Guidehouse

Massachusetts Energy Efficiency and Demand Response Potential Study for 2025-2027

Final Report

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Liberty Utilities

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Common Acronyms

AC	Air Conditioning
ACEEE	American Council for an Energy Efficient Economy
AESC	Avoided Energy Supply Component Study
BAE	Business-As-Expected Scenario
BCR	Benefit-Cost Ratio
BTM	Behind-the-Meter
BYOD	Bring Your Own Device
BYOT	Bring Your Own Thermostat
CECP	Massachusetts Clean Energy and Climate Plan for 2050
C&I	Commercial and Industrial
CBSA	Commercial Building Stock Assessment
CSP	Curtailment Service Provider
DLC	Direct Load Control
DNV	DNV Consulting Firm, formerly known as DNV-GL
DOE	United States Department of Energy
DR	Demand Response
DRIPE	Demand Reduction Induced Price Effects
DSM	Demand-Side Management
EE	Energy Efficiency
EEAC	Energy Efficiency Advisory Council
EERE	Energy Efficiency & Renewable Energy
EMS	Energy Management System
ES	Energy Storage
FTE	Full-Time Equivalent
HVAC	Heating, Ventilation, and Air Conditioning
IT	Information Technology
IE	Income Eligible

Common Acronyms, continued

MAX	Maximum Achievable Scenario (Demand Response Only)
MI	Moderate Income
NAICS	North American Industry Classification System

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NEI	Non-Energy Impact
NEW	New Construction
NPV	Net Present Value
NTG	Net-to-Gross
O&M	Operations and Maintenance
PA	Program Administrator
PNNL	Pacific Northwest National Laboratory
PV	Present Value
RET	Retrofit
ROB	Replace-on-Burnout
SEER	Seasonal Energy Efficiency Ratio
TRC	Total Resource Cost
TRM	Technical Reference Manual
TSD	Technical Support Document

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Executive Summary

Liberty Utilities and the other Massachusetts Program Administrators[1] (PAs) engaged Guidehouse, Inc and its subcontractor, Synapse Energy Economics (collectively, the Guidehouse Team or Guidehouse), to quantify the total technical, economic and achievable potential for energy efficiency and electrification (also called fuel substitution or fuel switching) (EE), and demand response (DR), in the PAs' service areas between 2025 and 2027. This study is a high-level assessment of electric, natural gas, oil, and propane savings opportunities in the Residential, Income Eligible, and Commercial and Industrial (C&I) sectors in Liberty Utilities' service area in Massachusetts..

Measure and market characterization data is input into Guidehouse's Demand-Side Management Simulator (DSMSim) and Demand Response Simulator (DRSim) models. DSMSim calculates the potential for energy efficiency and fuel switching, which will be used to inform energy efficiency and greenhouse gas goal setting and associated program design for Liberty Utilities in Massachusetts. For DR, DRSim calculates achievable potential estimates across Liberty Utilities' service area in Massachusetts by DR option and assesses cost-effectiveness of DR consistent with the approach used in the BCR model.[2]

Four scenarios were modeled:

- **Business-as-Expected (BAE):** Estimates of achievable potential calibrated to 2022 program actuals, assuming similar budgets and program activity, combined with expected program and regulatory modifications and the measures and technologies contained in the technical and economic potential estimates. This study is based off program designs in 2024 and does not consider design changes that may occur in 2025 and beyond because of statutory requirements and changes to planning parameters. This scenario was modeled for both EE and DR.
- **Clean Energy and Climate Plan (CECP) Scenarios:** Estimates achievable potential for Energy Efficiency (including fuel switching) and reaching the CECP carbon reduction mandates expected to be assigned to the PAs by the Commonwealth's Secretary of Energy and Environmental Affairs.

  Two CECP Scenarios were modeled, (1) assuming the same unit costs as the BAE scenario while maintaining cost effectiveness at the program or sector level **(CECP)**, and (2) assuming a cost premium for selected measures that are expected see large increases in implementation quantities **(CECP Cost Premium)**. The measure quantities and savings are identical between the two scenarios. For the CECP Cost Premium scenario, cost premiums are added to PA budgets and TRC costs at the program-level to estimate resulting cost test ratios and PA budgets to achieve the CECP targets. Therefore, the CECP Cost Premium scenario may not be cost effective at the program or sector level.
- **Maximum Achievable (MAX):** For DR only, instead of the CECP scenarios, which assumes higher participation in DR programs in association with higher levels of incentive offers.

[1] The six program administrators in Massachusetts are Berkshire Gas Company, Cape Light Compact, Eversource, Liberty Utilities, National Grid, and Unitil.

[2] Potential assessment approach differs for EE and DR since DR exists only under a "programmatic" or "achievable" construct and therefore technical and economic potential for DR are not relevant in the same manner for DR as for EE.

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Estimation of Energy Efficiency Potential

Guidehouse employed its proprietary DSMSim (which stands for "Demand-Side Management Simulator") potential model to estimate the technical, economic, and achievable potential for electricity and natural gas energy efficiency and summer and winter peak passive demand savings across Massachusetts. DSMSim is a bottom-up technology diffusion and stock tracking model implemented using a System Dynamics[3] framework. The model explicitly accounts for different types of efficient measures, such as retrofit (RET), replace-on-burnout (ROB), and new construction (NEW), including fuel substitution measures, and the impacts these measures have on savings potential. The model then reports the technical, economic, and achievable potential savings in aggregate by sector, customer segment, end-use category, and highest impact measures. A separate model was developed within DSMSim for each PA / operating company.

Guidehouse developed potential savings and cost estimates using a bottom-up analysis. The same approach was used across all of the PAs, using PA-specific data (customer densities, demographics, building stock, etc.) wherever available and statewide data only as necessary. In that way, the estimates of potential are PA-specific. The analysis involved five steps:

1. Characterize the market.
2. Develop baseline projections.
3. Define and characterize EE options.
4. Develop key assumptions for potential and costs.
5. Estimate potential and costs.

This study defines **technical potential** as the energy savings that can be achieved assuming that all installed measures can immediately be replaced with the efficient measure, wherever technically feasible, regardless of the cost, market acceptance, or whether a measure has failed (or burned out) and is in need of being replaced.

Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as in technical potential, but limiting the calculation only to those measures that have passed the benefit-cost test chosen for measure screening—in this case, the Total Resource Cost (TRC) test as used by Liberty Utilities in Massachusetts.

Achievable potential further considers the likely rate of demand-side management (DSM) resource acquisition given factors like the rate of equipment turnover (a function of a measure's lifetime), simulated incentive levels, consumer willingness to adopt efficient technologies, and the likely rate at which marketing activities can facilitate technology adoption. The adoption of DSM measures can be broken down into the calculation of the equilibrium market share and the calculation of the dynamic approach to equilibrium market share, as discussed in more detail in Section 4.3.

Achievable potential savings reported in this study are net rather than gross, meaning these include the impacts of free ridership, spillover, and market effects attributable to DSM programs. Providing net potential is appropriate for Liberty Utilities primary intended purposes for

[3] See Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill, 2000, for detail on System Dynamics modeling. Also see http://en.wikipedia.org/wiki/System_dynamics for a high-level overview.

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conducting this study—setting 2025-2027 goals and targets—because net savings is the definition used in Massachusetts.

Carbon Savings in 2030 and 2035 are calculated for efficient measures installed between 2025-2027, assuming those measures are still present in the reporting year, i.e., have not burned out and been replaced before the reporting year based on estimated measure life. For measures that burn out in the reporting year, half of the carbon savings for that measure is reported. Reported carbon savings for 2030 ("Carbon 2030") are aggregated across all impact types (electricity and natural gas) based on the achievable potential. Metric tons of CO_2 equivalent (CO_2e) reduction per impact type is calculated based on estimated generator-level emissions factors provided to Guidehouse by the Massachusetts Office of Energy and Environmental Affairs in November 2023. These are reported as adjusted gross quantities, unlike other estimates of potential, which are reported as net quantities.

Estimation of Demand Response Potential

Guidehouse developed DR potential and cost estimates using a bottom-up analysis approach. Guidehouse used a combination of primary data (e.g., market data from Liberty Utilities) and relevant secondary sources to develop data inputs required for assessing DR potential and cost-effectiveness. These data inputs feed into Guidehouse's Demand Response Simulator model (DRSim), customized for the study, which produces DR potential, annual program costs, and cost-effectiveness of DR options at various levels of disaggregation.

The approach for DR potential estimation and cost-effectiveness assessment consists of the following steps:

1. Undertake market characterization and segmentation for DR potential assessment.
2. Develop projections of customer counts and baseline peak demand over the study period.
3. Define and characterize DR options and map applicable options to relevant customer segments.
4. Develop programmatic assumptions, which include participation, unit load reductions, and cost assumptions.
5. Estimate potential, annual costs, levelized costs and cost-effectiveness by DR option, customer class and building type.
6. Conduct scenario analysis and present DR potentials, annual costs, and cost-effectiveness results by scenario.

The DR analysis considers each BAE and MAX scenario with variations in participation assumptions corresponding to variations in DR program participation incentives. Guidehouse considered a wide spectrum of DR-enabling technologies for realizing load reduction across different end uses and customer segments. The DR options characterization involved specifying unit impacts, participation assumptions, and itemized costs for realizing load reductions across the different end-use and DR-enabling technology combinations (referred to as DR suboptions) for Residential and C&I customers. For the purposes of the DR analysis, Residential includes market rate and IE customers. C&I customers are further segmented by size based on maximum demand values into small and medium, and large C&I.

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Guidehouse fed these inputs into the DRSim tool and assessed the cost-effectiveness of DR options and developed achievable potential and annual cost estimates. The potential and cost findings are summarized in the Findings section.

Findings

This section shows high-level results summaries for EE and DR. A discussion of key takeaways follows in the Conclusion.

EE Potential Results

Table ES-1 through Table ES-3 summarize the EE potential for the BAE, CECP and CECP Cost Premium scenarios, for each year of the analysis and in total over the 3-year period (2025-2027), by sector and, where applicable, by primary fuel. Potential savings estimates in these tables are "net at the meter," indicating savings projected to be realized at customer premises. CO_2e savings are reported at the generator.

The BAE results show increasing potential across the three years of the study for all sectors; the Residential Sector and the Income Eligible sector have higher contributions to savings than C&I sector. Gas savings increase in both CECP scenarios, because of the high amounts of electrification. Nevertheless, for CECP scenarios, total natural gas savings over the three years are nearly triple the BAE scenario savings.

Table ES-1. Energy Efficiency BAE Scenario Net Achievable Potential, Liberty Gas

Sector, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO_2e]
Residential Sector				
2025	156,700	12,500	233,900	850
2026	166,200	13,500	249,200	900
2027	176,500	14,500	264,800	960
Income Eligible Sector				
2025	168,400	13,900	257,900	850
2026	184,000	15,600	289,100	930
2027	201,000	17,400	322,700	1,030
Commercial & Industrial Sector				
2025	135,500	12,600	166,100	640
2026	144,600	13,400	172,600	720
2027	152,800	14,100	177,300	810
Portfolio Total				
2025	460,600	39,000	657,900	2,340
2026	494,800	42,500	710,900	2,550
2027	530,300	46,000	764,800	2,800

Source: Guidehouse

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Table ES-2. Energy Efficiency CECP Scenario Net Achievable Potential, Liberty Gas

Sector, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO_2e]
Residential Sector				
2025	443,700	35,500	809,000	2,330
2026	522,800	42,400	969,600	2,750
2027	606,300	49,500	1,136,100	3,190
Income Eligible Sector				
2025	354,000	29,700	623,400	1,800
2026	416,000	35,400	745,800	2,130
2027	481,200	41,300	872,700	2,470
Commercial & Industrial Sector				
2025	146,800	13,700	187,500	700
2026	152,700	14,500	196,500	780
2027	159,800	15,200	200,500	860
Portfolio Total				
2025	944,500	78,900	1,619,900	4,830
2026	1,091,500	92,300	1,911,900	5,660
2027	1,247,300	106,000	2,209,300	6,520

Source: Guidehouse

Table ES-3. Energy Efficiency CECP Cost Premium Scenario Net Achievable Potential, Liberty Gas

Sector, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO_2e]
Residential Sector				
2025	443,700	35,500	809,000	2,330
2026	522,800	42,400	969,600	2,750
2027	606,300	49,500	1,136,100	3,190
Income Eligible Sector				
2025	354,000	29,700	623,400	1,800
2026	416,000	35,400	745,800	2,130
2027	481,200	41,300	872,700	2,470
Commercial & Industrial Sector				
2025	146,800	13,700	187,500	700
2026	152,700	14,500	196,500	780
2027	159,800	15,200	200,500	860
Portfolio Total				
2025	944,500	78,900	1,619,900	4,830
2026	1,091,500	92,300	1,911,900	5,660
2027	1,247,300	106,000	2,209,300	6,520

Source: Guidehouse

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Energy Efficiency Program Costs

Table ES-4 shows the projected EE portfolio PA investments over the study period and across scenarios. The comparison across the scenarios indicates the CECP scenario would cost more than four times as much as the BAE scenario for both fuels, while the CECP Cost Premium scenario would cost more than eight times as much as the BAE over the 3-year term.

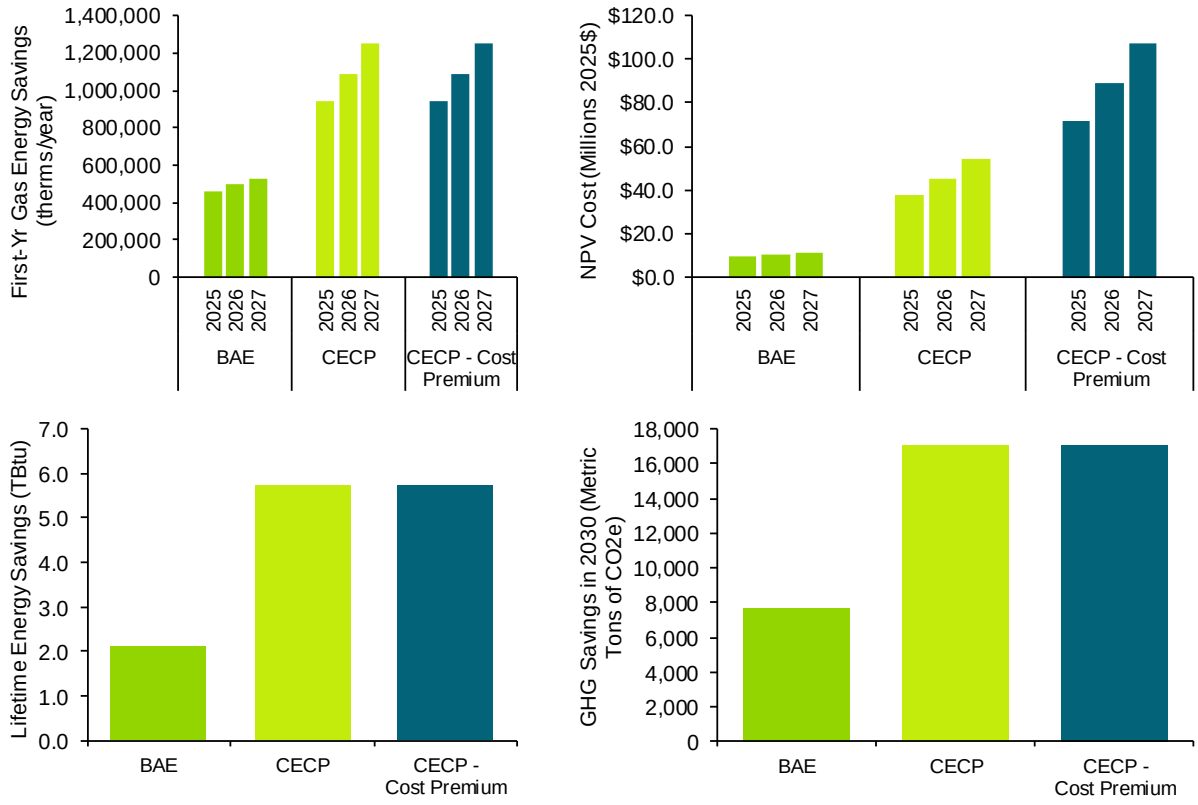
Table ES-4. Energy Efficiency Natural Gas Portfolio Costs, by Scenario

Install Year	BAE	CECP	CECP Cost Premium
2025	$9,850,000	$37,340,000	$71,650,000
2026	$10,580,000	$45,380,000	$88,940,000
2027	$11,370,000	$53,950,000	$107,700,000
Total	**$31,800,000**	**$136,670,000**	**$268,290,000**

Source: Guidehouse

Figure ES-1 compares the overall natural gas achievable potential in cumulative annual therms, lifetime MMBtu, and 2030 Carbon for all sectors and the NPV Cost totaled for all years for the BAE, CECP and CECP Cost Premium scenarios.

Figure ES-1. Scenario Comparison, Liberty Gas



Source: Guidehouse

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Demand Response Potential Results

None of the DR options and suboptions were assessed to be cost-effective using top 10-day natural gas costs from AESC 2024. The analysis results in Chapter 6 present potential for all DR options regardless of cost-effectiveness. If gas DR options were cost-effective, Residential customers could potentially contribute more than 70% of the savings from a combination of Direct Load Control of space heating and water heating and Behavioral DR. Large C&I customers could provide almost 25% of the total potential, and the remaining potential could be realized from Direct Load Control of small and medium C&I customers.

Conclusions

This study uses the most recently available information on Liberty and the Massachusetts customer base and state-of-the-art modeling to develop the potential for energy, demand and CO_2e reductions possible through EE and DR programs and initiatives during the forthcoming 2025-2027 term. While much EE and DR potential remain, Massachusetts faces unique challenges related to high levels of saturation, ineligibility of past popular measures, and aggressive carbon reduction targets in realizing this potential over the next three years. The potential study incorporates these real factors into the analysis by utilizing Massachusetts baseline study and historic program data to accurately reflect efficient measure saturations. Based on the assumptions made, the analyses conducted, and the results presented, these are realistic estimates of potential.

To contextualize the results from this study, Table ES-5 for natural gas compares BAE annual potential for 2025 as identified in this study to 2022 actual achievements for EE and 2022 base loads; Table ES-6 compares BAE costs to the 2022-2024 PA costs (excluding customer costs).

Table ES-5. Comparison of BAE Potential to Recent Experience, Liberty Gas

	2025 Potential	2022 Actual	2022 Load
Energy (Annual Therms)	460,600	282,648	68,000,000
Energy (Annual MMBtu)	39,000	26,153	N/A

Source: Guidehouse and MassSaveData.com

Table ES-6. Comparison of PA Costs for Three Year Period

	2025-2027 BAE	2022-2024 Plan
Natural Gas - Liberty	$31,800,000	$21,193,967

Source: Guidehouse and MassSaveData.com

Energy Efficiency

The following are high-level observations regarding the projections for energy efficiency potential:

- **Natural Gas Savings BAE Scenario:** Lifetime savings are approximately evenly spread across the Residential, Income-Eligible, and C&I sectors. Insulation and Air Sealing are the highest impact measures accounting for approximately half of the Residential top 10 measure lifetime savings and a lower proportion of Income-Eligible top 10 measure lifetime savings. Fuel substitution measures, both partial and full, also deliver an

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important share of savings in these two sectors. Considerably more than half of the top 10 measure savings for the C&I sector are attributable to the Custom Large C&I measure, though fuel substitution (Central Air Source Heat Pump) is also a meaningful contributor of achievable potential.

- **Carbon:** The primary source of carbon reduction in 2030 from achievable potential in 2025 through 2027 is from fuel substitution and insulation measures in the Residential and Income Eligible sectors and Custom measures in the C&I sector.

- **CECP Scenario Results:** The CECP scenarios demonstrate that the statewide carbon targets for 2030 can be met by accelerated deployment of weatherization and heat pumps by all PAs. The associated price tags for the PAs are also increased. In the Cost Premium scenarios, the price tag relative to the CECP scenario is approximately four to eight times higher than the BAE scenario. Because of the high costs, the Residential and Income Eligible sectors are not cost-effective in the CECP Cost Premium scenario; however, the C&I sector remains cost effective.

- **Key Drivers:** Major drivers of BAE potential are measure eligibility, carbon benefits, Liberty's actual and expected achievements during 2022-2024, and updated avoided costs. For the CECP scenarios, the major driver of results was the carbon-reduction rich measures that were targeted with accelerated deployment.

- **Achieving Potential:** While this report shows that much EE potential remains, there are unique challenges in Massachusetts in realizing this potential over the next three years. Assumptions adopted in this study represent these factors and Liberty Utilities should be aware of the factors as it develops its plans.

    - **Past Program Achievements:** Notably, Liberty Utilities has effectively implemented energy efficiency programs in Massachusetts for decades, often exceeding goals in terms of the amount of savings achieved. As greater levels of energy efficiency are implemented in Massachusetts and market saturation increases, it may become more challenging to harvest additional savings represented in the energy efficiency potential.

    - **Codes and Standards:** The challenge of continuing to capture savings from energy efficiency programs within an increasingly saturated market is exacerbated by tightening codes and standards.

    - **Changing Energy Efficiency Measure Costs:** Changes to the portfolio measure mix that occur due to market saturation and codes and standards changes drive incremental costs upward for many measures. More complex measures, such as fuel substitution may require a more sophisticated workforce, additional training, as well as increased installation and configuration time, compared to more static measures. This could result in increased incremental costs for these types of measures. As a result, costs may be highly variable, particularly as Liberty Utilities moves to more aggressive targets.

- **Investment Level:** Liberty Utilities will need to plan for significantly higher levels of investment in natural gas programs particularly for the CECP scenarios, and for mobilizing a significant increase in direct and indirect services to meet the increased level of demand for efficiency upgrades.

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Demand Response

The key observations from the gas DR analysis are:

- Gas DR is not cost-effective due to relatively low gas avoided costs for valuing gas DR using top 10-day value from AESC 2024.
- The analysis results presented potential for all DR options regardless of cost-effectiveness. If gas DR options were cost-effective, Residential customers could potentially contribute more than 70% of the savings from a combination of Direct Load Control of space heating and water heating and Behavioral DR. Large C&I customers could provide almost 25% of the total potential, and the remaining potential could be realized from Direct Load Control of small and medium C&I customers.

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1.1 Introduction

This section provides an overview of the potential study, including background and study goals, a discussion of the report's organization and key caveats and limitations of the potential study. Guidehouse's best-in-class modeling tools ensure the rigor, validity and sensibility required of the DSM Potential Study results. Our potential study models have been validated in numerous US states, and our DSM potential studies and models have been quoted by ACEEE as being "robust and transparent… [and] their methodology for forecasting participation is industry standard best-practice."[4]

As is typical in the development of such studies, Guidehouse worked collaboratively with Liberty Utilities and its stakeholders to ensure the study, to the fullest extent, best reflects current Massachusetts market conditions. Guidehouse received considerable guidance and feedback from Liberty Utilities staff, particularly in the development of global input assumptions, measure characterizations, and historical portfolio performance calibration. Guidehouse also carefully considered, and as appropriate, was responsive to stakeholders' input, incorporating their feedback into the analysis approach.

1.2 Context and Study Goals

Guidehouse was retained by the energy efficiency Program Administrators (PAs) of Massachusetts[5] to develop an estimate of the potential for energy efficiency (EE) and demand response (DR) in Massachusetts during the 3-year timeframe covering the period 2025 to 2027. Guidehouse worked with Liberty Utilities and the other PAs to develop information on current levels and patterns of energy use in Massachusetts, characterize potential measures which could be implemented to increase EE and DR through DSM programs in the state, and develop estimates of EE and DR potential. The study data and analysis will be used to inform EE and DR program design for Liberty Utilities in Massachusetts. Table 2-1 summarizes the various elements of the project scope.

Table 2-1. Summary of Project Scope

Element	Dimensions
Forms of Energy	Natural Gas, Electricity (as interactive effects)
Type of Potential	Energy Efficiency and Demand Response Technical, Economic, Achievable
Achievable Scenarios	Business-as-Expected (BAE) and two Clean Energy and Climate Plan (CECP) scenarios for EE, BAE and MAX for DR
Sectors	Residential, Income-Eligible (IE) and Commercial and Industrial (C&I); within these, other subsectors and building types (e.g., Multifamily)
Climate	Single Weather Zone
Time Horizon	2025-2027 (3 years)

[4] ACEEE study titled "Cracking the TEAPOT: Technical, Economic, and Achievable Energy Efficiency Potential Studies," August 2014.

[5] The six program administrators in Massachusetts are Berkshire Gas Company, Cape Light Compact, Eversource, Liberty Utilities, National Grid, and Unitil.

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1.3 Interactive Review Process

This study began in July 2023 and encompassed four phases involving interactive engagement and review, which is described as follows.

- **Measure list development.** Guidehouse recommended a list of measures to the PAs and made modifications in response to comments. This list was shared with the consultants to the Massachusetts Energy Efficiency Advisory Council (EEAC Consultants) who made additional suggestions. Given the study schedule, only high priority measures were added and then the measure list was finalized.
- **Measure characterization.** Following this process, the measures were characterized. Characterization involves development of savings and cost parameters associated with each measure. Measure characterization provides a key set of input assumptions for the potential analysis models.
- **Review of results.** Potential model results were reviewed at several stages. Key reviews occurred after measure characterization and model calibration, in addition to sharing results with Liberty Utilities and doing a cross-Program Administrator comparison of high-level results. A final review was performed when updated avoided costs from the 2024 Avoided Energy Supply Component Study were available.
- **External party review of results.** The stakeholder engagement process and level of participation in Massachusetts was typical of what Guidehouse has seen in other jurisdictions. Guidehouse appreciates the thorough review and comments provided by stakeholders, and thanks them for their feedback and participation in the process. Liberty Utilities shared draft results with the EEAC Consultants on several occasions as the study progressed. Modifications related to feedback from the consultant review were incorporated into this final report.

1.4 Caveats and Limitations

Several caveats and limitations are associated with the results of this study, as detailed below.

1.4.1 Program Design

The results of this study provide the savings potential for Liberty Utilities in Massachusetts and provide insights into how this potential can be translated into program design in key areas. However, this potential study is not intended to provide, nor does it have information on, detailed program designs. Different program designs and delivery mechanisms would inevitably result in different levels of adoption of efficient technologies, which means the output of this study is an estimate of what can be achieved under the specific set of assumptions outlined in this study. Program design is typically a separate activity and is outside the scope of this study.

1.4.2 Measure Characterization

The scope of this study employed both primary data collection techniques and a variety of secondary data sources for estimates of measure savings, costs, and market presence (e.g., saturations and densities). Primary data specific to Massachusetts was used wherever possible. Where Massachusetts-specific data was not available, the best available data was used. This situation and approach did not limit our ability to achieve the study objectives and is consistent with Guidehouse's experience in Massachusetts and other jurisdictions.

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Furthermore, the team considers the measure list used in this study to appropriately focus on those technologies likely to have the highest impact on savings potential over the study horizon. However, there is the possibility that unidentified emerging technologies may arise that could increase savings opportunities over the forecast horizon and broader societal changes may affect levels of energy use in ways not anticipated in the study. For some measures, the study assumes the consumption and cost baseline will change in the future, decreasing savings opportunities, due to new codes and standards that have been promulgated but have not yet taken effect. Assumptions regarding future code and standards changes are documented in the measure characterization sheets for relevant measures. However, this study does not make assumptions about future code and standard changes that have not yet been codified.

Potential studies must make assumptions about the adoption of technologies and options that inevitably come with a degree of uncertainty. While techniques such as use of payback acceptance curves and technology diffusion models are considered to provide reasonable aggregate estimates of savings potential, such techniques (which must be applied to dozens or in some cases hundreds of measures) are limited in their ability to accurately predict adoption for specific measures or in specific customer segments.

For energy efficiency, model calibration steps (e.g., comparing forecast results with past achieved results) seek to ground the forecasts in the real world, but inaccuracies are bound to exist the further one drills into a technology or segment—even if the aggregate results are considered reasonable. One reason that aggregate results can be more reliable than individual technology or segment results is that forecasting inaccuracies at the measure-level will exhibit a pooling effect when aggregated up to the portfolio (whereby positive or negative differences at a finer level of aggregation can help to offset each other in an aggregate result). While more in-depth technology adoption techniques do exist (e.g., discrete choice analysis) to improve the forecast accuracy for any given technology, application of these techniques to the quantity of measures analyzed in studies such as this are not typically warranted, considering the dramatic increase in costs one would have to incur to calibrate a different adoption model for every single measure.

1.5 Interpreting Results

This report includes a high-level account of savings potential results for Liberty Utilities in Massachusetts and focuses largely on aggregated forms of savings potential. Energy efficiency potential is estimated at the finest level of granularity, which is at the measure-level within each customer segment. The measure-level data is mapped to the various customer segments and end-use categories to permit a reviewer to easily create custom aggregations. Measure level results are available in the study appendices as noted below. DR potential is estimated using a bottom-up analysis, with primary data from Liberty Utilities and relevant secondary sources of information, as documented in the study appendices (noted below).

The annual energy savings values are the sum of natural gas and electric energy savings. Note that annual electric energy savings are adjusted for the projected effective heat rate of electric generation by savings period (Summer Off-Peak, Summer On-Peak, Winter Off-Peak, Winter On-Peak). Because different measures have different lifetimes and savings loadshapes, in practical terms, measures' heat rates range from 6 to 6.9 MMBtu per MWh.

Readers should note that quantitative energy savings results are presented as net quantities, that is, with all impact factors and net-to-gross ratios applied. GHG savings potential is presented as adjusted gross savings, in other words, with all impact factors applied but without

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net-to-gross ratios. Results are designated by, as appropriate, scenario, fuel, and whether these are incremental annual or lifetime. For example, the reported measure-level savings potential by impact type is only for the 2025 install year, while the measure-level MMBtu savings potential is the sum across all the period years (2025 through 2027). In the scenario results table, savings are generally rounded to the nearest thousand and budgets to the nearest hundred thousand, to indicate a level of uncertainty in the analysis.

Technical and economic potential results are broken out between energy efficiency and fuel substitution. Results for achievable potential are aggregated to provide overall net results. While the primary fuel of the analysis is natural gas, electricity savings are included to help demonstrate the broader energy savings as well as the carbon reduction impacts. Due to these interactive impacts as well as some overlapping market characterizations, the report will mention electricity in a few locations, even though Liberty is a single fuel PA.

The potential models were calibrated to 2022 actual achievements where available; therefore, if a measure was installed in 2022 it was modeled for potential, unless it was explicitly removed from the measure list. Potential forecasts will differ from recent achievements due to measure competition in the model, per unit savings differences, and cost-effectiveness changes. Projected budgets will diverge from recent actual spending trends due to changes in the measure mix, inflation of measure costs, and cost adjustments made to a handful of measures to reflect greater cost to serve remaining potential.[6] In general, the cost per unit savings for the CECP scenarios is greater than that of the BAE scenario because of the increased number of heat pumps in the CECP scenario.

1.6 Report Organization

The report is organized as follows:

- Section 2 provides an overview of **Global Data** developed and used in the study.
- Section 3 discusses the **Energy Efficiency Measure Characterization**, including key parameters.
- Section 4 presents **Energy Efficiency Potential**, including a summary of results by sector and end use for natural gas measures.
- Section 5 presents **Demand Response Assessment Methodology**, including market characterization, baseline projections, characterization of options, and key assumptions.
- Section 6 presents **Demand Response Potential** for the technical and achievable potentials, investment levels, scenario analysis, and discusses snapback effects. Achievable potential results are presented for DR options, suboptions, customer class, and building type for cost-effective DR options.
- Section 7 presents the **Conclusions** of the study.

[6] Income eligible budgets are projected irrespective of the statutory allocation of 10% of the natural budget. To the extent that projected budgets are less than the statutory limits, program planning will need to adapt to ensure that the allocation requirement is met.

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The report also includes the following four appendices:

- Appendix A: Massachusetts 2025-2027 Potential Study Modeling Methodology
- Appendix B: Energy Efficiency Measure List
- Appendix C: Energy Efficiency Results (Excel Spreadsheet Viewer)
- Appendix D: Demand Response Results (Excel Spreadsheet Viewer)

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2. Global Data

Guidehouse aggregated multiple data sources to simulate many elements of the market conditions in Massachusetts that help to define the potential for energy saving technologies modeled in this study. These inputs include Residential household counts, business and industrial building stock, electricity, electricity demand, and natural gas sales forecasts, and end-use energy allocations. Together, these inputs are referred to as the global data and help to define the context of the modeled savings potential, and the scope of potential adoption. Guidehouse developed global data for each PA's electric and natural gas service territories separately. To develop these inputs, Guidehouse prioritized primary data, or data specific to each PA including:

- Residential, Income Eligible and C&I customer counts and sales data.
- Historical and forecasted consumption and demand data.
- 2022 benefit-cost ratio (BCR) calculation model inputs.
- Residential (2022), Income Eligible (2022) and C&I (2022) end-use (Baseline Study) surveys.

2.1 Segmentation of Customer Sectors

Guidehouse developed consumption, demand, floorspace, customer counts, fuel splits, and end-use allocations by territory, sector, and customer segment where possible. Where data was not available to estimate these splits, Guidehouse aggregated to the sector level.

The segmentation also reflects Guidehouse's modeling approach for representing efficiency measures within the DSMSim model. DSMSim models energy efficiency measures at the segment level, and tracks building and equipment stocks for each segment. Differences in fuel choices (i.e., space and water heating market shares), types of equipment used (i.e., use of a furnace or boiler for space heating), and equipment and system efficiency levels are all represented within the model for each segment, as required and as permitted by data availability.

Table 2-1 shows the segmentation used for the Residential, Income Eligible and C&I sectors, with additional detail provided for each sector in the following sections.

Table 2-1. Customer Segments by Sector

Residential and Income Eligible	Commercial & Industrial	
Single Family	Colleges & Universities	Retail
Single Family Moderate Income	Food Sales	Schools
Single Family Income Eligible	Restaurants	Warehouse
Multifamily	Healthcare	Commercial – Other
Multifamily Income Eligible	Data Centers	Public Assembly
-	Lodging	Industrial
-	Office	Commercial - Multifamily

Note: Commercial Multifamily buildings contain more than 4 units.
Source: Guidehouse

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2.1.1 Residential and Income Eligible Sectors

Guidehouse divided Residential customers into five segments based on the type of Residential building occupied, as shown in Table 2-2.

Table 2-2. Description of Residential Segments

Segment	Description
Single Family	Single-family homes with 1 unit
Single Family Moderate Income (MI)	Single-family homes with 1 unit, Moderate Income occupants
Single Family Income Eligible (IE)	Single-family homes with 1 unit, Income Eligible occupants
Multifamily	Apartments, attached housing, 2-4 units
Multifamily Income Eligible (IE)	Apartments, attached housing, 2-4 units, Income Eligible occupants

Note: The characterization of the Multifamily segment aligns with the definitions used for the Residential Baseline Study and Multifamily census data.
Source: Guidehouse

Guidehouse developed the breakdown of the Residential and Income Eligible sectors into dwelling types based on the PA's customer data. This segmentation aligns with the Residential Baseline Study, where Moderate Income households are defined as 61-80% of statewide median income (by household occupancy), and Income Eligible households are defined as 60% of statewide median income and lower.[7] Multifamily buildings with five or more units are included in the C&I building stock in the Commercial - Multifamily segment.[8] However, Income Eligible stock, regardless of the number of units, is mapped to the Income Eligible sector.

Building stock data was developed at the service territory and customer segment level. Residential and Income Eligible segment stocks are considered as number of households, while commercial and industrial segments are per 1000 square feet of building floor space. The primary data used for determining Residential building stocks was delivered to Guidehouse by the PAs. Data included total natural gas customers. For customer counts where income-based distribution was not available, Guidehouse used the demographic distribution based on income type from the 2022 Massachusetts Residential Baseline Survey saturation results. Household counts with unknown segments were mapped to study segments assuming an equal weighting to the rest of the data.

[7] As of March 19, 2024, the upper limit of Moderate Income will change to less than the greater of 80% of state median income or area median income.

[8] This may not match with PA reporting tables as Residential-metered Multifamily buildings would show up in the Residential sector.

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Table 2-3 shows the stock estimates (in units of households) by housing type for the base year 2022. Multifamily buildings with four or more units are included in the C&I building stock in the Commercial - Multifamily segment.

Table 2-3. Base Year (2022) Housing Stocks (Residential and Income Eligible Units)

Housing Type	Natural Gas
Multifamily	9,596
Multifamily Income Eligible (IE)	10,888
Single Family	16,100
Single Family Income Eligible (IE)	15,047
Single Family Moderate Income (MI)	4,053
Total	**55,685**

Source: Guidehouse based on Liberty Utilities data

2.1.2 C&I Sector

Guidehouse selected 20 C&I segments with the goal that the building types within those segments be reasonably similar in terms of electricity use, operating and mechanical systems, and annual operating hours. This approach allowed for consistency in building characteristics within each segment as required by the measure characterization and modeling processes. Some of the customer segments were further split by size (small and large) to align with ongoing statewide commercial surveys that will help inform heat pump adoption.

This study defines C&I customer size based on annual consumption levels, with 1 million kWh and 40,000 therms as the threshold. PA thresholds differ for electricity consumption, but in conversation with the PAs, Guidehouse decided to use the lower threshold to have a consistent value across the analyses. Table 2-4 shows the segmentation used C&I sectors. The C&I multifamily customer segment includes C&I metered multifamily measures for natural gas.

Table 2-4. C&I Customer Segments

C&I Customer Segments	
Colleges & Universities	Lodging - Large
Schools	Restaurants
Other	Retail - Large
Data Centers	Retail - Small
Laboratories	Multifamily
Food Sales - Small	Healthcare - Large
Food Sales - Large	Healthcare - Small
Office - Small	Public Assembly
Office - Large	Warehouse
Lodging - Small	Industrial

Source: Guidehouse

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C&I Building stock data was developed at the service territory and customer segment level. Commercial and industrial segments are characterized as per 1000 square feet of building floor space. The primary data source used for determining building stock for all PAs was delivered to Guidehouse by DNV. Data included total natural gas customer counts as well as total square footage by Commercial Buildings Energy Consumption Survey (CBECS) customer segments.

As noted, Multifamily buildings with five or more units are included in the C&I building stock in the Commercial - Multifamily segment for both natural gas and electricity fuels using allocations based on the data obtained from DNV. However, Income Eligible stock, regardless of the number of units, is mapped to the Income Eligible sector. Data with unknown segments were mapped to study segments assuming an equal weighting to the rest of the data. The stock data was scaled through time using service territory annual sales forecasts provided by PAs.

Guidehouse used a stock demolition rate of 0.5% per year for Residential, Income Eligible and Commercial stock and 0.0% for Industrial stock. This value assumes a 200-year full stock turnover for the Residential, Income Eligible, and Commercial sectors and is a standard estimate. Table 2-5 summarizes the resulting floor space estimates developed for each C&I segment for the study base year, 2022.

Table 2-5. Base Year (2022) C&I Area

Customer Segment	Natural Gas Floorspace (1,000 sq. ft.)
Colleges & Universities	4,131
Schools	521
Other	3,306
Data Centers	4
Laboratories	343
Food Sales - Small	59
Food Sales - Large	484
Office - Small	1,095
Office - Large	3,431
Lodging - Small	764
Lodging - Large	1,495
Restaurants	892
Retail - Large	7,281
Retail - Small	1,877
Multifamily	4,282
Healthcare - Large	983
Healthcare - Small	168
Public Assembly	3,499
Warehouse	4,407
Industrial	13,165
Total	**52,187**

Source: Guidehouse

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2.2 End Use Definitions

This potential study defines end uses as a specific activity or customer need that requires energy, such as space heating or domestic water heating, without specifying the particular type of equipment used to satisfy that need. Table 2-6 presents the list of end uses by sector used in the potential study. These end-use categories are used primarily for the binning of potential estimates and for quality control steps to check the range of savings forecasts against the estimated end-use consumption.

Table 2-6. End Uses by Sector

Residential and Income Eligible	C&I
Behavior[9]	Behavior
Custom	Custom
New Construction	Envelope
Envelope	Compressed Air
Hot Water	HVAC
HVAC	Lighting
Lighting	Motors/Drives
Motors/Drives	Process
Plug Load	Refrigeration
Process	Hot Water
Refrigeration	Food Service

Source: Guidehouse

2.3 End-Use Allocations

End-use allocations were developed for each customer segment and impact type, by fuel. Allocations represent the average share of whole building consumption that is attributable to each end use, calculated using appropriate survey weightings to scale observed buildings, and as such, are representative of statewide building stock. The allocations were developed using data from:

- NREL's ComStock and ResStock End-Use Load Profiles (EULP) databases.
- U.S. EIA's Residential Energy Consumption Survey (RECS).
- U.S. EIA's Commercial Building Energy Consumption Survey (CBECS).
- U.S. EIA's Manufacturing Energy Consumption Survey.
- NREL's Manufacturing Thermal Energy Use database.
- NREL's Industrial Energy Data Book.
- U.S. EIA's State Energy Data System.

[9] Behavior program is not offered by all PAs.

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For commercial buildings, ComStock data was preferred to CBECS because it is Massachusetts-specific, whereas CBECS is regional. Some building types, however, are not included in ComStock. For Residential and Income Eligible buildings, both RECS and NREL EULP (ResStock) are viable data sources because these are Massachusetts-specific. NREL EULP was found to be more credible because of the greater sample size and modeling granularity, and the results also appear more consistent with other studies. End-use allocations are used in this study as guidelines for result quality control, not directly for potential scaling.

2.4 Fuel Shares

Due to the separation of building stock by primary fuel type (natural gas), fuel shares were not needed for this study.

2.5 Load Shapes

All load shape data were sourced from the 2022 BCR models. Electricity load shapes have four periods: Summer-On Peak, Summer-Off Peak, Winter-On Peak, and Winter-Off Peak. Natural gas, and water do not have load shapes, however, there are variations of avoided costs applicable to different natural gas consumption profiles, which have been considered with the avoided costs inputs.

2.6 Sales Forecast

Sales forecast data was developed at the service territory and customer segment level for electric energy, capacity and natural gas. Sales forecasts were not developed for propane and fuel oil due to the lack of data availability and reporting necessity. The relative weighting of building types is assumed to be constant over the study period. Table 2-7 shows the estimated total natural gas consumption by sector.

Table 2-7. Natural Gas Consumption in 2022 (At Meter)

Segment	Natural Gas Consumption MM Therms
Residential	21
Income Eligible	21
C&I	27
Total	**69**

Source: Guidehouse

2.7 Avoided Costs

Avoided costs for electric energy and capacity, natural gas, propane, and fuel oil impacts were developed using final results of the 2024 Avoided Energy Supply Component Study for New England (AESC 2024[1]); water, non-energy impacts, and other program administrator-specific values were adopted from the 2022 BCR models. Benefit streams were combined at the impact

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type level before importing into the DSMSim model. Therefore, each avoided cost stream may contain multiple BCR model benefits.

- Natural gas (per MMBtu) includes natural gas, DRIPE, cross DRIPE, and SCC environmental compliance benefits.
- Water (per gallon) includes only the price of water and sewage.
- Non-energy impacts are mapped to measures for each service territory and include per unit and per impact, one-time and per year benefits.

The BCR models provided these values as well as the values for avoided distribution capacity.

2.8 Retail Rates

Retail rates for electric energy, capacity, natural gas, propane, fuel oil, and water were developed using a variety of resources. Propane, fuel oil, and water rates are equal to the commodity price portion of the avoided costs from the PA BCR models. Current electricity and natural gas distribution rates are based on tariff documents sourced for each PA when provided, or from published rates available online when not provided by PAs. Electricity and natural gas supply rates are taken from PA basic supply rates when available or an average of current supply rates from third parties when a basic supply rate is not provided. The total cost of electricity and natural gas to consumers is the sum of the distribution rate and supply rate. All rates are forecasted over the study period based on the statewide rate of escalation of electricity and natural gas avoided costs provided in the PA BCR models. When sales data by rate class was provided by the PAs, a weighted average of rates based on sales is used for each sector. Retail rates are used to determine customer simple payback for each measure. This metric is used for determining the expected achievable potential adoption.

For the commercial and industrial sectors, electricity demand charges for each sector are weighted based on energy consumption between rate classes when that data was provided. The demand charges are escalated based on the escalation of avoided capacity costs for each PA based on the BCR models.

2.9 Other Economic Inputs

Other economic inputs such as inflation rate and discount rates were sourced from the AESC 2024. Note that discount rates are real (1.74%) to match PA BCR model logic. Line losses were sourced from evaluated 2022 BCR models.

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3. Energy Efficiency Measure Characterization

Guidehouse fully characterized approximately 100 energy efficiency (EE) and electrification measures across Liberty Utilities' Residential, Income Eligible and Commercial & Industrial (C&I) sectors. Guidehouse began the measure characterization process by developing a comprehensive list of measures likely to contribute to economic potential. Guidehouse reviewed current program offerings, previous potential studies conducted in Massachusetts, and potential model measure lists from other jurisdictions to identify measures with the highest expected economic impact. Guidehouse focused on EE and electrification measures which, in aggregate, are projected to achieve 90% or more of the incremental achievable savings. Except for Income Eligible customers, new fossil fuel-fired equipment is not included in the potential results. However, fossil fuel-fired measures are included in the measure list for competition with fuel substitution (i.e., electrification) measures. Also, some measures are included which do not themselves consume fossil fuels but indirectly result in fossil fuel savings; for example, weatherization measures that save fossil fuel energy when installed in homes or buildings that are heated by fossil fuels.

Guidehouse worked with the PAs to finalize the measure list and ensure it contained technologies viable for future program planning activities. Guidehouse did not include a generic future emerging technologies measure that would attempt to capture potential savings from technologies not currently ready for the market. Guidehouse also excluded Residential Behavior (i.e., Home Energy Reports) from the results for Liberty Utilities because Liberty Utilities has found Home Energy Reports to be non-cost-effective and is not planning to offer this program in the future. Unlike other efficient measures, customers cannot achieve savings from Home Energy Reports outside of the PA program, so Guidehouse did not model Residential Behavior savings for Liberty Utilities. Furthermore, Guidehouse excluded any gas savings from Residential New Construction for Liberty Utilities upon receiving guidance that natural gas PAs cannot claim any EE savings for Residential New Construction, and that Residential New Construction electrification assumes the home would be built with propane (and not natural gas) in the absence of the program. Finally, Guidehouse excluded fuel switching measures from results if these caused a net increase in CO_2 emissions, which was the case for industrial high heat electrification.

Not all of the measures considered in the study are offered by every PA in their programs, but all measures included in the results are currently available in the market and economically viable. This list was reviewed by the Energy Efficiency Advisory Council consultant team and a final consensus measure list was selected by the PAs. Appendix B includes a list of the EE measures considered in the study.

3.1 Energy Efficiency Measure Characterization Key Parameters

The measure characterization effort consisted of defining more than fifty individual parameters for each measure included in this study. Table 3-1 defines several key parameters and how these items impact technical and economic potential savings estimates.

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Table 3-1. Key Measure Characterization Parameters

Parameter Name	Definition	Example (for Illustration Purposes Only)
Baseline Measure	Existing inefficient equipment or process to be replaced.	Electric storage water heater
Energy Efficiency Measure	Efficient equipment, process, or project to replace the baseline.	Heat pump water heater (HPWH)
Measure Lifetime	Average lifetime in years for the base and energy efficient technologies. The base and energy efficient lifetimes only differ in instances where the two cases represent inherently different technologies, such as solar water heaters compared to a baseline of regular storage water heaters.	13 years
Measure Costs	The incremental cost between the assumed baseline and efficient technology using the following variables: • Base Cost: The cost of the base equipment, including both material and labor costs. • Energy Efficient Cost: The cost of the energy efficient equipment, including both material and labor costs. Retrofit (early retirement) measure costs will include the full material cost of the efficiency measure and associated labor rates for removal of existing equipment and installation of the efficient technology.	Base cost: $1,500 Efficient cost: $2,200
Incentives	Incentive offered by the PAs for certain EE measures.	$750 per water heater
Tax Credits	Additional tax credit under the Inflation Reduction Act (IRA), typically 30% of measure or project cost (after incentive) up to an annual or per-unit cap. The effect is to reduce measure cost which increases the measure's cost effectiveness and improves customer adoption.	30% of efficient cost after incentive is applied = $435 (less than $2,000 per Heat Pump Water Heater cap)
Replacement Type	Identifies when in the technology or building's life an efficiency measure is introduced. Replacement type affects when in the potential study period the savings are achieved, as well as the duration of savings. • Retrofit or early retirement (RET): A measure is added to, or replaces, an existing piece of equipment before the end of its life. • Replace-on-Burnout (ROB): An efficient measure is installed when existing equipment reaches the end of its life and needs to be replaced. • New Construction (NEW): An efficient measure is installed in a new home or building.	ROB, RET, NEW
Annual Energy Consumption	The annual energy consumption for natural gas in therms, for propane and fuel oil in MMBTU and for each baseline and EE measure.	Baseline: 2,000 kWh/year Efficient: 500 kWh/year
Unit Basis	The normalizing unit for energy, demand, cost, and density estimates. Per appliance, per hp, per kWh consumption, per therm consumption, etc.	Per water heater
Scaling Basis	The unit used to scale the energy, demand, cost and density estimate for each measure according to the reference forecast. For the Residential and Income Eligible sector, this is typically per home; for the Non-Residential sector this is typically per 1,000 square feet of floor area.	Per home Per 1,000 square feet of floor area

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Parameter Name	Definition	Example (for Illustration Purposes Only)
Sector and End-Use Mapping	The team mapped each measure to the appropriate end uses, customer segments and sectors.	Residential sector, Hot Water end use
Measure Density	Used to characterize the occurrence or count of a baseline measure that can be replaced with the efficiency measure, or stock, within a Residential / Income Eligible household. or within 1,000 square feet of a Commercial building. Measure density represents the average occurrence within a sector and building type.	0.15 Electric water heaters per household (average, accounting for the fact that some households have electric water heaters, while others have natural gas, or other types of water heaters which are represented by a different measure)
Energy Efficiency Saturation	The fraction of the Residential / Income Eligible housing stock or Commercial building space in 2022 that has the efficient measure installed.	There are almost no HPWHs currently installed, so the baseline saturation is 100% and efficient saturation is 0%.
Technical Suitability	Percentage of the base technology that can be reasonably and practically replaced with the specified efficient technology.	HPWHs have a technical suitability of 70% because not all homes have a space that can accommodate a HPWH.
Competition Group	Identifies measures competing to replace the same baseline density in order to avoid double counting of savings.	HPWH or an electric tankless water heater can replace an inefficient electric storage water heater, but not both.

3.2 Energy Efficiency Measure Characterization Approaches and Sources

This section lists sources of data accessed for the main measure characterization variables. Table 3-2 shows measure inputs and data sources used in the development of the characterization approach.

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Table 3-2. Measure Inputs and Data Sources

Measure Input	Data Sources
Measure Costs, Incentives, Tax Credits, Measure Life, Energy Savings, Demand Savings, Net-to-Gross (NTG) Values	• MA Technical Reference Manual (TRM), 2022 Plan Year Report Version[10] • PA program data including benefit-cost ratio (BCR) calculation models • Previous Massachusetts PA Potential Studies • United States Department of Energy (US DOE) Appliance Standards and Rulemakings supporting documents • Tax credit information in Section 13301 of the Inflation Reduction Act (IRA) - Extension, Increase, and Modifications of Nonbusiness Energy Property Credits.[11] • Engineering analyses • Other non-MA TRMs • Guidehouse measure database and previous potential studies in other jurisdictions
Density, Baseline Initial Saturation, Technical Suitability	• Massachusetts Residential Baseline Study[12] • National Renewable Energy Laboratory (NREL) commercial building sector stock model for 2023 (ComStock)[13] • National Renewable Energy Laboratory (NREL) Residential building sector stock model for 2023 (ResStock)[14] • C&I baseline data[15] • Commercial Building Stock Assessment (CBSA)[16] • U.S. EIA Residential Energy Consumption Survey (RECS)[17] • U.S. EIA Commercial Building Energy Consumption Survey (CBECS)[18] • U.S. EIA's Manufacturing Energy Consumption Survey[19] • NREL's Manufacturing Thermal Energy Use database[20] • Previous potential studies in Massachusetts • Other Guidehouse potential studies
Codes and Standards	• US DOE engineering analyses • Local building code

[10] 2022 Report Technical Reference Manual, https://www.masssavedata.com/TRL/Technical%20Reference%20Manual%202022%20Report%20FINAL.pdf

[11] https://www.irs.gov/pub/taxpros/fs-2022-40.pdf

[12] Most recent Residential baseline data from a Guidehouse study in progress at the time of this potential study. Some measure values derived from Navigant (2019) and Guidehouse (2020), "Massachusetts Residential Baseline Study." Available at https://ma-eeac.org/wp-content/uploads/RES-1-Residential-Baseline-Study-Comprehensive-Report-2019-04-30.pdf and https://ma-eeac.org/wp-content/uploads/RES-1-Residential-Baseline-Study-Ph4-Comprehensive-Report-2020-04-02.pdf.

[13] https://comstock.nrel.gov/

[14] https://resstock.nrel.gov

[15] C&I baseline data from a DNV study in progress at the time of this Potential Study.

[16] https://neea.org/data/commercial-building-stock-assessments

[17] https://www.eia.gov/consumption/residential/

[18] https://www.eia.gov/consumption/commercial/

[19] https://www.eia.gov/consumption/manufacturing/

[20] https://data.nrel.gov/submissions/118

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3.2.1 Energy and Demand Savings

Guidehouse took the following general bottom-up approaches to analyzing Residential, Income Eligible and C&I measure energy and demand savings:

1. **Technical Reference Manual (TRM) Standard Algorithms:** Guidehouse used the MA TRM (2022 Plan Year Report Version) as the primary source of savings for this study. From the TRM, Guidehouse sourced deemed savings and standard algorithms for unit energy savings and demand savings calculations. The exception is for certain Non-Residential heat pump fuel switching measures for which the PAs indicated that more recent estimates of impacts were significantly lower than the estimates in the 2022 TRM. The PAs provided draft impacts to the Guidehouse team that Guidehouse incorporated into the measure inputs. The affected measures included:
    a. Central Air Source Heat Pump (Split or Packaged) displacing Gas Heat
    b. Air Source Heat Pump displacing Gas Roof Top Unit (RTU)
    c. Variable Refrigerant Flow (VRF) Heat Pump displacing Gas RTU
    d. Variable Refrigerant Flow Heat Pump displacing Gas Heat
    e. Ground Source Heat Pump (Water-to-Water) displacing Gas Heat
    f. Ground Source Heat Pump (Water-to-Air) displacing Gas Heat
    g. Ductless Heat Pump displacing Gas Heat
2. **Program Evaluation Data:** Guidehouse used measure-specific program evaluation data from the PAs to inform energy and demand savings if these were more recent than the TRM values.
3. **Custom Program Data**: For Custom C&I measures, Guidehouse used the PAs' Custom program data to estimate consumption and savings for all custom measures included in this study. Guidehouse characterized three custom measures that aligned to program allocations: Custom C&I New Construction; Custom C&I Retrofit; and Custom C&I Replace-on-Burnout. The savings assumptions for Custom measures were derived from the PAs' Custom program data in 2022, aggregated into the three categories based on the program allocation. Assumptions about cost per therm saved for gas projects were derived from projects aggregated across gas PAs. To calculate the percent savings for each measure within each segment, Guidehouse collaborated with the PAs and DNV to get the site level energy savings as well as the customer annual consumption data. Depending on the granularity of the available data, Guidehouse characterized the Custom measure for each segment if segment level savings and consumption were available. In the absence of segment level information, an overall average was applied across Custom measures to get an average segment level savings percentage.
4. **Engineering Analysis:** Guidehouse used appropriate engineering algorithms to calculate energy savings for any measures not included in PA programs or available TRMs. As an example, this approach was taken for Data Center measures that did not have any program specific data or data in the TRM.
5. **Weather Updates:** Many TRM measures with deemed savings values rely on out-of-date TMY3 weather[21] data, but TMYx weather data is more current and readily available.

[21] https://www.masssavedata.com/TRL/Technical%20Reference%20Manual%202022%20Report%20FINAL.pdf

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Guidehouse analyzed a series of building simulation models and developed ratios to express changes in cooling/heating consumption and peak demand between TMY3 and TMYx weather data.

For electrification measures, the baseline condition is a natural gas appliance, while the efficient condition is an electric appliance. Electrification measures have positive natural gas savings, but negative electricity and demand savings because the efficient electric measure uses electricity, while the baseline measure predominantly uses natural gas.

3.2.2 Incremental Costs

Guidehouse relied primarily on PA-provided program data and recent evaluation studies for incremental cost data, including information in the PAs' 2022 evaluated BCR models for electricity, natural gas, propane, and fuel oil measures. Costs from sources other than the BCR were updated to 2022 dollars, if necessary, using the Bureau of Labor Statistics' consumer price index.[22] Then, 2022 dollars were escalated to 2025 dollars using the AESC 2024 escalation factor. Guidehouse also conducted secondary research and used a variety of other publicly available cost data sources (for example, incremental cost information published by the US DOE as part of efficiency standards rulemaking proceedings covering certain products). Incremental costs for Custom measures were calculated based on PAs' actual program data. Similar to the calculation of site-level savings, values were calculated based on site-level data.

3.2.3 Incentives, Tax Credits, Administrative Costs, and Net-to-Gross Ratios

Incentives and NTG ratios were included from the PAs' BCR models for all natural gas, propane, and fuel oil measures. Costs for administering and marketing programs were also taken from PA historical program data. Tax credit values were derived from guidance given for Section 13301 of the Inflation Reduction Act - Extension, Increase, and Modifications of Nonbusiness Energy Property Credits.[23] Inflation Reduction Act rebates issued through state-administered programs were excluded, as measures cannot receive both an Inflation Reduction Act rebate and a PA program incentive. Hard-to-measure and RCS costs were included in sector-level aggregations and BCR calculations. Hard-to-measure costs were estimated to be proportional to other administrative costs for the sector, based on 2022 actual costs.

For selected weatherization measures, Guidehouse made administrative cost adjustments to reflect the increasing difficulty of acquiring savings as saturation increases.

3.2.4 Building Stock and Densities

Guidehouse relied primarily on the Massachusetts Residential Baseline Study for information on equipment densities and saturations for Residential and Income Eligible measures. Where available, Guidehouse used the most recent baseline data collected in 2023, which has not yet been published. Otherwise, Guidehouse referenced previous versions of the Residential Baseline Study[24].For measures not covered in baseline research, and measures characterized

[22] https://www.bls.gov/data/inflation_calculator.htm

[23] https://www.irs.gov/pub/taxpros/fs-2022-40.pdf

[24] Navigant (2019) and Guidehouse (2020), "Massachusetts Residential Baseline Study." Available at https://ma-eeac.org/wp-content/uploads/RES-1-Residential-Baseline-Study-Comprehensive-Report-2019-04-30.pdf and https://ma-eeac.org/wp-content/uploads/RES-1-Residential-Baseline-Study-Ph4-Comprehensive-Report-2020-04-02.pdf. Both 2019 and 2020 versions of the baseline study were accessed for this study.

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directly through program offerings (e.g., custom, strategic energy management, and behavioral), Guidehouse used PA historical program results and other secondary sources.

For the commercial sector, Guidehouse referenced NREL's ComStock 2023 database,[25] as well as C&I baseline data,[26] for informing equipment densities and saturation. Guidehouse also leveraged PA program data. Previous potential studies in Massachusetts and other jurisdictions were also reviewed to derive density and saturation for measures that were not included in the aforementioned sources.

3.2.5 Program Allocation

Guidehouse mapped measures to Residential and Commercial & Industrial programs based on Liberty Utilities' 2022 BCR model. Generally, Guidehouse mapped measures characterized in Income Eligible building segments to the Income Eligible program. However, PAs indicated that the Heat Recovery Ventilator gas measure would be more appropriately mapped to the Residential Retail program even for Income Eligible program participants because this measure is not offered in the Income Eligible Program, and any savings from income-eligible customers from this measure would appear in the Residential Retail program.

3.3 Codes and Standards Adjustments

Estimates of adjustments in savings related to Federal and State codes and standards are included as part of the measure characterization process. The US DOE publishes federal EE regulations for many types of Residential appliances and commercial equipment. The US DOE Technical Support Documents (TSD)[27] contain information on energy and cost impacts of each appliance standard. As these codes and standards take effect, the energy savings from existing measures impacted by these codes and standards decline because the baseline efficiency increases to align with the new code or standard.

Guidehouse accounts for the effect of codes and standards through adjustments to baseline consumption and cost, typically through baseline energy and cost multipliers, which reduce the baseline equipment consumption starting from the year a code or standard takes effect. The baseline cost of an efficient measure affected by codes and standards will often increase upon the code's implementation. Guidehouse incorporated the 2023 Residential central air conditioners standard in this study, which results in the baseline for Residential air conditioners changing from a 14.0 Seasonal Energy Efficiency Ratio (SEER) to 14.3 SEER in 2023. Accordingly, the model accounts for a reduction in energy consumption and an increase in cost in 2023 for the baseline technology through the codes and standards multipliers. As such, computed measure-level potential is net of these adjustments from codes and standards implemented after the study's first year.

[25] https://comstock.nrel.gov/

[26] C&I baseline data from a DNV study in progress at the time of this Potential Study.

[27] Appliance standards rulemaking notices and TSDs can be found at: https://www.energy.gov/eere/buildings/appliance-and-equipment-standards-program

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4. Energy Efficiency Potential

This section describes Guidehouse's approach to calculating EE potential and presents the results for Liberty Utilities in Massachusetts at different levels of aggregation. Results are shown by sector and impact type. For more details and levels of aggregation of EE potential, see Appendix C.

4.1 Energy Efficiency Technical Potential Forecast

This section describes Guidehouse's approach to calculating technical potential and presents the results for Liberty Utilities in Massachusetts pertaining to technical savings potential at different levels of aggregation. Results are shown by sector and end-use category. For more details and levels of aggregation of technical potential, see Appendix C.

4.1.1 Approach to Estimating Energy Efficiency Technical Potential

This study defines **technical potential** as the total energy savings available assuming that all applicable installed baseline measures can *immediately* be replaced with the efficient measure/technology — wherever technically feasible — regardless of the cost, market acceptance, or whether a measure has burned out and must be replaced. Therefore, technical potential is neither cumulative nor incremental, but instead shows the total potential if all savings were to be achieved in a single year.

Massachusetts 2025-2027 Potential Study Modeling Methodology (see Appendix A) discusses the approach to estimating technical potential in more detail. Guidehouse used its DSMSim model to estimate the technical potential for demand-side resources considered for this study. DSMSim is a bottom-up, technology-diffusion and stock-tracking model implemented using a System Dynamics framework.[28] A separate model was developed within DSMSim for each PA / operating company.

4.1.2 Energy Efficiency Technical Potential Results by Sector

Table 4-1 through Table 4-3 show the net technical potential, by sector, fuel and impact type, with electricity and summer peak electricity demand at meter. The results reflect the effects of both EE (more efficient equipment, which provides positive savings) and fuel substitution (heat pump replacing a fossil fuel system, which provides negative savings for electricity and summer peak electricity demand, with positive fossil fuel savings).

For the natural gas technical potential, the Residential and Income Eligible sectors provide the most savings, with the C&I sector providing the least potential. Electricity and summer peak electricity demand are negative due to fuel substitution measures. All sectors provide positive water consumption potential and with none for oil, propane, or motor gasoline.

In the tables showing potential, savings are generally rounded to the nearest hundred, to indicate a level of uncertainty in the analysis.

[28] See Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill, 2000, for detail on System Dynamics modeling. Also see http://en.wikipedia.org/wiki/System_dynamics for a high-level overview.

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Table 4-1. Residential Technical Potential, Liberty Gas (Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
Residential Sector - Energy Efficiency Measures							
2025	696	539	7,862,000	0	0	0	85,570
2026	668	532	7,829,000	0	0	0	86,360
2027	641	526	7,796,200	0	0	0	87,150
Residential Sector - Fuel Substitution Measures							
2025	-155,708	-4,542	17,888,700	0	0	0	0
2026	-155,031	-4,540	17,810,600	0	0	0	0
2027	-154,358	-4,539	17,732,900	0	0	0	0

Source: Guidehouse

Table 4-2. Income Eligible Technical Potential, Liberty Gas (Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
Income Eligible Sector - Energy Efficiency Measures							
2025	3,280	947	8,004,600	0	0	0	65,050
2026	3,266	945	7,965,400	0	0	0	65,650
2027	3,251	943	7,926,500	0	0	0	66,240
Income Eligible Sector - Fuel Substitution Measures							
2025	-114,643	-3,338	15,511,100	0	0	0	0
2026	-114,159	-3,340	15,443,500	0	0	0	0
2027	-113,677	-3,342	15,376,100	0	0	0	0

Source: Guidehouse

Table 4-3. C&I Technical Potential, Liberty Gas (Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
C&I Sector - Energy Efficiency Measures							
2025	1,469	374	8,287,700	0	0	0	33,490
2026	1,440	366	8,204,400	0	0	0	32,960
2027	1,411	359	8,122,900	0	0	0	32,440
C&I Sector - Fuel Substitution Measures							
2025	-324,498	-82,164	10,442,400	0	0	0	0
2026	-324,768	-82,444	10,482,100	0	0	0	0
2027	-325,040	-82,727	10,522,300	0	0	0	0

Source: Guidehouse

4.2 Energy Efficiency Economic Potential Forecast

This section describes the economic potential, which meets a prescribed level of cost-effectiveness, available for Liberty Utilities in Massachusetts. The section begins by explaining Guidehouse's approach to calculating economic potential and then presents the results for economic potential at different levels of aggregation. Results are shown by sector and impact type. Guidehouse developed economic potential using a TRC of 1.0 as the measure screen. For economic potential, this screen is applicable to all measures including fuel substitution. For more details and levels of aggregation of economic potential, see Appendix C.

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4.2.1 Approach to Estimating Economic Potential

Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as technical potential, but including only those measures that have passed the benefit-cost test chosen for measure screening—in this case, the TRC test, per Liberty Utilities' guidance. The TRC ratio for each measure is calculated each year and compared against the measure-level TRC ratio screening threshold of 1.0. A measure with a TRC ratio greater than or equal to 1.0 is a measure that provides monetary benefits greater than or equal to its costs. If a measure's TRC ratio meets or exceeds the threshold, it is included in the economic potential. Measures with TRC ratios less than 1.0 were non-cost-effective and do not appear in the economic potential.

The TRC test is a benefit-cost metric that measures the net benefits of EE measures from a combined stakeholder viewpoint of the program administrator and its customers. The TRC benefit-cost ratio is calculated in the model using Equation 4-1.

Equation 4-1. Benefit-Cost Ratio for Total Resource Cost Test

$$TRC = \frac{PV(Avoided\ Costs + O\&M\ and\ NEI\ Savings)}{PV(Technology\ Cost + Admin\ Costs)}$$

Where:

- *PV( )* is the present value calculation that discounts cost streams over time using the selected nominal discount rate of 4.03% per AESC 2024.
- *Avoided Costs* are the monetary benefits resulting from electricity and capacity savings (e.g., avoided costs of infrastructure investments, due to electricity conserved by efficient measures)
- *O&M and NEI Savings* are the non-energy impacts, such as operation and maintenance cost savings, comfort benefits and reduced bill arrears.
- *Technology Cost* is the incremental equipment cost to the customer before PA incentives.
- *Admin Costs* are the administrative costs incurred by the program administrator.

Guidehouse calculated BCR ratios for each measure based on the present value of benefits and costs (as defined above) over each measure's lifetime. Similar to technical potential, only one economic measure (meaning that its TRC ratio meets the threshold) from each competition group is included in the summation of economic potential across measures (e.g., at the end-use category, customer segment, sector, service territory, or total level). If a competition group is composed of more than one measure that passes the TRC test, then the economic measure that provides the greatest savings potential for its primary impact type is included in the summation of economic potential. This approach ensures that double counting is not present in the reported economic potential.

4.2.2 Energy Efficiency Economic Potential Results by Sector

Table 4-4 through Table 4-6 show the economic potential by sector, fuel and impact type, with electricity and summer peak electricity demand at the meter. The results reflect the effects of both EE (more efficient equipment, which provides positive savings) and fuel substitution (heat

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pump replacing a fossil fuel system, which provides negative savings for electricity and summer peak electricity demand, with positive fossil fuel savings).

For the natural gas technical potential, the Residential and Income Eligible sectors provide similar savings, with the C&I sector providing slightly less. Electricity and summer peak electricity demand are negative for the Residential and Income Eligible sectors due to fuel substitution measures. All sectors provide positive water consumption potential with none for oil, propane, or motor gasoline.

Economic potential results closely align with technical potential for most fuel types and sectors with the exception of C&I fuel substitution. This is due to the targeted nature of the measure list with a focus on measures forecasted or historically incentivized by Liberty which, therefore, have already been established as economic. Additionally, certain measures with potentially variable costs, such as home insulation, are characterized as the average expected project from historic data, resulting in passing TRCs for the entire measure spectrum.

Table 4-4. Residential Economic Potential, Liberty Gas (Annual Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
Residential Sector - Energy Efficiency Measures							
2025	696	539	7,862,000	0	0	0	85,570
2026	668	532	7,829,000	0	0	0	86,360
2027	641	526	7,796,200	0	0	0	87,150
Residential Sector - Fuel Substitution Measures							
2025	-103,382	-2,593	13,427,800	0	0	0	0
2026	-102,921	-2,594	13,371,700	0	0	0	0
2027	-102,462	-2,596	13,315,700	0	0	0	0

Source: Guidehouse

Table 4-5. Income Eligible Economic Potential, Liberty Gas (Annual Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
Income Eligible Sector - Energy Efficiency Measures							
2025	3,070	797	7,958,500	0	0	0	65,050
2026	3,265	945	7,955,200	0	0	0	65,650
2027	3,251	943	7,916,300	0	0	0	66,240
Income Eligible Sector - Fuel Substitution Measures							
2025	-112,104	-2,945	15,490,500	0	0	0	0
2026	-111,592	-2,942	15,422,600	0	0	0	0
2027	-111,082	-2,940	15,355,000	0	0	0	0

Source: Guidehouse

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Table 4-6. C&I Economic Potential, Liberty Gas (Annual Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
C&I Sector - Energy Efficiency Measures							
2025	1,469	374	7,792,300	0	0	0	33,490
2026	1,440	366	7,752,900	0	0	0	32,960
2027	1,411	359	7,740,700	0	0	0	32,440
C&I Sector - Fuel Substitution Measures							
2025	-1,979	9,153	455,600	0	0	0	0
2026	-1,996	9,227	458,600	0	0	0	0
2027	-2,012	9,301	461,700	0	0	0	0

Source: Guidehouse

4.3 Energy Efficiency Achievable Potential Approaches

Achievable potential further considers the likely rate of demand-side management (DSM) resource acquisition, given factors including the rate of equipment turnover (a function of a measure's lifetime), simulated incentive levels, consumer willingness to adopt efficient technologies, word-of-mouth effects that increase awareness in customers, and the likely rate at which marketing activities can facilitate technology adoption. The adoption of DSM measures can be broken down into the calculation of the equilibrium market share and calculation of the dynamic approach to equilibrium market share, as discussed in more detail below.

Achievable potential differs from program potential in that achievable potential does not specifically consider the various delivery mechanisms that can be used by program managers to tailor their approach depending on the specific measure or market. Rather, achievable potential represents a high-level assessment of savings that could be achieved over time, factoring in broader assumptions about customer acceptance and adoption rates that are not dependent on a specified program design. Additional effort is typically undertaken by program designers, using the directional guidance from a market potential study, to develop detailed plans for delivering EE programs. Achievable potential for EE measures in this report relies on a TRC measure screen for cost-effectiveness, using a TRC benefit-cost test measure level screen of 0.80 for the majority of measures, intended to reflect Massachusetts' regulatory practice of screening at the program level.[29] For fuel substitution measures, no TRC screening threshold was used, as these measures are deployed based on forecasted estimates rather than traditional bass diffusion logic. The same screening criteria was used for all sectors.

This section discusses the steps taken to establish the reference scenario (business as expected, or BAE) for achievable potential. This scenario is termed "business as expected," rather than "business as usual," because of known changes between the current 2022-2024 term and the forecast 2025-2027 term, such as the anticipated discontinuation of fossil fuel-fired equipment incentives for Residential and C&I sectors. The BAE scenario becomes the foundation for other scenarios described in Section 4.3.3.2.

Table 4-7 summarizes the key methodological considerations and decision points informing the analysis in this report, with more detail provided in the report sections noted in the right-hand

[29] In order to maximize efficiency implementation, Massachusetts PAs promote and incentivize measures with BCRs less than 1.0 as long as program BCRs are greater than 1.0. To model this, measure level BCR screens are set to 0.8.

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column of the figure. Guidehouse decided upon this methodology through discussions with Liberty Utilities about which approach best serves the objective of the study to understand achievable potential.

Table 4-7. Energy Efficiency Achievable Potential Methodology Overview

Methodology Parameters	Approach
Benefit-cost test screen	Use the TRC as the primary screen for economic and achievable potential.
Diffusion parameters	Adjust diffusion parameters (e.g., marketing factor and word-of-mouth) referencing ranges recommended by industry standard data sources to produce savings that are reasonably aligned with Liberty Utilities' DSM sector-level historical achievements.
Budget constraints	Do not apply budget constraints.
Incentive strategy	Set incentive levels equal to historical program levels where applicable and 50% of incremental costs. For Income Eligible customers, incentives are 100% of incremental costs.
Treatment of administrative costs	Include program level incentive to administrative cost ratios, benchmarked to historical performance, that scale administrative costs with calculated incentive budget.
Net-to-Gross (NTG)	Achievable potential estimates are developed using net savings based on historical program NTG inputs and TRM values.
Re-participation	Assume 100% of measures re-participate as an efficient measure at the end of a measure's lifetime.
Codes and standards	Use the same assumptions about codes and standards as in technical and economic potential.

4.3.1 Calculation of Equilibrium Market Share

The equilibrium market share can be thought of as the percentage of individuals choosing to purchase a technology provided those individuals are fully aware of the technology and its relative merits (e.g., the energy- and cost-saving features of the technology). For DSM measures, a key differentiating factor between the base technology and the efficient technology is the energy and cost savings associated with the efficient technology. Of course, that additional efficiency's initial cost often comes at a premium. This study calculates an equilibrium market share as a function of the payback time of the efficient technology relative to the baseline technology. In effect, measures with more favorable customer payback periods after the incorporation of incentives will have higher equilibrium market share, which reflects consumers' economically rational decision-making. While such approaches certainly have limitations, nonetheless, these are directionally reasonable and simple enough to permit estimation of market share for the hundreds of technologies appearing in most potential studies.

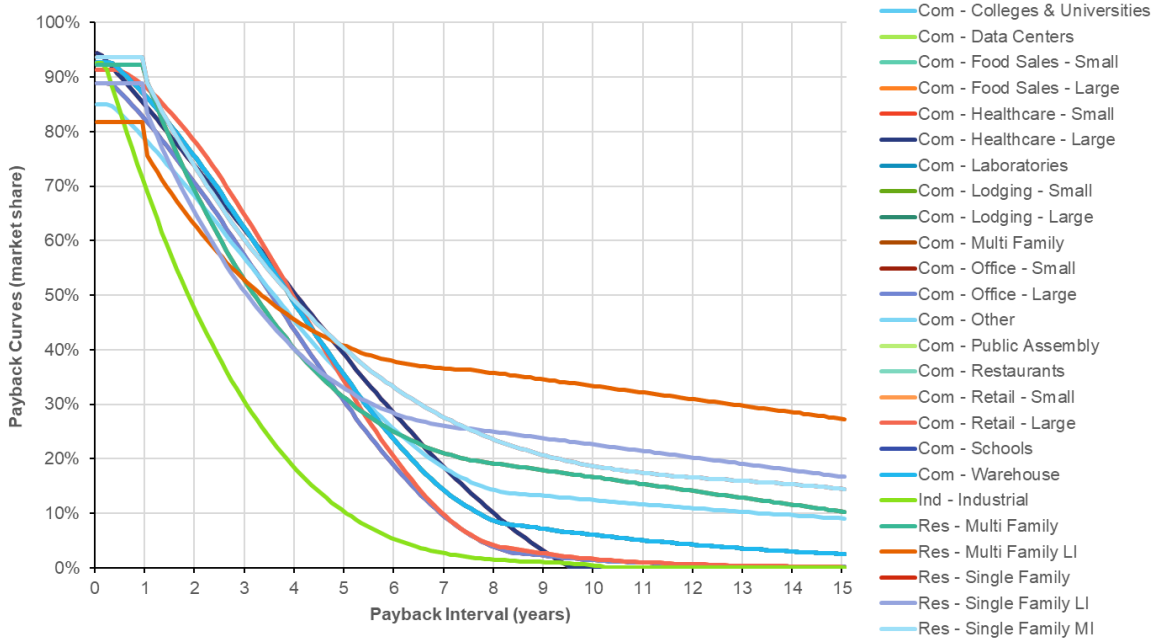
To inform this study, the team used equilibrium payback acceptance curves that Guidehouse developed using primary research from the National Grid 2018 Potential Study[30]. To develop these curves, Guidehouse relied on surveys of 1000 Residential and 200 C&I customers, which presented decision makers with numerous choices between technologies with low up-front costs, but high annual energy costs, and measures with higher up-front costs but lower annual

[30] Energy Efficiency Potential Study for 2019-2021 National Grid Massachusetts, Final Report, September 6, 2018

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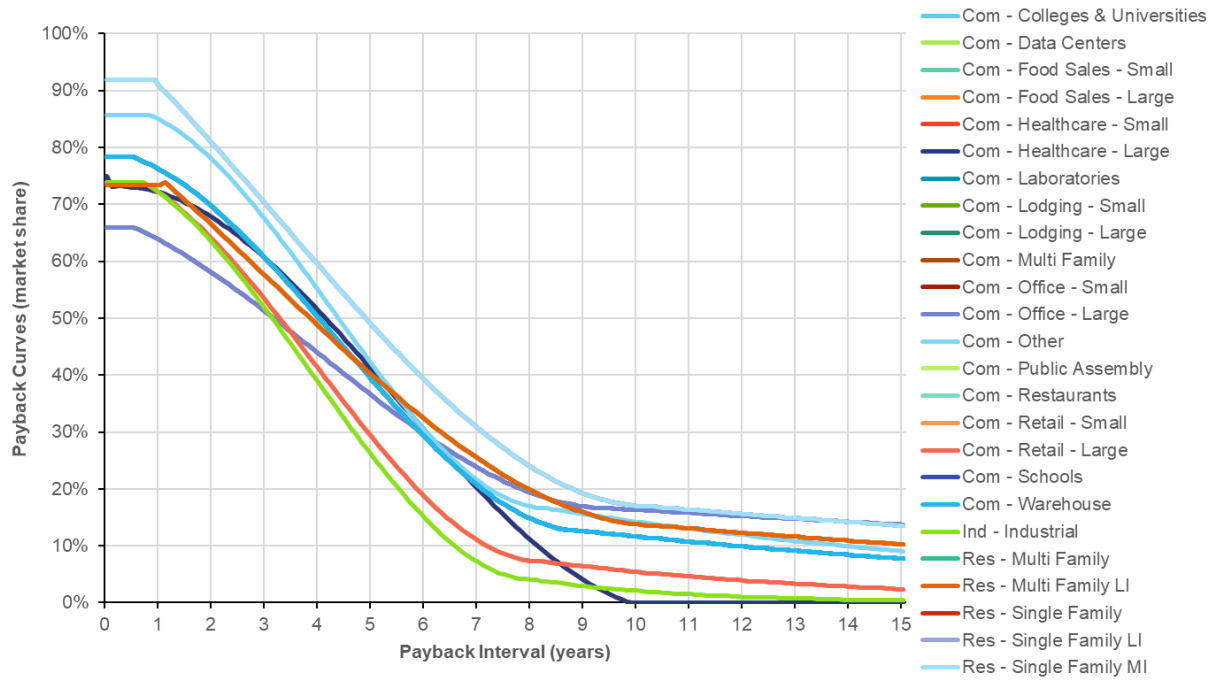
energy costs. Guidehouse fitted generalized logit models to customer willingness to pay survey results by technology cost bin and segment to develop the set of curves, which are used in this study. The resulting willingness to pay curves, shown in Figure 4-1 and Figure 4-2 are used as starting points for achievable potential calibration.

Figure 4-1. Low-Cost Willingness to Pay Curves by Customer Segment



Source: Guidehouse

Figure 4-2. High-Cost Willingness to Pay Curves by Customer Segment



Source: Guidehouse

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Because the payback period of a technology can change over time (as technology or energy costs change over time), the equilibrium market share can also change over time. The equilibrium market share is therefore recalculated for every year of the forecast to ensure the dynamics of technology adoption take this effect into consideration. As such, equilibrium market share is a bit of an oversimplification and a misnomer, as it can itself change over time and is therefore never truly in equilibrium, but it is used nonetheless to facilitate understanding of the approach.

4.3.1.1 Calculation of the Approach to Equilibrium Market Share

Two approaches are used for calculating the approach to equilibrium market share, one for technologies being modeled as retrofit (RET) measures, and one for technologies simulated as replace-on-burnout (ROB) or new construction (NEW) measures.[31] *Massachusetts 2025-2027 Potential Study Modeling Methodology* (see Appendix A) discusses the approach to equilibrium market share in more detail.

4.3.1.2 Behavioral Measures

Liberty Utilities is not offering behavioral measures and they were not modeled as part of the potential analysis.

4.3.1.3 Energy Efficiency Investment Strategy

Liberty Utilities elected to view achievable potential without imposing any explicit budget constraints on the simulated results. The implication of this decision is that achievable potential is only constrained by stock turnover, customer willingness to adopt efficient measures, and calibration to historical participation levels. Without future budget constraints, the program administrator spending falls out naturally from the input assumptions for per-unit incentives and program administrative cost, without tying spending to a given budget level. In this study, the per-unit incentive and administrative spending levels are fixed at the same levels (in real dollars, compared with nominal dollars) over the study horizon. Therefore, changes in spending (in real dollars) only reflect a changing mix and magnitude of savings among measures.

4.3.1.4 Energy Efficiency Incentive Strategy

Per Liberty Utilities' guidance, this study sets measure incentives based on Liberty Utilities' current program levels, where available, and 50% of incremental cost for new measures to the portfolio for the BAE scenario. For Income Eligible customers, incentives are 100% of the incremental measure cost.

4.3.1.5 Re-Participation

The model assumes that 100% of program participants re-adopt energy efficient measures after the end of the efficient measure's expected useful lifetime. This implies that efficient measures generally do not revert to a minimum code or lower efficiency level. As such, the model's cost accounting incurs an incentive cost upon the initial conversion of a minimum code or lower efficiency measure to an efficient measure, but it does not incur incentive costs when replacing incumbent equipment that was already updated to efficient equipment during the study horizon.

[31] Each of these approaches can be better understood by visiting Guidehouse's technology diffusion simulator, available at: http://forio.com/simulate/navigantsimulations/technology-diffusion-simulation.

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Thus, incremental savings are counted only for new program participants, and these savings are summed up year-over-year to represent cumulative potential.

4.3.1.6 Energy Efficiency Model Calibration

Any model simulating future product adoption faces challenges with calibration, as no future world exists for comparing simulated results to actual results. Engineering models, on the other hand, can often be calibrated to a higher degree of accuracy since simulated performance can be compared directly with the performance of actual equipment installed. Since DSM potential models do not have this luxury, Guidehouse therefore had to rely on other techniques to provide both the developer and the recipient of the model results with a level of comfort that simulated results are reasonable. For this study, Guidehouse took several steps to ensure that forecast model results are reasonable, including:

- Identifying the subset of potential measures that were included in historical Liberty Utilities program offerings in order to have a basis for comparison with historical program achievements.
- Ensuring similar trends and magnitudes between Liberty Utilities' historical sector- and end use-level savings and simulated sector- and end use-level savings from the measure subset in the model's base year.
    - For EE measures, 2022 historical achievements were used in the calibration process as these represent the most recent available data.
    - For fuel substitution measures, the PA's provided an estimated deployment of technologies from 2022-2024. Guidehouse calibrated the number of installations to the levels provided regardless of cost-effectiveness screening and customer payback results.
- Due to the sector and end-use granularity of calibration, PA-specific customer segments' results (such as Moderate Income or Commercial versus Industrial segments) are a function of comparative segment stock, sales, equipment density, and unique payback characteristics within the sector total. Consequently, Moderate Income results are a function of the overall Residential sector calibration.
- Review top five historical measures in each sector for detailed calibration; with the focus on the top five measures, the exact order of measure-level potential may vary from actual achievements.
- Review Income Eligible and market rate split within the Residential sector compared to historical (market rate includes moderate income).
- Studying results with program administrators to identify trends, high impact measure mixes, and savings trajectories for review at a more granular level than the sector and end-use calibration.

Before making comparisons of model results to historical achievements, it was first necessary to identify the potential measures that were included in Liberty Utilities historical program offerings. The simulated savings from this subset of potential measures became the basis for comparing modeled savings to historical savings during the calibration process. It is important to note that although the team calibrated to historical results for this subset of measures, the model's results for achievable potential may differ from Liberty Utilities historically achieved program savings. This is due to the iterative process for achievable potential review and the addition of new measures and competition groups to the portfolio. The subset measure calibration step is an

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important starting point for calibration to account for the differences in measure mix between the potential study and historical DSM programs.

To achieve alignment with Liberty Utilities' historical savings, Guidehouse adjusted technology diffusion coefficients and payback acceptance curves. Calibration required an iterative process of modifying the aforementioned parameters until all the goals of calibration were reasonably satisfied. For example, the marketing effectiveness parameters are the key lever for calibrating the magnitude of historical savings for each sector and end-use combination; the word-of-mouth parameter strongly influences the rate of adoption and savings growth over time; and the measure-level payback acceptance curves allow for detailed calibration of high impact measures with significant historical data to support granular review. Guidehouse varied these diffusion parameters within commonly observed ranges until simulated savings were trending reasonably compared with historic, sector-level savings.

To summarize, the calibration process ensures that forecast potential is grounded against real-world data considering the many factors that determine likely adoption of DSM measures, including both economic and non-economic factors.

4.3.2 Energy Efficiency Achievable Potential Results by Sector

Relative to the estimation of technical and economic potential, the methodology and assumptions underpinning the estimation of achievable potential are significantly more complex. As such, Guidehouse presents the high-level forecasts of Residential, Income Eligible and C&I achievable potential savings at the onset of this section, consistent with the detailed methodological discussion of achievable savings estimation beginning in Section 4.3.

Table 4-8 through Table 4-10 show the BAE scenario annal net achievable potential, by sector, fuel, and impact type. As with technical and economic potential, the results reflect the effects of both EE (more efficient equipment, which provides positive savings) and fuel substitution (heat pump replacing a fossil fuel system, which provides negative savings for electricity and summer peak electricity demand, with positive fossil fuel savings). Negative savings for fossil fuels also occur from interactive effects (electricity savings that result in increased natural gas usage, for example, from heat pump water heaters that cool the ambient air and require additional space heating).

For the natural gas achievable potential, the Residential and Income Eligible sectors provide roughly equal savings, with the C&I sector providing slightly less. All sectors provide positive water consumption potential with none for oil, propane or motor gasoline.

Achievable potential in any given year is significantly lower than economic potential. This is because economic potential represents a single year hypothetical savings given an unconstrained stock while achievable potential constrains annual stock by turnover logic based on replacement type, customer awareness, and willingness to pay. For example, a replace-on-burnout measure with a 20-year lifetime will only have 5% stock availability per year. It is expected to see single year achievable potential well below economic potential with cumulative achievable potential reaching or surpassing economic potential, with relaxed screening standards, and in the long run as awareness grows and stock turns over. Additionally, as fuel substitution measures are calibrated to an expected deployment ramp, comparison to economic potential is directly correlated to that forecast.

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In the tables showing potential, savings are generally rounded to the nearest hundred, to indicate a level of uncertainty in the analysis.

Table 4-8. Residential BAE Scenario Achievable Potential, Liberty Gas (Annual Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
Residential Sector - Energy Efficiency Measures							
2025	-15	2	99,100	0	0	0	240
2026	-17	3	108,800	0	0	0	250
2027	-18	4	118,500	0	0	0	260
Residential Sector - Fuel Substitution Measures							
2025	-523	-27	57,500	0	0	0	0
2026	-519	-27	57,300	0	0	0	0
2027	-523	-27	58,000	0	0	0	0
Residential Sector Total (All Measures)							
2025	-538	-25	156,600	0	0	0	240
2026	-536	-24	166,100	0	0	0	250
2027	-541	-23	176,500	0	0	0	260

Source: Guidehouse

Table 4-9. Income Eligible BAE Scenario Achievable Potential, Liberty Gas (Annual Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
Income Eligible Sector - Energy Efficiency Measures							
2025	57	16	97,800	0	0	0	280
2026	66	18	113,900	0	0	0	300
2027	76	21	131,200	0	0	0	320
Income Eligible Sector - Fuel Substitution Measures							
2025	-557	-18	70,600	0	0	0	0
2026	-550	-18	70,100	0	0	0	0
2027	-544	-18	69,800	0	0	0	0
Income Eligible Sector Total (All Measures)							
2025	-500	-2	168,400	0	0	0	280
2026	-484	0	184,000	0	0	0	300
2027	-468	3	201,000	0	0	0	320

Source: Guidehouse

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Table 4-10. C&I BAE Scenario Achievable Potential, Liberty Gas (Annual Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
C&I Sector - Energy Efficiency Measures							
2025	8	8	113,800	0	0	0	2,370
2026	9	9	120,400	0	0	0	2,670
2027	11	11	126,400	0	0	0	2,890
C&I Sector - Fuel Substitution Measures							
2025	-187	-147	21,700	0	0	0	0
2026	-204	-174	24,200	0	0	0	0
2027	-220	-199	26,400	0	0	0	0
C&I Sector Total (All Measures)							
2025	-179	-139	135,500	0	0	0	2,370
2026	-195	-165	144,600	0	0	0	2,670
2027	-209	-188	152,800	0	0	0	2,890

Source: Guidehouse

4.3.3 Energy Efficiency Achievable Potential Details

This section provides the achievable potential results calculated by the model at varying levels of aggregation. At-the-meter[32] net efficiency savings results are shown by programs for each sector and by highest impact measures; CO_2e savings are reported at the generator. For more details and levels of aggregation of achievable potential, including summaries for the BAE and CECP scenarios, see Appendix C.

4.3.3.1 Energy Efficiency Potential Results by Program

This section presents results for savings, and benefits and costs, for the BAE scenario for the Residential, Income Eligible, and C&I sectors, separately for electric and then natural gas programs. Mapping of measures to programs was based on Liberty Utilities 2022 BCR Model.

Note that Income Eligible budgets are projected irrespective of the statutory allocations of 10% of the natural gas budget. To the extent that projected budgets are less than the statutory limits, program planning will need to adapt to ensure that the allocation requirement is met.

Residential Sector

Table 4-11 presents the incremental net savings for Residential natural gas core initiatives for the 3-year study horizon for the BAE scenario. All savings are net, except GHG impacts are gross. The Residential Retail core initiative provides more than half the natural gas, annual MMBtu, and 2030 carbon impacts[33] and Residential Coordinated Delivery contributes the remainder. Residential Behavior and Residential New Homes & Renovations both do not contribute to savings. The study is calibrated at the sector level, therefore Residential results include Moderate Income potential savings.

[32] "Net at meter" designates savings projected to be realized at customer premises.

[33] Carbon 2030 is carbon reduction expected to result in 2030 from measures installed in the forecast year (e.g., 2025) and still in place in 2030.

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In the tables showing costs, they are generally rounded to the nearest hundred thousand, to indicate a level of uncertainty in the analysis.

Table 4-11. Residential Sector, Natural Gas Core Initiatives, BAE Scenario Incremental Net Achievable Potential

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO_2e]
A1a - Residential New Homes & Renovations				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
A2a - Residential Coordinated Delivery				
2025	56,900	5,800	117,200	300
2026	60,800	6,200	122,400	320
2027	64,900	6,600	127,500	340
Total			**367,100**	**960**
A2c - Residential Retail				
2025	99,800	6,700	116,600	550
2026	105,400	7,300	126,900	580
2027	111,600	7,900	137,300	620
Total			**380,800**	**1,750**
A2d - Residential Behavior				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
Residential Sector Total				
2025	156,700	12,500	233,800	850
2026	166,200	13,500	249,300	900
2027	176,500	14,500	264,800	960
Total			**747,900**	**2,710**

Source: Guidehouse

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Table 4-12 presents the benefits and costs by Residential natural gas programs for the 3-year study horizon for the BAE scenario. The Residential Existing Buildings program provides all of the Net TRC Benefits and Program Incentive Costs, which provide positive TRC Test results. The Residential Hard to Measure program provides almost half of the Program Administrative Costs. Incentives are more than half of the program costs.

Table 4-12. Residential Sector, Natural Gas Programs, BAE Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
A1 - Residential New Buildings					
2025		$0.0	$0.0	$0.0	$0.0
2026		$0.0	$0.0	$0.0	$0.0
2027		$0.0	$0.0	$0.0	$0.0
Total		**$0.0**	**$0.0**	**$0.0**	**$0.0**
A2 - Residential Existing Buildings					
2025	2.58	$7.5	$2.9	$0.8	$1.9
2026	2.63	$8.1	$3.1	$0.8	$1.9
2027	2.67	$8.7	$3.3	$0.9	$2.1
Total	**2.63**	**$24.3**	**$9.3**	**$2.5**	**$5.9**
A3 - Residential Hard-to-Measure					
2025	N/A	N/A	$0.5	$0.5	N/A
2026	N/A	N/A	$0.6	$0.6	N/A
2027	N/A	N/A	$0.6	$0.6	N/A
Total			**$1.7**	**$1.7**	
Residential Sector Total					
2025	2.18	$7.5	$3.4	$1.4	$1.9
2026	2.23	$8.1	$3.6	$1.4	$1.9
2027	2.26	$8.7	$3.9	$1.5	$2.1
Total	**2.23**	**$24.3**	**$10.9**	**$4.2**	**$5.9**

Source: Guidehouse

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Income Eligible Sector

Table 4-13 presents the incremental net savings for Income Eligible Coordinated Delivery natural gas core initiative for the 3-year study horizon for the BAE scenario.

Table 4-13. Income Eligible Sector, Natural Gas Core Initiatives, BAE Scenario Incremental Net Achievable Potential

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO_2e]
B1a - Income Eligible Coordinated Delivery				
2025	168,400	13,900	257,900	850
2026	184,000	15,600	289,100	930
2027	201,000	17,400	322,700	1,030
Total			**869,700**	**2,810**

Source: Guidehouse

Table 4-14 presents the benefits and costs by Income Eligible natural gas programs for the 3-year study horizon for the BAE scenario, with the Hard-to-Measure program contributing program administrative costs only.

Table 4-14. Income Eligible Sector, Natural Gas Programs, BAE Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
B1 - Income Eligible Existing Buildings					
2025	2.92	$12.2	$4.2	$1.1	$2.7
2026	3.01	$14.0	$4.6	$1.1	$2.9
2027	3.10	$15.8	$5.1	$1.3	$3.2
Total	**3.02**	**$42.0**	**$13.9**	**$3.4**	**$8.9**
B2 - Income Eligible Hard-to-Measure					
2025	N/A	N/A	$0.8	$0.8	N/A
2026	N/A	N/A	$0.8	$0.8	N/A
2027	N/A	N/A	$0.9	$0.9	N/A
Total			**$2.5**	**$2.5**	
Income Eligible Sector Total					
2025	2.47	$12.2	$4.9	$1.8	$2.7
2026	2.56	$14.0	$5.5	$2.0	$2.9
2027	2.63	$15.8	$6.0	$2.2	$3.2
Total	**2.56**	**$42.0**	**$16.4**	**$5.9**	**$8.9**

Source: Guidehouse

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C&I Sector

Table 4-15 presents the incremental net savings for C&I natural gas core initiatives for the 3-year study horizon for the BAE scenario. All savings are net, except GHG impacts are gross. The C&I Existing Building Retrofit and C&I New & Replacement Equipment core initiatives provide all of the savings.

Table 4-15. C&I Sector, Natural Gas Core Initiatives, BAE Scenario Incremental Net Achievable Potential

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO_2e]
C1a - C&I New Buildings & Major Renovations				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
C2a - C&I Existing Building Retrofit				
2025	51,300	5,000	31,800	170
2026	57,500	5,700	35,000	240
2027	63,900	6,300	38,400	330
Total			**105,200**	**740**
C2b - C&I New & Replacement Equipment				
2025	84,200	7,500	134,300	460
2026	87,100	7,700	137,600	480
2027	88,800	7,800	138,900	490
Total			**410,800**	**1,430**
C&I Sector Total				
2025	135,500	12,500	166,100	630
2026	144,600	13,400	172,600	720
2027	152,700	14,100	177,300	820
Total			**516,000**	**2,170**

Source: Guidehouse

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Table 4-16 presents the benefits and costs by C&I natural gas programs for the 3-year study horizon for the BAE scenario. The C&I Existing Buildings program contributes all of the benefits and positive TRC Test ratios. C&I Hard-to-Measure only contributes Program Administrative Costs.

Table 4-16. C&I Sector, Natural Gas Programs, BAE Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
C1 - C&I New Buildings					
2025		$0.0	$0.0	$0.0	$0.0
2026		$0.0	$0.0	$0.0	$0.0
2027		$0.0	$0.0	$0.0	$0.0
Total		**$0.0**	**$0.0**	**$0.0**	**$0.0**
C2 - C&I Existing Buildings					
2025	2.07	$5.2	$2.5	$0.9	$0.7
2026	1.94	$5.4	$2.8	$0.9	$0.8
2027	1.80	$5.6	$3.1	$1.0	$0.9
Total	**1.93**	**$16.3**	**$8.5**	**$2.8**	**$2.4**
C3 - C&I Hard-to-Measure					
2025	N/A	N/A	$0.5	$0.5	N/A
2026	N/A	N/A	$0.6	$0.6	N/A
2027	N/A	N/A	$0.6	$0.6	N/A
Total			**$1.7**	**$1.7**	
C&I Sector Total					
2025	1.72	$5.2	$3.0	$1.4	$0.7
2026	1.61	$5.4	$3.4	$1.5	$0.8
2027	1.51	$5.6	$3.7	$1.6	$0.9
Total	**1.61**	**$16.3**	**$10.2**	**$4.5**	**$2.4**

Source: Guidehouse

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4.3.3.2 Energy Efficiency Potential Results by Measure

Figure 4-3 through Figure 4-5 show the top ten lifetime BAE scenario natural gas savings EE measures, net at meter, installed in 2025, for the Residential, Income Eligible and C&I sectors, respectively. Similar results are included in Appendix C Energy Efficiency Results (Excel Spreadsheet Viewer). Appendix C also contains first-year annual and lifetime savings by measure.

In the Residential sector, the Residential Coordinated Delivery program, led by Insulation and Air Sealing, provides the largest lifetime natural gas savings, with the former roughly three times the latter. Taken together, these two measures provide significantly more than the remaining eight measures combined, which are all from the Residential Retail program.

The Income Eligible sector is also led by Insulation and Air Sealing in the Income Eligible Coordinated Delivery program. Insulation provides almost twice as much savings as Air Sealing.

The C&I sector top ten lifetime natural gas savings is dominated by a Custom Large C&I measure (C&I New & Replacement Equipment programs), with this measure providing significantly more savings than the remaining nine measures combined.

Figure 4-3. EE BAE Scenario Lifetime Achievable Natural Gas Potential, 2025 Top Residential Measures (net therms)

#	Measure	Core Initiative	LT Savings
1	Insulation	A2a - Residential Coordinated Delivery	660,000
2	Heat Recovery Ventilator	A2c - Residential Retail	533,000
3	Air Sealing	A2a - Residential Coordinated Delivery	436,000
4	Central ASHP Partially Displacing Gas Furnace and AC	A2c - Residential Retail	288,000
5	Ductless MSHP Partially Displacing Gas Boiler and AC	A2c - Residential Retail	240,000
6	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	189,000
7	Central ASHP Fully Replacing Gas Furnace and AC	A2c - Residential Retail	165,000
8	Heat Pump Water Heater Fuel Switch	A2c - Residential Retail	144,000
9	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	128,000
10	Ductless MSHP Fully Replacing Gas Boiler and AC	A2c - Residential Retail	89,000

Source: Guidehouse

Figure 4-4. EE BAE Scenario Lifetime Achievable Natural Gas Potential, 2025 Top Income Eligible Measures (net therms)

#	Measure	Core Initiative	LT Savings
1	Insulation	B1a - Income Eligible Coordinated Delivery	844,000
2	Air Sealing	B1a - Income Eligible Coordinated Delivery	552,000
3	Ductless MSHP Fully Replacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	389,000
4	Central ASHP Fully Replacing Gas Furnace and AC	B1a - Income Eligible Coordinated Delivery	261,000
5	Programmable Thermostat to Wifi Thermostat	B1a - Income Eligible Coordinated Delivery	234,000
6	Forced Hot Water Boiler - Gas	B1a - Income Eligible Coordinated Delivery	202,000
7	W2A GSHP Replacing Gas Furnace	B1a - Income Eligible Coordinated Delivery	189,000
8	Ductless MSHP Partially Displacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	170,000
9	Heat Pump Water Heater Fuel Switch	B1a - Income Eligible Coordinated Delivery	124,000
10	Manual Thermostat to Programmable Thermostat	B1a - Income Eligible Coordinated Delivery	120,000

Source: Guidehouse

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Figure 4-5. EE BAE Scenario Lifetime Achievable Natural Gas Potential, 2025 Top C&I Measures (net therms)

#	Measure	Core Initiative	LT Savings
1	Custom Large C&I	C2b - C&I New & Replacement Equipment	1,097,000
2	Central Air Source Heat Pump (Split or Packaged)	C2b - C&I New & Replacement Equipment	148,000
3	Demand Control Ventilation	C2a - C&I Existing Building Retrofit	100,000
4	Commissioning/Retrocommissioning	C2a - C&I Existing Building Retrofit	95,000
5	Ground Source Heat Pump (Water-to-Air)	C2b - C&I New & Replacement Equipment	56,000
6	Gas RTU to VRF	C2b - C&I New & Replacement Equipment	54,000
7	Boiler to Air Source Heat Pump	C2b - C&I New & Replacement Equipment	54,000
8	Pre-Rinse Spray Valve	C2a - C&I Existing Building Retrofit	46,000
9	Commercial HVAC Tune-up	C2a - C&I Existing Building Retrofit	42,000
10	Ductless Heat Pump	C2b - C&I New & Replacement Equipment	40,000

Source: Guidehouse

4.4 Energy Efficiency CECP Scenario Results

4.4.1 Energy Efficiency Scenario Configuration Approach

The reference scenario (business as expected, or BAE) was developed through the calibration process detailed in Section 4.3. Two alternative scenarios relating to achievement of the statewide CECP carbon reduction goals were developed and modeled relative to the BAE scenario, as described below.

4.4.1.1 Scenario Configuration

The scenarios were configured to estimate potential for EE (including fuel switching) and reaching the CECP carbon reduction mandates expected to be assigned to the PAs by the Commonwealth's Secretary of Energy and Environmental Affairs.

Two CECP scenarios were modeled, (1) assuming the same unit costs (TRC) as the BAE scenario while maintaining cost effectiveness at the program or sector level **(CECP)**, and (2) assuming a cost premium for selected measures that are expected see large increases in implementation quantities **(CECP Cost Premium)**. The measure quantities and savings are identical between the two scenarios. For the CECP Cost Premium scenario, cost premiums are added to PA budgets and TRC costs at the program-level to estimate resulting cost test ratios and PA budgets to achieve the CECP targets. Therefore, the CECP Cost Premium scenario may not be cost effective at the program or sector level.

For the CECP scenario, a detailed review of program level cost effectiveness was completed. If program level cost effectiveness was not achievable due to the required technology penetrations necessary to meet carbon reduction goals, sector level cost effectiveness was maintained. For each scenario, program and sector cost effectiveness results are shown to better understand the screening criteria that may be appropriate given the various penetration and cost forecasts. For Liberty, all programs achieve cost-effectiveness in the CECP scenario.

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Table 4-17 summarizes the scenarios.

Table 4-17. CECP Scenario Summary

Scenario	Measure Production	Unit Costs
1	To meet CECP Targets	Level with BAE
2	To meet CECP Targets	Cost Premium

4.4.1.2 CECP Scenario Inputs

To establish the parameters for these scenarios, Guidehouse created a worksheet model that calculated the amount of carbon reduction that could be provided by selected carbon-reducing technologies (weatherization, heat pumps, heat pump water heaters, etc.) in the Statewide PA portfolio. Guidehouse used the worksheet model to estimate the amounts of each technology that would be required to meet overall CECP carbon reduction targets assigned to the PAs, starting with 2022-24 Plan assumptions. (For 2024, modeling was performed using current PA heat pump adoption assumptions). PA-specific carbon reduction targets were allocated from statewide targets by applying the percentage of carbon reduction per PA from the BAE scenario. Guidehouse solicited feedback from the PAs and the EEAC Consultants and adjusted the quantities. For many technologies, the final projected number of installations needed to achieve CECP targets were orders of magnitude greater than recent PA achievements and/or 2024 projections.

Guidehouse conducted a series of discussions with the PAs, selected implementation vendors, and EEAC Consultants to discuss the practical implications of the large-scale increase in deployment of selected technologies, primarily to determine if a cost premium should be modeled in the CECP scenarios. Four discussions were conducted focusing on different segments of the market: Income Eligible, heat pumps for Residential and Small Commercial markets, Residential Coordinated Delivery, and Commercial and Industrial. Among the factors discussed were measure availability, workforce availability and capability, and timing.

Based on these discussions, Guidehouse established the modeling parameters shown in

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Table 4-18 for the CECP Cost Premium scenarios. In other words, the level cost assumption for the CECP scenarios defines a lower bound for achieving CECP targets, while the cost premiums define a reasonable upper bound of costs to achieve CECP targets. Cost premiums focus on PA costs only, not participant costs.

Similar to a classic MAX scenario, the CECP scenarios maximized incentive and marketing parameters for the targeted measures (for example, Ductless Mini Split Heat Pump fully replacing Oil Boiler); for all other measures, these parameters were left at the same values as the BAE scenario.

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Table 4-18. CECP Cost Premium Scenario Assumptions

Technology	Sector	PA Cost Premium
Weatherization	Residential, IE, C&I	Net increase of 8%/yr. over baseline
Pre-weatherization barrier remediation	Residential, IE	$5,000 per project
Heat Pumps, HP Water Heaters	IE	Net increase of 8%/year over baseline
Heat Pumps, HP Water Heaters	Residential	Net increase of 0%/year over baseline
Heat Pumps, HP Water Heaters	C&I	Net increase of 10%/year over baseline

Note: For the Residential Sector, the PA heat pump incentive is for equipment only; cost premiums are anticipated for labor only, which will increase participant costs in this sector, but not PA costs.

Production, or measure-level installation targets, for Liberty Utilities were determined by proportionately allocating the Statewide forecast measure counts according to 2024 planned installations.

4.4.1.3 CECP Scenario Modeling

The scenario adjustments were input into the model. As each scenario was run, the carbon reduction results were checked to ensure that these met the specified CECP reduction targets. If these did not, scalar adjustments were made to the quantities until the carbon reduction target was met.

If cost effectiveness could not be maintained at the program level, sector level cost effectiveness was maintained. This may result in some program TRCs below 1.0 with an overall sector aggregate ratio exceeding the 1.0 threshold. For the CECP Cost Premium scenario, cost premiums are added to PA budgets and TRC costs at the program-level to estimate resulting cost test ratios and PA budgets to achieve the CECP targets. Therefore, the CECP Cost Premium scenario may not be cost effective at the program or sector level.

4.4.1.4 Heat Pump Adoption Research

Guidehouse fielded a survey to Massachusetts gas and electric customers as part of the Residential Building Usage and Characteristics Study. This survey's primary goal is to calculate the saturation for a variety of end uses in Massachusetts homes and collect characterization data on a selection of high priority end uses. The survey is fielded to prior years' respondents and to previously uncontacted customers from an active customer list. Overall, Guidehouse administered the survey to 116,314 potential respondents and received 5,543 usable completes. As additional context on awareness and adoption of heat pumps, which is of particular interest as the number of heat pumps is forecast to greatly increase, Guidehouse worked with NMR to include additional panels within the survey.

The survey found that customers are generally aware of heat pumps (57%) and of those aware of heat pumps, majority are also aware that heat pumps can provide both heating and cooling. It

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was also found that heat pump awareness correlates with income and home type. NMR noted that market rate customers and customers living in single-family detached housing have greater awareness of heat pumps. According to the survey, program participants are also more likely to be aware of heat pumps. The survey found that only about one-third of respondents (31%) are aware of heat pump water heaters. Awareness for heat pump water heaters is not correlated with income level or building type.

Respondents indicated that there is more interest in adopting heat pumps if customers can maintain their existing heating system as a backup (36% for customers without any air conditioning and 30% for customers with a central air conditioner), but that there was much less interest in adoption if the customer is required to remove their existing system (23% for customers with and without AC). The interest in heat pump adoption is higher for customers without air conditioning when they can maintain their existing heating system as back-up.

Like heat pump water heater awareness, the interest in adoption of heat pump water heaters is also lower among respondents (21%). The most frequently reported reasons for lack of interest from respondents were related to costs concerns and overall lack of knowledge about heat pump water heaters.[34]

4.4.2 CECP Scenario Results

This section presents CECP scenario – Program results, individually by sector and fuel for the Residential sector electric programs.

[34] NMR plans to report additional analyses on the added survey batteries in the “Heat Pump Market Effects Indicators Baseline Study” (MA23X06-B-HPMEIB) final report.

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Table 4-19 presents the incremental net savings for Residential natural gas core initiatives for the 3-year study horizon for the BAE scenario. All savings are net, except 2030 carbon[35] impacts are gross. The Residential Coordinated Delivery initiative provides more than half the natural gas, Annual and Lifetime MMBtu savings, and the Residential Retail program provides the rest Liberty Utilities is not offering behavioral measures and they were not modeled as part of the potential analysis. In general, the cost per unit savings for the CECP scenarios is greater than that of the BAE scenario because of the increased number of heat pumps in the CECP scenario.

Table 4-19. Residential Sector, Natural Gas Core Initiatives, CECP Scenario Incremental Net Achievable Potential

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO_2e]
A1a - Residential New Homes & Renovations				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
A2a - Residential Coordinated Delivery				
2025	228,700	23,300	530,000	1,240
2026	276,800	28,200	641,400	1,500
2027	324,800	33,100	752,900	1,760
Total			**1,924,300**	**4,500**
A2c - Residential Retail				
2025	214,900	12,200	279,100	1,090
2026	246,000	14,200	328,200	1,250
2027	281,400	16,400	383,200	1,430
Total			**990,500**	**3,770**
A2d - Residential Behavior				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
Residential Sector Total				
2025	443,600	35,500	809,100	2,330
2026	522,800	42,400	969,600	2,750
2027	606,200	49,500	1,136,100	3,190
Total			**2,914,800**	**8,270**

Source: Guidehouse

[35] Carbon 2030 is carbon reduction expected to result in 2030 from measures installed in the forecast year (e.g., 2025) and still in place in 2023.

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Table 4-20 presents the benefits and costs by Residential natural gas programs for the 3-year study horizon for the CECP scenario. The Residential Existing Buildings program provides all of the Net TRC Benefits and Program Incentive Costs, with a positive TRC Test. The Residential Hard-to-Measure program provides about half of the Program Administrative Costs.

Table 4-20. Residential Sector, Natural Gas Programs, CECP Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
A1 - Residential New Buildings					
2025		$0.0	$0.0	$0.0	$0.0
2026		$0.0	$0.0	$0.0	$0.0
2027		$0.0	$0.0	$0.0	$0.0
Total		**$0.0**	**$0.0**	**$0.0**	**$0.0**
A2 - Residential Existing Buildings					
2025	2.31	$26.0	$11.3	$2.9	$11.2
2026	2.31	$31.5	$13.6	$3.5	$13.7
2027	2.30	$37.4	$16.2	$4.2	$16.6
Total	**2.31**	**$95.0**	**$41.1**	**$10.5**	**$41.5**
A3 - Residential Hard-to-Measure					
2025	N/A	N/A	$3.1	$3.1	N/A
2026	N/A	N/A	$3.9	$3.9	N/A
2027	N/A	N/A	$4.7	$4.7	N/A
Total			**$11.7**	**$11.7**	
Residential Sector Total					
2025	1.80	$26.0	$14.4	$6.0	$11.2
2026	1.80	$31.5	$17.5	$7.3	$13.7
2027	1.79	$37.4	$20.9	$8.8	$16.6
Total	**1.80**	**$95.0**	**$52.8**	**$22.2**	**$41.5**

Source: Guidehouse

Table 4-21 presents the incremental net savings for Income Eligible Coordinated Delivery natural gas program for the 3-year study horizon for the CECP scenario.

Table 4-21. Income Eligible Sector, Natural Gas Core Initiatives, CECP Scenario Incremental Net Achievable Potential

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO_2e]
B1a - Income Eligible Coordinated Delivery				
2025	354,000	29,700	623,400	1,800
2026	416,000	35,400	745,800	2,130
2027	481,200	41,300	872,700	2,470
Total			**2,241,900**	**6,400**

Source: Guidehouse

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Table 4-22 presents the benefits and costs by Income Eligible natural gas programs for the 3-year study horizon for the CECP scenario, with the Hard-to-Measure program contributing program administrative costs only.

Table 4-22. Income Eligible Sector, Natural Gas Programs, CECP Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
B1 - Income Eligible Existing Buildings					
2025	2.50	$30.7	$12.3	$3.9	$10.0
2026	2.49	$37.0	$14.9	$4.7	$12.2
2027	2.46	$43.7	$17.8	$5.7	$14.6
Total	**2.48**	**$111.4**	**$45.0**	**$14.3**	**$36.8**
B2 - Income Eligible Hard-to-Measure					
2025	N/A	N/A	$2.8	$2.8	N/A
2026	N/A	N/A	$3.4	$3.4	N/A
2027	N/A	N/A	$4.1	$4.1	N/A
Total			**$10.4**	**$10.4**	
Income Eligible Sector Total					
2025	2.03	$30.7	$15.1	$6.7	$10.0
2026	2.02	$37.0	$18.3	$8.2	$12.2
2027	1.99	$43.7	$21.9	$9.8	$14.6
Total	**2.01**	**$111.4**	**$55.3**	**$24.7**	**$36.8**

Source: Guidehouse

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Table 4-23 presents the incremental net savings for C&I natural gas core initiatives for the 3-year study horizon for the CECP scenario. All savings are net, except GHG impacts are gross. C&I New & Replacement Equipment provides almost two thirds of the savings.

Table 4-23. C&I Sector, Natural Gas Core Initiatives, CECP Scenario Incremental Net Achievable Potential

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO_2e]
C1a - C&I New Buildings & Major Renovations				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
C2a - C&I Existing Building Retrofit				
2025	52,500	5,100	33,600	180
2026	59,000	5,800	37,100	260
2027	65,700	6,500	41,000	340
Total			**111,700**	**780**
C2b - C&I New & Replacement Equipment				
2025	94,300	8,500	154,000	520
2026	93,700	8,700	159,300	520
2027	94,100	8,700	159,400	520
Total			**472,700**	**1,560**
C&I Sector Total				
2025	146,800	13,600	187,600	700
2026	152,700	14,500	196,400	780
2027	159,800	15,200	200,400	860
Total			**584,400**	**2,340**

Source: Guidehouse

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Table 4-24 presents the benefits and costs by C&I natural gas programs for the 3-year study horizon for the CECP scenario. The C&I Existing Buildings program contributes all of the benefits. Overall, the C&I sector has a positive TRC test ratio.

Table 4-24. C&I Sector, Natural Gas Programs, CECP Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
C1 - C&I New Buildings					
2025		$0.0	$0.0	$0.0	$0.0
2026		$0.0	$0.0	$0.0	$0.0
2027		$0.0	$0.0	$0.0	$0.0
Total		**$0.0**	**$0.0**	**$0.0**	**$0.0**
C2 - C&I Existing Buildings					
2025	2.07	$6.0	$2.9	$1.4	$1.2
2026	2.18	$6.3	$2.9	$1.6	$1.4
2027	2.14	$6.6	$3.1	$1.7	$1.4
Total	**2.13**	**$18.9**	**$8.8**	**$4.7**	**$4.0**
C3 - C&I Hard-to-Measure					
2025	N/A	N/A	$0.8	$0.8	N/A
2026	N/A	N/A	$1.0	$1.0	N/A
2027	N/A	N/A	$1.0	$1.0	N/A
Total			**$2.8**	**$2.8**	
C&I Sector Total					
2025	1.61	$6.0	$3.7	$2.2	$1.2
2026	1.64	$6.3	$3.9	$2.6	$1.4
2027	1.61	$6.6	$4.1	$2.7	$1.4
Total	**1.62**	**$18.9**	**$11.7**	**$7.5**	**$4.0**

Source: Guidehouse

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Figure 4-6 shows the CECP scenario top lifetime achievable MMBtu savings natural gas measures across all sectors and fuels, net at meter, installed in 2025-2027. Similar results are included in Appendix C Energy Efficiency Results (Excel Spreadsheet Viewer). Appendix C also contains first-year annual and lifetime savings by measure.

The top three natural gas measures, Insulation (Residential Coordinated Delivery), Insulation (Income Eligible Coordinated Delivery) and W1A GSHP Replacing Gas Furnace (Residential Retail), provide the majority of lifetime savings.

Figure 4-6. EE CECP Scenario Lifetime Achievable Potential, Top Natural Gas Measures, 2025-2027, MMBtu (all sectors)

#	Measure	Core Initiative	LT Savings
1	Insulation	A2a - Residential Coordinated Delivery	1,622,650
2	Insulation	B1a - Income Eligible Coordinated Delivery	972,790
3	W2A GSHP Replacing Gas Furnace	A2c - Residential Retail	512,050
4	Custom Large C&I	C2b - C&I New & Replacement Equipment	383,920
5	Air Sealing	B1a - Income Eligible Coordinated Delivery	346,650
6	W2A GSHP Replacing Gas Furnace	B1a - Income Eligible Coordinated Delivery	336,620
7	Air Sealing	A2a - Residential Coordinated Delivery	257,710
8	Ductless MSHP Partially Displacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	172,690
9	Heat Recovery Ventilator	A2c - Residential Retail	129,040
10	Ductless MSHP Partially Displacing Gas Boiler and AC	A2c - Residential Retail	126,010
11	Ductless MSHP Fully Replacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	62,940
12	Programmable Thermostat to Wifi Thermostat	B1a - Income Eligible Coordinated Delivery	60,890
13	Forced Hot Water Boiler - Gas	B1a - Income Eligible Coordinated Delivery	53,950
14	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	51,280
15	Heat Pump Water Heater Fuel Switch	A2c - Residential Retail	43,710
16	Ground Source Heat Pump (Water-to-Air)	C2b - C&I New & Replacement Equipment	41,650
17	Heat Pump Water Heater Fuel Switch	B1a - Income Eligible Coordinated Delivery	37,700
18	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	34,680
19	Manual Thermostat to Programmable Thermostat	B1a - Income Eligible Coordinated Delivery	29,790
20	Air to water heat pumps, gas baseline	A2c - Residential Retail	28,330
21	Demand Control Ventilation	C2a - C&I Existing Building Retrofit	27,590
22	Commissioning/Retrocommissioning	C2a - C&I Existing Building Retrofit	25,260
23	Ductless MSHP Fully Replacing Gas Boiler and AC	A2c - Residential Retail	24,160
24	Wi-Fi Thermostat	A2c - Residential Retail	24,010
25	Central ASHP Fully Replacing Gas Furnace and AC	B1a - Income Eligible Coordinated Delivery	23,760

Source: Guidehouse

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Figure 4-7 shows the CECP scenario natural gas top 2030 CO_2e-saving measures across all sectors, net at meter, installed in 2025-2027. Similar results are included in Appendix C Energy Efficiency Results (Excel Spreadsheet Viewer). Appendix C also contains first-year annual and lifetime savings by measure, as well as the top summer peak passive demand savings measures.

Similarly, the top three natural gas measures, Insulation (Residential Coordinated Delivery), Insulation (Income Eligible Coordinated Delivery) and Insulation (Residential Retail) provide the majority of lifetime savings.

Figure 4-7. EE CECP Scenario Lifetime Achievable Potential, Top Natural Gas Measures, 2025-2027, CO_2e Savings at Generator, Metrics Tons (all sectors)

#	Measure	Core Initiative	CO2e in 2030
1	Insulation	A2a - Residential Coordinated Delivery	3,498
2	Insulation	B1a - Income Eligible Coordinated Delivery	1,935
3	W2A GSHP Replacing Gas Furnace	A2c - Residential Retail	1,439
4	Air Sealing	B1a - Income Eligible Coordinated Delivery	1,226
5	Custom Large C&I	C2b - C&I New & Replacement Equipment	1,192
6	W2A GSHP Replacing Gas Furnace	B1a - Income Eligible Coordinated Delivery	946
7	Air Sealing	A2a - Residential Coordinated Delivery	877
8	Ductless MSHP Partially Displacing Gas Boiler and AC	A2c - Residential Retail	746
9	Ductless MSHP Partially Displacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	705
10	Heat Recovery Ventilator	A2c - Residential Retail	489
11	Ductless MSHP Fully Replacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	309
12	Demand Control Ventilation	C2a - C&I Existing Building Retrofit	265
13	Programmable Thermostat to Wifi Thermostat	B1a - Income Eligible Coordinated Delivery	210
14	Heat Pump Water Heater Fuel Switch	A2c - Residential Retail	206
15	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	203
16	Ductless MSHP Fully Replacing Gas Boiler and AC	A2c - Residential Retail	182
17	Heat Pump Water Heater Fuel Switch	B1a - Income Eligible Coordinated Delivery	178
18	Commissioning/Retrocommissioning	C2a - C&I Existing Building Retrofit	169
19	Air to water heat pumps, gas baseline	A2c - Residential Retail	155
20	Central ASHP Fully Replacing Gas Furnace and AC	B1a - Income Eligible Coordinated Delivery	147
21	Forced Hot Water Boiler - Gas	B1a - Income Eligible Coordinated Delivery	143
22	Pre-Rinse Spray Valve	C2a - C&I Existing Building Retrofit	139
23	Ground Source Heat Pump (Water-to-Air)	C2b - C&I New & Replacement Equipment	131
24	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	115
25	Air to water heat pumps, gas baseline	B1a - Income Eligible Coordinated Delivery	112

Source: Guidehouse

4.4.3 CECP Cost Premium Scenario Results

Table 4-25 through Table 4-26 show CECP Cost Premium scenario results for the Residential sector. The tables show summary energy, MW, MMBtu, and 2030 carbon savings for all fuels and benefit and costs and the BCR for the programs for each year. Residential Coordinated Delivery contributes about two-thirds of lifetime savings, and Residential Retail contributes about one-third of lifetime savings. After adding the cost premium estimations to TRC costs, the Residential Existing Buildings program remains cost-effective, however, with the addition of hard-to-measure costs, the sector as a whole does not achieve a 1.0 TRC throughout the 3-year study period. Due to the design of the scenarios, described above in Section 4.4.1, energy and

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CO_2e savings for the CECP cost Premium scenarios are identical to those of the CECP scenario while costs are greatly increased.

Table 4-25. Residential Sector, Natural Gas Core Initiatives, CECP Cost Premium Scenario Achievable Potential (Incremental Net)

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO_2e]
A1a - Residential New Homes & Renovations				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
A2a - Residential Coordinated Delivery				
2025	228,700	23,300	530,000	1,240
2026	276,800	28,200	641,400	1,500
2027	324,800	33,100	752,900	1,760
Total			**1,924,300**	**4,500**
A2c - Residential Retail				
2025	214,900	12,200	279,100	1,090
2026	246,000	14,200	328,200	1,250
2027	281,400	16,400	383,200	1,430
Total			**990,500**	**3,770**
A2d - Residential Behavior				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
Residential Sector Total				
2025	443,600	35,500	809,100	2,330
2026	522,800	42,400	969,600	2,750
2027	606,200	49,500	1,136,100	3,190
Total			**2,914,800**	**8,270**

Source: Guidehouse

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Table 4-26. Residential Sector, Natural Gas Programs, CECP Cost Premium Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
A1 - Residential New Buildings					
2025		$0.0	$0.0	$0.0	$0.0
2026		$0.0	$0.0	$0.0	$0.0
2027		$0.0	$0.0	$0.0	$0.0
Total		**$0.0**	**$0.0**	**$0.0**	**$0.0**
A2 - Residential Existing Buildings					
2025	1.03	$26.0	$25.3	$6.8	$21.3
2026	1.02	$31.5	$31.0	$8.3	$26.2
2027	1.01	$37.4	$37.0	$9.9	$31.5
Total	**1.02**	**$95.0**	**$93.3**	**$25.0**	**$79.0**
A3 - Residential Hard-to-Measure					
2025	N/A	N/A	$6.4	$6.4	N/A
2026	N/A	N/A	$7.8	$7.8	N/A
2027	N/A	N/A	$9.4	$9.4	N/A
Total			**$23.6**	**$23.6**	
Residential Sector Total					
2025	0.82	$26.0	$31.7	$13.1	$21.3
2026	0.81	$31.5	$38.8	$16.1	$26.2
2027	0.81	$37.4	$46.4	$19.3	$31.5
Total	**0.81**	**$95.0**	**$116.8**	**$48.6**	**$79.0**

Source: Guidehouse

Table 4-27 and Table 4-28 show CECP Cost Premium scenario results for the Income Eligible sector. The tables show summary energy, MW, MMBtu, and 2030 carbon savings for all fuels and benefit and costs and the BCR for the core initiatives for each year. Income Eligible Existing Buildings contributes all of the Net TRC Benefits. After adding the cost premium estimations to TRC costs, the Income-Eligible Existing Buildings program remains cost-effective, however, with the addition of hard-to-measure costs, the sector as a whole does not achieve a 1.0 TRC throughout the 3-year study period.

Table 4-27. Income Eligible Sector, Natural Gas Core Initiatives, CECP Cost Premium Scenario Achievable Potential (Incremental Net)

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO_2e]
B1a - Income Eligible Coordinated Delivery				
2025	354,000	29,700	623,400	1,800
2026	416,000	35,400	745,800	2,130
2027	481,200	41,300	872,700	2,470
Total			**2,241,900**	**6,400**

Source: Guidehouse

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Table 4-28. Income Eligible Sector, Natural Gas Programs, CECP Cost Premium Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
B1 - Income Eligible Existing Buildings					
2025	1.20	$30.7	$25.5	$7.7	$19.9
2026	1.17	$37.0	$31.6	$9.7	$25.0
2027	1.14	$43.7	$38.3	$12.0	$30.7
Total	**1.17**	**$111.4**	**$95.5**	**$29.4**	**$75.6**
B2 - Income Eligible Hard-to-Measure					
2025	N/A	N/A	$5.6	$5.6	N/A
2026	N/A	N/A	$7.0	$7.0	N/A
2027	N/A	N/A	$8.6	$8.6	N/A
Total			**$21.3**	**$21.3**	
Income Eligible Sector Total					
2025	0.99	$30.7	$31.1	$13.3	$19.9
2026	0.96	$37.0	$38.6	$16.7	$25.0
2027	0.93	$43.7	$47.0	$20.6	$30.7
Total	**0.95**	**$111.4**	**$116.7**	**$50.7**	**$75.6**

Source: Guidehouse

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Table 4-29 and Table 4-30 show CECP Cost Premium scenario results for the C&I sector. The tables show summary energy, MW, MMBtu, and 2030 carbon savings for all fuels and benefit and costs and the BCR for the core initiatives for each year. C&I New & Replacement contributes about three-quarters of total lifetime savings, C&I Existing Building Retrofit contributes about one-quarter of total lifetime savings, and C&I New Buildings & Major Renovations contributes no lifetime savings. After adding the cost premium estimations to TRC costs, the program and sector remain cost-effective.

Table 4-29. C&I Sector, Natural Gas Core Initiatives, CECP Cost Premium Scenario Achievable Potential (Incremental Net)

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO_2e]
C1a - C&I New Buildings & Major Renovations				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
C2a - C&I Existing Building Retrofit				
2025	52,500	5,100	33,600	180
2026	59,000	5,800	37,100	260
2027	65,700	6,500	41,000	340
Total			**111,700**	**780**
C2b - C&I New & Replacement Equipment				
2025	94,300	8,500	154,000	520
2026	93,700	8,700	159,300	520
2027	94,100	8,700	159,400	520
Total			**472,700**	**1,560**
C&I Sector Total				
2025	146,800	13,600	187,600	700
2026	152,700	14,500	196,400	780
2027	159,800	15,200	200,400	860
Total			**584,400**	**2,340**

Source: Guidehouse

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Table 4-30. C&I Sector, Natural Gas Programs, CECP Cost Premium Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
C1 - C&I New Buildings					
2025		$0.0	$0.0	$0.0	$0.0
2026		$0.0	$0.0	$0.0	$0.0
2027		$0.0	$0.0	$0.0	$0.0
Total		**$0.0**	**$0.0**	**$0.0**	**$0.0**
C2 - C&I Existing Buildings					
2025	1.84	$6.0	$3.2	$1.6	$1.4
2026	1.79	$6.3	$3.5	$2.0	$1.7
2027	1.64	$6.6	$4.0	$2.2	$1.9
Total	**1.75**	**$18.9**	**$10.8**	**$5.8**	**$5.0**
C3 - C&I Hard-to-Measure					
2025	N/A	N/A	$1.0	$1.0	N/A
2026	N/A	N/A	$1.2	$1.2	N/A
2027	N/A	N/A	$1.4	$1.4	N/A
Total			**$3.5**	**$3.5**	
C&I Sector Total					
2025	1.42	$6.0	$4.2	$2.6	$1.4
2026	1.34	$6.3	$4.7	$3.2	$1.7
2027	1.23	$6.6	$5.4	$3.6	$1.9
Total	**1.32**	**$18.9**	**$14.3**	**$9.3**	**$5.0**

Source: Guidehouse

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Figure 4-8 through Figure 4-9 show the top MMBtu and carbon savings measures across all sectors for the CECP Cost Premium scenario. Insulation (Income Eligible Coordinated Delivery), Insulation (Residential Coordinated Delivery), and W2A GSHP Replacing Gas Furnace (Residential Retail) contribute the majority of lifetime achievable potential.

Figure 4-8. EE CECP Cost Premium Scenario Lifetime Achievable Potential, Top Natural Gas Measures, 2025-2027, MMBtu (all sectors)

		Core Initiative	LT Savings
1	Insulation	A2a - Residential Coordinated Delivery	1,622,650
2	Insulation	B1a - Income Eligible Coordinated Delivery	972,790
3	W2A GSHP Replacing Gas Furnace	A2c - Residential Retail	512,050
4	Custom Large C&I	C2b - C&I New & Replacement Equipment	383,920
5	Air Sealing	B1a - Income Eligible Coordinated Delivery	346,650
6	W2A GSHP Replacing Gas Furnace	B1a - Income Eligible Coordinated Delivery	336,620
7	Air Sealing	A2a - Residential Coordinated Delivery	257,710
8	Ductless MSHP Partially Displacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	172,690
9	Heat Recovery Ventilator	A2c - Residential Retail	129,040
10	Ductless MSHP Partially Displacing Gas Boiler and AC	A2c - Residential Retail	126,010
11	Ductless MSHP Fully Replacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	62,940
12	Programmable Thermostat to Wifi Thermostat	B1a - Income Eligible Coordinated Delivery	60,890
13	Forced Hot Water Boiler - Gas	B1a - Income Eligible Coordinated Delivery	53,950
14	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	51,280
15	Heat Pump Water Heater Fuel Switch	A2c - Residential Retail	43,710
16	Ground Source Heat Pump (Water-to-Air)	C2b - C&I New & Replacement Equipment	41,650
17	Heat Pump Water Heater Fuel Switch	B1a - Income Eligible Coordinated Delivery	37,700
18	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	34,680
19	Manual Thermostat to Programmable Thermostat	B1a - Income Eligible Coordinated Delivery	29,790
20	Air to water heat pumps, gas baseline	A2c - Residential Retail	28,330
21	Demand Control Ventilation	C2a - C&I Existing Building Retrofit	27,590
22	Commissioning/Retrocommissioning	C2a - C&I Existing Building Retrofit	25,260
23	Ductless MSHP Fully Replacing Gas Boiler and AC	A2c - Residential Retail	24,160
24	Wi-Fi Thermostat	A2c - Residential Retail	24,010
25	Central ASHP Fully Replacing Gas Furnace and AC	B1a - Income Eligible Coordinated Delivery	23,760

Source: Guidehouse

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Figure 4-9. EE CECP Cost Premium Scenario Lifetime Achievable Potential, Top Natural Gas Measures, 2025-2027, CO_2e Savings at Generator, Metric Tons (all sectors)

#	Measure	Core Initiative	CO2e in 2030
1	Insulation	A2a - Residential Coordinated Delivery	3,498
2	Insulation	B1a - Income Eligible Coordinated Delivery	1,935
3	W2A GSHP Replacing Gas Furnace	A2c - Residential Retail	1,439
4	Air Sealing	B1a - Income Eligible Coordinated Delivery	1,226
5	Custom Large C&I	C2b - C&I New & Replacement Equipment	1,192
6	W2A GSHP Replacing Gas Furnace	B1a - Income Eligible Coordinated Delivery	946
7	Air Sealing	A2a - Residential Coordinated Delivery	877
8	Ductless MSHP Partially Displacing Gas Boiler and AC	A2c - Residential Retail	746
9	Ductless MSHP Partially Displacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	705
10	Heat Recovery Ventilator	A2c - Residential Retail	489
11	Ductless MSHP Fully Replacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	309
12	Demand Control Ventilation	C2a - C&I Existing Building Retrofit	265
13	Programmable Thermostat to Wifi Thermostat	B1a - Income Eligible Coordinated Delivery	210
14	Heat Pump Water Heater Fuel Switch	A2c - Residential Retail	206
15	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	203
16	Ductless MSHP Fully Replacing Gas Boiler and AC	A2c - Residential Retail	182
17	Heat Pump Water Heater Fuel Switch	B1a - Income Eligible Coordinated Delivery	178
18	Commissioning/Retrocommissioning	C2a - C&I Existing Building Retrofit	169
19	Air to water heat pumps, gas baseline	A2c - Residential Retail	155
20	Central ASHP Fully Replacing Gas Furnace and AC	B1a - Income Eligible Coordinated Delivery	147
21	Forced Hot Water Boiler - Gas	B1a - Income Eligible Coordinated Delivery	143
22	Pre-Rinse Spray Valve	C2a - C&I Existing Building Retrofit	139
23	Ground Source Heat Pump (Water-to-Air)	C2b - C&I New & Replacement Equipment	131
24	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	115
25	Air to water heat pumps, gas baseline	B1a - Income Eligible Coordinated Delivery	112

Source: Guidehouse

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5. Demand Response Potential Assessment Methodology

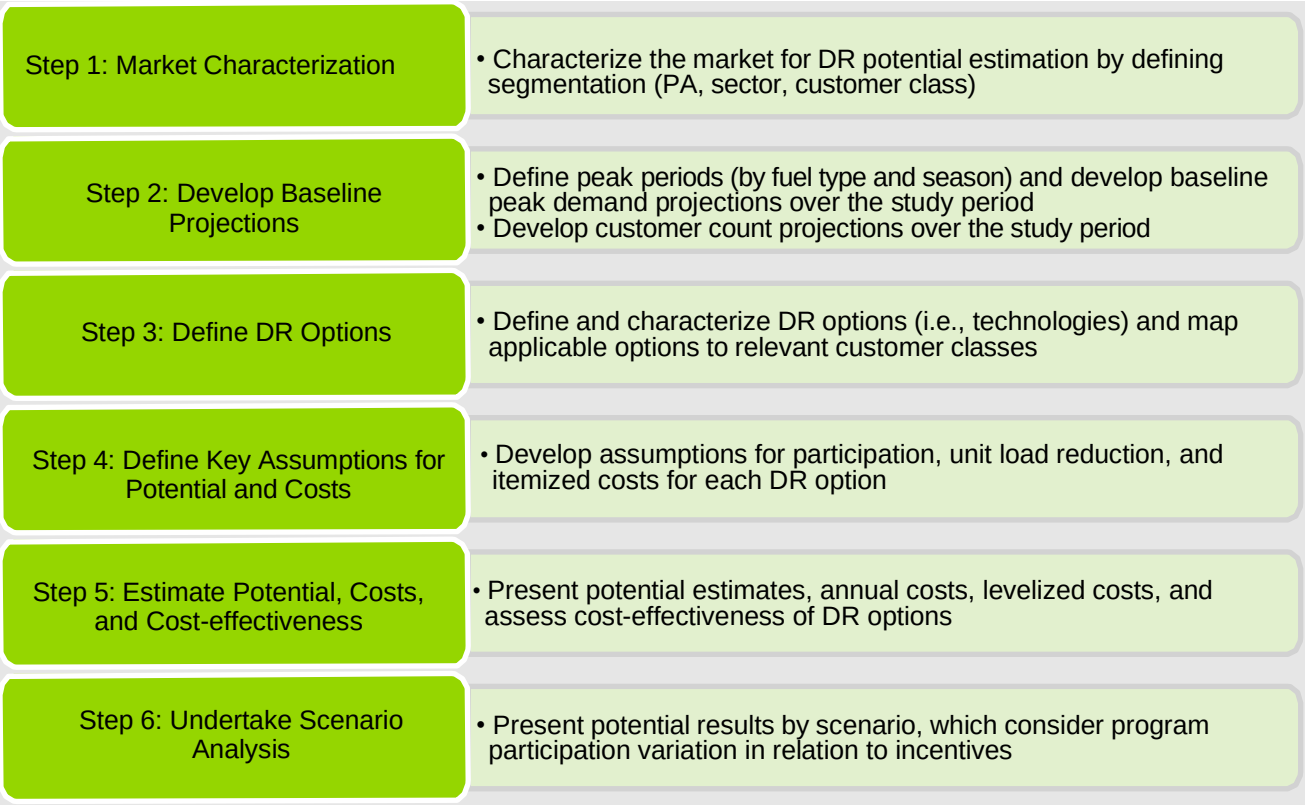
This section describes the approach for developing potential and cost estimates for Demand Response (DR), referred to as active demand reduction or active demand management. Guidehouse developed DR potential and cost estimates using a bottom-up analysis. The analysis utilizes a combination of primary data (e.g., market data from Liberty Utilities) and relevant secondary sources to develop data inputs required for assessing DR potential and cost-effectiveness. These data inputs feed into Guidehouse's DRSim model, customized for the study, which produces DR potential, annual program costs, and cost-effectiveness of DR options at various levels of disaggregation.

The following subsections describe the approach for DR potential estimation and cost-effectiveness assessment (summarized in Figure 5-1), which consists of the following steps:

1. Undertake market characterization and segmentation for DR potential assessment.
2. Develop projections of customer counts and baseline peak demand over the study period.
3. Define and characterize DR options and map applicable options to relevant customer segments.
4. Develop programmatic assumptions, which include participation, unit load reductions, and cost assumptions.
5. Estimate potential, annual costs, levelized costs and cost-effectiveness by DR option, customer class and building type.
6. Conduct scenario analysis and present DR potentials, annual costs, and cost-effectiveness results by scenario.

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Figure 5-1. DR Potential Assessment Steps



Source: Guidehouse

5.1 DR Market Characterization

Market characterization is the first step in the DR potential assessment process and consists of defining appropriate customer segments and developing customer count and peak demand projections which serve as the baseline for DR potential estimates. Market characterization is performed for each fuel type and season of interest in the study (natural gas DR in this case). The market characterization processes utilize data provided directly by Liberty Utilities wherever possible along with other secondary sources if needed.

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Table 5-1 summarizes the market segmentation approach for DR potential assessment.

Table 5-1. Market Segmentation for DR Potential Assessment

Level	Description
Level 1: Sector	• Residential • Commercial and Industrial (C&I)
Level 2: Customer Class	• Residential • C&I (Natural gas): – Small & Medium C&I (< 250,000 therms/year consumption) – Large C&I ≥ 250,000 therms/year consumption)

Note: Customer segments are mapped to applicable DR program types in our analysis, which was provided earlier in the DR measure characterization workbook provided to the PAs. The natural gas DR options apply to the customer segments listed for the natural gas DR analysis.

Note: Residential DR analysis included both market rate and IE customers under Residential.

Note: C&I natural gas segmentation is based on the data obtained from class average load profile information. The thresholds presented for segmentation by size are typically what is considered for DR potential studies, and to align with the differences in the type of DR program offer by customer size.

Source: Guidehouse

Level 1: Sector

The first level of segmentation is at the sector level, between Residential and C&I. The data used to develop inputs at the sector level, such as customer count data and overall sector energy sales, is consistent between the EE and DR analyses.

Level 2: Customer Class

For the Residential sector, there is no further customer segmentation. Market rate and Income Eligible customers are all included under the Residential sector. For the C&I sector, there is an additional segmentation to customer class, which represents size and rate class categories.

For natural gas, to define the customer class cutoff, Guidehouse used the DNV C&I stock database (customer count and square foot data), which groups customers in each rate class into business size categories. Table 5-2 shows how the DNV business size categories are defined and mapped to C&I customer class. The DNV data was used to determine the proportion of sector-level customer count and sales within each rate class to assign to each C&I customer class segment.

Table 5-2. Natural Gas C&I Customer Class Map

DNV Business Size	Annual Consumption (therms/year)	Customer Class
Microbusiness	< 8,000	Small & Medium C&I
Small Business	8,000 to 40,000	Small & Medium C&I
Medium Business	40,000 to 250,000	Small & Medium C&I
Large Business	> 250,000	Large C&I

Source: Guidehouse

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5.2 Baseline Projections

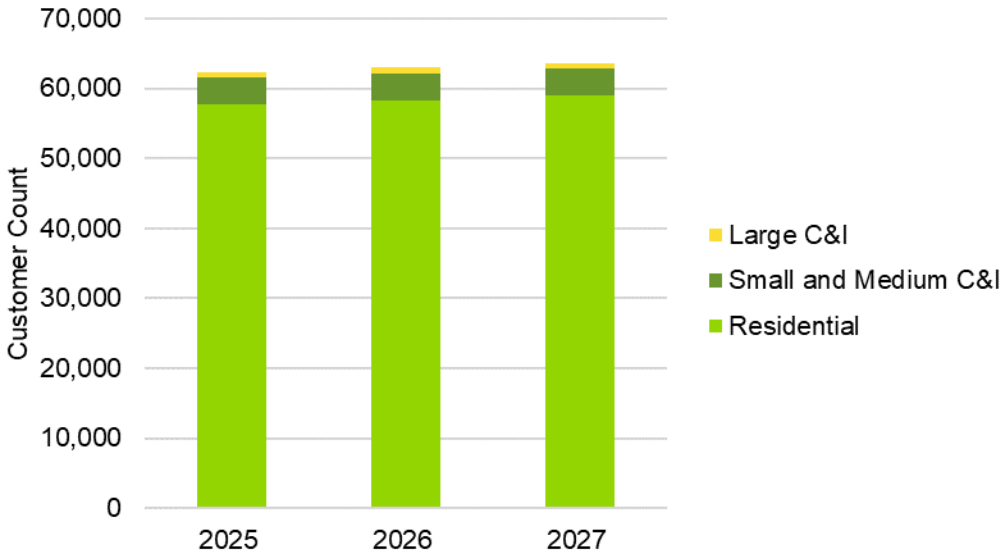
After customer segmentation, the next step in the DR market characterization is the development of baseline customer counts and associated peak demand projections for each segment over the potential analysis 3-year period (2025-2027). These projections were developed at the following levels for the DR potential assessment:

- Customer Count Projections
  - Fuel Type (Natural gas)
  - Customer Segment (Sector, Customer Class)
- Peak Demand Projections
  - Fuel Type (Natural gas)
  - Season (Winter)
  - Customer Segment (Sector, Customer Class)

5.2.1 Customer Count Projections

Guidehouse developed forecasts for the number of accounts by fuel type and customer segment. For the Residential sector, Guidehouse used customer count data provided by Liberty Utilities and the total count projections are aligned between the EE and DR analysis. For the C&I sector, Guidehouse developed DR-specific count projections at the customer class level, which differs from the building type segmentation used for EE, given limited available data that would allow for segmentation at the combined customer class and building type level. Guidehouse directly used the number of existing and forecasted accounts from Liberty Utilities data.

Figure 5-2. Natural Gas Customer Count Forecast by Customer Class



Source: Guidehouse

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5.2.2 Peak Period Definition and Peak Demand Projections

The final key element of DR market characterization is to develop disaggregated bottom-up peak demand projections by PA, fuel type, season, and customer segment. These estimates serve as the foundation for the DR potential estimates by defining the peak demand upon which DR measures can act to reduce load.

5.2.2.1 Natural Gas Peak Demand Projections (Winter Only)

Table **5-3** describes the methodology used to develop natural gas peak demand projections for the winter season.

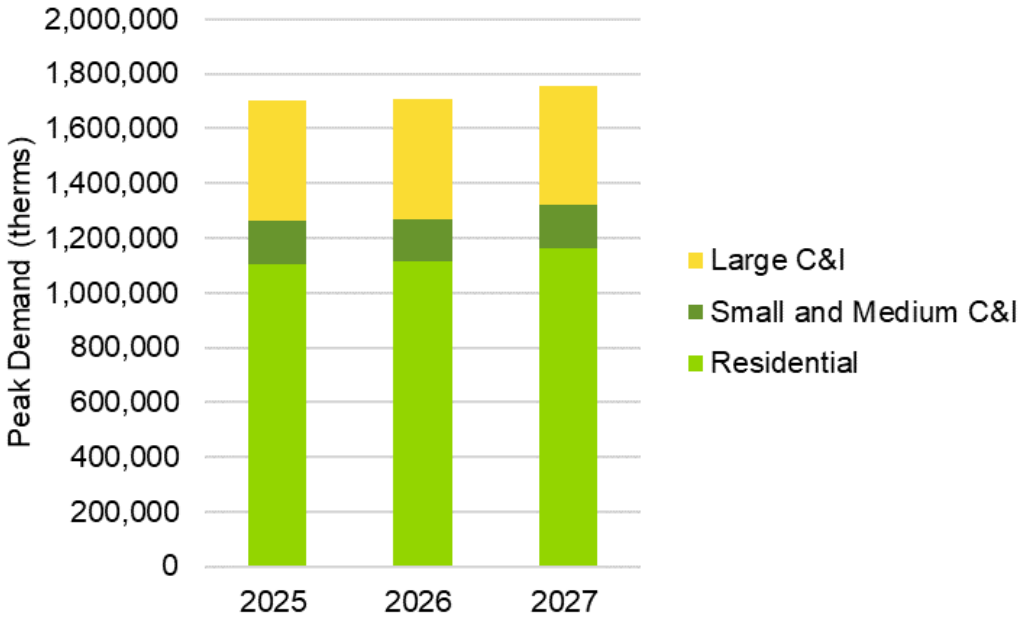
Table 5-3**. Natural Gas Baseline Peak Demand Projection Methodology**

Define Peak Period
• The peak period for the gas baseline forecast is defined as the PA design day within each winter season (often represented as a split-year, e.g. winter 2021-2022). Unlike for electricity, the winter gas peak period is not necessarily "coincident" at the system level across all PAs; instead, the peak design day is defined separately for each PA.
Develop Annual Sales Forecasts
• Guidehouse used Liberty Utilities-provided sales data and the customer segmentation approach described previously to determine annual gas sales forecasts by customer segment. The values are aligned with the EE gas sales inputs.
Collect and Gap-Fill Peak Design Day Estimates
• Guidehouse first directly used any peak design day values provided by Liberty Utilities • Where not provided directly (for certain forecast years), Guidehouse gap-filled peak design day estimates using a calculation based on the annual sales developed in the previous step. To convert annual sales forecasts to peak design demand values, Guidehouse calculated load factors (representing the average ratio between annual sales and design day load) based on provided years and applied these load factors to annual sales.
Determine Peak Contributions by Customer Segment
• Guidehouse then determined peak design day contributions from each customer segment to apportion the peak demand. Liberty Utilities provided sector and rate class breakdowns for their design day projections, which Guidehouse directly used. • Guidehouse also utilized annual building gas consumption load profiles from NREL's ResStock and ComStock tools for Massachussetts to estimate the design day contributions (relative to annual consumption) from each customer segment. Guidehouse compared the NREL-derived breakdowns to those provided by Liberty Utilities to check for reasonableness.

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Figure 5-3 shows the estimated winter natural gas peak demand over the forecast period, broken out by customer class. The winter natural gas baseline peak forecast increases during the 3-year period, with the 2027 forecast higher than in the prior two years. The Residential segment contributes the bulk of the baseline peak forecast, followed by the Large C&I segment, with the Small and Medium C&I segment providing the smallest portion.

Figure 5-3. Winter Natural Gas Baseline Peak Forecast by Customer Segment



Source: Guidehouse

5.3 Characterization of DR Options

After completion of the market characterization, the next key step in the DR potential assessment was to characterize the different types of DR options that could be utilized to curtail peak demand. The suboptions represent specific end uses and control technologies. The DR options considered are representative of commonly deployed programs and emerging DR-enabling technologies in the industry.

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Table 5-4 and Table 5-5 summarize all of the DR options and suboptions analyzed for the winter natural gas potential assessment. The overall options (DLC, C&I Curtailment, and Behavioral DR) are analogous to those for electricity, but the suboptions are more limited and represent end use and enabling technology combinations that are most relevant for reducing winter natural gas peaks.

Table 5-4. Summary of Natural Gas DR Options

DR Option	Brief Description	Eligible Customer Classes	End Use
DLC-Gas	Direct control of gas loads by a thermostat and/or load control switch or via smart appliances	Residential Small & Medium C&I	Space Heating HVAC Water Heating
C&I Curtailment - Gas	Firm capacity reduction commitment. $/therm payment based on delivered reduction, administered through third party aggregators.	Large C&I	HVAC Process
Behavioral DR - Gas	Behavioral interventions to induce peak demand reductions	Residential	All

Note: Space Heating applies to Residential. For Small & Medium C&I, Guidehouse refers to the end use load type as HVAC.

Source: Guidehouse

Table 5-5. Summary of Natural Gas DR Suboptions

DR Option	DR Suboption	End Use
DLC-Gas	BYOT-Smart Thermostat-Gas Space Heating Control	Space Heating
	Switch-Water Heating Control-Gas Water Heating	Space Heating
	DLC-Smart Thermostat-Gas Heating Control	HVAC (C&I)
	BYOD-Water Heaters-Gas	Water Heating
	DLC-Gas Water Heating Control	Water Heating (C&I)
C&I Curtailment - Gas	C&I Curtailment - Heating	HVAC
	C&I Curtailment - Process	Process
Behavioral DR - Gas	Behavioral DR- Gas	All

Source: Guidehouse

5.4 Key DR Potential and Cost-Effectiveness Assessment

The final step in Guidehouse's assumptions development process was to estimate programmatic inputs such as participation rates, unit load reductions and costs for the DR options. These assumptions were based on Guidehouse team's experience with similar DR potential studies and program performance data/information from DR programs in other jurisdictions.

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Table 5-6 summarizes the key DR potential and cost estimation variables considered in this study.

Table 5-6. Key Variables for DR Potential and Cost Estimates

Key Variables	Description
Participation Rates	• Percentage of eligible customers enrolled in DR programs by DR Options, DR suboptions, customer class and building types. • Participation ramp (rate at which the program ramps up to steady state participation over a specified period).
Unit Impacts	• Therm reduction per device for DLC (Residential and small and medium C&I customers). • Percentage of enrolled load by end use/total facility for DLC (Large C&I customers), C&I Curtailment, BTM Batteries, and EV Managed Charging.
Costs	• Customer incentives that may be specified in terms of $/device/yr. participating, $/new device enrolled, $/therms, etc. • Non-incentive costs that include program set up, customer outreach, program administration and O&M costs.
Global Parameters	• Avoided Costs, Discount Rate.

Source: Guidehouse

Guidehouse calculated achievable potential for DR according to Equation 5-1:

Equation 5-1. DR Achievable Potential

$$\begin{aligned} &Achievable\ Potential \\ &\quad = Eligible\ Load_{DR\ Sub\ Option,Segment,End\ Use,Year} \\ &\quad * Unit\ Impact_{DR\ Sub\ Option,Segment,Year} \\ &\quad * Achievable\ Participation\ Rate_{DR\ Sub\ Option,\ Segment,\ Year} \\ &* (1 - Event\ Opt\ Out\ Rate)_{DR\ Sub\ Option,\ Year} \end{aligned}$$

In addition to the potential estimates, Guidehouse developed annual and levelized costs by DR options and suboptions and conducted cost-effectiveness assessment of these options and suboptions. Development of DR program annual and levelized costs involve itemization of the various cost components, such as one-time program development costs, DR-enablement costs, equipment costs, participant marketing and recruitment costs, annual program administration costs, O&M costs, and customer incentives.

5.4.1 Key Assumptions for DR Potential and Cost-Effectiveness Assessment

The development of potential and cost assumptions is based on Guidehouse's industry expertise in the area, and relevant secondary sources of information, such as DR potential studies and evaluation reports from other jurisdictions. The key assumptions are briefly described below.

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5.4.1.1 Participation and Unit Impacts

The participation assumptions for DR options are developed by customer class and represent the most likely or achievable participation estimates in these options. The participation assumptions are developed by customer class and DR option and represent steady-state participation levels after the program is fully ramped up.

The unit impacts specify the amount of load that could be reduced during a DR event once customers are enrolled in a DR program. Unit impacts can be specified either directly as therm reduction per participant or as a percent of enrolled load. For the DLC option, unit impacts are based on a per-therm reduction for each suboption representing a specific control technology and end-use combination. For each suboption under C&I Curtailment, unit impacts are specified as a percent of enrolled load.

5.4.1.2 Program Costs and Related Assumptions for Cost-Effectiveness

Guidehouse developed detailed itemized cost assumptions for each DR option to assess annual program costs and calculate levelized costs for each option. Itemized costs include upfront program setup costs, marketing and recruitment costs, and ongoing program administration and O&M costs.

Cost-effectiveness was calculated for winter natural gas for each DR suboption and is based on the Total Resource Cost (TRC) test. Table 5-7 summarizes the benefits and costs considered in the cost-effectiveness assessment of DR options. Guidehouse followed the methodology used in Liberty Utilities' 2022-2024 BCR models, in which the only cost component included in the cost portion of the benefit-cost ratio is incentive costs. Avoided costs were obtained from AESC 2024.

Table 5-7. Summary of Benefit-Cost Streams for TRC Cost-Effectiveness

Natural Gas Benefits	Costs
Avoided 10-day Peak Period Costs	Incentives

Source: Guidehouse

DR options that had TRC benefit-to-cost ratios of 1.0 or greater were deemed cost-effective and included in the achievable potential estimates.

5.4.2 Scenarios and Related Assumptions

Guidehouse developed achievable potential estimates under two scenarios (1) Business as Expected (BAE), and (2) Max Achievable (MAX). These scenarios represent variations in the following input assumptions:

- **Customer Incentives:** MAX scenario assumed 50% higher incentives to customers than BAE.
- **Program Participation:** Higher participation levels than BAE associated with higher incentive levels. The higher participation assumptions were based off available participation curves in DR programs.

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6. Demand Response Potential and Cost-Effectiveness Results

This section presents DR potential and costs results based on the approach described in Section 5. Results are presented in the following order:[36]

- Cost-Effectiveness Assessment Results with Benefit-to-Costs Ratios:
  - Benefit-to-Cost Ratios for natural gas DR Options under BAE scenario
  - Comparison of cost-effectiveness results in MAX scenario vs. BAE scenario
- Achievable Potential Results:
  - DR option for BAE scenario for Residential and C&I
  - DR suboption for BAE scenario for Residential and C&I
- DR Program Cost Results:
  - Annual program costs across scenarios
  - Levelized costs and supply curves for BAE
- MAX scenario results for Residential and C&I

6.1 DR Cost-Effectiveness Assessment Results

The DR potential and cost analysis assessed winter natural gas cost-effectiveness of DR options and suboptions for the BAE scenario and the MAX scenario. The cost-effectiveness assessment results are first presented for the BAE scenario. The BAE results are then compared with the MAX scenario.

6.1.1 BAE Scenario Cost-Effectiveness Results

Table 6-1 shows natural gas TRC benefit-cost ratios for the BAE scenario by DR option and DR suboption. None of the natural gas DR suboptions are cost-effective in any year over the 3-year period due to low avoided cost values.

[36] Detailed potential and cost results are included in the excel-based results dashboards accompanying this report.

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Table 6-1. BAE Scenario (2025-2027) Benefit-Cost Ratios for Natural Gas DR Suboptions

DR Option	DR Suboption	TRC Ratio (BAE Scenario)		
		2025	2026	2027
DLC-Gas	Res BYOD-Water Heaters-Gas	0.002	0.002	0.003
	Res BYOT-Smart Thermostat-Gas Space Heating Control	0.02	0.02	0.03
	Res Switch-Water Heating Control- Gas Water Heating	0.002	0.002	0.003
	C&I DLC-Gas Water Heating Control	0.002	0.003	0.003
	C&I DLC-Smart Thermostat-Gas Space Heating Control	0.03	0.03	0.04
C&I Curtailment - Gas	C&I Curtailment-Heating (Gas)	0.7	0.6	0.6
	C&I Curtailment-Process (Gas)	0.7	0.6	0.6

Note: The Residential Behavioral DR – Gas option is not listed here because incentives (the cost component of the benefit-cost ratio) are 0. Behavioral DR is considered a cost-effective option.
Source: Guidehouse

6.1.2 Comparison of Cost-Effectiveness Results by Scenario

In addition to the BAE scenario, Guidehouse modeled potential results under the MAX scenario in which assumed participation levels and incentive amounts were increased to determine the impacts on the DR Achievable potential.

Table 6-2 shows natural gas TRC benefit-cost ratios for the MAX scenario. Like the BAE scenario, none of the natural gas DR suboptions are cost-effective in any year over the 3-year period.

Table 6-2. MAX Scenario (2025-2027) Benefit-Cost Ratios for Natural Gas DR Suboptions

DR Option	DR Suboption	TRC Ratio (MAX Scenario)		
		2025	2026	2027
DLC-Gas	Res BYOD-Water Heaters-Gas	0.001	0.002	0.002
	Res BYOT-Smart Thermostat-Gas Space Heating Control	0.01	0.02	0.02
	Res Switch-Water Heating Control-Gas Water Heating	0.001	0.002	0.002
	C&I DLC-Gas Water Heating Control	0.002	0.002	0.002
	C&I DLC-Smart Thermostat-Gas Space Heating Control	0.02	0.03	0.03
C&I Curtailment - Gas	C&I Curtailment-Heating (Gas)	0.4	0.4	0.4
	C&I Curtailment-Process (Gas)	0.4	0.4	0.4

Note: The Residential Behavioral DR – Gas option is not listed here because incentives (the cost component of the benefit-cost ratio) are 0. Behavioral DR is considered a cost-effective option.
Source: Guidehouse

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6.2 DR Potential Results for All Options

This section presents potential results for all DR options under the BAE scenario. As discussed previously, none of the DR options are cost-effective. Therefore, the potential discussed below represents potential with program enrollment/participation assumptions that are used for "achievable" potential estimates if these were to be cost-effective. For more details and levels of aggregation of achievable potential, including summaries for the BAE and MAX scenarios, see Appendix D.

6.2.1 BAE Scenario Potential Results by DR Option

Table 6-3 shows the winter natural gas DR potential by DR option for the BAE scenario. None of the DR options and suboptions are cost-effective using the 10-day peak natural gas values from AESC 2024. However, the table shows where the greatest amount of DR savings could be realized if benefits exceeded costs.

Table 6-3. Winter Natural Gas DR BAE Scenario Potential by Option

DR Option	2025 (therms) BAE Scenario	2026 (therms) BAE Scenario	2027 (therms) BAE Scenario
DLC-Gas	660	1,340	2,040
Behavioral DR-Gas	220	420	640
Subtotal Residential	**880**	**1,760**	**2,680**
DLC-Gas	40	80	120
C&I Curtailment-Gas	300	610	920
Subtotal C&I	**340**	**690**	**1,040**
Total	**1,220**	**2,450**	**3,710**

Source: Guidehouse

6.3 Annual Program Costs

This section presents the annual program cost estimates of the DR Portfolio by sector and DR option for the BAE scenario. Analogous results for the MAX scenario are provided in Appendix D: Demand Response Results (Excel Spreadsheet Viewer). The results in this section represent the total annual costs Liberty Utilities is estimated to incur to realize the potential values discussed above. The costs represent a sum of different types of fixed and variable costs, either incurred one-time or on a recurring basis, for implementing the DR programs (refer to Section 5.4.1.2 for a description of the different types of costs).

Table 6-4 presents the annual program costs for the winter natural gas DR BAE scenario. Benefits would have to exceed these costs in order for programs to be cost-effective. Non-incentives costs comprise slightly more than incentive costs annually, with the Residential sector contributing almost all of the costs.

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Table 6-4. Winter Natural Gas DR BAE Scenario Portfolio Costs by Sector and Cost Category

Sector	Cost Category	2025 ($) BAE Scenario	2026 ($) BAE Scenario	2027 ($) BAE Scenario
Residential	Incentives	$285,000	$396,000	$507,000
Residential	Non-Incentives	$1,173,000	$1,607,000	$2,062,000
Subtotal Residential		**$1,458,000**	**$2,003,000**	**$2,569,000**
C&I	Incentives	$10,000	$16,000	$21,000
C&I	Non-Incentives	$13,000	$19,000	$26,000
Subtotal C&I		**$23,000**	**$35,000**	**$48,000**
Subtotal Incentives		$295,000	$412,000	$528,000
Subtotal Non-Incentives		$1,185,000	$1,627,000	$2,088,000
Total		**$1,481,000**	**$2,038,000**	**$2,617,000**

Source: Guidehouse

Table **6-5** shows the breakdown of incentive costs among the winter natural gas DR BAE scenario. The Residential DLC-Gas option comprises almost 95% of the annual costs. The DLC costs for small and medium C&I customers comprises most of the C&I sector costs.

Table 6-5. Winter Natural Gas DR BAE Scenario Incentive Costs by Option

DR Option (Gas)	2025 ($) BAE Scenario	2026 ($) BAE Scenario	2027 ($) BAE Scenario
DLC-Gas	$285,000	$396,000	$507,000
Subtotal Residential	**$285,000**	**$396,000**	**$507,000**
DLC-Gas	$8,700	$12,700	$16,700
C&I Curtailment-Gas	$1,600	$3,100	$4,700
Subtotal C&I	**$10,300**	**$15,800**	**$21,400**
Total	**$295,000**	**$412,000**	**$528,000**

Note: The Residential Behavioral DR-Gas option is not listed here because incentives are 0.
Source: Guidehouse

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6.4 DR MAX Scenario Potential Results

Table 6-6 shows the winter natural gas DR potential by DR option for the MAX scenario. As discussed previously, none of the DR options are cost-effective under MAX scenario. However, the table shows where the greatest amount of DR savings could be realized if benefits exceeded costs. The total winter natural gas DR savings more than triple over the 3-year period for the MAX scenario, with Residential DLC-Gas option providing most of the savings.

Table 6-6. Winter Natural Gas DR MAX Scenario Potential by Option

DR Option	2025 (therms) MAX Scenario	2026 (therms) MAX Scenario	2027 (therms) MAX Scenario
DLC-Gas	730	1,470	2,240
Behavioral DR-Gas	220	420	630
Subtotal Residential	**950**	**1,890**	**2,870**
DLC-Gas	40	90	140
C&I Curtailment-Gas	330	670	1,010
Subtotal C&I	**380**	**760**	**1,140**
Total	**1,320**	**2,650**	**4,010**

Source: Guidehouse

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Table 6-7 presents the annual program costs for the winter natural gas DR MAX scenario. The Residential sector comprises almost all of the annual costs, with non-incentives contributing most of the sector costs. Non-incentive costs make up slightly more than half of the total costs for the C&I sector.

Table 6-7. Winter Natural Gas DR MAX Scenario Portfolio Costs by Sector and Cost Category

Sector	Cost Category	2025 ($) MAX Scenario	2026 ($) MAX Scenario	2027 ($) MAX Scenario
Residential	Incentives	$373,000	$554,000	$736,000
Residential	Non-Incentives	$1,525,000	$2,241,000	$2,977,000
Subtotal Residential		**$1,898,000**	**$2,796,000**	**$3,713,000**
C&I	Incentives	$14,300	$23,400	$32,600
C&I	Non-Incentives	$17,500	$28,700	$39,900
Subtotal C&I		**$31,900**	**$52,100**	**$72,500**
Subtotal Incentives		$388,000	$578,000	$768,000
Subtotal Non-Incentives		$1,542,000	$2,270,000	$3,017,000
Total		**$1,930,000**	**$2,848,000**	**$3,785,000**

Source: Guidehouse

Table 6-8 shows the breakdown of incentive costs among the winter natural gas DR MAX scenario. The Res DLC-Gas option comprises most of the costs annually. The C&I DLC-Gas option comprises most of the C&I sector costs.

Table 6-8. Winter Natural Gas DR MAX Scenario Incentive Costs by Option

DR Option (Gas)	2025 ($) MAX Scenario	2026 ($) MAX Scenario	2027 ($) MAX Scenario
DLC-Gas	$373,000	$554,000	$736,000
Subtotal Residential	**$373,000**	**$554,000**	**$736,000**
DLC-Gas	$11,800	$18,300	$24,800
C&I Curtailment-Gas	$2,600	$5,200	$7,800
Subtotal C&I	**$14,000**	**$23,000**	**$33,000**
Total	**$388,000**	**$578,000**	**$768,000**

Note: The Residential Behavioral DR-Gas option is not listed here because incentives are 0.
Source: Guidehouse

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7. Conclusions

This study uses the most recently available information on Liberty and the Massachusetts customer base and state-of-the-art modeling to develop the potential for energy, demand and CO_2e reductions possible through EE and DR programs and initiatives during the forthcoming 2025-2027 term. While much EE and DR potential remain, Massachusetts faces unique challenges related to high levels of saturation, ineligibility of past popular measures, and aggressive carbon reduction targets in realizing this potential over the next three years. The potential study incorporates these real factors into the analysis by utilizing Massachusetts baseline study and historic program data to accurately reflect efficient measure saturations. Based on the assumptions made, the analyses conducted, and the results presented, these are realistic estimates of potential.

To contextualize the results from this study, Table 7-1 compares BAE annual potential for 2025 as identified in this study to 2022 actual achievements for EE and 2022 base loads; Table 7-2 compares BAE costs to the 2022-2024 PA costs (excluding customer costs).

Table 7-1. Comparison of BAE Potential to Recent Experience, Liberty Gas

	2025 Potential	2022 Actual	2022 Load
Energy (Annual Therms)	460,600	282,648	68,000,000
Energy (Annual MMBtu)	39,000	26,153	N/A

Source: Guidehouse and MassSaveData.com

Table 7-2. Comparison of PA Costs for Three Year Period

	2025-2027 BAE	2022-2024 Plan
Natural Gas - Liberty	$31,800,000	$21,193,967

Source: Guidehouse and MassSaveData.com

7.1 Energy Efficiency

The following are high-level observations regarding the projections for energy efficiency potential:

- **Natural Gas Savings BAE Scenario:** Lifetime savings are approximately evenly spread across the Residential, Income-Eligible, and C&I sectors. Insulation and Air Sealing are the highest impact measures accounting for approximately half of the Residential top 10 measure lifetime savings and a lower proportion of Income-Eligible top 10 measure lifetime savings. Fuel substitution measures, both partial and full, also deliver an important share of savings in these two sectors. Considerably more than half of the top 10 measure savings for the C&I sector are attributable to the Custom Large C&I measure, though fuel substitution (Central Air Source Heat Pump) is also a meaningful contributor of achievable potential.

- **Carbon:** The primary source of carbon reduction in 2030 from achievable potential in 2025 through 2027 is from fuel substitution and insulation measures in the Residential and Income Eligible sectors and Custom measures in the C&I sector.

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- **CECP Scenario Results:** The CECP scenarios demonstrate that the statewide carbon targets for 2030 can be met by accelerated deployment of weatherization and heat pumps by all PAs. The associated price tags for the PAs are also increased. In the Cost Premium scenarios, the price tag relative to the CECP scenario is approximately four to eight times higher than the BAE scenario. Because of the high costs, the Residential and Income Eligible sectors are not cost-effective in the CECP Cost Premium scenario; however, the C&I sector remains cost effective.

- **Key Drivers:** Major drivers of BAE potential are measure eligibility, carbon benefits, Liberty's actual and expected achievements during 2022-2024, and updated avoided costs. For the CECP scenarios, the major driver of results was the carbon-reduction rich measures that were targeted with accelerated deployment.

- **Achieving Potential:** While this report shows that much EE potential remains, there are unique challenges in Massachusetts in realizing this potential over the next three years. Assumptions adopted in this study represent these factors and Liberty Utilities should be aware of the factors as it develops its plans.

    - **Past Program Achievements:** Notably, Liberty Utilities has effectively implemented energy efficiency programs in Massachusetts for decades, often exceeding goals in terms of the amount of savings achieved. As greater levels of energy efficiency are implemented in Massachusetts and market saturation increases, it may become more challenging to harvest additional savings represented in the energy efficiency potential.

    - **Codes and Standards:** The challenge of continuing to capture savings from energy efficiency programs within an increasingly saturated market is exacerbated by tightening codes and standards.

    - **Changing Energy Efficiency Measure Costs:** Changes to the portfolio measure mix that occur due to market saturation and codes and standards changes drive incremental costs upward for many measures. More complex measures, such as fuel substitution may require a more sophisticated workforce, additional training, as well as increased installation and configuration time, compared to more static measures. This could result in increased incremental costs for these types of measures. As a result, costs may be highly variable, particularly as Liberty Utilities moves to more aggressive targets.

- **Investment Level:** Liberty Utilities will need to plan for significantly higher levels of investment in natural gas programs particularly for the CECP scenarios, and for mobilizing a significant increase in direct and indirect services to meet the increased level of demand for efficiency upgrades.

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7.2 Demand Response

The key observations from the gas DR analysis are:

- Gas DR is not cost-effective due to relatively low gas avoided costs for valuing gas DR using top 10-day value from AESC 2024.
- The analysis results presented potential for all DR options regardless of cost-effectiveness. If gas DR options were cost-effective, Residential customers could potentially contribute more than 70% of the savings from a combination of Direct Load Control of space heating and water heating and Behavioral DR. Large C&I customers could provide almost 25% of the total potential, and the remaining potential could be realized from Direct Load Control of small and medium C&I customers.

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Appendix A: Massachusetts 2025-2027 Potential Study Modeling Methodology

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Energy Efficiency and Energy Optimization

Guidehouse uses a custom-designed version of its DSM Potential tool – DSMSim™ – to estimate technical, economic, and achievable EE and EO potential using best practice methods that have been vetted with many other clients. DSMSim™ is a bottom-up technology diffusion and stock/flow tracking model implemented in a powerful, flexible, modeling platform that can readily deal with high degrees of dimensionality and the evolving needs of potential studies.

The DSMSim™ model has been widely used to forecast energy and demand potential across the United States and Canada and adheres to all the current best practices in the evaluation industry. Key features include:

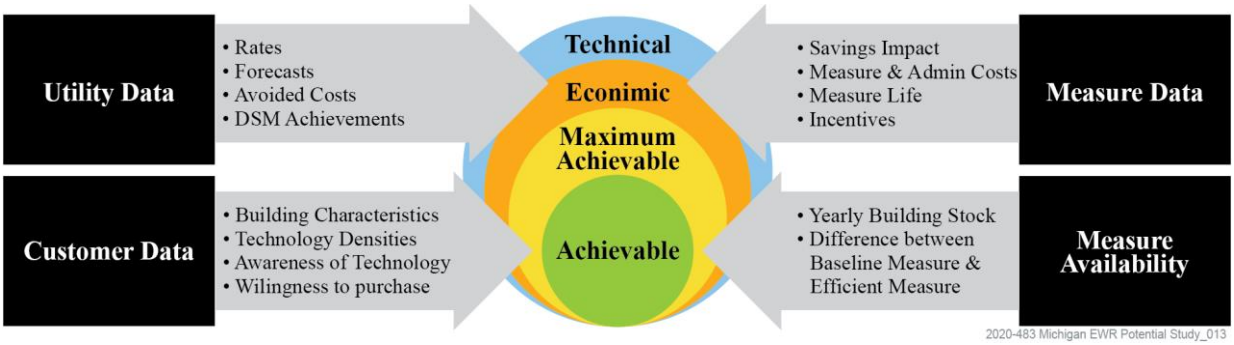
- Ability to accommodate standard or customized cost test protocols, such as those outlined in national standard practice manuals[1], as well as the Massachusetts PA benefit-cost tests defined in the PA's BCR models
- Ability to seamlessly assess sensitivities on avoided costs, retail rates, and load shape profiles, including the effects of seasonality and time of day
- Handles any number of measures, programs, sectors, program periods and savings types (electric energy/demand, gas, water, emissions, etc.)
- Accounting for three measure replacement types (i.e., retrofit, ROB, and new construction measures) and the effects of similar technologies competing for market share
- Results based on planned input assumptions (incentives, administrative costs, non-energy benefits, participation, etc.) can be compared against those derived from actual values after program implementation is finalized
- Can easily switch between net and gross savings and cost-effectiveness results
- Provides cost-effectiveness metrics at the measure, program, sector, portfolio, end-use or building type level, including combinations of these levels of granularity
- Powerful sensitivity and scenario analysis capability to identify key assumptions and largest leverage points
- Input data is imported from an Excel spreadsheet for portability, version control, and scenario analysis
- All summary results and intermediate calculations are immediately available in tabular or graphical form, in specified units, and can be exported to Excel

[1] E.g., the 2001 California Standard Practice Manual (CASPM); subsequent 2007 revision to the CASPM; 2017 National Standard Practice Manual by the National Efficiency Screening Project; etc.

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Guidehouse develops EE potential estimates starting with technical potential, followed by economic, and then finally achievable potential scenarios. Figure A-1 illustrates the key inputs and the layers of the potential modeling approach.

Figure A-1. Approach to Achievable Potential Analysis



Source: Guidehouse 2020

Developing Technical Potential

Technical potential is defined as the energy savings that can be achieved assuming that all installed measures can immediately be replaced with the efficient measure/technology, wherever technically feasible, regardless of the cost, market acceptance, or whether a measure has failed and must be replaced.

Guidehouse's modelling approach considers an energy-efficient measure to be any change made to a building, piece of equipment, process, or behaviour that could save energy or reduce emissions. The savings can be defined in numerous ways, depending on which method is most appropriate for a given measure.

The calculation of technical potential varies depending on the assumed measure replacement type, since technical potential is calculated on a per-measure basis and includes estimates of savings per unit, measure density (e.g., quantity of measures per home), and total building stock.

The potential forecast estimates the technical potential of energy and peak demand savings capable through energy efficiency annually, without consideration of any non-engineering constraints, and include all possible efficient measures, disregarding economic feasibility and market acceptance. Technical potential also considers how any anticipated future codes and standards will affect the baseline.

The DSMSim™ model accounts for three replacement types, where technical potential from **retrofit** and **replace-on-burnout** measures are calculated differently from technical potential for **new construction** measures. The formulae used to calculate technical potential by replacement type are discussed in the two subsections below.

Retrofit (RET) and Replace-On-Burnout (ROB) Measures

Retrofit (RET) measures, commonly referred to as advancement or early-retirement measures, are replacements of existing equipment before the equipment fails. RET measures can also be efficient processes that are not currently in place and that are not required for operational purposes. RET measures incur the full cost of implementation rather than incremental costs to some other baseline technology or process because the customer could choose not to replace the measure and would, therefore, incur no costs. In contrast, replace-on-burnout measures

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(ROB), sometimes referred to as lost-opportunity measures, are replacements of existing equipment that have failed and must be replaced, or existing processes that must be renewed. Because the failure of the existing measure requires a capital investment by the customer, the cost of implementing ROB measures is always incremental to the cost of a baseline (and less efficient) measure.

RET and ROB measures have a different meaning for technical potential compared with NEW measures. In any given year, the entire building stock is used for the calculation of technical potential. This method does not limit the calculated technical potential to any pre-assumed rate of adoption of retrofit measures. Existing building stock is reduced each year by the quantity of demolished building stock in that year and does not include new building stock that is added throughout the simulation.

For RET and ROB measures, annual potential is equal to total potential, thus offering an instantaneous view of technical potential. The equation used to calculate technical potential for retrofit measures is provided below.

Annual/Total Savings Potential = Existing Building Stock $_{YEAR}$ (e.g., number homes, 1000sqft of floorspace) X Measure Density (e.g., widgets/home) X Savings $_{YEAR}$ (e.g., first year kWh reduction per widget) X Technical Suitability (dimensionless)

New Construction (NEW) Measures

Similar to replace-on-burnout measures, the cost of implementing new measures is incremental to the cost of a baseline (and less efficient) measure. However, new construction technical potential is driven by equipment installations in new building stock rather than by equipment in existing building stock. New building stock is added to keep up with forecasted growth in total building stock and to replace existing stock that is demolished each year. Demolished (sometimes called replacement) stock is calculated as a percentage of existing stock in each year and can be specified to market conditions. New building stock (the sum of growth in building stock and replacement of demolished stock) determines the annual incremental additions to technical potential, which is then added to totals from previous years to calculate the total potential in any given year.

The equations used to calculate technical potential for new construction measures are provided below.

Annual Incremental Technical Potential (AITP): $AITP_{YEAR}$ = $New\ Stock_{YEAR}$ (e.g., homes/year) X Measure Density (e.g., widgets/home) X $Savings_{YEAR}$ (e.g., first year kWh reduction per widget) X Technical Suitability (dimensionless)

Total Technical Potential (TTP): $TTP_Y = \sum_{End\ Year}^{Start\ Year} AITPyear$

Competition Groups

The study defines competition as efficient measures competing for the same installation as opposed to competing for the same savings (e.g., window A/C vs. split-system A/C) or for the same budget (e.g., lighting vs. water heating). For instance, a consumer may install a condensing water heater or a tankless water heater; both of which belong to the same competition group, as only one of these would be installed. General characteristics of competing technologies used to define the competition groups proposed for this study include:

- Competing efficient technologies share the same baseline technology characteristics, including baseline technology densities, costs, and consumption

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- The total (baseline plus efficient) maximum densities of competing efficient technologies are the same

- Installation of competing technologies is mutually exclusive (i.e., installing one precludes installation of the others for that application)

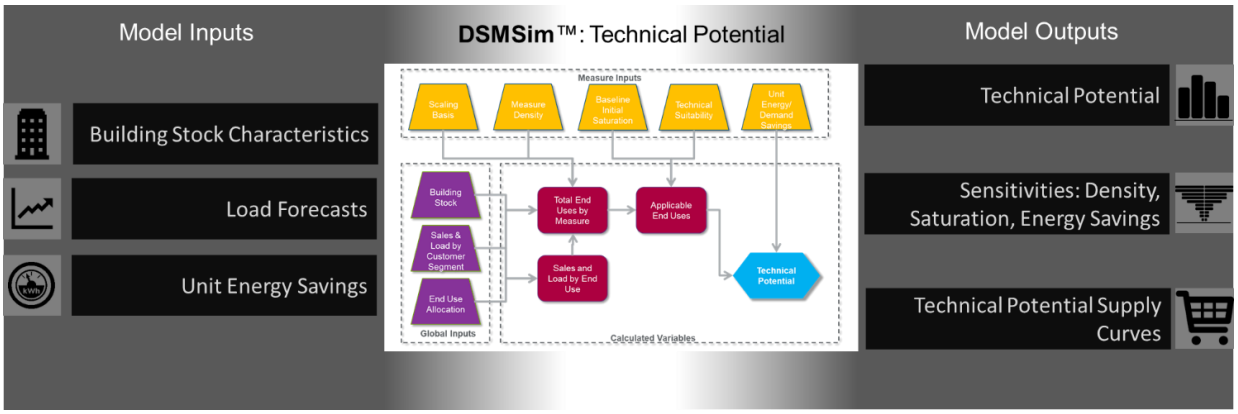
- Competing technologies share the same replacement type (RET, ROB, or NEW)

To address the overlapping nature of measures within a competition group, Guidehouse's analysis only selects one measure per competition group to include in the summation of technical potential across measures (i.e., at the end use, customer segment, sector, service territory, or total level). The measure with the largest first-year savings potential in a given competition group is used for calculating total technical potential of the competition group. This approach ensures that double counting is not present in the reported technical potential, though the technical potential for each individual measure is still calculated.

Technical Potential

For technical potential, the overall modelling framework is shown in Figure A-2. The chart identifies the data inputs, the resource potential module, and the specific output types provided from the various modules. Figure A-2 also summarizes the various dimensions of outputs produced from the potential model, including type of potential (technical) reported at various levels (sector, end use, etc.) and in certain units (kWh, kW, Dth, etc.).

Figure A-2. Guidehouse's Technical Potential Model Data Flow



Developing Economic Potential

Economic potential is a subset of technical potential and uses the same assumptions regarding immediate replacement as in technical potential. However, this only includes those measures that have passed the benefit-cost (B/C) tests chosen for measure screening. A measure with a B/C ratio greater than or equal to 1.0 is a measure that provides present value monetary benefits greater than or equal to its present value costs. If a measure's B/C meets or exceeds the threshold, it is included in the economic potential.

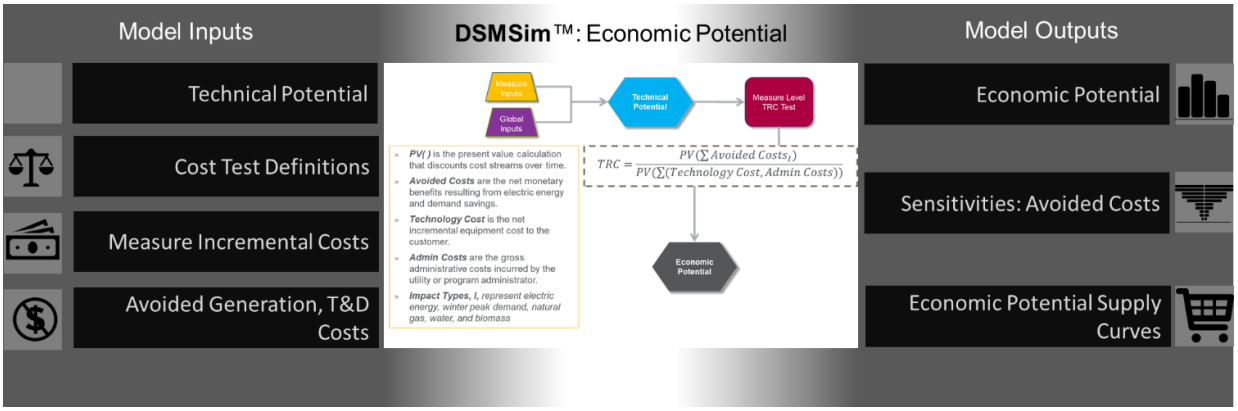
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DSMSim™ can calculate the five standard tests,[2] and use any of these tests for economic screening. It can also allow the economic potential threshold value to be adjusted (set at 1.0, or higher or lower). As with technical potential, Guidehouse recognizes codes and standards, replacement types, and competition groups in the development of economic potential.

Similar to technical potential, only one economic measure (meaning that its B/C ratio meets the threshold) from each competition group is included in the summation of economic potential across measures (e.g., at the end use, customer segment, sector, service territory or total level). If a competition group is composed of more than one measure that passes the TRC test, then the economic measure that provides the greatest first-year savings potential is included in the summation of economic potential. This approach checks that double counting is not present in the reported economic potential, though economic potential for each individual measure is still calculated.

Within DSMSim™, Massachusetts avoided cost forecasts and other financial inputs are used to apply cost-benefit screens for all measures considered in the technical potential analysis. Figure A-3 illustrates the overall economic potential modelling framework, with the resulting economic potential outputs outlined on the right-hand side. For Massachusetts, non-energy impacts (NEIs) are included as benefits in addition to avoided energy and demand costs where applicable.

Figure A-3. Guidehouse's Economic Potential Model Data Flow



Develop Achievable Potential

Achievable potential further reduces economic potential by considering the likely rate of efficient measure acquisition, which is driven by a number of factors including the rate of equipment turnover (a function of measure's lifetime), simulated incentive levels, budget constraints, consumer willingness to adopt efficient technologies, and the likely rate at which marketing activities can facilitate technology adoption. This section provides a high-level summary of the approach to calculating achievable potential, which is fundamentally more complex than calculation of technical or economic potential.

Achievable potential is further differentiated from technical and economic potential in the way that competition groups and cost-effectiveness screening are modelled. In achievable potential, each measure within a competition group may accrue savings in each year. The relative split of annual savings between measures within a competition group is a function of their comparative participant cost test (PACT) scores. Additionally, cost-effectiveness screening thresholds are relaxed at the measure level. A TRC screen of 0.8 is applied to most measures to allow for

2 The California Standard Practice Manual (CASPM) defines five standard cost tests for cost-benefit analysis: Participant Cost Test, Program Administrator Cost Test, Ratepayer Impact Measure Test, Total Resource Cost Test, and Societal Cost Test.

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certain non-cost-effective measures to be included in cost-effective programs and sectors in aggregate. Other measures may have no screening threshold as they are viewed as strategically important to the portfolio (e.g., certain fuel substitution measures). It is important to note that this may lead to long-run cumulative achievable potentials exceeding economic potentials in certain instances.

The critical first step in the process of accurately estimating achievable potential is to simulate market adoption of efficient measures. Annual program participation is modelled through technology adoption and diffusion algorithms. The long-run equilibrium market share[3] (i.e., how quickly a technology reaches final market saturation) is calculated by comparing a measure's payback period to a customer payback acceptance curve. Each measure's payback period is derived from subtracting the energy bill savings (retail rates multiplied by energy savings) and incentive from the measure's incremental participant cost. Guidehouse's model employs an enhanced Bass Diffusion model[4] to simulate the S-shaped growth toward equilibrium commonly seen for technology adoption. The Bass Diffusion model describes the process of the adoption of products as an interaction between users and potential users. In the model, achievable potential adopters "flow" to adopters by two primary mechanisms – adoption from external influences, such as marketing and advertising, and adoption from internal influences, such as word-of-mouth or peer-effects – with differences in stock turnover captured for replace-on-burnout measures relative to retrofit and new construction.

Guidehouse typically uses payback acceptance curves to estimate equilibrium market share. Payback acceptance curves have been developed in the past by presenting decision makers with numerous choices between technologies with low upfront costs but high annual energy costs, and measures with higher upfront costs but lower annual energy costs. Figure A-4 and Figure A-5 show payback acceptance curves for the potential study at the customer segment, split by low-cost and high-cost. Each curve represents the percentage of willing to purchase a technology based on its payback time. Separate curves were developed for high upfront cost and low upfront cost measures.

3 This term, although something of a misnomer due to the fact that the long run market share is dynamic, changing with building stocks, technology prices, and avoided costs for example, is used to describe the percentage of the market that would participate in a program if perfect information was available to the customer. As awareness of each measure increases, the market will move toward this point.

4 Bass, Frank (1969). "A new product growth model for consumer durables". Management Science 15 (5): pgs. 215–227.

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Figure A-4. Payback Acceptance Curves for High-Cost Measures

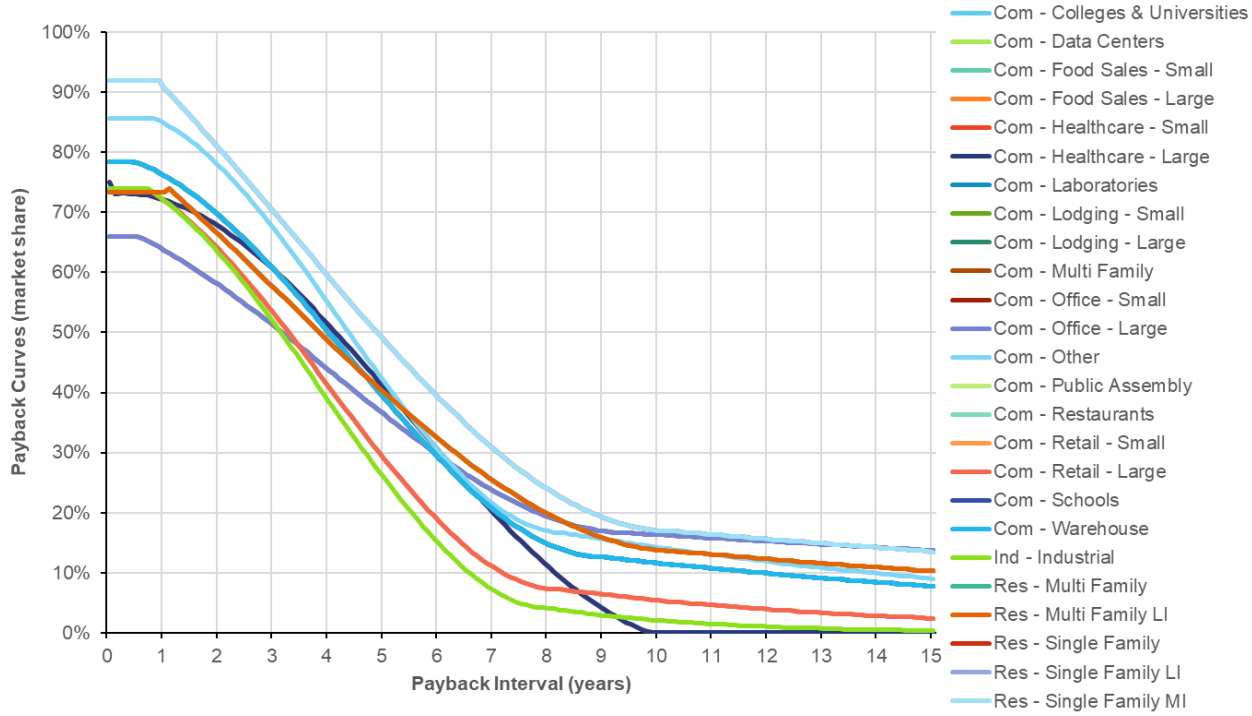
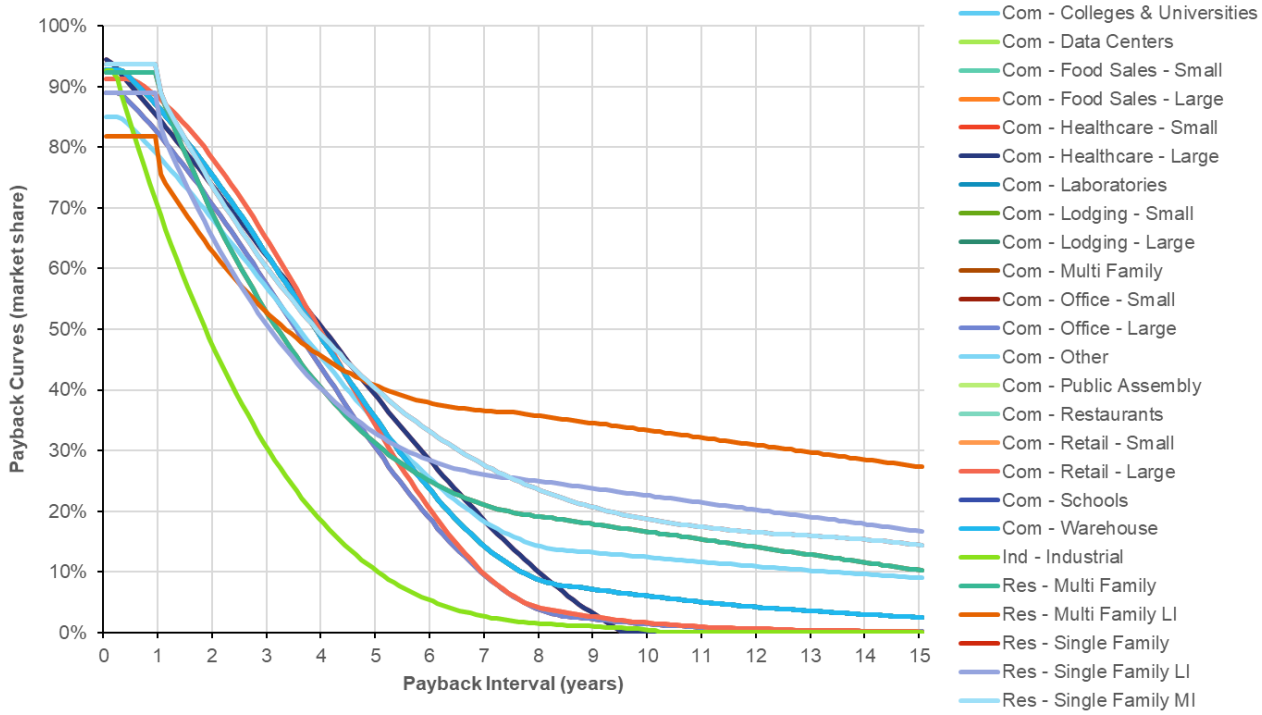


Figure A-5. Payback Acceptance Curves for Low-Cost Measures



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Since the payback time of a technology can change over time; as technology costs and/or energy costs change over time, the equilibrium market share can also change over time. The equilibrium market share is, therefore, recalculated for every time-step within the market simulation to make certain the dynamics of technology adoption considers this effect. As such, the term “equilibrium market share” is a bit of an oversimplification and a misnomer, as it can itself change over time and is, therefore, never truly in equilibrium; it is used nonetheless to facilitate understanding of the approach.

Calculation of the Approach to Equilibrium Market Share

Two approaches are used for calculating the approach to equilibrium market share (i.e., how quickly a technology reaches final market saturation): one for new technologies or those being modelled as a retrofit (a.k.a. discretionary) measures, and one for technologies simulated as ROB (a.k.a. lost opportunity) measures.

The retrofit and new technologies adoption approach uses an enhanced version of the classic Bass diffusion model to simulate the S-shaped approach to equilibrium that is commonly observed for technology adoption.

Figure A-6 provides a stock/flow diagram illustrating the causal influences underlying the Bass model. In this model, achievable potential adopters flow to adopters by two primary mechanisms: adoption from external influences, such as program marketing/advertising, and adoption from internal influences, including word-of-mouth. The fraction of the population willing to adopt is estimated using the payback acceptance curves in Figure A-4 and Figure A-5.

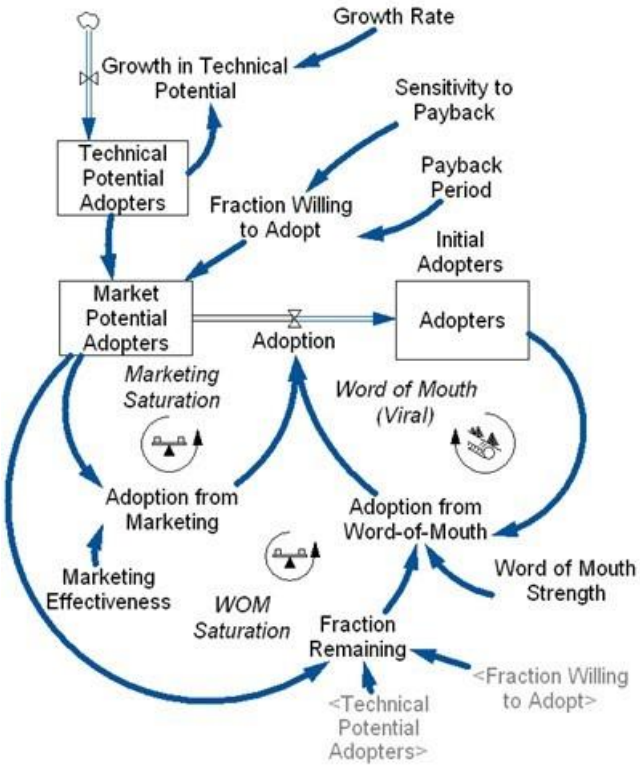


Figure A-6. Stock/Flow Diagram of Diffusion Model for New Products and Retrofits

The marketing effectiveness and external influence parameters for this diffusion model are typically estimated upon the results of case studies where these parameters were estimated for dozens of technologies. Recognition of the positive, or self-reinforcing, feedback generated by the word-of-mouth mechanism is evidenced by increasing discussion of the concepts such as social marketing as well as the term viral, which has been popularized and strengthened most recently by social networking sites such as Facebook and YouTube. However, the underlying positive feedback associated with this mechanism has been ever present and a part of the Bass diffusion model of product adoption since its inception in 1969.

The dynamics of adoption for the **ROB technologies adoption approach** is somewhat more complicated for new/retrofit technologies since it requires simulating the turnover of long-lived technology stocks. To account for this, the DSMSim™ model tracks the stock of all technologies and explicitly calculates technology retirements and additions consistent with the lifetime of the

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technologies. This approach considers the technology churn in the estimation of achievable potential, since only a fraction of the total stock of technologies are replaced each year, which affects how quickly technologies can be replaced. A model that endogenously generates growth in the familiarity of a technology, analogous to the Bass approach described above, is overlaid on the stock-tracking model to capture the dynamics associated with the diffusion of technology familiarity. A simplified version of the model employed in DSMSim™ is shown in Figure A-7.

Model Calibration

Another critical step in the process is the model calibration. We begin calibrating the model's marketing effectiveness and word-of-mouth parameters at the sector and end use level using PA historical program participation.

As noted, key inputs for the achievable potential assessment are payback acceptance curves that represent the percentage of customers from different sectors willing to purchase a technology based on the time it takes the technology to pay back the upfront cost through annual cost savings.

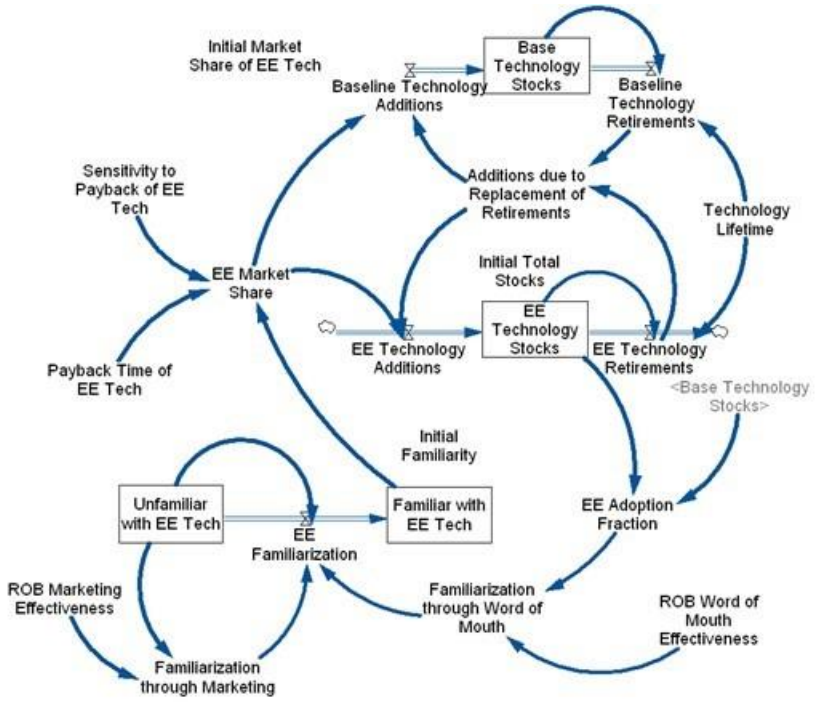


Figure A-7. Stock/Flow Diagram of Diffusion Model for Replace-on-Burnout Measures

Calibration of a predictive model imposes unique challenges, as future data is not available to compare against model predictions. While engineering models, for example, can often be calibrated to a high degree of accuracy since simulated performance can be compared directly with performance of actual hardware, predictive models do not have this luxury. **Demand-side management models, therefore, must rely on other techniques to provide both the developer and the recipient of model results with a level of comfort that simulated results are reasonable.** We take a number of steps to make sure that the initial, base year results used (2022) for the forecast model are reasonable and consider historic adoption, including:

- Comparing forecast values, by sector and end use, against historic achieved evaluated program savings for 2022 or given deployment forecasts (behavioral and fuel substitution). Although some studies indicate that demand-side management potential models are calibrated to check first-year simulated savings precisely equal to prior-year reported savings, we have found that forcing such precise agreement has the potential to introduce errors into the modeling process by effectively masking the explanation for differences—particularly when the measures included may vary significantly. Additionally, there may be sound reasons for first-year simulated savings to differ from prior-year reported savings (e.g., savings estimates have changed). Thus, we endeavor to achieve agreement to a degree that is reasonable between past results and forecast first-year results, within +/- 25% at the sector level with particular attention to end-uses

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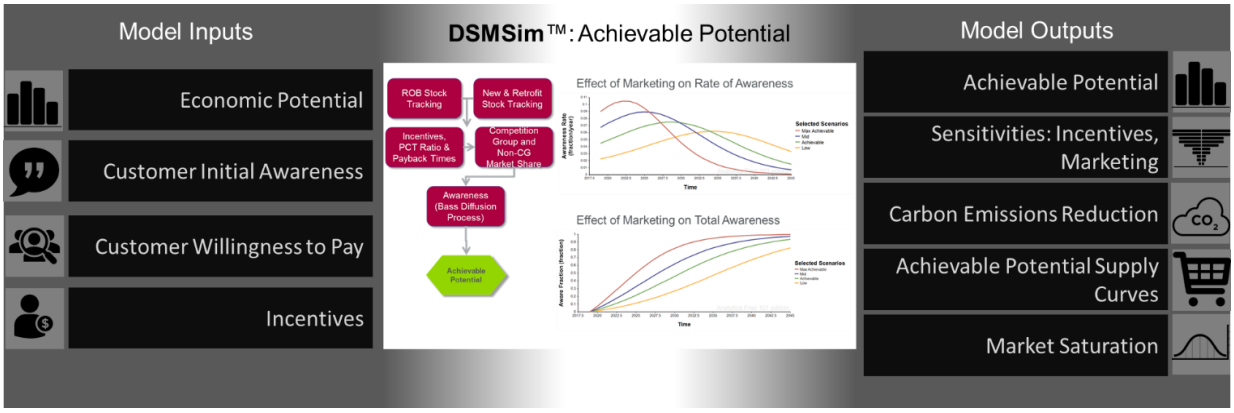
and top contributing measures for measures modeled in the study with historical program data.

- Identifying and ensuring an explanation existed for significant discrepancies between forecast savings and prior-year savings, recognizing that some ramp-up is expected, especially for new measures or archetype programs.

- Calculating total program spending by sector and end use and comparing the resulting values to historical program spending.

The overall achievable potential modelling framework is shown in Figure A-8. We draw on the results of the economic potential analysis (and any sensitivity parameters identified) to develop the achievable potential outputs in the manner outlined on the right-hand bar of Figure A-8.

Figure A-8. Guidehouse's Achievable Potential Model Data Flow



Guidehouse

Appendix B: Massachusetts 2025-2027 Potential Study Energy Efficiency Measure List

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Energy Efficiency and Electrification Measures

Guidehouse fully characterized approximately 100 gas energy efficiency (EE) and electrification measures across Residential, Income Eligible and Commercial & Industrial (C&I) sectors. This list was reviewed by the Energy Efficiency Advisory Council consultant team and a final consensus measure list was selected by the PAs. The following table contains the energy efficiency and electrification measures that were characterized.

The table includes the following columns:

- **Sector**: Residential & Income Eligible (Res & IE), Industrial, or Commercial
- **End Use**
- **Measure Name**
- **Primary Fuel Savings Type**: Natural Gas
- **Replacement Type**:
  - RET: Retrofit Add-On Equipment or Early Retirement/Accelerated Replacement
  - ROB: Replace-on-Burnout
  - NEW: New Construction
- **Measure Category**:
  - Fossil Fuel Efficiency: Measure that saves fossil fuel by replacing a fossil-fuel burning appliance or equipment with a more efficient fossil-fuel appliance or equipment. These measures were included for competition with electrification measures, but savings are not reported except in the Income Eligible sector.
  - Indirect Fossil Fuel Saving: Measure that saves fossil fuel indirectly, by causing an existing fossil fuel appliance or equipment to use less energy. Savings are reported for these measures. Examples include weatherization or controls.
  - Electrification: Measure that replaces fossil fuel equipment with electric equipment.
  - Custom: Commercial or Industrial Custom measure that was aggregated from the PAs' Custom program data in 2022, and could include multiple other measure categories.

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Table B-1. Energy Efficiency and Electrification Measures

Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Res & IE	Behavior	Home Energy Report[1]	Natural Gas	NEW	Indirect Fossil Fuel Saving
Res & IE	Behavior	Home Energy Report[1]	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Air Sealing	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Duct Insulation	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Duct Sealing	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Insulation	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Windows - Double to Triple Pane	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Windows - Single to Triple Pane	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Condensing Storage Water Heater	Natural Gas	ROB	Fossil Fuel Efficiency
Res & IE	Hot Water	Faucet Aerator	Natural Gas	NEW	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Faucet Aerator	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Heat Pump Water Heater Fuel Switch	Natural Gas	ROB	Electrification
Res & IE	Hot Water	Indirect Water Heater	Natural Gas	RET	Fossil Fuel Efficiency
Res & IE	Hot Water	Indirect Water Heater	Natural Gas	ROB	Fossil Fuel Efficiency
Res & IE	Hot Water	On Demand/Tankless Water Heater	Natural Gas	RET	Fossil Fuel Efficiency
Res & IE	Hot Water	On Demand/Tankless Water Heater	Natural Gas	ROB	Fossil Fuel Efficiency
Res & IE	Hot Water	Pipe Wrap (Water Heating)	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Showerhead	Natural Gas	NEW	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Showerhead	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Storage Water Heater	Natural Gas	RET	Fossil Fuel Efficiency
Res & IE	Hot Water	Storage Water Heater	Natural Gas	ROB	Fossil Fuel Efficiency
Res & IE	Hot Water	Thermostatic Valve	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Air-to-Water Heat Pumps Displacing Gas	Natural Gas	ROB	Electrification
Res & IE	HVAC	Boiler Reset Control	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Central Air Source Heat Pump Fully Replacing Gas Furnace	Natural Gas	ROB	Electrification

[1] Measure was characterized, but no savings reported because the PA is not planning to offer this measure in the future.

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Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Res & IE	HVAC	Central Air Source Heat Pump Partially Displacing Gas Furnace[2]	Natural Gas	RET	Electrification
Res & IE	HVAC	Ductless Mini-Split Heat Pump Fully Replacing Gas Boiler	Natural Gas	ROB	Electrification
Res & IE	HVAC	Ductless Mini-Split Heat Pump Partially Displacing Gas Boiler[2]	Natural Gas	RET	Electrification
Res & IE	HVAC	Forced Hot Water Boiler	Natural Gas	RET	Fossil Fuel Efficiency
Res & IE	HVAC	Forced Hot Water Boiler	Natural Gas	ROB	Fossil Fuel Efficiency
Res & IE	HVAC	Furnace	Natural Gas	RET	Fossil Fuel Efficiency
Res & IE	HVAC	Furnace	Natural Gas	ROB	Fossil Fuel Efficiency
Res & IE	HVAC	Heat Recovery Ventilator	Natural Gas	ROB	Indirect Fossil Fuel Saving
Res & IE	HVAC	Manual Thermostat to Programmable Thermostat	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Manual Thermostat to Wi-Fi Thermostat	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Pipe Wrap (Space Heating)	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Programmable Thermostat to Wi-Fi Thermostat	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Water-to-Air Ground Source Heat Pump Displacing Gas	Natural Gas	ROB	Electrification
Res & IE	HVAC	Wi-Fi Thermostat	Natural Gas	NEW	Indirect Fossil Fuel Saving
Res & IE	Plug Load	Induction Stove Fuel Switch	Natural Gas	ROB	Electrification
Res & IE	Whole Home	All-Electric Passive House[3]	Natural Gas	NEW	Electrification
Res & IE	Whole Home	New Construction Energy Efficiency[4]	Natural Gas	NEW	Fossil Fuel Efficiency
Industrial	Custom	Custom Large C&I	Natural Gas	RET	Custom
Industrial	Custom	Custom Large C&I	Natural Gas	ROB	Custom
Industrial	Custom	Custom New Construction	Natural Gas	NEW	Custom

[2] For Residential and Income Eligible HVAC electrification measures, partial displacement measures were characterized as retrofits while full displacement measures were characterized as replace-on-burnout. This was done to align with customers' likely adoption patterns.

[3] This measure was characterized but not included in results. Per PA guidance, the baseline for Residential Whole Home Electrification measure was considered to be propane.

[4] This measure was characterized but not included in results. Per PA guidance, Residential Whole Home New Construction fossil fuel energy efficiency savings are not included in the results for any customers, whether or not they are Income Eligible.

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Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Industrial	Hot Water	Steam Trap	Natural Gas	RET	Indirect Fossil Fuel Saving
Industrial	HVAC	Boiler Reset Control	Natural Gas	RET	Indirect Fossil Fuel Saving
Industrial	HVAC	Condensing Boiler	Natural Gas	ROB	Fossil Fuel Efficiency
Industrial	HVAC	Energy Management System	Natural Gas	NEW	Indirect Fossil Fuel Saving
Industrial	HVAC	Energy Management System	Natural Gas	RET	Indirect Fossil Fuel Saving
Industrial	Process	Industrial Process Electrification - High Heat[5]	Natural Gas	RET	Electrification
Industrial	Process	Industrial Process Electrification - Low Heat	Natural Gas	RET	Electrification
Industrial	Process	Industrial Process Electrification - Medium Heat	Natural Gas	RET	Electrification
Commercial	Behavior	Building Operator Certification	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Custom	Custom - Res End Use	Natural Gas	ROB	Custom
Commercial	Custom	Custom Large C&I	Natural Gas	RET	Custom
Commercial	Custom	Custom Large C&I	Natural Gas	ROB	Custom
Commercial	Custom	Custom New Construction	Natural Gas	NEW	Custom
Commercial	Envelope	Air Sealing	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Envelope	Air Sealing - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Envelope	Insulation	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Envelope	Insulation - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Food Service	Induction Cooktop Displacing Gas	Natural Gas	ROB	Electrification
Commercial	Hot Water	Condensing Storage Water Heater	Natural Gas	ROB	Fossil Fuel Efficiency
Commercial	Hot Water	Faucet Aerator	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Faucet Aerator	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Faucet Aerator - Res End Use	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Faucet Aerator - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Heat Pump Water Heater Displacing Gas	Natural Gas	ROB	Electrification
Commercial	Hot Water	High Speed Clothes Washer	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead	Natural Gas	NEW	Indirect Fossil Fuel Saving

[5] This measure was characterized but not included in results because it caused a net increase in CO_2 emissions. This was due to the relative inefficiency of the electric equipment required to replace natural gas for high heat industrial applications.

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Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Commercial	Hot Water	Low-Flow Showerhead	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead - Res End Use	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead With Thermostatic Valve - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pipe Wrap (Water Heating)	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pipe Wrap (Water Heating)	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pipe Wrap (Water Heating) - Res End Use	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pipe Wrap (Water Heating) - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pre-Rinse Spray Valve	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pre-Rinse Spray Valve	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Steam Trap	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Volume Water Heater	Natural Gas	ROB	Fossil Fuel Efficiency
Commercial	HVAC	Boiler Reset Control	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Boiler to Air Source Heat Pump	Natural Gas	ROB	Electrification
Commercial	HVAC	Central Air Source Heat Pump (Split or Packaged)	Natural Gas	ROB	Electrification
Commercial	HVAC	Commercial HVAC Tune-up	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Commissioning/Retrocommissioning	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Condensing Boiler	Natural Gas	ROB	Fossil Fuel Efficiency
Commercial	HVAC	Demand Control Ventilation	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Duct Insulation	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Duct Insulation - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Duct Sealing	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Duct Sealing - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Ductless Heat Pump	Natural Gas	ROB	Electrification
Commercial	HVAC	Energy Management System	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	HVAC	Energy Management System	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Furnace	Natural Gas	ROB	Fossil Fuel Efficiency
Commercial	HVAC	Gas Roof Top Unit to Air Source Heat Pump	Natural Gas	ROB	Electrification

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Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Commercial	HVAC	Gas Roof Top Unit to Variable Refrigerant Flow System	Natural Gas	ROB	Electrification
Commercial	HVAC	Ground Source Heat Pump (Water-to-Air)	Natural Gas	ROB	Electrification
Commercial	HVAC	Ground Source Heat Pump (Water-to-Water)	Natural Gas	ROB	Electrification
Commercial	HVAC	Programmable Thermostat	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Programmable Thermostat - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Strategic Energy Management	Natural Gas	ROB	Indirect Fossil Fuel Saving
Commercial	HVAC	Variable Refrigerant Flow Heat Pump	Natural Gas	ROB	Electrification
Commercial	HVAC	Wi-Fi Thermostat	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	HVAC	Wi-Fi Thermostat	Natural Gas	RET	Indirect Fossil Fuel Saving

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