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

Final Report

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Unitil

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Common Acronyms

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

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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
PNNL	Pacific Northwest National Laboratory
PV	Present Value
RET	Retrofit
ROB	Replace-on-Burnout
SEER	Seasonal Energy Efficiency Ratio
TRC	Total Resource Cost
TRM	Technical Reference Manual
TSD	Technical Support Document

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Executive Summary

Unitil and the other Massachusetts Program Administrators[1] (PAs) engaged Guidehouse, Inc and its subcontractor, Synapse Energy Economics (collectively, the Guidehouse Team or Guidehouse), to quantify the total technical, economic, and achievable potential for energy efficiency and electrification (also called fuel substitution or fuel switching) (EE), and demand response (DR), in the PAs' service areas between 2025 and 2027. This study is a high-level assessment of electric, natural gas, oil, and propane savings opportunities in the Residential, Income Eligible, and Commercial and Industrial (C&I) sectors in Unitil's service areas 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 Unitil in Massachusetts. For DR, DRSim calculates achievable potential estimates across Unitil's service areas 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 (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 electricity and natural gas energy efficiency and summer and winter peak passive demand savings across Massachusetts. DSMSim is a bottom-up technology diffusion and stock tracking model implemented using a System Dynamics[3] framework. The model explicitly accounts for different types of efficient measures, such as retrofit (RET), replace-on-burnout (ROB), and new construction (NEW), including fuel substitution measures, and the impacts these measures have on savings potential. The model then reports the technical, economic, and achievable potential savings in aggregate by sector, customer segment, end-use category, and highest impact measures. A separate model was developed within DSMSim for each PA / operating company.

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

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

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

Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as in technical potential, but limiting the calculation only to those measures that have passed the benefit-cost test chosen for measure screening—in this case, the Total Resource Cost (TRC) test as used by Unitil 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 modelling. 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 Unitil'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 approach. Guidehouse used a combination of primary data (e.g., market data from Unitil) and relevant secondary sources to develop data inputs required for assessing DR potential and cost-effectiveness. These data inputs feed into Guidehouse's Demand Response Simulator model (DRSim), customized for the study, which produces DR potential, annual program costs, and cost-effectiveness of DR options at various levels of disaggregation.

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

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

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 Unitil currently offers or could offer in the future. The DR options characterization involved specifying unit impacts, participation assumptions, and itemized costs for realizing load

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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.

The DR analysis considers BAE and MAX scenario with variations in participation assumptions corresponding to variations in DR program participation incentives for Unitil's existing DR programs.[4] The MAX scenario considered new DR options and suboptions that Unitil could potentially offer while the BAE scenario only considers existing programs. The MAX scenario assessed cost-effectiveness of the new DR options and suboptions and included achievable potential estimates from these in the reported results under MAX scenario. However, given Unitil's relatively small market size, it may be challenging to incorporate these new DR options and suboptions in a program. Unitil may incur high fixed setup program costs for these new offers and may also face challenges in finding an interested vendor to work with, given small market size of eligible customers.

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-6 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 and CECP results for electricity show increasing potential across the three years of the study for all sectors. For both CECP scenarios, total electricity savings over the three years are almost twice as large as the BAE scenario and deliver about two times the MMBtu and 2030 Carbon savings as the BAE scenario due to high amounts of electrification.

The BAE and CECP results for natural gas show increasing potential across the three years of the study for all sectors. Gas savings increase in the CECP scenarios, because of the high amounts of electrification. Nevertheless, for both CECP scenarios, total natural gas savings over the three years are usually around double the BAE savings, MMBtu, and carbon reduction compared to the BAE scenario. 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.

[4] Note that we there is no winter DR potential under BAE, given that BAE only represents Unitil's current DR programs which are offered for summer only.

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Table ES-1. Energy Efficiency BAE Scenario Net Achievable Potential, Unitil 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	1,280	130	21,300	247,100	1,020
2026	1,250	130	23,400	286,500	1,220
2027	1,240	130	25,500	321,700	1,400
Income Eligible Sector					
2025	50	20	2,300	42,400	150
2026	60	20	2,700	49,700	180
2027	70	20	3,000	56,600	210
Commercial & Industrial Sector					
2025	670	10	6,600	76,500	290
2026	580	-30	6,500	72,200	310
2027	650	-20	6,800	76,700	320
Portfolio Total					
2025	2,000	160	30,200	366,000	1,460
2026	1,890	120	32,600	408,400	1,710
2027	1,960	130	35,300	455,000	1,930

Source: Guidehouse

Table ES-2. Energy Efficiency CECP Scenario Net Achievable Potential, Unitil 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	1,600	300	50,500	824,400	3,220
2026	1,610	300	51,900	847,900	3,340
2027	1,690	300	48,400	769,000	3,030
Income Eligible Sector					
2025	410	70	9,400	171,400	560
2026	480	70	9,200	166,900	520
2027	440	70	8,700	156,800	500
Commercial & Industrial Sector					
2025	1,470	70	12,100	141,900	450
2026	1,440	40	12,200	140,800	480
2027	1,500	60	12,400	143,300	490
Portfolio Total					
2025	3,480	440	72,000	1,137,700	4,230
2026	3,530	410	73,300	1,155,600	4,340
2027	3,630	430	69,500	1,069,100	4,020

Source: Guidehouse

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Table ES-3. Energy Efficiency CECP Cost Premium Scenario Net Achievable Potential, Unitil 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	1,600	300	50,500	824,400	3,220
2026	1,610	300	51,900	847,900	3,340
2027	1,690	300	48,400	769,000	3,030
Income Eligible Sector					
2025	410	70	9,400	171,400	560
2026	480	70	9,200	166,900	520
2027	440	70	8,700	156,800	500
Commercial & Industrial Sector					
2025	1,470	70	12,100	141,900	450
2026	1,440	40	12,200	140,800	480
2027	1,500	60	12,400	143,300	490
Portfolio Total					
2025	3,480	440	72,000	1,137,700	4,230
2026	3,530	410	73,300	1,155,600	4,340
2027	3,630	430	69,500	1,069,100	4,020

Source: Guidehouse

Table ES-4. Energy Efficiency BAE Scenario Net Achievable Potential, Unitil Gas

Sector, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
Residential Sector				
2025	48,200	4,800	95,300	270
2026	58,100	5,800	114,300	320
2027	67,500	6,700	132,500	380
Income Eligible Sector				
2025	13,500	1,400	24,900	70
2026	16,500	1,700	30,500	90
2027	19,500	2,000	36,400	110
Commercial & Industrial Sector				
2025	88,700	8,700	123,000	480
2026	93,600	9,200	127,100	520
2027	97,800	9,600	129,700	570
Portfolio Total				
2025	150,400	14,900	243,200	820
2026	168,200	16,700	271,900	930
2027	184,800	18,300	298,600	1,060

Source: Guidehouse

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Table ES-5. Energy Efficiency CECP Scenario Net Achievable Potential, Unitil Gas

Sector, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
Residential Sector				
2025	131,200	11,300	253,000	700
2026	158,600	13,700	306,600	840
2027	186,400	16,100	360,800	990
Income Eligible Sector				
2025	33,700	3,000	60,900	180
2026	40,800	3,600	73,900	210
2027	48,000	4,300	87,000	250
Commercial & Industrial Sector				
2025	106,100	10,300	149,500	590
2026	114,500	11,000	159,400	650
2027	121,400	11,600	165,200	710
Portfolio Total				
2025	271,000	24,600	463,400	1,470
2026	313,900	28,300	539,900	1,700
2027	355,800	32,000	613,000	1,950

Source: Guidehouse

Table ES-6. Energy Efficiency CECP Cost Premium Scenario Net Achievable Potential, Unitil Gas

Sector, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
Residential Sector				
2025	131,200	11,300	253,000	700
2026	158,600	13,700	306,600	840
2027	186,400	16,100	360,800	990
Income Eligible Sector				
2025	33,700	3,000	60,900	180
2026	40,800	3,600	73,900	210
2027	48,000	4,300	87,000	250
Commercial & Industrial Sector				
2025	106,100	10,300	149,500	590
2026	114,500	11,000	159,400	650
2027	121,400	11,600	165,200	710
Portfolio Total				
2025	271,000	24,600	463,400	1,470
2026	313,900	28,300	539,900	1,700
2027	355,800	32,000	613,000	1,950

Source: Guidehouse

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Energy Efficiency Program Costs

Table ES-7 through Table ES-8 show the projected EE portfolio PA investments over the 3-year study period and across scenarios. The comparison across the scenarios indicates the CECP scenario would cost about four to five times as much as the BAE scenario for both fuels, while the CECP Cost Premium scenario would cost seven as much as the BAE scenario for electricity and more than nine times as much for natural gas over the 3-year term. Cumulative costs for the two CECP scenarios decline slightly from 2026 to 2027.

Table ES-7. Energy Efficiency Electric Portfolio Costs, by Scenario

Install Year	BAE	CECP	CECP Cost Premium
2025	$6,390,000	$30,780,000	$49,960,000
2026	$6,970,000	$31,510,000	$51,640,000
2027	$7,680,000	$29,630,000	$48,430,000
Total	**$21,040,000**	**$91,920,000**	**$150,030,000**

Source: Guidehouse

Table ES-8. Energy Efficiency Natural Gas Portfolio Costs, by Scenario

Install Year	BAE	CECP	CECP Cost Premium
2025	$2,370,000	$10,290,000	$19,920,000
2026	$2,750,000	$13,430,000	$25,880,000
2027	$3,140,000	$16,280,000	$31,920,000
Total	**$8,260,000**	**$40,000,000**	**$77,720,000**

Source: Guidehouse

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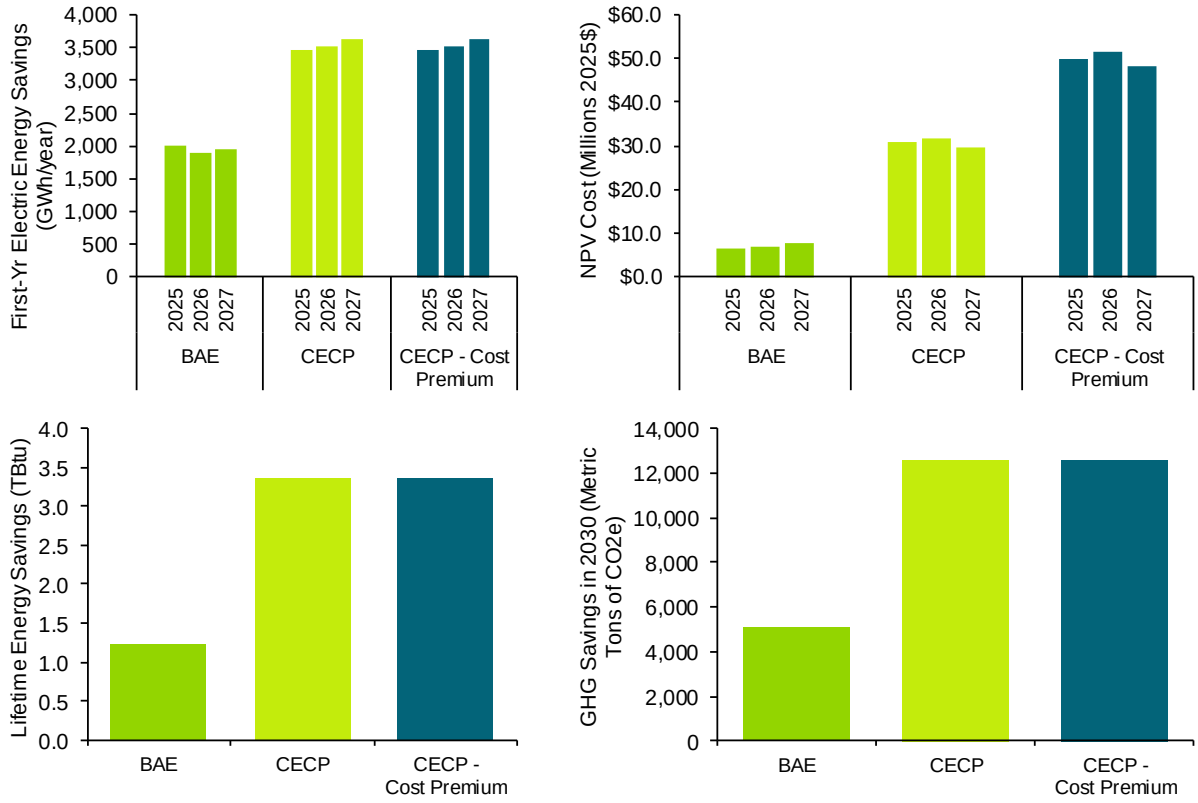
Figure ES-1 compares the overall electricity achievable potential in cumulative annual GWh, lifetime MMBtu, and 2030 Carbon for all sectors and the NPV Cost totaled for all years for the BAE, CECP and CECP Cost Premium scenarios. These figures graphically show the results discussed above.

Figure ES-1. Scenario Comparison, Unitil Electric



Source: Guidehouse

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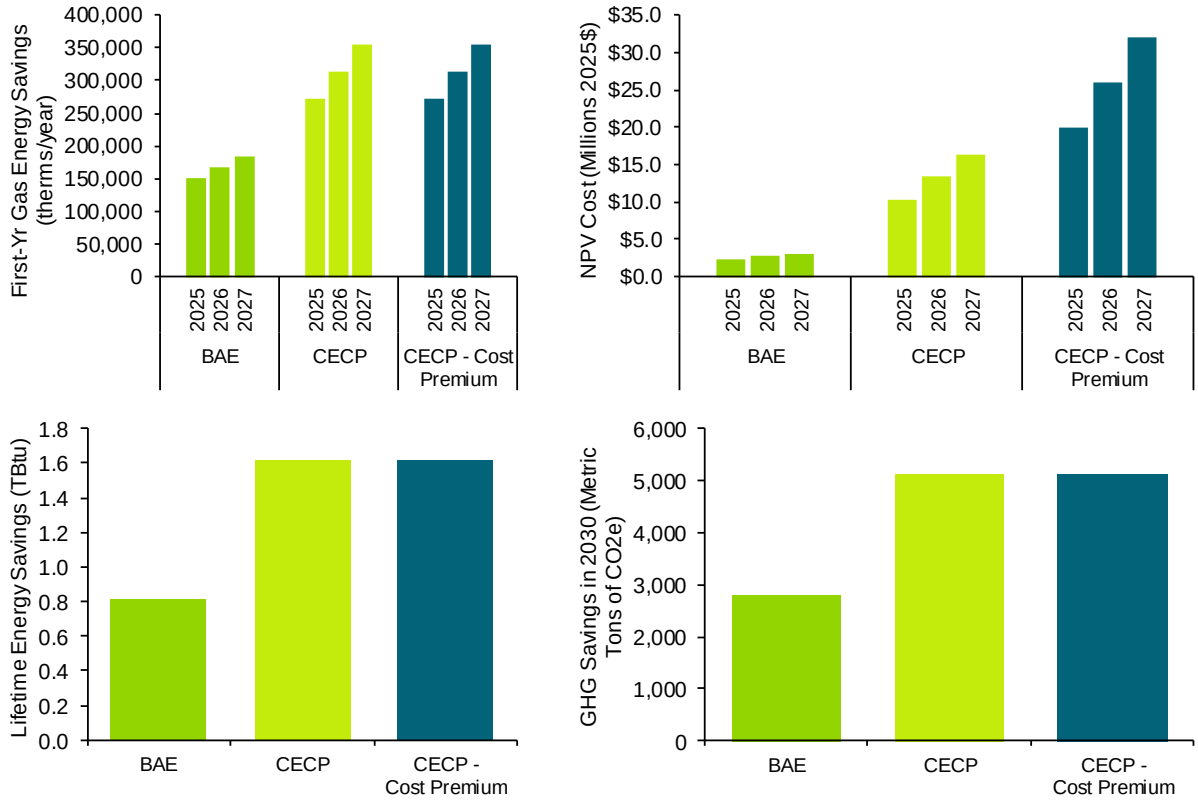
Figure ES-2 compares the overall natural gas achievable potential in cumulative annual therms, lifetime MMBtu, and 2030 Carbon for all sectors and the NPV Cost totaled for all years for the BAE, CECP and CECP Cost Premium scenarios. These figures graphically show the results discussed above.

Figure ES-2. Scenario Comparison, Unitil Gas



Source: Guidehouse

Demand Response Potential Results

Table ES-9 summarizes DR achievable electricity 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. BAE includes only summer electric potential and represents potential from Unitil' s current DR program offers. The MAX scenario potential for electricity in 2027 is around double that of the BAE scenario for summer, derived from Unitil's current programs and new DR options. BAE does not show any winter electric DR potential as Unitil's current DR programs are for summer only (BAE represents only existing DR program offers) and therefore winter DR potential is represented under the MAX scenario only.

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Table ES-9. BAE and MAX Scenarios Demand Response Achievable Potential, Electricity (Net at Meter)

Sector or 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	0.29	-	0.41	0.06
2026	0.29	-	0.53	0.13
2027	0.30	-	0.65	0.20
Commercial & Industrial Sector				
2025	0.10	-	0.12	0.10
2026	0.11	-	0.13	0.11
2027	0.12	-	0.14	0.12
Portfolio Total				
2025	0.39	-	0.53	0.16
2026	0.40	-	0.66	0.24
2027	0.41	-	0.79	0.32

Source: Guidehouse

For the BAE and MAX scenarios, none of the natural gas DR options and suboptions were assessed to be cost-effective using top 10-day natural gas costs from AESC 2024. The analysis results presented potential for all DR options regardless of cost-effectiveness. If gas DR options were cost-effective, Residential customers could potentially contribute about 10% of the savings from a combination of Direct Load Control of space heating and water heating and Behavioral DR. Large C&I customers[5] could provide almost 90% of the total potential, and the remaining potential could be realized from Direct Load Control of small and medium C&I customers.

Electricity Demand Response Supply Curve

Figure ES-3 shows the supply curve for cost-effective electric DR suboptions only. The x-axis represents achievable potential in 2027 and the y-axis represents the levelized incentive cost ($/kW-yr.) associated with realizing the potential.[6] The C&I Targeted Dispatch option has the least cost[7], followed by the Residential Bring Your Own (BYO) Thermostats.

[5] This is a small population, high load customer segment.

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

[7] The achievable potential from the targeted dispatch option is limited given market size and customer composition. Unitil has about 30 C&I customers whose annual usage > 1 million kWh most of whom have been approached and are not interested or able to participate in the DR program offer.

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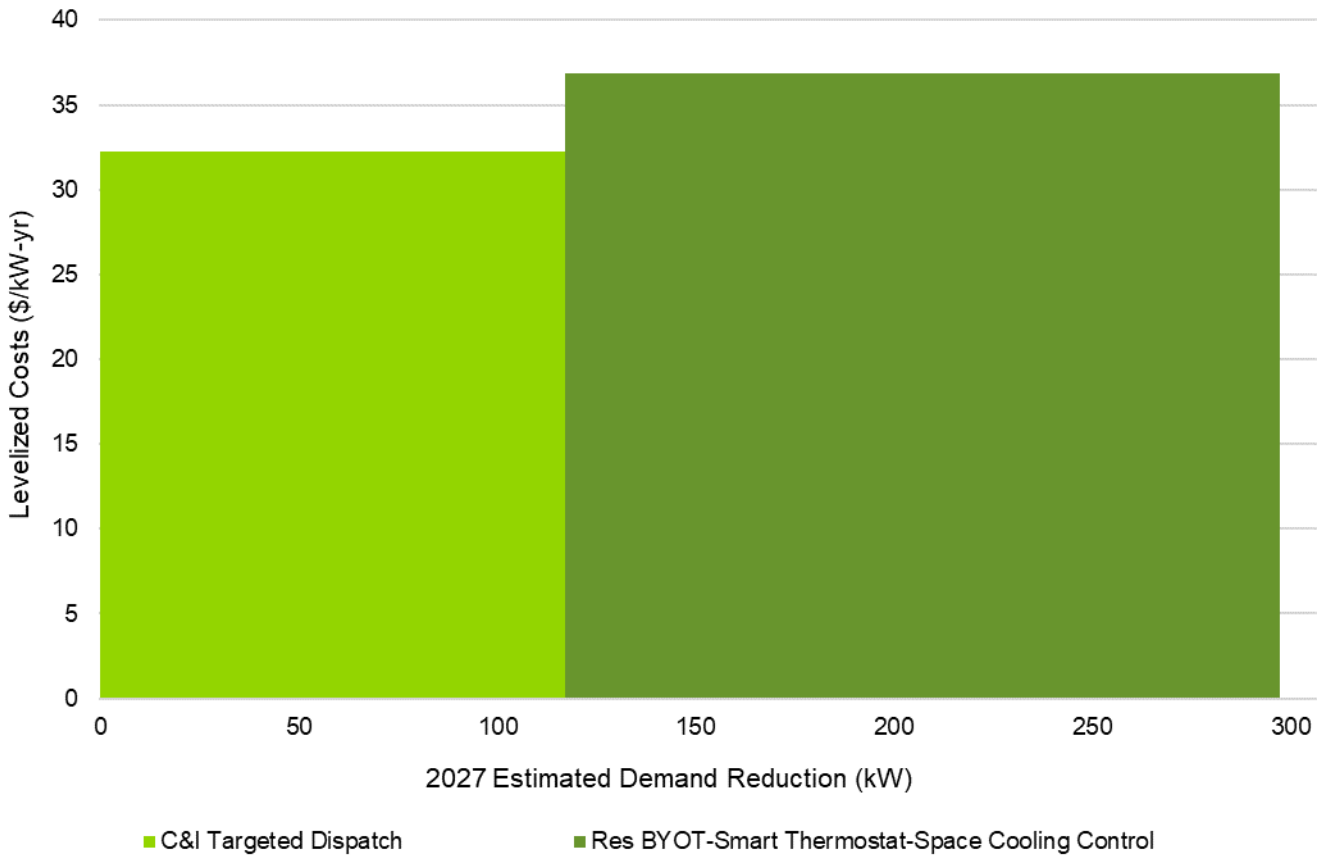
Figure ES-3. Supply Curve for Cost-Effective Electricity Demand Response Suboptions (BAE Scenario)



Source: Guidehouse

Demand Response Scenario Analysis

For the MAX case, Guidehouse adjusted assumed participation levels, incentive amounts, baseline peak, and equipment saturation to determine the impacts on the DR achievable potential. The peak demand forecasts varied by case, as these were tied to the different demand reduction scenario impacts from the energy efficiency potential analysis. Two scenarios were considered in the baseline summer peak projections: (1) BAE and (2) MAX. Figure ES-4 compares the overall summer electricity achievable DR potential for all sectors between the BAE and MAX scenarios. The BAE scenario savings remain steady over the 3-year period, while the MAX scenario increases steadily. The MAX scenario includes new DR options that Unitil could potentially offer which are cost-effective and therefore potential in MAX is considerably higher than potential in BAE. However, given Unitil's relatively small market size, it may be challenging to incorporate these new measures in a program. Unitil may incur high fixed set up costs for offering these measures in a program and may also face challenges in finding an interested vendor to work with, given small market size of eligible customers.

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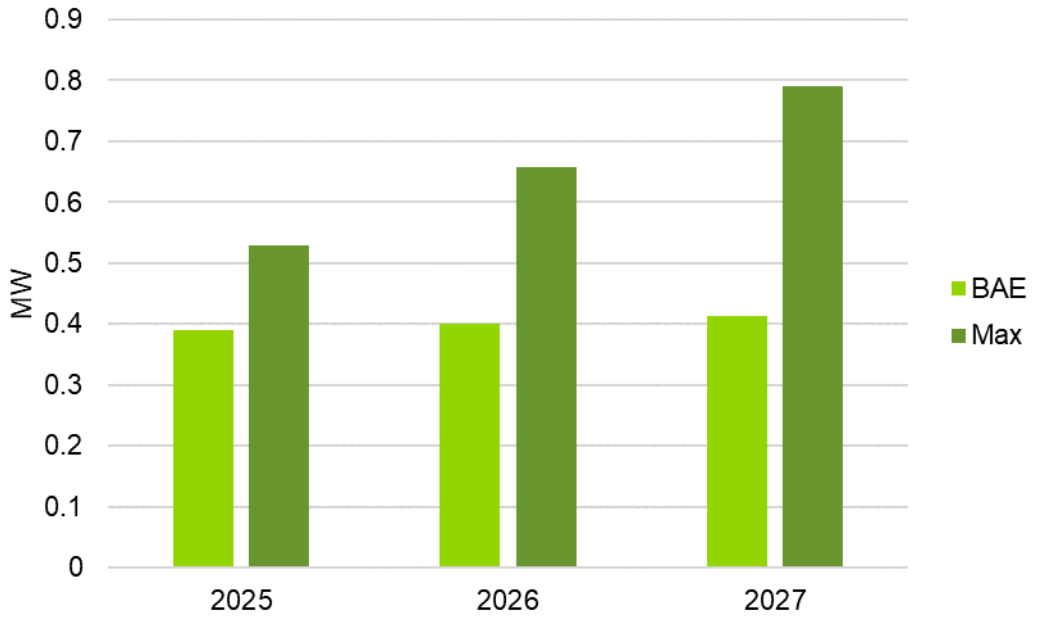
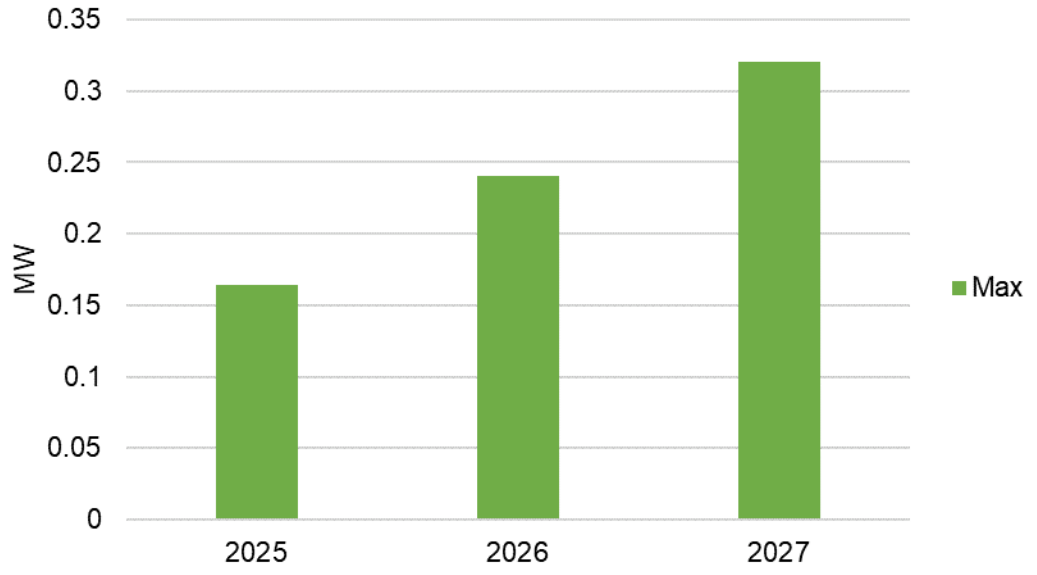
Figure ES-4. Summer Electricity Demand Response Achievable Potential by Scenario



Source: Guidehouse

Figure ES-5 shows the overall winter electric achievable DR potential for all sectors in the MAX scenario. As mentioned previously, BAE did not include winter electric DR since it does not represent Unitil's current DR programs, which were the only ones considered under BAE. The MAX scenario potential increases steadily due to high amounts of electrification of space heating and water heating that can potentially be controlled and serve as a DR resource.

Figure ES-5. Winter Electricity Demand Response Achievable Potential by Scenario



Source: Guidehouse

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Table ES-10 shows the DR electricity portfolio costs over the study period and across the two scenarios. Portfolio costs follow the trend for the demand reduction potential, though costs scale at a higher rate than potential.

Table ES-10. Demand Response BAE and MAX Scenarios Electric Portfolio Costs

Electricity DR Portfolio Cost	Summer DR BAE Scenario	Winter DR BAE Scenario	Summer DR MAX Scenario	Winter DR MAX Scenario
2025	$55,300	-	$179,800	$64,200
2026	$56,800	-	$198,100	$70,900
2027	$58,500	-	$223,600	$83,800
Total	**$170,600**	-	**$601,500**	**$218,900**

Source: Guidehouse

Conclusions

This study uses the most recently available information on Unitil 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-11 for electricity and Table ES-12 for natural gas compare BAE annual potential for 2025 as identified in this study to 2022 actual achievements for energy efficiency and 2022 base loads; Table ES-13 compares BAE costs to the 2022-2024 PA costs (excluding customer costs).

Table ES-11. Comparison of BAE Potential to Recent Experience, Unitil Electric

	2025 Potential	2022 Actual	2022 Load
Energy Efficiency (Annual GWh)	2	2.15	395
Energy Efficiency (Annual MMBtu)	30,200	27,149	N/A
Summer Demand (Annual Passive MW)	0.16	0.34	81

Source: Guidehouse and MassSaveData.com

Table ES-12. Comparison of BAE Potential to Recent Experience, Unitil Gas

	2025 Potential	2022 Actual	2022 Consumption
Energy Efficiency (Annual Therms)	150,000	118,477	29,000,000
Energy Efficiency (Annual MMBtu)	14,900	11,259	N/A

Source: Guidehouse and MassSaveData.com

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Table ES-13. Comparison of PA Costs for Three Year Period

	2025-2027 BAE	2022-2024 Plan
Electric – Unitil	$21,040,000	$21,805,774
Natural Gas – Unitil	$8,260,000	$7,329,146

Source: Guidehouse and MassSaveData.com

Energy Efficiency

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

- **Electricity Savings BAE Scenario:** As savings from lighting continues to decline, cost-effective energy efficiency annual potential is led by Home Energy Reports, Custom Large C&I Retrofit and Custom New Construction measures, and on a lifetime basis, led by Heat Pumps, Residential Insulation, Custom New Construction and Custom Large C&I Retrofit. There is a sharp drop off of achievable potential within the top ten measures, which could guide Unitil'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.

- **Natural Gas Savings BAE Scenario:** The most significant contributors to savings potential in the Residential and Income Eligible sectors are Insulation and Air Sealing. Programmable and Wi-Fi Thermostats add significant savings in Residential as well. For the C&I sector, Custom measures make up the most savings. There is a sharp drop off of achievable potential within the top ten measures, which could guide Unitil's program implementation efforts.

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

- **CECP Scenario Results:** The CECP scenarios demonstrate that the statewide carbon targets for 2030 can be met by accelerated deployment of weatherization and heat pumps by all PAs. The associated price tags for the PAs are also increased relative to the BAE scenario. The comparison across the scenarios indicates the CECP scenario would cost about four to five times as much as the BAE scenario for both fuels, while the CECP Cost Premium scenario would cost seven times as much as the BAE scenario for electricity and more than nine times as much for natural gas over the 3-year term. Because of the high cost of the CECP Cost Premium scenario, with the inclusion of hard-to-measure costs, the natural gas Residential and Income Eligible sectors are not cost effective, and the natural gas C&I sector is not cost-effective in one year, but is cost-effective over the three year term.

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

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- **Achieving Potential:** While this report shows that much energy efficiency 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 Unitil should be aware of the factors as it develops its plans.
    - **Past Program Achievements:** Notably, Unitil 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 Unitil moves to more aggressive targets.
- **Investment Level:** Unitil will need to plan for significantly higher levels of investment in electricity and natural gas programs, particularly for the CECP scenarios, and for mobilizing a significant increase in direct and indirect services to meet the increased level of demand for efficiency upgrades and electrification.

Demand Response

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

- **Growth in Electricity DR Potential:** Building off Unitil's existing experience with DR, the electricity demand response potential in Unitil's Massachusetts service territory is estimated to grow over 2025-2027. Under BAE, the growth is associated with existing program offers for Residential and C&I customers, while in the MAX scenario the growth is associated with higher levels of participation in existing programs than in BAE plus new program offers.
    - **Large C&I Contribution in Total Potential:** Large C&I customers have the highest share in the total potential. The C&I Targeted Dispatch-Electric option represents the DR potential from these customers and is also the lowest cost option.
    - **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.

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- **Gas DR Potential:** Gas DR is not cost-effective due to relatively low gas avoided costs for valuing gas DR based on AESC 2024. The analysis results presented potential for all DR options regardless of cost-effectiveness.

- **Cost-Effectiveness across Scenarios:** The C&I Targeted Dispatch-Electric option, which is the largest contributor, remains cost-effective in the MAX scenario. Similarly, the largest contributor to potential on the electric side, Residential BYOT, remains cost-effective. Many electric direct load control measures are cost-effective in the MAX scenario. No natural gas demand response suboptions are cost-effective for the BAE or MAX scenarios.

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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 quoted by ACEEE as being "robust and transparent… [and] their methodology for forecasting participation is industry standard best-practice."[8]

As is typical in the development of such studies, Guidehouse worked collaboratively with Unitil and its stakeholders to ensure the study, to the fullest extent, best reflects current Massachusetts market conditions. Guidehouse received considerable guidance and feedback from Unitil 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[9] 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 Unitil and the other PAs to develop information on current levels and patterns of energy use in Massachusetts, characterize potential measures which could be implemented to increase EE and DR through DSM programs in the state, and develop estimates of EE and DR potential. The study data and analysis will be used to inform EE and DR program design for Unitil 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, Natural Gas, Propane, Fuel Oil
Type of Potential	Energy Efficiency and Demand Response Technical, Economic, Achievable
Sectors	Residential, Income-Eligible (IE) and Commercial and Industrial (C&I); within these, other subsectors and building types (e.g., Multifamily)
Achievable Scenarios	Business-as-Expected (BAE) and two Clean Energy and Climate Plan (CECP) scenarios for EE, BAE and MAX for DR
Climate	Single Weather Zone
Time Horizon	2025-2027 (3 years)

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

[9] 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 Unitil 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. Unitil 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 Unitil 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 Unitil in Massachusetts and focuses largely on aggregated forms of savings potential. Energy efficiency potential is estimated at the finest level of granularity, which is at the measure-level within each customer segment. The measure-level data is mapped to the various customer segments and end-use categories to permit a reviewer to easily create custom aggregations. Measure level results are available in the study appendices as noted below. DR potential is estimated using a bottom-up analysis, with primary data from Unitil 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 fuels of the analysis are natural gas and electricity, oil and propane savings are included to help demonstrate the broader energy savings as well as the carbon reduction impacts.

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.[10] 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 and natural gas measures.
- Section 5 presents **Demand Response Assessment Methodology**, including market characterization, baseline projections, characterization of options, and key assumptions.
- Section 6 presents **Demand Response Potential** for the technical and achievable potentials, investment levels, scenario analysis, and discusses snapback effects. Achievable potential results are presented for DR options, suboptions, customer class, and building type for cost-effective DR options.
- Section 7 presents the **Conclusions** of the study.

The report also includes the following four appendices:

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

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

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- Appendix C: Energy Efficiency Results (Excel Spreadsheet Viewer)
- Appendix D: Demand Response Results (Excel Spreadsheet Viewer)

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2. Global Data

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

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

2.1 Segmentation of Customer Sectors

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

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

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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[11]

Source: Guidehouse

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[12]. Multifamily buildings with five or more units are included in the C&I building stock in the Commercial - Multifamily segment for both natural gas and electric fuels.[13] However, Income Eligible stock, regardless of the number of units, is mapped to the Income Eligible sector.

[11] Multifamily buildings with more than 4 units.

[12] 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.

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

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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 natural gas and 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.

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

Housing Type	Electricity	Natural Gas
Multifamily	4,034	3,532
Multifamily Income Eligible (IE)	2,119	2,010
Single Family	12,665	5,343
Single Family Income Eligible (IE)	2,571	1,364
Single Family Moderate Income (MI)	4,650	2,215
Total	**26,040**	**14,465**

Source: Guidehouse based on Unitil data
Note: Totals may not sum due to rounding.

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.

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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, gas, 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

C&I Building stock data was developed at the service territory and customer segment level. Commercial and industrial segments are characterized as per 1000 square feet of building floor space. The primary data source used for determining building stock for all PAs was delivered to Guidehouse by DNV. Data included total natural gas and 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 for both natural gas and electric fuels using allocations based on the data obtained from DNV. However, Income Eligible stock, regardless of the number of units, is mapped to the Income Eligible sector. Data with unknown segments were mapped to study segments assuming an equal weighting to the rest of the data. The stock data was scaled through time using service territory annual sales forecasts provided by PAs. 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.

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Table 2-5 summarizes the resulting floor space estimates developed for each C&I segment for the study base year, 2022.

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

Customer Segment	Electricity Floorspace (1,000 sq. ft.)	Natural Gas Floorspace (1,000 sq. ft.)
Colleges & Universities	2,358	3,450
Schools	273	77
Other	1,396	1,085
Data Centers	2	1
Laboratories	145	113
Food Sales - Small	0	46
Food Sales - Large	105	174
Office - Small	901	719
Office - Large	1,576	1,983
Lodging - Small	4,043	324
Lodging - Large	974	1,199
Restaurants	157	299
Retail - Large	1,759	2,315
Retail - Small	351	462
Multifamily	3,195	2,575
Healthcare - Large	214	529
Healthcare - Small	87	107
Public Assembly	1,546	2,010
Warehouse	1,437	2,266
Industrial	6,169	4,668
Total	**26,689**	**24,401**

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[14]	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.

[14] 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. 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 and natural gas. Sales forecasts were not developed for propane and fuel oil due to the lack of data availability and reporting necessity. The relative weighting of building types is assumed to be constant over the study period. Table 2-7 shows the estimated total electricity, demand, and natural gas consumption by sector.

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

Segment	Electricity Consumption GWh	Electricity Demand MW	Natural Gas Consumption MM Therms
Residential	117	24	7
Income Eligible	56	11	3
C&I	223	45	19
Total	**395**	**81**	**29**

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

[15]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 CO2, 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.
- Gas (per MMBtu) includes natural gas, DRIPE, cross DRIPE, and SCC environmental compliance benefits.
- 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, gas, propane, fuel oil, and water were developed using a variety of resources. Propane, fuel oil, and water rates are equal to the commodity price portion of the avoided costs from the PA BCR models. Current electricity and natural gas distribution rates are based on tariff documents sourced for each PA when provided, or from published rates available online when not provided by PAs. Electricity and natural gas supply rates are taken from PA basic supply rates when available or an average of current supply rates from third parties when a basic supply rate is not provided. The total cost of electricity and natural gas to consumers is the sum of the distribution rate and supply rate. All rates are forecasted over the study period based on the statewide rate of escalation of electricity and natural gas avoided costs provided in the PA BCR models. When sales data by rate class was provided by the PAs, a weighted average of rates based on sales is used for each sector. Retail rates are used to determine customer simple payback for each measure. This metric is used for determining the expected achievable potential adoption.

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

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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 350 energy efficiency and electrification measures across Unitil'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, prescriptive or custom weatherization measures that save fossil fuel energy when installed in homes or buildings that are heated by fossil fuels. Guidehouse generally considered electrification measures replacing natural gas, 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 natural gas or fuel oil) in the absence of the program. Finally, Guidehouse excluded fuel switching measures from results if these caused a net increase in CO_2 emissions, which was the case for industrial high heat electrification.

For Residential Behavior (Home Energy Reports), this program is offered by Unitil Electric but not Unitil Gas. Therefore, Guidehouse calculated savings for Unitil Electric only, as a percent of home energy saved, based on a previous behavior program evaluation in Massachusetts. This value was then calibrated to align to 2022 program achievements. Unitil Gas 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 Unitil Gas.

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. 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. The effect is to reduce measure cost which increases the measure's cost effectiveness and improves customer adoption.	30% of efficient cost after incentive is applied = $435 (less than $2,000 per Heat Pump Water Heater cap)
Replacement Type	Identifies when in the technology or building's life an efficiency measure is introduced. Replacement type affects when in the potential study period the savings are achieved, as well as the duration of savings. • Retrofit or early retirement (RET): A measure is added to, or replaces, an existing piece of equipment before the end of its life. • Replace-on-Burnout (ROB): An efficient measure is installed when existing equipment reaches the end of its life and needs to be replaced. • New Construction (NEW): An efficient measure is installed in a new home or building.	ROB, RET, NEW
Annual Energy Consumption	The annual energy consumption for electricity in kWh and demand in kW, for natural gas in therms, 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 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[16] • 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.[17] • 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[18] • National Renewable Energy Laboratory (NREL) commercial building sector stock model for 2023 (ComStock)[19] • National Renewable Energy Laboratory (NREL) Residential building sector stock model for 2023 (ResStock)[20] • C&I baseline data[21] • Commercial Building Stock Assessment (CBSA)[22] • U.S. EIA Residential Energy Consumption Survey (RECS)[23] • U.S. EIA Commercial Building Energy Consumption Survey (CBECS)[24] • U.S. EIA's Manufacturing Energy Consumption Survey[25] • NREL's Manufacturing Thermal Energy Use database[26] • Previous potential studies in Massachusetts • Other Guidehouse potential studies
Codes and Standards	• US DOE engineering analyses • Local building code

[16] 2022 Report Technical Reference Manual, https://www.masssavedata.com/TRL/Technical%20Reference%20Manual%202022%20Report%20FINAL.pdf

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

[18] 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.

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

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

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

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

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

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

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

[26] 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. Central Air Source Heat Pump (Split or Packaged) displacing Gas Heat
    d. Air Source Heat Pump displacing Gas Roof Top Unit (RTU)
    e. Variable Refrigerant Flow Heat Pump displacing Gas RTU
    f. Variable Refrigerant Flow Heat Pump displacing Oil Heat
    g. Variable Refrigerant Flow Heat Pump displacing Propane Heat
    h. Variable Refrigerant Flow Heat Pump displacing Gas Heat
    i. Ground Source Heat Pump (Water-to-Water) displacing Oil Heat
    j. Ground Source Heat Pump (Water-to-Water) displacing Propane Heat
    k. Ground Source Heat Pump (Water-to-Water) displacing Gas Heat
    l. Ground Source Heat Pump (Water-to-Air) displacing Oil Heat
    m. Ground Source Heat Pump (Water-to-Air) displacing Propane Heat
    n. Ground Source Heat Pump (Water-to-Air) displacing Gas Heat
    o. Ductless Heat Pump displacing Oil Heat
    p. Ductless Heat Pump displacing Propane Heat
    q. Ductless Heat Pump displacing Gas Heat
2. **Program Evaluation Data:** Guidehouse used measure-specific program evaluation data from the PAs to inform energy and demand savings if these were more recent than the TRM values.
3. **Custom Program Data**: For Custom C&I gas and electric 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. 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

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each measure within each segment, Guidehouse collaborated with the PAs and DNV to get the site level energy savings as well as the customer annual consumption data. Depending on the granularity of the available data, Guidehouse characterized the Custom measure for each segment if segment level savings and consumption were available. In the absence of segment level information, an overall average was applied across Custom measures to get an average segment level savings percentage.

4. **Engineering Analysis:** Guidehouse used appropriate engineering algorithms to calculate energy savings for any measures not included in PA programs or available TRMs. As an example, this approach was taken for Data Center measures that did not have any program specific data or data in the TRM.

5. **Weather Updates:** Many TRM measures with deemed savings values rely on out-of-date TMY3 weather[27] 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 gas, propane, or fuel oil appliance, while the efficient condition is an electric appliance. Electrification measures have positive gas, propane, or fuel oil savings, but negative electricity and demand savings because the efficient electric measure uses electricity, while the baseline measure predominantly uses gas, 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, gas, propane, and fuel oil measures. Costs from sources other than the BCR were updated to 2022 dollars, if necessary, using the Bureau of Labor Statistics' consumer price index.[28] 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, gas, propane, and fuel oil measures. Costs for administering and marketing programs were also taken from PA historical program data. Tax credit values were derived from guidance given for Section 13301 of the Inflation Reduction Act - Extension, Increase, and Modifications of Nonbusiness Energy Property Credits.[29] 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

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

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sector-level aggregations and BCR calculations. Hard-to-measure costs were estimated to be proportional to other administrative costs for the sector, based on 2022 actual costs.

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

3.2.4 Building Stock and Densities

Guidehouse relied primarily on the Massachusetts Residential Baseline Study for information on equipment densities and saturations for Residential and Income Eligible measures. Where available, Guidehouse used the most recent baseline data collected in 2023, which has not yet been published. Otherwise, Guidehouse referenced previous versions of the Residential Baseline Study[30].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,[31] as well as C&I baseline data,[32] 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 Unitil's 2022 BCR models. 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

[30] 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.

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

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

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- Electric Leafblower
- Electric Trimmer
- Electric Chainsaw

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)[33] 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 (sourced from the US DOE's analysis), 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)."[34] The UDRH was defined in the 2019 Residential New Construction Baseline and Code Compliance Study (MA19X02-B-RNCBL).[35] 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.[36] 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.

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

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

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

[36] 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 Unitil 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 Unitil 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.[37] 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 4-6 show the net technical potential, by sector, fuel, and impact type, with electricity and summer peak electricity demand at meter. The results reflect the effects of both 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 electricity demand, with positive fossil fuel savings). Negative savings for fossil fuels also occur from interactive effects (electricity savings that result in increased natural gas usage; for example, from heat pump water heaters that cool the ambient air and require additional space heating).

For the electricity technical potential, only the C&I sector provides positive electricity savings, with all sectors providing positive summer peak electricity demand. Natural gas savings from electric measures are negative (representing interactive effects), 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.

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

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For the natural gas technical potential, the C&I sector provides the most savings, followed by the Residential sector, with the Income Eligible sector providing the least potential. Electricity and summer peak electricity demand are negative due to fuel substitution measures. All sectors provide positive water consumption potential. There are no savings for oil, propane or motor gasoline in the natural gas tables because these fuels appear in the electric tables.

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, Unitil 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	34,810	11,420	-1,867	129,300	22,700	0	11,100
2026	34,700	11,350	-1,853	127,400	22,600	0	11,120
2027	34,590	11,290	-1,840	125,600	22,400	0	11,130
Residential Sector - Fuel Substitution Measures							
2025	-61,100	-8,020	0	601,800	195,900	50,200	0
2026	-60,620	-7,900	0	589,800	200,900	50,400	0
2027	-60,150	-7,790	0	578,100	205,800	50,600	0

Source: Guidehouse

Table 4-2. Residential Technical Potential, Unitil Gas (Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
Residential Sector - Energy Efficiency Measures							
2025	420	236	2,711,400	0	0	0	30,710
2026	400	230	2,660,500	0	0	0	30,640
2027	390	225	2,610,800	0	0	0	30,570
Residential Sector - Fuel Substitution Measures							
2025	-55,040	-1,619	6,320,300	0	0	0	0
2026	-53,980	-1,596	6,199,000	0	0	0	0
2027	-52,950	-1,574	6,080,100	0	0	0	0

Source: Guidehouse

Table 4-3. Income Eligible Technical Potential, Unitil 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	7,360	1,150	-657	25,700	16,400	0	1,950
2026	7,270	1,140	-652	25,300	16,100	0	1,950
2027	7,180	1,130	-647	24,900	15,900	0	1,960
Income Eligible Sector - Fuel Substitution Measures							
2025	-10,260	-1,270	0	107,800	49,800	0	0
2026	-10,060	-1,240	0	105,600	48,800	0	0
2027	-9,870	-1,220	0	103,500	47,900	0	0

Source: Guidehouse

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

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
Income Eligible Sector - Energy Efficiency Measures							
2025	290	92	931,300	0	0	0	7,910
2026	280	91	913,600	0	0	0	7,890
2027	280	89	896,300	0	0	0	7,880
Income Eligible Sector - Fuel Substitution Measures							
2025	-14,150	-420	1,915,900	0	0	0	0
2026	-13,890	-415	1,879,100	0	0	0	0
2027	-13,620	-409	1,843,100	0	0	0	0

Source: Guidehouse

Table 4-5. C&I Technical Potential, Unitil 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	87,760	12,850	0	700	500	0	15,640
2026	87,810	12,820	0	700	500	0	15,190
2027	87,900	12,800	0	700	500	0	14,750
C&I Sector - Fuel Substitution Measures							
2025	-5,120	-2,580	0	3,500	48,200	0	0
2026	-5,190	-2,610	0	3,600	48,800	0	0
2027	-5,260	-2,650	0	3,600	49,400	0	0

Source: Guidehouse

Table 4-6. C&I Technical Potential, Unitil Gas (Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
C&I Sector - Energy Efficiency Measures							
2025	760	217	4,857,800	0	0	0	14,210
2026	740	213	4,812,300	0	0	0	13,980
2027	730	209	4,767,900	0	0	0	13,760
C&I Sector - Fuel Substitution Measures							
2025	-205,650	-46,765	6,102,700	0	0	0	0
2026	-205,760	-46,867	6,118,900	0	0	0	0
2027	-205,870	-46,969	6,135,400	0	0	0	0

Source: Guidehouse

4.2 Energy Efficiency Economic Potential Forecast

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

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4.2.1 Approach to Estimating Economic Potential

Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as technical potential, but including only those measures that have passed the benefit-cost test chosen for measure screening—in this case, the TRC test, per Unitil'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 4.03%.
- *Avoided Costs* are the monetary benefits resulting from electricity and capacity savings (e.g., avoided costs of infrastructure investments, due to electricity conserved by efficient measures).
- *O&M and NEI Savings* are the non-energy impacts, such as operation and maintenance cost savings, comfort benefits and reduced bill arrears.
- *Technology Cost* is the incremental equipment cost to the customer before PA incentives.
- *Admin Costs* are the administrative costs incurred by the program administrator.

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

4.2.2 Energy Efficiency Economic Potential Results by Sector

Table 4-7 through Table 4-12 show the annual net economic potential by sector, fuel and impact type, with electricity and summer peak electricity demand at meter. 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

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electricity and summer peak electricity demand, with positive fossil fuel savings). Negative savings for fossil fuels also occur from interactive effects (electricity savings that result in increased natural gas usage; for example, from heat pump water heaters that cool the ambient air and require additional space heating).

For the electricity economic potential, only the C&I sector provides positive electricity savings, with the Residential and C&I sectors providing positive summer peak electricity demand, while the Income Eligible sector is slightly negative. Natural gas savings from electric measures are negative (representing interactive effects), 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.

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

Economic potential results closely align with technical potential for most fuel types and sectors. This is due to the targeted nature of the measure list with a focus on measures forecasted or historically incentivized by Unitil 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 4-7. Residential Economic Potential, Unitil 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	34,400	11,360	-1,867	129,300	22,700	0	11,100
2026	34,270	11,290	-1,853	127,400	22,600	0	11,120
2027	34,150	11,220	-1,840	125,600	22,400	0	11,130
Residential Sector - Fuel Substitution Measures							
2025	-61,100	-8,020	0	601,800	195,900	50,200	0
2026	-60,620	-7,900	0	589,800	200,900	50,400	0
2027	-60,150	-7,790	0	578,100	205,800	50,600	0

Source: Guidehouse

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Table 4-8. Residential Economic Potential, Unitil Gas (Annual Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
Residential Sector - Energy Efficiency Measures							
2025	420	236	2,711,400	0	0	0	30,710
2026	400	230	2,660,500	0	0	0	30,640
2027	390	225	2,610,800	0	0	0	30,570
Residential Sector - Fuel Substitution Measures							
2025	-36,500	-927	4,740,800	0	0	0	0
2026	-35,790	-914	4,651,000	0	0	0	0
2027	-35,100	-902	4,562,900	0	0	0	0

Source: Guidehouse

Table 4-9. Income Eligible Economic Potential, Unitil 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	6,840	1,180	-657	25,700	16,400	0	1,950
2026	6,770	1,170	-652	25,300	16,100	0	1,950
2027	6,690	1,160	-647	24,900	15,900	0	1,960
Income Eligible Sector - Fuel Substitution Measures							
2025	-10,260	-1,270	0	107,800	49,800	0	0
2026	-10,060	-1,240	0	105,600	48,800	0	0
2027	-9,870	-1,220	0	103,500	47,900	0	0

Source: Guidehouse

Table 4-10. Income Eligible Economic Potential, Unitil Gas (Annual Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
Income Eligible Sector - Energy Efficiency Measures							
2025	290	92	929,500	0	0	0	7,910
2026	280	91	911,800	0	0	0	7,890
2027	280	89	894,600	0	0	0	7,880
Income Eligible Sector - Fuel Substitution Measures							
2025	-13,840	-371	1,913,300	0	0	0	0
2026	-13,570	-365	1,876,500	0	0	0	0
2027	-13,300	-360	1,840,500	0	0	0	0

Source: Guidehouse

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Table 4-11. C&I Economic Potential, Unitil 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	84,760	12,740	0	700	500	0	15,640
2026	84,930	12,720	0	700	500	0	15,190
2027	85,140	12,700	0	700	500	0	14,750
C&I Sector - Fuel Substitution Measures							
2025	-4,930	-2,630	0	1,800	48,100	0	0
2026	-5,000	-2,660	0	1,800	48,700	0	0
2027	-5,060	-2,700	0	1,800	49,300	0	0

Source: Guidehouse

Table 4-12. C&I Economic Potential, Unitil Gas (Annual Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
C&I Sector - Energy Efficiency Measures							
2025	760	217	4,618,700	0	0	0	14,210
2026	740	213	4,585,300	0	0	0	13,980
2027	730	209	4,562,100	0	0	0	13,760
C&I Sector - Fuel Substitution Measures							
2025	-1,020	5,411	239,200	0	0	0	0
2026	-1,030	5,445	241,000	0	0	0	0
2027	-1,040	5,479	243,000	0	0	0	0

Source: Guidehouse

4.3 Energy Efficiency Achievable Potential Approaches

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

Achievable potential differs from program potential in that achievable potential does not specifically consider the various delivery mechanisms that can be used by program managers to tailor their approach depending on the specific measure or market. Rather, achievable potential represents a high-level assessment of savings that could be achieved over time, factoring in broader assumptions about customer acceptance and adoption rates that are not dependent on a specified program design. Additional effort is typically undertaken by program designers, using the directional guidance from a market potential study, to develop detailed plans for delivering energy efficiency programs. Achievable potential for energy efficiency measure 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

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practice of screening at the program level.[38] 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 4-13 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 column of the figure. Guidehouse decided upon this methodology through discussions with Unitil about which approach best serves the objective of the study to understand achievable potential.

Table 4-13. 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 Unitil'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

[38] 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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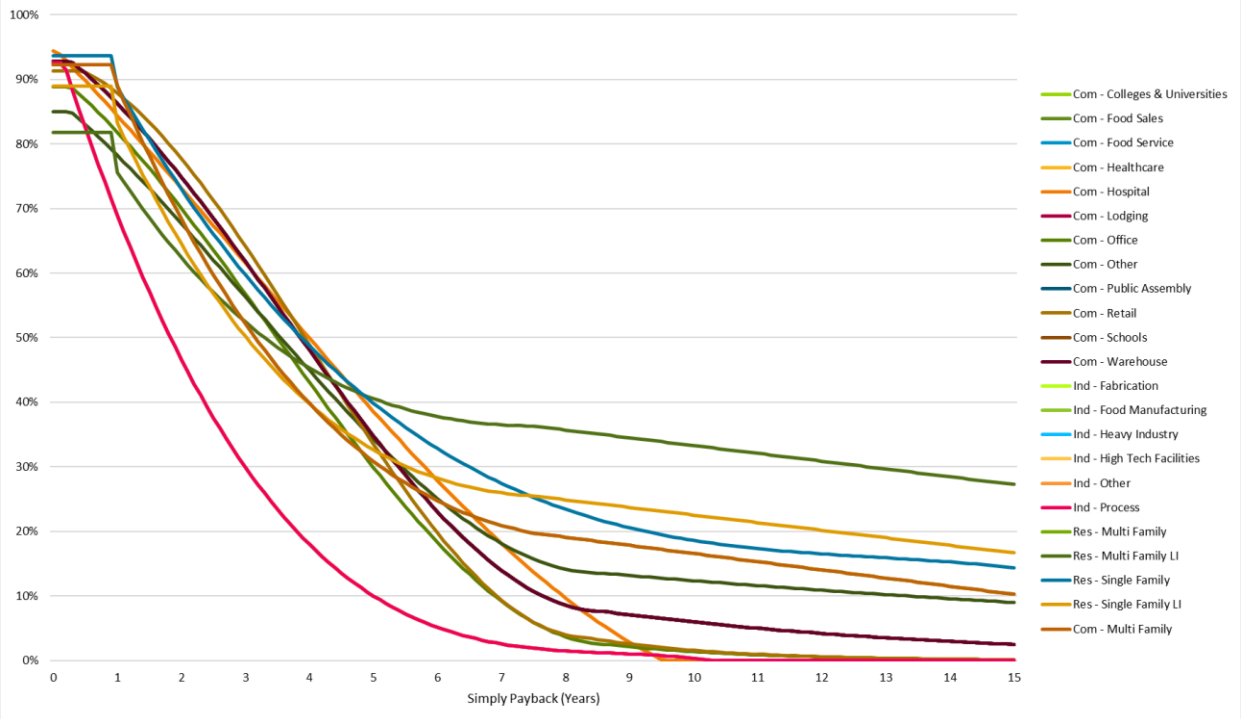
measures, a key differentiating factor between the base technology and the efficient technology is the energy and cost savings associated with the efficient technology. Of course, that additional efficiency's initial cost often comes at a premium. This study calculates an equilibrium market share as 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[39]. 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 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

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

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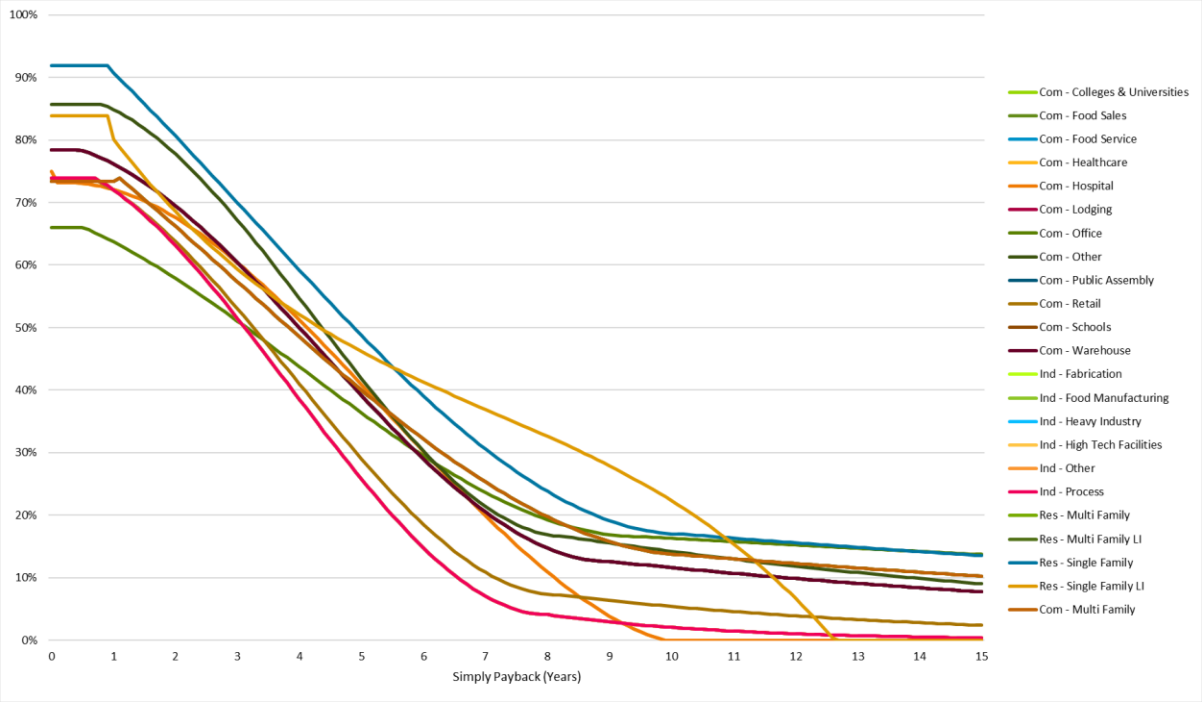
Figure 4-2. High-Cost Willingness to Pay Curves by Customer Segment



Source: Guidehouse

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.[40] *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

Behavior measures typically impose little to no direct costs to the participant[41] and their rate of adoption is highly dependent on the marketing and incentive efforts taken by program administrators. Given these unique characteristics of behavior measures, the payback

[40] 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.

[41] Participants may incur indirect costs through implementation of adjustments to typical operations in response to energy information feedback (e.g., through upgrading a water heater). However, estimating these indirect costs requires additional data on the actions taken by the participant beyond participating in the behavioral program and is beyond the scope of this analysis.

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acceptance curves and technology diffusion models have limited applicability to these types of measures. As such, this study models the adoption of behavior measures in terms of an equilibrium saturation level relative to economic potential, and a given amount of time to reach that equilibrium state. Equilibrium saturation levels were derived from Guidehouse's review of Unitil's historical and planned DSM program activity for the applicable measures. Since behavior measures have a one-year effective useful life, savings do not accrue beyond the year in which these occur.

4.3.1.3 Energy Efficiency Investment Strategy

Unitil 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 Unitil's guidance, this study sets measure incentives based on Unitil'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 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.

Behavior measures, such as Home Energy Reports, are an exception to this approach. When a behavior measure is re-adopted at the end of its expected useful lifetime, the incentives provided for those measures are added to total program administrator spending. The rationale is that similar savings opportunities provided by behavior measures are only available with ongoing support and/or administration from the program administrator. Since ongoing program administrator support is required to achieve behavior measure savings, the incentives provided to repeat adopters are incurred multiple times throughout the study horizon.

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

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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 Unitil program offerings in order to have a basis for comparison with historical program achievements.
- Ensuring similar trends and magnitudes between Unitil'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 Unitil'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 Unitil's historically achieved program savings. This is due to the iterative process for achievable potential review and the addition of new measures and competition groups to the portfolio. The subset measure calibration step is an 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 Unitil'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

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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.

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 have 5% stock availability per year. With relaxed screening standards, in the long run as awareness grows and stock turns over, it is expected to see single year achievable potential well below economic potential, with cumulative achievable potential reaching or surpassing economic potential. Additionally, as fuel 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 4-14 through Table 4-19 show the BAE scenario annual net achievable potential, by sector, fuel, and impact type, with the electricity and summer peak electricity demand at meter. 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 electricity demand, with positive fossil fuel savings). Negative savings for fossil fuels also occur from interactive effects (electricity savings that result in increased natural gas usage; for example, from heat pump water heaters that cool the ambient air and require additional space heating).

For the electricity achievable potential, the Residential sector provides the most electricity and summer peak electricity demand savings, followed by the C&I sector for electricity and the Income Eligible sector for demand. 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.

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

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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 have 5% stock availability per year. With relaxed screening standards, in the long run as awareness grows and stock turns over, it is expected to see single year achievable potential well below economic potential, with cumulative achievable potential reaching or surpassing economic potential. Additionally, as fuel 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 4-14. Residential BAE Scenario Achievable Potential, Unitil 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	1,920	170	-7	4,700	900	0	530
2026	2,030	180	-7	5,500	1,100	0	610
2027	2,130	180	-8	6,300	1,200	0	700
Residential Sector - Fuel Substitution Measures							
2025	-640	-40	0	6,000	1,100	200	0
2026	-770	-50	0	7,200	1,400	300	0
2027	-890	-50	0	8,200	1,700	400	0
Residential Sector Total (All Measures)							
2025	1,280	130	-7	10,700	2,000	200	530
2026	1,260	130	-7	12,700	2,500	300	610
2027	1,240	130	-8	14,500	2,900	400	700

Source: Guidehouse

Table 4-15. Residential BAE Scenario Achievable Potential, Unitil Gas (Annual Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
Residential Sector - Energy Efficiency Measures							
2025	10	4	43,700	0	0	0	330
2026	10	5	52,500	0	0	0	390
2027	20	6	61,200	0	0	0	430
Residential Sector - Fuel Substitution Measures							
2025	-30	-4	4,500	0	0	0	0
2026	-40	-5	5,600	0	0	0	0
2027	-40	-6	6,300	0	0	0	0
Residential Sector Total (All Measures)							
2025	-20	0	48,200	0	0	0	330
2026	-30	0	58,100	0	0	0	390
2027	-20	0	67,500	0	0	0	430

Source: Guidehouse

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Table 4-16. Income Eligible BAE Scenario Achievable Potential, Unitil 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	100	20	-2	800	500	0	80
2026	120	20	-2	900	600	0	100
2027	130	30	-2	1,100	700	0	110
Income Eligible Sector - Fuel Substitution Measures							
2025	-50	0	0	500	300	0	0
2026	-60	-10	0	500	300	0	0
2027	-60	-10	0	600	300	0	0
Income Eligible Sector Total (All Measures)							
2025	50	20	-2	1,300	800	0	80
2026	60	10	-2	1,400	900	0	100
2027	70	20	-2	1,700	1,000	0	110

Source: Guidehouse

Table 4-17. Income Eligible BAE Scenario Achievable Potential, Unitil Gas (Annual Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
Income Eligible Sector - Energy Efficiency Measures							
2025	10	2	12,200	0	0	0	100
2026	10	2	14,900	0	0	0	110
2027	10	3	17,700	0	0	0	120
Income Eligible Sector - Fuel Substitution Measures							
2025	-10	-1	1,300	0	0	0	0
2026	-10	-1	1,600	0	0	0	0
2027	-10	-2	1,800	0	0	0	0
Income Eligible Sector Total (All Measures)							
2025	0	1	13,500	0	0	0	100
2026	0	1	16,500	0	0	0	110
2027	0	1	19,500	0	0	0	120

Source: Guidehouse

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Table 4-18. C&I BAE Scenario Achievable Potential, Unitil 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	880	140	0	0	0	0	120
2026	840	130	0	0	0	0	130
2027	900	140	0	0	0	0	140
C&I Sector - Fuel Substitution Measures							
2025	-210	-130	0	100	2,000	0	0
2026	-250	-160	0	100	2,400	0	0
2027	-250	-160	0	100	2,400	0	0
C&I Sector Total (All Measures)							
2025	670	10	0	100	2,000	0	120
2026	590	-30	0	100	2,400	0	130
2027	650	-20	0	100	2,400	0	140

Source: Guidehouse

Table 4-19. C&I BAE Scenario Achievable Potential, Unitil Gas (Annual Net)

Install Year	Electricity (at Meter) [MWh]	Summer Peak Electricity Demand (at Meter) [kW]	Natural Gas [Therms]	Oil [MMBtu]	Propane [MMBtu]	Motor Gasoline [MMBtu]	Water Consumption [000s Gallons]
C&I Sector - Energy Efficiency Measures							
2025	10	5	85,000	0	0	0	390
2026	10	6	89,600	0	0	0	470
2027	10	7	93,300	0	0	0	580
C&I Sector - Fuel Substitution Measures							
2025	-40	-12	3,700	0	0	0	0
2026	-50	-15	4,000	0	0	0	0
2027	-50	-18	4,500	0	0	0	0
C&I Sector Total (All Measures)							
2025	-30	-7	88,700	0	0	0	390
2026	-40	-9	93,600	0	0	0	470
2027	-40	-11	97,800	0	0	0	580

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[42] 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.

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

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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 Unitil's 2022 BCR Model.

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

Residential Sector

Table 4-20 presents the incremental savings for Residential electric core initiatives for the 3-year study horizon for the BAE scenario. All savings are net, except GHG impacts are gross. The Residential Behavior core initiative provides almost all of the electricity potential, with the Behavior and Residential Retail core initiative providing sizable demand savings. All core initiatives contribute sizable Annual MMBtu savings, with the Residential New Homes & Renovations core initiative providing the lowest share. Lifetime MMBtu savings are mainly provided by the Residential Coordinated Delivery and Residential Retail core initiatives; Residential Behavior Lifetime MMBtu savings are much lower and equal to the Annual MMBtu savings, due to a 1-year effective useful lifetime (EUL) for these measures. 2030 carbon[43] impacts are mostly from the Residential Retail and Residential Coordinated Delivery core initiatives.

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

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Table 4-20. Residential Sector, Electric Core Initiatives, BAE Scenario Incremental 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	20	0	500	9,000	30
2026	10	0	500	10,100	40
2027	0	0	600	12,300	50
Total				**31,400**	**120**
A2a - Residential Coordinated Delivery					
2025	210	20	5,300	101,200	300
2026	260	20	6,300	119,900	370
2027	300	30	7,300	137,300	430
Total				**358,400**	**1,100**
A2c - Residential Retail					
2025	-180	50	7,300	128,600	680
2026	-270	40	8,400	148,300	810
2027	-340	40	9,300	163,700	920
Total				**440,600**	**2,410**
A2d - Residential Behavior					
2025	1,220	60	8,200	8,200	0
2026	1,250	60	8,300	8,300	0
2027	1,280	60	8,400	8,400	0
Total				**24,900**	**0**
Residential Sector Total					
2025	1,270	130	21,300	247,000	1,010
2026	1,250	120	23,500	286,600	1,220
2027	1,240	130	25,600	321,700	1,400
Total				**855,300**	**3,630**

Source: Guidehouse

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Table 4-21 presents the benefits and costs by Residential electric programs 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. The Residential Existing Buildings programs provide most of the Net TRC Benefits and Program Incentive Costs. The Residential Existing Buildings and Hard-to-Measure programs provide most of the Program Administrative Costs. Incentives are more than half of the program costs. All programs for which TRC is calculated provide positive TRC Test results.

Table 4-21. 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	2.04	$0.6	$0.3	$0.1	$0.2
2026	2.46	$0.7	$0.3	$0.1	$0.2
2027	3.04	$1.0	$0.3	$0.1	$0.2
Total	**2.53**	**$2.3**	**$0.9**	**$0.3**	**$0.6**
A2 - Residential Existing Buildings					
2025	4.50	$14.5	$3.2	$0.9	$1.9
2026	4.56	$17.0	$3.7	$1.0	$2.2
2027	4.61	$19.3	$4.2	$1.1	$2.5
Total	**4.56**	**$50.8**	**$11.1**	**$2.9**	**$6.5**
A3 - Residential Hard-to-Measure					
2025	N/A	N/A	$0.7	$0.7	N/A
2026	N/A	N/A	$0.8	$0.8	N/A
2027	N/A	N/A	$0.9	$0.9	N/A
Total			**$2.4**	**$2.4**	
Residential Sector Total					
2025	3.57	$15.1	$4.2	$1.7	$2.1
2026	3.66	$17.8	$4.9	$1.9	$2.4
2027	3.74	$20.3	$5.4	$2.1	$2.7
Total	**3.67**	**$53.1**	**$14.5**	**$5.6**	**$7.2**

Source: Guidehouse

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Table 4-22 presents the incremental net savings for Residential natural gas core initiatives for the 3-year study horizon for the BAE scenario. All savings are net, except GHG impacts are gross. The Residential Coordinated Delivery core initiative provides more than half the natural gas and Annual MMBtu savings and the Residential Retail core initiative provides the rest of the savings. The former also provides most of the Lifetime MMBtu savings and just over half of the 2030 carbon[44] impacts. The Residential Behavior and Residential New Homes & Renovation core initiatives do not address natural gas.

Table 4-22. Residential Sector, Natural Gas Core Initiatives, BAE Scenario Incremental Achievable Potential

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
A1a - Residential New Homes & Renovations				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
A2a - Residential Coordinated Delivery				
2025	33,400	3,400	73,800	180
2026	40,100	4,100	88,200	220
2027	47,000	4,800	102,800	250
Total			**264,800**	**650**
A2c - Residential Retail				
2025	14,800	1,400	21,500	90
2026	18,000	1,700	26,200	110
2027	20,400	1,900	29,700	120
Total			**77,400**	**320**
A2d - Residential Behavior				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
Residential Sector Total				
2025	48,200	4,800	95,300	270
2026	58,100	5,800	114,400	330
2027	67,400	6,700	132,500	370
Total			**342,200**	**970**

Source: Guidehouse

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

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Table 4-23 presents the benefits and costs by Residential natural gas programs for the 3-year study horizon for the BAE scenario. The Residential Existing Building program provides all of the Net TRC Benefits and Program Incentive Costs, with provide positive TRC Test results. The Residential Hard-to-Measure program provides more than half of the Program Administrative Costs. Incentives are less than half of the program costs. Natural gas programs' costs are less than half of projected electricity program spending.

Table 4-23. Residential Sector, Natural Gas Programs, BAE Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
A1 - Residential New Buildings					
2025		$0.0	$0.0	$0.0	$0.0
2026		$0.0	$0.0	$0.0	$0.0
2027		$0.0	$0.0	$0.0	$0.0
Total		**$0.0**	**$0.0**	**$0.0**	**$0.0**
A2 - Residential Existing Buildings					
2025	3.27	$3.2	$1.0	$0.3	$0.6
2026	3.29	$3.8	$1.2	$0.3	$0.7
2027	3.27	$4.5	$1.4	$0.4	$0.8
Total	**3.28**	**$11.5**	**$3.5**	**$1.0**	**$2.1**
A3 - Residential Hard-to-Measure					
2025	N/A	N/A	$0.4	$0.4	N/A
2026	N/A	N/A	$0.4	$0.4	N/A
2027	N/A	N/A	$0.5	$0.5	N/A
Total			**$1.3**	**$1.3**	
Residential Sector Total					
2025	2.37	$3.2	$1.3	$0.7	$0.6
2026	2.38	$3.8	$1.6	$0.8	$0.7
2027	2.37	$4.5	$1.9	$0.9	$0.8
Total	**2.38**	**$11.5**	**$4.8**	**$2.3**	**$2.1**

Source: Guidehouse

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Income Eligible Sector

Table 4-24 presents the incremental net savings for the Income Eligible Coordinated Delivery electric core initiative for the 3-year study horizon for the BAE scenario.

Table 4-24. 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	50	20	2,300	42,400	150
2026	60	20	2,700	49,700	180
2027	70	20	3,000	56,600	210
Total				**148,700**	**540**

Source: Guidehouse

Table 4-25 presents the benefits and costs by Income Eligible electric programs for the 3-year study horizon for the BAE scenario, with the Hard-to-Measure program contributing program administrative costs only.

Table 4-25. 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	3.77	$3.3	$0.9	$0.3	$0.5
2026	3.78	$3.8	$1.0	$0.4	$0.5
2027	3.79	$4.4	$1.2	$0.4	$0.6
Total	**3.78**	**$11.5**	**$3.0**	**$1.1**	**$1.6**
B2 - Income Eligible Hard-to-Measure					
2025	N/A	N/A	$0.3	$0.3	N/A
2026	N/A	N/A	$0.4	$0.4	N/A
2027	N/A	N/A	$0.4	$0.4	N/A
Total			**$1.1**	**$1.1**	
Income Eligible Sector Total					
2025	2.74	$3.3	$1.2	$0.6	$0.5
2026	2.75	$3.8	$1.4	$0.7	$0.5
2027	2.77	$4.4	$1.6	$0.8	$0.6
Total	**2.76**	**$11.5**	**$4.2**	**$2.2**	**$1.6**

Source: Guidehouse

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Table 4-26 presents the incremental net savings for Income Eligible Coordinated Delivery natural gas core initiative for the 3-year study horizon for the BAE scenario.

Table 4-26. Income Eligible Sector, Natural Gas Core Initiatives, BAE Scenario Incremental Net Achievable Potential

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
B1a - Income Eligible Coordinated Delivery				
2025	13,500	1,400	24,900	70
2026	16,500	1,700	30,500	90
2027	19,500	2,000	36,400	110
Total			**91,800**	**270**

Source: Guidehouse

Table 4-27 presents the benefits and costs by Income Eligible natural gas programs for the 3-year study horizon for the BAE scenario, with the Hard-to-Measure program contributing program administrative costs only.

Table 4-27. Income Eligible Sector, Natural Gas Programs, BAE Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
B1 - Income Eligible Existing Buildings					
2025	4.65	$1.4	$0.3	$0.1	$0.2
2026	4.57	$1.7	$0.4	$0.1	$0.2
2027	4.50	$2.1	$0.5	$0.1	$0.3
Total	**4.56**	**$5.2**	**$1.1**	**$0.3**	**$0.7**
B2 - Income Eligible Hard-to-Measure					
2025	N/A	N/A	$0.1	$0.1	N/A
2026	N/A	N/A	$0.2	$0.2	N/A
2027	N/A	N/A	$0.2	$0.2	N/A
Total			**$0.5**	**$0.5**	
Income Eligible Sector Total					
2025	3.20	$1.4	$0.4	$0.2	$0.2
2026	3.15	$1.7	$0.5	$0.3	$0.2
2027	3.12	$2.1	$0.7	$0.3	$0.3
Total	**3.15**	**$5.2**	**$1.6**	**$0.8**	**$0.7**

Source: Guidehouse

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C&I Sector

Table **4-28** presents the incremental net savings for C&I electric core initiatives for the 3-year study horizon for the BAE scenario. All savings are net, except GHG impacts are gross. The C&I Existing Buildings and C&I New Buildings & Major Renovations core initiatives provide positive electricity and electricity demand savings. The C&I Existing Buildings core initiatives contribute the majority of the Annual and Lifetime MMBtu savings. The C&I Existing Buildings core initiatives provide most of the 2030 carbon[45] impacts.

Table 4-28. 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	310	70	2,100	28,500	60
2026	220	50	1,500	20,000	40
2027	240	50	1,500	21,200	50
Total				**69,700**	**150**
C2a - C&I Existing Building Retrofit					
2025	370	50	2,500	23,200	60
2026	400	50	2,700	25,400	60
2027	440	50	2,900	27,600	70
Total				**76,200**	**190**
C2b - C&I New & Replacement Equipment					
2025	-10	-100	2,100	24,800	180
2026	-40	-130	2,300	26,800	200
2027	-20	-120	2,400	27,900	210
Total				**79,500**	**590**
C&I Sector Total					
2025	670	20	6,700	76,500	300
2026	580	-30	6,500	72,200	300
2027	660	-20	6,800	76,700	330
Total				**225,400**	**930**

Source: Guidehouse

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

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Table 4-29 presents the benefits and costs by C&I electric programs for the 3-year study horizon for the BAE scenario. All C&I programs provide sizable Net TRC Benefits, except for C&I Hard-to-Measure, which is N/A. The C&I Hard-to-Measure program provides a majority of the Program Administrative Costs. Incentives are less than one-third of the program costs. All programs except for C&I Hard-to-Measure, which is N/A, provide positive TRC Test results.

Table 4-29. 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	2.99	$1.7	$0.6	$0.2	$0.2
2026	3.05	$1.2	$0.4	$0.1	$0.1
2027	3.17	$1.3	$0.4	$0.1	$0.2
Total	**3.06**	**$4.2**	**$1.4**	**$0.5**	**$0.5**
C2 - C&I Existing Buildings					
2025	2.76	$2.3	$0.8	$0.2	$0.4
2026	2.86	$2.5	$0.9	$0.2	$0.4
2027	2.85	$2.6	$0.9	$0.3	$0.5
Total	**2.82**	**$7.4**	**$2.6**	**$0.7**	**$1.3**
C3 - C&I Hard-to-Measure					
2025	N/A	N/A	$0.5	$0.5	N/A
2026	N/A	N/A	$0.4	$0.4	N/A
2027	N/A	N/A	$0.5	$0.5	N/A
Total			**$1.4**	**$1.4**	
C&I Sector Total					
2025	2.12	$4.0	$1.9	$0.9	$0.6
2026	2.17	$3.7	$1.7	$0.8	$0.6
2027	2.18	$3.9	$1.8	$0.9	$0.6
Total	**2.16**	**$11.6**	**$5.4**	**$2.6**	**$1.8**

Source: Guidehouse

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Table 4-30 presents the incremental net savings for C&I natural gas core initiatives for the 3-year study horizon for the BAE scenario. All savings are net, except GHG impacts are gross. The C&I Existing Buildings core initiatives provides all of the savings.

Table 4-30. C&I Sector, Natural Gas Core Initiatives, BAE Scenario Incremental Net Achievable Potential

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
C1a - C&I New Buildings & Major Renovations				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
C2a - C&I Existing Building Retrofit				
2025	46,900	4,600	50,200	240
2026	51,700	5,100	54,500	290
2027	56,300	5,600	58,200	340
Total			**162,900**	**870**
C2b - C&I New & Replacement Equipment				
2025	41,800	4,100	72,800	230
2026	41,900	4,100	72,600	230
2027	41,500	4,000	71,500	230
Total			**216,900**	**690**
C&I Sector Total				
2025	88,700	8,700	123,000	470
2026	93,600	9,200	127,100	520
2027	97,800	9,600	129,700	570
Total			**379,800**	**1,560**

Source: Guidehouse

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Table 4-31 presents the benefits and costs by C&I natural gas programs for the 3-year study horizon for the BAE scenario. The C&I Existing Buildings program contributes all of the benefits and a positive TRC Test ratio. The C&I Hard-to-Measure program provides more than half of the Program Administrative Costs, which are most of the program costs.

Table 4-31. C&I Sector, Natural Gas Programs, BAE Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
C1 - C&I New Buildings					
2025		$0.0	$0.0	$0.0	$0.0
2026		$0.0	$0.0	$0.0	$0.0
2027		$0.0	$0.0	$0.0	$0.0
Total		**$0.0**	**$0.0**	**$0.0**	**$0.0**
C2 - C&I Existing Buildings					
2025	6.71	$4.1	$0.6	$0.2	$0.2
2026	6.43	$4.2	$0.7	$0.2	$0.2
2027	6.00	$4.4	$0.7	$0.2	$0.3
Total	**6.36**	**$12.7**	**$2.0**	**$0.7**	**$0.7**
C3 - C&I Hard-to-Measure					
2025	N/A	N/A	$0.3	$0.3	N/A
2026	N/A	N/A	$0.3	$0.3	N/A
2027	N/A	N/A	$0.3	$0.3	N/A
Total			**$0.9**	**$0.9**	
C&I Sector Total					
2025	4.64	$4.1	$0.9	$0.5	$0.2
2026	4.46	$4.2	$0.9	$0.5	$0.2
2027	4.19	$4.4	$1.0	$0.6	$0.3
Total	**4.42**	**$12.7**	**$2.9**	**$1.6**	**$0.7**

Source: Guidehouse

4.3.3.2 Energy Efficiency Potential Results by Measure

Figure 4-3 through Figure 4-5 show the BAE scenario top ten lifetime achievable electricity savings EE measures, net at meter, installed in 2027 for the Residential, Income Eligible and C&I sectors, respectively. Similar results are included in Appendix C Energy Efficiency Results (Excel Spreadsheet Viewer). Appendix C also contains first-year annual and lifetime savings by measure, as well as the top summer peak demand savings measures.

In the Residential sector, most of the top ten measures are in the Residential Retail core initiative led by Electric Resistance (ER) Baseboard replacing Ductless Mini-Split Heat Pump (DMSHP), followed by Insulation (Residential Coordinated Delivery core initiative). Home Energy Reports (Residential Behavior core initiative), notwithstanding a one-year EUL, Manual Thermostat to Programmable Thermostat, and New Construction (Residential New Homes & Renovation core initiative) provide large lifetime savings.

The top ten lifetime electricity measures in the Income Eligible sector are all provided by the Income Eligible Coordinated Delivery core initiative and include many of the same measures as the Residential sector.

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The C&I sector top ten lifetime electricity savings is dominated by two Custom measures, Custom New Construction and Custom Large C&I.

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	2,160
2	Insulation	A2a - Residential Coordinated Delivery	2,060
3	Home Energy Report	A2d - Residential Behavior	1,280
4	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	1,060
5	New Construction	A1a - Residential New Homes & Renovations	830
6	Clothes Dryer	A2c - Residential Retail	650
7	ECM Circulator Pump	A2c - Residential Retail	620
8	Advanced Power Strip	A2a - Residential Coordinated Delivery	460
9	Showerhead	A2a - Residential Coordinated Delivery	390
10	Room Air Cleaner	A2c - Residential Retail	370

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	Insulation	B1a - Income Eligible Coordinated Delivery	410
2	ER Baseboard to DMSHP	B1a - Income Eligible Coordinated Delivery	260
3	Manual Thermostat to Programmable Thermostat	B1a - Income Eligible Coordinated Delivery	180
4	Occupancy Sensor	B1a - Income Eligible Coordinated Delivery	170
5	Clothes Dryer	B1a - Income Eligible Coordinated Delivery	160
6	Advanced Power Strip	B1a - Income Eligible Coordinated Delivery	110
7	Windows - Single to triple pane	B1a - Income Eligible Coordinated Delivery	80
8	Heat Pump Water Heater	B1a - Income Eligible Coordinated Delivery	70
9	Room Air Cleaner	B1a - Income Eligible Coordinated Delivery	70
10	Showerhead	B1a - Income Eligible Coordinated Delivery	70

Source: Guidehouse

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 New Construction	C1a - C&I New Buildings & Major Renovations	1,980
2	Custom Large C&I	C2a - C&I Existing Building Retrofit	1,620
3	Lighting - Performance Lighting	C1a - C&I New Buildings & Major Renovations	870
4	ECM Circulator Pump	C2b - C&I New & Replacement Equipment	810
5	Air Nozzle	C2b - C&I New & Replacement Equipment	740
6	Demand Control Ventilation	C2a - C&I Existing Building Retrofit	640
7	Case Motor Replacement	C2a - C&I Existing Building Retrofit	460
8	Evaporator Fan Control	C2a - C&I Existing Building Retrofit	450
9	Air Nozzle	C1a - C&I New Buildings & Major Renovations	430
10	Heat Pump Water Heater	C2b - C&I New & Replacement Equipment	350

Source: Guidehouse

Figure 4-6 through Figure 4-8 show the top ten lifetime BAE scenario natural gas savings energy efficiency measures, net at meter, installed in 2025, for the Residential, Income Eligible and C&I sectors, respectively. Similar results are included in Appendix C Energy Efficiency Results (Excel Spreadsheet Viewer). Appendix C also contains first-year annual and lifetime savings by measure.

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In the Residential sector, the Residential Coordinated Delivery core initiative, led by Insulation and Air Sealing, provides the largest lifetime natural gas savings, with the former more than four times the latter, with both of these measures providing almost three times the combined savings than the other eight measures listed, which are all from the Residential Retail core initiative, except for Duct Sealing.

The top ten lifetime natural gas measures in the Income Eligible sector include many of the same measures as the Residential sector.

The C&I sector top ten lifetime natural gas savings is dominated by two Custom Large C&I measures (C&I New & Replacement Equipment and C&I Existing Building Retrofit core initiatives), with the top measure providing almost five times the savings. These two measures provide almost four times the combined savings of the other eight measures listed.

Figure 4-6. EE BAE Scenario Lifetime Achievable Natural Gas Potential, 2027 Top Residential Measures (net therms)

#	Measure	Core Initiative	LT Savings
1	Insulation	A2a - Residential Coordinated Delivery	733,000
2	Air Sealing	A2a - Residential Coordinated Delivery	191,000
3	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	58,000
4	Heat Pump Water Heater Fuel Switch	A2c - Residential Retail	52,000
5	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	44,000
6	Duct Sealing	A2a - Residential Coordinated Delivery	42,000
7	Wi-Fi Thermostat	A2c - Residential Retail	37,000
8	Boiler Reset Control	A2c - Residential Retail	33,000
9	Heat Recovery Ventilator	A2c - Residential Retail	31,000
10	Thermostatic Valve	A2c - Residential Retail	18,000

Source: Guidehouse

Figure 4-7. EE BAE Scenario Lifetime Achievable Natural Gas Potential, 2027 Top Income Eligible Measures (net therms)

#	Measure	Core Initiative	LT Savings
1	Insulation	B1a - Income Eligible Coordinated Delivery	137,000
2	Air Sealing	B1a - Income Eligible Coordinated Delivery	74,000
3	Programmable Thermostat to Wifi Thermostat	B1a - Income Eligible Coordinated Delivery	19,000
4	Heat Pump Water Heater Fuel Switch	B1a - Income Eligible Coordinated Delivery	15,000
5	Boiler Reset Control	B1a - Income Eligible Coordinated Delivery	13,000
6	Manual Thermostat to Wifi Thermostat	B1a - Income Eligible Coordinated Delivery	13,000
7	Manual Thermostat to Programmable Thermostat	B1a - Income Eligible Coordinated Delivery	11,000
8	Wi-Fi Thermostat	B1a - Income Eligible Coordinated Delivery	10,000
9	Forced Hot Water Boiler - Gas	B1a - Income Eligible Coordinated Delivery	8,000
10	Duct Sealing	B1a - Income Eligible Coordinated Delivery	7,000

Source: Guidehouse

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Figure 4-8. EE BAE Scenario Lifetime Achievable Natural Gas Potential, 2027 Top C&I Measures (net therms)

#	Measure	Core Initiative	LT Savings
1	Custom Large C&I	C2b - C&I New & Replacement Equipment	659,000
2	Custom Large C&I	C2a - C&I Existing Building Retrofit	389,000
3	Demand Control Ventilation	C2a - C&I Existing Building Retrofit	62,000
4	Commissioning/Retrocommissioning	C2a - C&I Existing Building Retrofit	45,000
5	Ground Source Heat Pump (Water-to-Air)	C2b - C&I New & Replacement Equipment	25,000
6	Programmable Thermostat	C2a - C&I Existing Building Retrofit	21,000
7	Commercial HVAC Tune-up	C2a - C&I Existing Building Retrofit	20,000
8	Programmable Thermostat - Res End Use	C2a - C&I Existing Building Retrofit	17,000
9	Boiler Reset Control	C2a - C&I Existing Building Retrofit	11,000
10	Central Air Source Heat Pump (Split or Packaged)	C2b - C&I New & Replacement Equipment	11,000

Source: Guidehouse

4.4 Energy Efficiency CECP Scenario Results

4.4.1 Energy Efficiency Scenario Configuration Approach

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

4.4.1.1 Scenario Configuration

The scenarios were configured to estimate potential for 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 Unitil, all programs achieve cost-effectiveness in the CECP scenario. Table 4-32 summarizes the scenarios**.**

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Table 4-32. 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 4-33 for the CECP Cost Premium scenarios. In other words, the level cost assumption for the CECP scenarios defines a lower bound for achieving CECP targets, while the cost premiums define a reasonable upper bound of costs to achieve CECP targets. Cost premiums focus on PA costs only, not participant costs.

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

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Table 4-33. 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 Unitil were determined by proportionately allocating the Statewide forecast measure counts according to 2024 planned installations.

4.4.1.3 CECP Scenario Modeling

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

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

4.4.1.4 Heat Pump Adoption Research

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

The survey found that customers are generally aware of heat pumps (57%) and of those aware of heat pumps, majority are also aware that heat pumps can provide both heating and cooling. It was also found that heat pump awareness correlates with income and home type. NMR noted

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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.[46]

4.4.2 CECP Scenario Results

This section presents CECP scenario results, individually by sector and fuel for the Residential sector electric programs.
Table 4-34 presents the incremental savings for Residential electric core initiatives for the 3-year study horizon for the CECP scenario. All savings are net, except 2030 carbon[47] impacts are gross. The Residential Behavior core initiative and Residential Coordinated Delivery core initiatives provide positive electricity savings, and lifetime MMBtu and GHG savings. The Residential Retail core initiative has negative electricity savings due to fuel substitution. All core initiatives, except Residential New Homes & Renovations, provide large summer peak electricity demand and annual MMBtu savings. Residential Behavior provides no 2030 GHG savings due to a 1-year effective useful lifetime (EUL). 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.

[46] 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.

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

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Table 4-34. 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	20	0	500	9,000	30
2026	10	0	500	10,100	40
2027	0	0	600	12,300	50
Total				**31,400**	**120**
A2a - Residential Coordinated Delivery					
2025	460	30	18,800	408,200	1,230
2026	480	40	19,100	410,900	1,250
2027	460	40	17,200	363,100	1,120
Total				**1,182,200**	**3,600**
A2c - Residential Retail					
2025	-100	200	23,000	398,900	1,960
2026	-130	200	24,000	418,700	2,050
2027	-50	200	22,200	385,300	1,870
Total				**1,202,900**	**5,880**
A2d - Residential Behavior					
2025	1,220	60	8,200	8,200	0
2026	1,250	60	8,300	8,300	0
2027	1,280	60	8,400	8,400	0
Total				**24,900**	**0**
Residential Sector Total					
2025	1,600	290	50,500	824,300	3,220
2026	1,610	300	51,900	848,000	3,340
2027	1,690	300	48,400	769,100	3,040
Total				**2,441,400**	**9,600**

Source: Guidehouse

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Table 4-35 presents the incremental net savings for Residential natural gas core initiatives for the 3-year study horizon for the CECP scenario. All savings are net, except 2030 carbon[48] impacts are gross. The Residential Coordinated Delivery core initiative provides more than half the natural gas, Annual and Lifetime MMBtu savings compared to the Residential Retail core initiative. The Residential Behavior and Residential New Homes & Renovation core initiatives do not address natural gas.

Table 4-35. Residential Sector, Natural Gas Core Initiatives, CECP Scenario Incremental Net Achievable Potential

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
A1a - Residential New Homes & Renovations				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
A2a - Residential Coordinated Delivery				
2025	81,100	8,300	186,700	440
2026	97,800	10,000	225,200	530
2027	114,300	11,700	263,600	620
Total			**675,500**	**1,590**
A2c - Residential Retail				
2025	50,200	3,100	66,300	260
2026	60,900	3,800	81,400	310
2027	72,000	4,400	97,200	370
Total			**244,900**	**940**
A2d - Residential Behavior				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
Residential Sector Total				
2025	131,300	11,400	253,000	700
2026	158,700	13,800	306,600	840
2027	186,300	16,100	360,800	990
Total			**920,400**	**2,530**

Source: Guidehouse

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

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Table 4-36 presents the benefits and costs by Residential electric programs for the 3-year study horizon for the CECP scenario. The Residential Existing Buildings programs provide most of the Net TRC Benefits and Program Incentive Costs. The Residential Hard-to-Measure program provides more than half of the Program Administrative Costs. Incentives are more than half of the program costs. All programs except for Residential Hard-to-Measure, which is N/A, provide positive TRC Test results.

Table 4-36. 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	2.04	$0.6	$0.3	$0.1	$0.2
2026	2.46	$0.7	$0.3	$0.1	$0.2
2027	3.04	$1.0	$0.3	$0.1	$0.2
Total	**2.53**	**$2.3**	**$0.9**	**$0.3**	**$0.6**
A2 - Residential Existing Buildings					
2025	4.20	$47.9	$11.4	$3.6	$11.4
2026	4.15	$49.7	$12.0	$3.7	$11.9
2027	4.14	$45.3	$10.9	$3.4	$10.7
Total	**4.16**	**$142.9**	**$34.3**	**$10.7**	**$33.9**
A3 - Residential Hard-to-Measure					
2025	N/A	N/A	$3.8	$3.8	N/A
2026	N/A	N/A	$3.9	$3.9	N/A
2027	N/A	N/A	$3.5	$3.5	N/A
Total			**$11.2**	**$11.2**	
Residential Sector Total					
2025	3.14	$48.5	$15.5	$7.4	$11.6
2026	3.12	$50.4	$16.2	$7.7	$12.1
2027	3.13	$46.3	$14.8	$7.0	$10.9
Total	**3.13**	**$145.3**	**$46.5**	**$22.2**	**$34.6**

Source: Guidehouse

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Table 4-37 presents the benefits and costs by Residential natural gas programs for the 3-year study horizon for the CECP scenario. The Residential Coordinated Delivery and Residential Retail programs provide all of the Net TRC Benefits and Program Incentive Costs, with a positive TRC Test result for the former, but not for the latter. The Residential Hard-to-Measure program provides two-thirds of the Program Administrative Costs. Incentives are more than half of the program costs. Natural gas programs' spending is less than half of electricity spending. The Residential sector benefit-cost ratio is almost 2.0, with sizable C&I Hard-to-Measure Program Administrative Costs.

Table 4-37. Residential Sector, Natural Gas Programs, CECP Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
A1 - Residential New Buildings					
2025		$0.0	$0.0	$0.0	$0.0
2026		$0.0	$0.0	$0.0	$0.0
2027		$0.0	$0.0	$0.0	$0.0
Total		**$0.0**	**$0.0**	**$0.0**	**$0.0**
A2 - Residential Existing Buildings					
2025	2.61	$8.2	$3.2	$0.9	$3.1
2026	2.57	$10.1	$3.9	$1.1	$3.9
2027	2.51	$12.0	$4.8	$1.3	$4.8
Total	**2.56**	**$30.3**	**$11.8**	**$3.2**	**$11.9**
A3 - Residential Hard-to-Measure					
2025	N/A	N/A	$1.9	$1.9	N/A
2026	N/A	N/A	$2.4	$2.4	N/A
2027	N/A	N/A	$2.9	$2.9	N/A
Total			**$7.2**	**$7.2**	
Residential Sector Total					
2025	1.63	$8.2	$5.1	$2.8	$3.1
2026	1.60	$10.1	$6.3	$3.4	$3.9
2027	1.56	$12.0	$7.7	$4.2	$4.8
Total	**1.59**	**$30.3**	**$19.0**	**$10.4**	**$11.9**

Source: Guidehouse

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Table 4-38 presents the incremental net savings for the Income Eligible Coordinated Delivery electric core initiative for the 3-year study horizon for the CECP scenario.

Table 4-38. 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	410	70	9,400	171,400	560
2026	480	70	9,200	166,900	520
2027	440	70	8,700	156,800	500
Total				**495,100**	**1,580**

Source: Guidehouse

Table 4-39 presents the incremental net savings for Income Eligible Coordinated Delivery natural gas core initiative for the 3-year study horizon for the CECP scenario.

Table 4-39. Income Eligible Sector, Natural Gas Core Initiatives, CECP Scenario Incremental Net Achievable Potential

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
B1a - Income Eligible Coordinated Delivery				
2025	33,700	3,000	60,900	180
2026	40,800	3,600	73,900	210
2027	48,000	4,300	87,000	250
Total			**221,800**	**640**

Source: Guidehouse

Table 4-40 presents the benefits and costs by Income Eligible electric programs for the 3-year study horizon for the CECP scenario, with the Income Eligible Hard-to-Measure program contributing program administrative costs only.

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Table 4-40. 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	2.95	$11.6	$3.9	$1.8	$2.7
2026	2.93	$11.3	$3.8	$1.7	$2.6
2027	2.88	$10.7	$3.7	$1.6	$2.5
Total	**2.92**	**$33.5**	**$11.5**	**$5.1**	**$7.7**
B2 - Income Eligible Hard-to-Measure					
2025	N/A	N/A	$1.9	$1.9	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			**$5.4**	**$5.4**	
Income Eligible Sector Total					
2025	2.00	$11.6	$5.8	$3.6	$2.7
2026	2.00	$11.3	$5.6	$3.5	$2.6
2027	1.97	$10.7	$5.4	$3.3	$2.5
Total	**1.99**	**$33.5**	**$16.9**	**$10.5**	**$7.7**

Source: Guidehouse

Table 4-41 presents the benefits and costs by Income Eligible natural gas programs for the 3-year study horizon for the CECP scenario, with the Income Eligible Hard-to-Measure program contributing program administrative costs only.

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Table 4-41. Income Eligible Sector, Natural Gas Programs, CECP Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
B1 - Income Eligible Existing Buildings					
2025	3.12	$3.3	$1.1	$0.3	$0.9
2026	3.02	$4.0	$1.3	$0.4	$1.1
2027	2.92	$4.7	$1.6	$0.5	$1.3
Total	**3.00**	**$12.0**	**$4.0**	**$1.3**	**$3.3**
B2 - Income Eligible Hard-to-Measure					
2025	N/A	N/A	$0.6	$0.6	N/A
2026	N/A	N/A	$0.8	$0.8	N/A
2027	N/A	N/A	$0.9	$0.9	N/A
Total			**$2.3**	**$2.3**	
Income Eligible Sector Total					
2025	1.98	$3.3	$1.7	$0.9	$0.9
2026	1.92	$4.0	$2.1	$1.2	$1.1
2027	1.86	$4.7	$2.5	$1.4	$1.3
Total	**1.91**	**$12.0**	**$6.3**	**$3.5**	**$3.3**

Source: Guidehouse

Table 4-42 presents the incremental net savings for C&I electric core initiatives for the 3-year study horizon for the CECP scenario. All savings are net, except GHG impacts are gross.

The C&I Existing Building Retrofit core initiative, followed by the C&I New Buildings & Major Renovations core initiative, provide positive electricity savings and summer peak electricity demand potential. Electricity potential is positive with demand potential negative for the C&I New & Replacement Equipment core initiative due to fuel substitution. All core initiatives contribute sizable Annual MMBtu savings, with the C&I New Buildings & Major Renovations core initiative providing the lowest share. Lifetime MMBtu savings and 2030 carbon impacts are

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mainly provided by C&I Existing Building Retrofit and C&I New & Replacement Equipment core initiatives.

Table 4-42. 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	310	70	2,100	28,500	60
2026	220	50	1,500	20,000	40
2027	240	50	1,500	21,200	50
Total				**69,700**	**150**
C2a - C&I Existing Building Retrofit					
2025	930	60	6,300	72,400	140
2026	1,000	70	6,700	75,900	150
2027	1,020	80	6,700	75,000	150
Total				**223,300**	**440**
C2b - C&I New & Replacement Equipment					
2025	230	-60	3,700	40,900	250
2026	220	-80	4,000	44,900	280
2027	250	-70	4,200	47,100	290
Total				**132,900**	**820**
C&I Sector Total					
2025	1,470	70	12,100	141,800	450
2026	1,440	40	12,200	140,800	470
2027	1,510	60	12,400	143,300	490
Total				**425,900**	**1,410**

Source: Guidehouse

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Table 4-43 presents the incremental net savings for C&I natural gas core initiatives for the 3-year study horizon for the CECP scenario. All savings are net, except GHG impacts are gross. The C&I Existing Building Retrofit and C&I New & Replacement Equipment core initiatives provide a similar level of savings, except for Lifetime MMBtu, which is led by the C&I Existing Building Retrofit core initiative.

Table 4-43. C&I Sector, Natural Gas Core Initiatives, CECP Scenario Incremental Net Achievable Potential

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
C1a - C&I New Buildings & Major Renovations				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
C2a - C&I Existing Building Retrofit				
2025	52,800	5,200	58,500	280
2026	58,700	5,800	64,300	340
2027	63,600	6,300	68,500	390
Total			**191,300**	**1,010**
C2b - C&I New & Replacement Equipment				
2025	53,300	5,100	91,100	300
2026	55,800	5,200	95,100	310
2027	57,900	5,300	96,700	320
Total			**282,900**	**930**
C&I Sector Total				
2025	106,100	10,300	149,600	580
2026	114,500	11,000	159,400	650
2027	121,500	11,600	165,200	710
Total			**474,200**	**1,940**

Source: Guidehouse

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Table 4-44 presents the benefits and costs by C&I electric programs for the 3-year study horizon for the CECP scenario. All C&I programs provide sizable Net TRC Benefits, except for C&I Hard-to-Measure. The C&I Hard-to-Measure program provides almost half of the Program Administrative Costs. Incentives are about one-third of the program costs. Overall, the C&I sector has a positive TRC test ratio, with sizable C&I Hard-to-Measure Program Administrative Costs.

Table 4-44. 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	2.99	$1.7	$0.6	$0.2	$0.2
2026	3.05	$1.2	$0.4	$0.1	$0.1
2027	3.17	$1.3	$0.4	$0.1	$0.2
Total	**3.06**	**$4.2**	**$1.4**	**$0.5**	**$0.5**
C2 - C&I Existing Buildings					
2025	1.67	$4.9	$2.9	$1.2	$2.1
2026	1.65	$5.3	$3.2	$1.3	$2.3
2027	1.61	$5.4	$3.4	$1.4	$2.4
Total	**1.64**	**$15.6**	**$9.5**	**$3.9**	**$6.8**
C3 - C&I 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	$1.9	$1.9	N/A
Total			**$5.4**	**$5.4**	
C&I Sector Total					
2025	1.27	$6.6	$5.2	$3.1	$2.3
2026	1.21	$6.5	$5.4	$3.2	$2.5
2027	1.19	$6.7	$5.6	$3.4	$2.6
Total	**1.22**	**$19.8**	**$16.2**	**$9.7**	**$7.3**

Source: Guidehouse

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Table 4-45 presents the benefits and costs of the C&I natural gas programs for the 3-year study horizon for the CECP scenario. The C&I Existing Buildings program contributes all of the benefits. The C&I Hard-to-Measure program provides more than half of the Program Administrative Costs, which are most of the program costs. Overall, the C&I sector has a positive TRC test ratio, with sizable C&I Hard-to-Measure Program Administrative Costs.

Table 4-45. C&I Sector, Natural Gas Programs, CECP Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
C1 - C&I New Buildings					
2025		$0.0	$0.0	$0.0	$0.0
2026		$0.0	$0.0	$0.0	$0.0
2027		$0.0	$0.0	$0.0	$0.0
Total		**$0.0**	**$0.0**	**$0.0**	**$0.0**
C2 - C&I Existing Buildings					
2025	3.53	$5.1	$1.4	$0.8	$0.8
2026	2.50	$5.2	$2.1	$1.2	$1.1
2027	2.11	$5.4	$2.6	$1.5	$1.3
Total	**2.58**	**$15.7**	**$6.1**	**$3.5**	**$3.1**
C3 - C&I Hard-to-Measure					
2025	N/A	N/A	$1.0	$1.0	N/A
2026	N/A	N/A	$1.5	$1.5	N/A
2027	N/A	N/A	$1.7	$1.7	N/A
Total			**$4.2**	**$4.2**	
C&I Sector Total					
2025	2.10	$5.1	$2.4	$1.8	$0.8
2026	1.47	$5.2	$3.5	$2.7	$1.1
2027	1.26	$5.4	$4.3	$3.2	$1.3
Total	**1.53**	**$15.7**	**$10.3**	**$7.7**	**$3.1**

Source: Guidehouse

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Figure 4-9 shows the CECP scenario top lifetime achievable MMBtu savings electricity measures across all sectors and fuels, net at meter, installed in 2025-2027. Similar results are included in Appendix C, Energy Efficiency Results. Appendix C also contains first-year annual and lifetime savings by measure, as well as the top summer peak passive demand savings measures.

The top two electricity measures, Insulation (Residential Coordinated Delivery) and Ductless Mini-Split Heat pump (MSHP) Partially Displacing Oil Boiler (Residential Retail), provide more lifetime MMBtu savings than the combined savings from the other measures listed, with the former providing almost three times the savings of the latter measure.

Figure 4-9. 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	919,500
2	Ductless MSHP Partially Displacing Oil Boiler	A2c - Residential Retail	311,400
3	ER Baseboard to DMSHP	A2c - Residential Retail	189,120
4	Air Sealing	A2a - Residential Coordinated Delivery	153,640
5	Insulation	B1a - Income Eligible Coordinated Delivery	145,620
6	Heat Pump Water Heater	A2c - Residential Retail	138,540
7	Central Heat Pump	A2c - Residential Retail	130,080
8	Air Sealing	C2a - C&I Existing Building Retrofit	92,680
9	ER Baseboard to DMSHP	B1a - Income Eligible Coordinated Delivery	79,010
10	Central ASHP Partially Displacing Oil Furnace	A2c - Residential Retail	74,090
11	W2W GSHP Replacing Oil Boiler	A2c - Residential Retail	54,190
12	Air Sealing	B1a - Income Eligible Coordinated Delivery	51,520
13	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	47,880
14	Custom Large C&I	C2a - C&I Existing Building Retrofit	46,980
15	Heat Pump Water Heater	B1a - Income Eligible Coordinated Delivery	44,440
16	Ductless MSHP Partially Displacing Oil Boiler	B1a - Income Eligible Coordinated Delivery	44,110
17	Custom New Construction	C1a - C&I New Buildings & Major Renovations	43,830
18	Duct Insulation	A2a - Residential Coordinated Delivery	39,790
19	Duct Sealing	A2a - Residential Coordinated Delivery	28,420
20	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	28,370
21	Central Heat Pump	B1a - Income Eligible Coordinated Delivery	26,200
22	Air Sealing - Res End Use	C2a - C&I Existing Building Retrofit	25,140
23	Home Energy Report	A2d - Residential Behavior	24,840
24	Heat Pump Water Heater	C2b - C&I New & Replacement Equipment	22,580
25	Ductless Mini-Split Heat Pump (DMSHP)	C2b - C&I New & Replacement Equipment	22,320

Source: Guidehouse

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Figure 4-10 shows the CECP scenario top lifetime achievable MMBtu savings natural gas measures across all sectors and fuels, net at meter, installed in 2025-2027. Similar results are included in Appendix C. The top three natural gas measures, Insulation (Residential Coordinated Delivery), Custom Large C&I (C&I New & Replacement Equipment), and Custom C&I Large (C&I Existing Building Retrofit), provide more twice the combined savings from the other measures listed.

Figure 4-10. EE CECP Scenario Lifetime Achievable Potential, Top Natural Gas Measures, 2025-2027, MMBtu (all sectors)

#	Measure	Core Initiative	LT Savings
1	Insulation	A2a - Residential Coordinated Delivery	562,240
2	Custom Large C&I	C2b - C&I New & Replacement Equipment	243,970
3	Custom Large C&I	C2a - C&I Existing Building Retrofit	136,580
4	W2A GSHP Replacing Gas Furnace	A2c - Residential Retail	120,070
5	Air Sealing	A2a - Residential Coordinated Delivery	91,790
6	Insulation	B1a - Income Eligible Coordinated Delivery	90,570
7	Ductless MSHP Partially Displacing Gas Boiler and AC	A2c - Residential Retail	45,400
8	Air Sealing	B1a - Income Eligible Coordinated Delivery	35,970
9	W2A GSHP Replacing Gas Furnace	B1a - Income Eligible Coordinated Delivery	28,240
10	Ductless MSHP Partially Displacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	21,450
11	Heat Pump Water Heater Fuel Switch	A2c - Residential Retail	17,080
12	Demand Control Ventilation	C2a - C&I Existing Building Retrofit	17,010
13	Ground Source Heat Pump (Water-to-Air)	C2b - C&I New & Replacement Equipment	15,600
14	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	15,500
15	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	12,170
16	Commissioning/Retrocommissioning	C2a - C&I Existing Building Retrofit	11,880
17	Duct Sealing	A2a - Residential Coordinated Delivery	10,060
18	Wi-Fi Thermostat	A2c - Residential Retail	9,890
19	Gas RTU to VRF	C2b - C&I New & Replacement Equipment	9,060
20	Boiler Reset Control	A2c - Residential Retail	8,980
21	Forced Hot Water Boiler - Gas	B1a - Income Eligible Coordinated Delivery	8,400
22	Heat Recovery Ventilator	A2c - Residential Retail	7,510
23	Programmable Thermostat	C2a - C&I Existing Building Retrofit	6,830
24	Programmable Thermostat - Res End Use	C2a - C&I Existing Building Retrofit	6,110
25	Commercial HVAC Tune-up	C2a - C&I Existing Building Retrofit	5,030

Source: Guidehouse

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Figure 4-11 shows the CECP scenario top 2030 CO_2e-saving electric measures across all sectors, net at generator, installed in 2025-2027. Similar results are included in Appendix C. The top two electricity measures, Ductless MSHP Partially Displacing Oil Boiler (Residential Retail) and Insulation (Residential Coordinated Delivery) provide about the same lifetime Carbon savings, which overall is more than 168% of the combined savings from the other measures listed.

Figure 4-11. 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	2,932
2	Insulation	A2a - Residential Coordinated Delivery	2,518
3	Central ASHP Partially Displacing Oil Furnace	A2c - Residential Retail	729
4	Air Sealing	A2a - Residential Coordinated Delivery	714
5	Electric forklifts C&I	C2b - C&I New & Replacement Equipment	404
6	Insulation	B1a - Income Eligible Coordinated Delivery	387
7	Ductless MSHP Partially Displacing Oil Boiler	B1a - Income Eligible Coordinated Delivery	283
8	Heat Pump Water Heater	A2c - Residential Retail	262
9	Air Sealing	B1a - Income Eligible Coordinated Delivery	244
10	W2W GSHP Replacing Oil Boiler	A2c - Residential Retail	214
11	ER Baseboard to DMSHP	A2c - Residential Retail	212
12	Central Heat Pump	A2c - Residential Retail	169
13	Air to water heat pumps, oil baseline	A2c - Residential Retail	149
14	Ductless MSHP Partially Displacing Propane Boiler	A2c - Residential Retail	147
15	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	137
16	Air Sealing	C2a - C&I Existing Building Retrofit	137
17	Duct Insulation	A2a - Residential Coordinated Delivery	137
18	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	133
19	Custom Large C&I	C2a - C&I Existing Building Retrofit	126
20	Heat Pump Water Heater	C2b - C&I New & Replacement Equipment	121
21	Heat Recovery Ventilator	A2c - Residential Retail	98
22	Duct Sealing	A2a - Residential Coordinated Delivery	97
23	ER Baseboard to DMSHP	B1a - Income Eligible Coordinated Delivery	89
24	Custom New Construction	C1a - C&I New Buildings & Major Renovations	87
25	Central ASHP Partially Displacing Propane Furnace	A2c - Residential Retail	85

Source: Guidehouse

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Figure 4-12 shows the CECP scenario top 2030 CO_2e-saving natural gas measures across all sectors, net at meter, installed in 2025-2027. Similar results are included in Appendix C. The top three natural gas measures, Insulation (Residential Coordinated Delivery), Custom Large C&I (C&I New & Replacement Equipment), and Custom C&I Large (C&I Existing Building Retrofit), provide more lifetime savings than the combined savings from the other measures listed.

Figure 4-12. EE CECP Scenario Lifetime Achievable Potential, Top Natural Gas Measures, 2025-2027, CO_2e Savings at Generator, Metric Tons (all sectors)

#	Measure	Core Initiative	CO2e in 2030
1	Insulation	A2a - Residential Coordinated Delivery	1,213
2	Custom Large C&I	C2b - C&I New & Replacement Equipment	757
3	Custom Large C&I	C2a - C&I Existing Building Retrofit	642
4	W2A GSHP Replacing Gas Furnace	A2c - Residential Retail	337
5	Air Sealing	A2a - Residential Coordinated Delivery	312
6	Ductless MSHP Partially Displacing Gas Boiler and AC	A2c - Residential Retail	269
7	Insulation	B1a - Income Eligible Coordinated Delivery	182
8	Demand Control Ventilation	C2a - C&I Existing Building Retrofit	163
9	Air Sealing	B1a - Income Eligible Coordinated Delivery	127
10	Ductless MSHP Partially Displacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	88
11	Heat Pump Water Heater Fuel Switch	A2c - Residential Retail	81
12	Commissioning/Retrocommissioning	C2a - C&I Existing Building Retrofit	79
13	W2A GSHP Replacing Gas Furnace	B1a - Income Eligible Coordinated Delivery	79
14	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	61
15	Ground Source Heat Pump (Water-to-Air)	C2b - C&I New & Replacement Equipment	49
16	Gas RTU to VRF	C2b - C&I New & Replacement Equipment	47
17	Boiler Reset Control	A2c - Residential Retail	42
18	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	40
19	Wi-Fi Thermostat	A2c - Residential Retail	39
20	Programmable Thermostat	C2a - C&I Existing Building Retrofit	36
21	Heat Recovery Ventilator	A2c - Residential Retail	28
22	Programmable Thermostat - Res End Use	C2a - C&I Existing Building Retrofit	25
23	Duct Sealing	A2a - Residential Coordinated Delivery	25
24	Heat Pump Water Heater Fuel Switch	B1a - Income Eligible Coordinated Delivery	24
25	Forced Hot Water Boiler - Gas	B1a - Income Eligible Coordinated Delivery	22

Source: Guidehouse

4.4.3 CECP Cost Premium Scenario Results

Table 4-46 through Table 4-49 show CECP Cost Premium scenario results for the Residential sector. The tables show summary energy, MW, MMBtu, and 2030 carbon savings for all fuels and benefit and costs and the BCR for the core initiatives 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.

Table 4-46 presents the incremental savings for Residential electric core initiatives for the 3-year study horizon for the CECP Cost Premium scenario. All savings are net, except 2030 carbon[49] impacts are gross. The Residential Behavior core initiative and Residential Coordinated Delivery core initiatives provide sizable positive electricity savings, lifetime MMBtu

[49] 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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and GHG savings. The Residential Retail core initiative has negative electricity savings due to fuel substitution. All core initiatives, provide summer peak electricity demand and annual MMBtu savings, except Residential New Homes & Renovations provides no demand savings. Residential Behavior provides no 2030 GHG savings due to a 1-year effective useful lifetime (EUL).

Table 4-46. 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	20	0	500	9,000	30
2026	10	0	500	10,100	40
2027	0	0	600	12,300	50
Total				**31,400**	**120**
A2a - Residential Coordinated Delivery					
2025	460	30	18,800	408,200	1,230
2026	480	40	19,100	410,900	1,250
2027	460	40	17,200	363,100	1,120
Total				**1,182,200**	**3,600**
A2c - Residential Retail					
2025	-100	200	23,000	398,900	1,960
2026	-130	200	24,000	418,700	2,050
2027	-50	200	22,200	385,300	1,870
Total				**1,202,900**	**5,880**
A2d - Residential Behavior					
2025	1,220	60	8,200	8,200	0
2026	1,250	60	8,300	8,300	0
2027	1,280	60	8,400	8,400	0
Total				**24,900**	**0**
Residential Sector Total					
2025	1,600	290	50,500	824,300	3,220
2026	1,610	300	51,900	848,000	3,340
2027	1,690	300	48,400	769,100	3,040
Total				**2,441,400**	**9,600**

Source: Guidehouse

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Table 4-47 presents the incremental net savings for Residential natural gas core initiatives for the 3-year study horizon for the CECP Cost Premium scenario. All savings are net, except 2030 carbon[50] impacts are gross. The Residential Coordinated Delivery core initiative provides about two-thirds of the natural gas savings, Annual and Lifetime MMBtu savings, and 2030 GHG impacts compared to the Residential Retail core initiative. The Residential Behavior and Residential New Homes & Renovation core initiatives do not address natural gas.

Table 4-47. Residential Sector, Natural Gas Core Initiatives, CECP Cost Premium Scenario Achievable Potential (Incremental Net)

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
A1a - Residential New Homes & Renovations				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
A2a - Residential Coordinated Delivery				
2025	81,100	8,300	186,700	440
2026	97,800	10,000	225,200	530
2027	114,300	11,700	263,600	620
Total			**675,500**	**1,590**
A2c - Residential Retail				
2025	50,200	3,100	66,300	260
2026	60,900	3,800	81,400	310
2027	72,000	4,400	97,200	370
Total			**244,900**	**940**
A2d - Residential Behavior				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
Residential Sector Total				
2025	131,300	11,400	253,000	700
2026	158,700	13,800	306,600	840
2027	186,300	16,100	360,800	990
Total			**920,400**	**2,530**

Source: Guidehouse

[50] 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, Residential programs and sector as a whole remain cost-effective.

Table 4-48 presents the benefits and costs by Residential electric programs for the 3-year study horizon for the CECP Cost Premium scenario. The Residential Existing Buildings programs provide almost all of the Net TRC Benefits and Program Incentive Costs. The Residential Hard-to-Measure program provides more than half of the Program Administrative Costs. Incentives are more than half of the program costs. All programs except for Residential Hard-to-Measure, which is N/A, provide positive TRC Test results. After adding the cost premium estimations to TRC costs, Residential programs and sector as a whole remain cost-effective.

Table 4-48. 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	2.04	$0.6	$0.3	$0.1	$0.2
2026	2.46	$0.7	$0.3	$0.1	$0.2
2027	3.04	$1.0	$0.3	$0.1	$0.2
Total	**2.53**	**$2.3**	**$0.9**	**$0.3**	**$0.6**
A2 - Residential Existing Buildings					
2025	2.10	$47.9	$22.8	$6.1	$19.9
2026	2.12	$49.7	$23.5	$6.3	$20.4
2027	2.16	$45.3	$21.0	$5.6	$18.2
Total	**2.13**	**$142.9**	**$67.3**	**$18.0**	**$58.5**
A3 - Residential Hard-to-Measure					
2025	N/A	N/A	$6.6	$6.6	N/A
2026	N/A	N/A	$6.7	$6.7	N/A
2027	N/A	N/A	$6.0	$6.0	N/A
Total			**$19.3**	**$19.3**	
Residential Sector Total					
2025	1.64	$48.5	$29.7	$12.8	$20.1
2026	1.65	$50.4	$30.5	$13.1	$20.6
2027	1.69	$46.3	$27.3	$11.7	$18.4
Total	**1.66**	**$145.3**	**$87.5**	**$37.7**	**$59.1**

Source: Guidehouse

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Table 4-49 presents the benefits and costs by Residential natural gas programs for the 3-year study horizon for the CECP Cost Premium scenario. The Residential Existing Buildings programs provide all of the Net TRC Benefits and Program Incentive Costs. The Residential Hard-to-Measure program provides two-thirds of the Program Administrative Costs. Incentives are more than half of the program costs. Natural gas programs' spending is about half of electricity spending. The Residential sector benefit-cost ratio is just above 1.0, mainly due to sizable C&I Hard-to-Measure Program Administrative Costs. After adding the cost premium estimations to TRC costs, the Residential program remains cost-effective, however, with the addition of hard-to-measure costs, the sector as a whole falls below a 1.0 for the 3-year study period.

Table 4-49. Residential Sector, Natural Gas Programs, CECP Cost Premium Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
A1 - Residential New Buildings					
2025		$0.0	$0.0	$0.0	$0.0
2026		$0.0	$0.0	$0.0	$0.0
2027		$0.0	$0.0	$0.0	$0.0
Total		**$0.0**	**$0.0**	**$0.0**	**$0.0**
A2 - Residential Existing Buildings					
2025	1.05	$8.2	$7.8	$2.0	$6.7
2026	1.05	$10.1	$9.6	$2.4	$8.3
2027	1.04	$12.0	$11.5	$2.9	$10.0
Total	**1.05**	**$30.3**	**$29.0**	**$7.3**	**$25.0**
A3 - Residential Hard-to-Measure					
2025	N/A	N/A	$4.2	$4.2	N/A
2026	N/A	N/A	$5.1	$5.1	N/A
2027	N/A	N/A	$6.2	$6.2	N/A
Total			**$15.5**	**$15.5**	
Residential Sector Total					
2025	0.69	$8.2	$12.0	$6.1	$6.7
2026	0.68	$10.1	$14.8	$7.5	$8.3
2027	0.68	$12.0	$17.7	$9.1	$10.0
Total	**0.68**	**$30.3**	**$44.4**	**$22.7**	**$25.0**

Source: Guidehouse

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Table 4-50 presents the incremental net savings for the Income Eligible Coordinated Delivery electric core initiative for the 3-year study horizon for the CECP Cost Premium scenario.

Table 4-50. 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	410	70	9,400	171,400	560
2026	480	70	9,200	166,900	520
2027	440	70	8,700	156,800	500
Total				**495,100**	**1,580**

Source: Guidehouse

Table 4-51 presents the incremental net savings for Income Eligible Coordinated Delivery natural gas core initiative for the 3-year study horizon for the CECP Cost Premium scenario.

Table 4-51. Income Eligible Sector, Natural Gas Core Initiatives, CECP Cost Premium Scenario Achievable Potential (Incremental Net)

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
B1a - Income Eligible Coordinated Delivery				
2025	33,700	3,000	60,900	180
2026	40,800	3,600	73,900	210
2027	48,000	4,300	87,000	250
Total			**221,800**	**640**

Source: Guidehouse

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Table 4-52 presents the benefits and costs by Income Eligible electric programs for the 3-year study horizon for the CECP Cost Premium scenario, with the Hard-to-Measure program contributing program administrative costs only. After adding the cost premium estimations to TRC costs, the income-eligible program and sector as a whole remain cost-effective.

Table 4-52. 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	1.57	$11.6	$7.4	$3.1	$4.8
2026	1.50	$11.3	$7.5	$3.2	$4.8
2027	1.46	$10.7	$7.3	$3.1	$4.6
Total	**1.51**	**$33.5**	**$22.2**	**$9.4**	**$14.2**
B2 - Income Eligible Hard-to-Measure					
2025	N/A	N/A	$3.3	$3.3	N/A
2026	N/A	N/A	$3.3	$3.3	N/A
2027	N/A	N/A	$3.2	$3.2	N/A
Total			**$9.9**	**$9.9**	
Income Eligible Sector Total					
2025	1.08	$11.6	$10.7	$6.5	$4.8
2026	1.04	$11.3	$10.8	$6.5	$4.8
2027	1.01	$10.7	$10.5	$6.3	$4.6
Total	**1.05**	**$33.5**	**$32.0**	**$19.3**	**$14.2**

Source: Guidehouse

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After adding the cost premium estimations to TRC costs, the income-eligible program remains cost-effective, however, with the addition of hard-to-measure costs, the sector as a whole falls below a 1.0 for the 3-year study period.

Table 4-53 presents the benefits and costs by Income Eligible natural gas programs for the 3-year study horizon for the CECP Cost Premium scenario, with the Hard-to-Measure program contributing program administrative costs only. After adding the cost premium estimations to TRC costs, the income-eligible program remains cost-effective, however, with the addition of hard-to-measure costs, the sector as a whole falls below a 1.0 for the 3-year study period.

Table 4-53. Income Eligible Sector, Natural Gas Programs, CECP Cost Premium Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
B1 - Income Eligible Existing Buildings					
2025	1.28	$3.3	$2.6	$0.8	$2.0
2026	1.25	$4.0	$3.2	$1.0	$2.5
2027	1.22	$4.7	$3.9	$1.2	$3.1
Total	**1.25**	**$12.0**	**$9.6**	**$2.9**	**$7.6**
B2 - Income Eligible Hard-to-Measure					
2025	N/A	N/A	$1.4	$1.4	N/A
2026	N/A	N/A	$1.7	$1.7	N/A
2027	N/A	N/A	$2.1	$2.1	N/A
Total			**$5.2**	**$5.2**	
Income Eligible Sector Total					
2025	0.83	$3.3	$4.0	$2.1	$2.0
2026	0.81	$4.0	$4.9	$2.7	$2.5
2027	0.79	$4.7	$6.0	$3.3	$3.1
Total	**0.81**	**$12.0**	**$14.9**	**$8.1**	**$7.6**

Source: Guidehouse

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Table 4-54 presents the incremental net savings for C&I electric core initiatives for the 3-year study horizon for the CECP Cost Premium scenario. The C&I Existing Building Retrofit core initiative provides most of the electricity savings, Annual and Lifetime savings, and sizable 2030 GHG impacts. The C&I New & Replacement Equipment core initiative provides negative summer peak electricity demand savings due to fuel substitution, with sizable Annual and Lifetime MMBtu savings, and 2030 carbon[51] impacts. The C&I New Buildings & Major Renovations core initiative contributes positive savings, but less than the other core initiatives.

Table 4-54. 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	310	70	2,100	28,500	60
2026	220	50	1,500	20,000	40
2027	240	50	1,500	21,200	50
Total				**69,700**	**150**
C2a - C&I Existing Building Retrofit					
2025	930	60	6,300	72,400	140
2026	1,000	70	6,700	75,900	150
2027	1,020	80	6,700	75,000	150
Total				**223,300**	**440**
C2b - C&I New & Replacement Equipment					
2025	230	-60	3,700	40,900	250
2026	220	-80	4,000	44,900	280
2027	250	-70	4,200	47,100	290
Total				**132,900**	**820**
C&I Sector Total					
2025	1,470	70	12,100	141,800	450
2026	1,440	40	12,200	140,800	470
2027	1,510	60	12,400	143,300	490
Total				**425,900**	**1,410**

Source: Guidehouse

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

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Table 4-55 presents the incremental net savings for C&I natural gas core initiatives for the 3-year study horizon for the CECP Cost Premium scenario. All savings are net, except GHG impacts are gross. The C&I Existing Building Retrofit core initiative provides a majority compared to the C&I New & Replacement Equipment core initiatives, except for 2030 GHG.

Table 4-55. C&I Sector, Natural Gas Core Initiatives, CECP Cost Premium Scenario Achievable Potential (Incremental Net)

Core Initiative, by Install Year	Natural Gas [Therms]	Annual MMBtu (all fuels)	Lifetime MMBtu (all fuels)	2030 GHG [Metric Tons CO2e]
C1a - C&I New Buildings & Major Renovations				
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
Total			**0**	**0**
C2a - C&I Existing Building Retrofit				
2025	52,800	5,200	58,500	280
2026	58,700	5,800	64,300	340
2027	63,600	6,300	68,500	390
Total			**191,300**	**1,010**
C2b - C&I New & Replacement Equipment				
2025	53,300	5,100	91,100	300
2026	55,800	5,200	95,100	310
2027	57,900	5,300	96,700	320
Total			**282,900**	**930**
C&I Sector Total				
2025	106,100	10,300	149,600	580
2026	114,500	11,000	159,400	650
2027	121,500	11,600	165,200	710
Total			**474,200**	**1,940**

Source: Guidehouse

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After adding the cost premium estimations to TRC costs, the programs and sector remain cost-effective.

Table 4-56 presents the benefits and costs by C&I electric programs for the 3-year study horizon for the CECP Cost Premium scenario. All C&I programs provide sizable Net TRC Benefits, except for C&I Hard-to-Measure. The C&I New Buildings& Major Renovations, C&I Existing Buildings and Hard-to-Measure programs provide most of the Program Administrative Costs. Incentives are less than half of the total program costs. Overall, the C&I sector has a positive TRC test ratio, with sizable C&I Hard-to-Measure Program Administrative Costs. After adding the cost premium estimations to TRC costs, the programs and sector remain cost-effective.

Table 4-56. 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	2.99	$1.7	$0.6	$0.2	$0.2
2026	3.05	$1.2	$0.4	$0.1	$0.1
2027	3.17	$1.3	$0.4	$0.1	$0.2
Total	**3.06**	**$4.2**	**$1.4**	**$0.5**	**$0.5**
C2 - C&I Existing Buildings					
2025	1.59	$4.9	$3.1	$1.3	$2.3
2026	1.51	$5.3	$3.5	$1.5	$2.7
2027	1.42	$5.4	$3.8	$1.7	$3.1
Total	**1.50**	**$15.6**	**$10.4**	**$4.5**	**$8.1**
C3 - C&I Hard-to-Measure					
2025	N/A	N/A	$1.8	$1.8	N/A
2026	N/A	N/A	$2.1	$2.1	N/A
2027	N/A	N/A	$2.3	$2.3	N/A
Total			**$6.2**	**$6.2**	
C&I Sector Total					
2025	1.20	$6.6	$5.5	$3.3	$2.5
2026	1.09	$6.5	$6.0	$3.7	$2.9
2027	1.03	$6.7	$6.5	$4.1	$3.2
Total	**1.10**	**$19.8**	**$18.0**	**$11.2**	**$8.6**

Source: Guidehouse

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After adding the cost premium estimations to TRC costs, programs remain cost-effective.

Table 4-57 presents the benefits and costs by C&I natural gas programs for the 3-year study horizon for the CECP Cost Premium scenario. The C&I Existing Buildings programs contribute almost all of the benefits. The C&I Hard-to-Measure program provides almost half of the Program Administrative Costs, which are most of the program costs. Overall, the C&I sector has a positive TRC test ratio (except for 2027), with sizable C&I Hard-to-Measure Program Administrative Costs. After adding the cost premium estimations to TRC costs, programs remain cost-effective.

Table 4-57. C&I Sector, Natural Gas Programs, CECP Cost Premium Scenario Benefits and Costs

Program, by Install Year	Net TRC Test Ratio = (a) / (b)	Net TRC Benefits [NPV 2025 $ Millions] (a)	Net TRC Costs [NPV 2025 $ Millions] (b)	Program Administrative Costs [2025 $ Millions]	Program Incentive Costs [2025 $ Millions]
C1 - C&I New Buildings					
2025		$0.0	$0.0	$0.0	$0.0
2026		$0.0	$0.0	$0.0	$0.0
2027		$0.0	$0.0	$0.0	$0.0
Total		**$0.0**	**$0.0**	**$0.0**	**$0.0**
C2 - C&I Existing Buildings					
2025	3.08	$5.1	$1.6	$0.9	$0.9
2026	1.94	$5.2	$2.7	$1.6	$1.4
2027	1.47	$5.4	$3.7	$2.2	$1.8
Total	**1.96**	**$15.7**	**$8.0**	**$4.7**	**$4.0**
C3 - C&I Hard-to-Measure					
2025	N/A	N/A	$1.1	$1.1	N/A
2026	N/A	N/A	$1.9	$1.9	N/A
2027	N/A	N/A	$2.5	$2.5	N/A
Total			**$5.5**	**$5.5**	
C&I Sector Total					
2025	1.82	$5.1	$2.8	$2.1	$0.9
2026	1.15	$5.2	$4.6	$3.5	$1.4
2027	0.88	$5.4	$6.2	$4.7	$1.8
Total	**1.16**	**$15.7**	**$13.5**	**$10.2**	**$4.0**

Source: Guidehouse

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Figure 4-13 shows the CECP Cost Premium scenario top lifetime achievable MMBtu savings electric measures across all sectors, net at meter, installed in 2025-2027. Similar results are included in Appendix C, Energy Efficiency Results. Appendix C also contains first-year annual and lifetime savings by measure, as well as the top summer peak passive demand savings measures.

The top two electricity measures, Insulation (Residential Coordinated Delivery) and Ductless MSHP Partially Displacing Oil Boiler (Residential Retail), provide lifetime MMBtu savings similar to the combined savings from the other measures listed, with the former providing almost two times the savings of the latter measure.

Figure 4-13. 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	919,500
2	Ductless MSHP Partially Displacing Oil Boiler	A2c - Residential Retail	311,400
3	ER Baseboard to DMSHP	A2c - Residential Retail	189,120
4	Air Sealing	A2a - Residential Coordinated Delivery	153,640
5	Insulation	B1a - Income Eligible Coordinated Delivery	145,620
6	Heat Pump Water Heater	A2c - Residential Retail	138,540
7	Central Heat Pump	A2c - Residential Retail	130,080
8	Air Sealing	C2a - C&I Existing Building Retrofit	92,680
9	ER Baseboard to DMSHP	B1a - Income Eligible Coordinated Delivery	79,010
10	Central ASHP Partially Displacing Oil Furnace	A2c - Residential Retail	74,090
11	W2W GSHP Replacing Oil Boiler	A2c - Residential Retail	54,190
12	Air Sealing	B1a - Income Eligible Coordinated Delivery	51,520
13	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	47,880
14	Custom Large C&I	C2a - C&I Existing Building Retrofit	46,980
15	Heat Pump Water Heater	B1a - Income Eligible Coordinated Delivery	44,440
16	Ductless MSHP Partially Displacing Oil Boiler	B1a - Income Eligible Coordinated Delivery	44,110
17	Custom New Construction	C1a - C&I New Buildings & Major Renovations	43,830
18	Duct Insulation	A2a - Residential Coordinated Delivery	39,790
19	Duct Sealing	A2a - Residential Coordinated Delivery	28,420
20	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	28,370
21	Central Heat Pump	B1a - Income Eligible Coordinated Delivery	26,200
22	Air Sealing - Res End Use	C2a - C&I Existing Building Retrofit	25,140
23	Home Energy Report	A2d - Residential Behavior	24,840
24	Heat Pump Water Heater	C2b - C&I New & Replacement Equipment	22,580
25	Ductless Mini-Split Heat Pump (DMSHP)	C2b - C&I New & Replacement Equipment	22,320

Source: Guidehouse

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Figure 4-14 shows the CECP Cost Premium scenario top lifetime achievable MMBtu savings natural gas measures across all sectors, net at meter, installed in 2025-2027. Similar results are included in Appendix C. The top four natural gas measures, Insulation (Residential Coordinated Delivery and Income Eligible Coordinated Delivery), Custom Large C&I (C&I New & Replacement Equipment), and Custom C&I Large (C&I Existing Building Retrofit), provide more than three the lifetime MMBtu savings than the combined savings from the other measures listed.

Figure 4-14. EE CECP Cost Premium Scenario Lifetime Achievable Potential, Top Natural Gas Measures, 2025-2027, MMBtu (all sectors)

#	Measure	Core Initiative	LT Savings
1	Insulation	A2a - Residential Coordinated Delivery	562,240
2	Custom Large C&I	C2b - C&I New & Replacement Equipment	243,970
3	Custom Large C&I	C2a - C&I Existing Building Retrofit	136,580
4	W2A GSHP Replacing Gas Furnace	A2c - Residential Retail	120,070
5	Air Sealing	A2a - Residential Coordinated Delivery	91,790
6	Insulation	B1a - Income Eligible Coordinated Delivery	90,570
7	Ductless MSHP Partially Displacing Gas Boiler and AC	A2c - Residential Retail	45,400
8	Air Sealing	B1a - Income Eligible Coordinated Delivery	35,970
9	W2A GSHP Replacing Gas Furnace	B1a - Income Eligible Coordinated Delivery	28,240
10	Ductless MSHP Partially Displacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	21,450
11	Heat Pump Water Heater Fuel Switch	A2c - Residential Retail	17,080
12	Demand Control Ventilation	C2a - C&I Existing Building Retrofit	17,010
13	Ground Source Heat Pump (Water-to-Air)	C2b - C&I New & Replacement Equipment	15,600
14	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	15,500
15	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	12,170
16	Commissioning/Retrocommissioning	C2a - C&I Existing Building Retrofit	11,880
17	Duct Sealing	A2a - Residential Coordinated Delivery	10,060
18	Wi-Fi Thermostat	A2c - Residential Retail	9,890
19	Gas RTU to VRF	C2b - C&I New & Replacement Equipment	9,060
20	Boiler Reset Control	A2c - Residential Retail	8,980
21	Forced Hot Water Boiler - Gas	B1a - Income Eligible Coordinated Delivery	8,400
22	Heat Recovery Ventilator	A2c - Residential Retail	7,510
23	Programmable Thermostat	C2a - C&I Existing Building Retrofit	6,830
24	Programmable Thermostat - Res End Use	C2a - C&I Existing Building Retrofit	6,110
25	Commercial HVAC Tune-up	C2a - C&I Existing Building Retrofit	5,030

Source: Guidehouse

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Figure 4-15 shows the CECP Cost Premium scenario top 2030 CO_2e-saving electric measures across all sectors and fuels, net at generator, installed in 2025-2027. Similar results are included in Appendix C. The top two electricity measures, Ductless MSHP Partially Displacing Oil Boiler (Residential Retail) and Insulation (Residential Coordinated Delivery) provide lifetime Carbon savings more than 150% of the combined savings from the other measures listed, with the former providing almost two times the savings of the latter measure.

Figure 4-15. 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	2,932
2	Insulation	A2a - Residential Coordinated Delivery	2,518
3	Central ASHP Partially Displacing Oil Furnace	A2c - Residential Retail	729
4	Air Sealing	A2a - Residential Coordinated Delivery	714
5	Electric forklifts C&I	C2b - C&I New & Replacement Equipment	404
6	Insulation	B1a - Income Eligible Coordinated Delivery	387
7	Ductless MSHP Partially Displacing Oil Boiler	B1a - Income Eligible Coordinated Delivery	283
8	Heat Pump Water Heater	A2c - Residential Retail	262
9	Air Sealing	B1a - Income Eligible Coordinated Delivery	244
10	W2W GSHP Replacing Oil Boiler	A2c - Residential Retail	214
11	ER Baseboard to DMSHP	A2c - Residential Retail	212
12	Central Heat Pump	A2c - Residential Retail	169
13	Air to water heat pumps, oil baseline	A2c - Residential Retail	149
14	Ductless MSHP Partially Displacing Propane Boiler	A2c - Residential Retail	147
15	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	137
16	Air Sealing	C2a - C&I Existing Building Retrofit	137
17	Duct Insulation	A2a - Residential Coordinated Delivery	137
18	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	133
19	Custom Large C&I	C2a - C&I Existing Building Retrofit	126
20	Heat Pump Water Heater	C2b - C&I New & Replacement Equipment	121
21	Heat Recovery Ventilator	A2c - Residential Retail	98
22	Duct Sealing	A2a - Residential Coordinated Delivery	97
23	ER Baseboard to DMSHP	B1a - Income Eligible Coordinated Delivery	89
24	Custom New Construction	C1a - C&I New Buildings & Major Renovations	87
25	Central ASHP Partially Displacing Propane Furnace	A2c - Residential Retail	85

Source: Guidehouse

Figure 4-16 shows the CECP Cost Premium scenario top 2030 CO_2e-saving natural gas measures across all sectors and fuels, net at meter, installed in 2025-2027. Similar results are included in Appendix C. The top three natural gas measures, Custom Insulation (Residential Coordinated Delivery), Large C&I (C&I New & Replacement Equipment), and Custom C&I Large (C&I Existing Building Retrofit), provide more than 150% of the lifetime savings than the combined savings from the other measures listed.

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Figure 4-16. EE CECP Cost Premium Scenario Lifetime Achievable Potential, Top Natural Gas Measures, 2025-2027, CO_2e Savings at Generator, Metric Tons (all sectors)

#	Measure	Core Initiative	CO2e in 2030
1	Insulation	A2a - Residential Coordinated Delivery	1,213
2	Custom Large C&I	C2b - C&I New & Replacement Equipment	757
3	Custom Large C&I	C2a - C&I Existing Building Retrofit	642
4	W2A GSHP Replacing Gas Furnace	A2c - Residential Retail	337
5	Air Sealing	A2a - Residential Coordinated Delivery	312
6	Ductless MSHP Partially Displacing Gas Boiler and AC	A2c - Residential Retail	269
7	Insulation	B1a - Income Eligible Coordinated Delivery	182
8	Demand Control Ventilation	C2a - C&I Existing Building Retrofit	163
9	Air Sealing	B1a - Income Eligible Coordinated Delivery	127
10	Ductless MSHP Partially Displacing Gas Boiler and AC	B1a - Income Eligible Coordinated Delivery	88
11	Heat Pump Water Heater Fuel Switch	A2c - Residential Retail	81
12	Commissioning/Retrocommissioning	C2a - C&I Existing Building Retrofit	79
13	W2A GSHP Replacing Gas Furnace	B1a - Income Eligible Coordinated Delivery	79
14	Programmable Thermostat to Wifi Thermostat	A2c - Residential Retail	61
15	Ground Source Heat Pump (Water-to-Air)	C2b - C&I New & Replacement Equipment	49
16	Gas RTU to VRF	C2b - C&I New & Replacement Equipment	47
17	Boiler Reset Control	A2c - Residential Retail	42
18	Manual Thermostat to Programmable Thermostat	A2c - Residential Retail	40
19	Wi-Fi Thermostat	A2c - Residential Retail	39
20	Programmable Thermostat	C2a - C&I Existing Building Retrofit	36
21	Heat Recovery Ventilator	A2c - Residential Retail	28
22	Programmable Thermostat - Res End Use	C2a - C&I Existing Building Retrofit	25
23	Duct Sealing	A2a - Residential Coordinated Delivery	25
24	Heat Pump Water Heater Fuel Switch	B1a - Income Eligible Coordinated Delivery	24
25	Forced Hot Water Boiler - Gas	B1a - Income Eligible Coordinated Delivery	22

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 Unitil to represent relevant DR program types that Unitil currently offers or could potentially offer to realize summer electric, winter electric, and winter natural gas 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 Unitil) and relevant secondary sources to develop data inputs required for assessing DR potential and cost-effectiveness. These data inputs feed into Guidehouse's DRSim model, customized for the study, which produces DR potential, annual program costs, and cost-effectiveness of DR options at various levels of disaggregation.

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

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

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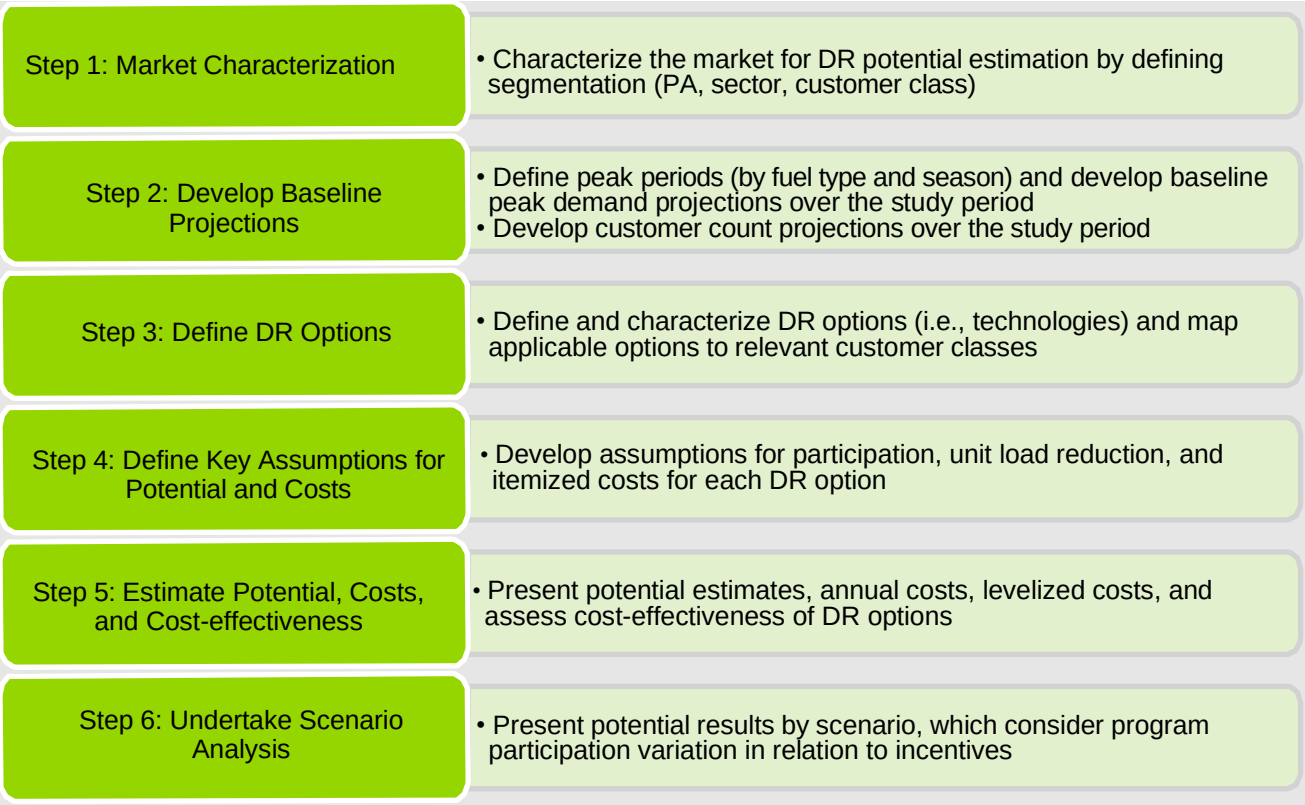
Figure 5-1. DR Potential Assessment Steps



Source: Guidehouse

5.1 DR Market Characterization

Market characterization is the first step in the DR potential assessment process and consists of defining appropriate customer segments and developing customer count and peak demand projections which serve as the baseline for DR potential estimates. Market characterization is performed for each fuel type and season of interest in the study (summer electric, winter electric, and winter natural gas). The market characterization processes utilize data provided directly by Unitil 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

DR 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) • C&I (Natural Gas): – Small & Medium C&I (< 250,000 therms/year consumption) – Large C&I (≥ 250,000 therms/year consumption)

Note: Customer segments are mapped to applicable DR program types in our analysis. 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 Unitil.

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

PA	C&I Electric Customer Class	Rate Classes
Unitil	Small & Medium	GD1, GD2, GD4, GD5
Unitil	Large	GD3

Source: Guidehouse

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For natural gas, to define the customer class cutoff, Guidehouse used the DNV C&I stock database (customer count and square foot data), which groups customers in each rate class into business size categories. Table 5-3 shows how the DNV business size categories are defined and mapped to C&I customer class. The DNV data was used to determine the proportion of sector-level customer count and sales within each rate class to assign to each C&I customer class segment.

Table 5-3. Natural Gas C&I Customer Class Map

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

Source: Guidehouse

5.2 Baseline Projections

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

- Customer Count Projections
  - Fuel Type (Electric, Natural Gas)
  - Customer Segment (Sector, Customer Class)
- Peak Demand Projections
  - Fuel Type (Electric, Natural Gas)
  - Season (Summer Electric, Winter Electric, Winter Natural Gas)
  - 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, shown in Figure 5-2 for electricity and in Figure 5-3 for natural gas. For the Residential sector, Guidehouse utilized projected count from Unitil and forecasted out for years with missing data using prior year growth rates. The Residential customer counts are aligned between EE and DR analysis. For the C&I sector, Guidehouse developed DR-specific count projections at the customer class level, which differs from the building type segmentation used for EE, given limited available data that would allow for segmentation at the combined customer class and building type level. Guidehouse directly used the number of existing and forecasted accounts from Unitil data.[52]

[52] Note that for gas, Unitil has only 25 large gas C&I customers where FG&E charges for their demand.

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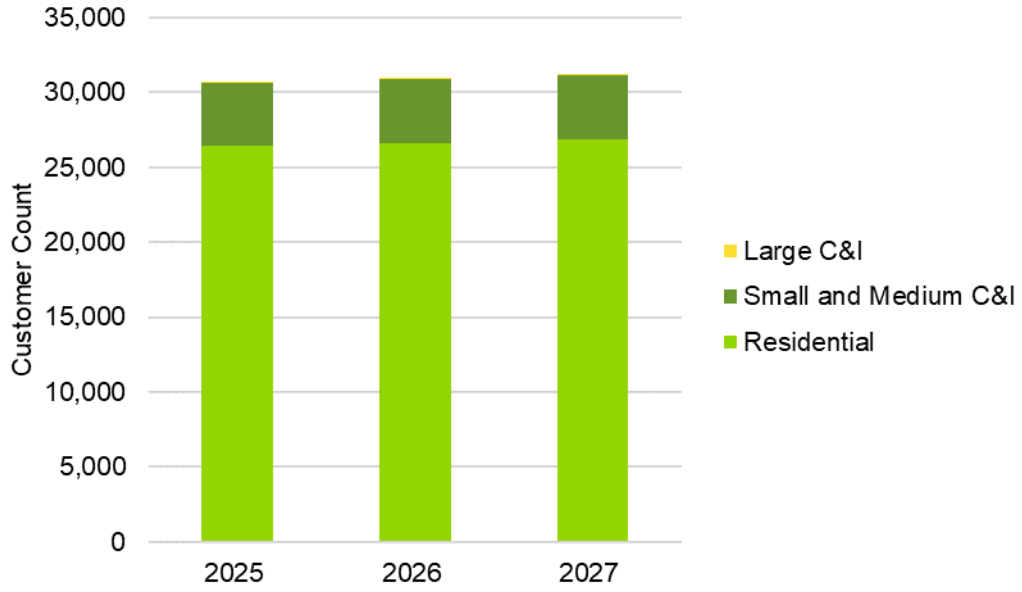
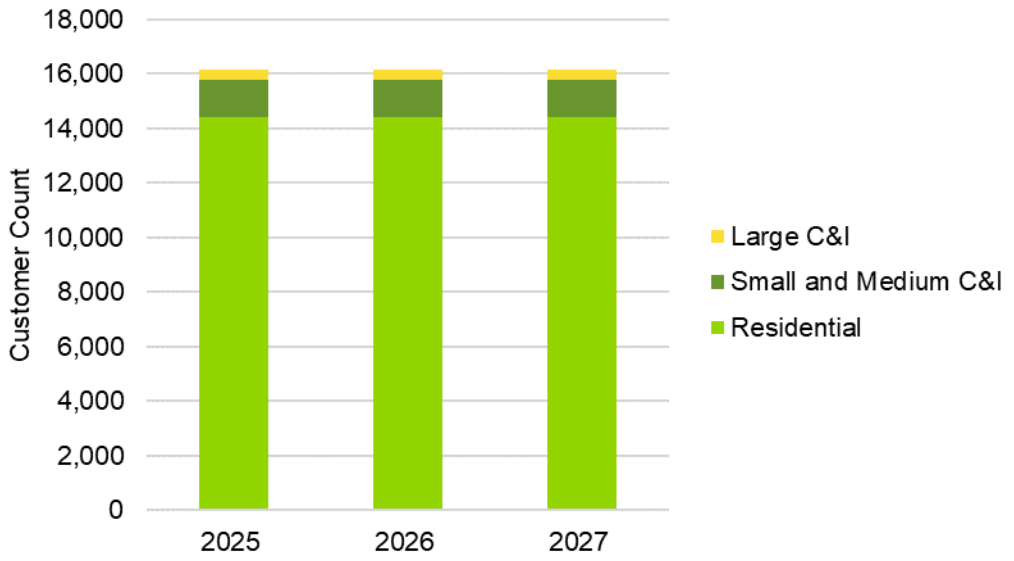
Figure 5-2. Electric Customer Count Forecast by Customer Class



Source: Guidehouse

Figure 5-3. Natural Gas 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 as the foundation for the DR potential estimates by defining the peak demand upon which DR measures can act to reduce load.

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5.2.2.1 Electric Peak Demand Projections (Summer and Winter)

Table 5-4 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 5-4 outlines the approach followed to develop baseline peak demand projections.

Table 5-4. 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 data provided by as well as publicly available data to obtain average hourly load profiles by rate class. 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 Unitil Peak Data
• Guidehouse compared bottom-up coincident peak demand estimate with Unitil-provided data. Since Unitil-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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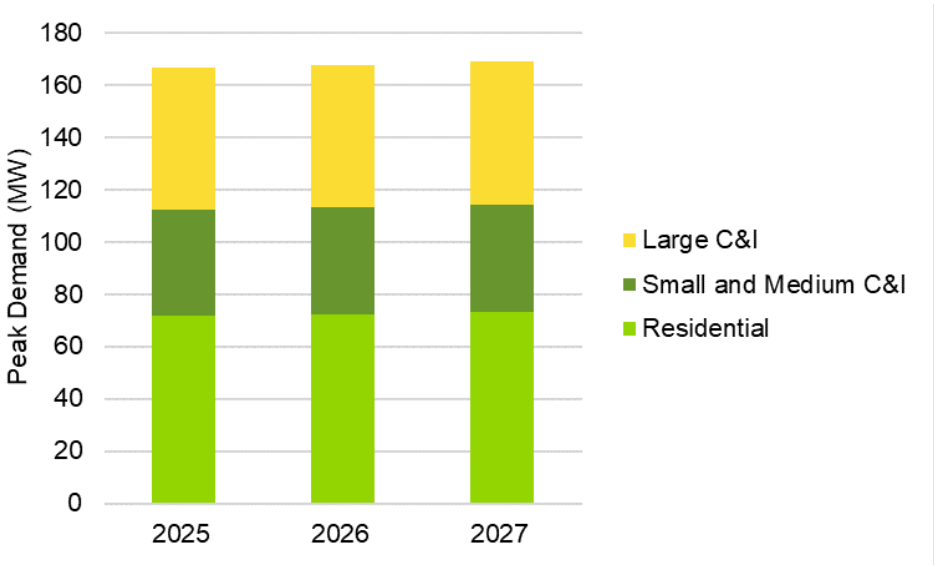
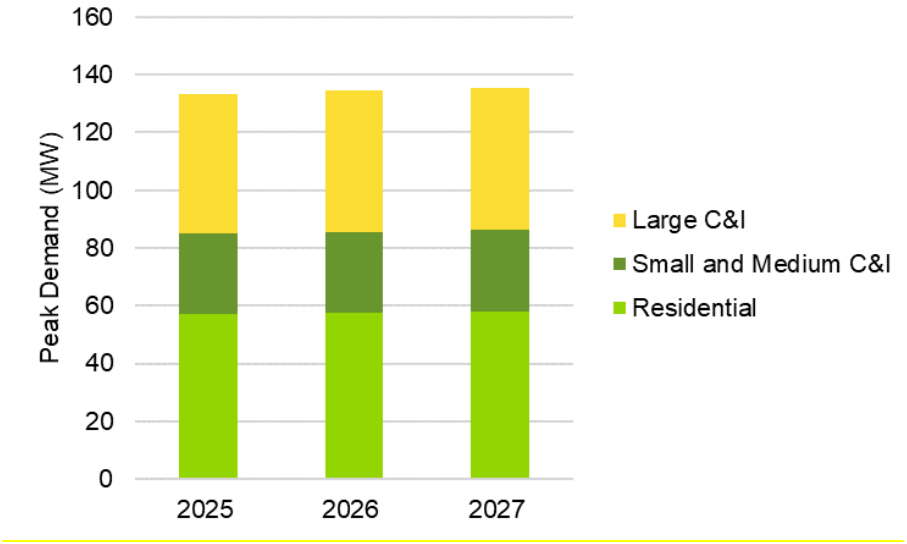
Figure **5-4** and Figure **5-5** show the estimated summer and winter electric peak demand, respectively, over the forecast period, broken by customer segment. The summer and winter electric baseline peak forecasts remain relatively flat over the 3-year period, increasing slightly each year and within each customer segment, with the summer peak higher than the winter peak. The Residential segment contributes the largest portion of the baseline peak forecast, followed by the Large C&I segment,[53] and then the Small and Medium C&I segment.

Figure 5-4. Summer Electric Baseline Peak Forecast by Customer Segment



Source: Guidehouse

Figure 5-5. Winter Electric Baseline Peak Forecast by Customer Segment



Source: Guidehouse

[53] The large C&I segment load is constituted from a small number of customers; therefore, the demand per customer is high.

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5.2.2.2 Natural Gas Peak Demand Projections (Winter Only)

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

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

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

Figure 5-6 shows the estimated winter natural gas peak demand over the forecast period, broken out by customer class. The winter natural gas baseline peak forecast increases during the 3-year period, with the 2027 forecast higher than in the prior two years. The Large C&I segment contributes the bulk of the baseline peak forecast, followed by the Small and Medium C&I segment, with the Residential segment providing the smallest portion.

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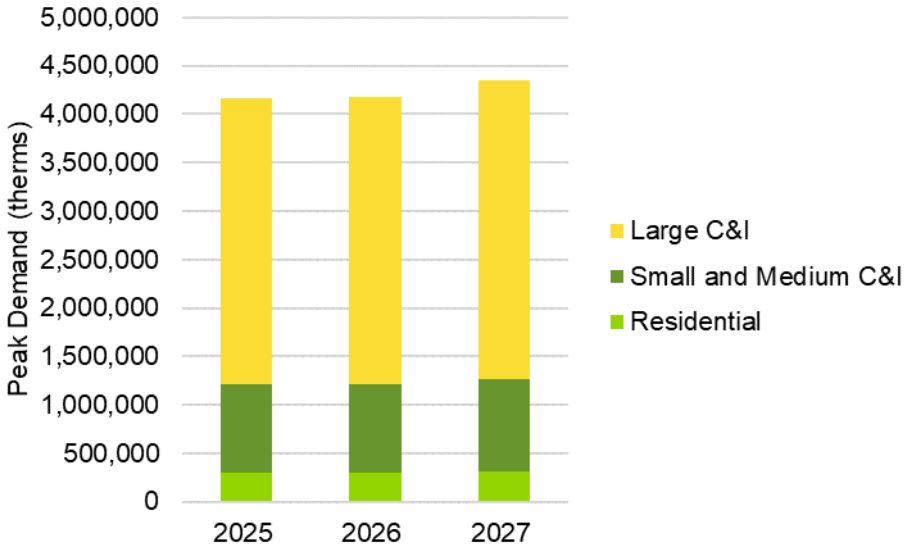
Figure 5-6. Winter Natural Gas Baseline Peak Forecast by Customer Segment



Source: Guidehouse

5.3 Characterization of DR Options

After completion of the market characterization, the next key step in the DR potential assessment was to characterize the different types of DR options that could be utilized to curtail peak demand.

Table 5-6 summarizes the broad electric DR options included in the analysis. Table 5-7 gives the full list of more granular electric DR suboptions within each DR option. The suboptions represent specific end uses and control technologies. The DR options considered are representative of what Unitil currently offers and other commonly deployed programs and emerging DR-enabling technologies in the industry.

Only existing program offers (that Unitil currently offers) were considered in BAE. New DR options that Unitil could potentially offer were only considered under the MAX scenario.

The DLC-Electric option applies to Residential and Small and Medium C&I customers. The end-uses and DR enabling technologies under DLC include Unitil'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. Only Residential smart thermostat space cooling control was considered for the BAE scenario and all other DLC suboptions were considered only under the MAX scenario. Also, Behavioral DR for Residential was only considered in the MAX scenario.

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, including load shifting to backup generators. This option applies to large C&I customers. Unitil currently has preferred Curtailment Service Providers (CSPs) to scope and plan demand reduction strategies from these customers. The projected demand reductions

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under C&I Curtailment represent what is currently available through existing customer recruitment in Unitil's current Interruptible Load offer along with the additional capacity that could be potentially available over the 2025-2027 timeframe considered in this study.

Table 5-6. Summary of Electric DR Options

DR Option Electric	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)	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
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 Unitil's Interruptible Load offer.

Source: Guidehouse

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Table 5-7. Summary of Electric DR Suboptions

DR Option	Electric 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)	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
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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Table 5-8 and Table 5-9 summarize all of the DR options and suboptions analyzed for the winter natural gas potential assessment. The overall options (DLC, C&I Curtailment, and Behavioral DR) are analogous to those for electricity, but the suboptions are more limited and represent end use and enabling technology combinations that are most relevant for reducing winter natural gas peaks.

Table 5-8. Summary of Natural Gas DR Options

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

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

Table 5-9. Summary of Natural Gas DR Suboptions

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

Source: Guidehouse

5.4 Key DR Potential and Cost-Effectiveness Assessment

The final step in Guidehouse's assumptions development process was to estimate programmatic inputs such as participation rates, unit load reductions and costs for the DR options. These assumptions were based on Guidehouse team's experience with similar DR potential studies and program performance data/information from DR programs in other jurisdictions. Table 5-10 summarizes the key DR potential and cost estimation variables considered in this study.

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Table 5-10. Key Variables for DR Potential and Cost Estimates

DR 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 or therm 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	• 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, Inflation Rate, Line Losses, Avoided Costs

Source: Guidehouse

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

Equation 5-1. DR Achievable Potential

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

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. Development of DR program annual and levelized costs involve itemization of the various cost components, such as one-time program development costs, DR-enablement costs, equipment costs, participant marketing and recruitment costs, annual program administration costs, O&M costs, and customer incentives.

5.4.1 Key Assumptions for DR Potential and Cost-Effectiveness Assessment

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

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5.4.1.1 Participation and Unit Impacts

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

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

5.4.1.2 Program Costs and Related Assumptions for Cost-Effectiveness

For existing DR suboptions (those that Unitil currently offers), Guidehouse calculated program costs using assumptions derived from Unitil'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 Unitil 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 and winter natural gas for each DR suboption and is based on the Total Resource Cost (TRC) test. Table 5-11 summarizes the benefits and costs considered in the cost-effectiveness assessment of DR options. Guidehouse followed the methodology used in Unitil's 2022-2024 BCR models, in which the only cost component included in the cost portion of the benefit-cost ratio is incentive costs. Avoided costs were obtained from AESC 2024.

Table 5-11. Summary of Benefit-Cost Streams for TRC Cost-Effectiveness

Electric Benefits	Natural Gas Benefits	Costs
Avoided Retail Uncleared Capacity Costs	Avoided 10-day Peak Period Costs	Incentives
Avoided Transmission Capacity Costs		
Avoided Distribution Capacity Costs		
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. Winter electric potential is shown for MAX and not for BAE as the BAE only represents Unitil's current DR programs, which apply to summer.

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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.
- **Electrification:** MAX scenario assumed a greater adoption of heating system electrification that can be controlled by DR.
- **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.

The MAX scenario considered new DR options and suboptions that Unitil could potentially offer while the BAE scenario only considered existing program offers. The MAX scenario assessed cost-effectiveness of the new DR options and suboptions and included achievable potential estimates from these in the reported results under the MAX scenario if these were cost-effective. However, given Unitil's relatively small market size, it may be challenging to incorporate these new measures in a program. Unitil may incur high fixed setup costs for offering these measures in a program and may also face challenges in finding an interested vendor to work with, given small market size of eligible customers.

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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:[54]

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

6.1 DR Cost-Effectiveness Assessment Results

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

6.1.1 BAE Scenario Cost-Effectiveness Results

Table 6-1 shows electric TRC benefit-cost ratios for the BAE scenario by DR Options and DR Suboptions, with both electric DR suboptions cost-effective each year over the 3-year period. 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. All suboptions included in the BAE scenario for Unitil are currently existing programs and are cost-effective.

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

DR Option	Electric DR Suboption	TRC Ratio (BAE Scenario)		
		2025	2026	2027
Res DLC - Electric	Res BYOT-Smart Thermostat-Space Cooling Control	11.10	11.97	12.01
C&I Targeted Dispatch - Electric	C&I Targeted Dispatch	9.26	9.65	9.68

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

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

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Table 6-2 shows natural gas TRC benefit-cost ratios for the BAE scenario by customer class and DR suboption, with none of the natural gas DR suboptions cost-effective in any year over the 3-year period. 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. There are no cost-effective natural gas DR suboptions due to low avoided cost values. The options that are closest to cost-effectiveness are in the C&I sector.

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

DR Option	Natural Gas DR Suboption	TRC Ratio (BAE Scenario)		
		2025	2026	2027
DLC – Gas	Res BYOD-Water Heaters-Gas	0.002	0.002	0.003
	Res BYOT-Smart Thermostat-Gas Space Heating Control	0.02	0.02	0.03
	Res Switch-Water Heating Control-Gas Water Heating	0.002	0.002	0.003
	C&I DLC-Gas Water Heating Control	0.03	0.04	0.05
	C&I DLC-Smart Thermostat-Gas Space Heating Control	0.03	0.03	0.04
C&I Curtailment – Gas	C&I Curtailment-Heating (Gas)	0.7	0.6	0.6
	C&I Curtailment-Process (Gas)	0.7	0.6	0.6

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

6.1.2 Comparison of Cost-Effectiveness Results by Scenario

In addition to the BAE scenario, Guidehouse modeled potential results under the MAX scenario in which assumed participation levels and incentive amounts were increased to determine the impacts on the DR Achievable potential. Table 6-3 shows electric TRC benefit-cost ratios for the MAX scenario with additional suboptions not considered in the BAE scenario. 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. All benefit-cost ratios in the MAX scenario are lower than those in BAE. Most DR suboptions reach cost-effectiveness in 2027 with the exception of Res BYOD-Clothes Dryer and Res BYOD-Clothes Washer.

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Table 6-3. Electric DR Suboptions MAX Scenario Benefit-Cost Ratios (2025-2027)

DR Option	DR Suboption	TRC Ratio (MAX Scenario)		
		2025	2026	2027
DLC - Electric	Res BYOD-Clothes Dryer	0.59	0.86	0.98
	Res BYOD-Clothes Washer	0.08	0.12	0.14
	Res BYOD-Dehumidifier	1.23	1.72	2.05
	Res BYOD-Pool Pump	3.86	5.40	6.42
	Res BYOD-Room AC	2.22	3.09	3.65
	Res BYOD-Water Heaters-Electric Resistance	1.29	1.82	2.15
	Res BYOD-Water Heaters-HPWH	0.61	0.86	1.02
	Res BYOT-Smart Thermostat-Space Cooling Control	7.51	8.10	8.13
	Res Switch-Pool Pump	3.86	5.82	6.66
	Res Switch-Water Heating Control-Electric Resistance	1.36	2.05	2.35
	Res Switch-Water Heating Control-HPWH	0.61	0.92	1.06
	C&I DLC-Electric Water Heating Control	1.29	1.93	2.22
	C&I DLC-Smart Thermostat HVAC Control	3.31	5.53	6.81
C&I Targeted Dispatch - Electric	C&I Targeted Dispatch	6.17	6.43	6.45

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

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Table 6-4 shows natural gas TRC benefit-cost ratios for the MAX scenario. Like the BAE scenario, none of the natural gas DR suboptions cost-effective in any year over the 3-year period. Like the BAE scenario, none of the natural gas suboptions are cost-effective in any year over the 3-year period.

Table 6-4. Natural Gas DR Suboptions MAX Scenario Benefit-Cost Ratios (2025-2027)

DR Option		Natural Gas DR Suboption	TRC Ratio (MAX Scenario)		
			2025	2026	2027
DLC – Gas	Res BYOD-Water Heaters-Gas	0.001	0.002	0.002	
	Res BYOT-Smart Thermostat-Gas Space Heating Control	0.01	0.02	0.02	
	Res Switch-Water Heating Control-Gas Water Heating	0.001	0.002	0.002	
	C&I DLC-Gas Water Heating Control	0.02	0.03	0.04	
	C&I DLC-Smart Thermostat-Gas Space Heating Control	0.02	0.03	0.03	
C&I Curtailment – Gas	C&I Curtailment-Heating (Gas)	0.4	0.4	0.4	
	C&I Curtailment-Process (Gas)	0.4	0.4	0.4	

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

Source: Guidehouse

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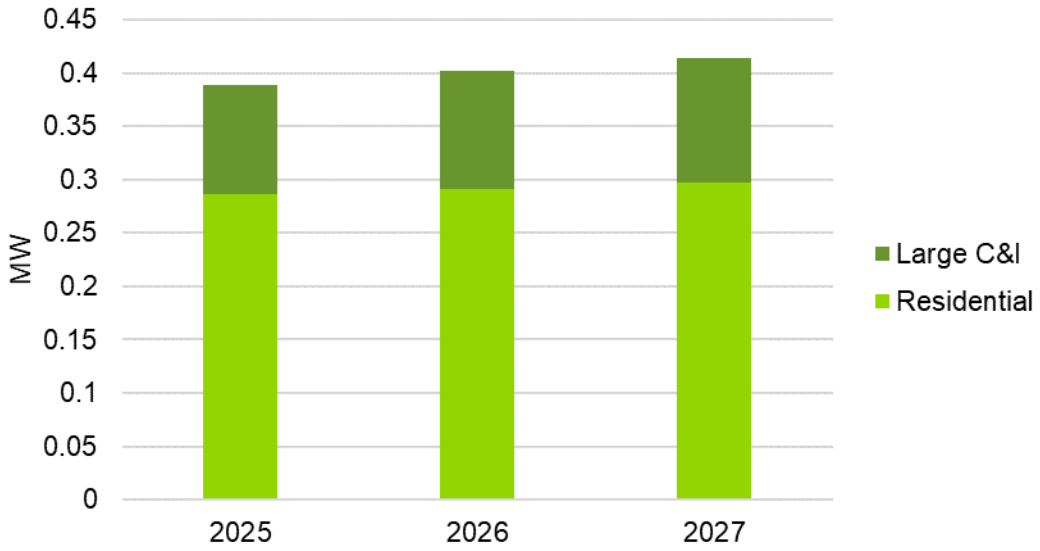
6.2 Demand Response BAE Scenario Achievable Potential Results

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.[55] No options were considered for the Small and Medium C&I segment. For more details and levels of aggregation of achievable potential, see Appendix D.

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



Source: Guidehouse

[55] The achievable potential from large C&I customers through the targeted dispatch option is limited given market size and customer composition. Unitil has about 30 C&I customers whose annual usage > 1 million kWh most of whom have been approached and are not interested or able to participate in the DR program offer.

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6.2.1 BAE Scenario Achievable Potential Results by DR Option

Table 6-5 shows the summer 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. The total summer electric DR savings increase slightly over the 3-year period for the BAE scenario, with the Res DLC-Electric option providing most of the savings, with the rest from the C&I Targeted Dispatch-Electric option. Since BAE represents Unitil's current DR programs, which are for summer only, the BAE case does not include any winter electric DR potential.

Table 6-5. Summer Electric DR BAE Scenario Achievable Potential by Option

DR Option Summer Electric	2025 (MW) BAE Scenario	2026 (MW) BAE Scenario	2027 (MW) BAE Scenario
Res DLC-Electric	0.29	0.29	0.30
Subtotal Residential	**0.29**	**0.29**	**0.30**
C&I Targeted Dispatch-Electric	0.10	0.11	0.12
Subtotal C&I	**0.10**	**0.11**	**0.12**
Total	**0.39**	**0.40**	**0.41**

Source: Guidehouse
Note: Totals may not sum due to rounding.

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

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

DR Option Winter Natural Gas	2025 (therms) BAE Scenario	2026 (therms) BAE Scenario	2027 (therms) BAE Scenario
Res DLC-Gas	180	370	560
Behavioral DR-Gas	60	110	190
Subtotal Residential	**240**	**480**	**750**
C&I DLC-Gas	30	60	90
C&I Curtailment-Gas	2,150	4,320	7,310
Subtotal C&I	**2,180**	**4,380**	**7,400**
Total	**2,420**	**4,850**	**8,150**

Source: Guidehouse
Note: Totals may not sum due to rounding.

6.3 Annual Program Costs

This section presents the annual program cost estimates of the DR Portfolio by sector and DR option for the BAE scenario. Analogous results for the MAX scenario are provided in Appendix D: Demand Response Results (Excel Spreadsheet Viewer). The results in this section represent the total annual costs. Unitil 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 new program offers, the non-incentive costs include program start up and

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implementation costs whereas for existing programs the non-incentive costs are the continuing implementation costs.

Table 6-7 presents the annual program costs for the summer electricity DR BAE scenario. Non-incentives costs comprise most of the total costs annually, with most of these for the Residential sector. Unlike the Residential sector, C&I sector costs are relatively closely apportioned between incentives and non-incentives.

Table 6-7. Summer Electric DR BAE Scenario Portfolio Costs by Sector and Cost Category

DR Sector Summer Electric	Cost Category	2025 ($) BAE Scenario	2026 ($) BAE Scenario	2027 ($) BAE Scenario
Residential	Incentives	$9,400	$9,500	$9,700
Residential	Non-Incentives	$37,400	$38,200	$39,000
Subtotal Residential		**$46,800**	**$47,700**	**$48,700**
C&I	Incentives	$3,800	$4,100	$4,400
C&I	Non-Incentives	$4,700	$5,000	$5,400
Subtotal C&I		**$8,500**	**$9,100**	**$9,700**
Subtotal Incentives		$13,200	$13,700	$14,100
Subtotal Non-Incentives		$42,100	$43,200	$44,300
Total		**$55,300**	**$56,800**	**$58,500**

Source: Guidehouse
Note: Totals may not sum due to rounding.

Table 6-8 shows the breakdown of incentive costs among the summer electric BAE scenario DR options. Res DLC-Electric costs comprise most of the annual costs.

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

DR Option Summer Electric	2025 ($) BAE Scenario	2026 ($) BAE Scenario	2027 ($) BAE Scenario
Res DLC-Electric	$9,400	$9,500	$9,700
Subtotal Residential	**$9,400**	**$9,500**	**$9,700**
C&I Targeted Dispatch-Electric	$3,800	$4,100	$4,400
Subtotal C&I	**$3,800**	**$4,100**	**$4,400**
Total	**$13,200**	**$13,700**	**$14,100**

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

Table 6-9 presents the annual program costs for the winter natural gas demand response BAE scenario. Benefits would have to exceed these costs in order for programs to be cost-effective. The Residential sector comprises almost all of the costs annually, with most of these for incentive costs. Unlike the Residential sector, C&I sector costs are relatively closely apportioned between incentives and non-incentives.

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Table 6-9. Winter Natural Gas DR BAE Scenario Portfolio Costs by Sector and Cost Category

Sector Winter Natural Gas	Cost Category	2025 ($) BAE Scenario	2026 ($) BAE Scenario	2027 ($) BAE Scenario
Residential	Incentives	$336,000	$434,000	$548,000
Residential	Non-Incentives	$78,000	$107,000	$135,000
Subtotal Residential		**$415,000**	**$541,000**	**$683,000**
C&I	Incentives	$18,000	$33,000	$54,000
C&I	Non-Incentives	$15,000	$27,000	$44,000
Subtotal C&I		**$32,000**	**$61,000**	**$99,000**
Subtotal Incentives		$354,000	$467,000	$603,000
Subtotal Non-Incentives		$93,000	$134,000	$179,000
Total		**$447,000**	**$601,000**	**$782,000**

Source: Guidehouse
Note: Totals may not sum due to rounding.

While none of the DR options and suboptions are cost-effective using the 10-day peak natural gas values from AESC 2024,

Table **6-10** shows the breakdown of incentive costs among the winter natural gas demand response BAE scenario.

Table 6-10. Winter Natural Gas DR BAE Scenario Incentive Costs by Option

DR Option Winter Natural Gas	2025 ($) BAE Scenario	2026 ($) BAE Scenario	2027 ($) BAE Scenario
Res DLC-Gas	$78,000	$107,000	$135,000
Subtotal Residential	**$78,000**	**$107,000**	**$135,000**
C&I DLC-Gas	$3,500	$5,200	$6,800
C&I Curtailment-Gas	$11,000	$22,000	$38,000
Subtotal C&I	**$15,000**	**$27,000**	**$44,000**
Total	**$93,000**	**$134,000**	**$179,000**

Note: The Residential Behavioral DR-Gas option is not listed here because incentives are 0.
Source: Guidehouse
Note: Totals may not sum due to rounding.

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6.4 Levelized Costs and Supply Curves

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.

Table 6-11 shows the levelized costs for all electric DR suboptions under the BAE scenario.

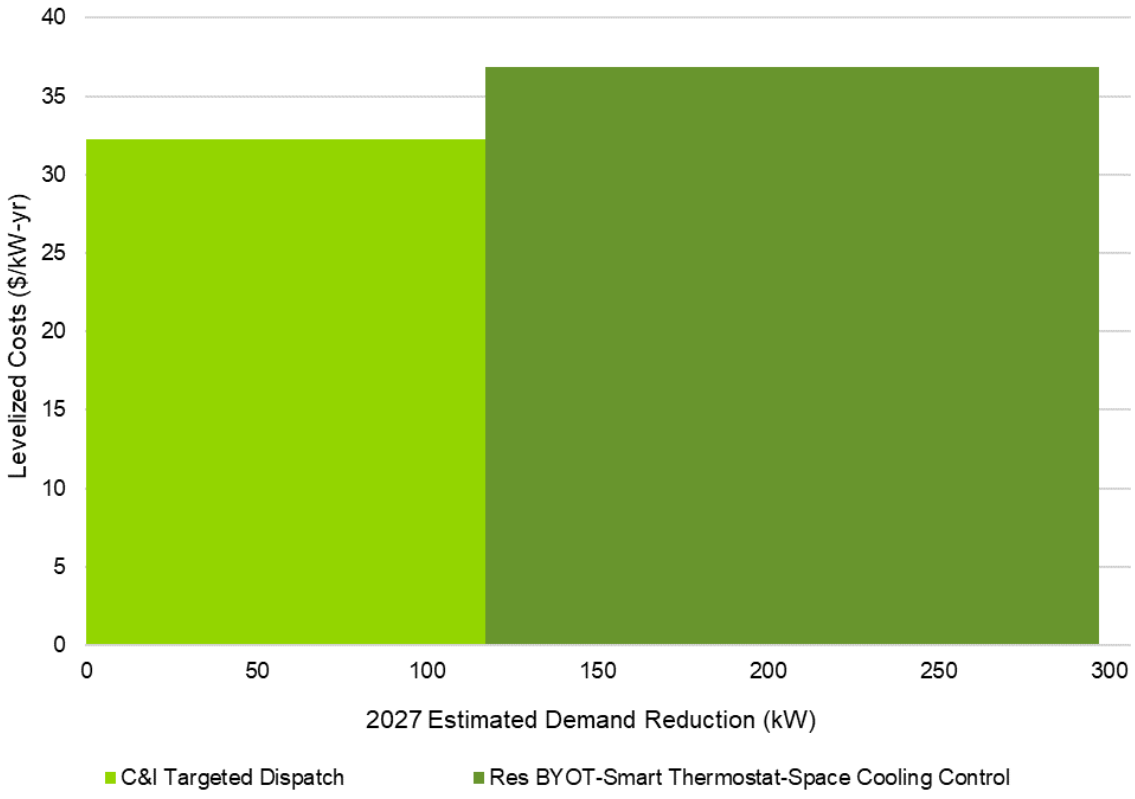
Table 6-11. Electric DR BAE Scenario Levelized Costs ($/kW-yr.) for All Suboptions

DR Option Electric	DR Sub-Option BAE Scenario	Levelized Cost, 2025-2027 ($/kW-yr.)
Res DLC - Electric	Res BYOT-Smart Thermostat-Space Cooling Control	32.27
C&I Targeted Dispatch - Electric	C&I Targeted Dispatch	36.89

Source: Guidehouse

Figure 6-2 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 cost associated with realizing the potential over 2025-2027.

Figure 6-2. Summer Electric Supply Curve for All DR Suboptions (BAE Scenario)



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

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6.5 Demand Response MAX Scenario Achievable Potential Results

Table 6-12 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 most of the annual savings, with the rest mostly from the C&I Targeted Dispatch-Electric option.

Table 6-12. Summer Electric DR MAX Scenario Achievable Potential by Option

DR Option Summer Electric	2025 (MW) MAX Scenario	2026 (MW) MAX Scenario	2027 (MW) MAX Scenario
Res DLC-Electric	0.41	0.53	0.65
Subtotal Residential	**0.41**	**0.53**	**0.65**
C&I DLC-Electric	0.003	0.006	0.009
C&I Targeted Dispatch-Electric	0.11	0.12	0.13
Subtotal C&I	**0.12**	**0.13**	**0.14**
Total	**0.53**	**0.66**	**0.79**

Source: Guidehouse
Note: Totals may not sum due to rounding.

The increase in winter DLC potential in MAX is associated with high amounts of electrification of space heating and water heating that can potentially be controlled and serve as a DR resource.

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Table 6-13 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 DLC-Electric and C&I Targeted Dispatch-Electric options providing most of the savings, with the former tripling over the 3-year period, while the latter remains largely unchanged. The increase in winter DLC potential in MAX is associated with high amounts of electrification of space heating and water heating that can potentially be controlled and serve as a DR resource.

Table 6-13. Winter Electric DR MAX Scenario Achievable Potential by Option

DR Option Winter Electric	2025 (MW) MAX Scenario	2026 (MW) MAX Scenario	2027 (MW) MAX Scenario
Res DLC-Electric	0.06	0.13	0.20
Subtotal Residential	**0.06**	**0.13**	**0.20**
C&I DLC-Electric	0.004	0.009	0.013
C&I Targeted Dispatch-Electric	0.10	0.10	0.11
Subtotal C&I	**0.10**	**0.11**	**0.12**
Total	**0.16**	**0.24**	**0.32**

Source: Guidehouse
Note: Totals may not sum due to rounding.

Table 6-14 shows the winter natural gas DR potential by DR option for the MAX scenario. None of the DR options and suboptions are cost-effective using the 10-day peak natural gas values from AESC 2024. However, the table shows where the greatest amount of DR savings could be realized if benefits exceeded costs.

Table 6-14. Winter Natural Gas DR MAX Scenario Potential by Option

DR Option Winter Natural Gas	2025 (therms) MAX Scenario	2026 (therms) MAX Scenario	2027 (therms) MAX Scenario
Res DLC-Gas	200	400	620
Behavioral DR-Gas	60	110	180
Subtotal Residential	**260**	**510**	**800**
DLC-Gas	30	70	100
C&I Curtailment-Gas	2,400	4,700	8,000
Subtotal C&I	**2,400**	**4,800**	**8,100**
Total	**2,700**	**5,300**	**8,900**

Source: Guidehouse
Note: Totals may not sum due to rounding.

Table 6-15 presents the annual program costs for the summer electric MAX scenario DR options. Non-incentives costs comprise most of the total costs annually, with most of these for the Residential sector. Unlike the Residential sector, C&I sector costs are relatively closely apportioned between incentives and non-incentives.

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Table 6-15. Summer Electric DR MAX Scenario Portfolio Costs by Sector and Cost Category

Sector Summer Electric	Cost Category	2025 ($) MAX Scenario	2026 ($) MAX Scenario	2027 ($) MAX Scenario
Residential	Incentives	$32,300	$42,600	$52,900
Residential	Non-Incentives	$131,400	$138,000	$151,700
Subtotal Residential		**$163,700**	**$180,600**	**$204,600**
C&I	Incentives	$6,800	$7,400	$8,000
C&I	Non-Incentives	$9,300	$10,100	$11,000
Subtotal C&I		**$16,100**	**$17,500**	**$19,000**
Subtotal Incentives		$39,100	$50,000	$60,900
Subtotal Non-Incentives		$140,700	$148,100	$162,700
Total		**$179,800**	**$198,100**	**$223,600**

Source: Guidehouse
Note: Totals may not sum due to rounding.

Table 6-16 presents the annual program costs for the winter electricity demand response MAX scenario. The Residential sector comprises a majority of the costs, with non-incentives most of the sector costs. The winter costs are less than half of the summer costs.

Table 6-16. Winter Electric DR MAX Scenario Portfolio Costs by Sector and Cost Category

Sector Winter Electric	Cost Category	2025 ($) MAX Scenario	2026 ($) MAX Scenario	2027 ($) MAX Scenario
Residential	Incentives	$4,700	$9,800	$15,600
Residential	Non-Incentives	$49,200	$49,700	$55,900
Subtotal Residential		**$53,900**	**$59,500**	**$71,500**
C&I	Incentives	$4,000	$4,400	$4,900
C&I	Non-Incentives	$6,300	$6,900	$7,500
Subtotal C&I		**$10,300**	**$11,300**	**$12,400**
Subtotal Incentives		$8,700	$14,300	$20,500
Subtotal Non-Incentives		$55,500	$56,600	$63,400
Total		**$64,200**	**$70,900**	**$83,800**

Source: Guidehouse
Note: Totals may not sum due to rounding.

Table 6-17 shows the breakdown of incentive costs among the summer electric MAX scenario DR options. Res DLC-Electric costs comprise most of the annual costs, with the remainder mostly from the C&I Targeted Dispatch-Electric option.

Table 6-17. Summer Electric DR MAX Scenario Incentive Costs by Option

DR Option Summer Electric	2025 ($) MAX Scenario	2026 ($) MAX Scenario	2027 ($) MAX Scenario

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Res DLC-Electric	$32,300	$42,600	$52,700
Subtotal Residential	**$32,300**	**$42,600**	**$52,700**
C&I DLC-Electric	$500	$600	$800
C&I Targeted Dispatch-Electric	$6,300	$6,800	$7,200
Subtotal C&I	**$6,800**	**$7,400**	**$8,000**
Total	**$39,100**	**$50,000**	**$60,700**

Note: The Residential Behavioral DR-Electric option is not listed here because incentives are 0.
Source: Guidehouse
Note: Totals may not sum due to rounding.

Table 6-18 shows the incentive costs for the winter electricity demand response MAX scenario. The Residential DC-Electric option comprises a little over half of annual incentive costs, tripling over the 3-year period, with the remainder mostly from the C&I Targeted Dispatch-Electric DR option.

Table 6-18. Winter Electric DR MAX Scenario Incentive Costs by Option

DR Option Winter Electric	2025 ($) MAX Scenario	2026 ($) MAX Scenario	2027 ($) MAX Scenario
Res DLC-Electric	$4,700	$9,800	$15,500
Subtotal Residential	**$4,700**	**$9,800**	**$15,500**
C&I DLC-Electric	$200	$300	$500
C&I Targeted Dispatch-Electric	$3,900	$4,100	$4,400
Subtotal C&I	**$4,000**	**$4,400**	**$4,900**
Total	**$8,700**	**$14,300**	**$20,400**

Note: The Residential Behavioral DR-Electric option is not listed here because incentives are 0.
Source: Guidehouse
Note: Totals may not sum due to rounding.

Table 6-19 presents the annual program costs for the winter natural gas demand response MAX scenario. Benefits would have to exceed these costs in order for programs to be cost-effective.

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Table 6-19. Winter Natural Gas DR MAX Scenario Portfolio Costs by Sector and Cost Category

DR Sector Winter Natural Gas	Cost Category	2025 ($) MAX Scenario	2026 ($) MAX Scenario	2027 ($) MAX Scenario
Residential	Incentives	$433,000	$605,000	$793,000
Residential	Non-Incentives	$103,000	$150,000	$196,000
Subtotal Residential		**$536,000**	**$755,000**	**$989,000**
C&I	Incentives	$28,000	$54,000	$88,000
C&I	Non-Incentives	$23,000	$44,000	$72,000
Subtotal C&I		**$51,000**	**$98,000**	**$161,000**
Subtotal Incentives		$461,000	$659,000	$882,000
Subtotal Non-Incentives		$126,000	$194,000	$268,000
Total		**$587,000**	**$853,000**	**$1,150,000**

Source: Guidehouse
Note: Totals may not sum due to rounding.

While none of the DR options and suboptions are cost-effective using the 10-day peak natural gas values from AESC 2024,

Table 6-20 shows the breakdown of incentive costs among the winter natural gas demand response MAX scenario.

Table 6-20. Winter Natural Gas DR MAX Scenario Incentive Costs by Option

DR Option Winter Natural Gas	2025 ($) MAX Scenario	2026 ($) MAX Scenario	2027 ($) MAX Scenario
Res DLC-Gas	$103,000	$150,000	$196,000
Subtotal Residential	**$103,000**	**$150,000**	**$196,000**
C&I DLC-Gas	$4,700	$7,400	$10,100
C&I Curtailment-Gas	$18,000	$37,000	$62,000
Subtotal C&I	**$23,000**	**$44,000**	**$72,000**
Total	**$126,000**	**$194,000**	**$268,000**

Note: The Residential Behavioral DR-Gas option is not listed here because incentives are 0.
Source: Guidehouse
Note: Totals may not sum due to rounding.

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7. Conclusions

This study uses the most recently available information on Unitil 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 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 7-1 for electricity and Table 7-2 for natural gas compare BAE annual potential for 2025 as identified in this study to 2022 actual achievements for energy efficiency and 2022 base loads; Table 7-3 compares BAE costs to the 2022-2024 PA costs (excluding customer costs).

Table 7-1. Comparison of BAE Potential to Recent Experience, Unitil Electric

	2025 Potential	2022 Actual	2022 Load
Energy Efficiency (Annual GWh)	2	2.15	395
Energy Efficiency (Annual MMBtu)	30,200	27,149	N/A
Summer Demand (Annual Passive MW)	0.16	0.34	81

Source: Guidehouse and MassSaveData.com

Table 7-2. Comparison of BAE Potential to Recent Experience, Unitil Gas

	2025 Potential	2022 Actual	2022 Consumption
Energy Efficiency (Annual Therms)	150,000	118,477	29,000,000
Energy Efficiency (Annual MMBtu)	14,900	11,259	N/A

Source: Guidehouse and MassSaveData.com

Table 7-3. Comparison of PA Costs for Three Year Period

	2025-2027 BAE	2022-2024 Plan
Electric - Unitil	$21,040,000	$21,805,774
Natural Gas - Unitil	$8,260,000	$7,329,146

Source: Guidehouse and MassSaveData.com

7.1 Energy Efficiency

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

- **Electricity Savings BAE Scenario:** As savings from lighting continues to decline, cost-effective energy efficiency annual potential is led by Home Energy Reports, Custom Large C&I Retrofit and Custom New Construction measures, and on a lifetime basis, led

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by Heat Pumps, Residential Insulation, Custom New Construction and Custom Large C&I Retrofit. There is a sharp drop off of achievable potential within the top ten measures, which could guide Unitil'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.

- **Natural Gas Savings BAE Scenario:** The most significant contributors to savings potential in the Residential and Income Eligible sectors are Insulation and Air Sealing. Programmable and Wi-Fi thermostats add significant savings in Residential as well. For the C&I sector, Custom measures make up the most savings. There is a sharp drop off of achievable potential within the top ten measures, which could guide Unitil's program implementation efforts.

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

- **CECP Scenario Results:** The CECP scenarios demonstrate that the statewide carbon targets for 2030 can be met by accelerated deployment of weatherization and heat pumps by all PAs. The associated price tags for the Unitil are also increased relative to the BAE scenario. The comparison across the scenarios indicates the CECP scenario would cost about four to five times as much as the BAE scenario for both fuels, while the CECP Cost Premium scenario would cost seven times as much as the BAE scenario for electricity and more than nine times as much for natural gas over the 3-year term. Because of the high cost of the CECP Cost Premium scenario, with the inclusion of hard-to-measure costs, the natural gas Residential and Income Eligible sectors are not cost effective, and the natural gas C&I sector is not cost-effective in one year, but is cost-effective over the three year term.

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

- **Achieving Potential:** While this report shows that much energy efficiency 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 Unitil should be aware of the factors as it develops its plans.

    - **Past Program Achievements:** Notably, Unitil 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.

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  - **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 Unitil moves to more aggressive targets.

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

7.2 Demand Response

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

- **Growth in Electricity DR Potential:** Building off Unitil's existing experience with DR, the electricity demand response potential in Unitil's Massachusetts service territory is estimated to grow over 2025-2027. Under BAE, the growth is associated with existing program offers for Residential and C&I customers, while in the MAX scenario the growth is associated with higher levels of participation in existing programs than in BAE plus new program offers.

  - **Large C&I Contribution in Total Potential:** Large C&I customers have the highest share in the total potential. The C&I Targeted Dispatch-Electric option represents the DR potential from these customers and is also the lowest cost option.

  - **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.

- **Gas DR Potential:** Gas DR is not cost-effective due to relatively low gas avoided costs for valuing gas DR based on AESC 2024. The analysis results presented potential for all DR options regardless of cost-effectiveness.

- **Cost-Effectiveness across Scenarios:** The C&I Targeted Dispatch-Electric option, which is the largest contributor, remains cost-effective in the MAX scenario. Similarly, the largest contributor to potential on the electric side, Residential BYOT, remains cost-effective. Many electric direct load control measures become cost-effective in the MAX scenario. No natural gas demand response suboptions are cost-effective for the BAE or MAX scenarios.

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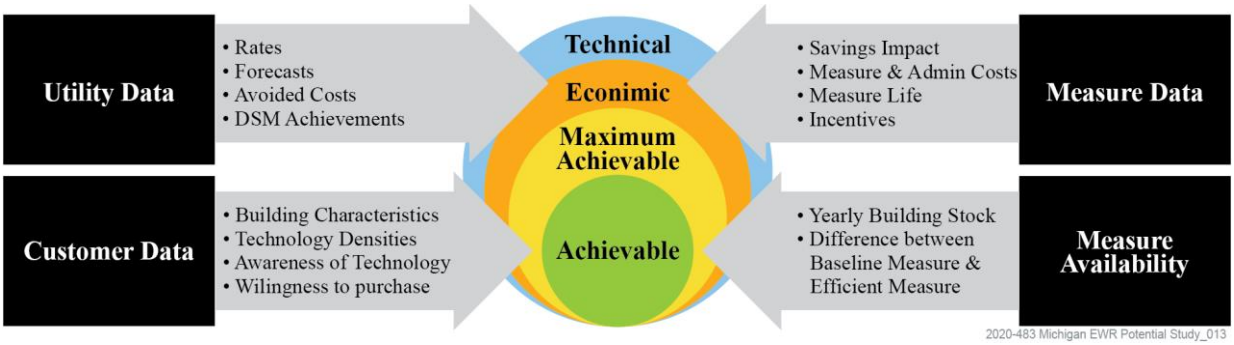
Guidehouse develops EE potential estimates starting with technical potential, followed by economic, and then finally achievable potential scenarios. Figure A-1 illustrates the key inputs and the layers of the potential modeling approach.

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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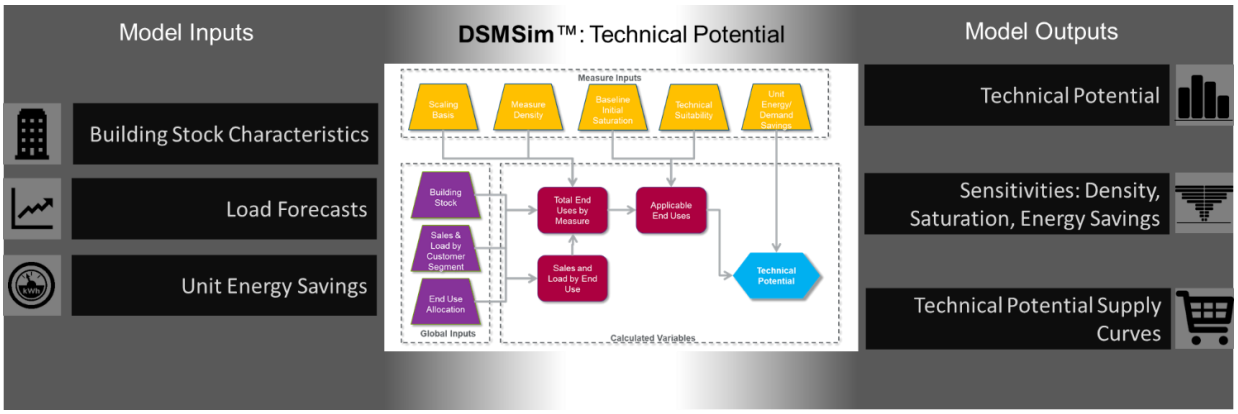
- The total (baseline plus efficient) maximum densities of competing efficient technologies are the same
- Installation of competing technologies is mutually exclusive (i.e., installing one precludes installation of the others for that application)
- Competing technologies share the same replacement 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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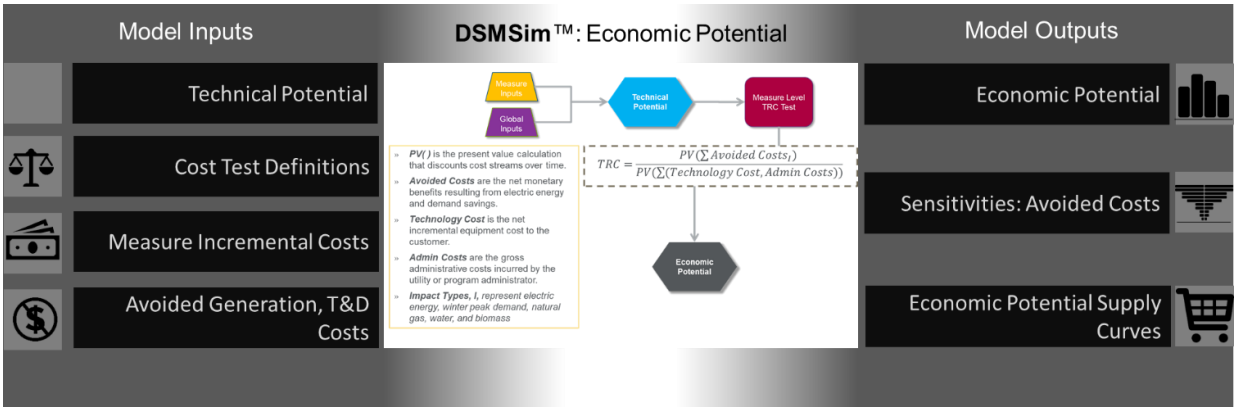
DSMSim™ can calculate the five standard tests,[2] and use any of these tests for economic screening. It can also allow the economic potential threshold value to be adjusted (set at 1.0, or higher or lower). As with technical potential, Guidehouse recognizes codes and standards, replacement types, and 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

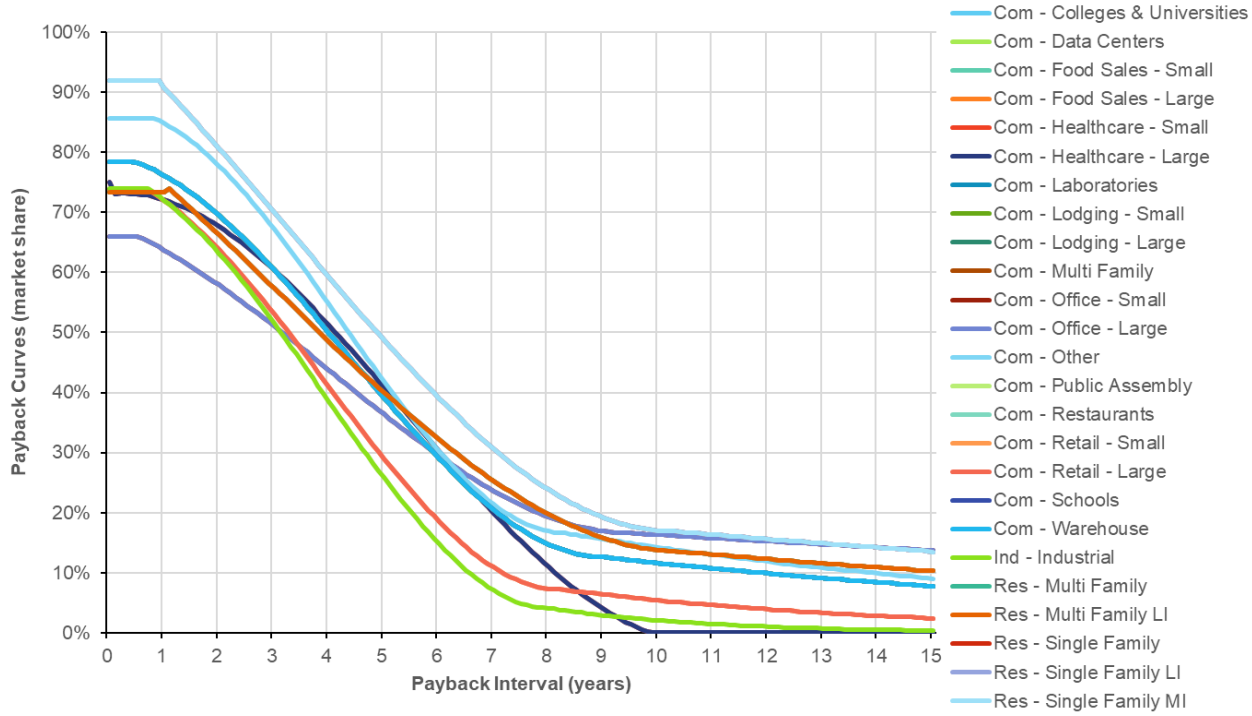
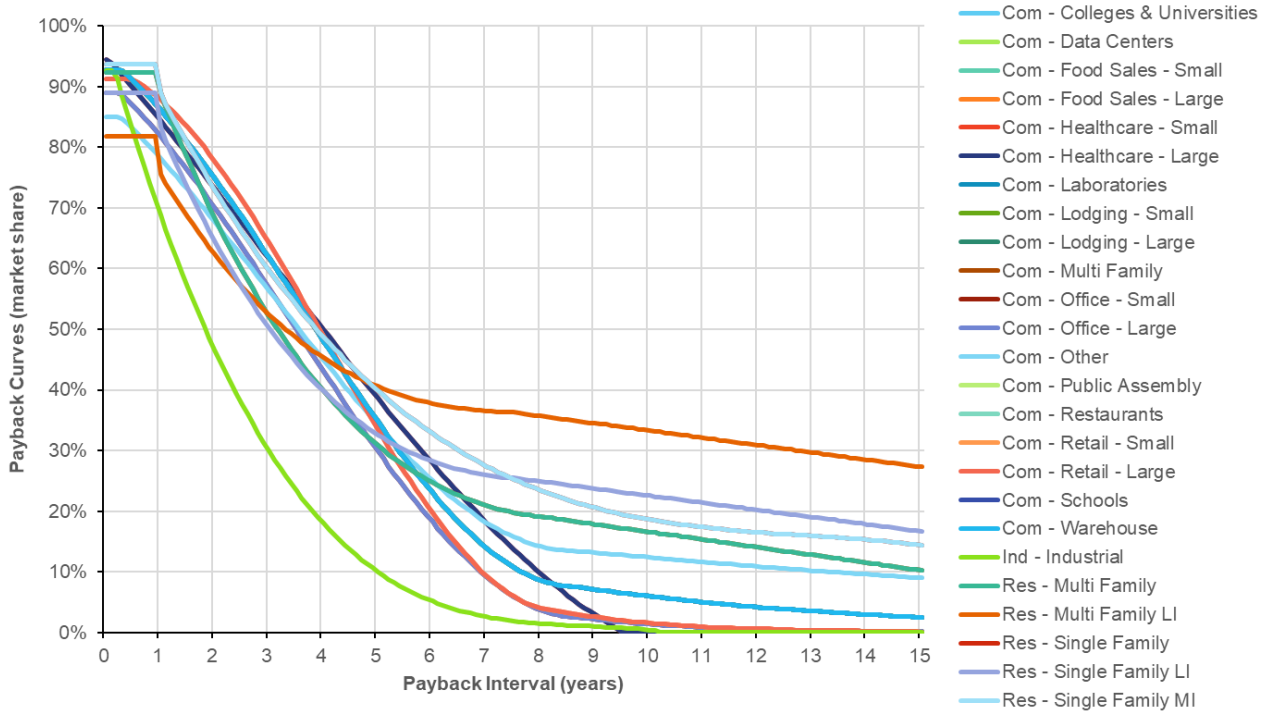


Figure A-5. Payback Acceptance Curves for Low-Cost Measures



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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.

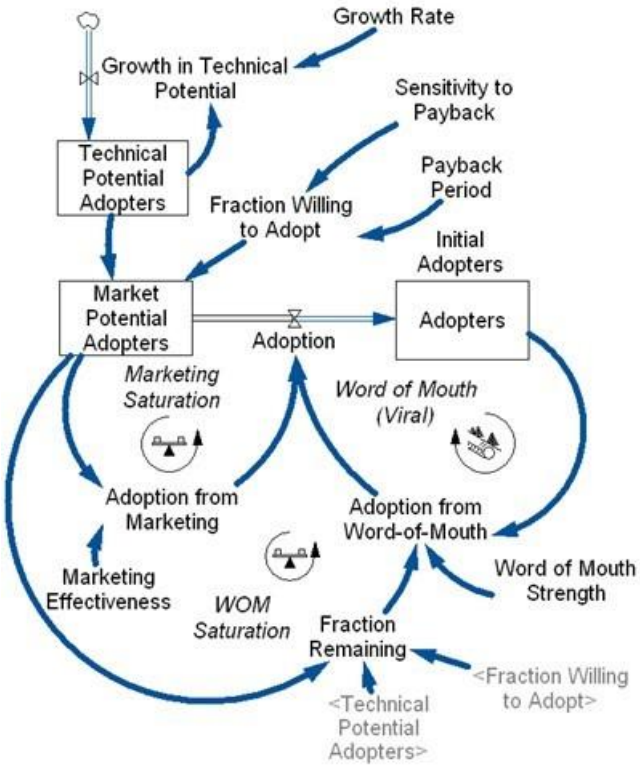

Figure A-6. Stock/Flow Diagram of Diffusion Model for New Products and Retrofits

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.

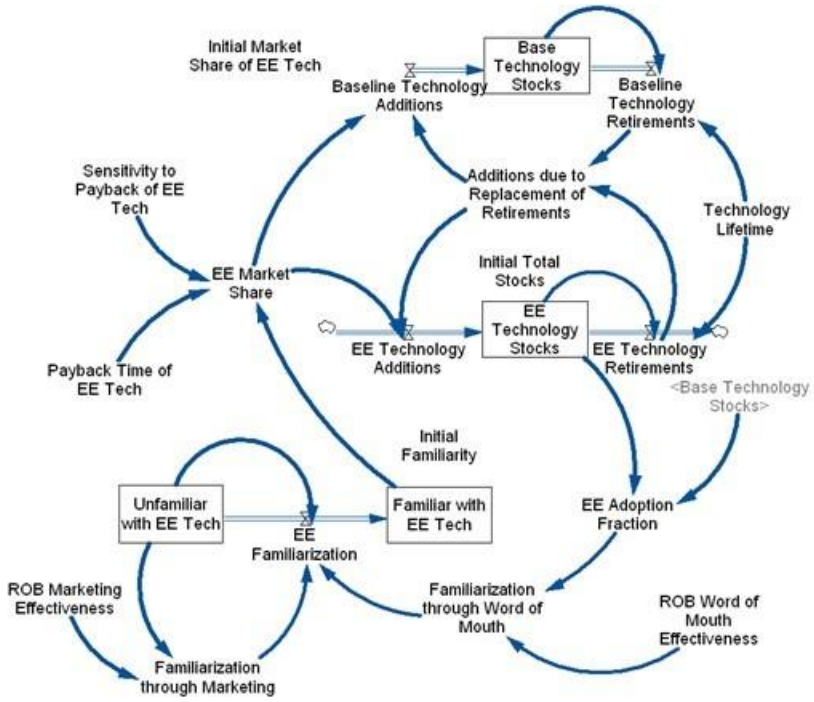

Figure A-7. Stock/Flow Diagram of Diffusion Model for Replace-on-Burnout Measures

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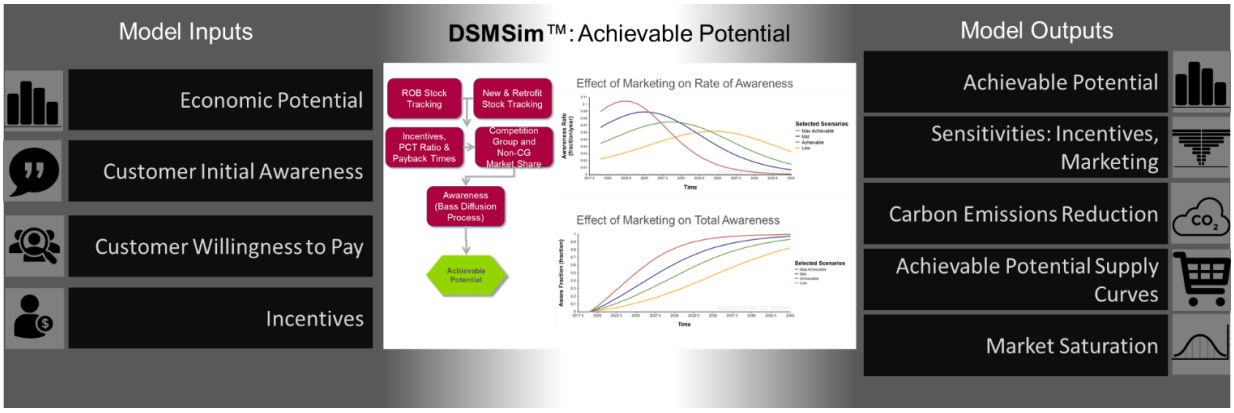
and top contributing measures for measures modeled in the study with historical program data.

- 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



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

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Energy Efficiency and Electrification Measures

Guidehouse fully characterized approximately 350 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	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	Behavior	Home Energy Report[1]	Natural Gas	NEW	Indirect Fossil Fuel Saving
Res & IE	Behavior	Home Energy Report[1]	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	Envelope	Air Sealing	Electricity	RET	Electricity Saving
Res & IE	Envelope	Air Sealing	Natural Gas	RET	Indirect Fossil Fuel 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	Natural Gas	RET	Indirect Fossil Fuel 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	Natural Gas	RET	Indirect Fossil Fuel 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	Natural Gas	RET	Indirect Fossil Fuel 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	Natural Gas	RET	Indirect Fossil Fuel 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	Natural Gas	RET	Indirect Fossil Fuel Saving

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

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Sector	End Use	Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
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	Condensing Storage Water Heater	Natural Gas	ROB	Fossil Fuel Efficiency
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	Natural Gas	NEW	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Faucet Aerator	Natural Gas	RET	Indirect Fossil Fuel 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
Res & IE	Hot Water	Heat Pump Water Heater Fuel Switch	Natural Gas	ROB	Electrification
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	Natural Gas	RET	Fossil Fuel Efficiency
Res & IE	Hot Water	Indirect Water Heater	Natural Gas	ROB	Fossil Fuel Efficiency
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	Natural Gas	RET	Fossil Fuel Efficiency
Res & IE	Hot Water	On Demand/Tankless Water Heater	Natural Gas	ROB	Fossil Fuel Efficiency
Res & IE	Hot Water	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)	Natural Gas	RET	Indirect Fossil Fuel Saving

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Sector	End Use	Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
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	Natural Gas	NEW	Indirect Fossil Fuel Saving
Res & IE	Hot Water	Showerhead	Natural Gas	RET	Indirect Fossil Fuel 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	Storage Water Heater	Natural Gas	RET	Fossil Fuel Efficiency
Res & IE	Hot Water	Storage Water Heater	Natural Gas	ROB	Fossil Fuel Efficiency
Res & IE	Hot Water	Thermostatic Valve	Electricity	RET	Electricity Saving
Res & IE	Hot Water	Thermostatic Valve	Natural Gas	RET	Indirect Fossil Fuel 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 Gas	Natural Gas	ROB	Electrification
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	Boiler Reset Control	Natural Gas	RET	Indirect Fossil Fuel Saving
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 Gas Furnace	Natural Gas	ROB	Electrification
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	Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Res & IE	HVAC	Central Air Source Heat Pump Partially Displacing Gas Furnace[2]	Natural Gas	RET	Electrification
Res & IE	HVAC	Central Air Source Heat Pump Partially Displacing Oil Furnace[2]	Fuel Oil	RET	Electrification
Res & IE	HVAC	Central Air Source Heat Pump Partially Displacing Propane Furnace[2]	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 Gas Boiler	Natural Gas	ROB	Electrification
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 Gas Boiler[2]	Natural Gas	RET	Electrification
Res & IE	HVAC	Ductless Mini-Split Heat Pump Partially Displacing Oil Boiler[2]	Fuel Oil	RET	Electrification
Res & IE	HVAC	Ductless Mini-Split Heat Pump Partially Displacing Propane Boiler[2]	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	Natural Gas	RET	Fossil Fuel Efficiency
Res & IE	HVAC	Forced Hot Water Boiler	Natural Gas	ROB	Fossil Fuel Efficiency
Res & IE	HVAC	Forced Hot Water Boiler	Fuel Oil	RET	Fossil Fuel Efficiency

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

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Sector	End Use	Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
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	Natural Gas	RET	Fossil Fuel Efficiency
Res & IE	HVAC	Furnace	Natural Gas	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
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	Natural Gas	ROB	Indirect Fossil Fuel 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	Natural Gas	RET	Indirect Fossil Fuel 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	Natural Gas	RET	Indirect Fossil Fuel 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)	Natural Gas	RET	Indirect Fossil Fuel Saving
Res & IE	HVAC	Pipe Wrap (Space Heating)	Fuel Oil	RET	Indirect Fossil Fuel Saving

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Sector	End Use	Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
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	Natural Gas	RET	Indirect Fossil Fuel 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 Gas	Natural Gas	ROB	Electrification
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
Res & IE	HVAC	Wi-Fi Thermostat	Electricity	NEW	Electricity Saving
Res & IE	HVAC	Wi-Fi Thermostat	Natural Gas	NEW	Indirect Fossil Fuel 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

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Sector	End Use	Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
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	Induction Stove Fuel Switch	Natural Gas	ROB	Electrification
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[3]	Natural Gas	NEW	Electrification
Res & IE	Whole Home	All-Electric Passive House[3]	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[4]	Natural Gas	NEW	Fossil Fuel Efficiency
Res & IE	Whole Home	New Construction Energy Efficiency[4]	Fuel Oil	NEW	Fossil Fuel Efficiency
Res & IE	Whole Home	New Construction Energy Efficiency[4]	Propane	NEW	Fossil Fuel Efficiency
Industrial	Compressed Air	Air Nozzle	Electricity	NEW	Electricity Saving
Industrial	Compressed Air	Air Nozzle	Electricity	RET	Electricity Saving
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 Large C&I	Natural Gas	RET	Custom
Industrial	Custom	Custom Large C&I	Natural Gas	ROB	Custom

[3] 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.

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

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Sector	End Use	Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Industrial	Custom	Custom New Construction	Electricity	NEW	Custom
Industrial	Custom	Custom New Construction	Natural Gas	NEW	Custom
Industrial	Custom	Electric Forklifts	Propane	ROB	Electricity Saving
Industrial	Hot Water	Steam Trap	Natural Gas	RET	Indirect Fossil Fuel Saving
Industrial	HVAC	Boiler Reset Control	Natural Gas	RET	Indirect Fossil Fuel Saving
Industrial	HVAC	Condensing Boiler	Natural Gas	ROB	Fossil Fuel Efficiency
Industrial	HVAC	Energy Management System	Electricity	NEW	Electricity Saving
Industrial	HVAC	Energy Management System	Electricity	RET	Electricity Saving
Industrial	HVAC	Energy Management System	Natural Gas	NEW	Indirect Fossil Fuel Saving
Industrial	HVAC	Energy Management System	Natural Gas	RET	Indirect Fossil Fuel Saving
Industrial	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
Industrial	Process	Industrial Process Electrification - Low Heat	Natural Gas	RET	Electrification
Industrial	Process	Industrial Process Electrification - Medium Heat	Natural Gas	RET	Electrification
Industrial	Process	Industrial Process Electrification - High Heat[5]	Natural Gas	RET	Electrification
Commercial	Behavior	Building Operator Certification	Electricity	RET	Electricity Saving
Commercial	Behavior	Building Operator Certification	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Custom	Custom - Res End Use	Electricity	ROB	Custom
Commercial	Custom	Custom - Res End Use	Natural Gas	ROB	Custom
Commercial	Custom	Custom Large C&I	Electricity	RET	Custom
Commercial	Custom	Custom Large C&I	Electricity	ROB	Custom
Commercial	Custom	Custom Large C&I	Natural Gas	RET	Custom
Commercial	Custom	Custom Large C&I	Natural Gas	ROB	Custom
Commercial	Custom	Custom New Construction	Electricity	NEW	Custom

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

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Sector	End Use	Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Commercial	Custom	Custom New Construction	Natural Gas	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	Natural Gas	RET	Indirect Fossil Fuel 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	Natural Gas	RET	Indirect Fossil Fuel 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	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Envelope	Insulation	Propane	RET	Indirect Fossil Fuel Saving
Commercial	Envelope	Insulation - Res End Use	Electricity	RET	Electricity Saving
Commercial	Envelope	Insulation - Res End Use	Natural Gas	RET	Indirect Fossil Fuel 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	Induction Cooktop Displacing Gas	Natural Gas	ROB	Electrification
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	Condensing Storage Water Heater	Natural Gas	ROB	Fossil Fuel Efficiency
Commercial	Hot Water	Faucet Aerator	Electricity	NEW	Electricity Saving

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Sector	End Use	Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Commercial	Hot Water	Faucet Aerator	Electricity	RET	Electricity Saving
Commercial	Hot Water	Faucet Aerator	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Faucet Aerator	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Faucet Aerator - Res End Use	Electricity	NEW	Electricity Saving
Commercial	Hot Water	Faucet Aerator - Res End Use	Electricity	RET	Electricity Saving
Commercial	Hot Water	Faucet Aerator - Res End Use	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Faucet Aerator - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	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 Gas	Natural Gas	ROB	Electrification
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	High Speed Clothes Washer	Natural Gas	RET	Indirect Fossil Fuel Saving
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	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead	Natural Gas	RET	Indirect Fossil Fuel 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	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Low-Flow Showerhead - Res End Use	Fuel Oil	NEW	Indirect Fossil Fuel Saving
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

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Sector	End Use	Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
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	Natural Gas	RET	Indirect Fossil Fuel 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)	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pipe Wrap (Water Heating)	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pipe Wrap (Water Heating) - Res End Use	Electricity	NEW	Electricity Saving
Commercial	Hot Water	Pipe Wrap (Water Heating) - Res End Use	Electricity	RET	Electricity Saving
Commercial	Hot Water	Pipe Wrap (Water Heating) - Res End Use	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pipe Wrap (Water Heating) - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pre-Rinse Spray Valve	Electricity	NEW	Electricity Saving
Commercial	Hot Water	Pre-Rinse Spray Valve	Electricity	RET	Electricity Saving
Commercial	Hot Water	Pre-Rinse Spray Valve	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pre-Rinse Spray Valve	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pre-Rinse Spray Valve	Propane	NEW	Indirect Fossil Fuel Saving
Commercial	Hot Water	Pre-Rinse Spray Valve	Propane	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Steam Trap	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	Hot Water	Volume Water Heater	Natural Gas	ROB	Fossil Fuel Efficiency
Commercial	HVAC	Air Source Heat Pump	Electricity	ROB	Electricity Saving
Commercial	HVAC	Air Source Heat pump - Res End Use	Electricity	RET	Electricity Saving
Commercial	HVAC	Boiler Reset Control	Natural Gas	RET	Indirect Fossil Fuel Saving

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Sector	End Use	Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Commercial	HVAC	Boiler to Air Source Heat Pump	Natural Gas	ROB	Electrification
Commercial	HVAC	Central Air Source Heat Pump (Split or Packaged)	Natural Gas	ROB	Electrification
Commercial	HVAC	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	Commercial HVAC Tune-up	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Commissioning/Retrocommissioning	Electricity	RET	Electricity Saving
Commercial	HVAC	Commissioning/Retrocommissioning	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Condensing Boiler	Natural Gas	ROB	Fossil Fuel Efficiency
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
Commercial	HVAC	Data Center Water-side Economizer	Electricity	RET	Electricity Saving
Commercial	HVAC	Demand Control Ventilation	Electricity	RET	Electricity Saving
Commercial	HVAC	Demand Control Ventilation	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Dual Enthalpy Economizer Controls	Electricity	RET	Electricity Saving
Commercial	HVAC	Duct Insulation	Electricity	RET	Electricity Saving
Commercial	HVAC	Duct Insulation	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Duct Insulation - Res End Use	Electricity	RET	Electricity Saving
Commercial	HVAC	Duct Insulation - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Duct Sealing	Electricity	RET	Electricity Saving
Commercial	HVAC	Duct Sealing	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Duct Sealing - Res End Use	Natural Gas	RET	Indirect Fossil Fuel Saving
Commercial	HVAC	Ductless Heat Pump	Natural Gas	ROB	Electrification
Commercial	HVAC	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

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

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Sector	End Use	Measure Name	Primary Fuel Savings Type	Replacement Type	Measure Category
Commercial	HVAC	Wi-Fi Thermostat	Electricity	NEW	Electricity Saving
Commercial	HVAC	Wi-Fi Thermostat	Electricity	RET	Electricity Saving
Commercial	HVAC	Wi-Fi Thermostat	Natural Gas	NEW	Indirect Fossil Fuel Saving
Commercial	HVAC	Wi-Fi Thermostat	Natural Gas	RET	Indirect Fossil Fuel Saving
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

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

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