In addition, for the residential sector, it is assumed that the market dominance of LEDs is still growing but the study sunset the lighting measures after five years. At this point the market will be fully transformed or a new standard will be adopted and thus no more savings can be claimed. For C&I, a similar market transformation assumption is used; however, savings are claimed for different timescales depending on the Hours of Use (HOU) in a segment.

C.2 Market Characterization

C.2.1 Customer Population Counts

Customer population counts are a key parameter for defining market opportunities. Population counts were estimated using anonymized monthly customer meter data provided by Maritime Electric and then scaled to include Summerside Electric customers. The final population counts for each sector and segment are presented in Table C-4.

Table C-4. Customer Sector and Segment Population Counts.

Sector / Segment	Number of Customers
Residential	75,021
Single Family	*47,699*
Multi-Family[11]	*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

To arrive at these population estimates, the customer data was treated with the following approach.

- Residential – Metered accounts under rate codes 110 (Residential Urban) and 130 (Residential Urban) were included. Based on information provided by Maritime Electric, one meter is assumed to be one customer. Note, seasonal accounts were excluded from the study. The Maritime Electric data does not include a breakdown by residential segment therefore the results of the primary market data collection and the 2016 Statistics Canada Census were used to estimate the number of single family, multi-family, and low-income customers. These were then escalated by 10% to include Summerside Electric customers.

- Commercial & Industrial – Maritime Electric provided C&I consumption by rate code as well as total consumption by three-digit SIC code and the associated number of meters. Dunsky mapped the SIC codes into groups, segments, and divisions of the classification structure, aggregating the consumption data into the appropriate C&I segment. Residential accounts were removed from the dataset and some adjustments were made based on additional information provided by Maritime Electric (e.g., education was isolated from offices). Based on information provided by Maritime Electric, it is assumed that C&I customers have on average 1.8 meters; this was used to convert the data from meters to number of customers. These were then escalated by 10% to include Summerside Electric customers. To note, electricity consumption related to agriculture is included under the industrial segment.

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

C.2.2 Market Baseline Data

The DEEP model requires detailed baseline information, including stock, size and efficiency of existing energy-intensive equipment as well as information pertaining to typical building characteristics (e.g., heating fuel mixes, year of construction, building size) that can impact use. Ultimately, this information is used to determine which homes, commercial buildings, processes, and equipment might be eligible for more efficient equipment and the level of savings that might be achieved from various measures.

The study uses residential and C&I baseline information derived from telephone surveys conducted by Ad Hoc Research in the summer of 2020. This includes 150 residential and 200 commercial and industrial observations. The total number of observations by sector is a sufficient sample size to ensure a validity rate of 70% of the survey rate, which is typically considered acceptable for a high-level market baseline study. A snapshot of the residential and C&I respondents is provided in the tables below.

Table C-5. Summary of Residential phone survey respondents by type of building and income

	Total	Single Family	Multi / Plex / Condo	Other		Low Income (less than $50K)	Higher Income ($50K or more)
Unweighted Counts	150	128	19	3		41	63
Prince	37	32	3	2		12	19
Queens	96	82	14	0		22	36
Kings	17	14	2	1		7	8

Table C-6. Summary of C&I phone survey respondents by segment

	Total	Offices	Retail	Food Services	Health / Hospital	Campus / Education	Warehouse	Lodging	Indus. / Ag	Other
Unweighted Count	200	20	24	23	15	17	23	25	18	35
Weighted Count	200	38	56	18	13	9	15	9	12	31

Where Prince Edward Island specific baseline data was not available (or was based on a low number of observations), baseline data from neighboring jurisdictions, in particular New Brunswick and Newfoundland and Labrador, was leveraged and adjusted for PEI specific attributes wherever possible.

C.2.3 Growth Factors

Table C-7 lists the growth factors used in this study.

Table C-7. New growth factors

Sector	Growth Factor
Residential	1.23%
Commercial and Industrial	0.30%

C.3 Program Characterization

Program characterization was performed by reviewing past EE program investments and savings. These were then compared to Dunsky's internal database of program incentive levels from other potential studies and program design work and the program costs, incentive levels and measure barrier reductions resulting from enabling activities in each program were set for each of the program scenarios.

C.3.1 Residential and C&I Programs

Table C-8 describes each residential and C&I program characterized for this study and the default barrier reductions applied based on existing enabling activities.

Table C-8. Residential and C&I Energy Efficiency Program Enabling Activity Descriptions

Program	Description	Barrier reductions
Energy Efficient Equipment	The program provides rebates for high efficiency equipment such as heat pumps and boilers.	Half step barrier reduction due to subsidized energy audits and availability of financing.
Home Insulation Rebates	The program encourages homeowners to perform energy efficient upgrades by providing information about the energy efficiency of their homes through home energy assessments and financial incentives to implement EE upgrades.	Half step barrier reduction due to subsidized energy audits and the availability of financing.
New Home Construction	The program encourages homeowners and builders to implement EE features in their new builds by providing customized EE recommendations through a review of house plans (evaluated by energy advisors) and financial incentives.	Half step barrier reduction due to subsidized energy evaluation of home plans.
Winter Warming	The program provides low to moderate income Islanders free-of charge direct installation of EE products.	Full step barrier reduction as program is direct install.
Instant Energy Savings	Instant cash rebates (in store and spring/fall campaigns) for lighting products, low-flow products, and appliances.	Half step barrier reduction due to in-

Program	Description	Barrier reductions
		store promotional materials and customer engagement events.
Home Comfort	This is a low-income program that is run in parallel with the Department of Social Development and Housing.	Full step barrier reduction due to turn-key nature of the program, with efficiencyPEI approving quotes and paying contractors directly.
Home Energy Report	NEW	No barrier reduction
Busines Energy Rebates	The program provides commercial, industrial and agricultural customers with rebates for qualified high-efficiency products such as lighting, controls and heat pumps.	No barrier reduction – list of contractors provided but largely participant driven.
Community Energy Solutions	This program provides energy audits and rebates for energy efficiency measures to businesses, community centers, and agricultural operations.	Half step barrier reduction due to free energy audit.
Appliance Recycling	NEW	Half step barrier reduction (assumed to be similar to Instant Energy Savings)

BAU Scenario: Current Programs

The BAU Scenario applies current program parameters as per 2019/20 evaluated program results.

Table C-9. Residential Energy Efficiency Program Inputs (BAU Scenario)

Program Name	Fixed Administrative Costs	Variable Administrative Costs ($/annual kWh)	Incentive as a percentage of incremental cost[12]	NTG
Energy Efficient Equipment	33,845	0.02	27%	0.74
Energy Efficient Equipment Low-Income	3,761		54%	1
Home Insulation Rebates	15,889	0.11	43%	0.77

[12] Incentive as a percentage of incremental costs refers to the portion of the incremental cost of the new, more efficient measure that will be incentivized by the program administrator. In other words, if a high-efficiency heat pump replaces an older, less efficiency heat pump, the incremental cost between the two (cost of new minus old heat pump) is reduced by x%. The percentage is based on current efficiencyPEI program incentive levels and the primary or mix of technology baselines.

Home Insulation Rebates Low Income	1,765		70%	1
Instant Energy Savings - lighting	$15,668	0.09	100%	0.30
Instant Energy Savings - other	$491		14%	0.62
New Home Construction	20,466	0.14	29%	0.62
Winter Warming	13,600	0.04	100%	1
Home Energy Report	2,204	0.15	100%	1
Appliance Recycling[13]	0	0.09	14%	1
Business Energy Rebates	41,251	0.04	50%	0.7 for lighting, 1 for heat pumps, 0.84 otherwise
Community Energy Solutions	17,654	0.11	50%	1

Note: Incentives are expressed as the portion of efficient equipment incremental costs covered by the program.

Mid Scenario: Best in class incentives

The Mid Scenario increases incentives to 75% except where they already exceeded this level with the exception of heat pumps, which were held constant at the BAU incentive level. Barrier reductions were held constant at BAU levels as the Mid scenario does not assume additional enabling activities beyond what is currently in place.

However, two enabling activity sensitivities were applied to the Mid Scenario. For the first, where feasible, a ½ step barrier reduction was added to each program to represent additional enabling activities and the fixed costs increased by 25% and variable costs by 15% to account for increased program investments. For the second, where feasible, a full step barrier reduction was added to each program to account for the additional enabling activities. An additional 5% increase in fixed costs and a 10% increase in variable costs was also applied to reflect the corresponding increase in program investments.

Max Scenario: 100% Incentives

Under the Max scenario, all incentives are increased to 100%, with the exception of heat pumps, which were held constant at BAU levels. As was the case for the Mid Scenario, barrier reductions were held constant at BAU levels.

[13] The appliance recycling program was modelled as if it were an addition to the Instant Energy Savings program; however, as a new element it has been included separately for reporting purposes.

C.4 Economic and other parameters

C.4.1 Discount and Inflation Rates

The discount and inflation rates were sourced from efficiencyPEI's most recent program evaluation reports as well as Maritime Electric's 2019 General Rate Application filing.

Table C-10. Discount and inflation rates

Rate Name	Rate Value
Nominal Discount	3.200%
Real Discount	1.276%
Inflation	2.000%

C.4.2 Avoided Costs

Avoided costs for energy and demand were sourced from efficiencyPEI's program evaluation reports and confirmed through a review of Maritime Electric's 20219 General Rate Application filing. Only one year of avoided cost information was available and therefore avoided costs forecasts were calculated using NB Power's avoided cost annual escalation rates for both energy and capacity.

The aggregated avoided cost inputs used in this study are available in a separate workbook accompanying this report. The values are reported in 2021 real-dollar terms.

C.4.3 Retail Rates

The study uses marginal retail rates to estimate customer bill impacts – one component of calculating adoption and thus achievable potential – for energy savings measures. Marginal electric retail energy and demand rates were developed by reviewing Maritime Electric's Schedule of "Adjusted Rates" as per the 2016 General Rate Agreement. To estimate the marginal rates by segment, Dunsky aggregated the rate variable costs by rate classes (e.g., residential market, general service, small industrial, and large industrial). Using consumption data by size and segment, Dunsky then blended the C&I rates to create general C&I segment rates.

The electricity rates were then forecasted through 2050 using the same yearly percent increases as use for avoided costs as the rate escalators.

C.4.4 Emission Factors

Marginal emission factors were sourced from efficiencyPEI.

Marginal emission factors

Rate Name	Value
Electricity	22g CO_2e/kWh

C.4.5 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 in Prince Edward Island, the study establishes baseline energy and demand forecasts for the study period.

Anonymized customer consumption data from Maritime Electric was used to set the base year energy forecast for the residential, commercial, and industrial sectors.[14] Sector consumption was escalated using annual rates based on average historic annual growth rates presented in Schedule 7-3 of Maritime Electric's 2019 General Rate Application. A 10% adder was then applied to account for Summerside Electric customers, thus generating an Island-wide electricity forecast. This forecast was checked against the energy sales forecast included in Schedule 7-3 and the total was found to be 1% lower than the 2021 forecast in Schedule 7-3.[15] It was also compared against Maritime Electrics 2020 Integrated Systems Plan.

The peak demand forecast is based on the Island-wide load forecast in the 2016/17 PEI Energy Strategy, which itself is based on Maritime Electric and Summerside Electric forecasts. The 2021 and 2022 values were used and then escalated using an average annual escalation rate derived from the peak load forecast in the energy strategy. The demand forecast was also compared against Maritime Electrics 2020 Integrated Systems Plan.

C.5 Demand Response Inputs

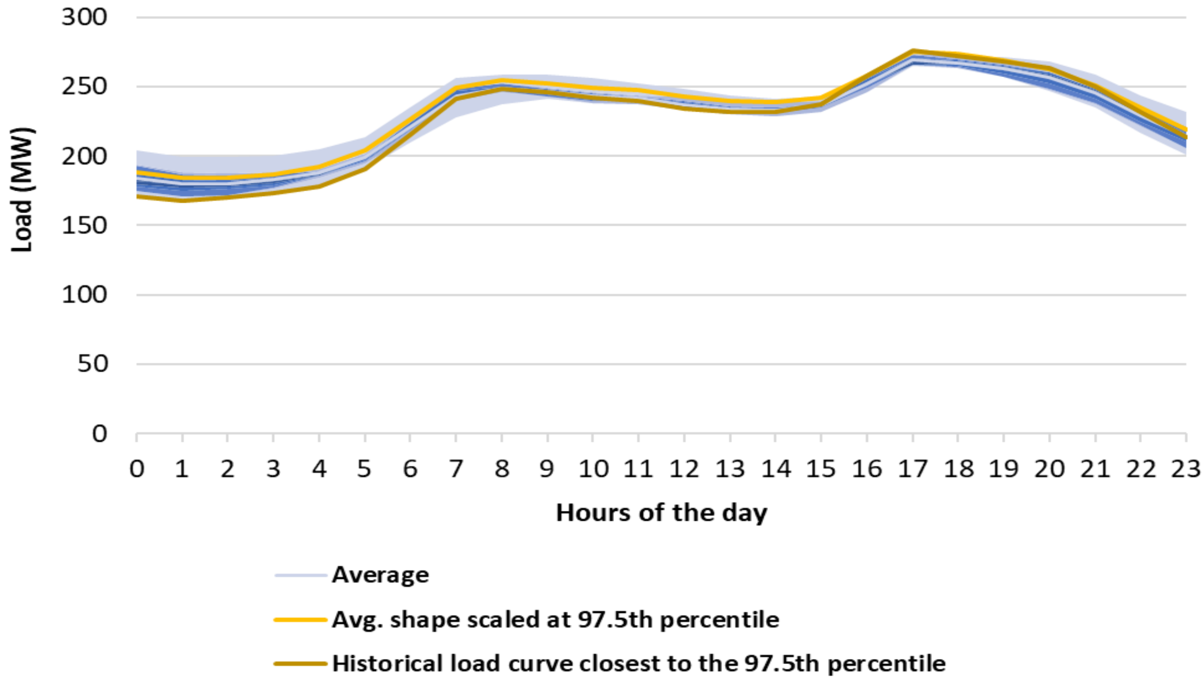
C.5.1 Standard Peak Day

MECL provided Dunsky with hourly historical load data for 2019. This historical data was used to create a standard peak day for the system.

[14] To note, seasonal accounts were removed.

[15] To note, for the sector comparison, customer consumption associated with the agriculture sector was isolated. 75% of this was then moved from residential sales in the General Rate Application Schedule 7-3 to account for the fact that most agricultural operations are currently included as residential customers. This consumption was then added to industrial customers, as agriculture is incorporated into the study's industrial energy forecast.

Figure C-1. Standard Peak Day – PEI



When considering all the impacts on peak demand, it should be noted that with increasing penetration of heat pumps, there is the potential to shift from an evening to morning peak, which has been seen in other jurisdictions. While not part of this assessment, a heat pump forecast study would provide additional insights into how the timing of the peak may shift (more likely towards the end of the study period).

C.5.2 End-Use Breakdowns

Dunsky developed end-use load curves for each market sector and end-use and where relevant, for individual segments. **Note that these breakdowns are for the electric consumption only, not the whole building (all fuel) energy use.** These provide a basis for three study processes:

1. They were used to assess standard peak day adjustments for DR addressable peak determination.
2. They were used to develop savings for custom measures, which are expressed as the potential savings as a portion of the associated end-use consumption.
3. They were used to benchmark savings when calibrating the model.

The end-use load curves were developed from the following sources:

- US Department of Energy (US DOE) published load curves, taken from buildings in comparable climate zones to the PEI climate zones, and adjusted to account for heating energy source.
- Engineered load profiles and Dunsky's in-house developed sample consumption profiles.
- Data from the Ad Hoc primary data collection survey results.

In this study, the industrial sector was grouped into one segment "Manufacturing / Industrial". The segment was modeled using one industrial end-use ("Industrial"), as seen in Error! Reference source not found.6. Industrials were evaluated using Dunsky's internal datasets.

Using this breakdown, an annual (hourly – 8670 hours) building energy consumption simulation from the US DOE (*Commercial Reference Buildings & Building America House Simulation Protocols*) allowed for the recreation of the end-use breakdown for a standard peak day. The figures below present the sector and end-use breakdown of the electric system.

Figure C-2. Standard peak day – Sector breakdown

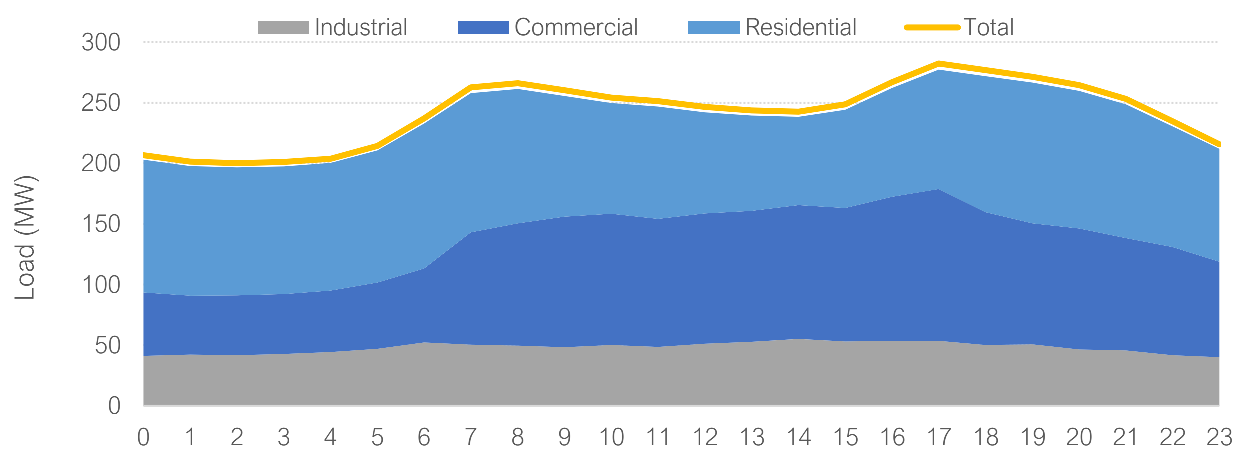
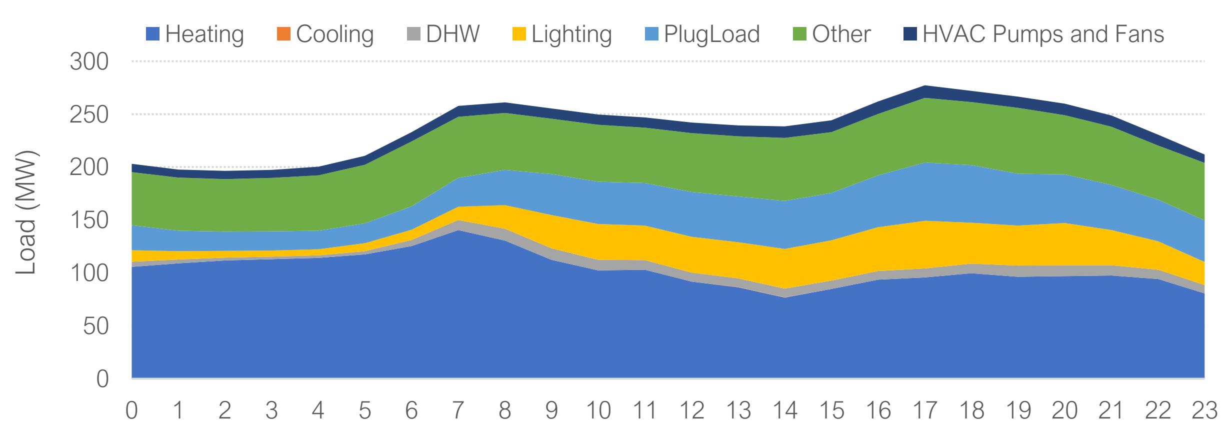


Figure C-3. Standard peak day – End-use breakdown



C.5.3 Future impacts

The standard peak day was forecasted using the same peak demand forecast as the rest of the potential study. It is presented in the table below.

Table C-11. Peak Demand Forecast for Prince Edward Island

Year	Peak (MW)
2021	286
2022	294
2023	300
2024	307
2025	313
2030	348

C.5.4 Measures

To assess the DR potential in the jurisdiction, Dunsky characterized over 25 specific demand reducing measures, based on commonly applied approaches in DR programs across North America, and emerging opportunities such as battery storage. As defined in Appendix B, the measures are covering all customer segments and can be categorized into two groups: Type 1 (constrained by the load curve) and type 2 (unconstrained by load curve). Measures of all types have the following key metrics:

- Load shape of the measure
- Constraints
- Measure Effective Useful Life (EUL)
- Costs

Dunsky applied our existing library of applicable DR measure characterizations and adjusted them to reflect end-use energy use profiles in Prince Edward Island's climate. Each measure was evaluated independently for each segment of the study. Tables 4 and 5 provide an overview of each measure characterization and approach.

Table C-12. Residential Demand Response Measures

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST
Appliances				
Clothes Dryer - DLC	Appliance shut off during event	Smart Plug	Number of non-smart clothes dryers in the jurisdiction	Smart Plug
Clothes Dryer – BYOD[16]	Appliance shut off during event	Smart Appliance	Number of smart clothes dryers in the jurisdiction	Incentive upon program inscription
Clothes Washer - DLC	Appliance shut off during event	Smart Plug	Number of non-smart clothes washers in the jurisdiction	Smart Plug
Clothes Washer - BYOD	Appliance shut off during event	Smart Appliance	Number of smart clothes washers in the jurisdiction	Incentive upon program inscription
Dishwasher - DLC	Appliance shut off during event	Smart Plug	Number of non-smart dishwashers in the jurisdiction	Smart Plug
Dishwasher - BYOD	Appliance shut off during event	Smart Appliance	Number of smart dishwashers in the jurisdiction	Incentive upon program inscription
Hot Tub/Spa	Temperature setpoint reduction during event	Smart Switch	Number of hot tubs in the jurisdiction	Smart Switch
Hot Water				
Resistance Storage Water Heater - DLC	Appliance shut off during event	Smart Switch	Non-smart electric water heater (excl. heat pump water heater)	Smart Switch
Heat Pump Storage Water Heater – BYOD	Appliance shut off during event	Smart Heat Pump Water Heater	Smart heat pump water heater	Incentive upon program inscription
HVAC				
Central Heating – DLC	Temperature setback	Wi-Fi Thermostat	Households with electric central	Installation of a Wi-Fi

[16] Bring-Your-Own-Device (BYOD) programs are a type of Direct Load Control (DLC) programs.

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST
	(including pre-heating strategies)		heating and with manual or programmable thermostat	thermostat
Central Heating – BYOD	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with electric central heating and with Wi-Fi Thermostat	Incentive upon program inscription
Baseboards - DLC	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with electric baseboards and with manual or programmable thermostat	Installation of a Wi-Fi thermostat
Baseboards - BYOD	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with electric baseboards and with Wi-Fi Thermostat	Incentive upon program inscription
Ductless HP – DLC	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with a Ductless HP	Installation of a Wi-Fi thermostat
Ductless HP – BYOD	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with a Ductless HP and a smart thermostat	Incentive upon program inscription
Ducted HP – DLC	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with a Ducted HP	Installation of a Wi-Fi thermostat
Ducted HP – BYOD	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Households with a Ducted HP and a smart thermostat	Incentive upon program inscription
Dual-fuel Systems	Fuel-switching at peak hours	Integrated Controls	Households with an electric central heating system.	Replacement of the existing system for a dual-fuel system.

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST
Electric Thermal Storage (ETS)	Stored heat (in ceramic bricks) is released throughout the peak hours	Integrated Controls	Households with compatible heating systems	Full cost of installing a new ETS system.
Other				
Electrical Vehicle (EV)	Shut off during event	Smart Electric Vehicle Supply Equipment (EVSE) or Smart Plug (such as FloCarma Plug)	Number of EVs in the jurisdiction x % charged at home	Smart EVSE or Smart Plug
Battery Energy Storage (BES) – BYOD	Battery discharges during event	Battery	All households with an existing BES system	Incentive upon program inscription
Time-of-Use (TOU) Rates	Implementation of a TOU Rates	AMI	All commercial and institutional buildings	None

Table C-13. Non-Residential Demand Response Measures

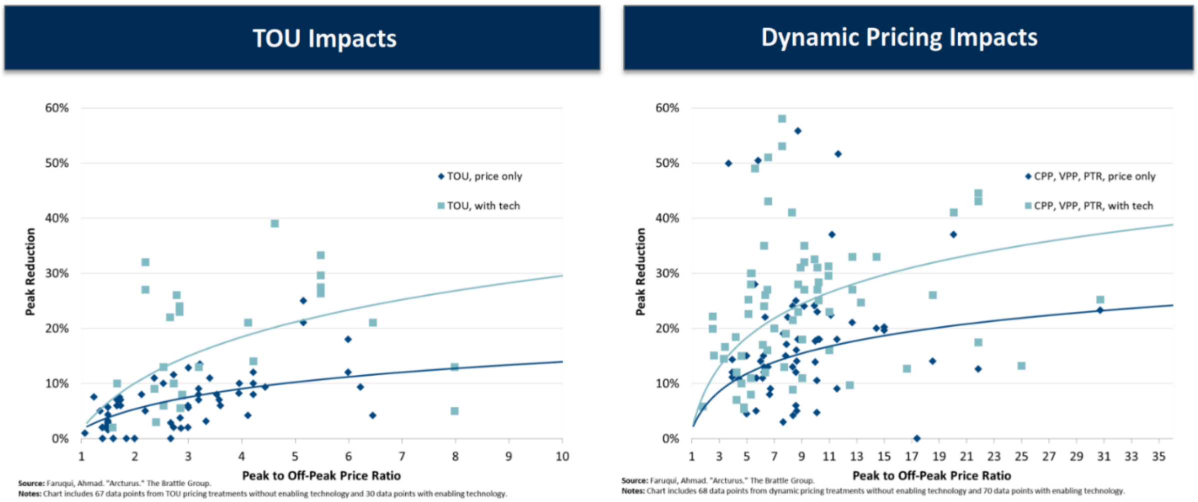
MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST
Appliances				
Commercial Refrigeration	Refrigeration loads shed	Auto-DR	Refrigeration load per building with low-temperature cases x number of buildings (Grocery only)	Automated demand response
Water Heater				
Resistance Storage Water Heater - DLC	Appliance shut off during event	Smart Switch	Non-smart electric water heaters (excl. heat pump water heater)	Smart Switch
HVAC				
Wi-Fi Thermostat – DLC	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Small C&I buildings with central AC and with manual or programmable thermostat	Wi-Fi Thermostat
Wi-Fi Thermostat – BYOD	Temperature setback (including pre-heating strategies)	Wi-Fi Thermostat	Small C&I buildings with central AC and with Wi-Fi thermostat	Incentive upon program inscription
Medium C&I – HVAC Curtailment	HVAC demand curtailment	Manual, BAS or existing Auto-DR	All medium-sized C&I buildings	None
Medium C&I – HVAC Curtailment (Auto-DR)	HVAC demand curtailment	Auto-DR	All medium-sized C&I buildings without existing systems	Auto-DR system
Large C&I – HVAC Curtailment	HVAC demand curtailment	Manual, BAS or existing Auto-DR	All medium-sized C&I buildings	None
Large Cpl – HVAC Curtailment (Auto-DR)	HVAC demand curtailment	Auto-DR	All medium-sized C&I buildings without existing systems	Auto-DR system
Lighting				
Medium C&I – Lighting Curtailment	Turning off some of the fixtures or reducing	Manual, BAS or Auto-DR	All medium-sized C&I buildings	None

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST
	lighting levels during peak events			
Large C&I – Lighting Curtailment	Turning off some of the fixtures or reducing lighting levels during peak events	Manual, BAS or Auto-DR	All large-sized C&I buildings	None
Other				
Electrical Vehicle (EV)	Shut off during event	Smart Electric Vehicle Supply Equipment (EVSE) or Smart Plug	Number of EVs in the jurisdiction x % charged at the office	Smart EVSE or Smart Plug
Energy Storage	Battery Energy Storage (BES) discharges during event	BES	All C&I buildings with an existing BES system.	Incentive upon program inscription
Large Interruptible Loads	Load shifting with no intraday rebound, via expansion of interruptible rates	Manual, BAS or Auto-DR	All large-sized buildings	None
Time-of-Use (TOU) Rates	Implementation of a TOU Rates	AMI	All commercial and institutional buildings	None

C.5.5 Dynamic Rates

Dynamic rates impacts were assessed using a peak to off-peak ratio. Figure C-4presents this relationship that was established in a meta-analysis of TOU and dynamic rates by the Brattle Group[17]. This relationship is used to estimate peak savings and the energy shifted outside of the peak hours. Finally, based on Ontario's TOU roll-out, little to no energy conservation was reported when implementing TOU rates. For this reason, the study assumes a small 2% savings on the energy displaced over peak hours.

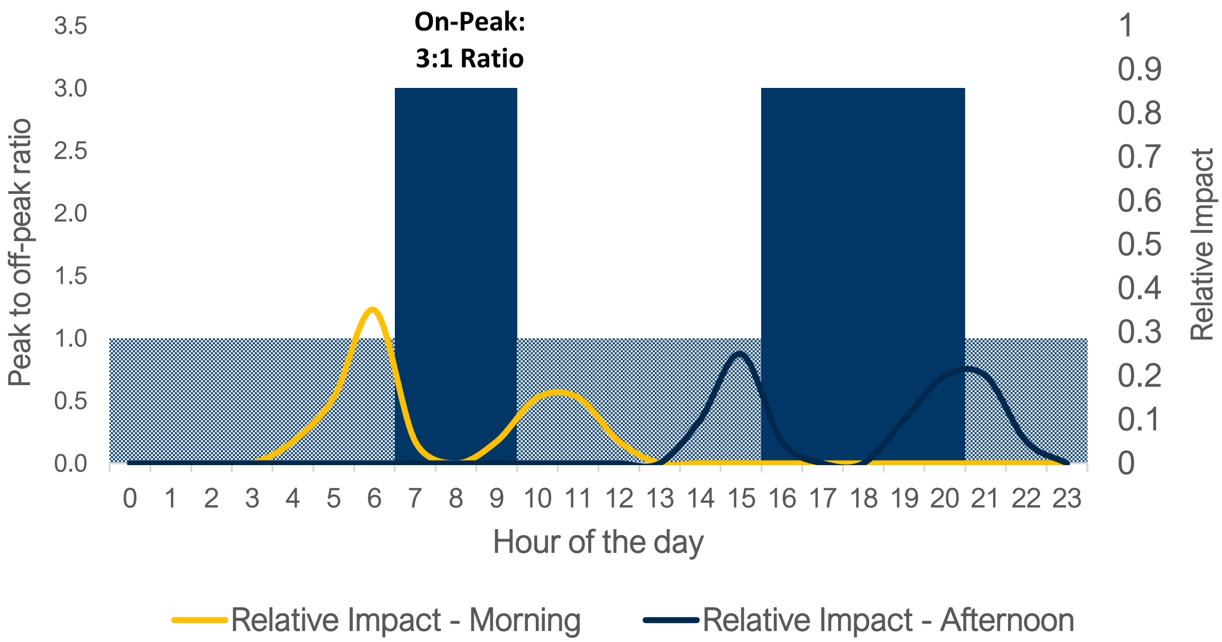
Figure C-4. Dynamic Rate Peak Reduction



Ultimately a two-tier, 3:1 peak to off-peak TOU rate design, applied to residential customers, was found to deliver a reasonable benefit/cost ratio, when applied in the absence of other DR programs and measures. This was applied to the peak day load shape to create two peak rate windows (7-9 am and 4-7pm). Figure C-5, below, presents this TOU rate structure as well as the normalized energy redistribution profiles from the TOU demand savings.

[17] Peak reduction from dynamic rates was assessed from "Arcturus: International Evidence on Dynamic Pricing", A. Faruqui and S. Sergici. 2013.

Figure C-5. Dynamic Rate Peak Reduction



The two-tier 3:1 TOU Rate design was applied to the system peak day, and it reduced the peak demand by 10.7 MW in 2030.

C.5.6 Programs

Table C-14 below presents the program costs for each major program type applied in the DR potential model. Program costs account for program development (set up), annual management costs, and customer engagement costs. These are added over and above any equipment installation and customer incentive costs to assess the overall program cost-effectiveness. In some cases, a program's constituent measures may be cost-effective, but the program may not pass cost-effectiveness testing due to the additional program costs. Under those scenarios, the measures in the underperforming program are eliminated from the achievable potential measure mix, and the DR potential steps are recalculated to reassess the potential and cost-effectiveness of each measure and program.

Table C-14. DR Program Administration Costs Applied in Study (excluding DR equipment costs)

Program Name	Development Complexity	Development Costs	Program Fixed Annual Costs	Other Costs ($/customers) for marketing, IT, admin
Residential DLC	Medium	$150,000	$75,000	$35
Small Commercial DLC	Medium	$150,000	$75,000	$40
Medium & Large C&I Curtailment	Medium	$150,000	$75,000	$30
Residential Energy Storage	Medium	$150,000	$75,000	$30
C&I Energy Storage	Medium	$150,000	$100,000	$25
Dual Fuel Program	Medium	$150,000	$75,000	$30
Large Interruptible Rates	Small	$100,000	$150,000	$25
TOU Rates	High	$300,000	$150,000	$5

D. Energy Efficiency Model Assumptions and Outputs

Appendix D contains additional detailed results tables for the energy efficiency module of the Potential Study as needed and is provided in an Excel Workbook format.

E. Demand Response Model Outputs

E.1 DR Technical and Economic Potential

The analysis applies a range of DR programs, assessing the ability of each to address the PEI annual peak. A description of each individual program assessed follows.

It is important to note that in this section the technical and economic potentials are assessed for each measure individually, interactions within each individual measure are included but no interactions among the measures are considered. The following technical and economic potential results provide the DR potential of each measure, across all applicable segments, including currently enrolled demand reduction capacity.

Measures that cost-effectively deliver sufficient peak load reductions individually are retained and applied in the achievable potential scenario analysis to determine their achievable potential, the results of which are presented later in this chapter. Consistent with the other savings modules in this study, only cases where the measure yields a Program Administrator Cost (PAC) Test value in excess of 1.0 are retained in the economic potential. In all cases test values presented here are those associated with the specific installation year indicated, covering just the market segments that yield PAC Test values that exceed the threshold.

E.1.1 Medium and Large Commercial and Industrial Programs

MECL and Summerside have already enrolled a certain amount of large commercial and industrial load reductions through their current large interruptible load agreement (15MW based on PEI Energy Strategy). This is comprised of facility load curtailment, as well as self-generation capacity, that can be currently engaged in emergency cases. Table E-1, below, presents the measures providing a notable degree of peak load reduction.

Table E-1. Medium and Large Commercial and Industrial Potential

Measure	2025		2030	
	Technical Potential (MW)	Economic Potential (MW)	Technical Potential (MW)	Economic Potential (MW)
Battery Energy Storage (BYOD)	10.5	10.5	11.4	11.4
Medium & Large Curtailment	39.2	34.9	39.9	35.6
Large Interruptible	16.7	16.7	18.3	18.3

Curtailment measures assumed a 4-hour curtailment window. These measures cover all HVAC measures (setpoint reduction, fresh airflow reduction, etc.) along with other various end-uses and processes (hot water, pumps, etc.). For larger buildings, lighting curtailment can be implemented alongside HVAC system curtailment, applying manual controls at the facility level during DR calls.

As limited data was available regarding the medium & large customers, it was assumed that most of the large customers willing to participate in a DR program were already enrolled under the interruptible program. For the purpose of this study, the interruptible measure refers to interruptible customers that would be willing to participate in DR-specific events in exchange for an additional performance incentive. Finally, battery energy storage measure leverages existing batteries without any up-front costs from the utility[18].

E.1.2 Small Business – Equipment Control Program

Small Business Equipment Control measures include Bring-Your-Own-Device (BYOD) and utility Direct Load Control (DLC) measures, similar to the residential sector programs of the same names. These measures were applied just to the portion of each commercial segment that would be considered a small building or premises.

Table E-2. Commercial Equipment Control Potential

Measure	2025		2030	
	Technical Potential (MW)	Economic Potential (MW)	Technical Potential (MW)	Economic Potential (MW)
Battery Energy Storage (BYOD)	0.5	0.5	0.5	0.5
Water Heater (BYOD & DLC)	0.8	0.3	0.9	0.4
Wi-Fi Thermostat (BYOD & DLC)	3.2	3.2	3.5	3.5

E.1.3 Residential Programs

Residential programs include a range of existing and new equipment control measures. It includes both Bring-Your-Own-Device (BYOD) and utility provided Direct Load Control (DLC) measures, as listed in

[18] Assuming that market penetration grows up to 5% of large customers and 3% of medium customers.

Table E-3, below.

Table E-3. Residential Equipment Control Potential

Measure	2025		2030	
	Technical Potential (MW)	Economic Potential (MW)	Technical Potential (MW)	Economic Potential (MW)
Clothes Dryer (BYOD & DLC)	7.6	0.7	8.4	1.0
Clothes Washer (BYOD & DLC)	0.5	0	0.55	0
Dishwasher (BYOD & DLC)	0.6	0	0.7	0
Spa (DLC)	0.59	0.59	0.63	0.63
Wi-Fi Thermostat – Central (BYOD & DLC)	12.6	12.6	13.5	13.5
Wi-Fi Thermostat – Baseboards (BYOD & DLC)	4.3	3.6	4.6	3.9
Wi-Fi Thermostat – Ductless HP (BYOD & DLC)	11.2	11.2	13.1	13.1
Wi-Fi Thermostat – ASHP (BYOD & DLC)	3.3	3.3	3.6	3.6
Dual Fuel Systems	33	31.2	35	33.2
Thermal Energy Storage	14.7	14.7	16.3	16.3
Water Heater (BYOD & DLC)	22.7	22.7	24.1	24.1
Battery Energy Storage (BYOD)	0.3	0.3	0.35	0.35
EV Charging (DLC)	0.2	0.2	0.5	0.5

Most of the economic potential lies in Wi-Fi Thermostat (setpoint control), thermal energy storage systems, dual fuel systems, and smart water heaters. EV load management potential is limited by the projected uptake of EVs over the study period. It should be noted however that as EV adoption accelerates, it is expected to amplify the peak and shift it later in the evening, making EV load management ever more important.

E.2 Demand Response Achievable Potential

E.2.1 Active Demand Potential Results by Measure

Tables below displays the achievable potential for each residential and C&I measures that passed the cost-effectiveness screening.

Table E-4. Residential Achievable Potential Results by Measure by Scenario (MW)

Program	Measure	2030	
		Customer Incentives	Customer Incentives + Interruptible Rates
Residential BYOD	Wi-Fi Thermostat – Central	0.3	0.3
Residential BYOD	Wi-Fi Thermostat – Baseboard	0	0
Residential BYOD	Wi-Fi Thermostat – Ductless HP	0.6	0.6
Residential BYOD	Wi-Fi Thermostat – ASHP	0.1	0
Residential BYOD	Smart Clothes Dryer	0.1	0
Residential DLC	Wi-Fi Thermostat – Central	1.5	1.2
Residential DLC	Wi-Fi Thermostat – Baseboard	0.5	0
Residential DLC	Wi-Fi Thermostat – Ductless HP	0	0
Residential DLC	Wi-Fi Thermostat – ASHP	0.3	0
Residential DLC	Electric Vehicle	0.1	0
Residential DLC	Spa (smart switch)	0.1	0
Residential DLC	Resistance Storage Water Heater (smart switch)	3.0	1.1
Residential Energy Storage	Battery Energy Storage	0.1	0.1
Residential Energy Storage	Thermal Energy Storage	3.3	0
Dual Fuel Program	Dual Fuel System	4.0	4.0

Table E-5. C&I Achievable Potential Results by Measure by Scenario (MW)

Program	Measure	2030	
		Customer Incentives Scenario	Customer Incentives + Interruptible Rates
Medium & Large C&I Curtailment	Commercial Refrigeration (Auto-DR)	0.1	0
Medium & Large C&I Curtailment	Medium Curtailment	3.7	3.1
Medium & Large C&I Curtailment	Medium Curtailment (Auto-DR)	0.4	0.3
Medium & Large C&I Curtailment	Large Curtailment	0.5	0.5
Medium & Large C&I Curtailment	Large Curtailment (Auto-DR)	0	0
Small Commercial BYOD/DLC	Resistance Storage Water Heater (smart switch)	0	0
Small Commercial BYOD/DLC	Wi-Fi Thermostat	0.2	0
C&I Energy Storage	Small Battery Energy Storage	0	0
C&I Energy Storage	Large Battery Energy Storage	1.3	1.3
C&I Energy Storage	Medium Battery Energy Storage	0.3	0.3
Large Interruptible	Large Interruptible	0	18.3

E.2.2 Active Demand Potential Detailed Results

A detailed set of model outputs are included in a separate Excel spreadsheet. The spreadsheet includes achievable potential per segment as well as costs and cost-effectiveness results by measure by year.