New Hampshire Potential Study

Statewide Assessment of Energy Efficiency and Active Demand Opportunities, 2021-2023

Volume II: Appendices

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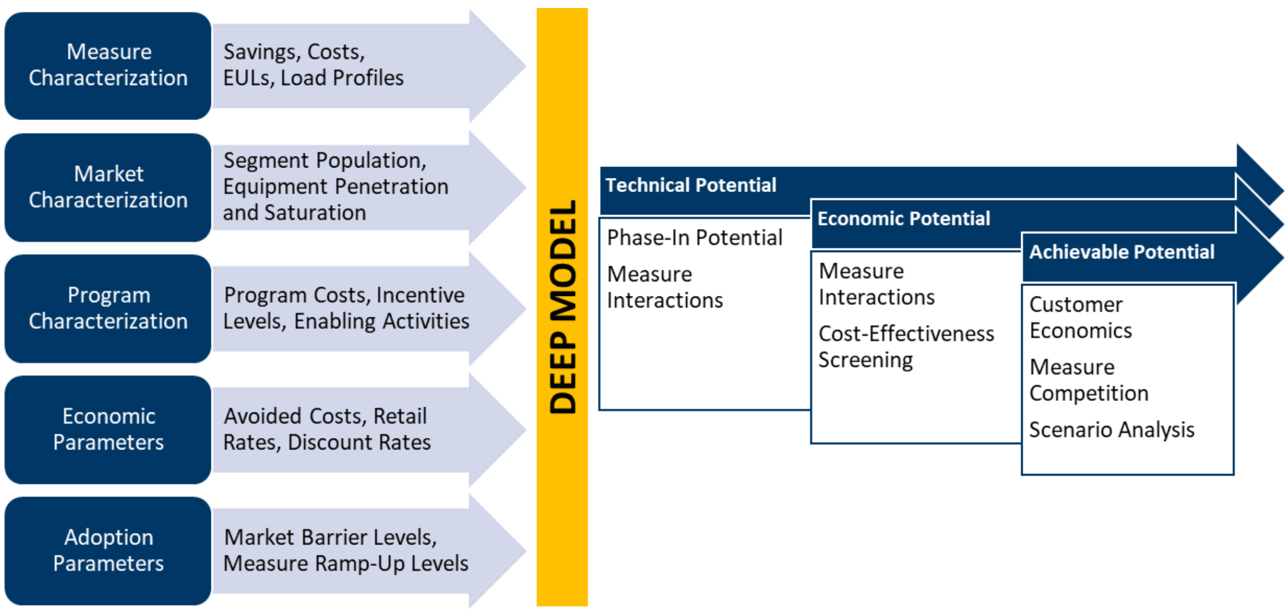
A. Energy Efficiency Methodology

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 modeling 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 "top-down" analysis), DEEP 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-saving opportunities for each measure-market combination each year. This provides an important time series for each energy-saving 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.

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 existing measures in NHSaves 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 were highly unlikely to pass cost-effectiveness testing 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 the Sponsor group. The final measure list

[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.

represents more than 2,200 measure-market combinations, representing the full range of commercially avialable technologies (current and emerging). The complete measure list is included in Appendix C.

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 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. The table below describes these parameters.

Table 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 Burnout • 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

New Hampshire does not currently have a state-specific Technical Reference Manual (TRM). This study characterized measures using inputs from 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 when determining the maximum annual market available for phase-in potential. 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 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.
Early Replacement (ER)	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.

In this study, only a small number of measures were characterized as early replacement measures. In general, early replacement measures are limited to those where energy savings are sufficient to motivate a customer to replace existing equipment significantly before the end of its expected life. This is generally limited to measures with long EULs and a large difference between existing installed efficiency and baseline efficiencies for new equipment (e.g. furnaces and boilers) as the early replacement of these measures will create significant additional savings through the early retirement of particularly inefficient equipment. While current NHSaves programs may incentivize customers to replace equipment before it actually ceases to function or maintenance costs become excessive, the exclusion of these measures in the model will not impact overall savings estimates as the model is calibrated to the savings currently procured by programs.

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.

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 C.

This study characterized programs through an extensive review of NHSaves existing programs and conversations with NHSaves program specialists to develop initial estimates of program costs, incentives, and enabling activities. The initial program characterization was reviewed by the Sponsor group and subsequent updates were made. For each achievable scenario in the DEEP model, incentive levels are set at the program level as a portion of the incremental costs for each eligible measure in the program. However, a real-world program design would likely set unique incentive levels for each measure, applying higher incentive levels for measures that may have had limited uptake in the past, and maintaining or lowering incentive levels for measures that meet their expected adoption. The text box below describes how a more granular approach to incentive setting could lead to significantly lower program spending at minimal expense of reducing savings.

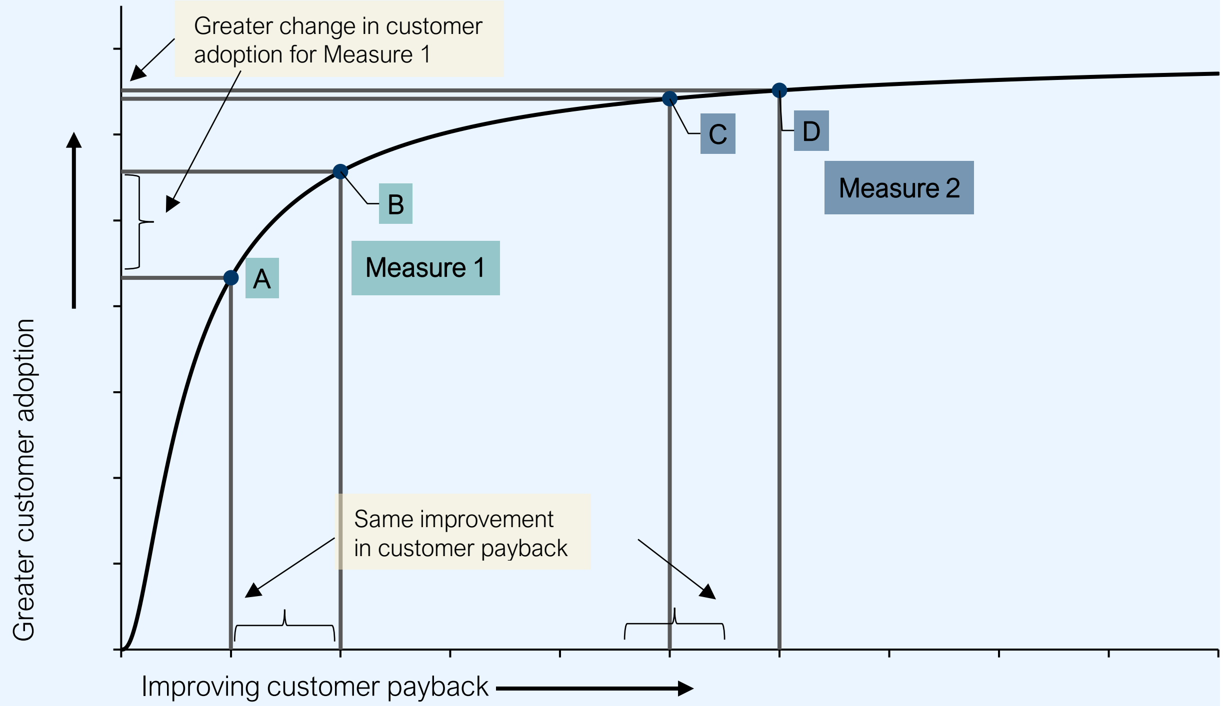
DEEP's Adoption Methodology and Optimizing Program Savings

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

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

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

Schematic Example of Adoption Theory



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

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 cost-effectiveness and customer adoption.

A.3.5 Adoption Parameter Development

DEEP requires a number of key inputs to determine achievable measure adoption including market barrier levels and factors determining customer cost-effectiveness:

- 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.

- Customer cost-effectiveness considers the costs, and benefits, associated with the uptake of an energy efficient measure from the participant's perspective (including the effects of any incentives offered through energy efficiency programs).

A.4 Assessment of Potential

Using the comprehensive 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 performance. Table 3 provides a summary of how DEEP treats each potential type.

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

APPLIED CALCULATION	TECHNICAL POTENTIAL	ECONOMIC POTENTIAL	ACHIEVABLE POTENTIAL
1. ECONOMIC SCREENING	No Screen	Cost-Effectiveness (Granite State Benefit-Cost Test)	Cost-Effectiveness (Granite State Benefit-Cost Test and Participant Cost Test [PCT])
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. ADJUSTED GROSS SAVINGS[2]	Not Considered	Not Considered	Gross ratio adjustments

A.4.1 Technical and Economic Potential

Technical potential is all theoretically possible energy savings stemming from 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 further detail).

[2] Savings are adjusted gross with the exception of specific measures delivered through midstream/upstream strategies and C&I LED technologies in general, where a net-to-gross ratio was applied to generate net savings.

Mid-Life Baseline Adjustments

Where a new standard may alter the baseline of a measure before the end of its EUL, the model removes a portion of the savings for previously installed measures from the cumulative savings for that measure. The amount removed is equivalent to the difference between the baselines, which may represent all or just a portion of the previously installed measure's cumulative savings.

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.

The study screened measures based on New Hampshire's Granite State cost-effectiveness test, a modified version of the Total Resource Cost. The Granite State cost-effectiveness test consists of multiple benefit and cost streams, which were treated and aggregated for use in the DEEP model.

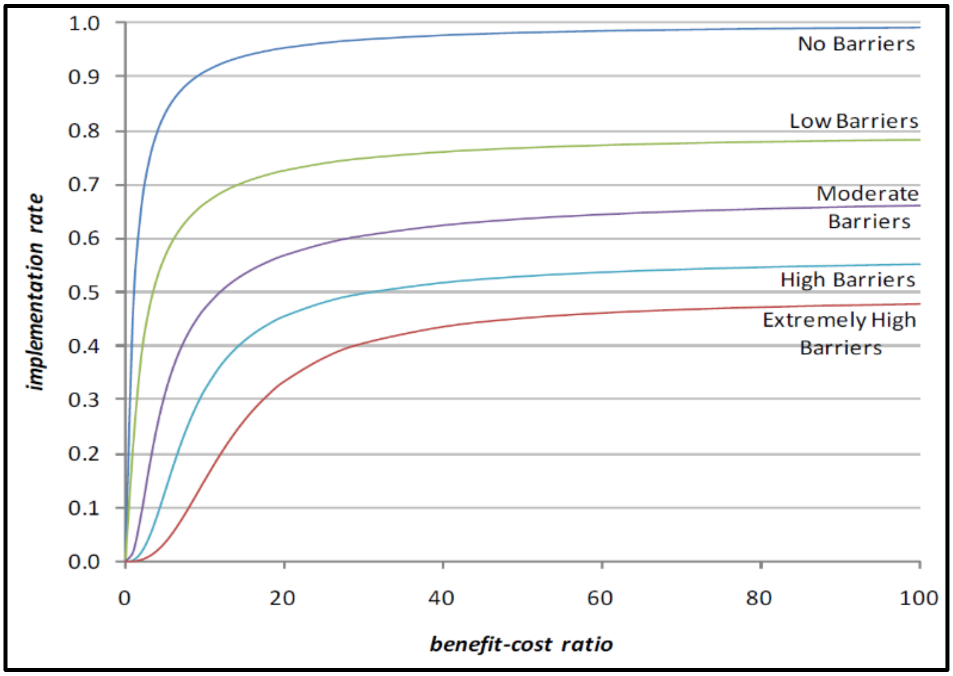
A.4.2 Achievable Potential and Scenario Modeling

Achievable potential is the energy savings stemming from the customer adoption of measures. Rooted in the United States' Department of Energy (U.S. DOE) adoption curves,[3] 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 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 an important refinement as described below:

[3] 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.

Figure 1. Representative Example of Adoption Curves



Refinement: 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 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.

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.

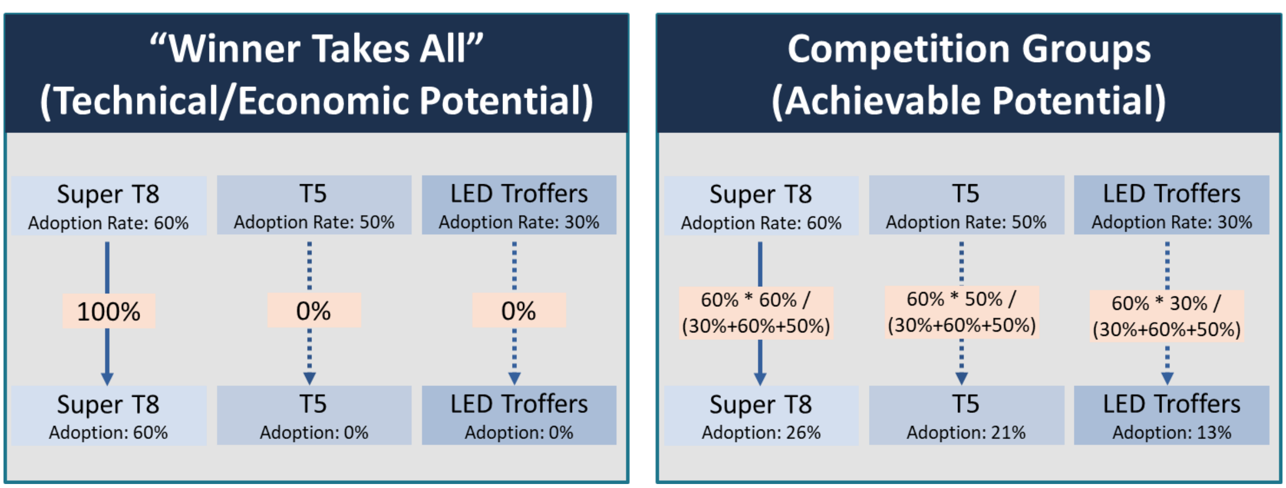
A.4.3 Measure Competition

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 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 2. Example of DEEP Measure Competition

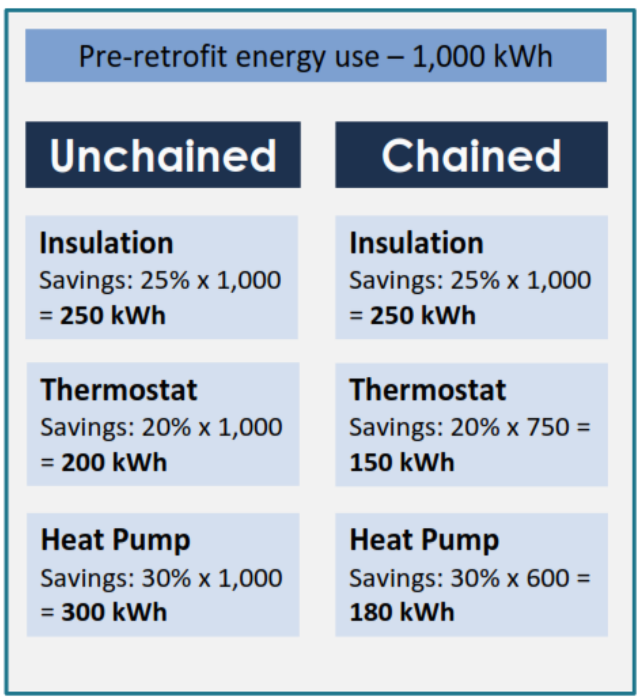


A.4.4 Measure Interactions (Chaining)

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.

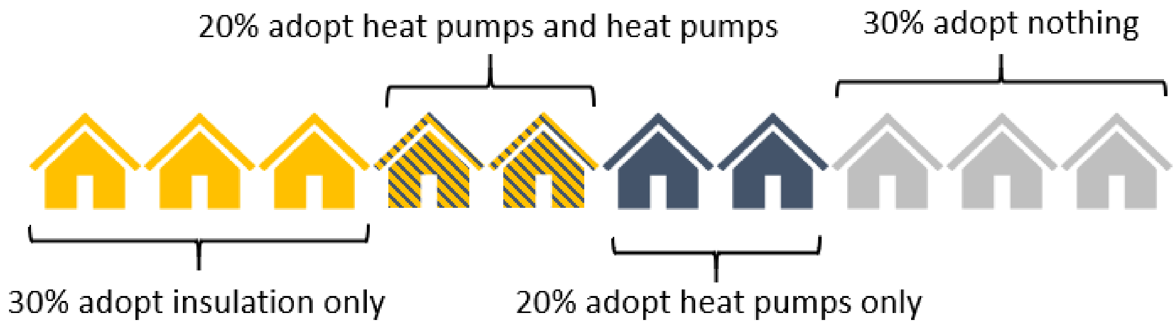
DEEP applies a hierarchy of measures in the chain reducing the savings from each measure that is lower down the chain. The model adjusts the chained measures' savings for each individual measure, with the final adjustment calculated based on the likelihood that measures will be chained together (determined by their respective adoption rates) and the collective interactive effects of all measures higher in the chain. Figure 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 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 4.

Figure 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. Active Demand 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 active demand (called demand response or DR below) potential, is that it takes into account two specific considerations that differentiate it from energy efficiency potential assessments.

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.

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

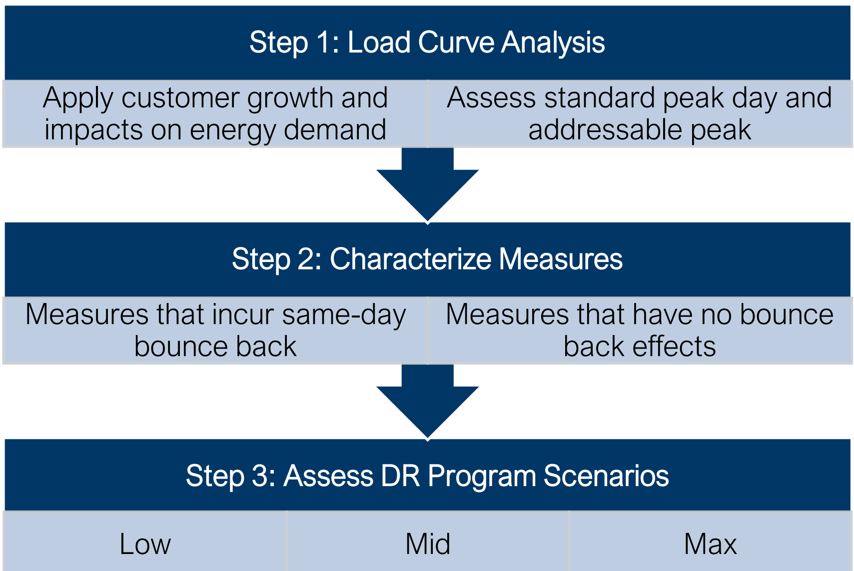
- Participants must receive an incentive over and above simply covering the incremental cost associated with installing the DR equipment.[4]
- Incentives can be based on an annual payment basis, a rebate/reduced rate based on a participant agreement to curtail load, or through time-dependent rates that 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.

[4] 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 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.

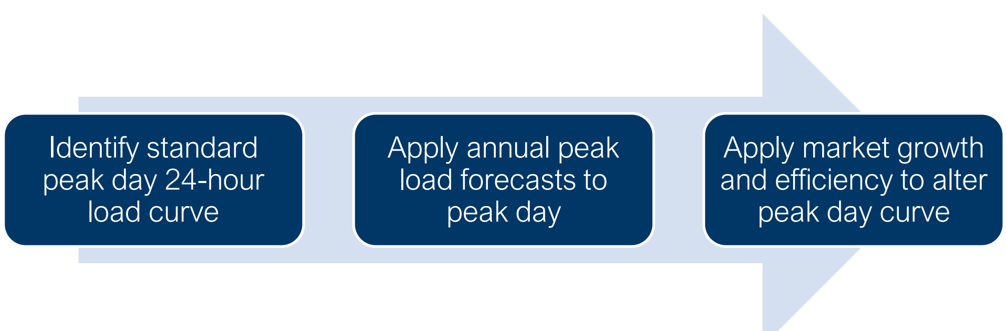
Figure 5. Demand Response Potential Assessment Steps



B.2 Load Curve Analysis

The first modelling step of Dunsky’s 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 and efficiency and heating electrification program savings (as well as solar PV and EV adoption, where relevant) are applied to further adjust the peak day load curve. Since DR measures are assessed against the ISO-NE load curve, the load curve analysis process was applied to both utilities and ISO-NE load curves.

Figure 6. Load Curve Analysis Tasks

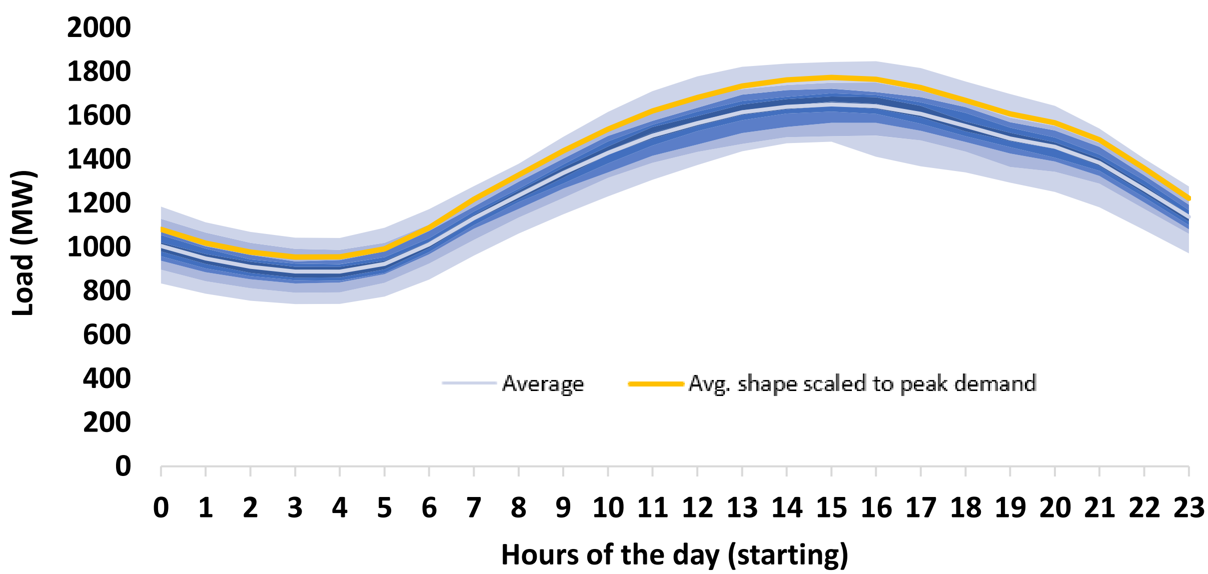


Once complete, the load curve analysis provides a tool which can assess the individual measure, and combined program impacts against a valid utility peak baseline curve that evolves to reflect market changes over the study period.

B.2.1 Identify Standard Peak Day

The **Standard Peak Day** is assessed through an analysis of historical hourly annual load curves. For each 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. 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 7 below.

Figure 7. An Example of Standard Peak Day Curve



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

From the standard peak day curve, a DR window was identified which represent the 6-hour time period that capture the highest demand hours.[5] These are assessed against the historical annual curves to ensure that 90% of DR peak events within a given year fall within the defined DR windows. 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.

[5] A 6-hour peak period is applied as it is considered a reasonable maximum event duration for most DR measures.

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.[6] 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 8. DR 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)

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

- 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)

Dunsky's existing library of applicable DR measure characterizations was 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 corresponds to the program life and assumes that customers will stay enrolled for at least 3 years.

3. **Costs:** At measure level, the costs include the initial cost of the installed equipment (i.e. controls devices and telemetry) and the annual cost (equipment operation and maintenance if any and customer incentives).

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)

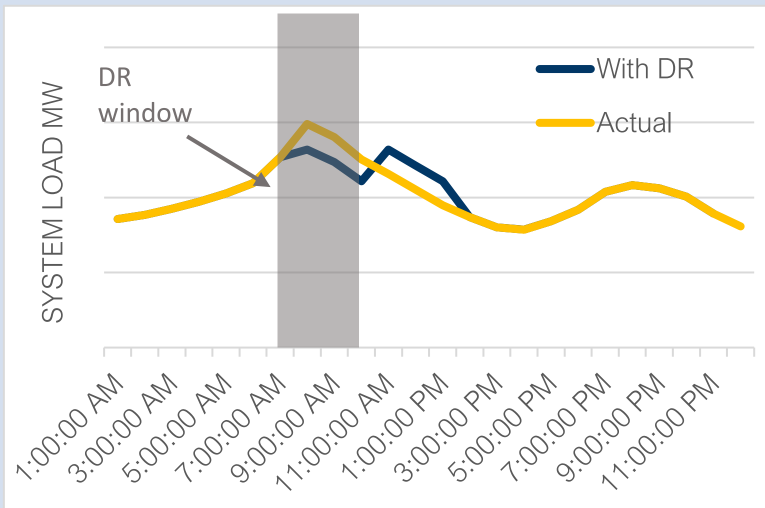
The assessment of each measure's economic potential is conducted in three key steps: adjustment of the technical potential, screening for cost-effectiveness, and adjusting for market adoption limitations.

1. **Net Technical Potential Adjustment**[7]**:** 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 9 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 9. 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.[8] 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).

   For measures that pass the cost-effectiveness screening, program incentives can then be set

[7] Since measures are assessed against the ISO-NE curve, the possibility for NH specific measures to create a new peak on the ISO-NE curve are limited.

[8] Any measure that cannot achieve a cost-effectiveness test > 1.0 is not retained for further consideration in the model. For customer curtailment measures cost-effectiveness test screening may be assessed under a baseline incentive level (i.e. $20/kW). For equipment control measures the baseline incentive can be set to zero, and then adjusted for measures that return net benefits to the utility.

either as a fixed portion of the avoided costs net of measure costs (i.e. 50%) or at the level that maximizes the cost-effectiveness test value for the measure in question.

Table 4. DR Benefits and Costs Included in Determination of the PACT

Benefits	Costs
Avoided Capacity Costs Other ancillary benefits (as applicable)	Controls equipment installation Controls 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.[9]

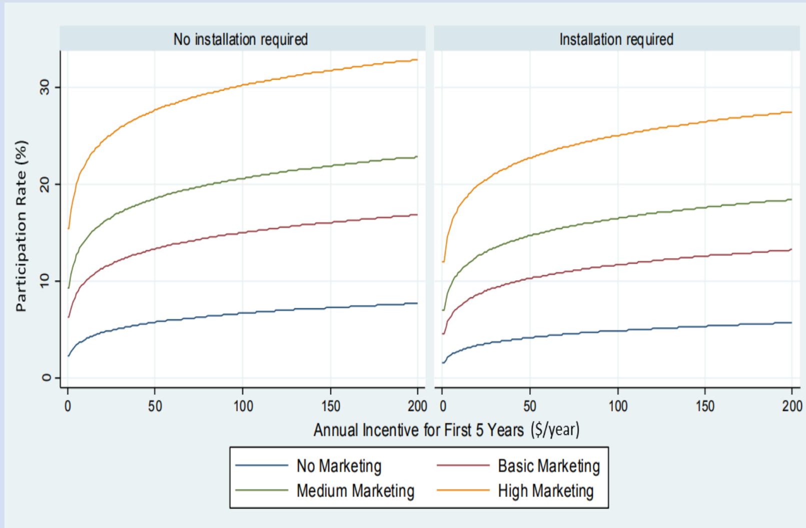
   The DR model assesses both the utility curve economic potential market and the maximum adoption at the resulting incentive levels, then constrains the market (maximum number of participants) to the lower of the two. This is then applied as a measure input for the achievable potential assessment described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

[9] 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.

Figure 10. Residential Adoption Curves used in the study



B.4 Assessment of Achievable Potential Scenarios

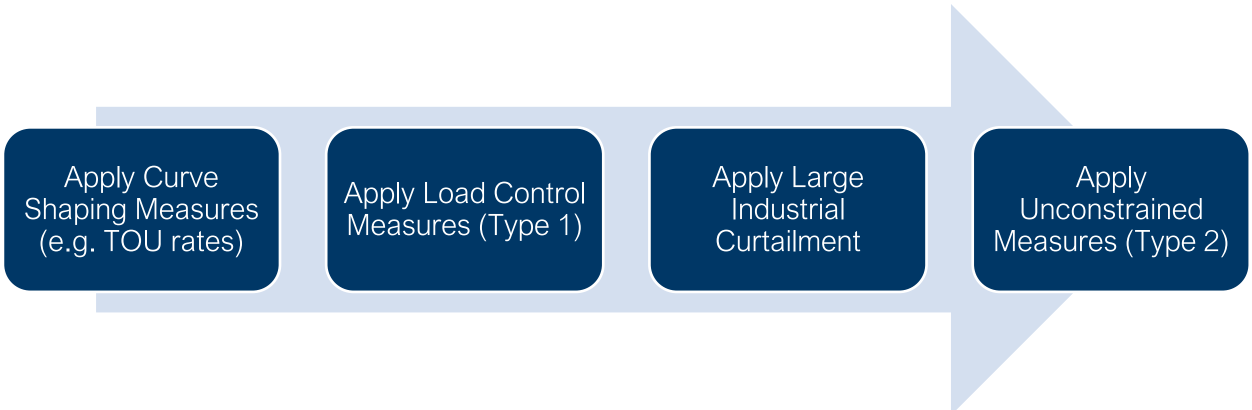
The achievable potential is determined through an optimization process that considers market adoption constraints, individual measure constraints, and the combined inter-measure impacts on the utility load curve.

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 11 below.

Figure 11. 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 remaining Type 2 measures that have no 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 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. In order to take into account program drop-out levels, a percentage of drop-out participants is assumed by program type on a 3-year basis (corresponding to a 3-year enrollment contract). This approach allows the model to fairly assess the program's costs and benefits for an ongoing 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. Typically, it is assumed that it takes three years for a new or expanded program or measure to reach full participation and roll out (i.e. a ramp rate of 33% per year was applied for adding new programs).

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

C.1 Measure Characterization

C.1.1 Energy Efficiency Measure List

The following tables include the energy efficiency measures used in this study.

Table 5. Residential Energy Efficiency Measures

Class	Measure
Appliance	Air Purifier
Appliance	Clothes Dryer
Appliance	Clothes Washer
Appliance	Dehumidifier
Appliance	Dehumidifier Recycle
Appliance	Freezer
Appliance	Freezer Recycle
Appliance	Heat Pump Clothes Dryers
Appliance	Refrigerator
Appliance	Refrigerator Recycle
Behavioral	Home Energy Report
Envelope	Air Sealing
Envelope	Efficient Windows
Envelope	Insulation
Envelope	Insulation - Attic
Envelope	Insulation - Basement
Envelope	Insulation - Wall
Envelope	New Home Construction
Hot Water	Low Flow Faucet Aerator
Hot Water	Low Flow Shower Head
Hot Water	Thermostatic Restrictor Shower Valve
Hot Water	Water Heater - Heat Pump Water Heater (HPWH)
Hot Water	Water Heater - Solar
Hot Water	Water Heater - Storage
Hot Water	Water Heater - Tankless
HVAC	Air Source Heat Pump (ASHP)
HVAC	Air Source Heat Pump (ASHP) Tune Up

Class	Measure
HVAC	Boiler
HVAC	Boiler Reset Control
HVAC	Ceiling Fan
HVAC	Central Air Conditioning (CAC)
HVAC	Central Air Conditioning Tune Up
HVAC	Duct Insulation
HVAC	Duct Sealing
HVAC	Furnace
HVAC	Ground Source Heat Pump (GSHP)
HVAC	Heat Recovery Ventilator (HRV)
HVAC	Mini-split Ductless Heat Pump (DMSHP)
HVAC	RAC Recycling
HVAC	Room Air Conditioner (RAC)
HVAC	Thermostat Wi-Fi
HVAC	Whole House Fan
Lighting	LED A-Lamp (Interior)
Lighting	LED Bulbs (exterior)
Lighting	LED Linear Tube
Lighting	LED Specialty - Candelabras, Globes (Interior)
Lighting	LED Specialty - Reflectors (Interior)
Other	Advanced Power Strips
Other	Pool Pump

Table 6. C&I Energy Efficiency Measures

Class	Measure
Compressed Air	Air Entrainment Nozzle
Compressed Air	Air Receiver for Load/No Load Compressor
Compressed Air	Compressed Air Leak Repair
Compressed Air	High Efficiency Air Compressor
Compressed Air	Low Pressure Drop Filters
Compressed Air	Refrigerated Air Dryer
Compressed Air	Zero Loss Condensate Drain
Envelope	Building Shell Air Sealing
Envelope	Efficient Windows
Envelope	Insulation - Attic/Roof
Envelope	Insulation - Wall

Class	Measure
Envelope	New Construction
Hot Water	Circulator Pump EC Motor
Hot Water	Low Flow Faucet Aerator
Hot Water	Low Flow Pre-Rinse Spray Valve
Hot Water	Low Flow Shower Head
Hot Water	Ozone Laundry
Hot Water	Recirculation Pump with Demand Controls
Hot Water	Salon Sprayer
Hot Water	Thermostatic Restrictor Shower Valve
Hot Water	Volume Water Heater
Hot Water	Water Heater - Condensing
Hot Water	Water Heater - Heat Pump Water Heater (HPWH)
Hot Water	Water Heater - Indirect
Hot Water	Water Heater - Storage
Hot Water	Water Heater - Tankless
HVAC	Waste Heat Recovery
HVAC	Air Source Heat Pumps (ASHP)
HVAC	Boiler
HVAC	Boiler Reset Control
HVAC	Building Management System (BMS)
HVAC	Chiller, Air Cooled
HVAC	Chiller, Water Cooler, Centrifugal
HVAC	Condensing Make Up Air Unit
HVAC	Condensing RTU
HVAC	Demand Control Ventilation (DCV)
HVAC	Destratification Fan - High Efficiency
HVAC	Dual Enthalpy Economizer Controls
HVAC	Energy Management System (EMS)
HVAC	Energy Recovery Ventilator (ERV)
HVAC	Fresh Air controlled by CO2 monitors
HVAC	Furnace
HVAC	Ground Source Heat Pump (GSHP)
HVAC	Guest Room Energy Management
HVAC	High Efficiency Unit Heaters
HVAC	Infrared Heater
HVAC	Kitchen Demand Control Ventilation
HVAC	Mini-split Ductless Heat Pump (DMSHP)

Class	Measure
HVAC	Package Terminal Air Conditioner (PTAC)
HVAC	Package Terminal Heat Pump (PTHP)
HVAC	Refrigeration Heat Recovery
HVAC	Retro-commissioning Strategic Energy Manager (RCx SEM)
HVAC	Room/Wall-Mounted Air Conditioner (RAC)
HVAC	Steam Boiler
HVAC	Steam Boiler Stack Economizer
HVAC	Steam Pipe Insulation
HVAC	Steam Trap
HVAC	Thermostat Wi-Fi
HVAC	Unitary Air Conditioner
HVAC	Water Boiler Stack Economizer
HVAC Motors	HVAC EC Motor
HVAC Motors	HVAC VFD - Cooling Tower
HVAC Motors	HVAC VFD - Fan
HVAC Motors	HVAC VFD - Pump
Kitchen	Dishwasher
Kitchen	Fryer
Kitchen	Hot Food Holding Cabinet
Kitchen	Infrared Broiler
Kitchen	Oven
Kitchen	Steamer
Lighting	LED A-Lamp (Interior)
Lighting	LED Exit Sign
Lighting	LED High Bay
Lighting	LED Linear Luminaire
Lighting	LED Linear Tube
Lighting	LED Parking Garage (Exterior)
Lighting	LED Pole Mounted (Exterior)
Lighting	LED Specialty - Reflectors (Interior)
Lighting	LED T12 Linear Tube
Lighting	Lighting Controls (Daylighting)
Lighting	Lighting Controls (Network)
Lighting	Lighting Controls (Occupancy)
Office Equipment	Advanced Power Strips
Process	Custom Processes
Process	Motor Controls - Conveyors

Class	Measure
Process	Motor Controls - Process
Process	Motor Controls - Pumps
Refrigeration	ENERGY STAR Ice Maker
Refrigeration	LED Refrigerated Case Lighting
Refrigeration	Refrigerated Case Anti-Sweat Door Heaters
Refrigeration	Refrigerated Case EC Motor
Refrigeration	Refrigerated Case Night Cover
Refrigeration	Refrigerated Vending Machines
Refrigeration	Refrigerated Walk-ins EC Motor
Refrigeration	Refrigerated Walk-ins Evaporator Fan Control
Refrigeration	Refrigeration Defrost Control

C.1.2 Appliance and Equipment Standards

Updates to US Federal appliance and equipment standards impact the claimable savings for affected measures. This study accounts for updates to standards that are scheduled to occur during the study period. The study only considers published final standards updates with compliance dates within the study period given that draft standards are subject to revisions and revocations. Standards that will updated before the study period are applied for the entire study period, impacting the baseline efficiency of applicable efficiency measures.

Only one standards update was relevant to this study, as outlined below. This standard update increases the efficiency of baseline equipment beginning in the compliance year, which results in fewer claimable savings from efficiency measures for this technology.

Table 7. Federal U.S. standard update within study period

Product	Compliance Date
Commercial – Warm Air Furnaces	2023

C.1.3 Lighting Assumptions

At the time of this study, there were several uncertainties related to the evolution of the lighting market and the natural adoption of LED technologies. For the 2021-2023 DSM planning horizon, the program administrators have developed assumptions related to the adoption of LED technologies in absence of program intervention, and have integrated net-to-gross factors in their benefit-cost analysis to reflect the increased natural adoption.

To assess the savings attributable to NHSaves programs, the net-to-gross developed for the LED technologies promoted through midstream and upstream programs have been applied to all LED measures.

The following table presents the net to gross ratios used for LED measures in the model.

Measure	2021	2022	2023
Residential LEDs (all programs, except hard to reach)	0.33	0.23	0.13
Residential LEDs (hard to reach sectors)	0.53	0.43	0.33
Commercial screw-ins LEDs	0.73	0.63	0.53
Commercial linear LEDs	0.84	0.77	0.70

C.2 Program Characterization

Program characterization was developed by reviewing past EE program investments and savings, as well as the draft 2021-2023 NHSaves Statewide EE Plan investments and savings. These were then compared to Dunsky's internal database of program incentive levels and measure barrier reductions resulting from enabling activities in each program were set for each of the program scenarios.

C.2.1 Residential Programs

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

Table 8. Residential Program and Enabling Strategy Description and Associated Barrier Reductions

Program	Description	Barrier Reductions
ENERGYSTAR Homes	This program provides incentives directly to homebuilders or homeowners who build homes that meet or exceed the ENERGYSTAR standards. It also provides the services of independent home energy raters who ensure quality assurance and certification throughout the construction process.	Half-step barrier reduction for contracting training and support and customer support at the building design phase, and for reducing product requirements for
ENERGYSTAR Products	This upstream program promotes lighting, appliances, HVAC equipment, and water heating products through in-store rebates. It also provides appliance and equipment recycling services.	Half step reduction for program partnership development with vendors to promote consumer education on the cost-effectiveness of energy-saving products and streamlined online rebate process.
Home Energy Assistance	This program provides energy saving support to income-eligible residents, including air	Full-step barrier reduction to reflect the turn-key assessment,

	sealing, insulation, and health and safety measures.	coordination and outreach activities.
Home Energy Reports	This program achieves energy savings through changes in customer behavior by providing customers with a summary of their energy consumption and a comparison of energy consumption among homes.	No barriers applied for this program in model
Home Performance with Energy Star	This program provides comprehensive energy efficiency improvements for existing homes through a streamlined whole-house approach, including energy audit, installation, and inspection.	Half step barrier reduction for energy audits, technical assistance, financing, and outreach efforts.

Low Scenario: Current Programs

The low scenario applies current program parameters as per the NHSaves 2018-2020 program plan.

Table 9. Residential Energy Efficiency Program Inputs (Low Scenario)

Program Name	Fuel Type	Non-Incentive Fixed Costs	Non-Incentive Variable Costs (electric - $/kWh, gas - $/therm)	Incentive	Barrier Reduction
Energy Star Homes	Electric	$152,755	$0.089	63%	-0.5
Energy Star Products	Electric	$291,726	$0.062	61%	-0.5
Home Energy Assistance	Electric	$498,522	$0.106	100%	-1
Home Energy Reports	Electric	$76,797	$0.011	100%	0
Home Performance with Energy Star	Electric	$331,037	$0.055	75%	-0.5
Small Business Energy Solutions	Electric	$555,695	$0.017	34%	-0.5
Energy Star Homes	Gas	$367,019	$3.40	68%	-0.5
Energy Star Products	Gas	$29,540	$1.39	48%	-0.5
Home Energy Assistance	Gas	$39,789	$5.07	100%	-1
Home Energy Reports	Gas	$62,218	$0.60	100%	0
Home Performance with Energy Star	Gas	$9,481	$2.65	54%	-0.5

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

Mid Scenario: Best-in-Class Incentives with Increased Investments in Enabling Strategies

The Mid Scenario increases incentives to 75% except where they already exceeded this level. Where feasible, a half-step barrier reduction was added to represent additional enabling strategies and the fixed costs and variable costs increased by 25% and 15%, respectively, to account for increased investments.

Program Name	Fuel Type	Fixed Costs	Variable Costs (electric - $/kWh, gas - $/therm)	Incentive	Barrier Reduction
Energy Star Homes	Electric	$190,943	$0.102	75%	-1
Energy Star Products	Electric	$364,658	$0.071	75%	-1
Home Energy Assistance	Electric	$623,152	$0.122	100%	-1
Home Energy Reports	Electric	$76,797	$0.011	100%	0
Home Performance with Energy Star	Electric	$413,796	$0.063	75%	-1
Energy Star Homes	Gas	$458,774	$3.91	75%	-1
Energy Star Products	Gas	$36,924	$1.60	75%	-1
Home Energy Assistance	Gas	$49,736	$5.83	100%	-1
Home Energy Reports	Gas	$62,218	$0.60	100%	0
Home Performance with Energy Star	Gas	$11,852	$3.05	75%	-1

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

Max Scenario: 100% Incentives

Under the Max achievable scenario, all incentives are increased to 100% and the same barrier reductions are applied as in the Mid Scenario. This scenario assumes that best in class barrier reducing effort was applied, and with full incentives that EE Plan budgets were not constrained to pursue all cost-effective savings.

Program Name	Fuel Type	Fixed Costs	Variable Costs (electric - $/kWh, gas -$/therm)	Incentive	Barrier Reduction
Energy Star Homes	Electric	$190,943	$0.102	100%	-1
Energy Star Products	Electric	$364,658	$0.071	100%	-1
Home Energy Assistance	Electric	$623,152	$0.122	100%	-1
Home Energy Reports	Electric	$76,797	$0.011	100%	0

Home Performance with Energy Star	Electric	$413,796	$0.063	100%	-1
Energy Star Homes	Gas	$458,774	$3.91	100%	-1
Energy Star Products	Gas	$36,924	$1.60	100%	-1
Home Energy Assistance	Gas	$49,736	$5.83	100%	-1
Home Energy Reports	Gas	$62,218	$0.60	100%	0
Home Performance with Energy Star	Gas	$11,852	$3.05	100%	-1

C.2.2 Non-Residential Programs

Table 10 describes each residential program characterized for this study and the default barrier reductions applied based on existing enabling activities.

Table 10. Non- Residential Program and Enabling Strategy Description and Associated Barrier Reductions

Program	Description	Barrier Reductions
Small Business Energy Solutions	This program provides incentives for new and retrofit projects and turn-key energy services to small commercial customers.	Half-step reduction for 1) targeted marketing and outreach to stakeholders and customers by segment. 2) Outreach to contractors, installers and distributors on the program. 3) Financing solutions and technical assistance are provided for small businesses. 4) Provides turn-key services, reducing customer retention barriers.
Large Business Energy Solutions	This program provides incentives to large commercial and industrial customers who are retrofitting existing facilities or equipment, constructing new facilities, adding equipment, or replacing equipment at the end of its useful life.	Half step reduction for 1) utilizing utility employees, account representatives, and EE program representatives to identify and target customers during the project design stage. 2) Providing a variety of prescriptive and custom programs to fit customer needs 3) Develops and markets case-studies reflecting best in class projects 4) Works with trade allies to identify and overcome barriers to action.

Municipal Energy Solutions	This program provides incentives to municipal customers who are retrofitting existing facilities or constructing new facilities.	Half step reduction for turn-key solutions including: providing financing options, direct technical assistance, direct communication options with utility, payback analysis, staff walkthroughs, HVAC selection assistance, and targeted audits.
Energy Rewards Request for Proposals	This program (only offered by Eversource), encourages large commercial and industrial customers to propose energy efficiency projects through a competitive solicitation process.	Half-step barrier reduction

Low Scenario: Current Programs

The low scenario applies current program parameters as per the NHSaves 2018-2020 program plan.

Program Name	Fuel Type	Non-Incentive Fixed Costs	Non-Incentive Variable Costs (electric - $/kWh, gas - $/therm)	Incentive	Barrier Reduction
Small Business Energy Solutions	Electric	$555,695	$0.017	34%	-0.5
Large Business Energy Solutions	Electric	$601,209	$0.049	42%	-0.5
Municipal Energy Solutions	Electric	$99,148	$0.060	35%	-0.5
Small Business Energy Solutions	Gas	$103,336	$0.80	42%	-0.5
Large Business Energy Solutions	Gas	$141,696	$1.74	37%	-0.5
Municipal Energy Solutions	Gas	$9,161	$2.75	53%	-0.5

Mid Scenario: Best-in-Class Incentives with Increased Investments in Enabling Strategies

The Mid Scenario increases incentives to 75% except where they already exceeded this level. Where feasible, a half-step barrier reduction was added to represent additional enabling strategies and the fixed costs and variable costs increased by 25% and 15%, respectively, to account for increased investments.

Program Name	Fuel Type	Non-Incentive Fixed Costs	Non-Incentive Variable Costs (electric - $/kWh, gas - $/therm)	Incentive	Barrier Reduction
Small Business Energy Solutions	Electric	$694,618	$0.019	75%	-1
Large Business Energy Solutions	Electric	$751,511	$0.057	75%	-1
Municipal Energy Solutions	Electric	$123,935	$0.069	75%	-1
Small Business Energy Solutions	Gas	$129,170	$0.92	75%	-1
Large Business Energy Solutions	Gas	$177,120	$2.00	75%	-1
Municipal Energy Solutions	Gas	$11,451	$3.16	75%	-1

Max Scenario: 100% Incentives

Under the Max achievable scenario, all incentives are increased to 100% and the same barrier reductions are applied as in the Mid Scenario. This scenario assumes that best in class barrier reducing effort was applied, and with full incentives that EE Plan budgets were not constrained to pursue all cost-effective savings.

Program Name	Fuel Type	Non-Incentive Fixed Costs	Non-Incentive Variable Costs (electric - $/kWh, gas - $/therm)	Incentive	Barrier Reduction
Small Business Energy Solutions	Electric	$694,618	$0.019	100%	-1
Large Business Energy Solutions	Electric	$751,511	$0.057	100%	-1
Municipal Energy Solutions	Electric	$123,935	$0.069	100%	-1
Small Business Energy Solutions	Gas	$129,170	$0.92	100%	-1
Large Business Energy Solutions	Gas	$177,120	$2.00	100%	-1
Municipal Energy Solutions	Gas	$11,451	$3.16	100%	-1

C.3 Economic and Other Parameters

This section outlines the economic and other inputs and parameters used in the study.

C.3.1 Discount and Inflation Rates

The study included discount and inflation rates that are in-line with the benefit-cost ratio models provided by the utilities, outlined in Table 11 below.

Table 11. Discount and Inflation Rates Included in the Study

Rate Name	Rate Value
Nominal Discount Rate	5.5%
Real Discount Rate	3.5%
Inflation Rate	1.94%

C.3.2 Avoided Costs

Dunsky calculated annual avoided costs for electric energy (2021$/kWh), electric capacity (2021$/kW), natural gas (2021$/MMBtu), delivered fuels (fuel oil, propane, kerosene, and biomass)(2021$/MMBtu), and water ($2021/Gallon). Dunsky gathered all required avoided cost inputs from the utility assumptions used in the benefit-cost ratio (BCR) models, converting all values to 2021 real dollars.

C.3.3 Retail Rates

The study used annual segment-specific marginal retail rates. Rates are used in the study to estimate customer bill impacts – one component of calculating achievable potential – for energy saving measures. Dunsky blended the rates from the four utilities, weighted by the last year of total consumption. Dunsky also used the retail rate growth factor included in the BCR models and converted all rates to 2021 real dollars.

C.3.4 Baseline Energy and Demand Forecasts

Dunsky established baseline energy and demand forecasts for the study period in order to understand the impact of the savings from energy efficiency and active demand measures modeled in the study. Electric and natural gas consumption and electric demand forecasts provided by the utilities and delivered fuel forecasts developing by the Energy Information Agency were adjusted to remove the projected impacts of existing and planned energy efficiency programs.

C.4 COVID-19 Sensitivity Analysis

There is a high degree of uncertainty surrounding the short and long-term impacts of the COVID-19 pandemic. Dunsky does not suggest that this analysis predicts what is likely to happen in the future. What it does do is provide information about the sensitivity of modelled savings to changes in market conditions that may plausibly be expected as a direct result of the pandemic – decreased market sizes and increased barriers to efficiency. In the coming years, as more is known about the impact of the pandemic on both the residential and non-residential sectors, gauging this sensitivity is expected to help the utilities refine their understanding of how efficiency programs will be impacted. Our analysis only considers the impacts on energy efficiency programs and does not include any additional sensitivity analysis on the demand reduction potential.

Within the potential model, the following parameters can be adjusted to assess sensitivity of savings potential impacts from the COVID-19 pandemic:

- **Market size**: The market size can be reduced to reflect fewer customers within a given segment due to temporary or permanent business closures
- **Barrier levels:** Barrier levels can be increased to reflect increased competition for capital, decreased resources, and other impediments to energy efficiency upgrades

Leveraging these parameters, we completed the following analysis to develop the sensitivity analysis model settings, which allowed us to then assess the sensitivity of modeled potential savings to impacts from the COVID-19 pandemic.

C.4.1 Methodology

1. **Categorized each non-residential segment into one of three impact categories**
    1. Low: No anticipated closures, increased barriers
    2. Moderate: Anticipated short-term closures, increased barriers
    3. High: Anticipated long-term closures, increased barriers

To categorize non-residential segments, the Dunsky team reviewed the following data sources:

- **United States Census Small Business Pulse Survey[10]:** The United States Census completed the Small Business Pulse Survey from April to June 2020, measuring the changes in business conditions during the pandemic. The data from the final week of the survey (6/21-6/27) was used for the analysis.
- **NHSaves Utility COVID-19 Survey:** Luth Research completed an email survey of NH electric and gas customers to understand the impacts of COVID-19 on the attitudes and planned activities of NH customers related to energy efficiency actions and investments.

The information used from each data source is outlined below.

United States Census Small Business Pulse Survey (United States-Wide)
The following Pulse survey question was considered in the analysis[11]

[10] https://www.census.gov/data/experimental-data-products/small-business-pulse-survey.html
[11] The Pulse survey collected data at the segment level across the United States using NAICS codes. The NAICS codes were mapped to the potential study segments, and this mapping is included in the final section.

1. Overall, how has this business been affected by the COVID-19 pandemic?
    - Large negative impact
    - Moderate negative impact
    - Little or no effect
    - Moderate positive effect
    - Large positive effect

An average response was determined for each segment (see 'Rounded overall category' columns in Table 12 below).

Table 12. Pulse Survey Responses: Overall, how has this business been affected by the COVID-19 pandemic?

Segment	Large negative effect (score=1)	Moderate negative effect (score=2)	Little to no effect (score=3)	Moderate positive effect (score=4)	Large positive effect (score=5)	Overall score	Rounded overall score	Rounded overall category
Campus/Education	59%	33%	1%	2%	1%	1.42	1	Large negative effect
Food Sales	34%	42%	5%	10%	5%	1.92	2	Moderate negative effect
Food Service	71%	23%	1%	2%	1%	1.31	1	Large negative effect
Healthcare/ Hospitals	48%	45%	0%	0%	0%	1.42	1	Large negative effect
Lodging	71%	23%	1%	2%	1%	1.31	1	Large negative effect
Manufacturing/Industrial	39%	42%	1%	4%	1%	1.43	1	Large negative effect
Office	27%	52%	0%	3%	0%	1.44	1	Large negative effect
Retail	34%	42%	5%	10%	5%	1.92	2	Moderate negative effect
Warehouse	42%	41%	2%	4%	2%	1.51	2	Moderate negative effect
Other	35%	44%	1%	1%	1%	1.33	1	Large negative effect

It should be noted that the Pulse survey did not report the number of respondents (n) associated with each question.

Luth Research COVID-19 Survey (New Hampshire-Specific)

An analogous question was included in the Luth Research survey, as outlined below[12].

1. How big an impact has the COVID-19 pandemic and efforts to combat it had on your company's/ organization's financial situation?[13]
   - It has had a very significant impact
   - It has had a significant impact
   - It has had some impact
   - It has had a minor impact
   - It has had no impact

Again, an average overall response was determined for each segment and is included in the 'Rounded overall category' column in the tables below.

Table 13. Luth Research Responses: How big an impact has the COVID-19 pandemic and efforts to combat it had on your company's/ organization's financial situation?

Segment	n	Very significant impact (score=1)	Significant impact (score=2)	Some impact (score=3)	Minor impact (score=4)	No impact (score=5)	Overall score	Rounded overall score	Rounded overall category
Campus/Education	20	30%	30%	25%	5%	10%	2.35	2.00	It has had a significant impact
Food Sales	7	29%	29%	14%	14%	14%	2.57	3.00	It has had some impact
Food Service	24	71%	21%	0%	8%	0%	1.46	1.00	It has had a very significant impact
Healthcare/ Hospitals	22	45%	27%	23%	0%	5%	1.91	2.00	It has had a significant impact
Lodging	66	20%	14%	26%	18%	23%	3.11	3.00	It has had some impact
Manufacturing/Industrial	38	37%	34%	13%	5%	11%	2.18	2.00	It has had a significant impact
Office	67	24%	27%	25%	13%	10%	2.60	3.00	It has had some impact
Retail	41	49%	32%	15%	0%	5%	1.80	2.00	It has had a significant impact
Warehouse	6	0%	33%	50%	17%	0%	2.83	3.00	It has had some impact

[12] The segments that were included in the survey vary slightly from those included in the potential study. A mapping is provided in the final section.

[13] It should be noted that the scale of the Luth Research question varies from 'Very significant impact' to 'No impact' and does not specify whether the impact is considered to be positive or negative. Conversely, the scale of the Pulse survey varies from 'Large negative effect' to 'Large positive effect'. Given the low level of respondents who described the pandemic as having a positive effect on their business in the Pulse survey, this analysis makes the simplifying assumption that the Luth Research survey participants are referring to negative impacts in their responses.

Other	171	31%	22%	25%	9%	13%	2.52	3.00	It has had some impact

Assessment Category Assignment

In this analysis, negative impacts to businesses are assumed to correspond to both increased barrier levels, and – for moderate to high impacts - to decreased market sizes due to business closures. Below the results of the Pulse survey and the Luth Research survey are considered together to categorize each segment.

First, the results from Luth Research were assessed and used to perform an initial classification of impacts, placing segments into either a low, moderate, or high category. The Luth Research results were used as the basis of the initial categorization given that they include responses that are specific to New Hampshire (the Pulse survey is nation-wide), and they include respondents from all segment size categories (the Pulse survey is focused on small business).

Next, the results of the Pulse survey were compared to the Luth Research survey. In cases where the two surveys differed by more than one impact category the assessment category was adjusted to result in categorization that is an average of the two surveys. For example, Luth Research found the Office segment to have Low impacts, while the Pulse survey found Office to have High impacts, so the final assessment category assigned Office Moderate impacts. All segments that were adjusted further based on the Pulse survey results are indicated with an asterix in the 'Assessment Category – Final' column below (lodging, office, other).

Table 14. Combined Responses and Assessment Category Assignment

	Luth Research		Pulse Survey	
Segment	How big an impact has the COVID-19 pandemic and efforts to combat it had on your company's/ organization's financial situation?	Assessment Category – Luth Research	Overall, how has this business been affected by the COVID-19 pandemic?	Assessment Category - Final
Campus/Education	It has had a significant impact	Moderate	Large negative effect	Moderate
Food Sales	It has had some impact	Low	Moderate negative effect	Low
Food Service	It has had a very significant impact	High	Large negative effect	High
Healthcare/Hospitals	It has had a significant impact	Moderate	Large negative effect	Moderate
Lodging	It has had some impact	Low	Large negative effect	Moderate*
Manufacturing/Industrial	It has had a significant impact	Moderate	Large negative effect	Moderate
Office	It has had some impact	Low	Large negative effect	Moderate*
Retail	It has had a significant impact	Moderate	Moderate negative effect	Moderate

Warehouse	It has had some impact	Low	Moderate negative effect	Low
Other	It has had some impact	Low	Large negative effect	Moderate*

Legend
Low
Moderate
High

2. Define sensitivity settings for each of the three categories and for the residential sector

In the table below, settings are outlined for each category. A single setting will be used for the residential sector.

Table 15. Sensitivity Settings by Category for 'Low Impact on Savings' Scenario and 'High Impact on Savings Scenario'

Sector	Category	Segments	Low Impact on Savings Scenario	High Impact on Savings Scenario
Non-Residential	Low	Food sales Warehouse	Market size: No change Barriers: Increase by 0.2 for all study years	Market size: No change Barriers: Increased by 0.5 for all study years
	Moderate	Campus/Education Healthcare/Hospitals Lodging Manufacturing/Industrial Office Retail Other	Market size: Reduce 1st year market size by 10%, return 2nd and 3rd year markets to baseline size Barriers: Increase by 0.5 for all study years	Market size: Reduce 1st year market size by 25%, return 2nd and 3rd year markets to baseline size Barriers: Increase by 0.7 for all study years
	High	Food Service	Market size: Reduce market size by 10% for all study years Barriers: Increase by 0.7 for all study years	Market size: Reduce market size by 25% for all study years Barriers: Increase by 1 for all study years
Residential	N/A	N/A	Market size: No change Barriers: Increase by 0.2 for all study years	Market size: No change Barriers: Increased by 0.5 for all study years

3. **Model sensitivity of achievable potential savings**

Finally, the Dunsky team modelled each of the settings, providing sensitivity around the low and mid achievable potential scenarios. The results of this exercise are included in Volume I of the report in the COVID-19 Sensitivity Analysis section.

C.4.2 Segment Mapping

A mapping of NAICS codes included in the Pulse survey to potential study segments is included below.

Table 16. Pulse Survey NAICS Codes to Potential Study Segment Mapping

NAICS Code	Industry	Potential Study Segment
21	Mining, Quarrying, Oil and Gas Extraction	Manufacturing/Industrial
22	Utilities	Other
23	Construction	Other
31	Manufacturing	Manufacturing/Industrial
42	Wholesale Trade	Warehouse
44	Retail Trade	Retail; Food Sales
48	Transportation and Warehousing	Warehouse
51	Information	Office
52	Finance and Insurance	Office
53	Real Estate and Rental and Leasing	Office
54	Professional, Scientific, and Technical Services	Office
55	Management of Companies and Enterprises	Office
56	Administrative and Support and Waste Management and Remediation Services	Manufacturing/Industrial
61	Educational Services	Campus/Education
62	Healthcare and Social Assistance	Healthcare/Hospitals
71	Arts, Entertainment, and Recreation	Other
72	Accomodation and Food Services	Food Service; Lodging
81	Other Services (except Public Administration)	Other

A mapping of the segments included in the Luth Research suvey to the potential study segments is included below

Table 17. Luth Research Segment to Potential Study Segment Mapping

Luth Research Segment	Potential Study Segment
Multi-family	Lodging
Office	Office
Healthcare and hospitals	Healthcare/Hospitals
Other business/commercial (Please specify)	Other
Food sales and grocery	Food Sales
Education	Campus/Education
Municipal/government	Office
Retail	Retail
Lodging	Lodging
Manufacturing and industrial	Manufacturing/Industrial
Food service and restaurants	Food Service
Warehouse	Warehouse

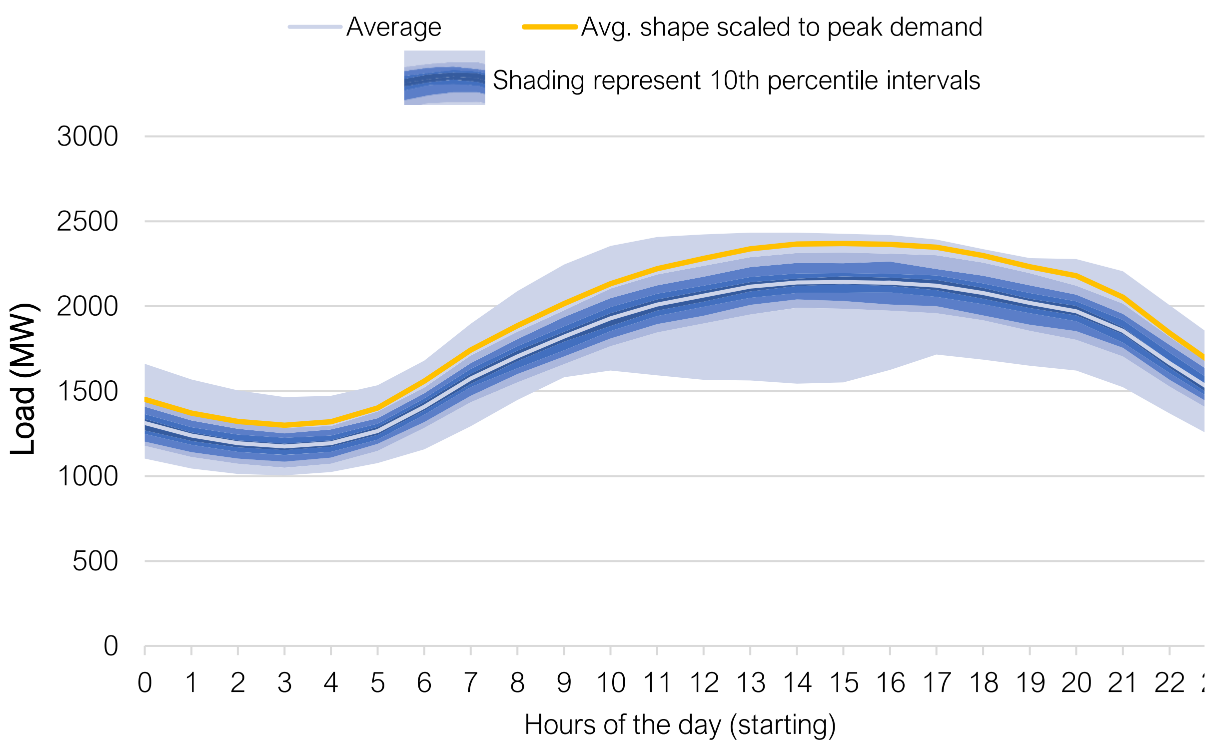
C.5 Active Demand Input

In addition to the data already described in this appendix, a number of other inputs were used in the active demand potential assessment.

C.5.1 Standard Peak Day

Dunsky extracted hourly historical load data from ISO-NE. The data covered January 1st, 2011 to December 31st, 2019 (81,072 data points). This historical data was used to create standard peak day for the system.

Figure 12. Standard Peak Day – New Hampshire



Over the 3-year study period, when considering all the impacts on peak demand, such as energy efficiency and load growth, the effects are small. Since peak shape is an important factor for DR potential, a fixed load shape means that most of the DR solutions will be valid throughout 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 the New Hampshire climate zones, and adjusted to account for heating energy source.

- Engineered load profiles and Dunsky's in-house developed sample consumption profiles

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 Figure 13. 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 figure below presents the end-use and sector breakdown of the electric system.

Figure 13. Standard peak day – Sector breakdown

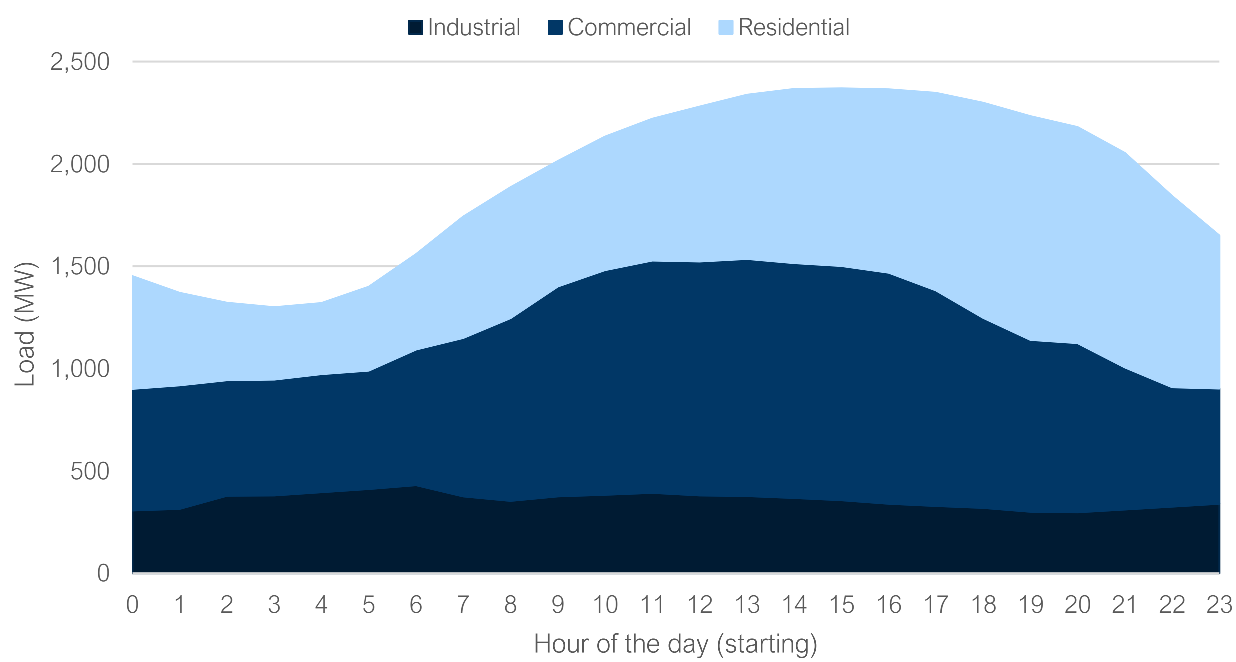
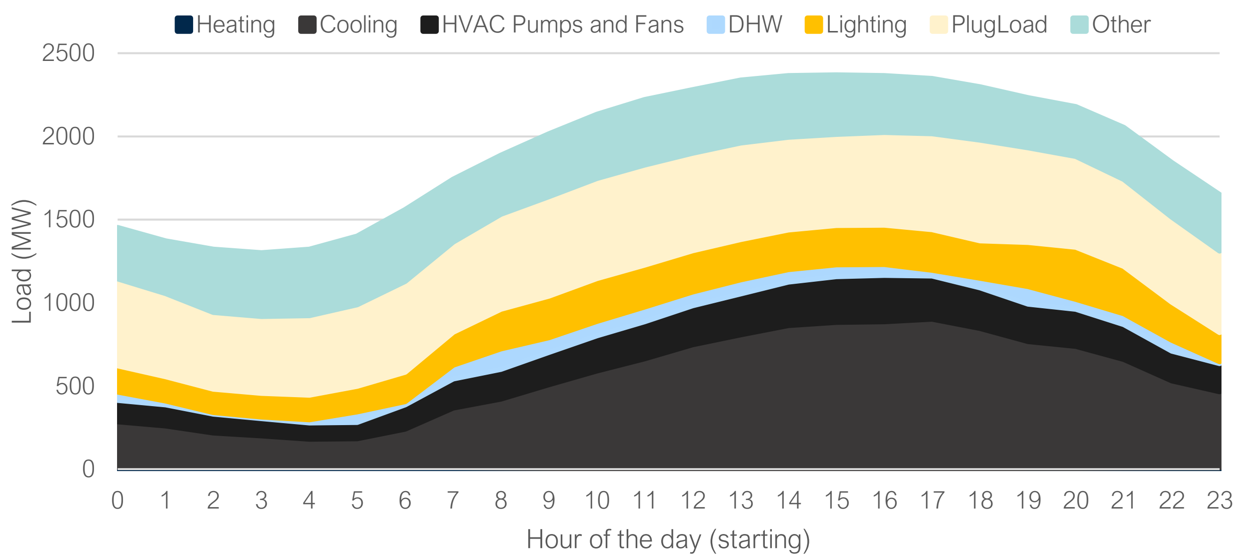


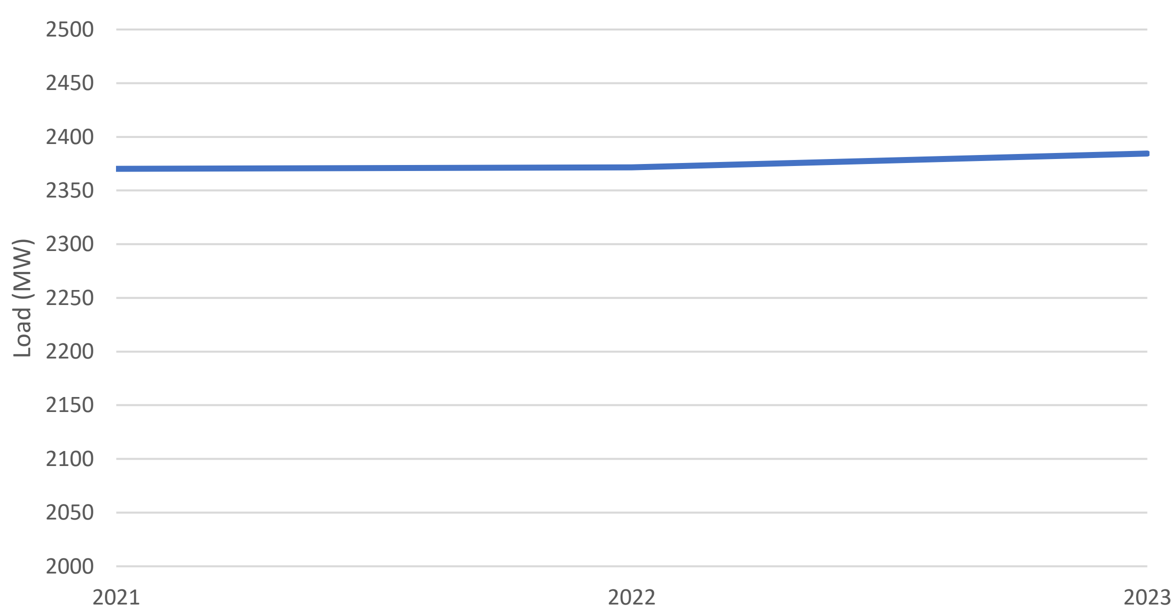
Figure 14. Standard peak day – End-use breakdown



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 figure below.

Figure 15. New Hampshire load forecasting (before EE)



Furthermore, results (baseline scenario - low) for energy efficiency were combined with the forecast in order to have a better grasp at the future load shape. Since this study only covers 3 years, the impact of energy efficiency program is limited.

Table 18. Impact of energy efficiency on Key Demand Response Factors (2023)

Average hourly reduction	Peak reduction	Peak-to-average difference
17 MW	21 MW	- 4 MW

C.5.4 Measures

To assess the DR potential in the jurisdiction, Dunsky characterized over 30 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 addressable peak) and type 2 (unconstrained by the addressable peak). 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 New Hampshire's climate. Each measure was evaluated independently for each segment of the study. Table 19 and Table 20 provide an overview of each measure characterization and approach.

Table 19. Residential Demand Response Measures

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST	Granite State Test[14]	Inclusion in the Achievable Potential
Appliances						
Clothes Dryer - DLC	Appliance shut off during event	Smart Plug	Number of non-smart clothes dryers in the jurisdiction	Smart Plug	Fail	Not included
Clothes Dryer - BYOD	Appliance shut off during event	Smart Appliance	Number of smart clothes dryers in the jurisdiction	Incentive upon program inscription	Pass only at measure level	Not included[15]
Dehumidifier - BYOD	Appliance shut off during event	Smart Appliance	Number of smart dehumidifiers in the jurisdiction	Incentive upon program inscription	Pass only at measure level	Not included
Pool Pumps – Timer or Smart Switch – DLC	Postponing filtering and cleaning work of the pump	Simple Timer Switch or Smart Switch	Number of non-smart pool pumps in the jurisdiction	Timer or Smart Switch	Pass	Included
Pool Pumps – BYOD	Postponing filtering and cleaning work of the pump	Smart Appliance	Number of smart pool pumps in the jurisdiction	Incentive upon program inscription	Pass	Included
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	Fail	Not included

[14] Main results from Granite State Test: Some specific segments in a given measure may not pass.
[15] When adding program administration costs, the measure fails the cost-effectiveness. Smart clothes dryers, dehumidifiers, room ACs and heat pump water heaters were therefore removed from the achievable potential.

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST	Granite State Test[14]	Inclusion in the Achievable Potential
Resistance Storage Water Heater - BYOD	Appliance shut off during event	Smart Water Heater	Smart electric water heater (excl. heat pump water heater)	Incentive upon program inscription	Pass only at measure level	Included[16]
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	Pass only at measure level	Not included
HVAC						
Central Air-Conditioner (AC) – DLC	Temperature setback (including pre-cooling strategies)	Wi-Fi Thermostat	Households with central AC and with manual or programmable thermostat	Installation of a WiFi thermostat	Pass	Included
Central Air-Conditioner – BYOD	Temperature setback (including pre-cooling strategies)	Wi-Fi Thermostat	Households with central AC and with Wi-Fi Thermostat	Incentive upon program inscription	Pass	Included
Ductless HP/AC – DLC	Temperature setback (including pre-cooling strategies)	Wi-Fi Thermostat	Households with a Ductless HP/AC	Installation of a WiFi thermostat	Pass only at measure level	Included
Ductless HP/AC – BYOD	Temperature setback (including pre-cooling strategies)	Wi-Fi Thermostat	Households with a Ductless HP/AC a smart thermostat	Incentive upon program inscription	Pass only at measure level	Included
Room AC – BYOD	Temperature setback (including pre-cooling strategies)	Smart Appliance	Smart room AC in the jurisdiction	Incentive upon program inscription	Fail	Not included
Other						

[16] When adding program administration costs, the measure slightly fails the cost-effectiveness. Given that the measure is close enough to the threshold of 1.0, the measure was kept in the achievable potential.

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST	Granite State Test[14]	Inclusion in the Achievable Potential
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	Pass only at measure level	Included
Battery Energy Storage – With Solar - BYOD	Battery discharges during event and extra power is send back into the grid	Battery	Households with solar panels and battery	None	Pass only at measure level	Included
Battery Energy Storage – Without Solar - BYOD	Battery discharges during event to cover the house loads only	Battery	All households with a battery, excluding households with solar panels	None	Pass only at measure level	Included
Energy Storage- DLC	Thermal Energy Storage (TES) discharges during event	TES	TES: All households with central AC but no TES.	Full cost of the storage unit	Fail	Not cost-effective

Table 20. Non-Residential Demand Response Measures

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST	Granite State Test[17]	Inclusion in the Achievable Potential
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	Pass	Included
Hot Water						
Resistance Storage Water Heater - DLC	Appliance shut off during event	Smart Switch	Non-smart electric water heaters (excl. heat pump water heater)	Smart Switch	Pass	Included
Resistance Storage Water Heater - BYOD	Appliance shut off during event	Smart Water Heater	Smart electric water heaters (excl. heat pump water heater)	Incentive upon program inscription	Pass	Included
HVAC						
WiFi Thermostat – DLC	Temperature setback (including pre-cooling strategies)	Wi-Fi Thermostat	Small C&I buildings with central AC and with manual or programmable thermostat	Wi-Fi Thermostat	Pass	Included
WiFi Thermostat – BYOD	Temperature setback (including pre-cooling strategies)	Wi-Fi Thermostat	Small C&I buildings with central AC and with Wi-Fi thermostat	Incentive upon program inscription	Pass	Included
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	Fail	Not included

[17] Main results from Granite State Test: Some specific segments in a given measure may not pass.

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST	Granite State Test[17]	Inclusion in the Achievable Potential
Emergency Generator (Gas)	Use of emergency generator during event	Manual, BAS or Auto-DR	Number of gas emergency generator in the jurisdiction	Costs of EPA stationary nonemergency compliance	Pass	Included
Combined Heat and Power	Use of CHP system during event	Manual, BAS or Auto-DR	Number of CHPs in the jurisdiction (non already involved with C&I program)	None	Pass	Included
Battery Energy Storage	Battery discharges during event	Battery	C&I buildings with existing batteries	None	Pass	Included
Energy Storage	Battery Energy Storage (BES) or Thermal Energy Storage (TES) discharges during event	BES or TES	All C&I buildings with central AC but no BES or TES.	Half of the costs of the storage unit	Pass	Included
Medium Commercial and Industrial – Curtailment	Load curtailment through HVAC demand curtailment (fresh airflow reduction, temperature adjustment, interruption of dehumidification, etc.), lighting or process curtailment.	Manual, BAS or existing Auto-DR	All medium-sized C&I buildings	None	Pass	Included
Medium Commercial and Industrial – Curtailment (Auto-DR)	Load curtailment through HVAC demand curtailment (fresh airflow reduction, temperature adjustment, interruption of dehumidification, etc.),	Auto-DR	Medium-sized C&I buildings not willing/able to participate through their existing systems	Auto-DR system	Pass	Included

MEASURE BY END USE	DEMAND RESPONSE STRATEGY	ENABLING DEVICE	MARKET SIZE	INITIAL MEASURE COST	Granite State Test[17]	Inclusion in the Achievable Potential
	lighting or process curtailment.					
Large Commercial and Industrial – Curtailment	Load curtailment through HVAC demand curtailment (fresh airflow reduction, temperature adjustment, interruption of dehumidification, etc.), lighting or process curtailment.	Manual, BAS or existing Auto-DR	All large-sized C&I buildings	None	Pass	Included
Large Commercial and Industrial – Curtailment (Auto-DR)	Load curtailment through HVAC demand curtailment (fresh airflow reduction, temperature adjustment, interruption of dehumidification, etc.), lighting or process curtailment.	Auto-DR	Large-sized C&I buildings not willing/able to participate through their existing systems	Auto-DR system	Pass	Included

C.5.5 Programs

Table 21 below presents the program costs for each major program type applied in the DR potential model, which were developed based on historical program information provided by New Hampshire utilities. 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 21. Active Demand Program Administration Costs Applied in Study (excluding equipment costs)

Program Name	Development Costs	Program Fixed Annual Costs	Other Costs ($/customers) for marketing, IT, admin	Program Adoption Ramp-up
Residential DLC	$100,000	$68,075	$40	Yes
Residential BYOD	$0	$68,075	$35	No
Small Commercial BYOD/DLC	$100,000	$68,075	$40	Yes
Residential Energy Storage	$0	$68,075	$30	No
Medium & Large C&I Curtailment	$0	$171,090	$30	No
C&I Energy Storage	$0	$100,00	$30	No

D. Energy Efficiency Model Assumptions and Outputs

A detailed set of model assumptions and outputs are included in a separate Excel spreadsheet, embedded below. The spreadsheet includes key model inputs, program and measure-level results for electric, natural gas, and delivered fuel efficiency, and costs and cost-effectiveness results.

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E. Active Demand Model Outputs

E.1 Active Demand Technical and Economic Potential

The analysis applies a range of new and existing DR programs, assessing the ability of each to address the ISO-NE 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, and 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 Granite State 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 Granite State Test values that exceed the threshold.

E.1.1 Medium and Large Commercial and Industrial Programs

Eversource and Unitil have already enrolled a certain amount of commercial and industrial load reduction through their current industrial and commercial curtailment program. This is comprised of facility load curtailment, as well as self-generation capacity, that can be engaged when a DR event is called by the utility. Table 22 below presents the measures providing a notable degree of peak load reduction.

Table 22. Medium and Large Commercial and Industrial Potential

Measure	2023	
	Technical Potential (MW)	Economic Potential (MW)
Battery Energy Storage	9	9
Large Industrial Curtailment	18	18
Medium Industrial Curtailment	16	16
Large Commercial Curtailment	25	25
Medium Commercial Curtailment	20	20
Back-Up Generators (Gas only)	22	22
Combined Heat and Power (CHP)	9	9

A large part of the technical potential and growth is offered by curtailment measures. These measures are assumed to apply a 3-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.

Because no details were available regarding the current application of existing CHP systems in existing curtailment program, it was assumed that 50% of the existing systems were available for adding further DR potential, along with all new CHP capacity installed over the study period.[18] While the battery energy storage measure leverages existing batteries without any up-front costs from the utility, the back-up generator measure considers an up-front cost to cover costs for achieving emissions compliance in a nonemergency application.

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 23. Commercial Equipment Control Potential

Measure	2023	
	Technical Potential (MW)	Economic Potential (MW)
Battery Energy Storage (BYOD)	0.7	0.7
Thermal Energy Storage	149	30
Water Heater (BYOD & DLC)	24	17
Wi-Fi Thermostat (BYOD & DLC)	7	7

Thermal energy storage offers, by far, the most technical and economic potential due to the versatility of the device, which allows it to charge at night during demand troughs. It is important to note that this measure includes a large up-front incentive covering 50% of the equipment purchase and installation.

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 Table 24 below.

Table 24. Residential Equipment Control Potential

[18] The CHP DR capacity was determined based on the portion of the system capacity that is not expected to be engaged during system peak hours (late weekday afternoons on July and August weekdays).

Measure	2023	
	Technical Potential (MW)	Economic Potential (MW)
Clothes Dryer (BYOD & DLC)	42	0
Dehumidifier (BYOD)	0.9	0
Pool Pump (BYOD & DLC)	30	30
Wi-Fi Thermostat – Central AC (BYOD & DLC)	60	60
Wi-Fi Thermostat – Ductless HP/AC (BYOD & DLC)	2.1	2.1
Room AC (BYOD)	1.3	0
Thermal Energy Storage	170	0
Battery Energy Storage (BYOD)	4.0	4.0
Water Heater (BYOD & DLC)	18	2.4
EV Charging (DLC)	2.1	2.1

Most of the economic potential lies in Wi-Fi Thermostat (setpoint control), pool pumps, battery, 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. The BYOD battery storage measure, which leverages solar paired storage, is cost-effective and is retained for consideration in the achievable potential. Similarly, thermal energy storage offers significant technical potential, but does not prove to be cost-effective and is not retained for the achievable potential assessment.

E.2 Active Demand 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 25. Residential Achievable Potential Results by Measure by Scenario (MW)

Program	Measure	2023		
		Low Scenario	Mid Scenario	Max Scenario
Residential BYOD	Wi-Fi Thermostat – Central AC	3.64	3.75	3.84
Residential BYOD	Wi-Fi Thermostat – Ductless HP/AC	0.09	0.09	0.10
Residential BYOD	Smart Pool Pump	-	0.40	0.44
Residential BYOD	Smart Resistance Storage Water Heater	-	0.66	0.67
Residential DLC	Central AC	-	9.10	9.10
Residential DLC	Ductless HP/AC	-	0.30	0.32

Residential DLC	Electric Vehicle	-	0.38	0.38
Residential DLC	Pool Pump (simple timer switch)	-	3.60	4.01
Residential DLC	Pool Pump (smart switch)	-	1.80	2.00
Residential Energy Storage	Battery Energy Storage (with solar)	1.35	1.35	1.35
Residential Energy Storage	Battery Energy Storage (without solar)	0.09	0.09	0.09

Table 26. C&I Achievable Potential Results by Measure by Scenario (MW)

Program	Measure	2023		
		Low Scenario	Mid Scenario	Max Scenario
Medium & Large C&I Curtailment	Commercial Refrigeration (Auto-DR)	-	0.65	0.68
Medium & Large C&I Curtailment	Large Industrial Curtailment	5.13	6.16	9.41
Medium & Large C&I Curtailment	Medium Industrial Curtailment	3.15	3.26	3.52
Medium & Large C&I Curtailment	Medium Curtailment	2.45	2.46	2.61
Medium & Large C&I Curtailment	Medium Curtailment (Auto-DR)	-	0.45	0.00
Medium & Large C&I Curtailment	Large Curtailment	3.80	4.12	5.87
Medium & Large C&I Curtailment	Large Curtailment (Auto-DR)	-	0.48	1.18
Medium & Large C&I Curtailment	Large Emergency generators	-	6.05	6.42
Medium & Large C&I Curtailment	Large Combined Heat and Power (additional capacity only)	-	2.77	2.77
Small Commercial BYOD/DLC	Resistance Storage Water Heater (smart switch)	-	0.90	0.90
Small Commercial BYOD/DLC	Smart Resistance Storage Water Heater	-	0.15	0.15
Small Commercial BYOD/DLC	WiFi Thermostat	-	0.40	0.42
C&I Energy Storage	Battery Energy Storage (with solar)	0.13	0.13	0.13
C&I Energy Storage	Thermal Energy Storage	-	1.30	1.47
C&I Energy Storage	Large Battery Energy Storage	2.17	2.17	2.55
C&I Energy Storage	Medium Battery Energy Storage	0.65	0.65	0.65

E.2.2 Active Demand Potential Detailed Results

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

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