Guidehouse

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

Final Report

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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
BEV	Battery Electric Vehicle
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
EV	Electric Vehicle
FTE	Full-Time Equivalent
HVAC	Heating, Ventilation, and Air Conditioning
IT	Information Technology
LLLC	Luminaire Level Lighting Control
IE	Income Eligible

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Common Acronyms, continued

MAX	Maximum Achievable Scenario (Demand Response Only)
MI	Moderate Income
NAICS	North American Industry Classification System
NEI	Non-Energy Impact
NEW	New Construction
NPV	Net Present Value
NTG	Net-to-Gross
O&M	Operations and Maintenance
PA	Program Administrator
PHEV	Plug-in Hybrid Electric Vehicle
PNNL	Pacific Northwest National Laboratory
PV	Present Value
QC	Quality Control or Quality Control Check
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

Cape Light Compact (CLC) 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 (EE), electrification (also called fuel substitution or fuel switching), 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 CLC's 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 CLC in Massachusetts. For DR, DRSim calculates achievable potential estimates across Cape Light Compact's 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 energy efficiency and demand response.
- **Clean Energy and Climate Plan Program (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.

[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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- **Maximum Achievable (MAX):** For Demand Response only, instead of the CECP scenarios, which assumes higher participation in DR programs in association with higher levels of incentive offers.

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 electric and natural gas energy efficiency and summer 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 Cape Light Compact 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

[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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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 Cape Light Compact's primary intended purposes for 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, natural gas, fuel oil and propane savings) 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 following the five-step process outlined for EE. Guidehouse used both primary data from Cape Light Compact and relevant secondary sources for this analysis, as documented in this report. The DR market and measure characterization efforts provide input data to Guidehouse's Demand Response Simulator model (DRSim), which estimates potential and costs, and assesses the cost-effectiveness of DR options.

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 of DR options and suboptions.
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; these technologies represent those that Cape

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Light Compact currently offers or could offer in the future. 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.

Guidehouse fed these inputs into the DRSim tool and assessed the cost-effectiveness of DR options and developed achievable potential and annual cost estimates, as well as levelized costs and supply curves for the different DR options. 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 steadily increasing total achievable potential across the three years of the study. Electricity savings decline in the CECP scenarios, because of the high amounts of electrification. Consequently, total CECP scenario electricity savings over the three years are approximately the same as the BAE scenario but deliver between two and three times the MMBtu and 2030 Carbon savings as BAE. For both CECP scenarios, due to the assumption of equal numbers of installations to achieve expected greenhouse gas reduction targets, energy and greenhouse gas savings are identical.

In the Department of Public Utilities' January 11, 2023, approval order for the Cape Light Compact's Cape & Vineyard Electrification Offering, the Department required the Compact to conduct a third-party study on its remaining potential for serving low-income (i.e., "Income Eligible") customers.[4] Section 4.3 and Section 6.2 of this study consider energy efficiency and demand response potential, respectively, for the Compact's Income Eligible customers. The following are high-level observations regarding the Compact's remaining ability to serve Income Eligible customers:

- For energy efficiency, which includes fuel switching, Income Eligible potential is the smallest among the three sectors, comprising about 2% of the achievable BAE potential over the three-year period, and about 7% of the budget.
- The Income Eligible measures with the greatest potential lifetime savings are electric resistance baseboard to ductless minisplit heat pump conversions and insulation.

[4] Cape Light Compact JPE, D.P.U. 22-137 at 43 (2023)

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Central heat pumps, window retrofits, and advanced power strips round out the top five measures (see Figure 4-4).

- For Demand Response, potential for Income Eligible was studied together with Residential, so there is no way to isolate the IE results from Residential combined with IE.

Table ES-1. Energy Efficiency BAE Scenario Net Achievable Potential, CLC Electric

Sector, by Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
Residential Sector					
2025	3,730	440	137,600	2,511,000	8,960
2026	4,050	580	166,900	3,036,000	11,140
2027	3,840	700	182,500	3,306,000	12,560
Income Eligible Sector					
2025	220	-10	7,100	134,000	440
2026	180	0	7,700	144,000	500
2027	140	10	8,200	152,000	550
Commercial & Industrial Sector					
2025	4,410	540	31,300	321,000	850
2026	4,860	600	33,900	351,000	940
2027	5,250	670	36,100	376,000	1,010
Portfolio Total					
2025	8,360	970	176,000	2,966,000	10,250
2026	9,090	1,180	208,500	3,531,000	12,580
2027	9,230	1,380	226,800	3,834,000	14,120

Source: Guidehouse

Table ES-2. Energy Efficiency CECP Scenario Net Achievable Potential, CLC Electric

Sector, by Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
Residential Sector					
2025	-880	1,390	356,100	6,942,000	28,140
2026	-1,790	1,610	390,100	7,580,000	31,140
2027	-2,520	1,690	378,400	7,313,000	30,620
Income Eligible Sector					
2025	180	50	18,600	354,000	1,340
2026	140	30	19,700	373,000	1,440
2027	100	40	18,600	351,000	1,380
Commercial & Industrial Sector					
2025	6,460	730	45,400	493,000	1,300
2026	7,030	820	48,600	530,000	1,420
2027	7,410	900	50,600	550,000	1,490
Portfolio Total					
2025	5,760	2,170	420,100	7,789,000	30,780
2026	5,380	2,460	458,400	8,483,000	34,000
2027	4,990	2,630	447,600	8,214,000	33,490

Source: Guidehouse

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Table ES-3. Energy Efficiency CECP Cost Premium Scenario Net Achievable Potential, CLC Electric

Sector, by Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
Residential Sector					
2025	-880	1,390	356,100	6,942,000	28,140
2026	-1,790	1,610	390,100	7,580,000	31,140
2027	-2,520	1,690	378,400	7,313,000	30,620
Income Eligible Sector					
2025	180	50	18,600	354,000	1,340
2026	140	30	19,700	373,000	1,440
2027	100	40	18,600	351,000	1,380
Commercial & Industrial Sector					
2025	6,460	730	45,400	493,000	1,300
2026	7,030	820	48,600	530,000	1,420
2027	7,410	900	50,600	550,000	1,490
Portfolio Total					
2025	5,760	2,170	420,100	7,789,000	30,780
2026	5,380	2,460	458,400	8,483,000	34,000
2027	4,990	2,630	447,600	8,214,000	33,490

Source: Guidehouse

Energy Efficiency Program Costs

Table ES-4 shows CLC's projected EE portfolio investments over the study period and across scenarios. The comparison across the scenarios indicates the CECP scenario would cost about four times as much as the BAE scenario, while the CECP Cost Premium scenario would cost almost six times as much as BAE over the three-year term.

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

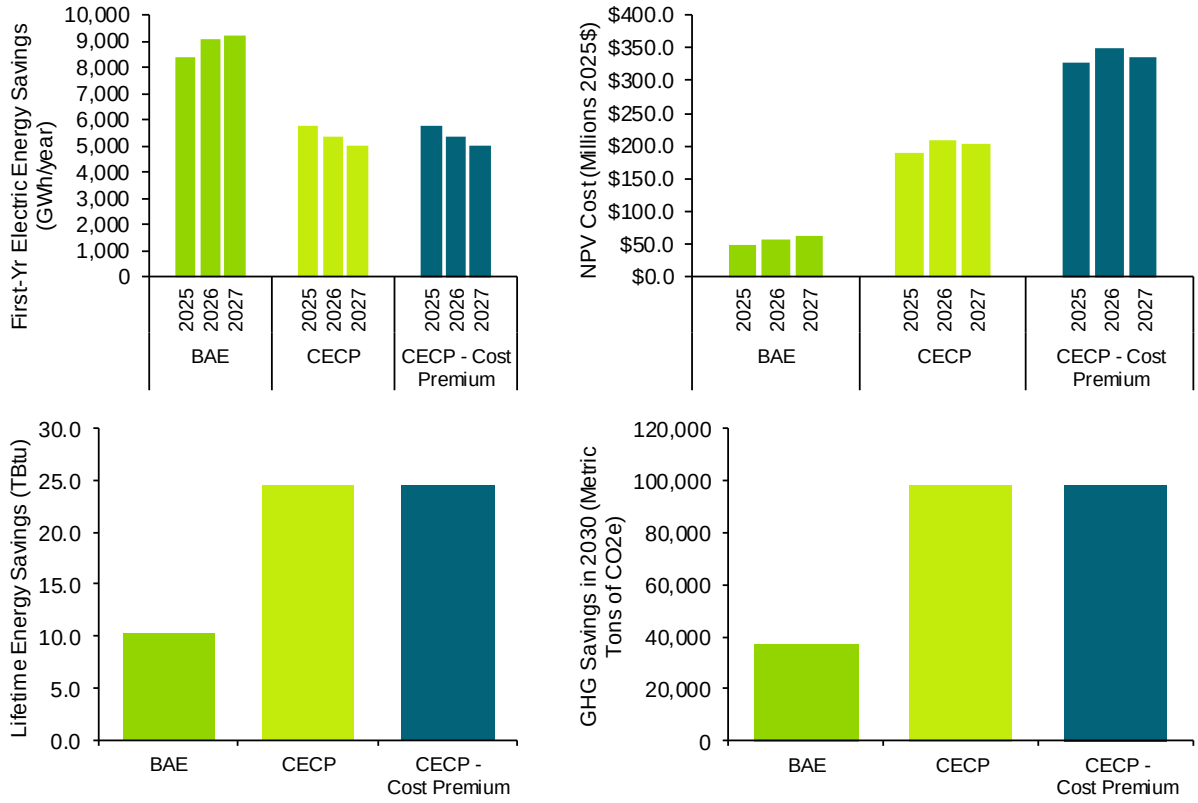
Install Year	BAE	CECP	CECP Cost Premium
2025	$49,010,000	$189,830,000	$326,120,000
2026	$57,940,000	$208,780,000	$350,440,000
2027	$61,510,000	$204,430,000	$334,700,000
Total	**$168,460,000**	**$603,040,000**	**$1,011,260,000**

Source: Guidehouse

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Figure ES-1 compares the overall electric achievable potential in cumulative annual GWh, 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. These figures graphically show the results discussed above.

Figure ES-1. Scenario Comparison, CLC Electric



Source: Guidehouse

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Demand Response Potential Results

Table ES-5 summarizes DR achievable potential for each of the two scenarios, for each year of the analysis and in total over the 3-year period (2025-2027), by sector. Both summer and winter DR increase in the BAE scenario, with winter DR increasing at a faster rate than summer DR. The MAX scenario potential is approximately 15% greater than the BAE potential for both seasons.

Table ES-5. BAE and MAX Scenarios Demand Response Achievable Potential, Electricity (Net at Meter)

Sector and Year	Summer DR BAE Scenario Annual MW	Winter DR BAE Scenario Annual MW	Summer DR MAX Scenario Annual MW	Winter DR MAX Scenario Annual MW
Residential Sector				
2025	3.1	1.1	3.5	1.6
2026	3.9	1.7	4.5	2.2
2027	4.9	2.4	5.5	2.8
Commercial & Industrial Sector				
2025	1.4	1.2	1.6	1.4
2026	1.7	1.6	2.0	1.8
2027	2.1	2.0	2.5	2.3
Portfolio Total				
2025	4.5	2.3	5.1	3.0
2026	5.6	3.2	6.5	4.0
2027	7.0	4.4	8.0	5.1

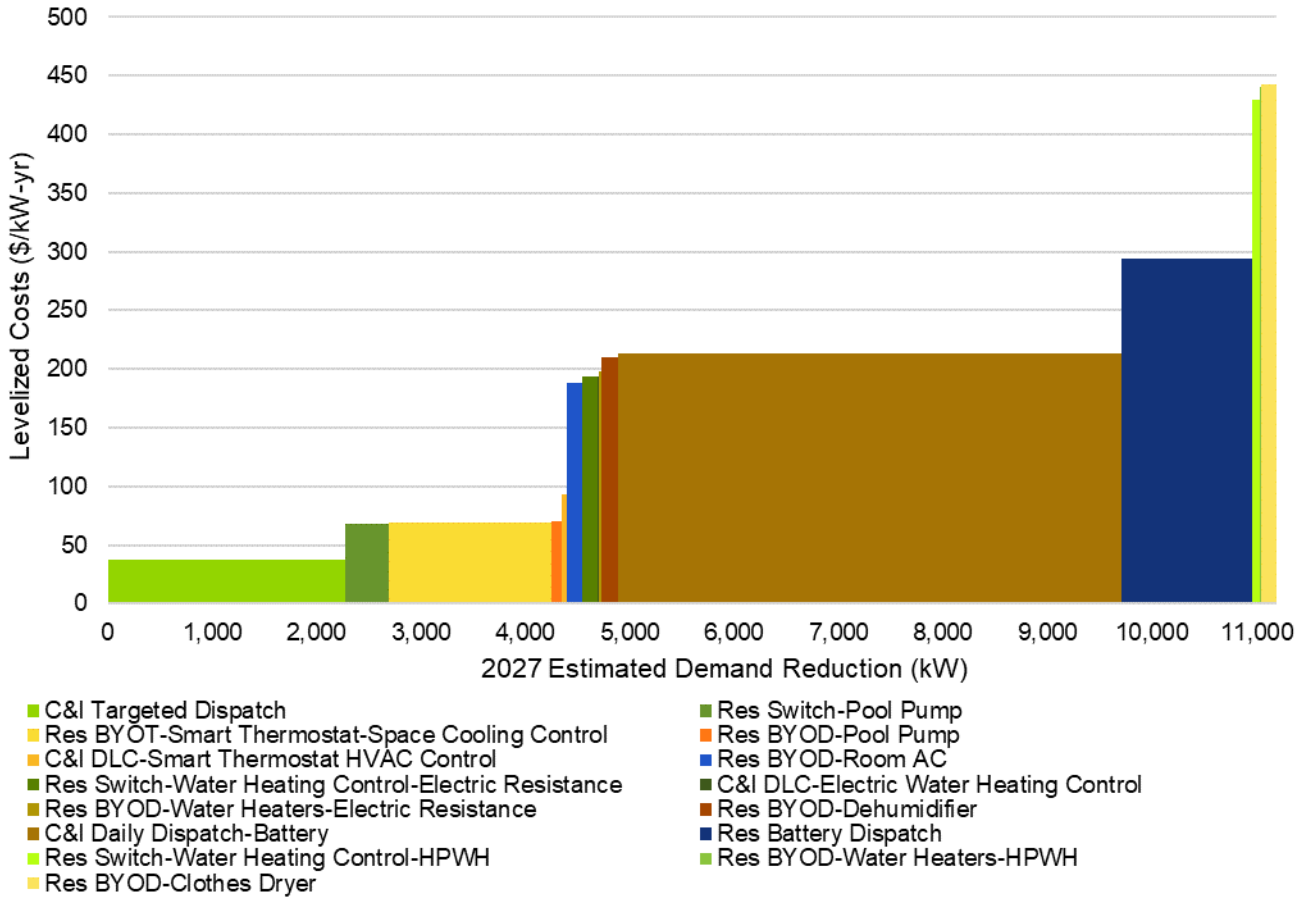
Source: Guidehouse

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Demand Response Supply Curve

Figure ES-2 shows the supply curve for all DR suboptions. The x-axis represents achievable potential in 2027 and the y-axis represents the levelized incentive cost ($/kW-yr.) associated with realizing the potential.[5] The C&I Targeted Dispatch suboption from large C&I customers has the least cost. Other significant contributors at higher costs are C&I Daily Dispatch-Battery and Residential BYOT and Res-Battery Dispatch suboptions.

Figure ES-2. Supply Curve for All Demand Response Suboptions



Source: Guidehouse

Demand Response Scenario Analysis

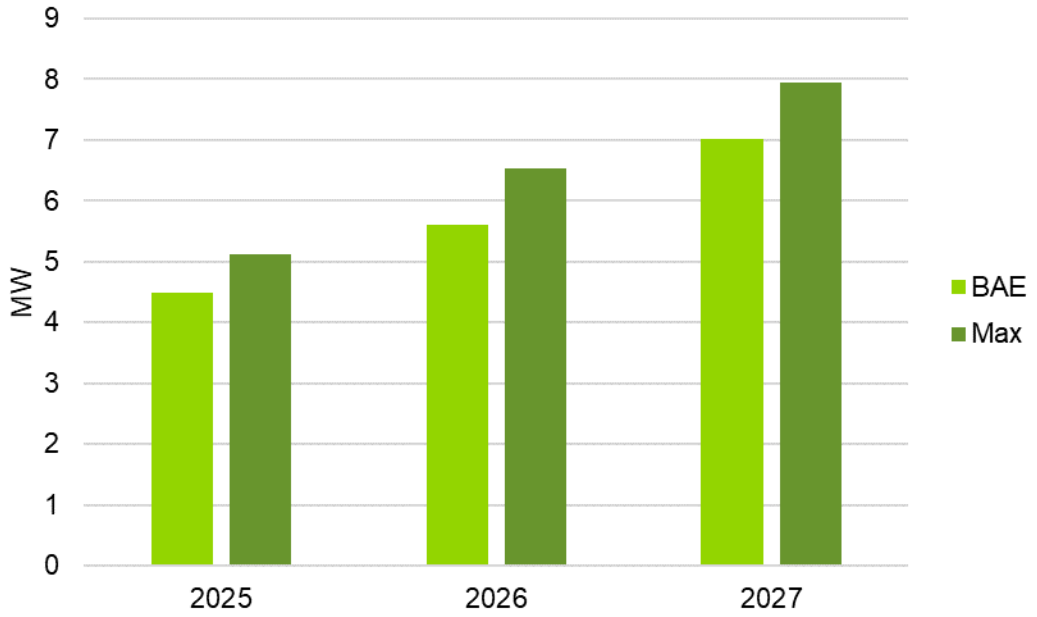
For the MAX case, Guidehouse adjusted assumed participation levels and incentive amounts to determine the impacts on the DR achievable potential.

[5] The non-incentive costs are represented in aggregate at the sector level, not by individual suboption, and are presented in Section 6.3

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Figure ES-3 compares the overall summer electricity achievable potential for all sectors between the BAE and MAX scenarios.

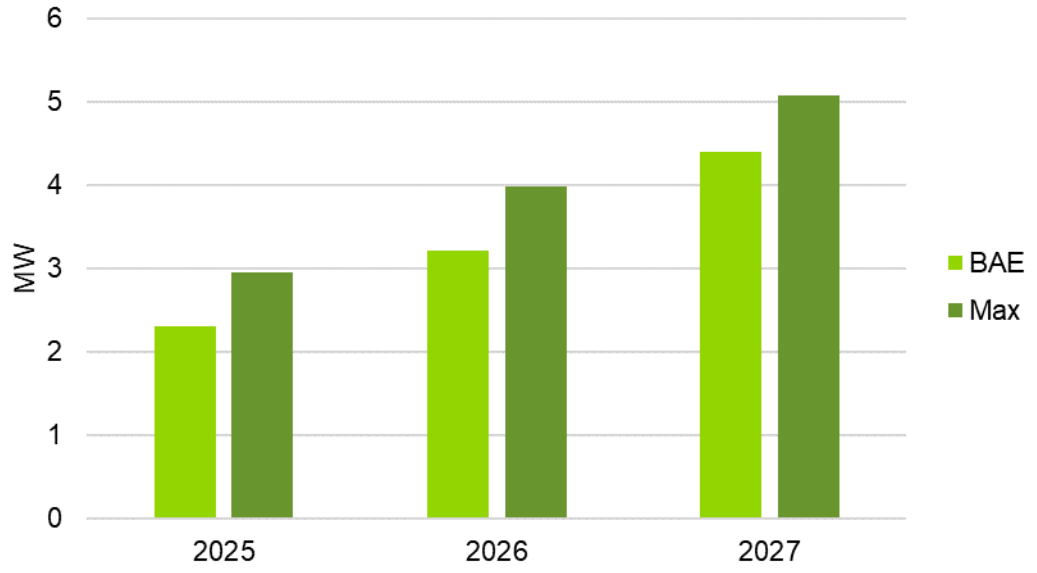
Figure ES-3. Summer Electric Demand Response Achievable Potential by Scenario



Source: Guidehouse

Figure ES-4 compares the overall winter electric achievable potential for all sectors between the BAE and MAX scenarios.

Figure ES-4. Winter Electric Demand Response Achievable Potential by Scenario



Source: Guidehouse

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Table ES-6 shows the DR electricity portfolio costs over the study period and across the two scenarios. Both C&I and Residential costs follow the trend for the demand reduction potential, though costs scale at a higher rate than potential. For C&I, costs are higher for the MAX scenario due to higher incentives paid to customers and higher enrollment. Residential costs follow the same trend as DR potential forecasts, with the MAX scenario having the highest costs.

Table ES-6. Demand Response BAE and Max Scenarios Electric Portfolio Costs

DR Portfolio Cost	Summer DR BAE Scenario	Winter DR BAE Scenario	Summer DR MAX Scenario	Winter DR MAX Scenario
2025	$1,497,000	$311,000	$2,702,000	$534,000
2026	$1,915,000	$489,000	$3,279,000	$677,000
2027	$2,452,000	$696,000	$3,966,000	$835,000
Total	**$5,864,000**	**$1,497,000**	**$9,947,000**	**$2,046,000**

Source: Guidehouse

Conclusions

This study uses the most recently available information on CLC and the Massachusetts customer base and state-of-the-art modeling to develop the potential for energy, demand, and CO_2e reductions possible through energy efficiency and demand response programs and initiatives during the forthcoming 2025-2027 term. While much energy efficiency and demand response potential remains, 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-7 compares BAE annual potential for 2025 as identified in this study to 2022 actual achievements for energy efficiency and 2022 base loads; Table ES-8 compares BAE costs to the 2022-2024 PA costs (excluding customer costs).

Table ES-7. Comparison of BAE Potential to Recent Experience, CLC Electric

	2025 Potential	2022 Actual Achievements	2022 Load
Energy Efficiency (Annual GWh)	8.36	9	1,970
Energy Efficiency (Annual MMBtu)	176,000	153,307	NA
Summer Demand (Annual Passive MW)	0.97	1.47	536

Source: Guidehouse and MassSaveData.com

Table ES-8. Comparison of PA Costs for Three Year Period

	2025-2027 BAE	2022-2024 Plan
Electric - CLC	$168,460,000	$193,604,311

Source: Guidehouse and MassSaveData.com

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Energy Efficiency

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

- **BAE Energy Efficiency:** As savings from lighting continues to decline, cost-effective energy efficiency potential is available from weatherization, heat pumps, and C&I Custom measures. There is a sharp drop off of achievable potential even within the top ten measures, which could guide CLC's program implementation efforts. Overall, potential annual net GWh savings are less than 2022 actual savings, but MMBtu impacts across all fuels are greater, reflecting the impact of increased electrification.

- **Carbon:** The primary source of carbon reduction in 2030 from achievable potential in 2025 through 2027 is from fuel substitution measures, in particular oil heating to heat pump conversions, and weatherization measures, in particular insulation and air sealing.

- **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 of the CECP scenarios is four to six times greater than the BAE scenario cost. However, all programs and sectors remain cost effective in both scenarios.

- **Key Drivers:** Major drivers of BAE potential were measure eligibility, carbon benefits, Cape Light Compact'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 for 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 Cape Light Compact should be aware of the factors as it develops its plans.

    - **Past Program Achievements:** Notably, Cape Light Compact 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 controls and 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

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increased incremental costs for these types of measures. As a result, costs may be highly variable, particularly as CLC moves to more aggressive targets.

- **Investment Level:** Cape Light Compact will need to plan for significantly higher levels of investment in electricity 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 and electrification.

Demand Response

The following are high-level observations regarding the projections for demand response potential:

- **Growth in DR Potential:** Building off Cape Light Compact's existing experience with DR, the summer demand response potential in Cape Light Compact's Massachusetts service territory is estimated to grow from ~4.5 MW to ~7 MW over 2025-2027. This increase in savings is primarily driven by steady growth in battery adoption and utilization for DR dispatch, over the 3-year timeframe.
    - **Large Residential Contribution in Total Potential:** Residential customers have the highest share in the total potential, which increases by 60% from 2025-2027. Most of this comes from the Res DLC-Electric option.
    - **Battery Potential Growth:** Due to the high incentives for battery participation in demand response, potential from battery dispatch is estimated to grow steadily in Residential and C&I sectors.[6]
    - **Residential Thermostat Program Growth and Contribution:** The potential from Residential HVAC control via smart thermostats (BYOT program) is estimated to grow as the program progressively scales up over time.
- **Cost-Effectiveness across Scenarios:** The Res DLC-Electric option, which is the largest contributor, remains cost-effective in the MAX scenarios. Similarly, most options remain cost-effective across all scenarios.

[6] The battery DR MW estimates were calibrated to the evaluated and Plan BC model values for 2022-2024 and the growth trend from years with existing data was used to project enrollment for 2025-2027.

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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 cited by ACEEE as being "robust and transparent… [and] their methodology for forecasting participation is industry standard best-practice."[7]

As is typical in the development of such studies, Guidehouse worked collaboratively with Cape Light Compact and its stakeholders to ensure the study, to the fullest extent, best reflects current Massachusetts market conditions. Guidehouse received considerable guidance and feedback from Cape Light Compact 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.

1.1 Context and Study Goals

Guidehouse was retained by the energy efficiency Program Administrators (PAs) of Massachusetts[8] to develop an estimate of the potential for electric energy efficiency (EE) and demand response (DR) in Massachusetts during the 3-year timeframe covering the period 2025 to 2027. Guidehouse worked with Cape Light Compact 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 energy efficiency and demand response 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 Cape Light Compact in Massachusetts. Table 1-1 summarizes the various elements of the project scope.

Table 1-1. Summary of Project Scope

Element	Dimensions
Forms of Energy	Electricity, Propane, Fuel Oil, Natural gas (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)

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

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

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1.2 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 Cape Light Compact 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. Cape Light Compact 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.

1.3 Caveats and Limitations

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

1.3.1 Program Design

The results of this study provide the savings potential for Cape Light Compact 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.

1.3.2 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.

1.4 Interpreting Results

This report includes a high-level account of savings potential results for Cape Light Compact 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. Demand Response potential is estimated using a bottom-up analysis, with primary data from Cape Light Compact 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, fuel oil, propane, motor gasoline, 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

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presented as adjusted gross savings, in other words, with all impact factors applied but without 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 of 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 electricity, natural gas, oil, and propane 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 natural gas in a few locations, even though CLC 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.[9] 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.

1.5 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 electricity 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 **Assessment of PV Codelivery** of Solar Photovoltaic systems with Energy Efficiency.
- Section 8 presents the **Conclusions** of the study.

[9] Income Eligible budgets are projected irrespective of the statutory allocation of 10% of the electric 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 and electricity demand 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.[10] Multifamily buildings with five or more units are included in the C&I building stock in the Commercial - Multifamily segment.[11] 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 source used for determining Residential building stocks was delivered to Guidehouse by the PAs. Data included total electric 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. Propane and fuel oil potential were scaled based on the electric service territory stocks.

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.

[10] 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.

[11] 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. Base Year (2022) Housing Stocks (Residential and Income Eligible Units)

Housing Type	Electricity
Multifamily	3,980
Multifamily Income Eligible (IE)	534
Single Family	140,022
Single Family Income Eligible (IE)	7,301
Single Family Moderate Income (MI)	28,775
Total	**180,613**

Source: Guidehouse based on Cape Light Compact 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 both electricity and delivered fuels.

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 electric 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 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. Propane and fuel oil potential were scaled based on the electric service territory stocks.

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.

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

Customer Segment	Electricity Floorspace (1,000 sq. ft.)
Colleges & Universities	3,826
Schools	1,226
Other	17,879
Data Centers	20
Laboratories	1,857
Food Sales - Small	240
Food Sales - Large	179
Office - Small	4,418
Office - Large	3,157
Lodging - Small	12,612
Lodging - Large	4,049
Restaurants	1,461
Retail - Large	6,830
Retail - Small	3,133
Multifamily	2,396
Healthcare - Large	1,330
Healthcare - Small	632
Public Assembly	8,977
Warehouse	5,221
Industrial	895
Total	**80,337**

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[12]	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.

[12] 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 (electricity and natural gas), fuel shares were not needed for this study. Propane and fuel oil equipment shares are characterized in the measure density values and applied to the electric territory stock forecast.

2.5 Load Shapes

All loadshape data were sourced from the 2022 BCR models. Electricity loadshapes have four periods: Summer-On Peak, Summer-Off Peak, Winter-On Peak, and Winter-Off Peak. Natural gas, propane, fuel oil, and water do not have loadshapes, 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 and capacity. 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 electricity and demand consumption by sector.

Table 2-7. Electricity and Demand Consumption in 2022 (At Meter)

Segment	Electricity Consumption GWh	Electric Demand MW
Residential	966	244
Income Eligible	220	56
C&I	783	236
Total	**1,970**	**536**

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)[13]; water, non-energy impacts, and other program administrator-specific values were adopted from the 2022 BCR models. Benefit streams were combined at the impact

[13] https://www.synapse-energy.com/aesc-2024-materials

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

- Electric energy (per kWh) includes energy, DRIPE, environmental compliance (Societal Cost of CO_2, or SCC), and cross DRIPE benefits. A 1.5% discount rate was used for SCC.

- Electric capacity (per kW) includes cleared capacity, DRIPE, reliability, transmission, and PA-specific distribution benefits. Uncleared capacity, DRIPE, and reliability values are imported as unique benefit streams as their valuation methodologies differ from the other capacity scaling benefit streams.

  Guidehouse has updated model logic to incorporate these custom valuation parameters for uncleared capacity to align the BCR model and DSMSim TRC results.

- Propane (per MMBtu) includes propane and SCC environmental compliance benefits.

- Fuel Oil (per MMBtu) includes oil, DRIPE, and SCC environmental compliance benefits. AESC 2024 provided all of these values.

- 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 and 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-associated 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, electric 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.

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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 250 energy efficiency (EE) and electrification measures across Cape Light Compact's 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 energy efficiency 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. Per PA guidance, Residential New Construction fossil fuel energy efficiency savings are not included in the results for any customers, whether or not they are Income Eligible. 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 propane or fuel oil when installed in homes or buildings that are heated by fossil fuels. Finally, Guidehouse generally considered electrification measures replacing both fuel oil and propane technologies. The exception is for Residential New Construction Whole Building electrification (Passive House measure). On guidance from the PAs, Guidehouse assumed a propane baseline for all homes—in other words, that the home would be built with propane (and not fuel oil) in the absence of the program.

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 Cape Light Compact because Cape Light Compact 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 Cape Light Compact.

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 Energy Efficiency 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 energy efficiency 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. This 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 electricity in kWh and demand in kW, for propane and fuel oil in MMBTU and for each baseline and energy efficiency 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

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Parameter Name	Definition	Example (for Illustration Purposes Only)
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
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[14] • 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.[15] • 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[16] • National Renewable Energy Laboratory (NREL) commercial building sector stock model for 2023 (ComStock)[17] • National Renewable Energy Laboratory (NREL) Residential building sector stock model for 2023 (ResStock)[18] • C&I baseline data[19] • Commercial Building Stock Assessment (CBSA)[20] • U.S. EIA Residential Energy Consumption Survey (RECS)[21] • U.S. EIA Commercial Building Energy Consumption Survey (CBECS)[22] • U.S. EIA's Manufacturing Energy Consumption Survey[23] • NREL's Manufacturing Thermal Energy Use database[24] • Previous potential studies in Massachusetts • Other Guidehouse potential studies
Codes and Standards	• US DOE engineering analyses • Local building code

[14] 2022 Report Technical Reference Manual, https://www.masssavedata.com/TRL/Technical%20Reference%20Manual%202022%20Report%20FINAL.pdf

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

[16] 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.

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

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

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

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

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

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

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

[24] 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 electrification 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 Oil Heat
    b. Central Air Source Heat Pump (Split or Packaged) displacing Propane Heat
    c. Variable Refrigerant Flow Heat Pump displacing Oil Heat
    d. Variable Refrigerant Flow Heat Pump displacing Propane Heat
    e. Ground Source Heat Pump (Water-to-Water) displacing Oil Heat
    f. Ground Source Heat Pump (Water-to-Water) displacing Propane Heat
    g. Ground Source Heat Pump (Water-to-Air) displacing Oil Heat
    h. Ground Source Heat Pump (Water-to-Air) displacing Propane Heat
    i. Ductless Heat Pump displacing Oil Heat
    j. Ductless Heat Pump displacing Propane 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 four custom measures: Custom C&I New Construction; Custom C&I Retrofit; Custom C&I Replace-on-Burnout; and Custom C&I Refrigeration. For Cape Light Compact, Guidehouse characterized electric savings from these measures but not propane or fuel oil savings. The savings assumptions for Custom measures were derived from the PAs' Custom program data in 2022, aggregated into replacement types (new construction, retrofit, and replace-on-burnout) based on the program allocation. Assumptions about cost per therm saved for natural gas-saving projects were derived from projects aggregated across natural 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

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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[25] data, but TMYx weather data is more current and readily available. 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 propane or fuel oil appliance, while the efficient condition is an electric appliance. Electrification measures have positive propane or fuel oil savings, but negative electricity and demand savings because the efficient electric measure uses electricity, while the baseline measure predominantly uses propane or fuel oil. The exception is Residential New Construction Whole Building electrification (Passive House measure) for which Guidehouse assumed a propane baseline for all homes.

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, 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.[26] 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 electricity, 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.[27] 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.

[25] https://www.masssavedata.com/TRL/Technical%20Reference%20Manual%202022%20Report%20FINAL.pdf
[26] https://www.bls.gov/data/inflation_calculator.htm
[27] https://www.irs.gov/pub/taxpros/fs-2022-40.pdf

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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.[28] For measures not covered in baseline research, and measures characterized 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,[29] as well as C&I baseline data,[30] 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 Cape Light Compact's 2022 BCR model. Generally, Guidehouse mapped measures characterized in Income Eligible building segments to the Income Eligible program. However, PAs indicated that several measures 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. These measures included:

- Central Air Conditioning (AC)
- Electronically Commutated Motor (ECM) Circulator Pump
- Central AC Quality Installation Verification
- Ductless Mini-Split Heat Pump Quality Installation Verification
- Heat Pump Quality Installation Verification
- HVAC Quality Installation with Duct Modification
- Heat Pump Tune Up
- Heat Recovery Ventilator
- HVAC Downsize
- Ultra Low Global Warming Potential (GWP) Refrigerator
- Electric Lawnmower
- Electric Leafblower
- Electric Trimmer
- Electric Chainsaw

[28] 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.

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

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

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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 energy efficiency regulations for many types of Residential appliances and commercial equipment. The US DOE Technical Support Documents (TSD)[31] 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.

Savings for whole building new construction also considered the impact of building codes, including municipal stretch codes. Residential New Construction program energy savings were based on the 2022 Massachusetts Technical Reference Manual, which states that savings were "calculated using a RESNET accredited Rating Software Tool (Ekotrope) where a user inputs a detailed set of technical data about a project, comparing as-built projected energy consumption to that of a baseline home, the User-Defined Reference Home (UDRH)."[32] The UDRH was defined in the 2019 Residential New Construction Baseline and Code Compliance Study (MA19X02-B-RNCBL).[33] The UDRH analysis considered a mix of homes built to the 2015 version of the International Energy Conservation Code (IECC), and homes built to comply with the 2017 stretch code. A later study also considered the impact of stretch codes on program net-to-gross ratio, developing a net-to-gross ratio of 49% for 2022 that was reflective of high free-ridership in municipalities that adopted stretch codes.[34] Per guidance from the PAs, Guidehouse only considered electric energy efficiency savings in Residential New Construction. For Residential New Construction electrification, Guidehouse assumed a propane baseline home.

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

[32] Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures, 2022 Report Version, June 1, 2023, page 252.

[33] NMR Group, Inc. 2019 Residential New Construction Baseline/Compliance Study (MA19X02-B-RNCBL), April 1, 2020.

[34] NMR Group, Inc. Low-Rise Residential New Construction NTG Study (MA20X05-B-RNCNTG), July 27, 2021.

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4. Energy Efficiency Potential

This section describes Guidehouse's approach to calculating Energy Efficiency potential and presents the results for Cape Light Compact in Massachusetts at different levels of aggregation. Results are shown by sector and impact type. For more details and levels of aggregation of energy efficiency 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 Cape Light Compact 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.[35] 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 technical potential, by sector, fuel, and impact type. The results reflect the effects of both energy efficiency (more efficient equipment, which provides positive savings) and fuel substitution (electric equipment replacing a fossil fuel system, which provides negative savings for electricity and summer peak electric demand, with positive fossil fuel savings). Negative savings for fossil fuels also occur from interactive effects (for example, from heat pump water heaters that cool the ambient air and require additional space heating).

For the electricity technical potential, only the C&I sector provides positive electricity savings when accounting for both energy efficiency and fuel substitution, with Residential and C&I sectors providing positive summer peak electric demand. Natural gas savings associated with electric programs are negative, except for the C&I sector, which provides no natural gas or motor gasoline savings. Otherwise, all sectors provide positive oil, propane, motor gasoline and water consumption potential.

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

Table 4-1. Residential Technical Potential, CLC Electric (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	254,200	91,110	-14,600	1,235,700	182,500	0	89,270
2026	257,500	91,670	-14,680	1,234,900	183,000	0	90,390
2027	260,800	92,230	-14,750	1,234,000	183,500	0	91,500
Residential Sector - Fuel Substitution Measures							
2025	-562,600	-74,430	0	5,983,900	1,484,900	421,500	0
2026	-563,100	-74,600	0	5,954,700	1,535,400	427,700	0
2027	-563,600	-74,770	0	5,925,600	1,585,500	433,900	0

Source: Guidehouse

Table 4-2. Income Eligible Technical Potential, CLC Electric (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	8,900	1,560	-840	59,700	27,000	0	3,330
2026	8,900	1,570	-840	59,600	27,000	0	3,370
2027	9,000	1,570	-850	59,400	27,000	0	3,410
Income Eligible Sector - Fuel Substitution Measures							
2025	-21,900	-2,890	0	253,100	83,100	0	0
2026	-21,800	-2,870	0	251,800	82,700	0	0
2027	-21,700	-2,860	0	250,600	82,400	0	0

Source: Guidehouse

Table 4-3. C&I Technical Potential, CLC Electric(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	348,200	56,050	0	2,300	1,800	0	63,490
2026	343,900	55,100	0	2,200	1,800	0	61,400
2027	339,900	54,200	0	2,200	1,700	0	59,390
C&I Sector - Fuel Substitution Measures							
2025	-3,400	-290	0	21,400	21,000	0	0
2026	-3,400	-290	0	21,400	21,000	0	0
2027	-3,400	-290	0	21,400	21,000	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 Cape Light Compact 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

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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.

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 Cape Light Compact's 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 energy efficiency 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% from 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.

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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. As with technical potential, the results reflect the effects of both energy efficiency (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 electric demand, with positive fossil fuel savings). Negative savings for fossil fuels also occur from interactive effects, similar to the technical potential results.

For the electricity economic potential, only the C&I sector provides positive electricity savings, with all sectors providing positive summer peak electric demand. Natural gas savings associated with electric programs are negative, except for the C&I sector, which provides no natural gas or motor gasoline savings. Otherwise, all sectors provide positive oil, propane, motor gasoline and water consumption potential.

Economic potential results closely align with technical potential for most fuel types and sectors. This is due to the targeted nature of the measure list with a focus on measures forecasted or historically incentivized by CLC 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, CLC Electric (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	250,400	90,650	-14,600	1,235,700	182,500	0	89,270
2026	253,600	91,210	-14,680	1,234,900	183,000	0	90,390
2027	256,800	91,770	-14,750	1,234,000	183,500	0	91,500
Residential Sector - Fuel Substitution Measures							
2025	-562,600	-74,430	0	5,983,900	1,484,900	421,500	0
2026	-563,100	-74,600	0	5,954,700	1,535,400	427,700	0
2027	-563,600	-74,770	0	5,925,600	1,585,500	433,900	0

Source: Guidehouse

Table 4-5. Income Eligible Economic Potential, CLC Electric (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	7,400	1,660	-840	59,700	27,000	0	3,330
2026	7,500	1,660	-840	59,600	27,000	0	3,370
2027	7,500	1,670	-850	59,400	27,000	0	3,410
Income Eligible Sector - Fuel Substitution Measures							
2025	-21,900	-2,890	0	253,100	83,100	0	0
2026	-21,800	-2,870	0	251,800	82,700	0	0
2027	-21,700	-2,860	0	250,600	82,400	0	0

Source: Guidehouse

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Table 4-6. C&I Economic Potential, CLC Electric (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	335,100	55,760	0	2,300	1,800	0	63,490
2026	331,300	54,810	0	2,200	1,800	0	61,400
2027	328,000	53,960	0	2,200	1,700	0	59,390
C&I Sector - Fuel Substitution Measures							
2025	-2,400	-600	0	10,400	20,700	0	0
2026	-2,400	-530	0	10,400	20,800	0	0
2027	-2,400	-530	0	10,400	20,800	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 energy efficiency programs. Achievable potential for energy efficiency 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.[36] 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

[36] 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 Cape Light Compact 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 Cape Light Compact's 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.

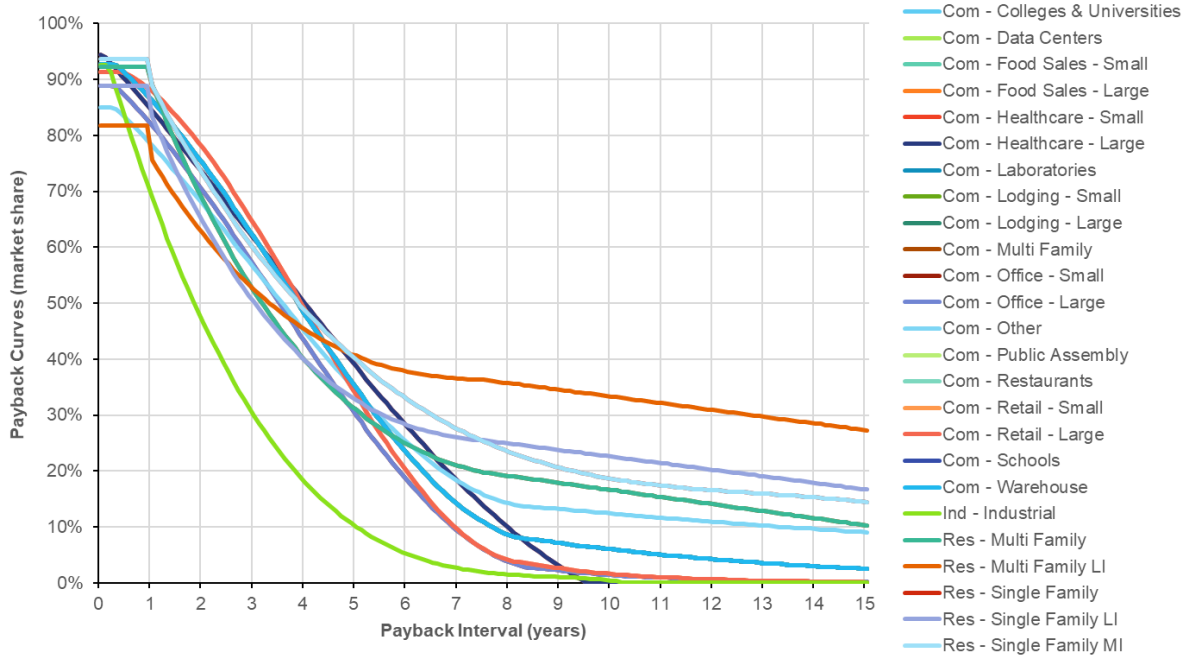
To inform this study, the team used equilibrium payback acceptance curves that Guidehouse developed using primary research from the National Grid 2018 Potential Study[37]. To develop these curves, Guidehouse relied on surveys of 1000 Residential and 200 C&I customers, which presented decision makers 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 energy

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

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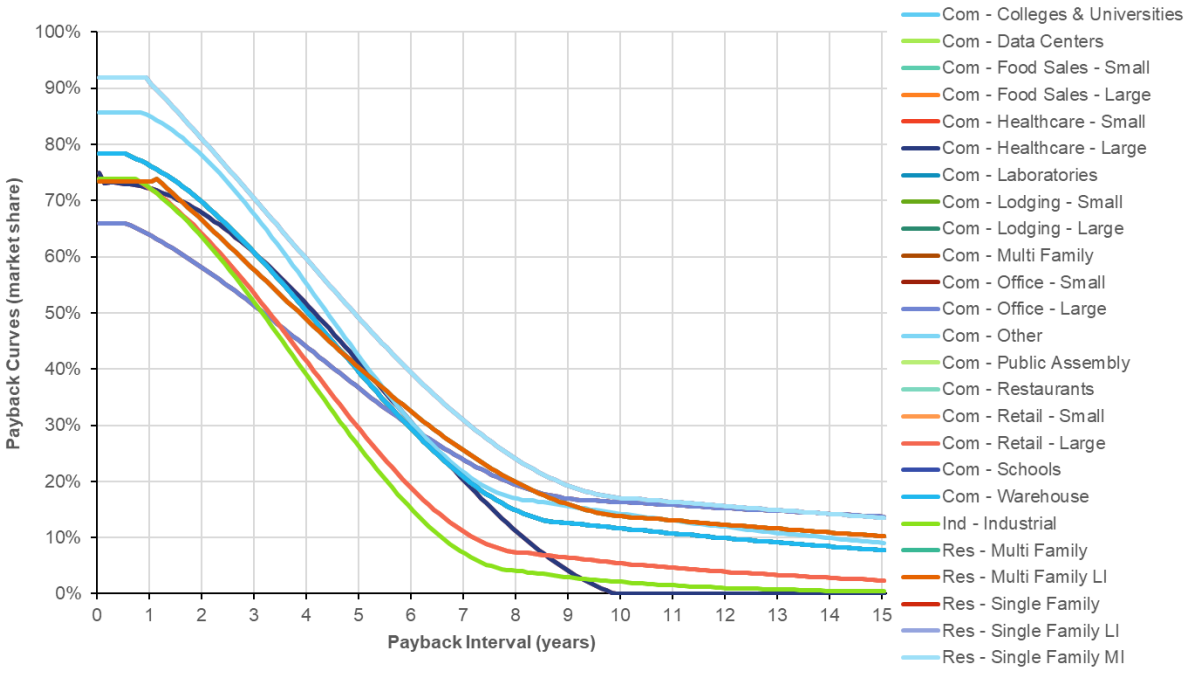
costs. Guidehouse fitted generalized logit models to customer willingness to pay survey results by technology cost bin and segment to develop the set of curves, which are used in this study. The resulting willingness to pay curves, shown in Figure 4-1 and Figure 4-2 are used as starting points for achievable 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.[38] *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

Cape Light Compact is not offering behavioral measures and they were not modeled as part of the potential analysis.

4.3.1.3 Energy Efficiency Investment Strategy

Cape Light Compact 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 Cape Light Compact's guidance, this study sets measure incentives based on Cape Light Compact's 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

[38] 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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incumbent equipment that was already updated to efficient equipment during the study horizon. 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 Cape Light Compact program offerings in order to have a basis for comparison with historical program achievements.
- Ensuring similar trends and magnitudes between Cape Light Compact's 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 energy efficiency 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 Cape Light Compact's 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 Cape Light Compact's historically achieved program savings. This is due to the iterative process for achievable potential review

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and the addition of new measures and competition groups to the portfolio. The subset measure calibration step is an 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 Cape Light Compact's 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 total achievable potential, by sector, fuel, and impact type. As with technical and economic potential, the results reflect the effects of both energy efficiency (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 electric 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 electricity achievable potential, the C&I sector provides the most electricity savings, while the Residential sector provides the greatest summer peak electric demand savings with the Income Eligible sector providing the least potential for both. Natural gas savings are either slightly negative or zero. Except for the C&I sector, which provides no oil or motor gasoline savings, all sectors provide positive oil, propane, motor gasoline and water consumption potential.

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

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substitution measures are calibrated to an expected deployment ramp, comparison to economic potential is directly correlated to that forecast.

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, CLC Electric (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	8,500	800	-90	44,500	9,900	0	2,010
2026	9,900	1,030	-120	54,500	11,400	0	2,800
2027	10,400	1,200	-130	63,100	12,200	0	3,300
Residential Sector - Fuel Substitution Measures							
2025	-4,800	-350	0	27,400	29,900	2,500	0
2026	-5,900	-450	0	32,800	40,400	2,900	0
2027	-6,600	-500	0	38,400	42,300	3,200	0
Residential Sector Total (All Measures)							
2025	3,700	450	-90	71,900	39,800	2,500	2,010
2026	4,000	580	-120	87,300	51,800	2,900	2,800
2027	3,800	700	-130	101,500	54,500	3,200	3,300

Source: Guidehouse

Table 4-9. Income Eligible BAE Scenario Achievable Potential, CLC Electric (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	400	20	0	2,000	1,700	0	70
2026	300	30	-10	2,500	1,800	0	90
2027	300	40	-10	2,900	1,800	0	110
Income Eligible Sector - Fuel Substitution Measures							
2025	-100	-30	0	1,300	600	0	0
2026	-200	-30	0	1,600	700	0	0
2027	-200	-40	0	1,800	800	0	0
Income Eligible Sector Total (All Measures)							
2025	300	-10	0	3,300	2,300	0	70
2026	100	0	-10	4,100	2,500	0	90
2027	100	0	-10	4,700	2,600	0	110

Source: Guidehouse

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Table 4-10. C&I BAE Scenario Achievable Potential, CLC Electric (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	4,600	660	0	0	0	0	40
2026	5,000	730	0	0	0	0	40
2027	5,400	790	0	0	0	0	40
C&I Sector - Fuel Substitution Measures							
2025	-100	-120	0	500	1,100	0	0
2026	-200	-130	0	500	1,200	0	0
2027	-100	-120	0	500	1,100	0	0
C&I Sector Total (All Measures)							
2025	4,500	540	0	500	1,100	0	40
2026	4,800	600	0	500	1,200	0	40
2027	5,300	670	0	500	1,100	0	40

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[39] 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. Mapping of measures to programs was based on Cape Light Compact's 2022 BCR Model.

Note that Income Eligible budgets are projected irrespective of the statutory allocations of 10% of the electric 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 annual net savings for Residential electric core initiatives for the 3-year study horizon for the BAE scenario. Table 4-12. presents the benefits and costs by Residential electric core initiatives for the 3-year study horizon for the BAE scenario. In this and all similar tables, "Program Administrative Costs" include: (1) Program Planning and Administration; (2) Marketing and Advertising; (3) Sales, Technical Assistance and Training; and (4) Evaluation and Market Research; these costs do not include incentives paid to program participants. In the tables showing costs, they are generally rounded to the nearest hundred thousand; to provide further specificity in the quantitative tables is inappropriate with the nature of potential analyses. The study is calibrated at the sector level, therefore Residential results include Moderate Income potential savings.

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

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These tables show that most annual and lifetime savings potential is associated with the Residential Coordinated Delivery core initiative, while the greatest amount of cost and carbon reduction is found in the Residential Retail core initiative, because of the preponderance of heat pumps found in that program. All programs are well above the cost-effectiveness threshold of 1.0.

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

Core Initiative, by Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
A1a - Residential New Homes & Renovations					
2025	-30	-60	19,100	383,000	1,360
2026	-50	-80	27,100	542,000	1,930
2027	-50	-80	26,900	539,000	1,920
Total				**1,464,000**	**5,210**
A2a - Residential Coordinated Delivery					
2025	2,370	140	57,900	1,094,000	3,320
2026	2,640	180	67,000	1,258,000	3,960
2027	2,810	220	74,600	1,389,000	4,540
Total				**3,741,000**	**11,820**
A2c - Residential Retail					
2025	1,400	360	60,600	1,034,000	4,280
2026	1,470	480	72,800	1,235,000	5,250
2027	1,090	570	80,900	1,377,000	6,090
Total				**3,646,000**	**15,620**
A2d - Residential Behavior					
2025	0	0	0	0	0
2026	0	0	0	0	0
2027	0	0	0	0	0
Total				**0**	**0**
Residential Sector Total					
2025	3,740	440	137,600	2,511,000	8,960
2026	4,060	580	166,900	3,035,000	11,140
2027	3,850	710	182,400	3,305,000	12,550
Total				**8,851,000**	**32,650**

Source: Guidehouse

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Table 4-12. Residential Sector, Electric 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	4.01	$30.2	$7.5	$1.0	$6.5
2026	4.03	$43.0	$10.7	$1.4	$9.2
2027	4.05	$43.0	$10.6	$1.4	$9.2
Total	**4.03**	**$116.2**	**$28.8**	**$3.9**	**$24.9**
A2 - Residential Existing Buildings					
2025	4.00	$119.9	$30.0	$7.1	$18.4
2026	4.13	$143.2	$34.7	$7.9	$21.2
2027	4.28	$162.8	$38.1	$8.5	$23.2
Total	**4.15**	**$425.9**	**$102.7**	**$23.4**	**$62.8**
A3 - Residential Hard-to-Measure					
2025	N/A	N/A	$7.6	$7.6	N/A
2026	N/A	N/A	$9.2	$9.2	N/A
2027	N/A	N/A	$9.8	$9.8	N/A
Total			**$26.6**	**$26.6**	
Residential Sector Total					
2025	3.33	$150.1	$45.1	$15.7	$24.9
2026	3.41	$186.2	$54.5	$18.6	$30.4
2027	3.52	$205.7	$58.5	$19.7	$32.4
Total	**3.43**	**$542.1**	**$158.2**	**$54.0**	**$87.7**

Source: Guidehouse

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Income Eligible Sector

Table 4-13 presents the incremental annual net savings for Income Eligible electric core initiatives for the 3-year study horizon for the BAE scenario. Table 4-14 presents the benefits and costs by Income Eligible electric programs for the 3-year study horizon for the BAE scenario.

These tables show that Income Eligible Coordinated Delivery savings decrease over the study horizon while summer peak demand savings increase. The program is well above the cost-effectiveness threshold of 1.0.

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

Core Initiative, by Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
B1a - Income Eligible Coordinated Delivery					
2025	220	-10	7,100	134,000	440
2026	180	0	7,700	144,000	500
2027	140	10	8,200	152,000	550
Total				**430,000**	**1,490**

Source: Guidehouse

Table 4-14. Income Eligible Sector, Electric 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	2.58	$8.7	$3.4	$0.7	$2.4
2026	2.76	$9.8	$3.5	$0.7	$2.5
2027	2.87	$10.6	$3.7	$0.7	$2.6
Total	**2.74**	**$29.2**	**$10.6**	**$2.1**	**$7.6**
B2 - Income Eligible Hard-to-Measure					
2025	N/A	N/A	$0.5	$0.5	N/A
2026	N/A	N/A	$0.5	$0.5	N/A
2027	N/A	N/A	$0.6	$0.6	N/A
Total			**$1.6**	**$1.6**	
Income Eligible Sector Total					
2025	2.23	$8.7	$3.9	$1.2	$2.4
2026	2.39	$9.8	$4.1	$1.2	$2.5
2027	2.49	$10.6	$4.3	$1.3	$2.6
Total	**2.37**	**$29.2**	**$12.3**	**$3.7**	**$7.6**

Source: Guidehouse

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C&I Sector

Table 4-15. presents the incremental annual net savings for C&I electric core initiatives for the 3-year study horizon for the BAE scenario. Table 4-16. presents the benefits and costs by C&I electric programs for the 3-year study horizon for the BAE scenario.

These tables show that most annual and lifetime savings potential and carbon reduction is associated with the C&I Existing Building Retrofit core initiative, while the greatest amount of cost is found in the C&I New & Replacement Equipment core initiative, because of the preponderance of heat pumps found in that program. Nevertheless, all programs providing energy savings are cost-effective.

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

Core Initiative, by Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
C1a - C&I New Buildings & Major Renovations					
2025	420	90	2,800	38,000	80
2026	530	120	3,500	47,000	100
2027	630	140	4,100	55,000	120
Total				**140,000**	**300**
C2a - C&I Existing Building Retrofit					
2025	2,950	390	19,900	191,000	430
2026	3,300	440	21,900	211,000	490
2027	3,610	490	23,700	229,000	550
Total				**631,000**	**1,470**
C2b - C&I New & Replacement Equipment					
2025	1,030	50	8,600	91,000	340
2026	1,040	50	8,500	93,000	350
2027	1,020	50	8,300	92,000	340
Total				**276,000**	**1,030**
C&I Sector Total					
2025	4,400	530	31,300	320,000	850
2026	4,870	610	33,900	351,000	940
2027	5,260	680	36,100	376,000	1,010
Total				**1,047,000**	**2,800**

Source: Guidehouse

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Table 4-16. C&I Sector, Electric 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	4.31	$2.2	$0.5	$0.1	$0.2
2026	4.31	$2.7	$0.6	$0.2	$0.3
2027	4.40	$3.2	$0.7	$0.2	$0.3
Total	**4.35**	**$8.1**	**$1.9**	**$0.6**	**$0.9**
C2 - C&I Existing Buildings					
2025	2.67	$10.8	$4.1	$0.7	$2.4
2026	2.74	$11.7	$4.3	$0.7	$2.6
2027	2.86	$12.5	$4.4	$0.8	$2.7
Total	**2.76**	**$35.0**	**$12.7**	**$2.2**	**$7.7**
C3 - C&I Hard-to-Measure					
2025	N/A	N/A	$1.3	$1.3	N/A
2026	N/A	N/A	$1.4	$1.4	N/A
2027	N/A	N/A	$1.5	$1.5	N/A
Total			**$4.2**	**$4.2**	
C&I Sector Total					
2025	2.21	$13.0	$5.9	$2.1	$2.7
2026	2.28	$14.4	$6.3	$2.3	$2.9
2027	2.38	$15.7	$6.6	$2.5	$3.0
Total	**2.29**	**$43.1**	**$18.8**	**$7.0**	**$8.6**

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 lifetime electricity savings measures, net at meter in 2027 for the Residential, Income Eligible and C&I sectors, respectively. Lifetime savings are dominated by heat pump and weatherization measures for the Residential and Income Eligible sectors. The All-electric Passive House measures also offers significant savings. In the C&I sector, three of the top six measures are Custom measures. As seen in these figures, there is a sharp drop off of achievable potential even within the top ten measures.

Figure 4-3. EE BAE Scenario Lifetime Achievable Electricity Potential, 2027 Top Residential Measures (MWh, Net at Meter)

#	Measure	Core Initiative	LT Savings
1	ER Baseboard to DMSHP	A2c - Residential Retail	44,560
2	Insulation	A2a - Residential Coordinated Delivery	23,580
3	All-Electric Passive House	A1a - Residential New Homes & Renovations	22,880
4	Central Heat Pump	A2c - Residential Retail	18,310
5	Air Sealing	A2a - Residential Coordinated Delivery	5,930
6	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	5,880
7	Advanced Power Strip	A2a - Residential Coordinated Delivery	5,750
8	Heat Pump Water Heater	A2c - Residential Retail	5,000
9	ECM Circulator Pump	A2c - Residential Retail	4,520
10	Ductless Mini-Split Heat Pump (DMSHP)	A2c - Residential Retail	2,800

Source: Guidehouse

Figure 4-4. EE BAE Scenario Lifetime Achievable Electricity Potential, 2027 Top Income Eligible Measures (MWh, Net at Meter)

#	Measure	Core Initiative	LT Savings
1	ER Baseboard to DMSHP	B1a - Income Eligible Coordinated Delivery	2,250
2	Insulation	B1a - Income Eligible Coordinated Delivery	1,180
3	Central Heat Pump	B1a - Income Eligible Coordinated Delivery	600
4	Windows - Single to triple pane	B1a - Income Eligible Coordinated Delivery	270
5	Advanced Power Strip	B1a - Income Eligible Coordinated Delivery	230
6	Heat Pump Water Heater	B1a - Income Eligible Coordinated Delivery	220
7	Manual Thermostat to Programmable Thermostat	B1a - Income Eligible Coordinated Delivery	200
8	Clothes Dryer	B1a - Income Eligible Coordinated Delivery	80
9	Room Air Cleaner	B1a - Income Eligible Coordinated Delivery	80
10	Showerhead	B1a - Income Eligible Coordinated Delivery	80

Source: Guidehouse

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Figure 4-5. EE BAE Scenario Lifetime Achievable Electricity Potential, 2027 Top C&I Measures (MWh, Net at Meter)

#	Measure	Core Initiative	LT Savings
1	Custom Large C&I	C2a - C&I Existing Building Retrofit	13,610
2	Indoor LED Fixture w / controls - High/Low Bay	C2a - C&I Existing Building Retrofit	6,350
3	Custom New Construction	C1a - C&I New Buildings & Major Renovations	5,180
4	Lighting - Performance Lighting	C1a - C&I New Buildings & Major Renovations	3,600
5	Case Motor Replacement	C2a - C&I Existing Building Retrofit	3,550
6	Custom Large C&I	C2b - C&I New & Replacement Equipment	3,300
7	Demand Control Ventilation	C2a - C&I Existing Building Retrofit	3,140
8	Energy Management System	C2a - C&I Existing Building Retrofit	1,920
9	Indoor LED Fixture/Retrofit kit w / controls - Linear	C2a - C&I Existing Building Retrofit	1,900
10	Evaporator Fan Control	C2a - C&I Existing Building Retrofit	1,810

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 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 (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 CLC, 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.

Per the EEAC Consultants, 40% of the remaining CECP target – after counting 2022-2024 carbon reductions – was assumed as the target for 2025-27. 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. The split of heat pumps between Residential and C&I sectors was approximately 85% to 15%. Heat Pump Water Heaters were characterized as Replace on Burnout only (as opposed to Early Replacement).

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 Table 4-18 for the CECP Cost Premium scenario. 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 Cape Light Compact 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.

For the CECP scenario, 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.[40]

4.4.2 CECP Scenario Results

Table 4-19 to Table 4-24 show CECP scenario results, individually by sector and fuel. The tables show summary energy, summer and winter peak demand, and 2030 carbon[41] savings for all fuels and benefit and costs and the BCR for the programs for each year. Cape Light Compact is not offering behavioral measures and they were not modeled as part of the potential analysis.

These show the total achievable potential, by sector, fuel, and impact type. The results reflect the effects of both energy efficiency (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 electric demand, with positive fossil fuel savings). Negative savings for fossil fuels also occur from interactive effects (for example, from heat pump water heaters that cool the ambient air and require additional space heating).

In the Residential sector, the tables amplify the trends seen in the BAE scenario, primarily because of the large amounts of heat pumps. The tables show that positive annual and lifetime electric savings potential is associated only with the Residential Coordinated Delivery core initiative, while the greatest amount of cost and carbon reduction is found in the Residential Retail core initiative. All programs remain cost-effective. 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.

In the Income Eligible Sector, the tables show that Income Eligible Coordinated Delivery electricity and summer peak demand savings decline over the study horizon. The program is

[40] 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.

[41] 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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well above the cost-effectiveness threshold of 1.0. Projected savings for the Residential and Income Eligible sector are greater in 2026 than in 2027, perhaps because of approaching saturation in those sectors.

In the C&I Sector, the results show that most annual and lifetime savings potential and carbon reduction is associated with the C&I Existing Building Retrofit program, while the greatest amount of cost is found in the C&I New & Replacement Equipment program, because of the preponderance of heat pumps found in that program. Nevertheless, the programs and sectors are cost-effective.

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

Core Initiative, by Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
A1a - Residential New Homes & Renovations					
2025	-30	-60	19,100	383,000	1,360
2026	-50	-80	27,100	542,000	1,930
2027	-50	-80	26,900	539,000	1,920
Total				**1,464,000**	**5,210**
A2a - Residential Coordinated Delivery					
2025	3,540	240	160,600	3,477,000	10,650
2026	3,640	290	168,300	3,638,000	11,250
2027	3,490	310	158,700	3,402,000	10,660
Total				**10,517,000**	**32,560**
A2c - Residential Retail					
2025	-4,390	1,210	176,300	3,082,000	16,130
2026	-5,380	1,410	194,700	3,400,000	17,960
2027	-5,960	1,470	192,700	3,371,000	18,040
Total				**9,853,000**	**52,130**
A2d - Residential Behavior					
2025	0	0	0	0	0
2026	0	0	0	0	0
2027	0	0	0	0	0
Total				**0**	**0**
Residential Sector Total					
2025	-880	1,390	356,000	6,942,000	28,140
2026	-1,790	1,620	390,100	7,580,000	31,140
2027	-2,520	1,700	378,300	7,312,000	30,620
Total				**21,834,000**	**89,900**

Source: Guidehouse

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Table 4-20. Residential Sector, Electric 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	4.01	$30.2	$7.5	$1.0	$6.5
2026	4.03	$43.0	$10.7	$1.4	$9.2
2027	4.05	$43.0	$10.6	$1.4	$9.2
Total	**4.03**	**$116.2**	**$28.8**	**$3.9**	**$24.9**
A2 - Residential Existing Buildings					
2025	4.33	$401.3	$92.8	$27.0	$96.3
2026	4.35	$438.2	$100.7	$28.9	$104.9
2027	4.38	$429.1	$98.0	$27.8	$102.5
Total	**4.35**	**$1,268.6**	**$291.5**	**$83.8**	**$303.7**
A3 - Residential Hard-to-Measure					
2025	N/A	N/A	$31.2	$31.2	N/A
2026	N/A	N/A	$34.5	$34.5	N/A
2027	N/A	N/A	$33.7	$33.7	N/A
Total			**$99.4**	**$99.4**	
Residential Sector Total					
2025	3.28	$431.5	$131.5	$59.2	$102.8
2026	3.30	$481.2	$145.9	$64.9	$114.1
2027	3.32	$472.0	$142.3	$63.0	$111.7
Total	**3.30**	**$1,384.8**	**$419.7**	**$187.1**	**$328.6**

Source: Guidehouse

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

Core Initiative, by Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
B1a - Income Eligible Coordinated Delivery					
2025	180	50	18,600	354,000	1,340
2026	140	30	19,700	373,000	1,440
2027	100	40	18,600	351,000	1,380
Total				**1,078,000**	**4,160**

Source: Guidehouse

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Table 4-22. Income Eligible Sector, Electric 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	2.36	$23.8	$10.1	$2.1	$7.7
2026	2.32	$25.2	$10.8	$2.3	$8.3
2027	2.33	$23.9	$10.3	$2.2	$7.8
Total	**2.34**	**$72.9**	**$31.2**	**$6.6**	**$23.8**
B2 - Income Eligible Hard-to-Measure					
2025	N/A	N/A	$1.7	$1.7	N/A
2026	N/A	N/A	$1.8	$1.8	N/A
2027	N/A	N/A	$1.7	$1.7	N/A
Total			**$5.2**	**$5.2**	
Income Eligible Sector Total					
2025	2.02	$23.8	$11.7	$3.8	$7.7
2026	1.99	$25.2	$12.6	$4.1	$8.3
2027	2.00	$23.9	$12.0	$3.9	$7.8
Total	**2.00**	**$72.9**	**$36.4**	**$11.7**	**$23.8**

Source: Guidehouse

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

Core Initiative, by Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
C1a - C&I New Buildings & Major Renovations					
2025	420	90	2,800	38,000	80
2026	530	120	3,500	47,000	100
2027	630	140	4,100	55,000	120
Total				**140,000**	**300**
C2a - C&I Existing Building Retrofit					
2025	4,210	420	28,400	303,000	610
2026	4,630	480	30,800	326,000	680
2027	4,920	540	32,300	338,000	730
Total				**967,000**	**2,020**
C2b - C&I New & Replacement Equipment					
2025	1,830	210	14,200	152,000	610
2026	1,870	220	14,400	157,000	640
2027	1,870	220	14,200	156,000	640
Total				**465,000**	**1,890**
C&I Sector Total					
2025	6,460	720	45,400	493,000	1,300
2026	7,030	820	48,700	530,000	1,420
2027	7,420	900	50,600	549,000	1,490
Total				**1,572,000**	**4,210**

Source: Guidehouse

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Table 4-24. C&I Sector, Electric 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	4.31	$2.2	$0.5	$0.1	$0.2
2026	4.31	$2.7	$0.6	$0.2	$0.3
2027	4.40	$3.2	$0.7	$0.2	$0.3
Total	**4.35**	**$8.1**	**$1.9**	**$0.6**	**$0.9**
C2 - C&I Existing Buildings					
2025	1.91	$18.0	$9.4	$2.5	$9.0
2026	1.92	$19.2	$10.0	$2.6	$9.6
2027	1.96	$20.0	$10.2	$2.7	$9.8
Total	**1.93**	**$57.2**	**$29.7**	**$7.8**	**$28.4**
C3 - C&I Hard-to-Measure					
2025	N/A	N/A	$4.5	$4.5	N/A
2026	N/A	N/A	$4.8	$4.8	N/A
2027	N/A	N/A	$4.9	$4.9	N/A
Total			**$14.2**	**$14.2**	
C&I Sector Total					
2025	1.40	$20.2	$14.4	$7.1	$9.2
2026	1.42	$21.9	$15.4	$7.6	$9.9
2027	1.46	$23.2	$15.9	$7.9	$10.2
Total	**1.43**	**$65.4**	**$45.7**	**$22.6**	**$29.3**

Source: Guidehouse

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Figure 4-6 through Figure 4-7 show the top MMBtu and carbon savings measures across all sectors for the CECP scenario. Residential heat pump and weatherization measures dominate lifetime MMBtu savings and 2030 Carbon reduction; none of the top measures are in the C&I or Income Eligible sectors. As seen in these figures, there is a sharp drop off of achievable potential even within the top measures, particularly for carbon reduction, which could guide program implementation efforts.

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

#	Measure	Core Initiative	LT Savings
1	Insulation	A2a - Residential Coordinated Delivery	8,245,740
2	Ductless MSHP Partially Displacing Oil Boiler	A2c - Residential Retail	2,418,940
3	Air Sealing	A2a - Residential Coordinated Delivery	1,375,380
4	ER Baseboard to DMSHP	A2c - Residential Retail	1,254,240
5	Heat Pump Water Heater	A2c - Residential Retail	1,098,420
6	All-Electric Passive House	A1a - Residential New Homes & Renovations	1,039,990
7	Central Heat Pump	A2c - Residential Retail	984,070
8	Central ASHP Partially Displacing Oil Furnace	A2c - Residential Retail	654,080
9	Ductless MSHP Partially Displacing Propane Boiler	A2c - Residential Retail	541,300
10	W2W GSHP Replacing Oil Boiler	A2c - Residential Retail	452,760
11	All-Electric Passive House	A1a - Residential New Homes & Renovations	387,570
12	Insulation	B1a - Income Eligible Coordinated Delivery	353,260
13	Duct Insulation	A2a - Residential Coordinated Delivery	330,030
14	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	307,570
15	Air Sealing	C2a - C&I Existing Building Retrofit	298,180
16	Custom Large C&I	C2a - C&I Existing Building Retrofit	272,030
17	Duct Sealing	A2a - Residential Coordinated Delivery	270,950
18	Central ASHP Partially Displacing Propane Furnace	A2c - Residential Retail	250,070
19	Ductless Mini-Split Heat Pump (DMSHP)	A2c - Residential Retail	215,220
20	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	209,140
21	Ductless MSHP Partially Displacing Oil Boiler	B1a - Income Eligible Coordinated Delivery	198,920
22	Air to water heat pumps, oil baseline	A2c - Residential Retail	175,070
23	Heat Recovery Ventilator	A2c - Residential Retail	148,330
24	Pipe Wrap (Space Heating)	A2a - Residential Coordinated Delivery	146,890
25	Wi-Fi Thermostat	A2c - Residential Retail	111,940

Source: Guidehouse

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

#	Measure	Core Initiative	CO2e in 2030
1	Ductless MSHP Partially Displacing Oil Boiler	A2c - Residential Retail	22,935
2	Insulation	A2a - Residential Coordinated Delivery	22,916
3	Air Sealing	A2a - Residential Coordinated Delivery	6,528
4	Central ASHP Partially Displacing Oil Furnace	A2c - Residential Retail	6,476
5	All-Electric Passive House	A1a - Residential New Homes & Renovations	4,682
6	Ductless MSHP Partially Displacing Propane Boiler	A2c - Residential Retail	3,950
7	Heat Pump Water Heater	A2c - Residential Retail	2,078
8	Central ASHP Partially Displacing Propane Furnace	A2c - Residential Retail	1,912
9	W2W GSHP Replacing Oil Boiler	A2c - Residential Retail	1,785
10	Air to water heat pumps, oil baseline	A2c - Residential Retail	1,508
11	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	1,430
12	ER Baseboard to DMSHP	A2c - Residential Retail	1,407
13	Ductless MSHP Fully Replacing Oil Boiler	A2c - Residential Retail	1,358
14	Ductless MSHP Partially Displacing Oil Boiler	B1a - Income Eligible Coordinated Delivery	1,277
15	Central Heat Pump	A2c - Residential Retail	1,277
16	Duct Insulation	A2a - Residential Coordinated Delivery	1,140
17	Insulation	B1a - Income Eligible Coordinated Delivery	949
18	Duct Sealing	A2a - Residential Coordinated Delivery	932
19	Heat Recovery Ventilator	A2c - Residential Retail	761
20	Custom Large C&I	C2a - C&I Existing Building Retrofit	734
21	Pipe Wrap (Space Heating)	A2a - Residential Coordinated Delivery	703
22	Air to water heat pumps, propane baseline	A2c - Residential Retail	647
23	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	594
24	Wi-Fi Thermostat	A2c - Residential Retail	520
25	Air Sealing	B1a - Income Eligible Coordinated Delivery	520

Source: Guidehouse

4.4.3 CECP Cost Premium Scenario Results

Table 4-25 through Table 4-30 show CECP Cost Premium scenario results, individually by sector and fuel. The tables show summary energy, summer and winter peak demand, and 2030 carbon[42] savings for all fuels and benefit and costs and the BCR for the programs for each year. Due to the design of the scenarios, described above in Section 4.4.1, energy and CO_2e savings for the CECP Cost Premium scenario are identical to those of the CECP scenario, while costs are greatly increased.

These show the total achievable potential, by sector, fuel, and impact type. The results reflect the effects of both energy efficiency (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 electric 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).

Across all sectors, target savings and carbon reduction quantities are the same as in the CECP scenario. Costs increase by 70 to 80% across each program in the Residential sector with relatively smaller increases in Income Eligible and C&I, causing benefit-cost ratios to decrease.

[42] 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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After adding the cost premium estimations to TRC costs, each program and sector remain cost-effective.

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

Core Initiative, by Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
A1a - Residential New Homes & Renovations					
2025	-30	-60	19,100	383,000	1,360
2026	-50	-80	27,100	542,000	1,930
2027	-50	-80	26,900	539,000	1,920
Total				**1,464,000**	**5,210**
A2a - Residential Coordinated Delivery					
2025	3,540	240	160,600	3,477,000	10,650
2026	3,640	290	168,300	3,638,000	11,250
2027	3,490	310	158,700	3,402,000	10,660
Total				**10,517,000**	**32,560**
A2c - Residential Retail					
2025	-4,390	1,210	176,300	3,082,000	16,130
2026	-5,380	1,410	194,700	3,400,000	17,960
2027	-5,960	1,470	192,700	3,371,000	18,040
Total				**9,853,000**	**52,130**
A2d - Residential Behavior					
2025	0	0	0	0	0
2026	0	0	0	0	0
2027	0	0	0	0	0
Total				**0**	**0**
Residential Sector Total					
2025	-880	1,390	356,000	6,942,000	28,140
2026	-1,790	1,620	390,100	7,580,000	31,140
2027	-2,520	1,700	378,300	7,312,000	30,620
Total				**21,834,000**	**89,900**

Source: Guidehouse

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Table 4-26. Residential Sector, Electric 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	4.01	$30.2	$7.5	$1.0	$6.5
2026	4.03	$43.0	$10.7	$1.4	$9.2
2027	4.05	$43.0	$10.6	$1.4	$9.2
Total	**4.03**	**$116.2**	**$28.8**	**$3.9**	**$24.9**
A2 - Residential Existing Buildings					
2025	2.01	$401.3	$199.6	$56.3	$170.8
2026	2.09	$438.2	$210.1	$58.9	$181.2
2027	2.18	$429.1	$196.7	$54.9	$171.4
Total	**2.09**	**$1,268.6**	**$606.3**	**$170.1**	**$523.4**
A3 - Residential Hard-to-Measure					
2025	N/A	N/A	$56.6	$56.6	N/A
2026	N/A	N/A	$60.6	$60.6	N/A
2027	N/A	N/A	$57.2	$57.2	N/A
Total			**$174.4**	**$174.4**	
Residential Sector Total					
2025	1.64	$431.5	$263.7	$113.9	$177.4
2026	1.71	$481.2	$281.3	$120.9	$190.4
2027	1.78	$472.0	$264.5	$113.5	$180.5
Total	**1.71**	**$1,384.8**	**$809.5**	**$348.4**	**$548.3**

Source: Guidehouse

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

Core Initiative, by Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
B1a - Income Eligible Coordinated Delivery					
2025	180	50	18,600	354,000	1,340
2026	140	30	19,700	373,000	1,440
2027	100	40	18,600	351,000	1,380
Total				**1,078,000**	**4,160**

Source: Guidehouse

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Table 4-28. Income Eligible Sector, Electric 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	1.64	$23.8	$14.5	$3.2	$11.6
2026	1.60	$25.2	$15.7	$3.6	$12.9
2027	1.59	$23.9	$15.1	$3.5	$12.6
Total	**1.61**	**$72.9**	**$45.3**	**$10.2**	**$37.2**
B2 - Income Eligible Hard-to-Measure					
2025	N/A	N/A	$2.5	$2.5	N/A
2026	N/A	N/A	$2.8	$2.8	N/A
2027	N/A	N/A	$2.8	$2.8	N/A
Total			**$8.1**	**$8.1**	
Income Eligible Sector Total					
2025	1.39	$23.8	$17.0	$5.7	$11.6
2026	1.36	$25.2	$18.6	$6.4	$12.9
2027	1.34	$23.9	$17.8	$6.2	$12.6
Total	**1.36**	**$72.9**	**$53.4**	**$18.4**	**$37.2**

Source: Guidehouse

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

Core Initiative, by Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
C1a - C&I New Buildings & Major Renovations					
2025	420	90	2,800	38,000	80
2026	530	120	3,500	47,000	100
2027	630	140	4,100	55,000	120
Total				**140,000**	**300**
C2a - C&I Existing Building Retrofit					
2025	4,210	420	28,400	303,000	610
2026	4,630	480	30,800	326,000	680
2027	4,920	540	32,300	338,000	730
Total				**967,000**	**2,020**
C2b - C&I New & Replacement Equipment					
2025	1,830	210	14,200	152,000	610
2026	1,870	220	14,400	157,000	640
2027	1,870	220	14,200	156,000	640
Total				**465,000**	**1,890**
C&I Sector Total					
2025	6,460	720	45,400	493,000	1,300
2026	7,030	820	48,700	530,000	1,420
2027	7,420	900	50,600	549,000	1,490
Total				**1,572,000**	**4,210**

Source: Guidehouse

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Table 4-30. C&I Sector, Electric 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	4.31	$2.2	$0.5	$0.1	$0.2
2026	4.31	$2.7	$0.6	$0.2	$0.3
2027	4.40	$3.2	$0.7	$0.2	$0.3
Total	**4.35**	**$8.1**	**$1.9**	**$0.6**	**$0.9**
C2 - C&I Existing Buildings					
2025	1.84	$18.0	$9.8	$2.6	$9.6
2026	1.80	$19.2	$10.7	$3.0	$10.9
2027	1.79	$20.0	$11.2	$3.3	$12.0
Total	**1.81**	**$57.2**	**$31.6**	**$8.9**	**$32.5**
C3 - C&I Hard-to-Measure					
2025	N/A	N/A	$4.8	$4.8	N/A
2026	N/A	N/A	$5.4	$5.4	N/A
2027	N/A	N/A	$5.9	$5.9	N/A
Total			**$16.1**	**$16.1**	
C&I Sector Total					
2025	1.34	$20.2	$15.1	$7.6	$9.9
2026	1.31	$21.9	$16.7	$8.6	$11.2
2027	1.30	$23.2	$17.9	$9.4	$12.3
Total	**1.32**	**$65.4**	**$49.6**	**$25.6**	**$33.4**

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. The pattern among the top measures in the CECP Cost Premium scenario is identical to that of the CECP scenario because there is no change to measure quantities between the two scenarios.

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

#	Measure	Core Initiative	LT Savings
1	Insulation	A2a - Residential Coordinated Delivery	8,245,740
2	Ductless MSHP Partially Displacing Oil Boiler	A2c - Residential Retail	2,418,940
3	Air Sealing	A2a - Residential Coordinated Delivery	1,375,380
4	ER Baseboard to DMSHP	A2c - Residential Retail	1,254,240
5	Heat Pump Water Heater	A2c - Residential Retail	1,098,420
6	All-Electric Passive House	A1a - Residential New Homes & Renovations	1,039,990
7	Central Heat Pump	A2c - Residential Retail	984,070
8	Central ASHP Partially Displacing Oil Furnace	A2c - Residential Retail	654,080
9	Ductless MSHP Partially Displacing Propane Boiler	A2c - Residential Retail	541,300
10	W2W GSHP Replacing Oil Boiler	A2c - Residential Retail	452,760
11	All-Electric Passive House	A1a - Residential New Homes & Renovations	387,570
12	Insulation	B1a - Income Eligible Coordinated Delivery	353,260
13	Duct Insulation	A2a - Residential Coordinated Delivery	330,030
14	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	307,570
15	Air Sealing	C2a - C&I Existing Building Retrofit	298,180
16	Custom Large C&I	C2a - C&I Existing Building Retrofit	272,030
17	Duct Sealing	A2a - Residential Coordinated Delivery	270,950
18	Central ASHP Partially Displacing Propane Furnace	A2c - Residential Retail	250,070
19	Ductless Mini-Split Heat Pump (DMSHP)	A2c - Residential Retail	215,220
20	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	209,140
21	Ductless MSHP Partially Displacing Oil Boiler	B1a - Income Eligible Coordinated Delivery	198,920
22	Air to water heat pumps, oil baseline	A2c - Residential Retail	175,070
23	Heat Recovery Ventilator	A2c - Residential Retail	148,330
24	Pipe Wrap (Space Heating)	A2a - Residential Coordinated Delivery	146,890
25	Wi-Fi Thermostat	A2c - Residential Retail	111,940

Source: Guidehouse

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

#	Measure	Core Initiative	CO2e in 2030
1	Ductless MSHP Partially Displacing Oil Boiler	A2c - Residential Retail	22,935
2	Insulation	A2a - Residential Coordinated Delivery	22,916
3	Air Sealing	A2a - Residential Coordinated Delivery	6,528
4	Central ASHP Partially Displacing Oil Furnace	A2c - Residential Retail	6,476
5	All-Electric Passive House	A1a - Residential New Homes & Renovations	4,682
6	Ductless MSHP Partially Displacing Propane Boiler	A2c - Residential Retail	3,950
7	Heat Pump Water Heater	A2c - Residential Retail	2,078
8	Central ASHP Partially Displacing Propane Furnace	A2c - Residential Retail	1,912
9	W2W GSHP Replacing Oil Boiler	A2c - Residential Retail	1,785
10	Air to water heat pumps, oil baseline	A2c - Residential Retail	1,508
11	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	1,430
12	ER Baseboard to DMSHP	A2c - Residential Retail	1,407
13	Ductless MSHP Fully Replacing Oil Boiler	A2c - Residential Retail	1,358
14	Ductless MSHP Partially Displacing Oil Boiler	B1a - Income Eligible Coordinated Delivery	1,277
15	Central Heat Pump	A2c - Residential Retail	1,277
16	Duct Insulation	A2a - Residential Coordinated Delivery	1,140
17	Insulation	B1a - Income Eligible Coordinated Delivery	949
18	Duct Sealing	A2a - Residential Coordinated Delivery	932
19	Heat Recovery Ventilator	A2c - Residential Retail	761
20	Custom Large C&I	C2a - C&I Existing Building Retrofit	734
21	Pipe Wrap (Space Heating)	A2a - Residential Coordinated Delivery	703
22	Air to water heat pumps, propane baseline	A2c - Residential Retail	647
23	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	594
24	Wi-Fi Thermostat	A2c - Residential Retail	520
25	Air Sealing	B1a - Income Eligible Coordinated Delivery	520

Source: Guidehouse

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5. Demand Response Potential Assessment Methodology

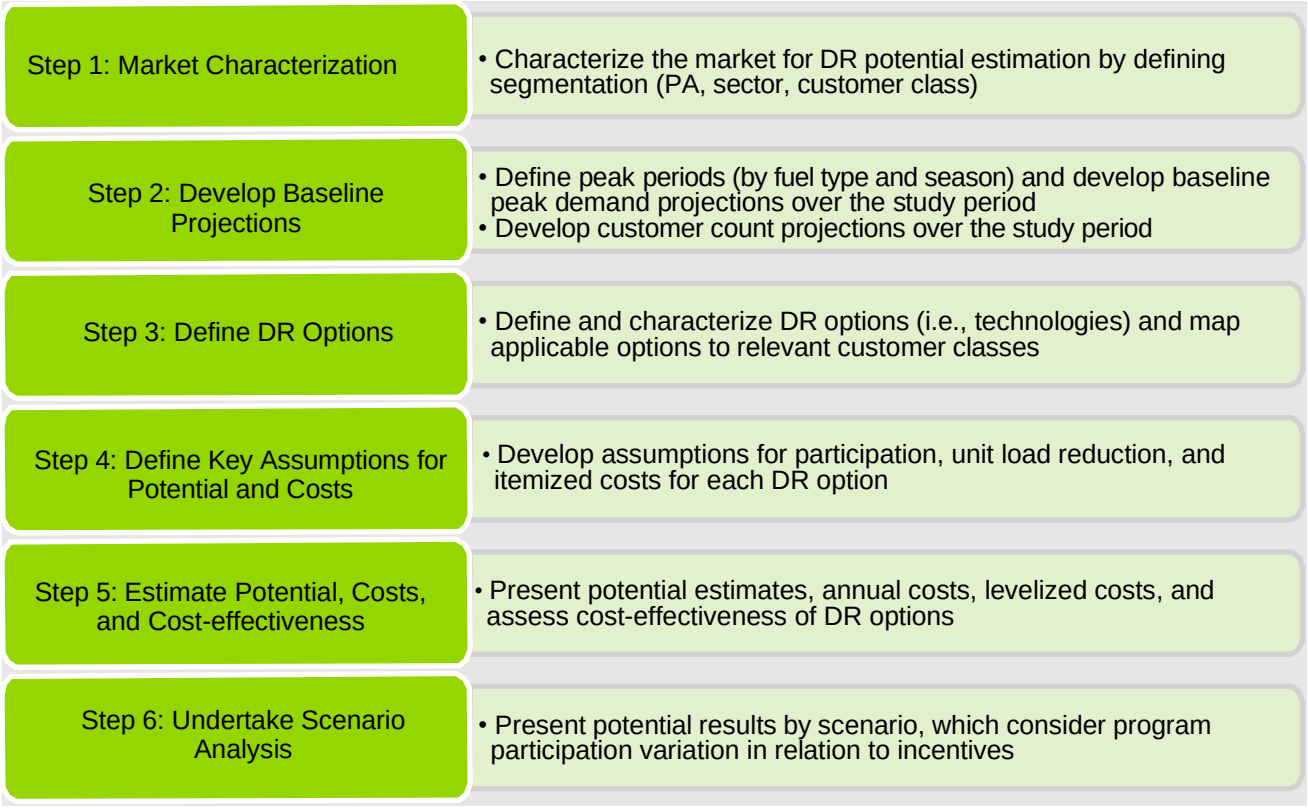
This section describes the approach for developing potential and cost estimates for Demand Response (DR), referred to as active demand reduction or active demand management. Using previous Massachusetts DR potential studies as a starting point, Guidehouse worked with Cape Light Compact to represent relevant DR program types that Cape Light Compact currently offers or could potentially offer to realize summer electric and winter electric peak demand reductions. Guidehouse developed DR potential and cost estimates using a bottom-up analysis. The analysis utilizes a combination of primary data (e.g., market and DR program data from Cape Light Compact) 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 of DR options and suboptions.
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 (summer electric and winter electric) The market characterization processes utilize data provided directly by Cape Light Compact 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 (includes IE) • Commercial and Industrial (C&I)
Level 2: Customer Class	• Residential • C&I (Electric): – Small & Medium C&I (< 100 kW maximum demand) – Large C&I (≥ 100 kW maximum demand)

Note: Customer segments are mapped to applicable DR program types in our analysis. For electric, Guidehouse covers both summer and winter peak demand reduction options. Some DR options are common for both summer and winter electric peak demand reduction, whereas others apply to one season only. The gas DR options are characterized separately and apply to the customer segments listed for the gas DR analysis.
Note: Residential DR analysis included both market rate and IE customers under Residential.
Note: C&I Electric segmentation is based on the data obtained from class average load profile information. The demand 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. For the C&I sector, there is an additional segmentation to customer class, which represents size and rate class categories.

For electricity, the C&I customer class segmentation is based on maximum demand values, which were identified using rate class distinctions, class average load profiles, and demand data. The rate classes were cross-referenced with class average load profile data to determine maximum demand values for each rate class. The rate classes were then sorted into Small & Medium C&I or Large C&I customer class segments, with the cutoff threshold of 100 kW. Table 5-2 details the C&I rate class to customer class mapping for Cape Light Compact.

Table 5-2. Electric C&I Rate Class to Customer Class Map

PA	Customer Class	Rate Classes
CLC	Small & Medium	G1, G5, G7
CLC	Large	G2, G3

Source: Guidehouse

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

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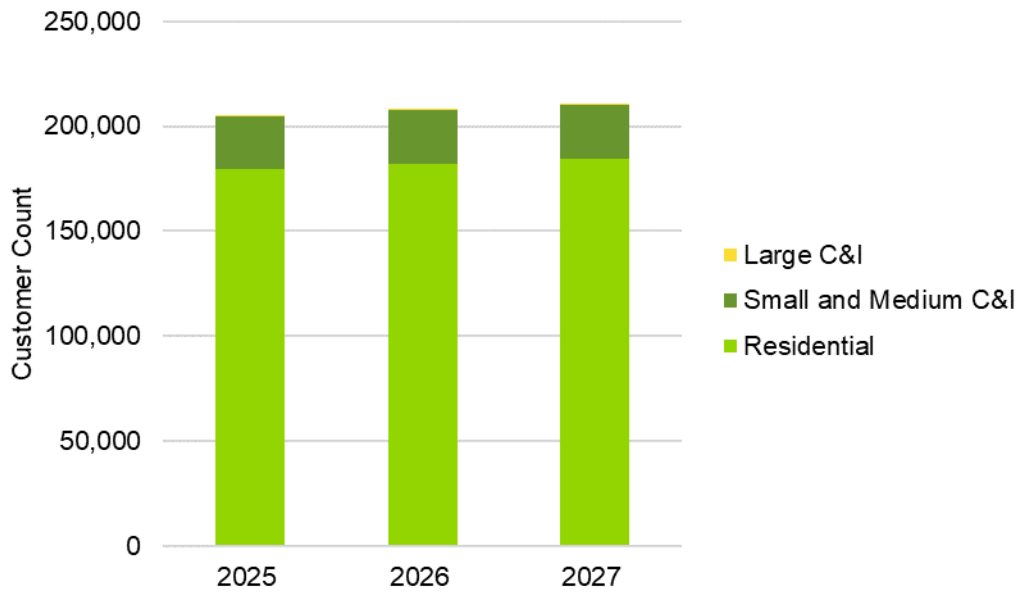
segment over the potential analysis 3-year period (2025-2027). These projections were developed at the following levels for the DR potential assessment:

- Customer Count Projections
  - Fuel Type (Electric)
  - Customer Segment (Sector, Customer Class)
- Peak Demand Projections
  - Fuel Type (Electric)
  - Season (Summer Electric, Winter Electric)
  - 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 utilized the same customer count projections as developed for the EE market characterization. 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. Where available, Guidehouse directly used the number of existing and forecasted accounts from Cape Light Compact data and projected out to future years using growth trends from prior years.

Figure 5-2. Electric Customer Count Forecast by Customer Class



Source: Guidehouse

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 fuel type, season, and customer segment. These estimates serve

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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 Electric Peak Demand Projections (Summer and Winter)

Table 5-3 describes the methodology used to develop electric peak demand projections for both summer and winter seasons. A key element of market characterization for the DR potential study is to develop disaggregated bottom-up peak demand projections by customer class, building type, and end use, which serves as the foundation for the DR potential estimates. Table 5-3 outlines the approach followed to develop baseline peak demand projections.

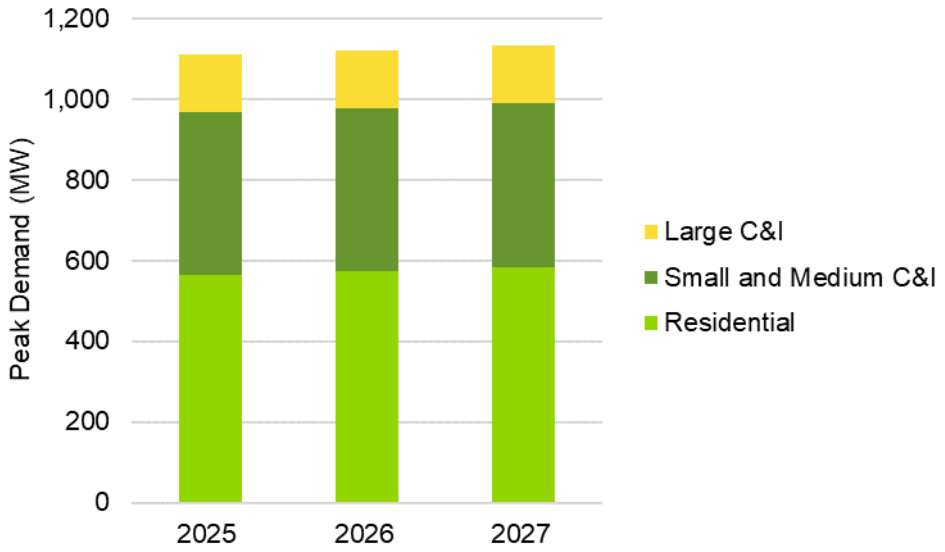
Table 5-3. Electric Baseline Peak Demand Projection Methodology

Define Peak Periods
• The peak period is defined as the highest ISO-NE load hour (in both summer and winter seasons). The peak hour in base years was identified using ISO-NE historical load data.
Obtain Class Average Load Profiles
• Guidehouse used publicly available data from Eversource to obtain average hourly load profiles by rate class, and this was applied for Cape Light Compact in the absence of Cape Light Compact-provided data. These profiles provide hourly kW per customer load estimates for each rate class. • Guidehouse used the maximum hourly contribution from each class average load profile to assign each rate class to the appropriate C&I size and customer class segment.
Calculate Peak Contributions by Customer Segment
• Guidehouse calculated aggregate hourly load for each customer segment by multiplying class average load profiles with customer counts. • Guidehouse then overlaid the ISO-NE identified peak period hours to determine bottom-up coincident peak demand contributions by customer class.
Compare to Cape Light Compact Peak Data
• Guidehouse compared bottom-up coincident peak demand estimate with Cape Light Compact-provided data. Since Cape Light Compact-provided data is not necessarily coincident with ISO-NE peak, the data was used to confirm the magnitude of the bottom-up coincident peak demand estimates.

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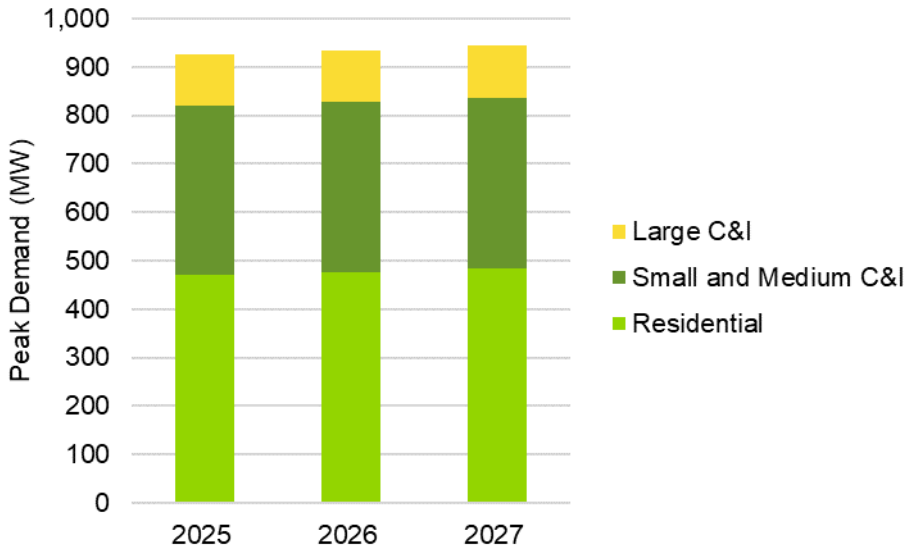
Figure 5-3 and Figure 5-4 show the estimated summer and winter electric peak demand, respectively, over the forecast period, broken out by customer segment.

Figure 5-3. Summer Electricity Baseline Peak Forecast by Customer Segment



Source: Guidehouse

Figure 5-4. Winter Electricity 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. Table 5-4 summarizes the broad electric DR options included in the analysis. Table 5-5. gives the full list of more granular electric DR suboptions within each DR option. The

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suboptions represent specific end uses and control technologies. The DR options considered are representative of what Cape Light Compact currently offers and other commonly deployed programs and emerging DR-enabling technologies in the industry.

The DLC-Electric option applies to Residential and Small and Medium C&I customers. The end uses and DR enabling technologies under DLC include Cape Light Compact's Bring Your Own Thermostat (BYOT) option under Connected Solutions and other end uses and DR enabling technology combinations to directly control electric water heating, pool pumps, and smart appliances during peak demand periods. For Small and Medium C&I customers, DR suboptions included HVAC thermostat control and electric water heating control.

The C&I Curtailment – Electric option represent demand reductions through control of a variety of end uses at customer facilities using a combination of manual and automated control mechanisms. The projected demand reductions under C&I Curtailment represent what is currently available through existing customer recruitment (in Targeted and Daily Dispatch programs) along with the additional capacity that could be potentially available over the 2025-2027 timeframe considered in this study. Dispatch of BTM batteries for peak demand reduction was considered for all customer classes, representing Cape Light Compact's current program.

Table 5-4. Summary of Electric DR Options

DR Option	Brief Description	Eligible Customer Classes	End Use
DLC - Electric	Direct control of electric loads by a thermostat and/or load control switch or via smart appliances	Residential Small & Medium C&I	Space Cooling Space Heating Room AC HVAC Clothes Dryer Clothes Washer Dehumidifier Pool Pump Water Heating
C&I Curtailment – Electric (Targeted Dispatch and Daily Dispatch)	Firm capacity reduction commitment. $/kW payment based on delivered capacity, administered through third party aggregators	Large C&I	HVAC Lighting Refrigeration Water Heating Total Facility
BTM Battery	Dispatch of BTM Batteries for peak demand reduction	Residential Small & Medium C&I Large C&I	Batteries
Behavioral DR - Electric	Behavioral interventions to induce peak demand reductions	Residential	All

Note: Space Cooling, Space Heating, and Room AC apply to Residential. For Small & Medium C&I, Guidehouse refers to the end-use load type as HVAC.

Note: Targeted Dispatch represents CLC's Interruptible Load offer

Source: Guidehouse

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Table 5-5. Summary of Electric DR Suboptions

DR Option	DR Suboption	End Use
DLC - Electric	BYOT-Smart Thermostat-Space Cooling Control	Space Cooling (summer only)
	BYOT-Smart Thermostat-Space Heating Control	Space Heating (winter only)
	BYOD-Room AC	Room AC (summer only)
	DLC-Smart Thermostat HVAC Control	HVAC (C&I)
	BYOD-Clothes Dryer	Clothes Dryer
	BYOD-Clothes Washer	Clothes Washer
	BYOD-Dehumidifier	Dehumidifier
	BYOD-Pool Pump	Pool Pump
	Switch-Pool Pump	
	BYOD-Water Heaters-Electric Resistance	Water Heating
	BYOD-Water Heaters-HPWH	
	DLC-Electric Water Heating Control	
	Switch-Water Heating Control-Electric Resistance	
	Switch-Water Heating Control-HPWH	
C&I Curtailment – Electric (Targeted Dispatch and Daily Dispatch)	C&I Curtailment - Manual HVAC	HVAC
	C&I Curtailment - Auto-DR HVAC	
	C&I Curtailment - Standard Lighting Control	Lighting
	C&I Curtailment - Advanced Lighting Control	
	C&I Curtailment - Refrigeration	Refrigeration
	C&I Curtailment - Water Heating	Water Heating
	C&I Curtailment - Industrial	Total Facility
	C&I Curtailment – C&I Battery Dispatch	Batteries
Res – BTM Battery	Res Battery Dispatch	Batteries
Behavioral DR - Electric	Behavioral DR- Electric	All

Note: Automated Demand Response (Auto-DR) is a platform to automatically activate a pre-programmed load reduction strategy in response to a signal from a Demand Response Automation Server (DRAS). *For example. the EMCS controlling the HVAC is pre-programmed with load reduction strategies that are automatically initiated upon receipt of remote signal. So instead of having to manually adjust HVAC load at a facility, Auto-DR sends a signal from a central server that launches the customer's pre-programmed load adjustment strategy. The customer always retains the ability to override the curtailment sequence in the event a site cannot participate in a specific demand response dispatch. Auto-DR ensures higher reliability of response without manual intervention.*

Source: Guidehouse

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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 current DR program data (enrollment, impacts, and costs) from Cape Light Compact's Massachusetts service territory and the Guidehouse team's experience with similar DR potential studies and program performance data/information from DR programs in other jurisdictions.

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	• kW reduction per device for DLC (Residential and small and medium C&I customers). • Percentage of enrolled load by end use/total facility/battery for DLC (Large C&I customers), C&I Curtailment, BTM Batteries, and EV Managed Charging.
Costs[43]	• One-time fixed costs related to program development. • One-time variable costs for customer recruitment and program marketing, equipment installation and enablement. • Recurring fixed and variable costs such as annual program admin. costs, customer incentives, O&M, etc.
Global Parameters	• Program Lifetime, Discount Rate, Avoided Costs.

Source: Guidehouse

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

Equation 5-1. DR Achievable Potential

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

[43] Itemized buildup of costs was only considered for new DR options and suboptions. The non-incentive costs for existing DR options and suboptions (those currently offered by CLC) were based on CLC's current program experience.

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In addition to the potential estimates, Guidehouse developed annual and levelized costs by DR options and suboptions and conducted cost-effectiveness assessments of these options and suboptions.

5.4.1 Key Assumptions for DR Potential and Cost-Effectiveness Assessment

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

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 participation assumptions for existing programs are built off historical program achievements presented in the BCR models.

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 kW reduction per participant or as a percent of enrolled load. For the DLC option, unit impacts are based on a per-kW 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. For example, the load reductions associated with Manual HVAC control and Auto-DR HVAC control are different and are specified accordingly. For existing program offers, the unit impact assumptions are aligned with latest evaluation findings on these programs.[44]

5.4.1.2 Program Costs and Related Assumptions for Cost-Effectiveness

For existing DR suboptions (those that Cape Light Compact currently offers), Guidehouse calculated program costs using assumptions derived from Cape Light Compact's evaluated BCR model for 2022 and Plan BCR model for 2022-2024. Information from current program offers were used to develop per-customer incentive costs, and the BCR models were used to derive ratios of non-incentive costs to incentive costs which were used to calculate future costs for these existing programs.

For new DR suboptions (those that Cape Light Compact does not currently offer but could in the future), Guidehouse developed itemized cost assumptions that include upfront program setup costs, marketing and recruitment costs, and ongoing program administration and O&M costs.

Cost-effectiveness was calculated for summer electric for each DR suboption and is based on the Total Resource Cost (TRC) test and aligned with how benefit-cost ratios are calculated in the BCR model. Table 5-7 summarizes the benefits and costs considered in the cost-effectiveness assessment of DR options. Guidehouse followed the methodology used in Cape Light Compact's 2022-2024 BCR models, in which the only cost component included in the cost

[44] For the BYOT and the Targeted Dispatch program ("Interruptible Offer"), the MW savings for 2022 were calibrated to the values in the 2022 evaluated BC model.

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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

Electric Benefits	Costs
Avoided Retail Uncleared Capacity Costs	Incentives
Avoided Transmission Capacity	
Avoided Distribution Capacity	
Avoided Capacity DRIPE	
Avoided Reliability Costs	

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. The winter electric potential represents potential from DR options that passed economic screening in summer.

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 available for similar program offers in other jurisdictions.[45]

[45] Guidehouse used latest information available in California Demand Response potential studies conducted by the Lawrence Berkeley National Lab.

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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:[46]

- Cost-Effectiveness Assessment Results with Benefit-to-Costs Ratios:
  - Benefit-to-Cost Ratios for Electric 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 summer electric 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.[47]

6.1.1 BAE Scenario Cost-Effectiveness Results

Table 6-1 shows electric TRC benefit-cost ratios for the BAE scenario by DR Options and Suboptions. Green cells indicate that the suboption is cost-effective (i.e., benefit-cost ratio above 1.0), while red cells indicate that the suboption is not cost-effective. Most of the suboptions are cost-effective. Cost-effectiveness increases from 2025-2027 with increase in avoided costs over that period. Due to that, certain suboptions that are not cost-effective in 2025 switch to being cost-effective in 2026 and 2027. The ones that are currently offered by CLC remain cost-effective over 2025-2027.

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

[47] Note that Behavioral DR does not offer any incentives to customers and therefore TRC benefit-cost ratio calculations do not apply to Behavioral DR.

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

DR Option	DR Suboption	TRC Ratio (BAE Scenario)		
		2025	2026	2027
DLC - Electric	Res BYOD-Clothes Dryer	0.69	0.99	1.12
	Res BYOD-Clothes Washer	0.10	0.14	0.16
	Res BYOD-Dehumidifier	1.46	2.02	2.39
	Res BYOD-Pool Pump	4.39	6.07	7.19
	Res BYOD-Room AC	1.63	2.25	2.66
	Res BYOD-Water Heaters-Electric Resistance	1.55	2.14	2.53
	Res BYOD-Water Heaters-HPWH	0.70	0.96	1.14
	Res BYOT-Smart Thermostat-Space Cooling Control	5.90	6.64	6.21
	Res Switch-Pool Pump	4.39	6.53	7.46
	Res Switch-Water Heating Control-Electric Resistance	1.55	2.30	2.63
	Res Switch-Water Heating Control-HPWH	0.70	1.04	1.18
	C&I DLC-Electric Water Heating Control	1.55	2.28	2.62
	C&I DLC-Smart Thermostat HVAC Control	3.87	4.80	5.21
C&I Targeted Dispatch - Electric	C&I Targeted Dispatch	10.52	10.80	10.82
C&I Daily Dispatch - Electric	C&I Daily Dispatch-Battery	2.07	2.31	2.33
Res – BTM Battery	Res Battery Dispatch	1.51	1.70	1.72

Note: The Residential Behavioral DR – Electric 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.

Note: C&I Targeted Dispatch represents the "Interruptible Load" offer by CLC.

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 electric TRC benefit-cost ratios for the MAX scenario. All benefit-cost ratios in the MAX scenario are lower than those in BAE. As costs increase, the Res Battery Dispatch suboption verges on being non-cost effective. Certain suboptions that were close to the cost-effectiveness threshold in BAE (e.g., BYOD-water heaters-HPWH) are not cost-effective under the MAX scenario.

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

DR Option	DR Suboption	TRC Ratio (MAX Scenario)		
		2025	2026	2027
DLC - Electric	Res BYOD-Clothes Dryer	0.56	0.76	0.84
	Res BYOD-Clothes Washer	0.08	0.11	0.12
	Res BYOD-Dehumidifier	1.19	1.57	1.79
	Res BYOD-Pool Pump	3.59	4.71	5.37
	Res BYOD-Room AC	1.33	1.75	1.99
	Res BYOD-Water Heaters-Electric Resistance	1.27	1.66	1.89
	Res BYOD-Water Heaters-HPWH	0.57	0.75	0.85
	Res BYOT-Smart Thermostat-Space Cooling Control	4.21	4.66	4.45
	Res Switch-Pool Pump	3.59	4.99	5.52
	Res Switch-Water Heating Control-Electric Resistance	1.27	1.76	1.94
	Res Switch-Water Heating Control-HPWH	0.57	0.79	0.87
	C&I DLC-Electric Water Heating Control	1.27	1.74	1.94
	C&I DLC-Smart Thermostat HVAC Control	4.60	2.84	3.36
C&I Targeted Dispatch - Electric	C&I Targeted Dispatch	7.02	7.20	7.21
C&I Daily Dispatch - Electric	C&I Daily Dispatch-Battery	1.38	1.54	1.56
Res – BTM Battery	Res Battery Dispatch	1.01	1.14	1.15

Note: The Residential Behavioral DR – Electric 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.

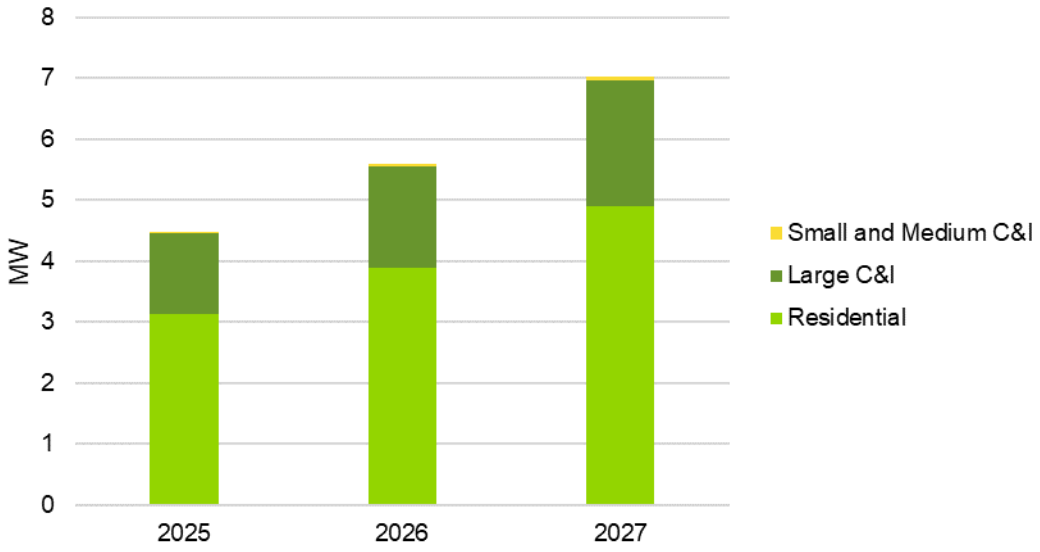
Source: Guidehouse

6.2 DR Achievable Potential Results

This section presents achievable potential results for cost-effective DR suboptions under the BAE scenario. Figure 6-1 shows the overall summer electric achievable potential for all sectors. Most of the savings are projected from the Residential segment compared to the Large C&I segment, with a very small amount of potential for the Small and Medium C&I segment. For more details and levels of aggregation of achievable potential, including summaries for the BAE and MAX scenarios, see Appendix D.

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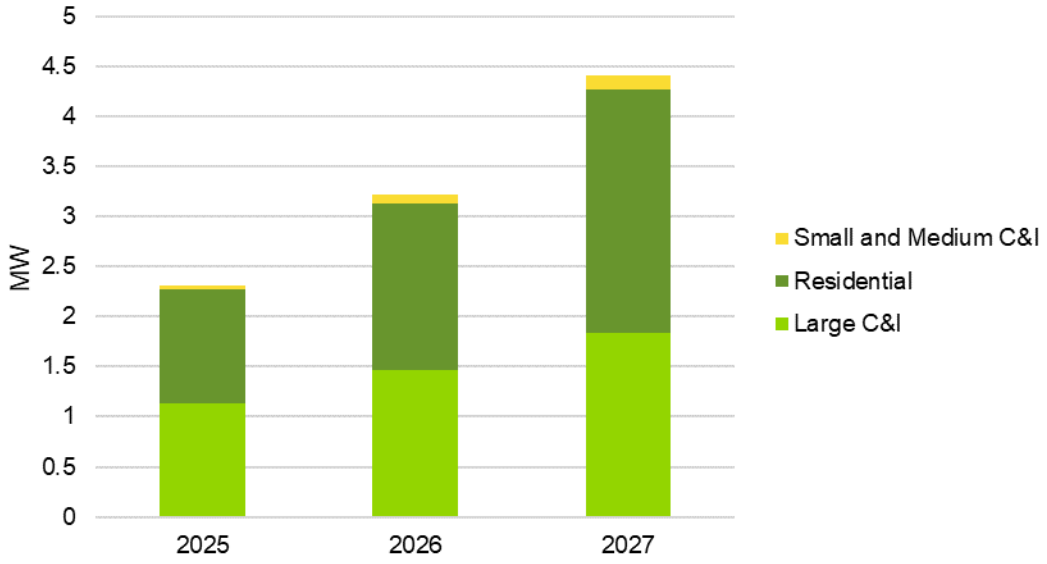
Figure 6-1. Summer Electric BAE Scenario DR Achievable Potential



Source: Guidehouse

Figure 6-2 shows the overall winter electric achievable potential for all sectors, which only includes DR suboptions that were assessed to be cost-effective. Most of the winter savings are projected from the Residential segment, with a very small amount of potential for the Small and Medium C&I segment. Winter DR potential is approximately three-quarters of the summer electric potential.

Figure 6-2. Winter Electric BAE Scenario DR Achievable Potential



Source: Guidehouse

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6.2.1 Achievable Potential Results by DR Option

Table 6-3 and Table 6-4 show the summer and winter electric DR achievable potential by DR option for the BAE scenario. These options only include the cost-effective suboptions as presented in Table 6-1. For both summer and winter periods, the total DR savings increase slightly over the 3-year period for the BAE scenario, with the Res DLC-Electric option being the leading option for the Residential sector and C&I Daily Dispatch-Electric being the leading option for the C&I Sector for summer potential. For winter potential, BTM battery dispatch has largest contribution under Residential and C&I Daily Dispatch has largest contribution under C&I.

Table 6-3. Summer Electric DR BAE Scenario Achievable Potential by Option

DR Option	2025 (MW) BAE Scenario	2026 (MW) BAE Scenario	2027 (MW) BAE Scenario
DLC-Electric	2.3	2.9	3.7
Res - BTM Battery	0.85	1.0	1.2
Subtotal Residential	**3.1**	**3.9**	**4.9**
DLC-Electric	0.03	0.04	0.05
C&I Targeted Dispatch-Electric	0.6	0.6	0.7
C&I Daily Dispatch-Electric	0.7	1.0	1.4
Subtotal C&I	**1.4**	**1.7**	**2.1**
Total	**4.5**	**5.6**	**7.0**

Source: Guidehouse

Table 6-4. Winter Electric DR BAE Scenario Achievable Potential by Option

DR Option	2025 (MW) BAE Scenario	2026 (MW) BAE Scenario	2027 (MW) BAE Scenario
DLC-Electric	0.28	0.64	1.2
Res - BTM Battery	0.85	1.0	1.2
Subtotal Residential	**1.1**	**1.7**	**2.4**
DLC-Electric	0.04	0.09	0.13
C&I Targeted Dispatch-Electric	0.4	0.4	0.5
C&I Daily Dispatch-Electric	0.7	1.0	1.4
Subtotal C&I	**1.2**	**1.6**	**2.0**
Total	**2.3**	**3.2**	**4.4**

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 for cost-effective suboptions. Analogous results for the MAX scenario are provided in Appendix D. The results in this section represent the total annual costs Cape Light Compact is estimated to incur to realize the potential values discussed above. The costs represent a sum of incentives and non-incentive costs for implementing DR programs. For

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new program offers, the non-incentive costs include program start up and implementation costs whereas for existing programs the non-incentive costs are the continuing implementation costs.

Table 6-5 and Table 6-6 present annual program costs for the summer and winter electric DR options. Non-incentive costs are greater than incentives annually, with costs increasing over the study period. The C&I sector has a greater proportion of costs from incentives, while the Residential sector costs greater for non-incentives.

Table 6-5. Summer Electric DR BAE Scenario Portfolio Costs by Sector and Cost Category

Sector	Cost Category	2025 ($) BAE Scenario	2026 ($) BAE Scenario	2027 ($) BAE Scenario
Residential	Incentives	$446,000	$560,000	$745,000
Residential	Non-Incentives	$770,000	$976,000	$1,213,000
Subtotal Residential		**$1,216,000**	**$1,537,000**	**$1,959,000**
C&I	Incentives	$184,000	$250,000	$325,000
C&I	Non-Incentives	$96,000	$129,000	$168,000
Subtotal C&I		**$281,000**	**$379,000**	**$493,000**
Subtotal Incentives		$631,000	$810,000	$1,070,000
Subtotal Non-Incentives		$866,000	$1,106,000	$1,381,000
Total		**$1,497,000**	**$1,915,000**	**$2,452,000**

Source: Guidehouse

Table 6-6. Winter Electric DR BAE Scenario Portfolio Costs by Sector and Cost Category

Sector	Cost Category	2025 ($) BAE Scenario	2026 ($) BAE Scenario	2027 ($) BAE Scenario
Residential	Incentives	$62,000	$101,000	$179,000
Residential	Non-Incentives	$170,000	$281,000	$380,000
Subtotal Residential		**$231,000**	**$382,000**	**$559,000**
C&I	Incentives	$51,000	$69,000	$89,000
C&I	Non-Incentives	$29,000	$38,000	$48,000
Subtotal C&I		**$80,000**	**$107,000**	**$138,000**
Subtotal Incentives		$113,000	$170,000	$268,000
Subtotal Non-Incentives		$198,000	$319,000	$428,000
Total		**$311,000**	**$489,000**	**$696,000**

Source: Guidehouse

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Table 6-7 and Table 6-8 show the breakdown of incentive costs among the summer and winter electric DR options. For the Residential sector for the summer peak period, costs are approximately the same between the two options. Res-BTM Battery starts off with higher costs but is overtaken by Res DLC-Electric by 2027. In both summer and winter, for the C&I sector, most of the costs are associated with the C&I Daily Dispatch option.

Table 6-7. Summer Electric DR BAE Scenario Incentive Costs by Option

DR Option (Electric)	2025 ($) BAE Scenario	2026 ($) BAE Scenario	2027 ($) BAE Scenario
DLC-Electric	$196,000	$259,000	$392,000
Res - BTM Battery	$250,000	$301,000	$353,000
Subtotal Residential	**$446,000**	**$560,000**	**$745,000**
DLC-Electric	$3,200	$3,800	$4,400
C&I Targeted Dispatch-Electric	$22,000	$24,000	$26,000
C&I Daily Dispatch-Electric	$159,000	$222,000	$295,000
Subtotal C&I	**$184,000**	**$250,000**	**$325,000**
Total	**$631,000**	**$810,000**	**$1,070,000**

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

Table 6-8. Winter Electric DR BAE Scenario Incentive Costs by Option

DR Option (Electric)	2025 ($) BAE Scenario	2026 ($) BAE Scenario	2027 ($) BAE Scenario
DLC-Electric	$16,000	$46,000	$114,000
Res - BTM Battery	$45,000	$55,000	$64,000
Subtotal Residential	**$62,000**	**$101,000**	**$179,000**
DLC-Electric	$1,100	$2,300	$3,500
C&I Targeted Dispatch-Electric	$11,000	$11,000	$12,000
C&I Daily Dispatch-Electric	$40,000	$55,000	$74,000
Subtotal C&I	**$51,000**	**$69,000**	**$89,000**
Total	**$113,000**	**$170,000**	**$268,000**

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

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6.4 Levelized Costs and Supply Curve

This section presents the levelized cost estimates for the DR options. Levelized costs are calculated over the study period and shown for all DR options and suboptions in the BAE scenario. These levelized costs only include the incentive costs. Table 6-9 shows the levelized costs for all electric DR suboptions under the BAE scenario. The Residential DR suboptions with the lowest levelized costs are Res BYOD-Pool Pump, Res Switch-Pool Pump, and Res BYOD-Smart Thermostat-Space Cooling Control. For C&I suboptions, C&I Targeted Dispatch has the lowest levelized cost.

Table 6-9. Electric DR BAE Scenario Levelized Costs ($/kW-yr.) for All Suboptions

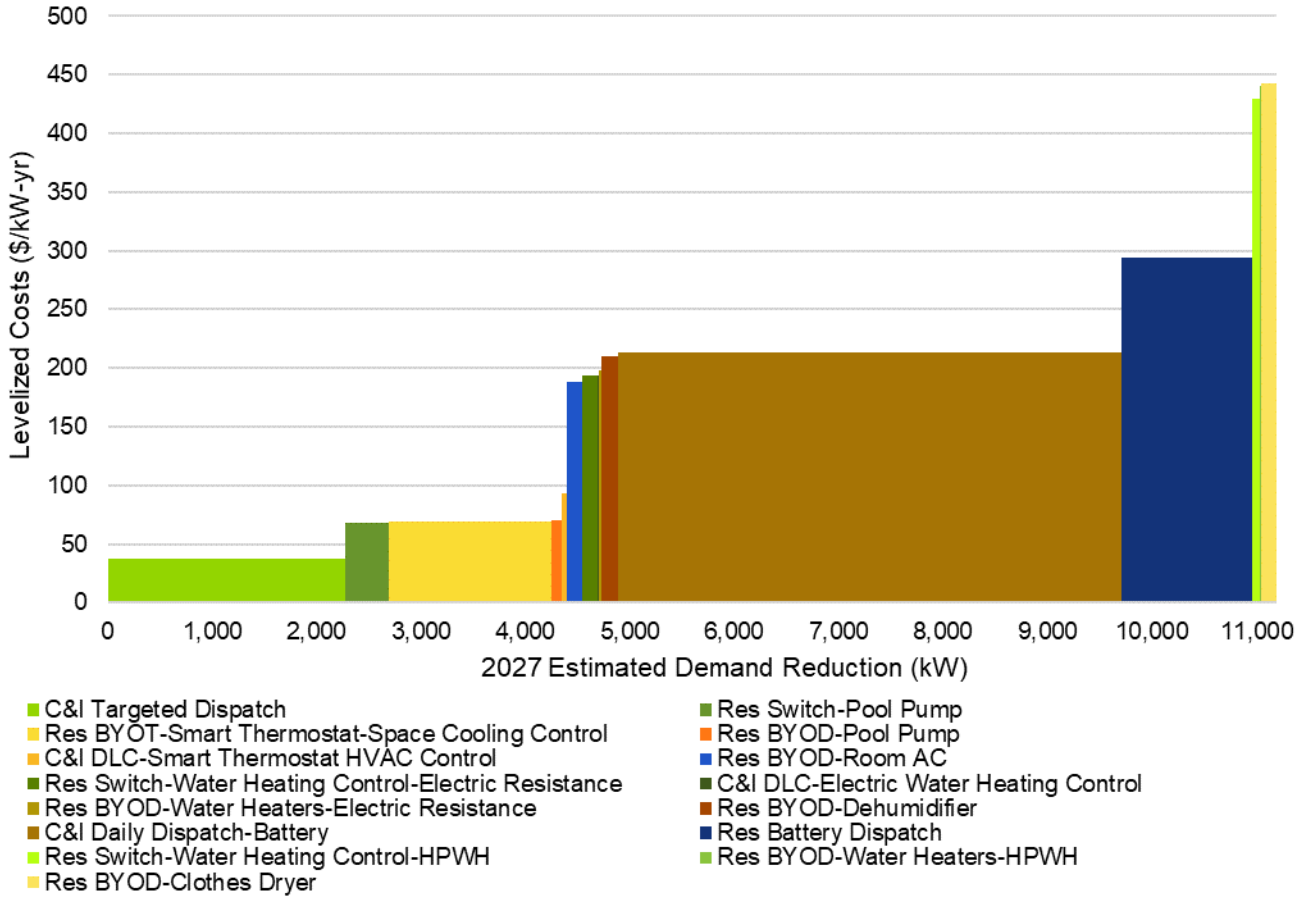
DR Option	DR Suboption	Levelized Cost, 2025-2027 ($/kW-yr.)
DLC - Electric	Res BYOD-Clothes Dryer	443
	Res BYOD-Clothes Washer	3189
	Res BYOD-Dehumidifier	210
	Res BYOD-Pool Pump	70
	Res BYOD-Room AC	188
	Res BYOD-Water Heaters-Electric Resistance	198
	Res BYOD-Water Heaters-HPWH	440
	Res BYOT-Smart Thermostat-Space Cooling Control	69
	Res Switch-Pool Pump	68
	Res Switch-Water Heating Control-Electric Resistance	193
	Res Switch-Water Heating Control-HPWH	430
	C&I DLC-Electric Water Heating Control	194
	C&I DLC-Smart Thermostat HVAC Control	93
C&I Targeted Dispatch - Electric	C&I Targeted Dispatch	37
C&I Daily Dispatch - Electric	C&I Daily Dispatch-Battery	214
Res – BTM Battery	Res Battery Dispatch	294

Source: Guidehouse

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Figure 6-3 shows the summer electric supply curve for all DR suboptions under the BAE scenario. The x-axis represents achievable potential in 2027 and the y-axis represents the levelized incentive cost ($/kW-yr.) associated with realizing the potential.[48] This figure can be used to guide program design, balancing the amount of DR potential available for each suboption with its cost.

Figure 6-3. Summer Electric Supply Curve for All DR Suboptions (BAE Scenario)



Note: Note that BDR is left out because of no incentives and Res BYOD-Clothes Washer was left out because of its high levelized cost.

Source: Guidehouse

6.5 DR MAX Scenario Potential Results

The total summer electric DR savings increase over the 3-year period for the MAX scenario, with the Res DLC-Electric option providing most of the annual savings, with the rest mostly from the C&I Daily Dispatch-Electric option. At the portfolio level, costs are relatively evenly split between incentive and non-incentive costs. At the option level, the Res-BTM Battery option is allocated more incentive dollars in both the winter and summer periods, due to the growing amount of dispatch in the MAX scenario.

[48] The non-incentive costs are represented in aggregate at the sector level and not by individual suboption and are presented in Section 6.3

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Table 6-10 shows the summer electric DR achievable potential by DR option for the MAX scenario. The total summer electric DR savings increase over the 3-year period for the MAX scenario, with the Res DLC-Electric option providing more of the annual savings, followed by the Res-BTM Battery option, and then the C&I Daily Dispatch-Electric option and the C&I Targeted Dispatch-Electric option, with the rest providing few savings.

Table 6-10. Summer Electric DR MAX Scenario Achievable Potential by Option

DR Option	2025 (MW) MAX Scenario	2026 (MW) MAX Scenario	2027 (MW) MAX Scenario
DLC-Electric	2.3	3.0	3.7
Res - BTM Battery	1.3	1.5	1.8
Subtotal Residential	**3.5**	**4.5**	**5.5**
DLC-Electric	0.02	0.04	0.06
C&I Targeted Dispatch-Electric	0.7	0.7	0.8
C&I Daily Dispatch-Electric	0.9	1.2	1.7
Subtotal C&I	**1.6**	**2.0**	**2.5**
Total	**5.1**	**6.5**	**8.0**

Source: Guidehouse

Table 6-11 shows the shows the winter electric DR achievable potential by DR option for the MAX scenario. The total winter electric DR savings increase over the 3-year period for the MAX scenario, with the Res-BTM Battery option proving more of the annual savings, followed by the C&I Daily Dispatch-Electric option, and then the C&I Targeted Dispatch-Electric option, with the rest providing few savings.

Table 6-11. Winter Electric DR MAX Scenario Achievable Potential by Option

DR Option	2025 (MW) MAX Scenario	2026 (MW) MAX Scenario	2027 (MW) MAX Scenario
DLC-Electric	0.31	0.6	1.0
Res - BTM Battery	1.3	1.5	1.8
Subtotal Residential	**1.6**	**2.2**	**2.8**
DLC-Electric	0.05	0.10	0.15
C&I Targeted Dispatch-Electric	0.4	0.5	0.5
C&I Daily Dispatch-Electric	0.9	1.2	1.7
Subtotal C&I	**1.4**	**1.8**	**2.3**
Total	**3.0**	**4.0**	**5.1**

Source: Guidehouse

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Table 6-12 presents the annual program costs for the summer electric MAX scenario DR options. Non-incentives costs comprise more of the costs annually, and the Residential sector has more non-incentive costs, while the C&I sector has more incentive costs annually.

Table 6-12. Summer Electric DR MAX Scenario Portfolio Costs by Sector and Cost Category

Sector	Cost Category	2025 ($) MAX Scenario	2026 ($) MAX Scenario	2027 ($) MAX Scenario
Residential	Incentives	$842,000	$1,018,000	$1,221,000
Residential	Non-Incentives	$1,368,000	$1,587,000	$1,865,000
Subtotal Residential		**$2,209,000**	**$2,604,000**	**$3,086,000**
C&I	Incentives	$325,000	$446,000	$582,000
C&I	Non-Incentives	$168,000	$229,000	$298,000
Subtotal C&I		**$493,000**	**$675,000**	**$880,000**
Subtotal Incentives		$1,167,000	$1,463,000	$1,803,000
Subtotal Non-Incentives		$1,536,000	$1,816,000	$2,163,000
Total		**$2,702,000**	**$3,279,000**	**$3,966,000**

Source: Guidehouse

Table 6-13 presents the annual program costs for the winter electric MAX scenario DR options. Non-incentive costs comprise more of the total costs annually, with most of these for the Residential sector, while the C&I sector has more incentive costs annually.

Table 6-13. Winter Electric DR MAX Scenario Portfolio Costs by Sector and Cost Category

Sector	Cost Category	2025 ($) MAX Scenario	2026 ($) MAX Scenario	2027 ($) MAX Scenario
Residential	Incentives	$129,000	$181,000	$234,000
Residential	Non-Incentives	$266,000	$309,000	$359,000
Subtotal Residential		**$395,000**	**$490,000**	**$592,000**
C&I	Incentives	$91,000	$122,000	$159,000
C&I	Non-Incentives	$49,000	$65,000	$84,000
Subtotal C&I		**$140,000**	**$188,000**	**$242,000**
Subtotal Incentives		$220,000	$303,000	$392,000
Subtotal Non-Incentives		$315,000	$374,000	$443,000
Total		**$534,000**	**$677,000**	**$835,000**

Source: Guidehouse

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Table 6-14 shows the breakdown of incentive costs among the summer electric MAX scenario DR options. mostly from the Residential options, which provide more of the cost annually. The Res-BTM Battery contributes more than the Res DLC-Electric option annually, followed by the C&I Daily Dispatch-Electric option, with the remaining options with little cost.

Table 6-14. Summer Electric DR MAX Scenario Incentive Costs by Option

DR Option (Electric)	2025 ($) MAX Scenario	2026 ($) MAX Scenario	2027 ($) MAX Scenario
DLC-Electric	$386,000	$519,000	$686,000
Res - BTM Battery	$562,000	$678,000	$794,000
Subtotal Residential	**$948,000**	**$1,197,000**	**$1,480,000**
DLC-Electric	$2,200	$6,700	$8,700
C&I Targeted Dispatch-Electric	$37,000	$40,000	$43,000
C&I Daily Dispatch-Electric	$286,000	$399,000	$530,000
Subtotal C&I	**$325,000**	**$446,000**	**$582,000**
Total	**$1,273,000**	**$1,642,000**	**$2,062,000**

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

Table 6-15 shows the breakdown of incentive costs among the winter electric MAX scenario DR options, mostly from the C&I Daily Dispatch-Electric option, which provides more of the cost annually. The Res-BTM Battery and C&I Targeted Dispatch options each provide about the same costs annually, followed by the Res DLC-Electric option and the C&I Targeted Dispatch-Electric option, with the C&I DLC-Electric option with little cost.

Table 6-15. Winter Electric DR MAX Scenario Incentive Costs by Option

DR Option (Electric)	2025 ($) MAX Scenario	2026 ($) MAX Scenario	2027 ($) MAX Scenario
DLC-Electric	$27,000	$57,000	$89,000
Res - BTM Battery	$102,000	$123,000	$144,000
Subtotal Residential	**$129,000**	**$181,000**	**$234,000**
DLC-Electric	$1,900	$3,800	$5,700
C&I Targeted Dispatch-Electric	$17,000	$19,000	$20,000
C&I Daily Dispatch-Electric	$72,000	$100,000	$133,000
Subtotal C&I	**$91,000**	**$122,000**	**$159,000**
Total	**$220,000**	**$303,000**	**$392,000**

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

The total summer electric DR savings increase over the 3-year period for the MAX scenario, with the Res DLC-Electric option providing most of the annual savings, with the rest mostly from the Res-BTM Battery and the C&I Daily Dispatch-Electric option. At the portfolio level, costs are relatively evenly split between incentive and non-incentive costs. At the option level, the Res-BTM Battery option is allocated more incentive dollars in the summer and winter periods, due to the growing amount of dispatch in the MAX scenario.

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7. Solar PV Codelivery with Energy Efficiency

7.1 Overview of Codelivery

Codelivery is the linked or simultaneous delivery of energy efficiency (EE) and other non-EE services or products. Cape Light Compact (CLC) is interested in the development of a codelivery strategy that combines EE and/or electrification measures with solar photovoltaics (Solar PV), and which reflects the influence of Inflation Reduction Act (IRA), as well as SMART program and any other local/regional influencing factors. A codelivery program that combines the implementation of these components could provide customers with a more streamlined interaction with CLC as they modernize their buildings and transition to a less carbon intensive energy future and could help CLC to prioritize measures that minimize grid constraints and prioritize the most impactful and beneficial upgrades for all customers. Ideally it would help CLC to identify win-win situations for customers and the electric grid, where financial savings, energy savings, beneficial grid impacts, carbon emissions, or a combination of the four can be realized by both customers and grid stakeholders. A major benefit of a codelivery program is the potential to increase uptake of each measure through mutual exposure from the others – customers who were interested in one measure might adopt two or more of them.

7.1.1 Approach for Assessing Codelivery Strategy

To assess the value of a codelivery strategy, first consider the impacts, costs, and benefits of the various component technologies individually. The EE potential for CLC is described in Chapters 2, 3, and 4 of this report. The first sections of this chapter describe the assessment of the Solar PV potential. With the potential of Solar PV and EE each described, Guidehouse will then describe implementation, cost, and savings implications of codelivery in section 7.4, based on potential interactions between EE and Solar PV measures, as well as PA, utility and customer interactions throughout program administration.

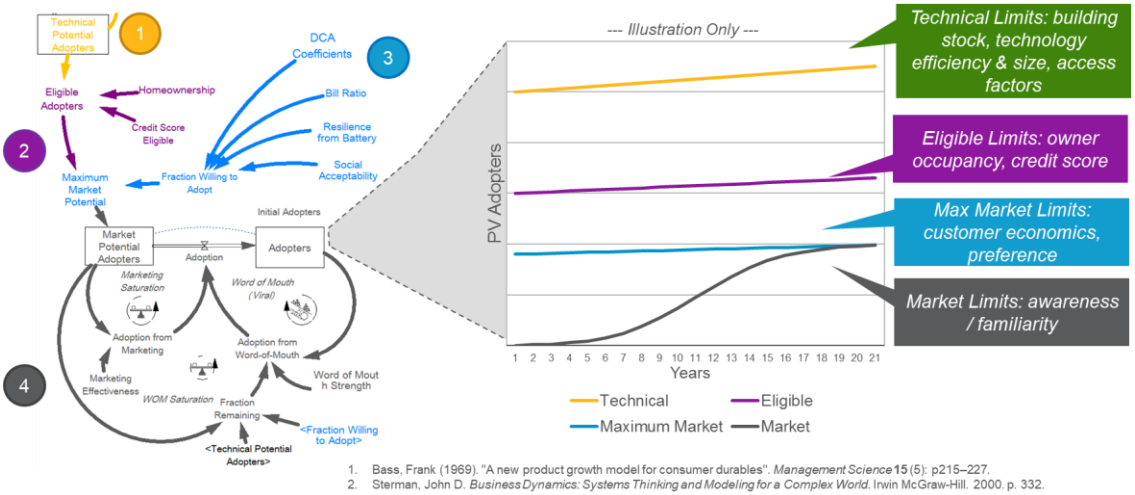
7.2 Solar PV Forecasting Methodology

Distributed Energy Resource Simulator (DERSim) is the Guidehouse-developed toolset used forecast adoption in CLC territory over the forecast window of 2023 – 2027. DERSim forecast methodology is based on a detailed analysis of the potential pool of adopters and utilizes a structural model to project incremental (DER sales) and aggregated (DER population) growth of Solar PV. Starting with a detailed analysis of the potential Solar PV adopter base and ending with a Bass Diffusion model tailored to local conditions, this approach offers an understanding of the past and current state of the Solar PV market and potential growth. Also, Guidehouse's methodology accounts for both physical and market-based limitations and opportunities. This ensures that the forecast is not only comprehensive but also sensitive to the nuances of the Cape Light Compact service area in Cape Cod and Martha's Vineyard.

Technical, Eligible, and Maximum Market Potential Assessment: The first step focuses on identifying the customers likely to become adopters of rooftop Solar PV installations. DERSim assesses technical potential limitations by considering rooftop areas and orientations. Next, the model refines the eligible potential by incorporating credit access as a function of credit score and property ownership constraints. Finally, Guidehouse estimates the maximum market potential by factoring in aspects like customer economics, consumer preferences towards DER and technology competition.

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Figure 7-1. Overview of DERSim Model



Source: Guidehouse

Figure 7-1 shows each limitation applied to the potential, with more detail provided here:

- **Customer Base (Stock)**: This is the total number of customers in CLC segmented by Residential and Commercial. This segmentation provides insight in the different energy needs and Solar PV adoption potential across these segments.
- **Technical Potential**: Technical potential refers to the customer base that could host a rooftop Solar PV installation given likely constraints on rooftop space and orientation.
- **Eligible Potential**: In this part, the model quantifies the portion of the total customer base that meets credit and homeownership criteria. This provides a more elastic picture of the potential market for Solar PV installations beyond only technical suitability.
- **Maximum Market Potential**: Finally, Guidehouse's model calculates the highest achievable market penetration under optimal market conditions. This considers factors like viability of Solar PV economics, policy incentives and consumer willingness to adopt Solar PV.

Incremental and Aggregate Forecast of Solar PV Adoption: To forecast adoption rates, DERSim uses a Bass Diffusion model that incorporates various market drivers of Solar PV adoption. The different Bass model parameters are customized to align with the unique attributes of the Solar PV market in CLC's territory. This customization includes calibrating the model with current market trends and historical adoption rates that includes the impact of policy interventions like the Green Communities Act and the SMART program. This methodology allows us to create a realistic projection of how Solar PV will penetrate the local Residential and commercial markets over time.

7.2.1 Model Inputs and Assumptions

DERSim is a structural model that incorporates various inputs to predict how factors like market conditions, technological advancements and policy changes will impact the rate of adoption of

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Solar PV Installations. Key inputs used in the model can be grouped, with some overlap, into inputs defining the total pool of potential Solar PV adopters and inputs controlling the rate of adoption:

7.2.1.1 Technical Potential Inputs and Adoption Assumptions

Table 7-1 below summarizes the technical potential and adoption input assumptions.

Table 7-1. Technical Input and Adoption Assumptions

Parameter	Description/Application	Assumption	Source
Customer Counts	Incorporates number of existing customers in various sectors (Residential and Commercial) to estimate market size and growth.	Estimated no significant growth within forecast window. Therefore, annual counts will stay the same year over year.	1
Historical PV Installations	Historical interconnection data used to analyze trends, growth patterns and Solar PV market maturity level.	Historical rates of adoption will inform forecasted rates.	1
Technical and Credit Eligibility	Considers factors that determine customer's eligibility for Solar PV installations, such as roof suitability, credit requirements and technical constraints.		2
Consumer Behavior and Preference	Used to understand consumer trends and preferences towards solar energy adoption. Will inform non-economic adoption drivers.		1
Electricity Rates	Used to understand how current and projected electricity rates can influence economic attractiveness of solar PV investments	Rates for different Billing Codes per used to generate a blended rate applicable to each sector (Residential and Commercial) as a whole.	1
Installation Incentives	Used applicable Tax Credits, Rebates and Grants to inform the cost of Solar PV installations (CAPEX).	Incentives mapped to Residential and Commercial sectors	3
Capacity and Efficiency	Used to predict solar PV performance and cost effectiveness.	Assumption: Historical mean system capacity and system efficiency to continue and stay	1

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Parameter	Description/Application	Assumption	Source
		constant during the forecast window	
Solar PV Irradiance and Yield	Used Cape Cod solar irradiance (power per unit area received from the sun), likely installation orientations and historical Solar PV module efficiency to estimate the energy production potential of Solar PV systems in the region	A single year of representative weather from Barnstable, MA, used in the analysis.	4

Sources:
1. CLC and Eversource
2. NREL (Technical Constraints) and U.S. Census (Credit and Eligibility Constraints)
3. Federal or State Government
4. National Renewable Energy Labs (NREL) and System Advisor Model (SAM)

7.2.2 Customer Economics

Market dynamics such as fluctuating energy prices, evolving technology cost, and changing regulatory landscape will influence the customer decision to adopt a Solar PV system. Likewise, factors like electricity rate structures, net-metering policies and incentives programs will have an influence on the economic viability of Solar PV installation. DERSim incorporates these drivers into the analysis to generate an in-depth perspective on the economics of Solar PV adoption from the customer's viewpoint. Each of the following subsections walks through a component of the inputs, assumptions, or method that contributes to the customer economics of Solar PV adoption, culminating in the bill ratio – a metric for comparing cost of grid electricity and Solar PV.

7.2.2.1 Cost of Capital

Capital structure inputs are key to customer economics, with the following capital structure inputs used to annualize Solar PV system installation costs. Costs are distributed over the lifetime of the system, which is 25 years for Solar PV. Guidehouse's model assumes a loan system for Solar PV adoption and generates cash flows for the money made on extra unconsumed energy. Components of the capital structure for the model input include the following:

- **Cost of Equity**: Return homeowners expect from their personal investment towards DER installation.
- **Cost of Debt**: Interest rate homeowners pay on their DER loan.
- **Debt Ratio**: Proportion of DER cost financed by a loan, compared to out-of-pocket expense which is equal to Debt / (Debt + Equity).
- **Tax Rate**: Percentage at which incentives or credits for DER installations are taxed, if applicable.

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Table 7-2 summarizes the cost of capital assumptions used in the analysis.

Table 7-2. Cost of Capital

Customer Segment	Cost of Equity	Cost of Debt	Debt Ratio	Tax Rate
Residential	20%	10%	100%	0%
Commercial	7%	10%	28%	8%

Source: Guidehouse

7.2.2.2 Customer Solar PV System Capacity

Cape Light Compact provided historical interconnection data that contained records of per-customer installation capacities (kW DC) ranging from 2016 to partial data for 2023. This information was then used to generate a set of typical Solar PV installed capacities per customer to inform the likely Solar PV installed capacities of new adopters throughout the forecast windows of 2023 – 2027 as shown in Table 7-3. Based on historical trends, Guidehouse assumed that typical rooftop Solar PV installations will not change significantly over the forecast window.

Table 7-3. Typical Solar PV Installed Capacity

Customer Segment	Technology	Unit	Capacity DC
Commercial	Solar PV	kW	14.7
Residential	Solar PV	kW	7.6

Source: Guidehouse

Using historical interconnection data, Guidehouse determined that the typical rooftop Solar PV installation for either the Residential or Commercial sectors are eligible to claim energy exports at the full net-metering rate. Only Residential system with installed capacity greater than 10 kW or Commercial systems greater than 25 kW would have a cap on their net-metering payments[49].

7.2.2.3 Installation CAPEX and OPEX

DERSim uses an annualized cash flow model to calculate the financial incentives for adoption. Two inputs of this model are the Capital Expenditure (CAPEX) for installing the customer's Solar PV system and the Operating Expenses (OPEX) that includes annual operating cost such as maintenance and repairs of the installation by the customer. To annualize both costs, the Weighted Cost of Capital (WACC) is calculated using equity and debt of the project to reflect the average cost of financing.

Table 7-4 shows the annualized CAPEX, OPEX and their combined value to reflect the cost of DER ownership on a given year. IRA and SMART incentives are included in system cost and financing calculations. Specifically, IRA tax incentives of 30% for Residential and 50% for commercial customers, and performance-based incentives of 0.17 ($/kWh) from the SMART program are included alongside purchase incentives from the state of Massachusetts. Non-Residential customers are further benefited by the Modified Accelerated Cost Recovery System

[49] https://www.mass.gov/info-details/net-metering-guide

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(MACRS) that allows the cost of an asset to be recovered over the useful life of the asset by way of accelerated depreciation. For non-Residential customers the tax savings from applying MACRS depreciation is higher than the annual operating cost. This difference is reflected by the negative OPEX during the first few years of operation of commercial systems shown in Table 7-4.

Table 7-4. Commercial and Residential CAPEX and OPEX

Year	Customer Segment	Annualized OPEX	Annualized CAPEX	Annualized Cost of DER
2023	Commercial	$-133.23	$1,772.79	$1,639.56
2027	Commercial	$-92.94	$1,772.04	$1,679.10
2023	Residential	$230.11	$1,857.51	$2,087.62
2027	Residential	$258.99	$1,839.69	$2,098.69

Source: Guidehouse

7.2.2.4 Typical Annual Consumption and Solar PV Generation per Customer (kWh)

In CLC territory, a typical Residential or Commercial sector customer exports back to the grid over half of their Solar PV Generation based on:

- Customer demand profiles from Eversource per Rate code,
- CLC's Customer breakdown per Rate Code,
- Barnstable, MA, (Latitude: 41.69; Longitude: -70.3) hourly weather profile for a typical year, and
- Estimated per customer system capacities.

This is due to the difference between customer consumption and Solar PV generation. Table 7-5 shows how Residential customers are net energy generators and, in a year, generate more energy than they consume. Factors contributing to this include the size of installed Solar PV system, local climate conditions, seasonality in habitation, and household energy consumption patterns.[50]

Table 7-5. Annual Energy Flows

Customer Segment	Year	Raw Load	PV Generation	PV On Site Consumption	PV Gen Export
Commercial	2023	20,846	19,533	8,660	-10,874
Commercial	2027	20,846	19,533	8,668	-10,866
Residential	2023	6,560	9,982	2,727	-7,255
Residential	2027	6,560	9,982	2,718	-7,265

Source: Guidehouse

Commercial buildings often have different energy usage patterns compared to Residential homes, with higher daytime consumption while still having net exports during peak generation

[50] Based on current typical heating consumption patterns and sources; net generation may change as electric heat penetration increases.

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periods. Given the larger scale of commercial systems, the volume of export electricity can be substantial (i.e., 3,000+ kWh per typical Commercial customer more than the typical Residential customer).

7.2.2.5 Customer Electricity Rates

Guidehouse calculated a table of blended rates per customer segment over the years of the study. These blended rates combined different types of rates weighted by the number of customers in each rate. The rate structure reflects various costs of providing an electricity service and includes generation, transmission, and distribution charges. The rates shown in Table 7-6 are based on current rates, inflated year over year using a constant inflation rate of 3.0%.

Table 7-6. Blended Customer Rates Applicable to CLC Customers

Customer Segment	Year	Energy Charge	Demand Charge	Fixed Charge
Commercial	2023	$0.26	$26.68	$14.39
Commercial	2027	$0.32	$32.43	$17.49
Residential	2023	$0.21	$-	$10.03
Residential	2027	$0.26	$-	$12.19

Source: Guidehouse

A key difference between Residential and Commercial rates is that only Commercial customers are billed an additional Demand Charge based on the highest rate of electricity usage (measured in kW) during peak periods during a bill cycle. This Demand Charge reflects the cost of ensuring sufficient capacity to meet the customer's maximum demand. Solar PV installations can reduce peak demand, thereby potentially lowering these charges.

For both Residential and Commercial customers, the structure of the electricity rate can have a significant impact on the economic benefits of rooftop Solar PV adoption. As Solar PV systems offset the amount of energy drawn from the grid, they substantially reduce the energy charge portion of the electricity bill.

7.2.2.6 Typical DER Adopter Bill Ratio

The calculation of the bill ratio (shown in Table 7-7) in DERSim synthesizes the economic drivers for Solar PV adoption. As indicated by the equation below, the bill ratio is calculated by taking the combined post-adoption electricity bill plus the annualized cost of adoption and dividing by the pre-adoption bill. A ratio less than one indicates a reduction in electricity cost due to DER adoption and a ratio greater than one indicates an increase in electricity cost due to DER adoption.

$$Bill\ Ratio = \frac{Bill\ After\ DER + Cost\ of\ DER}{Bill\ Before\ DER}$$

As seen in Table 7-7 both commercial and Residential bill ratios show a trend of becoming increasingly beneficial over the four years of the study, where the bill ratio reflects the first year of operations on a system installed in a given year. This improvement is attributed to factors

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such as increasing grid electricity prices, performance of Solar PV systems and reductions in solar technology costs. For Residential customers, strong historical adoption with a bill ratio greater than one indicates that non-economic drives of adoption have a significant role in the reasons for adoption.

Table 7-7. Annual Bill Ratio (After DER / Before DER)

Customer Segment	Year	Bill Ratio
Commercial	2023	0.62
Commercial	2027	0.60
Residential	2023	1.17
Residential	2027	1.00

Source: Guidehouse

7.2.3 Model Calibration

Guidehouse calibrated the adoption model for this study using historical Solar PV interconnection data provided by CLC. This interconnection data was used to calibrate a set of model coefficients that control the ceiling of potential adopters (Max Market Potential) and the rate of growth of annual installations seen in Table 7-8.

Table 7-8. Limits on Potential Solar PV Adopters

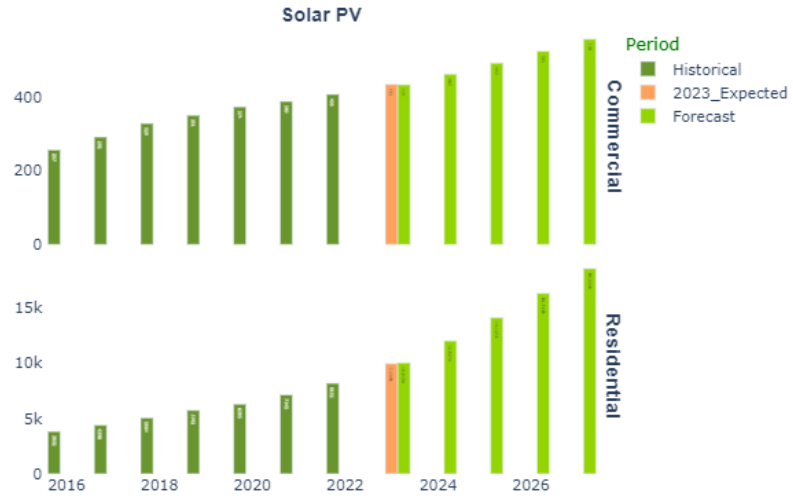
Customer Segment	Year	Aggregated Installations [Count of Solar PV Systems]	Max Market Potential [Count of Solar PV Systems]
Commercial	2027	558	4,245
Residential	2027	18,555	32,734

Source: Guidehouse

Figure 7-2 shows how the calibrated model generates a forecast that aligns well with the historical aggregated Solar PV installations (light and dark green bars), for both the Commercial (top of figure) and Residential (bottom) sectors. The figure also shows how the expected number of installations extrapolated from partial 2023 data matches that of the forecast.

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Figure 7-2. Historical and Forecasted Aggregated Installations



Source: Guidehouse

7.3 Solar PV Forecast Results and Discussions

Residential Solar PV has seen a steady rise in adoption within the PA territory over the historical period, a trend anticipated to increase. This continued growth is expected despite the economics of Solar PV adoption being less favorable compared to traditional grid electricity. The driving forces for this growth are non-economic factors, such strong environmental awareness and interest in energy resiliency, enhanced by improving economics through measures like the IRA and other incentives. Moreover, the Residential Solar PV market still has significant expansion potential, suggesting room for future adoption.

Guidehouse projects a significant uptick in Solar PV installations in the CLC service area, estimating an addition of 66.6 MW DC of Solar PV Generation capacity across the Residential and Commercial sectors in the forecast window of 2023 to 2027 (Table 7-9). The study shows a strong increase for the Residential sector, with growth outpacing the Commercial sector in both number of installations and aggregated capacity. This trend indicates a robust and significant shift towards renewable energy in household energy consumption, greater preference for renewable energy and the improving economics of solar power adoption.

Table 7-9. Net added Solar PV Installations and Capacity in MW DC

	Residential	Commercial	TOTAL
2023 - 2027 Added Solar PV Installations	8,591	123	8,714
2023 - 2027 Added Solar PV Capacity [MW]	64.7	1.8	66.6

Source: Guidehouse

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This forecast has implications for CLC's energy policy and infrastructure planning. It suggests a need for continuous investment in grid modernization to accommodate the rapid pace of Solar PV interconnections and added solar capacity in the Residential sector.

Greater and rapidly increasing Solar PV adoption may have the following effects on CLC and its customers:

- **Economic Impacts for Utilities and Consumers**: While the focus of Guidehouse's forecast is on installations and capacity, it is important to highlight other potential impacts:
  - **Utilities:** Shifts in revenue structures and increased investment in grid infrastructure may be needed to accommodate solar integration.
  - **Consumers:** Reduced electricity bills and potential earnings from excess energy generation provide benefits to Solar PV adopters.
- **Alignment with Green Communities Act**: This program aims to promote energy efficiency and renewable energy. The forecasted rise in Solar PV installations directly supports these objectives by contributing to the reduction in carbon emissions and enhancing local energy sustainability.
- **Synergy with SMART Program**: State-level programs, particularly the SMART program, have been key drivers in making Solar PV adoption an economically viable option for customers. These incentives do not only lower the entry barrier for consumers but also influence the overall energy market dynamics towards increasing rates of adoption. Forecasted Solar PV growth will also align with this program's goals. Greater solar capacity will contribute to the state's target for renewable energy production, supported by the program's financial incentives.

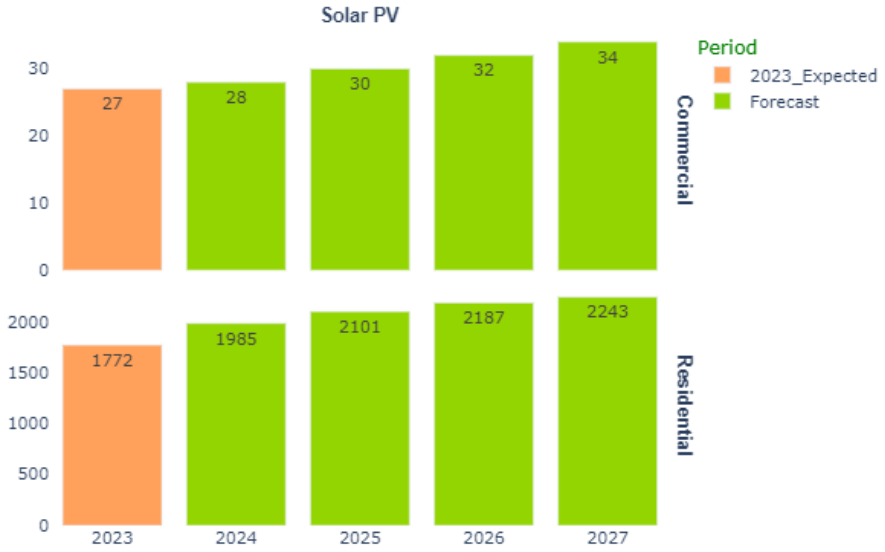
While both the Green Communities Act and the SMART Program are instrumental in driving Solar PV growth, they serve different, yet complementary, roles. The Green Communities Act provides a broad legislative framework promoting renewable energy and energy efficiency, whereas the SMART program offers direct, tangible incentives for Solar PV adoption. Their overlap lies in their goal of increasing renewable energy use, but they differ in their approach and scope.

7.3.1 Incremental Solar PV Installations

In Figure 7-3, Guidehouse estimates a continued increase in annual installations for both Residential and Commercial sectors. During the forecast window of 2023 – 2027, Guidehouse calculates a 5.2% Compound Annual Growth Rate (CAGR) for the Residential sector and 5.5% for the Commercial sector. However, as shown in Figure 7-3 the Residential sector will add significantly more units even when the CAGR rate for both sectors is similar.

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Figure 7-3. Solar PV Incremental Solar PV Installations (Unit Counts)



Source: Guidehouse

7.3.2 Aggregated Solar PV Installations

Incremental installations trends are reflected in the forecast of aggregated installations. The forecast shown in Figure 7-4 includes forecasted new systems as well as historical installations. The increasing rate of annual installations will lead to a doubling of Residential system in 2027 as compared to the existing base in 2023.

Figure 7-4. Solar PV Aggregated Solar PV Installations (Unit Counts)



Source: Guidehouse

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7.3.3 Solar PV Penetration Rates

As reflected in the forecasted installations, Table 7-10 shows Residential Solar PV adoption rates nearly doubling over the course of the study's four-year period 2023 – 2027, with a roughly 30% increase for Commercial adoption rates. This trend is reflective of a growing awareness and acceptance of Solar PV solutions, as well as improvements in the affordability and accessibility of solar technology.

Table 7-10. Penetration of Solar PV Adoption in CLC Customer Base[51]

Customer Segment	Year	Aggregated Solar PV	Customer Counts	Penetration %
Commercial	2023	434	24,948	1.74%
Commercial	2027	558	24,948	2.24%
Residential	2023	10,039	181,074	5.54%
Residential	2027	18,555	181,074	10.25%

Source: Guidehouse

The results shown in Table 7-10 underscore the growing importance of solar energy in meeting consumer consumption and achieving sustainability goals. It also points towards a greater trend of customers becoming both consumers and producers of energy.

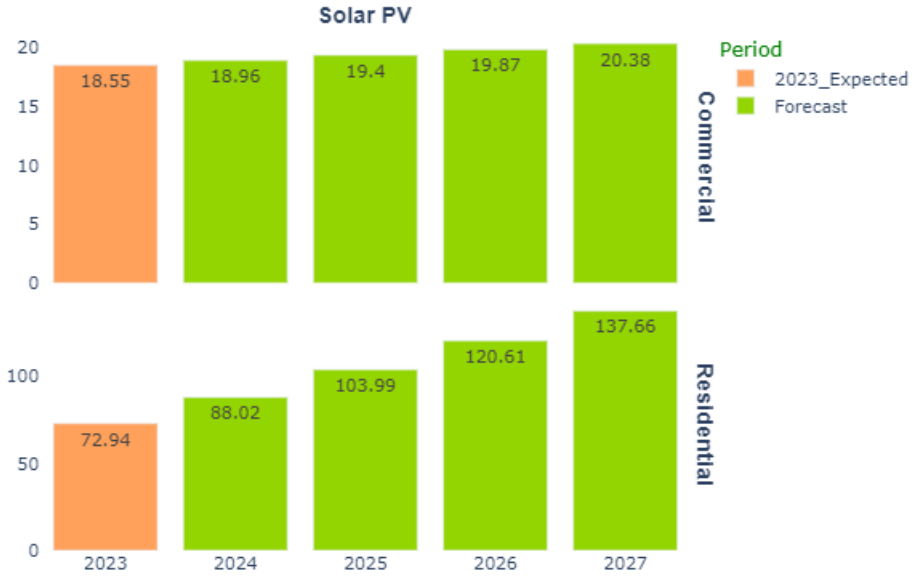
7.3.4 Solar PV Capacity

Guidehouse expects the system wide adoption of Solar PV capacity to show similar trends as the number of total installations, with aggregated Residential capacity almost doubling in the 2023 – 2027 forecast window. Commercial aggregated capacity will keep increasing, but not at the same rate as the Residential sector, even with similar incremental adoption rates in the forecast window (Residential CAGR: 5.2%, Commercial CAGR: 5.5%). This difference in the rates of aggregated capacity (Residential CAGR: 16.8%, Commercial CAGR: 2.3%) is due to the much larger historical capacity baseline from the Residential sector before the forecast window. Figure 7-5 shows the cumulative growth in solar installations over time, capturing both historical data and forecasted growth.

[51] Guidehouse assumes no significant change CLC's customer base in the next four years. Therefore, customer counts stay flat year over year.

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Figure 7-5. Solar PV Aggregated Capacity [MW]



Source: Guidehouse

7.3.5 Grid Impacts

The significant addition of Solar PV generation during the next four years will impact the grid by reducing net consumption and adding to the load transported by the local grid.[52] Guidehouse calculated the per customer hourly impacts of Solar PV generation, as discussed in this section.

Impact is defined as the hourly difference between the load of a Solar PV customer minus that of a non-PV customer. A negative hourly impact means net demand is decreasing because of Solar PV generation. Peak impact is the average impact calculated between the hours of 1 to 5 PM during the months of June, July, and August. This window matches the states peak times for New England ISO. The annual impact is the sum of the hourly impacts (i.e., with 8,760 hours in a year).

Generation Impacts:
Guidehouse estimates that the 137.7 MW of Residential and 20.4 MW of Commercial Solar PV capacity in 2027 would result in a net reduction in annual consumption of 180.8 GWh from Residential and 27.0 GWh from Commercial by 2027. Further details are provided in

[52] Guidehouse is aware that Eversource's ESMP was filed in late January; however, the observations presented here about potential grid impacts are independent of the findings of that filing.

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Table 7-11. Other effects from the added Solar PV capacity are the reduction in utilization of baseload power plants and the export of excess energy during sunny periods.

Table 7-11. Peak Impacts and Annual Generation Impacts of Solar PV Adoption at the System Level

Customer Segment	Year	Solar PV Customer Count	Cumulative Capacity (MW)	Cumulative Peak Impacts (MW)	Annual Generation Impacts (GWh)
Commercial	2023	435	18.6	(7.8)	(24.6)
Commercial	2027	558	20.4	(8.6)	(27.0)
Residential	2023	9,964	72.9	(30.1)	(95.8)
Residential	2027	18,555	137.7	(56.7)	(180.8)

Source: Guidehouse

7.3.5.1 Peak Impacts

Solar PV systems can significantly reduce peak load, especially during sunny afternoons and when the system peak coincides with peak generation. In the case of CLC, there is partial overlap between peak generation (typically centered around noon) and system peak demand (1 to 5 PM). This discrepancy leads to a mismatch between the highest availability for solar energy and the time of highest energy consumption. CLC will need to work with the distribution utility to develop a strategy to store, redistribute or manage this surplus generation.

7.4 Codelivery

CLC is interested in developing a codelivery strategy for EE with Solar PV and other program offerings, including electrification measures like heat pumps. Based on results from the EE and Solar PV sections in this report, as well as Guidehouse program design expertise, a summary of implications and considerations for CLC is presented. Codelivery programs are not common as of this writing, so much of the discussion is speculative and should provide CLC with a better understanding of the potential costs, benefits, and impacts of a codelivery program.

7.4.1 Implementation: What does codelivery look like?

There are several different dimensions to codelivery implementation.

Restructuring: Solar PV, EE, and heat pump measures are already included in CLC's program offerings as part of the Cape and Vineyard Electrification Offering (CVEO). Additionally, the CVEO program provides electrification (including batteries) to primarily low and moderate-income customers. All of these and other customer facing programs that CLC administers conform to DPU rules; a codelivery program would need to conform to the same rules, and would entail combining some administrative processes, adding staff, and/or reorganizing teams to deliver EE, Solar PV, and electrification measures together, with the end goal being to streamline customer interactions, and maximize the uptake of all measures for all eligible customers. Tracking and accounting for funding of each program will be important, since funding for each measure may come from different sources (e.g., EE funding comes from the EE surcharge, which may not be applicable to solar or heat pump measures), and a successful codelivery program would shield customers from some or all of this complexity, braiding the various funding streams together for the customer. In addition to restructuring and training some of its own staff to be knowledgeable of and responsive to the needs of three programs concurrently instead of one, CLC may need to train and work with industry stakeholders to

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develop a local work force that is knowledgeable about all included technologies and the interactions between them. This will likely require change management and could face short-term setbacks but should pay dividends over time as synergies are realized.

Delivery Approaches: CLC may elect to roll out a new codelivery program by combining some existing ones, however it may make more sense to work with a third party, and/or focus on training and upskilling the local workforce to provide streamlined experiences for customers. There are some representative business models for how this is done today:

- "All-in-house" Contractors who have all trades internal can provide the intended combinations of measures directly to customers; CLC's role would be to curate a list of approved contractors.

- Individual knowledgeable HVAC or Solar PV or Electrical Contractors who take a lead role with a customer and sub out the work they cannot do in-house.

- "One Stop Shop" Electrification Coordinators that lead the customer journey, but partner with local subcontractors.

- Electrification Advisors / Gateways which provide front-end advice, assessments, and aggregate quotes from subcontractors who manage individual projects (EE, Solar PV, or electrification) directly with the customer.

    - CLC's home energy assessment program already provides some of this to customers. A codelivery program could build on this program and further engage with customers as they implement EE, Solar PV, and other electrification projects.

Another consideration in providing multiple electrified systems to customers is the inclusion of a Home Energy Management System (HEMS), which can help to orchestrate various complex electric systems working together and could play a role in a demand response program. Here again CLC may not have a direct role in the HEMS sales process other than maintaining qualified contractor lists, and potentially partnering with electrification advisors or third-party gateways to provide guidance to customers and connect them with contractors.

Measure Sequencing: The interactions between energy efficiency, Solar PV, and heat pumps are important for CLC administrators, as well as contractors and implementers to understand and consider. A heat pump may only make sense for a home *after* it has been weatherized, and a solar system might be improperly sized if it is designed based on customer bills that do not account for the addition of a heat pump, or do not account for significant efficiency increases from other measures. A solar system might make sense, but may require structural changes to a roof, or might benefit from the removal of a heating system flue or chimney. To help with this, a codelivery strategy should consider sequencing customer adoption of EE, heat pumps, and solar PV to:

1. Address any code related, structural, or systemic building issues that would preclude other measures.

2. Reduce overall energy requirements through energy efficiency and weatherization measures.

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3. Reduce heating energy consumption and carbon emissions through heat pump adoption, where feasible.

4. Add solar to homes.

Sequencing improvements per this order, or an order that aligns with the customer needs and budget, or local grid constraints is important to reduce waste and maximize program benefits. It will also ensure that heat pumps and solar systems are right sized to support upgraded buildings that have (potentially) both added electrical load from fuel switching, and reduced loads from energy efficiency improvements, or upgrading from resistance heat to a more efficient heat pump.

Caps on Added Customer Capacity: The Commonwealth of Massachusetts has a limit or cap [53]on the participation in the net metering program. This cap is determined by a percentage of the electric company's highest historic peak load. Some installations are exempted from this cap, as their nameplate rating is below a threshold (10 kW DC for Residential and 25 kW DC for Commercial). Guidehouse's estimated representative installation capacities using historical interconnection data (7.6 kW DC for Residential and 14.73 kW DC for Commercial) are below the cap threshold and therefore will not be limited by the current net metering program. All installations in the analysis are considered to be net metered, and none are qualifying facilities.

Customer Benefits and Risks: For customers, a successful codelivery program would provide a single source of information and a single point of entry to communication with CLC. Similar to key account managers, a codelivery representative can speak to all of the customer's available options and potential solutions. No customer wants to hear: "press 1 for EE, press 2 for HP, or press 3 for PV," if instead they could just get straight to a person who can help with any of the three, and a codelivery program gives them that simpler interaction. A drawback for customers may be that the program seems too complex or overwhelming, if they aren't prepared for a conversation about, or aware of, the different technologies. Downstream lighting discounts and single-form appliance rebate programs are much simpler and easier for customers to participate in, understand, and agree to than combinations of potentially significant and costly home improvements.

PA Benefits and Risks: For the program administrator, program delivery is a bit more challenging, since more complex projects and processes cannot be as easily streamlined and optimized. The various combinations of measures, timing of installations, and different requirements for each measure (e.g., potentially needing an electrician, plumber, carpenter, and a roofer, instead of just one or two of the trades to implement a single measure), will make it harder to standardize costs, control quality, and account for program impacts. The main benefit for PAs is that all customers who come through the program are likely to be aware of all of the potential measures after interacting with a program representative and may be more likely to adopt a package of measures, or to take a more intentional and comprehensive approach to conserving energy and/or generating their own. In other words, a successful program will increase awareness of various options, and thus increase uptake of each.

Adoption: Until codelivery programs are more common, it is hard to say if adoption of one measure will truly or significantly be increased by adoption of other measures. EE adoption, in particular weatherization and insulation measures – could move a building from ineligible to eligible for installing a heat pump or reduce the size requirement for a heating system. There

[53] https://www.mass.gov/info-details/net-metering-guide

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are perverse disincentives between EE and Solar PV adopters; an extremely efficient home has less to gain from a solar system – a smaller electric bill means there is less potential bill savings to pay back an investment in Solar PV. And similarly, a customer with a large Solar PV system might not care as much about energy efficiency, since they may perceive their energy as "free" and won't feel inclined to conserve it.

7.4.2 Costs

This section includes a discussion of costs that customers, utilities, and implementers might encounter as participants or administrators of a co-delivery program, as well as the implications for rates. Customers of a co-delivery program may come with knowledge of all potential measures, or none – and the administrator of the program will need to consider the spectrum of customer awareness and present cost information to them accordingly. Given that customer interest in solar PV, heating electrification, or EE is often driven by benefits shared across these measures (e.g., lower energy costs, environmental benefits, etc.), customers with interest in one measure (e.g., EE), may be more aware of the others and have higher propensity for adopting other measures (e.g., solar PV) and may be more receptive to codelivery. Other customers who are less aware of the measures may present an upside to CLC in that they will be exposed to all other measures if they are interested in any one and might present untapped opportunity. There is also potential for these "unaware" customers to be overwhelmed by a large amount of information on technologies or program offerings they are unprepared for, so information-sharing – especially around costs and benefits for customers, will be important.

Customer Economics: An important goal for CLC's codelivery program could be to help customers prioritize and sequence the most impactful and/or cost-effective measures and support their longer-term efficiency, decarbonization, and renewable generation journey as they implement each measure. Costs associated with solar, heat pumps, batteries, and other significant home upgrades are high, often require financing, and many customers are not able to afford all measures concurrently.

A successful codelivery program will have a rich understanding of financing and the interactive effects between measures. Combining a heat pump with a solar system might work for some customers, if inexpensive solar energy can help to offset high electric heating costs, especially for commercial customers. Weatherizing and insulating the home before installing the heat pump could make the proposition of heating via heat pump an even more economically viable option, since weatherizing would reduce the home's heating (and cooling) load, potentially leading to a smaller heat pump and/or a reduction in the heating bill. A codelivery representative will know and understand these interactions (and others) to recommend cost effective options to customers.

Grid Costs: As the electrical infrastructure in the Cape and Vineyard becomes more peak constrained, with electrification of vehicles, heating, cooling, cooking, lawn maintenance and other equipment replacing gas equipment, measures like EE, batteries, and renewable generation will play an increasingly important role in mitigating grid constraints. Considering summer peak demands during the active tourist season, solar generation can help on sunny days, but energy efficiency is more certain to reduce peak demand. Pilot programs like CVEO, DR programs, vehicle-to-grid (V2G), and other approaches to load management including HEMS could also be rolled out through a codelivery program and targeted geographically to help manage constraints on the grid in CLC territory.

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With more solar coming online each year, CLC's summer load profile is likely to trend towards a duck curve, with late afternoon demand coming online just as solar generation wanes, which could result in a need to ramp up peaker plants and result in higher strain on any circuits that are near capacity. A codelivery program can help to target specific measures or programs regionally to help mitigate grid constraints. It could steer customers on constrained areas of the grid who have A/C towards heat pumps for higher efficiency cooling, or to weatherization programs to reduce summer cooling requirements, or propose that Solar PV customers also adopt a stationary battery that can help to minimize evening peak demand when Solar PV generation wanes.

Rates: On the whole, the impact of codelivery on rates is uncertain, and may depend on the magnitude of the deployment of its various components. One region may see a reduction in grid requirements from high solar adoption while another experiences an increase in grid requirements from a high penetration of electrification measures. Following from the grid costs discussion, codelivery could reduce grid electricity requirements through EE and Solar PV adoption, mitigate constraints with batteries, or increase grid requirements through electrification measures. To the extent that CLC can deliver measures in a targeted manner, there is opportunity to reduce, postpone, or eliminate the need for some infrastructure upgrades – which in turn will help to keep rates from rising. However, managing widespread Solar PV will not be free and will require supplemental generation to be available to ramp up and down as solar generation goes offline and ramps back on each day and with cloudy weather systems passing through. This requirement is likely to increase rates, and/or lead to additional TOU rate updates.

Implementation and Administrative Costs: Costs for CLC to administer and implement a codelivery program would likely be on the order of delivering the Residential Coordinated Delivery program on a longer-term basis but would come with initial setup costs to get the program up and running. Linking and cross-linking the various other programs and offerings together, and cross-training staff, establishing communication channels and relationships between different teams will be nontrivial. Both the human systems that administer Solar PV, electrification, and EE programs will need to be aligned and in sync, as well as the back-end data tracking and reporting systems for each program. In the end, the program may boil down to a website that redirects customers to a home energy assessment and a list of approved contractors, which could be effective and would certainly be less costly for CLC than a dedicated team providing more hands-on service.

7.4.3 Emissions Impacts

Each of the three measures reduces greenhouse gas emissions in its own way:

- Locally generated **solar power** offsets the requirement for large scale grid power generation, which is still primarily fossil-fueled.
- For **heating** applications, heat pumps either replace a fossil-fueled heating system thus offsetting local fuel burning entirely or reduce the energy requirement when replacing electrical resistance heat.
- For **cooling** applications, heat pumps reduce the energy requirement when replacing less efficient central A/C or window units, but there does exist a potential increase in energy requirements (and thus greenhouse gas emissions) where heat pumps add cooling to a building that previously lacked any cooling system.

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- **Energy efficiency** measures reduce carbon emissions by reducing overall energy requirements.

- Other **electrification measures** (cooking, clothes driers, lawn care appliances, etc.) all replace local combustion with grid electricity. To the extent that the grid generation mix is cleaner and generates less emissions than local combustion, these measures reduce overall carbon emissions. In all cases, they reduce *local* emissions, even if the net emissions are equal or greater from the grid.

7.4.4 Energy Impacts

When considering a codelivery program, the interactions of the three measures are important to consider.

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Table 7-12 below lists some impacts of each measure on the other two; most importantly, some weatherization EE measures may be required to enable a heat pump to fully heat a home in CLC's service area, and while EE measures could make solar systems pay back slower, heat pump adoption will serve to make solar systems pay back faster.

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Table 7-12. Interactive Impacts of Codelivery

Impact on system → / From system ↓	Energy Efficiency	Heat Pumps	Solar PV Generation
Energy Efficiency	**Overall impact**: energy efficiency reduces overall energy requirements.	Weatherization measures will reduce heating and cooling loads, potentially leading to a smaller heat pump system.	Less electricity consumption could lead to: • A smaller solar system requirement – reducing system cost. • Slower solar system payback due to reduced bill savings.
Heat Pumps	Heat pump adoption may prompt or require customers to weatherize their homes to enable a heat pump system to perform well enough in extreme cold weather.	**Overall impact**: • Increases electrical load when fuel-switching. • Reduces electrical load when replacing resistance. • Reduces A/C load when replacing old system. • Increases cooling energy when adding cooling.	More electricity consumption from a HP replacing fossil fuel could lead to: • A larger solar system requirement – increasing system cost. • Faster solar system payback due to increased bill savings. A heat pump replacing electric resistance for heating will reduce Solar PV system sizing and bill savings
Solar PV Generation	Solar PV power, when cheaper than grid electricity, makes energy efficiency measures less cost effective, and less attractive to economically minded customers.	Solar PV power, when cheaper than grid electricity, makes heating with electricity more attractive to consumers since it reduces heating costs. This could also lead customers to use more energy for cooling for the same reason – or if customers perceive solar power as “free”.	**Overall impact**: Solar PV power provides cleaner electricity to customers than the local grid; accounting for financing and the various incentives (details in section 7.2.2) currently solar is cheaper for commercial customers than the grid, but Residential customers pay more for solar than for grid derived electricity.

Source: Guidehouse

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7.5 Summary: Impacts of Solar PV Codelivery

Current BAE scenario results indicate that fuel substitution measures in the Residential segment will add 5-6 GWh/year to the electrical energy requirements in the 2025-2027 timeframe. By comparison, Residential solar installations are forecasted to generate 15 to 20 GWh of additional energy per year in the same timeframe, and energy efficiency measures will reduce overall energy requirements by 8 to 9 GWh. In other words, in the BAE scenario, Residential EE will more than offset fuel substitution measures – leading to a net reduction in energy required from the grid, and Residential solar generation will lead to additional reduced generation requirements (annually) from the grid. If one assumes the low end of those ranges, and that all impacts can be summed, grid generation requirements would be reduced by 18 GWh/yr. due to the adoption of all measures.

To the extent that a codelivery program would outperform 2 to 3 individual programs in the uptake of all measures, CLC might expect proportional uptake of all measures, and thus an overall increase in net impact. If the codelivery program leads to a more pronounced increase in solar or EE adoption, the impact will be larger, and if the codelivery program leads to more fuel switching (than EE or Solar PV alone), the net impact will be smaller.

7.5.1 Conclusion

Given the unique population and seasonal requirements of the distribution system in CLC's service area, with significant grid demands during summer peak hours, CLC may benefit from a codelivery program that is aimed at mitigating grid constraints in key areas, or within targeted customer groups. Where individual program delivery operating in isolation could lead to a general increase in Solar PV, EE, or electrification adoption, this analysis shows that a codelivery program could present an opportunity for more targeted and coordinated delivery of whichever measures provide the greatest benefit in each region of CLC's territory. Note that the analysis did not include demand response, which could be an additional element of codelivery.

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8. Conclusions

This study uses the most recently available information on CLC and the Massachusetts customer base and state-of-the-art modeling to develop the potential for energy, demand, and CO_2e reductions possible through energy efficiency and demand response programs and initiatives during the forthcoming 2025-2027 term. While much energy efficiency and demand response potential remains, 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 8-1 compares BAE annual potential for 2025 as identified in this study to 2022 actual achievements for energy efficiency and 2022 base loads; Table 8-2 compares BAE costs to the 2022-2024 PA costs (excluding customer costs).

Table 8-1. Comparison of BAE Potential to Recent Experience, CLC Electric

	2025 Potential	2022 Actual	2022 Load
Energy Efficiency (Annual GWh)	8.36	9	1,970
Energy Efficiency (Annual MMBtu)	176,000	153,307	NA
Summer Demand (Annual Passive MW)	0.97	1.47	536

Source: Guidehouse and MassSaveData.com

Table 8-2. Comparison of PA Costs for Three Year Period

	2025-2027 BAE	2022-2024 Plan
Electric - CLC	$168,460,000	$193,604,311

Source: Guidehouse and MassSaveData.com

8.1 Energy Efficiency

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

- **BAE Energy Efficiency:** As savings from lighting continues to decline, cost-effective energy efficiency potential is available from weatherization, heat pumps, and C&I Custom measures. There is a sharp drop off of achievable potential even within the top ten measures, which could guide CLC's program implementation efforts. Overall, potential annual net GWh savings are less than 2022 actual savings, but MMBtu impacts across all fuels are greater, reflecting the impact of increased electrification.

- **Carbon:** The primary source of carbon reduction in 2030 from achievable potential in 2025 through 2027 is from fuel substitution measures, particularly in oil heating to heat pump conversions, and weatherization measures, particularly in insulation and air sealing.

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- **CECP Scenario Results:** The CECP scenarios demonstrate that the carbon targets for 2030 can be met by accelerated deployment of weatherization and heat pumps. The associated price tag for Cape Light Compact is also increased. In the Cost Premium scenarios, the price tag of the CECP scenarios is four to six times greater than the BAE scenario cost. However, all programs and sectors remain cost effective in both scenarios.

- **Key Drivers:** Major drivers of BAE potential were measure-eligibility, carbon benefits, Cape Light Compact's actual and expected achievements during 2022-2024 and updated avoided costs. For the CECP scenarios, the major drive of results were the carbon-reduction rich measures that were targeted for 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 Cape Light Compact should be aware of the factors as it develops its plans.

    - **Past Program Achievements:** Notably, Cape Light Compact 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 controls and 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 Cape Light Compact moves to more aggressive targets.

- **Investment Level:** Cape Light Compact will need to plan for significantly higher levels of investment in electricity 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 and electrification.

8.2 Demand Response

The following are high-level observations regarding the projections for demand response potential:

- **Growth in DR Potential:** Building off Cape Light Compact's existing experience with DR, the summer demand response potential in Cape Light Compact's Massachusetts service territory is estimated to grow from ~4.5 MW to ~7 MW over 2025-2027. This

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increase in savings is primarily driven by steady growth in battery adoption and utilization for DR dispatch, over the 3-year timeframe.

- **Large Residential Contribution in Total Potential:** Residential customers have the highest share in the total potential, which increases by 60% from 2025-2027. Most of this comes from the Res DLC-Electric option.
- **Battery Potential Growth:** Due to the high incentives for battery participation in demand response, potential from battery dispatch is estimated to grow steadily in Residential and C&I sectors.[54]
- **Residential Thermostat Program Growth and Contribution:** The potential from Residential HVAC control via smart thermostats (BYOT program) is estimated to grow as the program progressively scales up over time.

- **Cost-Effectiveness Across Scenarios:** The Res DLC-Electric, which is the largest contributor, remains cost-effective in the MAX scenarios. Similarly, most options remain cost-effective across all scenarios.

[54] The battery DR MW estimates were calibrated to the evaluated and Plan BC model values for 2022-2024 and the growth trend from years with existing data was used to project enrollment for 2025-2027.

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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:

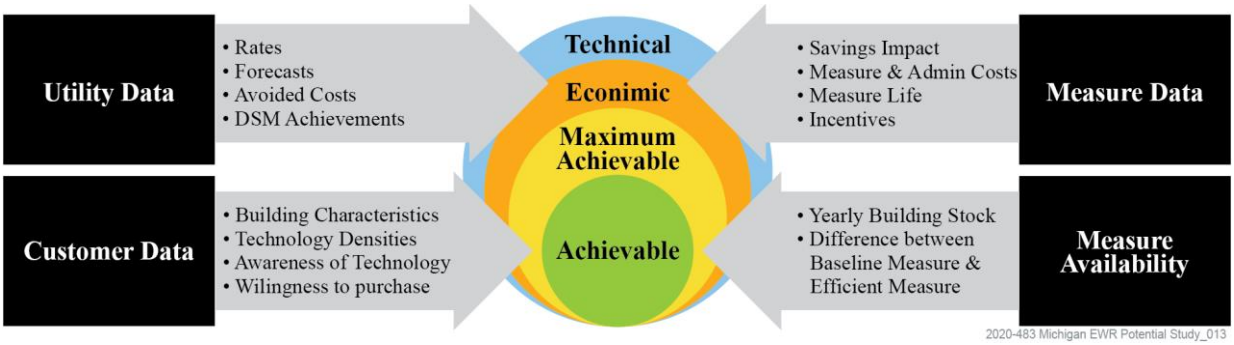
- Ability to accommodate standard or customized cost test protocols, such as those outlined in national standard practice manuals[1], as well as the Massachusetts PA benefit-cost tests defined in the PA's BCR models
- Ability to seamlessly assess sensitivities on avoided costs, retail rates, and load 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)

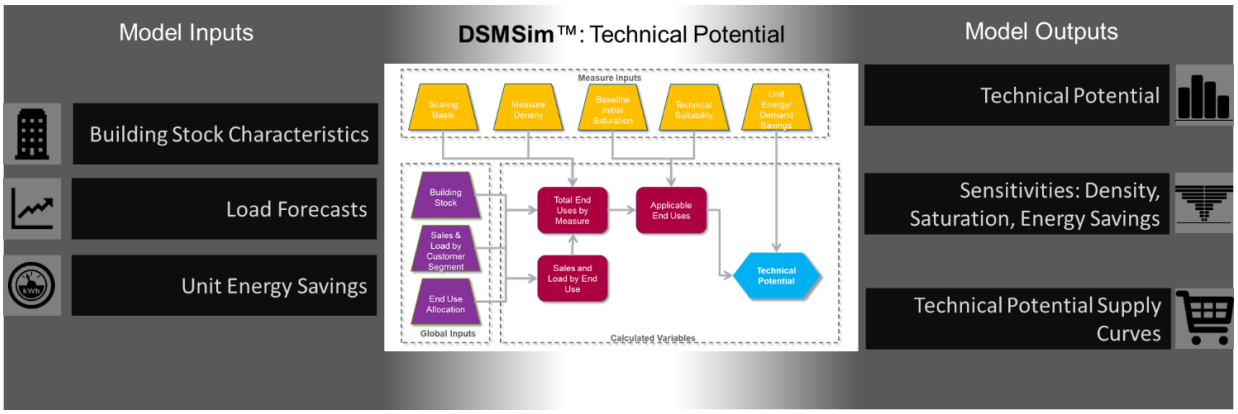
- Competing technologies share the same replacement type (RET, ROB, or NEW)

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.

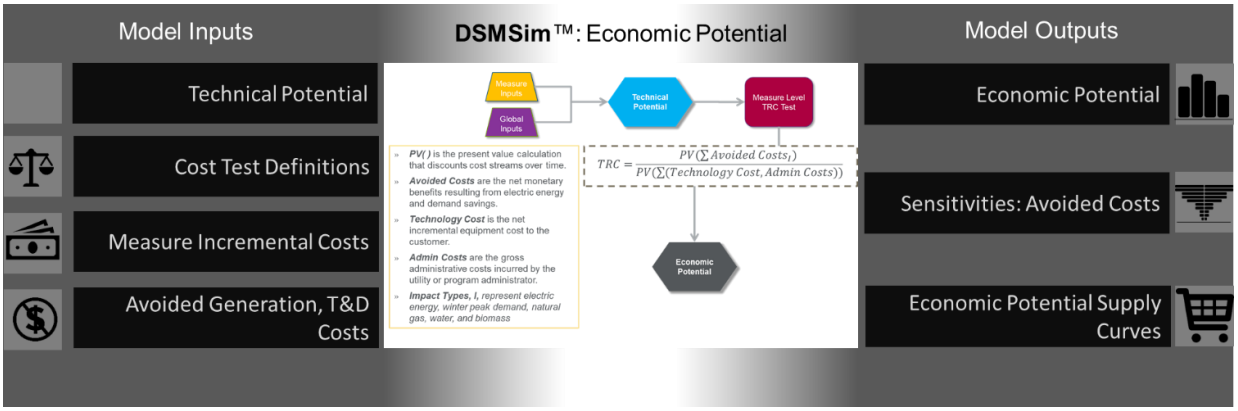
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DSMSim™ can calculate the five standard tests,[2] and use any of these tests for economic screening. It can also allow the economic potential threshold value to be adjusted (set at 1.0, or higher or lower). As with technical potential, Guidehouse recognizes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

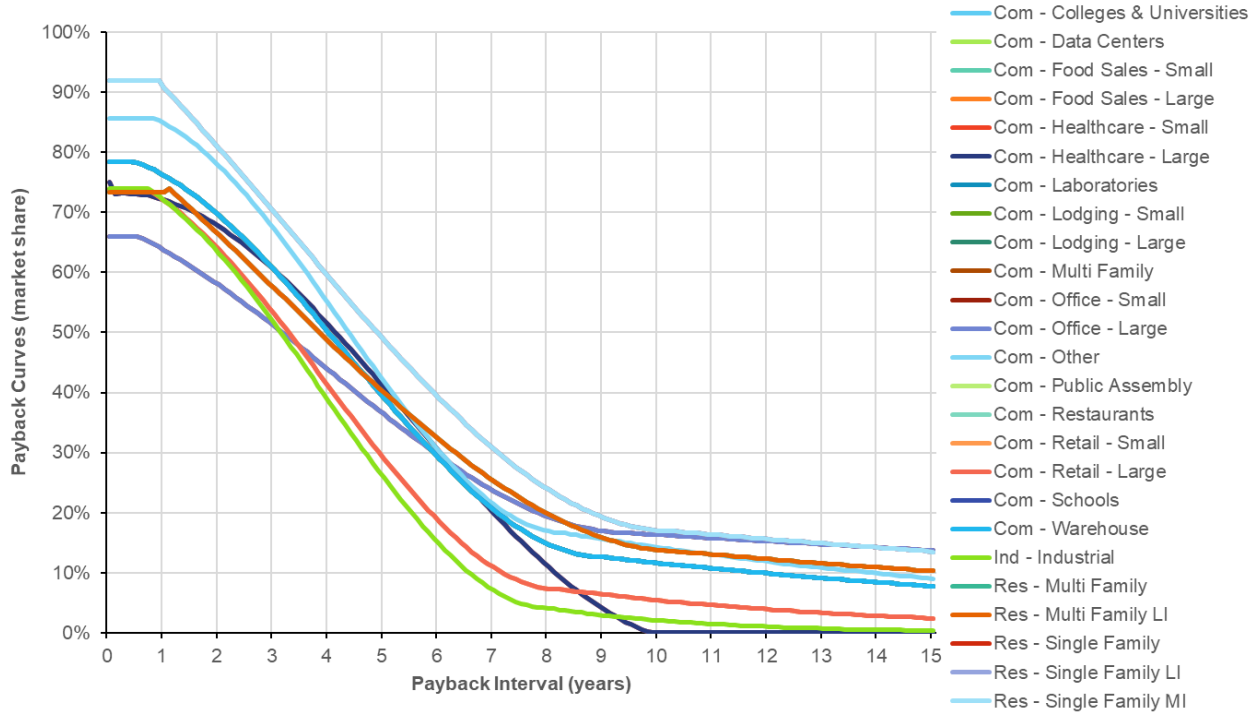
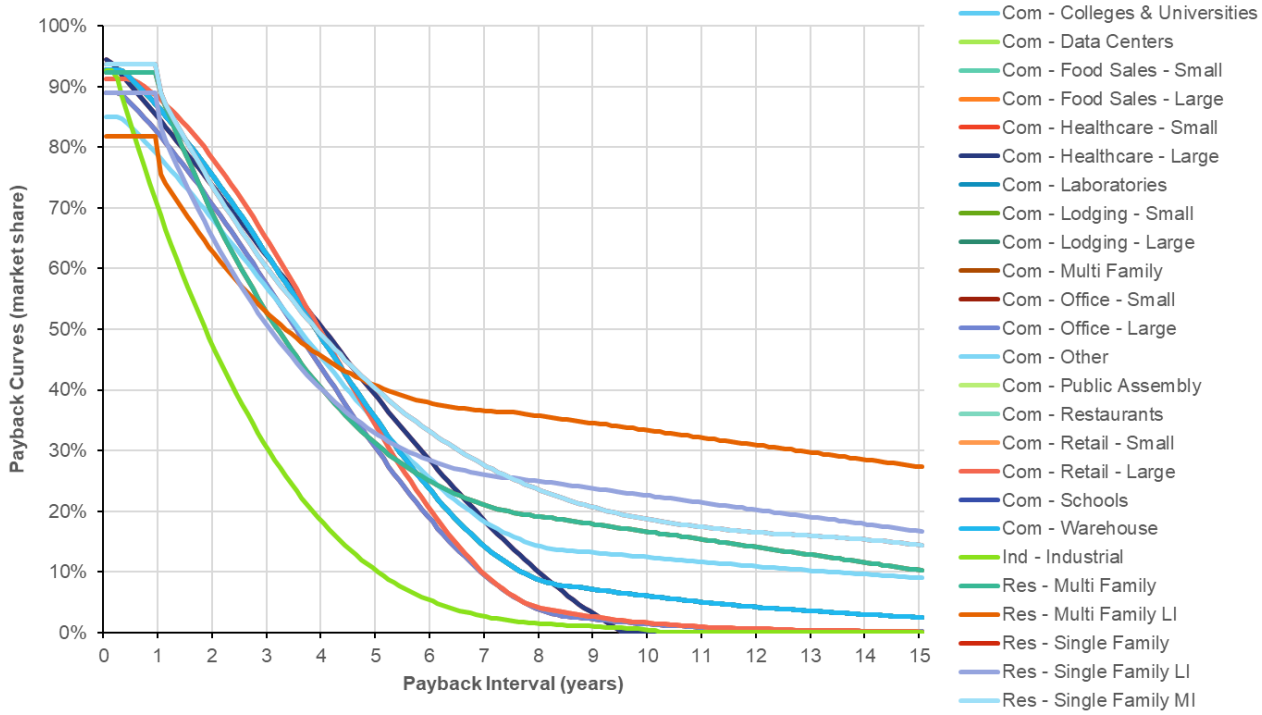


Figure A-5. Payback Acceptance Curves for Low-Cost Measures



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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.

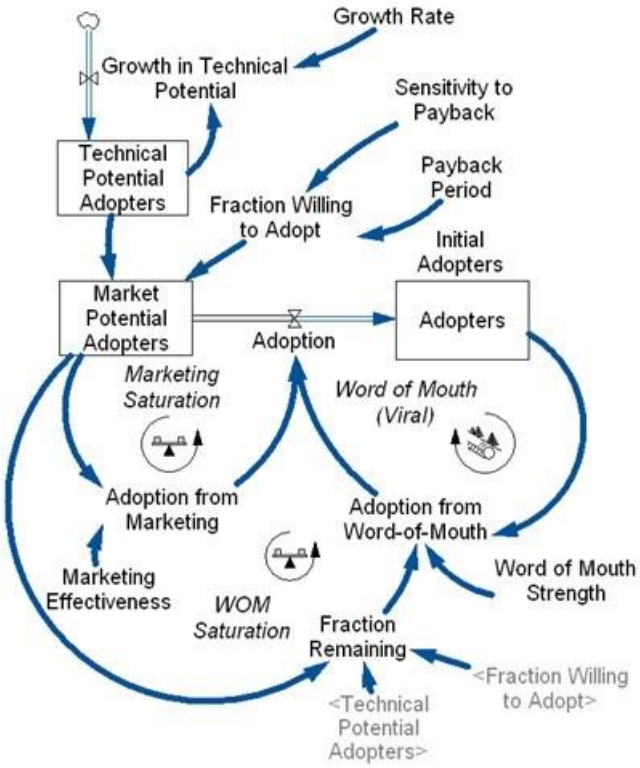


Figure A-6. Stock/Flow Diagram of Diffusion Model for New Products and Retrofits

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.

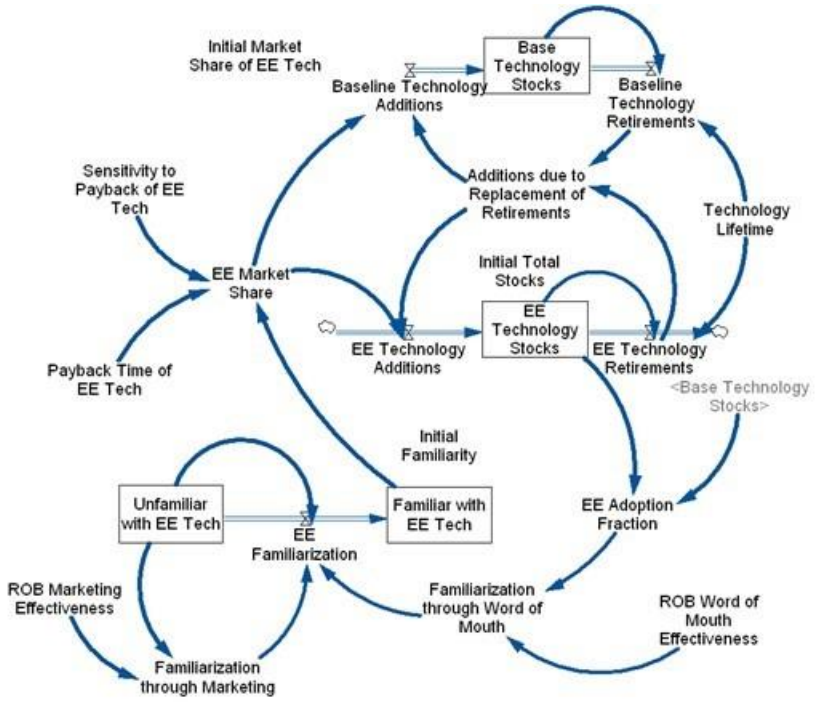


Figure A-7. Stock/Flow Diagram of Diffusion Model for Replace-on-Burnout Measures

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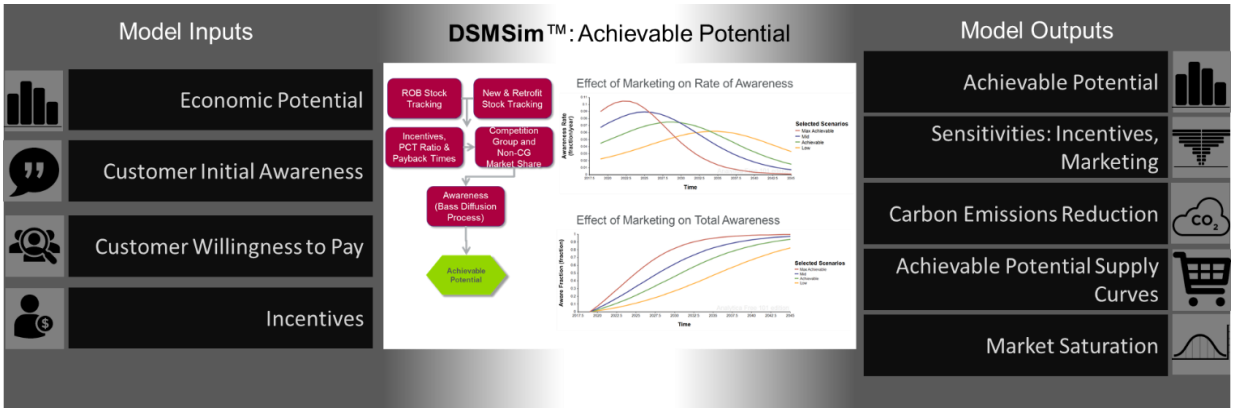
and top contributing measures for measures modeled in the study with historical program data.

- 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 250 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**: Electricity, Natural Gas, Fuel Oil, Propane, or Gasoline
- **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.
  - Electricity Saving: Measure that saves electricity either directly by replacing an electric appliance, or indirectly by causing an existing electric appliance to use less energy.
  - 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	Electricity	NEW	Electricity Saving
Res & IE	Behavior	Home Energy Report	Electricity	RET	Electricity Saving
Res & IE	Envelope	Air Sealing	Electricity	RET	Electricity Saving
Res & IE	Envelope	Air Sealing	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Air Sealing	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Duct Insulation	Electricity	RET	Electricity Saving
Res & IE	Envelope	Duct Insulation	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Duct Insulation	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Duct Sealing	Electricity	RET	Electricity Saving
Res & IE	Envelope	Duct Sealing	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Duct Sealing	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Insulation	Electricity	RET	Electricity Saving
Res & IE	Envelope	Insulation	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Insulation	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Windows - Double to Triple Pane	Electricity	RET	Electricity Saving
Res & IE	Envelope	Windows - Double to Triple Pane	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Windows - Double to Triple Pane	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Windows - Single to Triple Pane	Electricity	RET	Electricity Saving
Res & IE	Envelope	Windows - Single to Triple Pane	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Windows - Single to Triple Pane	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Faucet Aerator	Electricity	NEW	Electricity Saving
Res & IE	Hot Water	Faucet Aerator	Electricity	RET	Electricity Saving
Res & IE	Hot Water	Faucet Aerator	Fuel Oil	NEW	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Faucet Aerator	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Faucet Aerator	Propane	NEW	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Faucet Aerator	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Heat Pump Water Heater	Electricity	RET	Electricity Saving
Res & IE	Hot Water	Heat Pump Water Heater	Electricity	ROB	Electricity Saving

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Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Res & IE	Hot Water	Heat Pump Water Heater Fuel Switch	Fuel Oil	ROB	Electrification
Res & IE	Hot Water	Heat Pump Water Heater Fuel Switch	Propane	ROB	Electrification
Res & IE	Hot Water	Indirect Water Heater	Fuel Oil	RET	Fossil Fuel Efficiency
Res & IE	Hot Water	Indirect Water Heater	Fuel Oil	ROB	Fossil Fuel Efficiency
Res & IE	Hot Water	Indirect Water Heater	Propane	RET	Fossil Fuel Efficiency
Res & IE	Hot Water	Indirect Water Heater	Propane	ROB	Fossil Fuel Efficiency
Res & IE	Hot Water	On Demand/Tankless Water Heater	Electricity	ROB	Electricity Saving
Res & IE	Hot Water	On Demand/Tankless Water Heater	Propane	RET	Fossil Fuel Efficiency
Res & IE	Hot Water	On Demand/Tankless Water Heater	Propane	ROB	Fossil Fuel Efficiency
Res & IE	Hot Water	Pipe Wrap (Water Heating)	Electricity	RET	Electricity Saving
Res & IE	Hot Water	Pipe Wrap (Water Heating)	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Pipe Wrap (Water Heating)	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Showerhead	Electricity	NEW	Electricity Saving
Res & IE	Hot Water	Showerhead	Electricity	RET	Electricity Saving
Res & IE	Hot Water	Showerhead	Fuel Oil	NEW	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Showerhead	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Showerhead	Propane	NEW	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Showerhead	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Thermostatic Valve	Electricity	RET	Electricity Saving
Res & IE	Hot Water	Thermostatic Valve	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Thermostatic Valve	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Air-to-Water Heat Pumps Displacing Oil	Fuel Oil	ROB	Electrification
Res & IE	HVAC	Air-to-Water Heat Pumps Displacing Propane	Propane	ROB	Electrification
Res & IE	HVAC	Central AC Quality Installation Verification	Electricity	ROB	Electricity Saving
Res & IE	HVAC	Central Air Conditioning	Electricity	RET	Electricity Saving
Res & IE	HVAC	Central Air Conditioning	Electricity	ROB	Electricity Saving
Res & IE	HVAC	Central Air Source Heat Pump Fully Replacing Oil Furnace	Fuel Oil	ROB	Electrification
Res & IE	HVAC	Central Air Source Heat Pump Fully Replacing Propane Furnace	Propane	ROB	Electrification

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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 Oil Furnace[1]	Fuel Oil	RET	Electrification
Res & IE	HVAC	Central Air Source Heat Pump Partially Displacing Propane Furnace[1]	Propane	RET	Electrification
Res & IE	HVAC	Central Heat Pump	Electricity	RET	Electricity Saving
Res & IE	HVAC	Central Heat Pump	Electricity	ROB	Electricity Saving
Res & IE	HVAC	Ductless Mini-Split Heat Pump	Electricity	RET	Electricity Saving
Res & IE	HVAC	Ductless Mini-Split Heat Pump	Electricity	ROB	Electricity Saving
Res & IE	HVAC	Ductless Mini-Split Heat Pump Fully Replacing Oil Boiler	Fuel Oil	ROB	Electrification
Res & IE	HVAC	Ductless Mini-Split Heat Pump Fully Replacing Propane Boiler	Propane	ROB	Electrification
Res & IE	HVAC	Ductless Mini-Split Heat Pump Partially Displacing Oil Boiler[1]	Fuel Oil	RET	Electrification
Res & IE	HVAC	Ductless Mini-Split Heat Pump Partially Displacing Propane Boiler[1]	Propane	RET	Electrification
Res & IE	HVAC	Ductless Mini-Split Heat Pump Quality Installation Verification	Electricity	ROB	Electricity Saving
Res & IE	HVAC	Electric Resistance Baseboard to Ductless Mini-Split Heat Pump	Electricity	RET	Electricity Saving
Res & IE	HVAC	Electronically Commutated Motor Circulator Pump	Electricity	ROB	Electricity Saving
Res & IE	HVAC	Forced Hot Water Boiler	Fuel Oil	RET	Fossil Fuel Efficiency
Res & IE	HVAC	Forced Hot Water Boiler	Fuel Oil	ROB	Fossil Fuel Efficiency
Res & IE	HVAC	Forced Hot Water Boiler	Propane	RET	Fossil Fuel Efficiency
Res & IE	HVAC	Forced Hot Water Boiler	Propane	ROB	Fossil Fuel Efficiency
Res & IE	HVAC	Furnace	Fuel Oil	RET	Fossil Fuel Efficiency
Res & IE	HVAC	Furnace	Fuel Oil	ROB	Fossil Fuel Efficiency
Res & IE	HVAC	Furnace	Propane	RET	Fossil Fuel Efficiency
Res & IE	HVAC	Furnace	Propane	ROB	Fossil Fuel Efficiency

[1] For residential 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.

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Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Res & IE	HVAC	Heat Pump Quality Installation Verification	Electricity	ROB	Electricity Saving
Res & IE	HVAC	Heat Pump Tune Up	Electricity	RET	Electricity Saving
Res & IE	HVAC	Heat Recovery Ventilator	Fuel Oil	ROB	Indirect Fossil Fuel Saving
Res & IE	HVAC	Heat Recovery Ventilator	Propane	ROB	Indirect Fossil Fuel Saving
Res & IE	HVAC	HVAC Downsize 1/2 Ton	Electricity	ROB	Electricity Saving
Res & IE	HVAC	HVAC Quality Installation with Duct Modification	Electricity	ROB	Electricity Saving
Res & IE	HVAC	Manual Thermostat to Programmable Thermostat	Electricity	RET	Electricity Saving
Res & IE	HVAC	Manual Thermostat to Programmable Thermostat	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Manual Thermostat to Programmable Thermostat	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Manual Thermostat to Wi-Fi Thermostat	Electricity	RET	Electricity Saving
Res & IE	HVAC	Manual Thermostat to Wi-Fi Thermostat	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Manual Thermostat to Wi-Fi Thermostat	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Pipe Wrap (Space Heating)	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Pipe Wrap (Space Heating)	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Programmable Thermostat to Wi-Fi Thermostat	Electricity	RET	Electricity Saving
Res & IE	HVAC	Programmable Thermostat to Wi-Fi Thermostat	Fuel Oil	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Programmable Thermostat to Wi-Fi Thermostat	Propane	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Room Air Conditioner	Electricity	ROB	Electricity Saving
Res & IE	HVAC	Water-to-Air Ground Source Heat Pump Displacing Oil	Fuel Oil	ROB	Electrification
Res & IE	HVAC	Water-to-Air Ground Source Heat Pump Displacing Propane	Propane	ROB	Electrification
Res & IE	HVAC	Water-to-Water Ground Source Heat Pump Displacing Oil	Fuel Oil	ROB	Electrification
Res & IE	HVAC	Water-to-Water Ground Source Heat Pump Displacing Propane	Propane	ROB	Electrification

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Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Res & IE	HVAC	Wi-Fi Thermostat	Electricity	NEW	Electricity Saving
Res & IE	HVAC	Wi-Fi Thermostat	Fuel Oil	NEW	Indirect Fossil Fuel Saving
Res & IE	HVAC	Wi-Fi Thermostat	Propane	NEW	Indirect Fossil Fuel Saving
Res & IE	Lighting	Occupancy Sensor	Electricity	RET	Electricity Saving
Res & IE	Motors/Drives	Variable Frequency Drive - Multifamily Income Eligible	Electricity	RET	Electricity Saving
Res & IE	Plug Load	Advanced Power Strip	Electricity	NEW	Electricity Saving
Res & IE	Plug Load	Advanced Power Strip	Electricity	RET	Electricity Saving
Res & IE	Plug Load	Clothes Dryer	Electricity	ROB	Electricity Saving
Res & IE	Plug Load	Dehumidifer Replacement	Electricity	RET	Electricity Saving
Res & IE	Plug Load	Electric Chainsaw	Gasoline	ROB	Electrification
Res & IE	Plug Load	Electric Lawnmower	Gasoline	ROB	Electrification
Res & IE	Plug Load	Electric Leafblower	Gasoline	ROB	Electrification
Res & IE	Plug Load	Electric Trimmer	Gasoline	ROB	Electrification
Res & IE	Plug Load	Induction Stove	Electricity	ROB	Electricity Saving
Res & IE	Plug Load	Room Air Cleaner	Electricity	ROB	Electricity Saving
Res & IE	Plug Load	Ultra Low Global Warming Potential Refrigerator	Electricity	ROB	Electricity Saving
Res & IE	Whole Home	All-Electric Passive House	Electricity	NEW	Electricity Saving
Res & IE	Whole Home	All-Electric Passive House[2]	Fuel Oil	NEW	Electrification
Res & IE	Whole Home	All-Electric Passive House	Propane	NEW	Electrification
Res & IE	Whole Home	New Construction Energy Efficiency	Electricity	NEW	Electricity Saving
Res & IE	Whole Home	New Construction Energy Efficiency[3]	Fuel Oil	NEW	Fossil Fuel Efficiency
Res & IE	Whole Home	New Construction Energy Efficiency[3]	Propane	NEW	Fossil Fuel Efficiency
Industrial	Compressed Air	Air Nozzle	Electricity	NEW	Electricity Saving
Industrial	Compressed Air	Air Nozzle	Electricity	RET	Electricity Saving

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

[3] 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	Compressed Air	High Efficiency Air Compressor	Electricity	ROB	Electricity Saving
Industrial	Compressed Air	Low Pressure Drop Filter	Electricity	ROB	Electricity Saving
Industrial	Compressed Air	Refrigerated Air Dryer	Electricity	ROB	Electricity Saving
Industrial	Compressed Air	Zero-Loss Condensate Drain	Electricity	ROB	Electricity Saving
Industrial	Custom	Custom Large C&I	Electricity	RET	Custom
Industrial	Custom	Custom Large C&I	Electricity	ROB	Custom
Industrial	Custom	Custom New Construction	Electricity	NEW	Custom
Industrial	Custom	Electric Forklifts	Propane	ROB	Electricity Saving
Industrial	HVAC	Energy Management System	Electricity	NEW	Electricity Saving
Industrial	HVAC	Energy Management System	Electricity	RET	Electricity Saving
Industrial	HVAC	Energy Management System	Fuel Oil	NEW	Indirect Fossil Fuel Saving
Industrial	HVAC	Energy Management System	Fuel Oil	RET	Indirect Fossil Fuel Saving
Industrial	HVAC	Energy Management System	Propane	NEW	Indirect Fossil Fuel Saving
Industrial	HVAC	Energy Management System	Propane	RET	Indirect Fossil Fuel Saving
Commercial	Behavior	Building Operator Certification	Electricity	RET	Electricity Saving
Commercial	Custom	Custom - Res End Use	Electricity	ROB	Custom
Commercial	Custom	Custom Large C&I	Electricity	RET	Custom
Commercial	Custom	Custom Large C&I	Electricity	ROB	Custom
Commercial	Custom	Custom New Construction	Electricity	NEW	Custom
Commercial	Custom	Custom Refrigeration	Electricity	ROB	Custom
Commercial	Custom	Electric Forklifts	Propane	ROB	Electricity Saving
Commercial	Envelope	Air Sealing	Electricity	RET	Electricity Saving
Commercial	Envelope	Air Sealing	Fuel Oil	RET	Indirect Fossil Fuel Saving
Commercial	Envelope	Air Sealing	Propane	RET	Indirect Fossil Fuel Saving
Commercial	Envelope	Air Sealing - Res End Use	Electricity	RET	Electricity Saving
Commercial	Envelope	Air Sealing - Res End Use	Fuel Oil	RET	Indirect Fossil Fuel Saving
Commercial	Envelope	Air Sealing - Res End Use	Propane	RET	Indirect Fossil Fuel Saving
Commercial	Envelope	Insulation	Electricity	RET	Electricity Saving
Commercial	Envelope	Insulation	Propane	RET	Indirect Fossil Fuel Saving

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Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Commercial	Envelope	Insulation - Res End Use	Electricity	RET	Electricity Saving
Commercial	Envelope	Insulation - Res End Use	Propane	RET	Indirect Fossil Fuel Saving
Commercial	Food Service	Conveyor Broiler	Electricity	ROB	Electricity Saving
Commercial	Food Service	Food Holding Cabinet	Electricity	ROB	Electricity Saving
Commercial	Food Service	Fryer	Electricity	ROB	Electricity Saving
Commercial	Food Service	Griddle	Electricity	ROB	Electricity Saving
Commercial	Food Service	High Temperature Commercial Dishwasher	Electricity	ROB	Electricity Saving
Commercial	Food Service	Ice Machine	Electricity	ROB	Electricity Saving
Commercial	Food Service	Low Temperature Commercial Dishwasher	Electricity	ROB	Electricity Saving
Commercial	Food Service	Oven	Electricity	ROB	Electricity Saving
Commercial	Food Service	Steamer	Electricity	ROB	Electricity Saving
Commercial	Hot Water	Faucet Aerator	Electricity	NEW	Electricity Saving
Commercial	Hot Water	Faucet Aerator	Electricity	RET	Electricity Saving
Commercial	Hot Water	Faucet Aerator - Res End Use	Electricity	NEW	Electricity Saving
Commercial	Hot Water	Faucet Aerator - Res End Use	Electricity	RET	Electricity Saving
Commercial	Hot Water	Faucet Aerator - Res End Use	Fuel Oil	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Faucet Aerator - Res End Use	Fuel Oil	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Faucet Aerator - Res End Use	Propane	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Faucet Aerator - Res End Use	Propane	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Heat Pump Water Heater	Electricity	ROB	Electricity Saving
Commercial	Hot Water	Heat Pump Water Heater Displacing Oil	Fuel Oil	ROB	Electrification
Commercial	Hot Water	Heat Pump Water Heater Displacing Propane	Propane	ROB	Electrification
Commercial	Hot Water	Low-Flow Showerhead	Electricity	NEW	Electricity Saving
Commercial	Hot Water	Low-Flow Showerhead	Electricity	RET	Electricity Saving
Commercial	Hot Water	Low-Flow Showerhead	Propane	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead	Propane	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead - Res End Use	Electricity	NEW	Electricity Saving
Commercial	Hot Water	Low-Flow Showerhead - Res End Use	Electricity	RET	Electricity Saving
Commercial	Hot Water	Low-Flow Showerhead - Res End Use	Fuel Oil	NEW	Indirect Fossil Fuel Saving

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Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Commercial	Hot Water	Low-Flow Showerhead - Res End Use	Fuel Oil	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead - Res End Use	Propane	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead - Res End Use	Propane	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead With Thermostatic Valve	Electricity	RET	Electricity Saving
Commercial	Hot Water	Low-Flow Showerhead With Thermostatic Valve	Propane	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead With Thermostatic Valve - Res End Use	Electricity	RET	Electricity Saving
Commercial	Hot Water	Low-Flow Showerhead With Thermostatic Valve - Res End Use	Fuel Oil	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead With Thermostatic Valve - Res End Use	Propane	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pipe Wrap (Water Heating)	Electricity	RET	Electricity Saving
Commercial	Hot Water	Pipe Wrap (Water Heating) - Res End Use	Electricity	NEW	Electricity Saving
Commercial	Hot Water	Pipe Wrap (Water Heating) - Res End Use	Electricity	RET	Electricity Saving
Commercial	Hot Water	Pre-Rinse Spray Valve	Electricity	NEW	Electricity Saving
Commercial	Hot Water	Pre-Rinse Spray Valve	Electricity	RET	Electricity Saving
Commercial	Hot Water	Pre-Rinse Spray Valve	Propane	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pre-Rinse Spray Valve	Propane	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Air Source Heat Pump	Electricity	ROB	Electricity Saving
Commercial	HVAC	Air Source Heat pump - Res End Use	Electricity	RET	Electricity Saving
Commercial	HVAC	Central Air Source Heat Pump (Split or Packaged)	Fuel Oil	ROB	Electrification
Commercial	HVAC	Central Air Source Heat Pump (Split or Packaged)	Propane	ROB	Electrification
Commercial	HVAC	Commercial HVAC Tune-up	Electricity	RET	Electricity Saving
Commercial	HVAC	Commissioning/Retrocommissioning	Electricity	RET	Electricity Saving
Commercial	HVAC	Data Center Air-side Economizer	Electricity	RET	Electricity Saving
Commercial	HVAC	Data Center Computer Room Air Conditioner	Electricity	RET	Electricity Saving
Commercial	HVAC	Data Center Hot Aisle/Cold Aisle	Electricity	RET	Electricity Saving

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Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Commercial	HVAC	Data Center Water-side Economizer	Electricity	RET	Electricity Saving
Commercial	HVAC	Demand Control Ventilation	Electricity	RET	Electricity Saving
Commercial	HVAC	Dual Enthalpy Economizer Controls	Electricity	RET	Electricity Saving
Commercial	HVAC	Duct Insulation	Electricity	RET	Electricity Saving
Commercial	HVAC	Duct Insulation - Res End Use	Electricity	RET	Electricity Saving
Commercial	HVAC	Duct Sealing	Electricity	RET	Electricity Saving
Commercial	HVAC	Ductless Heat Pump	Fuel Oil	ROB	Electrification
Commercial	HVAC	Ductless Heat Pump	Propane	ROB	Electrification
Commercial	HVAC	Ductless Mini-Split Heat Pump	Electricity	ROB	Electricity Saving
Commercial	HVAC	Electronically Commutated Motor Circulator Pump	Electricity	ROB	Electricity Saving
Commercial	HVAC	Energy Management System	Electricity	NEW	Electricity Saving
Commercial	HVAC	Energy Management System	Electricity	RET	Electricity Saving
Commercial	HVAC	Energy Management System	Fuel Oil	NEW	Indirect Fossil Fuel Saving
Commercial	HVAC	Energy Management System	Fuel Oil	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Energy Management System	Propane	NEW	Indirect Fossil Fuel Saving
Commercial	HVAC	Energy Management System	Propane	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Ground Source Heat Pump	Electricity	ROB	Electricity Saving
Commercial	HVAC	Ground Source Heat Pump (Water-to-Air)	Fuel Oil	ROB	Electrification
Commercial	HVAC	Ground Source Heat Pump (Water-to-Air)	Propane	ROB	Electrification
Commercial	HVAC	Ground Source Heat Pump (Water-to-Water)	Fuel Oil	ROB	Electrification
Commercial	HVAC	Ground Source Heat Pump (Water-to-Water)	Propane	ROB	Electrification
Commercial	HVAC	High Efficiency Chiller	Electricity	ROB	Electricity Saving
Commercial	HVAC	Programmable Thermostat	Electricity	RET	Electricity Saving
Commercial	HVAC	Strategic Energy Management	Electricity	ROB	Electricity Saving
Commercial	HVAC	Variable Refrigerant Flow Heat Pump	Fuel Oil	ROB	Electrification
Commercial	HVAC	Variable Refrigerant Flow Heat Pump	Propane	ROB	Electrification
Commercial	HVAC	Wi-Fi Thermostat	Electricity	NEW	Electricity Saving
Commercial	HVAC	Wi-Fi Thermostat	Electricity	RET	Electricity Saving

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Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Commercial	Lighting	Exterior LED Fixture with Controls - Building Exterior	Electricity	RET	Electricity Saving
Commercial	Lighting	Exterior LED Fixture with Controls - Parking Garage and Canopy	Electricity	RET	Electricity Saving
Commercial	Lighting	Exterior LED Fixture with Controls - Pole/Arm Mounted	Electricity	RET	Electricity Saving
Commercial	Lighting	Indoor LED Fixture with Controls - High/Low Bay	Electricity	RET	Electricity Saving
Commercial	Lighting	Indoor LED Fixture/Retrofit kit with Controls - Linear	Electricity	RET	Electricity Saving
Commercial	Lighting	Lighting Controls	Electricity	RET	Electricity Saving
Commercial	Lighting	Performance Lighting with Advanced Controls	Electricity	ROB	Electricity Saving
Commercial	Motors/Drives	Variable Frequency Drive	Electricity	ROB	Electricity Saving
Commercial	Process	Advanced Power Strip - Res End Use	Electricity	RET	Electricity Saving
Commercial	Process	Data Center Server Virtualization	Electricity	RET	Electricity Saving
Commercial	Process	Data Center Uninterruptible Power Supply	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Case Motor Replacement	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Cooler Night Cover	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Door Heater Controls	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Electric Deck Oven	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Electronic Defrost Control	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Electronically Commutated Evaporator Fan Motors for Walk-in Cooler/Freezer	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Evaporator Fan Control	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Hand Wrapper	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Lab-Grade Cold Storage	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Low-Global Warming Potential Refrigerant Retrofits	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Novelty Cooler Shutoff	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Refrigerant Leak Remediation	Electricity	RET	Electricity Saving
Commercial	Refrigeration	Refrigerated Chef Base	Electricity	RET	Electricity Saving

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Sector	End Use	Common Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Commercial	Refrigeration	Vending Miser	Electricity	RET	Electricity Saving

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