Cape Light Compact 2014 Penetration, Potential and Program Opportunity Study:

Volume 1: Methodology and Results

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July 20, 2015

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Executive Summary

This report summarizes the methodology and results of the 2014 Cape Light Compact Penetration, Potential, and Program Opportunity Study, conducted by Opinion Dynamics Corporation and Dunsky Energy Consulting. The goal of this research was to determine the remaining achievable potential from electric measures among residential, low income, and commercial and industrial customers for the six-year period 2016-2021 and to inform CLC's program planning efforts. The outputs of this study satisfy the requirements of the Massachusetts Department of Public Utilities ("DPU") Order dated January 31, 2013 (D.P.U. 12-107) to document the penetration of energy efficiency within the Compact's service territory and develop estimates of remaining savings potential.[1]

The results presented in this report are based on extensive primary and secondary data collection. The primary data collection activities for the residential and low income sectors included a mail survey with 2,785 customers, in-home visits at 169 homes, and a telephone survey with 144 customers. The primary data collection activities for the commercial & industrial sector included a telephone survey with 448 customers and on-site visits at 150 facilities. We also conducted in-depth interviews with a small number of local contractors to inform assumptions for the potential model.

We estimate CLC's total achievable energy efficiency potential for the six-year period 2016-2021 to be 246 annual GWh[2] and 62 MW.[3] Achievable potential represents 51% of economic potential and 36% of technical potential. On average over the six-year period, achievable energy savings represent 1.98% of CLC forecasted annual sales.[4] These electric savings would be expected to cost CLC $220 million (incentive and non-incentive program costs;[5] in 2016 dollars), an average of $37 million per year or $0.895 per annual kWh.[6] It should be noted that per kWh projected costs are relatively high for CLC as compared to the statewide average due to a number of territory-specific reasons, including the small base of large C&I customers and the seasonal nature of many homes and businesses. The total cost (including the participants' net cost) amounts to $246 million for the six-year period. All of the 2016-2021 proposed investments are currently cost-effective, with an expected Total Resource Cost (TRC) ratio of 3.6 and a Program Administrator Cost (PAC) ratio of 2.8.

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[1] MA DPU Order dated January 31, 2013 (D.P.U. 12-107) included the following requirement: "The Program Administrators with an aggregate three-year savings goal of greater than 20 percent below the statewide three-year aggregate goal will conduct a study, either jointly or individually, during the upcoming three-year term to document the penetration of energy efficiency within its service territory and the remaining cost-effective energy efficiency opportunities available."

[2] The gigawatt-hour, or GWh, is a measure of energy, and is equal to 1,000 megawatt-hours (MWh).

[3] These findings reflect the best information and assumptions available as of April 2015. Cape Light Compact and the Opinion Dynamics/Dunsky team plan to refresh these results, prior to the September Three Year Plan draft filing, to incorporate any newly available evaluation findings, as well as updates to non-incentive program costs.

[4] Note that annual sales are forecasted by Eversource.

[5] Non-incentive program costs, dated March 31, 2015, are estimates based on the average actual Cape Light Compact non-incentive costs for plan years 2013 and 2014, and projected non-incentive costs for plan year 2015.

[6] This compares to a projected average cost of $0.794/kWh during the 2013-2015 Three Year Plan Cycle.

Table ES-1 summarizes these results for the six-year period 2016-2021, as well as for each of the next two three-year planning periods.

Table ES-1. Key Potential Results – All Sectors, by Period

	2016-2021		2016-2018		2019-2021	
Potential (Total)	GWh	MW	GWh	MW	GWh	MW
Technical	675	163	343	86	332	77
Economic	481	117	246	63	235	54
Achievable	246	62	121	33	125	29
Potential (Yearly)	GWh	MW	GWh	MW	GWh	MW
Technical	112.5	27.1	114.4	28.7	110.6	25.5
Economic	80.0	19.5	81.9	21.1	78.0	18.0
Achievable	40.9	10.3	40.3	11.1	41.5	9.5
Annual Achievable as % of Sales	1.98%		1.94%		2.02%	
Cost						
Total (millions)	$246		$120		$126	
CLC (millions)	$220		$107		$113	
CLC Cost/kWh	$0.895		$0.882		$0.908	
Cost-Effectiveness						
Total Resource Cost Test	3.6		3.6		3.6	
Program Administrator Cost Test	2.8		2.8		2.9	

Table ES-2 and Table ES-3 detail annual achievable potentials as a percentage of sales, by year and sector, for the first three-year period and the second three-year period, respectively.

Table ES-2. Achievable Potential as a Percentage of Forecasted Energy Sales – 2016 to 2018

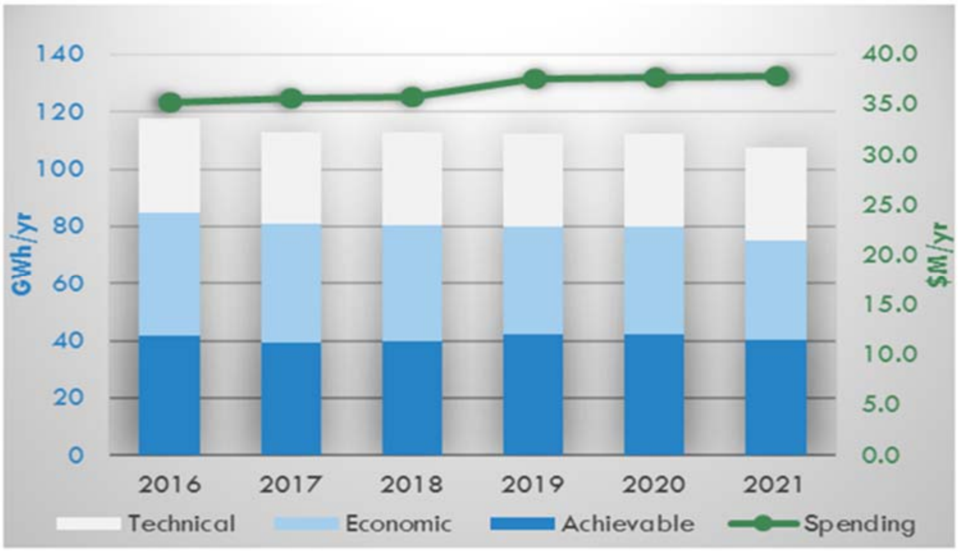
	2016	2017	2018	2016-2018
Residential	2.06%	1.80%	1.79%	1.88%
Low Income	2.39%	2.05%	2.04%	2.16%
Commercial	1.94%	2.00%	2.04%	1.99%
All Sectors	**2.02%**	**1.89%**	**1.90%**	**1.94%**

Table ES-3. Achievable Potential as a Percentage of Forecasted Energy Sales – 2019 to 2021

	2019	2020	2021	2019-2021
Residential	2.00%	2.01%	1.87%	1.96%
Low Income	2.18%	2.19%	2.12%	2.16%
Commercial	2.07%	2.11%	2.07%	2.09%
All Sectors	**2.03%**	**2.06%**	**1.96%**	**2.02%**

Figure ES-1 presents annual savings (GWh) for the three types of potential – technical, economic, and achievable – as well as annual spending required to meet the achievable potential. The increase in spending during the second three-year period (2019–2021) is due to higher LED uptake, which results from an assumption of lower market barriers.[7] While savings from LEDs are higher for that period, they are counterbalanced by somewhat lower savings for other measures.

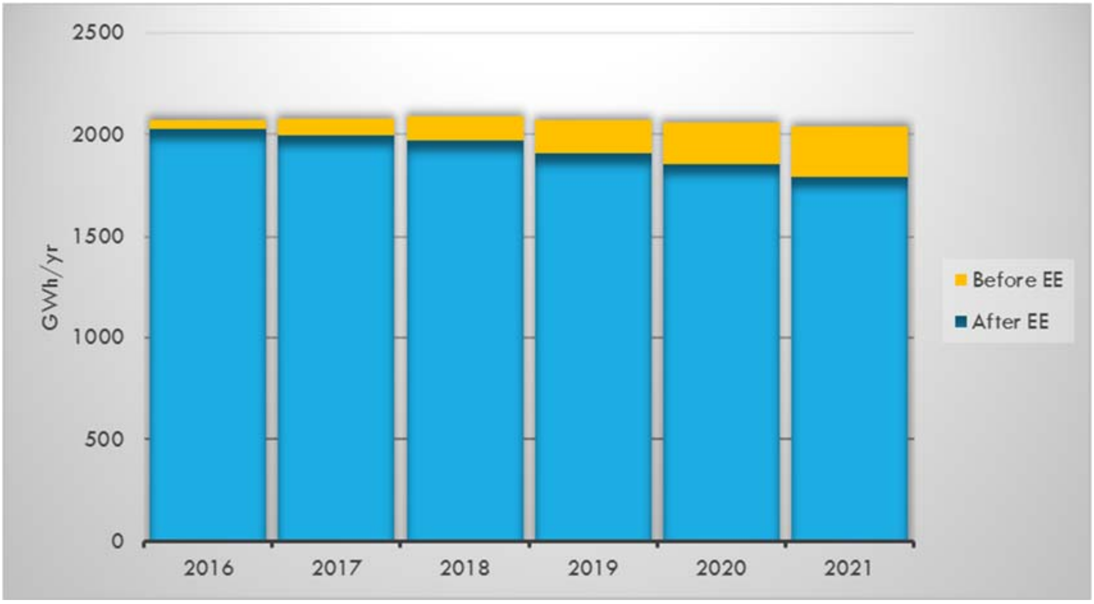
Figure ES-1. Annual Savings and Spending



Energy sales, provided to CLC by Eversource, are forecasted to decline slightly, before energy efficiency (EE) efforts, over the six-year period, with total sales of 2,041 GWh in 2021 compared to 2,071 in 2016. With EE efforts at the level of the achievable potential, energy sales would decline faster, with 2021 sales amounting to 1,795 GWh, a drop of 12% from 2016 sales (Figure ES-2).

[7] The assumptions for measure uptake are based on the best information available at this time and could change in the future.

Figure ES-2. Impact of Achievable Potential on Annual Sales



Achievable potential estimated in this study (120.8 GWh total for the three plan years 2016-2018) is lower than the 2016-2018 savings goal in CLC's Three-Year Plan[8] (156.3 GWh total for the three plan years 2016 - 2018). When comparing CLC's published goal to results from the potential model, it is important to remember that the potential study is not meant to be a direct forecast of claimable savings, because some of the assumptions and inputs used to estimate potential are different from those used for setting goals and claiming savings. In particular, a key objective of this potential study was to reflect the unique circumstances of CLC's service territory and customer base, including the effects on achievable savings of having a large share of seasonal customers. To this end, we collected a wealth of primary data which is reflected in the potential study results. In contrast, the Massachusetts goal setting and savings claiming process requires consistency with Technical Resource Manual (TRM) assumptions.

A key programmatic area where different potential model and TRM assumptions lead to a difference in savings is C&I upstream lighting: The Three-Year Plan estimates savings of 40.9 GWh from C&I upstream lighting whereas the potential model only estimates 8.7 GWh. The main drivers of this difference are assumptions about (1) the mix of baseline (replaced) bulbs (i.e., incandescent vs CFL units); (2) the size (wattage) of the baseline (replaced) bulbs; and (3) hours of use. Aligning potential model assumptions with TRM assumptions for these (and a few other) parameters would increase the achievable potential of the C&I upstream lighting offering to 35.1 GWh and total CLC achievable potential to 147.3 GWh. This change of assumptions would yield an annual achievable potential as a percentage of sales of 2.36% overall in 2016-2018, as compared to 1.94% in the base case (as shown in Table ES-1 above).[9]

[8] References to the Three Year Plan in this document denote the April 30, 2015 draft of this document.

[9] It should be noted, however, that even with these adjustments to C&I upstream lighting, Plan goals are not perfectly comparable to the achievable potential estimated in this study. The potential model also uses CLC-specific assumptions in the other sectors (residential and low income), which we did not vary for this analysis.

1. Introduction

Cape Light Compact contracted with the Opinion Dynamics team to complete a Penetration, Potential, and Program Opportunities Study of its residential, low income, and commercial & industrial sectors. The goal of this research was to determine the remaining achievable potential from electric measures for the six-year period 2016 – 2021 and to inform program planning efforts. The outputs of this study satisfy the requirements of the Massachusetts Department of Public Utilities ("DPU") Order dated January 31, 2013 (D.P.U. 12-107) to document the penetration of energy efficiency within the Compact's service territory and develop estimates of remaining savings potential.[10]

This document, Volume 1, presents the methodology for this study as well as penetration and saturation results and electric potential estimates. Volume 1 is organized as follows:

- **Section 2: Methodology.** This section presents information about our approaches to primary data collection and potential modeling. It includes details about our survey sampling and weighting methodology, and defines key terms and concepts used throughout this report.
- **Section 3: Summary of Key Penetration and Saturation Results.** This section presents the penetration and saturation data collected in the mail and telephone surveys and adjusted, where necessary, by site visit results.
- **Section 4: Overall Potential Results.** This section shows potential results for CLC's service territory, including estimates of technical, economic, and achievable potential for 2016 – 2018, 2019 – 2021 as well as for the six-year period 2016 – 2021. Results are presented by sector, segment, and end-use. This section also includes a comparison of potential model results to CLC three-year Plan.
- **Section 5: Residential Potential Results.** This section shows potential results for the residential sector.
- **Section 6: Low Income Potential Results.** This section shows potential results for the low income sector.
- **Section 7: Commercial & Industrial Potential Results.** This section shows potential results for the commercial and industrial sector.

In addition to this report, separate volumes present additional technical details of the potential modeling, the primary data collection instruments, as well as detailed results from the residential/low income mail survey (adjusted by site visit information) and from the C&I Telephone Survey (also adjusted by site visit information).

However, the different assumptions for C&I upstream lighting can explain a significant portion of the difference between Plan goals and our estimated achievable potential.

[10] MA DPU Order dated January 31, 2013 (D.P.U. 12-107) included the following requirement: "The Program Administrators with an aggregate three-year savings goal of greater than 20 percent below the statewide three-year aggregate goal will conduct a study, either jointly or individually, during the upcoming three-year term to document the penetration of energy efficiency within its service territory and the remaining cost-effective energy efficiency opportunities available."

2. Methodology

Key activities in support of the Potential and Program Opportunities Study included extensive primary data collection as well as potential modeling. The following sections present details about each of these activities.

2.1 Primary Data Collection – Residential & Low Income Sectors

The primary data collection activities for the residential and low income sectors included a mail survey with 2,785 customers, in-home visits at 169 homes, and a telephone survey with 144 customers. This section describes the sampling and weighting methodologies associated with these three activities.

2.1.1 Residential/LI Mail Survey

The 2014 Residential Energy Use Survey consisted of a mail/internet survey of CLC residential and low income customers. The mail survey was designed to collect comprehensive penetration and saturation data on energy-using equipment as well as information about the customers and their homes.

The survey was sent to 12,000 homes in June 2014. To enhance recognition and response rates, all written communications with customers were conducted on specially-designed stationery, displaying the CLC logo. The cover letter included a reference to a website and a personal identification number (PIN), and offered customers the option to complete the survey on-line instead of by mail. The cover letter also announced a drawing of ten $100 gift cards as well as a grand prize of $1,000 in new energy efficient appliances among respondents who returned the completed survey by the specified deadline.

About two and four weeks later, respectively, two reminder mailings – one postcard and one mailing containing another copy of the survey booklet – were sent to customers who had not yet returned a completed survey.

Sample Design

As of February 2014, there were 165,203 residential and 8,530 low income accounts in CLC's service territory.[11] After consultation with CLC, we moved a total of 2,692 accounts classified as residential and low income (including Condo Associations, Realities, Trusts, and Housing Authorities) into the commercial sample frame. We also moved 2,567 accounts classified as "commercial residential" from the commercial sample frame into the residential sample frame, typically because they were single family homes on a commercial rate because of their ownership status as a rental or new construction property in the name of a commercial entity. In either instance, we reclassified these accounts to better capture their energy usage with our primary data collection instruments for their respective sector. Table 2-1 summarizes these account relocations.

[11] It should be noted that the number of CLC customers fluctuates throughout the year.

Table 2-1. Mail Survey Sample Frame Account Relocations

	Residential	Low Income	Total
Number of Accounts in Customer Files	165,203	8,530	173,733
Accounts Moved to Commercial	- 2,688	- 4	- 2,692
Accounts Added from Commercial Residential	+ 2,567	+ 0	+ 2,567
Final Number of Accounts	165,082	8,526	173,608

We then aggregated accounts with the same name and service address to the premise level, resulting in 160,444 residential and 8,507 low income premises. Of these, we dropped records that had no valid usage data (i.e., usage for all 12 months was missing or zero). We also dropped records that had less than 2 kWh average daily usage and an on-Cape mailing address (indicating homes that are likely vacant, rather than seasonal).

The final sample frame for the mail survey consisted of 156,747 residential and 8,338 low income premises (see Table 2-2).

Table 2-2. Mail Survey Sample Frame Premise Drops

	Residential	Low Income	Total
Initial Number of Premises	160,444	8,507	168,951
Dropped Because of Missing or Zero Usage	1,987	136	2,123
Dropped Because of Low Usage (Average Daily Usage < 2 kWh and On-Cape Mailing Address)	1,710	33	1,743
Final Number of Premises (Sample Frame)	156,747	8,338	165,085

The residential premises in the sample frame were classified into non-seasonal and seasonal, based on their 2013 electricity usage pattern. We considered premises seasonal if their usage in June through September exceeded their usage during the rest of the year.

The target number of completed surveys was 1,750. To achieve this number we sent out 12,000 survey booklets, assuming a response rate of approximately 15%. The sampling approach was a random sample within each of the three analysis segments (residential non-seasonal, residential seasonal, and low income).

The following table presents, for the three segments, the number of premises in the population as well as the sample for the outgoing surveys and the expected number of completed surveys.

Table 2-3. Mail Survey Sample Frame and Targets

Sector/Segment	Population	Sample	Expected Completes
Residential Non-Seasonal	107,077	3,500	500
Residential Seasonal	49,670	3,500	500
Low Income	8,338	5,000	750
Total	165,085	12,000	1,750

Summary of Survey Statistics

Overall, we received 2,815 responses to the survey, 2,541 by mail and 274 via the Internet. Of these, 29 responses were duplicates and one was completed by a business. Removing these ineligible responses resulted in a total of 2,785 usable responses. Overall, 1% of mailed surveys were undeliverable. The resulting response rate, calculated as the number of completed surveys divided by the number of deliverable surveys, was 24%. The percentage of undeliverables and the response rates were almost identical for the three segments.

Given this higher than expected response rate, we greatly exceeded the target number of completes in all three segments. Table 2-4 summarizes these survey statistics.

Table 2-4. Summary of Mail/Internet Survey Responses

	TOTAL	Residential Non-Seasonal[a]	Residential Seasonal[a]	Low Income
Total Mailed	12,000	3,500	3,500	5,000
Completed Survey – Mail	2,514	721	699	1,094
Completed Survey – Internet	271	103	86	82
Completed Survey – Total	2,785	824	785	1,176
Undeliverable – Number	154	33	50	71
Undeliverable – Percent	1%	1%	1%	1%
Response Rate	24%	24%	23%	24%

[a] Note that we reclassified the segments for a few respondents, based on their occupancy patters reported in the mail survey.

Weighting

To ensure that mail survey results are representative of CLC's populations of residential and low income customers, respectively, we developed and applied weights. We developed these weights in a two-step process, as described below.

Sample Weights

We first developed sample weights for the residential sector to correct for the fact that we over-sampled seasonal homes and under-sampled non-seasonal homes.[12] For each segment, we estimated the weight by dividing the segment's share of the overall residential population by its share of responses. For example, the seasonal segment represents 32.1% of the residential population but 49.3% of the residential mail survey responses. The weight for this segment is calculated as 32.1% divided by 49.3%, or approximately 0.65. This means that the survey responses of seasonal customers are weighted down, i.e., each response only counts about two-thirds, compared to a weight of 1. Conversely, the weight for non-seasonal customers is 1.34, meaning that each response from a non-seasonal customer is weighted up.

[12] For analysis purposes, both residential segments had the same target number of completes even though the non-seasonal segment is much larger than the seasonal segment.

Table 2-5. Mail Survey Residential Sample Weights

Segment	Population[a]		Responses		Sample Weight
	Count	%	Count	%	
Residential Non-Seasonal	106,399	67.9%	816	50.7%	1.3385
Residential Seasonal	50,348	32.1%	793	49.3%	0.6517
Total Residential	156,747	100%	1,609	100%	

[a] Population counts for the two segments are based on 2013 usage, but were adjusted to reflect occupancy patters reported in the mail survey.

We did not develop sample weights for the low income sector since we did not stratify that sample. Rather, the low income sample was drawn as a simple random sample from the population of low income customers.

Post-Stratification Weights

Post-stratification can be used as a basis for adjusting samples that are not representative of the population for important variables. In other words, it is used when (1) survey respondents are not representative of the population from which they were selected, i.e., some subgroups of interest are over-represented and some are under-represented; and (2) over-represented subgroups are different from under-represented subgroups on important variables. In order to conduct post-stratification, information is required on both the percentage of the population and the percentage of the respondents that fall into the subgroups of interest (or strata). It is important that the strata available for the population are the same as the strata available for survey respondents.

We determined the need for post-stratification by comparing survey responses with known statistics about the population. We compared the survey data across core demographic and household characteristics with 2007-2011 American Community Survey data for CLC's service territory. This comparison found that homes with older heads-of-household are over-represented in our survey responses relative to the population.[13] Since customers of different ages likely vary in their ownership and use of certain electricity-using equipment, we developed an age-based post-stratification weight. This weight is calculated the same way as the sample weight, by dividing the stratum's share of the population by the stratum's share of the sample. It should be noted that to determine the stratum's share of the sample, we first apply the sample weights.

Since the distribution of the age of the head-of-household is different for residential and low income populations, we created separate weights for each. The residential post-stratification weights are shown in Table 2-6; the low income post-stratification weights are shown in Table 2-7.

[13] We also compared the housing type (i.e., single-family attached, single-family detached, apartment/condominium, and mobile home) of respondents to the population in CLC's service territory. Since the distribution of housing types among respondents was almost identical to that in the population, we did not develop post-stratification weights for this statistic.

Table 2-6. Mail Survey Residential Post-Stratification Weights

Age	Population Count	Population %	Responses Count	Responses %	Weight
Under 44 years	20,843	22.3%	108	6.9%	3.2448
45 to 64 years	39,866	42.6%	566	36.0%	1.1822
65 years and over	32,950	35.2%	899	57.1%	0.6157
Missing Response			36		1.0000
TOTAL	93,659		1,609		

Table 2-7. Mail Survey Low Income Post-Stratification Weights

Age	Population Count	Population %	Responses Count	Responses %	Weight
Under 44 years	2,866	33.0%	161	14.1%	2.3451
45 to 64 years	3,262	37.6%	454	39.7%	0.9465
65 years and over	2,556	29.4%	529	46.2%	0.6365
Missing Response			32		1.0000
TOTAL	8,684		1,176		

Rebalancing Weights

When we applied post-stratification weights for residential customers, the distribution of the sample between seasonal and non-seasonal homes slightly changed from its original proportions. To preserve the proper proportion of the two segments, we developed rebalancing weights. These weights are 1.052 for seasonal homes and 0.977 for non-seasonal homes.

Note that this step was not necessary for the low income sector since it consists of a single segment.

Final Mail Survey Weights

The final weight for each mail survey respondent is the product of the respondent's sample weight, their post-stratification weight (based on their reported age of head-of-household), and their rebalancing weight.[14] These final weights have to be applied whenever mail survey responses are aggregated across multiple respondents. The exception is mail survey variables that have been adjusted with site visit data. For those variables, variable-specific adjustment factors are applied to the final weights (see discussion in the next section).

Adjustment of Mail Survey Data

We used some of the information from the in-home visits, discussed in more detail below, to adjust certain mail survey responses. In general, we considered for adjustment items that are technical in nature and often difficult for customers to report correctly, e.g., questions about

[14] Note that for all low income customers, the sample weight is equal to 1.0 since we did not stratify the sample and the rebalancing weight is equal to 1.0 since the sector consists of a single segment. As a result, the final weight for low income customers is equal to their post-stratification weight.

equipment age or ENERGY STAR rating or questions about the customer's type of windows. We did not consider for adjustment items that cannot be observed during in-home visits (such as questions about home occupancy). We also did not adjust questions with very low incidence in the in-home sample.

We first conducted a Pearson's chi-squared test for questions considered for adjustment. For each question tested, we compared the on-site observations and the mail survey responses for the same set of households (i.e., the comparison only included mail survey responses for homes that received an on-site visit). Only if the test showed that mail survey responses are significantly different from on-site observations, did we include the question for adjustment.

Table 2-8 below presents the survey questions we adjusted, by report section. The number in parentheses indicates the question number in the mail survey (see Appendix 2 for the final mail survey instrument).

Table 2-8. Mail Survey Questions Adjusted with Site Visit Data

B. Central Air Conditioning/Cooling o ENERGY STAR rating of CAC (B4) C. Window Air Conditioning o ENERGY STAR rating of window unit (C4a) D. Insulation and Ventilation o Inches of attic insulation (D2) o Exterior walls are insulated (D3) o Basement walls are insulated (D4) o Basement ceiling insulated (D5) o Type of windows (D6) F. Water Heating o Presence of low-flow showerheads (F5) o Presence of faucet aerators (F6)	G. Appliances o ENERGY STAR rating of clothes washer (G2) o ENERGY STAR rating of refrigerators (G8c) o ENERGY STAR rating of dishwasher (G15) H. Entertainment and Technology o Count of various TV types (H2a, H2b, H2c, H2f, H2h, H2k) J. Lighting o Number of bulbs inside the home (J1) o Percentage of indoor bulbs that are CFLs (J2) o Percentage of indoor bulbs that are LEDs (J3) o Number of bulbs outside the home (J4) o Percentage of outdoor bulbs that are CFLs (J5) o Percentage of outdoor bulbs that are LEDs (J6)

Adjustment Methodology

We used a ratio adjustment approach to adjust the mail survey responses for the questions listed above. The values to be adjusted can be either a mean or a proportion. The ratio adjustment method first develops an adjustment factor, based on the unweighted value of the 169 in-home visits and the unweighted value of the survey responses for the same 169 households:

$$\text{Adjustment Factor} = \frac{Y_{\text{In-Home Visits}}}{Y_{\text{Survey Responses}}}$$

Where:

$Y_{\text{In-Home Visits}}$	=	unweighted mean or proportion from the 169 in-home visits
$Y_{\text{Survey Responses}}$	=	unweighted mean or proportion from the survey responses for the 169 households with in-home visits

The adjustment factor is then multiplied by the weighted number of survey responses for all households (by sector), to develop an adjusted distribution of responses across response categories. This new distribution is then used to calculate new means or proportions for the adjusted question.

Consider the following example:

If a home reported having a clothes washer, we collected information on whether or not the washer is ENERGY STAR rated (at the time of purchase). The in-home visits found that 56.4% of clothes washers are ENERGY STAR rated. By contrast, the mail survey responses provided by the same 169 households reported that 83.8% are ENERGY STAR rated.[15] Using these values, we developed an adjustment factor for each response category of this question, as follows:

Clothes washer is ENERGY STAR rated: $Adjustment \quad Factor = \dfrac{56.4\%}{83.8\%} = 0.673$

Clothes washer is not ENERGY STAR rated: $Adjustment \quad Factor = \dfrac{43.6\%}{16.2\%} = 2.691$

We then apply these adjustment factors to weighted mail survey results by response category. Of all residential mail survey respondents with a clothes washer, 916 reported that their washer is ENERGY STAR rated and 212 reported that it is not (valid n=1,128). Multiplying these responses by the adjustment factor yields:

Clothes washer is ENERGY STAR rated: *Adjusted “n” = 916 * 0.673 = 617*

Clothes washer is not ENERGY STAR rated: *Adjusted “n” = 212 * 2.691 = 571*

When adjusting proportions, an additional step is necessary. Because each response category is adjusted separately, the total number of responses no longer sums to the correct valid “n”. In the example above, the correct “n” is 1,128 but the adjusted “n”s sum to 1,188 (617+571). To correct for this, we developed an additional balancing factor, which is the ratio of the correct “n” and the adjusted “n”. This ratio is multiplied by the adjustment factor for each response category to derive the final adjustment factors for the question.

The final adjustment factor is then multiplied by the post-stratification weight, by response category, to develop adjusted weights. These adjusted weights are specific to each adjusted question. They are used when developing the results used in this analysis.

[15] Percentages are based on unweighted responses.

Precision of Results

Overall, the estimated precision of mail survey results is approximately 2.4% for residential customers and 2.6% for low income customers (at a 95% confidence level). This estimate is based on a two-tailed test, corrected for a finite population, uses an assumed coefficient of variation of 0.5, and includes the total number of responses received (i.e., 1,609 for residential customers and 1,176 for low income customers).

For equipment with low incidence in the population (e.g., central air conditioning), the precision value is higher (i.e., results are less precise) for follow-up questions about equipment characteristics. Similarly, the precision level is higher for questions with many incomplete or invalid responses. For example, a typical rate of incomplete or invalid responses to the mail survey is about 5%. This translates into slightly less precise results, with precision levels of 2.5% for residential customers and 2.7% for low income customers (at a 95% confidence level and holding all other assumptions constant). However, in both examples here, the precision is very good.

2.1.2 Residential/LI In-Home Visits

We conducted a total of 169 in-home visits with Cape Light Compact residential and low income customers. The in-home visits were designed to collect data to verify mail survey responses and to collect additional, more technical data (such as equipment capacity or efficiency ratings) that we did not include in the mail survey as customers generally find it difficult to report.

The site visits took place between August and September 2014 and typically took 60 to 90 minutes per survey. To compensate customers for their efforts, we offered an incentive of $75 for site visits.

Sample Design

The target number of in-home visits was 175. This included 50 residential non-seasonal, 50 residential seasonal, and 75 low income visits. The sampling approach was a random sample within each of these three segments.

The in-home visits were designed as a nested sample, i.e., we drew the sample of homes from the population of mail survey respondents. Therefore, we have a completed mail survey for every in-home visit we conducted.

Overall, we conducted 169 in-home visits. We conducted 61 visits with residential non-seasonal customers, 36 with residential seasonal customers, and 72 with low income customers. The final distribution of site visits by segment was different from the quota since we reassigned the segment for some residential customers based on their self-reported occupancy patterns.

Table 2-9. In-home Visit Quotas by Segment

Segment	Quota	Completed Visits
Residential Non-Seasonal	50	61
Residential Seasonal	50	36
Low Income	75	72
Total	175	169

Weighting

To ensure that in-home results are representative of CLC's population of residential and low income customers, we developed and applied weights. We used the same two-step weighting process that was used for the mail survey.

Sample Weights

We first developed sample weights for the residential sector to correct for the fact that we oversampled seasonal households and under-sampled non-seasonal households. For each segment, we estimated the weight by dividing the segment's share of the overall residential population by its share of responses.[16]

Table 2-10. Site Visit Residential Sample Weights

Segment	Population		Responses		Sample Weight
	Count	%	Count	%	
Residential Non-Seasonal	106,399	67.9%	61	62.9%	1.0794
Residential Seasonal	50,348	32.1%	36	37.1%	0.8655
Total Residential	156,747	100%	97	100%	

We did not develop sample weights for the low income sector since we did not stratify that sample.

Post-Stratification Weights

As with the mail survey, we compared demographics of in-home visit participants with those of the population and found that homes with older heads-of-household are over-represented in our visits. To correct for this, we developed an age-based post-stratification weight. This weight is calculated the same way as the sample weight, by dividing the stratum's share of the population by the stratum's share of the sample. It should be noted that to determine the stratum's share of the sample, we first apply the sample weights.

Since the distribution of the age of the head-of-household is different for residential and low income populations, we created separate weights for each. The residential post-stratification weights are shown in Table 2-11; the low income post-stratification weights are shown in Table 2-12.

[16] As with the mail survey, residential segments had the same target number of completes for analysis purposes even though the non-seasonal segment is much larger than the seasonal segment.

Table 2-11. Site Visit Residential Post-Stratification Weights

Age	Population		Responses		Weight
	Count	%	Count	%	
Under 44 years	20,843	22.3%	7	7.2%	3.0874
45 to 64 years	39,866	42.6%	26	27.5%	1.5487
65 years and over	32,950	35.2%	63	65.3%	0.5387
Missing Response			1		1.0000
TOTAL	93,659		97		

Table 2-12. Site Visit Low Income Post-Stratification Weights

Age	Population		Responses		Weight
	Count	%	Count	%	
Under 44 years	2,866	33.0%	8	11.4%	2.8878
45 to 64 years	3,262	37.6%	29	41.4%	0.9067
65 years and over	2,556	29.4%	33	47.1%	0.6243
Missing Response			2		
TOTAL	8,684		72		

Rebalancing Weights

When we applied post-stratification weights for residential customers, the distribution of the sample between seasonal and non-seasonal homes slightly changed from its original proportions. To preserve the proper proportion of the two segments, we developed rebalancing weights. These weights are 1.058 for seasonal homes and 0.896 for non-seasonal homes.

Note that this step was not necessary for the low income sector since it consists of a single segment.

Final In-Home Visit Weights

The final weight for each in-home visit participant is the product of the participant's sample weight, their post-stratification weight (based on their reported age of head-of-household), and their rebalancing weight.[17] These final weights have to be applied whenever in-home data are aggregated across multiple participants.

2.1.3 Residential/LI Barriers Telephone Survey

The residential/low income telephone survey was aimed at persons in the household who make decisions about purchasing new energy-using equipment for the home. It collected information on barriers to energy efficiency and participation in CLC programs, the role of incentives in adopting energy efficient technologies, as well as program awareness and past program participation. Questions about barriers and incentives were asked separately for

[17] Note that for all low income customers, the sample weight is equal to 1.0 since we did not stratify the sample and the rebalancing weight is equal to 1.0 since the sector consists of a single segment. As a result, the final weight for low income customers is equal to their post-stratification weight.

three major end-use categories: heating and cooling systems, major appliances, and lighting. Survey responses were a key input into the adoption curves developed for the potential model.

The survey was fielded between October 10th and November 10th, 2014 and resulted in 144 completed interviews. On average, the survey took just under 15 minutes to complete. Our response rate was 5.5% with a cooperation rate of 18.0%.

The telephone survey instrument is included in Appendix 2.

Sample Design

Our sampling unit was the residential or low income household. Similar to the mail survey, the population included 107,077 residential non-seasonal households; 49,670 residential seasonal households; and 8,338 low income households. We removed customers who had already received the mail survey and drew a random sample of 2,000 households for each segment. We further removed customers with duplicate or invalid phone numbers. The resulting sample frame included 1,961 residential non-seasonal households; 1,924 residential seasonal households; and 1,965 low income households.

Summary of Telephone Survey Statistics

Table 2-13 presents the final dispositions for the telephone survey. The response rate[18] was 5.5% and the cooperation rate 18.0%, computed using the equations following the table.

[18] Using AAPOR Rate3 (RR3).

Table 2-13. Residential/LI Barrier Survey Disposition

Disposition	Number
Completed Interviews (I)	144
Eligible Non-Interviews	1,995
Refusals (R)	*590*
Mid-Interview terminate (R)	*56*
Partial Interview (P)	*12*
Respondent never available (NC)	*272*
Answering Machine (NC)	*1,053*
Language Problem (NC)	*12*
Not Eligible (E)	582
Fax/Data Line	*26*
Duplicate Number	*4*
Non-Working Number	*461*
Wrong Number	*49*
Business, government office, other organization	*41*
No eligible respondent	*1*
Unknown Eligibility Non-Interview (U)	654
No Answer	*585*
Busy	*54*
Call Blocking	*15*
Total Contacts in Sample	3,375
Response Rate	*5.5%*
Cooperation Rate	*18.0%*

Equation 1

$$\text{Response Rate} = \frac{I}{I+R+NC+(e*U)}$$

$$\text{Where:} \quad e = \frac{I+R+P+NC}{I+R+P+NC+E}$$

Equation 2

$$\text{Cooperation Rate} = \frac{I}{(I+R)}$$

2.2 Primary Data Collection – Commercial & Industrial Sector

The primary data collection activities for this effort included a telephone survey with 448 C&I customers and on-site audits at 150 businesses. This subsection describes the sampling and weighting, data collection, and adjustment methodologies associated with these activities.

The telephone survey primarily gathered high level penetration information on electricity-using equipment and information on barriers to energy efficiency and participation in CLC programs. We conducted site visits with a subset of customers who completed the telephone survey. The site visits collected more detailed information about electricity-using equipment, including penetration, saturation, efficiency, and end-use specific information such as wattage, cooling capacity, and horsepower. We used the combined data from these two sources to characterize penetration and saturation of energy efficiency equipment in the C&I sector and estimate potential.

The primary objective of the sample design was to have a large enough pool of completed phone interviews to recruit site visit participants and to have a distribution of business segments and sizes to enable us to aggregate findings to the sector level. Because the site visit recruits came from the respondents who completed the telephone survey, the basic sample development steps outlined for the telephone survey also form the foundation of the site visit sample.

2.2.1 Telephone Survey

The telephone survey collected high level penetration information on electricity-using equipment and building characteristics, as well as information about customers' decision-making and barriers to purchasing energy-using equipment, and firmographic information, including hours of operation. End-uses for equipment penetration included lighting, cooling, electric space heating, refrigeration, motors, office equipment, water heating, compressed air, cooking, and other energy-using equipment. To maintain a reasonable length and to reduce the likelihood of collecting inaccurate information, the survey only asked high level penetration questions that respondents could be expected to be able to answer over the phone.

The survey was aimed at building owners, business managers, and facility managers with knowledge of energy-using equipment at the premise. We also used the telephone survey to recruit a subset of survey respondents for on-site audits. We implemented the survey through our call center between August 25 and November 3, 2014, and completed 448 interviews.[19] On average, the survey took 15 minutes and 10 seconds to complete. Our response rate was 7%. The telephone survey instrument is presented in Appendix 2.

[19] Nine of the 448 interviews with CLC's top 20 highest usage customers, were completed by more trained Opinion Dynamics analysts in an effort that was managed separately outside of our call center.

Table 2-14. Types of Information Collected in Commercial Telephone Surveys

Business and Occupancy	Penetration of major end-uses	Energy Decision-Making and Barriers
▪ Business segment verification ▪ Own/rent space ▪ Seasonal occupancy ▪ Building structure type ▪ Square footage ▪ Number of employees	▪ Lighting ▪ Cooling ▪ Ventilation ▪ Refrigeration ▪ Electric space heating ▪ Electric water heating ▪ Motors, fans and pumps ▪ Compressed air ▪ Office equipment ▪ Electric food service equipment	▪ Decision-making structure ▪ Equipment investment criteria ▪ Benefits of energy efficiency ▪ Barriers to energy efficiency ▪ Role of incentives on energy efficiency

Sample Design

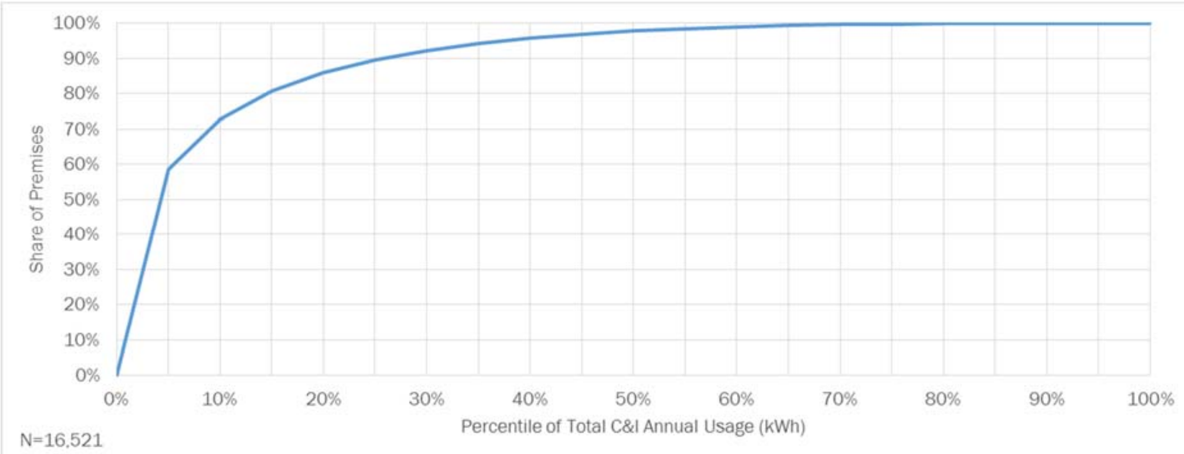
Our sampling unit was the business premise. We developed the population of premises in CLC's territory using two steps. First, we identified accounts with the same name and address and consolidated them. Next, we identified accounts with similar names and addresses, using fuzzy text match, and reviewed these names manually to identify which accounts should be combined to the business premise level. Using an extract of customer data provided by CLC in March 2014, we identified 25,111 customer accounts in CLC's territory, which we consolidated to 18,635 premises. A portion of these premises (2,114, or 11%) were out of scope for this study (e.g., communication towers and street lighting) or had only zero or missing usage data. These records were excluded from the sample frame, resulting in a final frame of 16,521 C&I premises.

Businesses on Cape Cod and Martha's Vineyard are predominantly low users of electricity. As illustrated in Figure 2-1, 9,701 (59%) of 16,521 premises[20] in the sample frame have annual usage that falls within the bottom 5% of total usage.[21]

[20] These premises were not cross-checked with CLC premises as defined by Eversource. As mentioned, low users are defined as low users of electricity and do not reflect fuel use (oil, propane, natural gas).

[21] The threshold for bottom 5% of usage is 11,730 kWh per year.

Figure 2-1. Breakout of C&I Premises by Percentile of Total Annual Usage



To optimize our primary research budget, we used different research approaches for the top 95% of C&I usage and the bottom 5%. We targeted customers in the top 95% usage category with both the telephone survey and site visits while customers in the lowest usage category only completed the telephone survey. The sampling approaches for both groups are described below.[22]

Top 95% Usage Group

The primary objective of the sample design was to have a large enough pool of completed phone interviews to recruit site visit participants and to have a distribution of business segments and sizes to enable us to report findings at the segment level. As such, we developed the target number of site visits needed to meet our research objectives and then determined the number of completed phone interviews required to recruit and complete the site visits based on an average target conversion rate of approximately 33%. We thus targeted 455 completed phone interviews from the Top 95% Usage Group to meet our target of 148 site visits.

Our sample design employed a stratified random sampling approach, with strata based on customers' annual electricity usage. For the stratification, we used the Dalenius-Hodges method to determine strata boundaries and the Neyman allocation to determine the optimal allocation of the available projects to the strata. Table 2-15 shows the number of premises in the sample frame by stratum and the targeted number of phone interviews and site visits.

[22] While we did not specifically sample for Martha's Vineyard businesses, we attempted to survey a representative proportion. Martha's Vineyard customers make up 7% of the total sample and 10% of completed interviews.

Table 2-15. Sample Frame and Expected Completes by Usage Category of Top 95% Usage Group

Stratum	Usage Range	Number of Premises in Sample Frame	Targeted Number of Phone Interviews	Targeted Number of Site Visits
3	≥ 1000 MWh/year	84	34	16
2	125-1000 MWh/year	936	121	41
1	<125 MWh/year and still in top 95% of usage	5,800	300	91
Total		6,820	455	148

After defining the sample frame and strata, we assigned a phone number to each premise.[23] We identified 5,573 premises in the top 95% group with unique phone numbers. These premises represent our CATI sample.[24]

Bottom 5% Usage Group

We targeted 70 completed interviews from the Bottom 5% Usage Group.[25] We drew a stratified random sample of 2,200 from the Bottom 5% Usage Group, ensuring that the proportion of business segments was representative of the population of businesses on Cape Cod and Martha's Vineyard.

C&I Segment Classification

We established 10 business segments based on discussions with CLC and our review of the customer data. CLC provided segment classifications for all CLC C&I premises.[26] Although we did not use these segments to develop the sample for the Top 95% Usage Group, we sought to complete surveys with a representative share of businesses in each business segment (to ensure that the overall results matched the mix of business segments on Cape Cod and Martha's Vineyard). We therefore set quotas for each business segment in each usage stratum. However, given the low number of premises in some of the segments, we were unable to meet the quotas for all segments. In order to maximize the total number of responses, we conducted a census attempt of all businesses in the Top 95% Usage Group. We then weighted the results of the completed surveys and site visits back to the population (as described below).

Table 2-16 shows the segment groupings, based on CLC's assignments and the customer usage data.

[23] We assigned phone numbers based on account information, program implementer contact data, and results from a matching service used to identify phone numbers for premises with non-unique or missing phone numbers.

[24] After assigning the best phone number to each premise, we also removed four premises from the sample because they participated in Project 21.

[25] The sample frame from which we drew the sample was developed using the same sample cleaning and phone number assignment processes as the top 95% group.

[26] We verified these segment assignments as part of our phone survey.

Table 2-16. C&I Segment Definitions

Study Segment	SIC Category Code	SIC Segment	Number of Premises		
			Top 95%	Bottom 5%	Total
Small Retail	C3	Retail - Small	915	1,135	2,050
	C14	Health Club/Spa	113	175	288
	C94	Gallery/Museum	52	130	182
Office	C71	Office - Large	10	0	10
	C7	Office - Small	758	1,383	2,141
	C100	Charitable/Non-Profit	70	74	144
Restaurant	C31	Restaurant - Full Service	441	159	600
	C1	Restaurant - Fast Food	324	107	431
Government or Education	G4	Government	494	611	1,105
	C98	Schools K-12	81	20	101
	C101	Laboratory/Research Facility	38	14	52
	C18	Library	23	5	28
	C25	Community College/University	2	0	2
Lodging/ Hospitality	C15	Lodging - Hotel/Motel	258	66	324
	C11	Lodging - B&B/Inn/Rooming House	175	126	301
Multifamily or Rental Housing[A]	C96	Multifamily Commercial	562	2,337	2,899
Health Services	C6	Healthcare - Clinic	347	320	667
	C27	Healthcare - Hospital/Nursing Home	51	9	60
Grocery, Convenience or Large Retail	C2	Grocery - Small/ Convenience/Liquor	197	62	259
	C28	Grocery - Supermarket	35	9	44
	C32	Retail - Large	53	4	57
	C91	Big Box	5	1	6
	C99	Warehouse - Refrigerated	8	9	17
Automotive, Warehouse/ Distribution or Industrial	C9	Automotive	253	255	508
	C92	Water and Waste Water Treatment	112	34	146
	C93	Industrial - Light	279	507	786
	C95	Industrial - Heavy	3	3	6
	C30	Transportation	49	110	159
	C26	Warehouse	232	752	984
Other Commercial	C104	Mixed Use Commercial	322	573	895
	C22	Recreational - Other	242	240	482
	C23	Religious/Houses of Worship	132	146	278
	C8	Other	69	152	221
	C29	Agriculture	44	93	137
	C10	Assembly Hall	44	53	97
	C17	Laundry/dry cleaning	23	13	36
	C97	Recreational - Ice Arena	3	1	4
	M2	Unknown	1	13	14
TOTAL			6,820	9,701	16,521

[A]To leverage the C&I sector's telephone survey contact strategy, 1,476 centrally managed residential rental premises were included in the multifamily/rental housing segment.

Summary of Telephone Survey Statistics

Opinion Dynamics fielded the telephone survey between August 25 and November 3, 2014.[27] Table 2-17 presents the final dispositions for the CATI telephone survey, including both the Top 95% and Bottom 5% Usage Groups. The response rate[28] was 7.0% and the cooperation rate was 12.3%, computed using the same equations described for the residential/LI barriers telephone survey in Section 2.1.3. Please note that this includes only full completes for the CATI telephone survey. An additional two respondents completed nearly all of the phone survey, for a total of 439 usable responses. Opinion Dynamics analysts also completed 9 interviews of CLC's top 20 accounts, an effort that was managed separately, resulting in the total number of completes of 448 we present elsewhere in this report.

Table 2-17. C&I Customer Survey Disposition

Disposition	Number
Completed Interviews (I)	437*
Eligible Non-Interviews	5,224
Refusals (R)	*2,945*
Mid-interview terminate (R)	*161*
Respondent never available (NC)	*1,469*
Answering machine confirming contact (NC)	*636*
Language problem (NC)	*13*
Not Eligible (e)	1,520
Fax/data line	*122*
Duplicate number	*46*
Non-Working	*766*
Wrong Number	*366*
Business, government office, other organization	*199*
No eligible respondent	*18*
Quota filled	*3*
Unknown Eligibility Non-Interview (U)	537
Not dialed/worked	*2*
No answer	*495*
Busy	*21*
Call Blocking	*19*
Total Contacts in Sample	7,748
Response Rate	7.0%
Cooperation Rate	12.3%

*Includes only full completes for the CATI C&I telephone survey. Does not include an additional 2 respondents who completed nearly all of the survey or the 9 interviews of CLC's top 20 accounts completed by Opinion Dynamics analysts.

[27] In addition, Opinion Dynamics analysts completed two of nine interviews with top 20 accounts in January 2015.

[28] Using AAPOR Rate3 (RR3).

2.2.2 Telephone Survey Data Weighting and Adjustments

The telephone survey data presented in this report were weighted to be representative of the population and adjusted using the data collected during the site visits. We also adjusted several key survey questions using other sources when respondents could not accurately provide answers. We describe the weighting and data adjustments in the sections below.

Telephone Survey Weighting

We developed and applied weights to ensure that the telephone survey results are representative of the population of premises in CLC's commercial and industrial sector. The penetration and saturation findings presented in this report are weighted to account for the following factors:

1) Differences in the distribution of customer counts by usage group within our sample compared with the population (i.e., customer base), since we oversampled premises with high usage to collect information on electricity-using equipment typically only found in large facilities. For example, chillers are typically only found in large facilities and to collect enough information on this type of equipment, we needed to oversample large facilities (i.e., those with usage over 1,000 MWh/year).

2) Differences in the distribution of customer counts by segment, to account for variations in survey response rates by segment.

We developed the weights using a multiple step process. First, we created a segment weight by dividing the segment's share of the overall commercial population by its share of respondents. For example, the small retail segment represents 18% of survey responses but only 15% of the C&I population. We therefore weighted down the survey responses from this segment so that, when aggregated to the total, the responses are representative of the overall population. The segment weight for small retail is 15% divided by 18%, or 0.8436. Next, we calculated a usage weight by dividing the usage category's share of the overall population by its share of respondents. For example, the Less than 125 MWh/Year stratum accounts for 70% of survey completes but only 35% of the all premises in that stratum, resulting in a weight of 0.5009. The initial sample weight is the product of the segment weight and the usage weight. In this example, the initial sample weight for small retail respondents in the Less than 125 MWh/Year stratum is 0.4226 (0.8436 multiplied by 0.5009).

We then evaluated the initial sample weights for undesirable unequal weighting effects and determined that one weight (7.04 for lodging/hospitality in the Bottom 5% stratum) was higher than desirable.[29] To correct this, we reweighted the data, trimming the weighting factor at 4.70 and equally redistributing the differential across the other categories.[30] The weights applied to the C&I telephone survey results presented in this report are shown in the Final Sample Weight column in Table 2-18.

[29] A weighting scheme with a high standard deviation of weights relative to the mean weight can yield undesirable results by allowing some customer responses too much influence on the direction of results of their segment.

[30] We trimmed the weight for this segment to three standard deviations from the mean, which is the cutoff recommended by Levy and Lemeshow. (Paul S. Levy and Stanley Lemeshow. Sampling of Populations. 2008. p. 513.)

Table 2-18. C&I Telephone Survey Sample Weights

Usage Stratum	Segment	Premise Count	Responses	Initial Sample Weight	Final Sample Weight
Bottom 5%	Small Retail	1,440	13	3.1704	3.2415
Bottom 5%	Office	1,457	16	3.5981	3.6788
Bottom 5%	Restaurant	266	3	2.2840	2.3353
Bottom 5%	Government or Education	650	1	3.2814	3.3550
Bottom 5%	Lodging/Hospitality	2,529	4	7.0415	4.7051
Bottom 5%	Health Services	329	3	3.5279	3.6070
Bottom 5%	Grocery, Convenience or Large Retail	85	0	--	--
Bottom 5%	Automotive, Warehouse/ Distribution or Industrial	1,661	20	3.3825	3.4584
Bottom 5%	Other Commercial	1,284	10	4.4105	4.5094
<125 MWh/Year	Small Retail	996	66	0.4226	0.4320
<125 MWh/Year	Office	791	48	0.4796	0.4903
<125 MWh/Year	Restaurant	601	33	0.3044	0.3113
<125 MWh/Year	Government or Education	444	24	0.4374	0.4472
<125 MWh/Year	Lodging/Hospitality	843	36	0.9385	0.9596
<125 MWh/Year	Health Services	334	12	0.4702	0.4808
<125 MWh/Year	Grocery, Convenience or Large Retail	171	9	0.3251	0.3324
<125 MWh/Year	Automotive, Warehouse/ Distribution or Industrial	844	51	0.4508	0.4609
<125 MWh/Year	Other Commercial	776	35	0.5879	0.6010
125 - 1000 MWh/Year	Small Retail	84	2	0.4283	0.4379
125 - 1000 MWh/Year	Office	45	1	0.4860	0.4969
125 - 1000 MWh/Year	Restaurant	163	10	0.3085	0.3154
125 - 1000 MWh/Year	Government or Education	163	9	0.4432	0.4532
125 - 1000 MWh/Year	Lodging/Hospitality	141	9	0.9512	0.9725
125 - 1000 MWh/Year	Health Services	54	2	0.4765	0.4872
125 - 1000 MWh/Year	Grocery, Convenience or Large Retail	98	5	0.3295	0.3369
125 - 1000 MWh/Year	Automotive, Warehouse/ Distribution or Industrial	84	7	0.4569	0.4672
125 - 1000 MWh/Year	Other Commercial	104	5	0.5958	0.6091
>1000 MWh/Year	Small Retail	0	0	--	--
>1000 MWh/Year	Office	2	0	--	--
>1000 MWh/Year	Restaurant	1	0	--	--
>1000 MWh/Year	Government or Education	31	6	0.1421	0.1453

Usage Stratum	Segment	Premise Count	Responses	Initial Sample Weight	Final Sample Weight
>1000 MWh/Year	Lodging/Hospitality	11	2	0.3049	0.3117
>1000 MWh/Year	Health Services	10	4	0.1527	0.1562
>1000 MWh/Year	Grocery, Convenience or Large Retail	29	2	0.1056	0.1080
>1000 MWh/Year	Automotive, Warehouse/ Distribution or Industrial	0	0	--	--
>1000 MWh/Year	Other Commercial	0	0	--	--
Total		16,521	448		

Adjustment of Telephone Survey Data

We used information from the site visits to adjust for self-report error in certain phone survey responses. In general, we considered for adjustment any items that customers would be likely to misreport (e.g., penetration of relatively minor equipment and systems), as well as specific equipment types within an overall category (e.g., types of air conditioning systems when a customer had already reported they had air conditioning).

We first conducted a Pearson's chi-squared test for questions considered for adjustment. Only if the test showed that phone survey responses are significantly different from on-site observations, did we include the question for adjustment. We did not adjust questions with low incidence in the site visit sample.

Below are the phone survey questions we adjusted.

- Central Air Conditioning/Cooling
  - Presence of packaged air conditioners (M8)
  - Presence of split air conditioning systems (M8)
  - Presence of heat pumps[31] (M8)
- Water Heating
  - Presence of water heating equipment (M17)
- Refrigeration
  - Presence of ice machines (M27)
- Compressed Air
  - Presence of compressed air equipment (M30)
- Energy Management Systems
  - Presence of EMS (M34)

[31] This study categorizes split air conditioning systems and heat pumps separately. While a heat pump can also be a split system – i.e., have a separate evaporator unit and condenser and compressor unit – a split air conditioning system only provides cooling and cannot provide heating like a heat pump.

Adjustment Methodology

We used the ratio adjustment method to adjust the phone survey responses for the items listed above.[32] This method first develops an adjustment factor, based on the unweighted values of the completed phone survey responses for those sites that later received an on-site visit and the value from the unweighted site visit measurements analogous to the phone survey question being adjusted. The adjustment factor is then multiplied by the value from the survey responses for all sites. The values to be adjusted can be either a mean or a proportion. In the case of this study, we adjusted only penetration, or "presence of" information.

The equation below shows this two-step ratio adjustment method.

$$\text{Adjustment Factor} = \frac{Y_{\text{Site Visits}}}{Y_{\text{Survey Responses}}}$$

Where:

$Y_{\text{Site Visits}}$ = unweighted proportion from the 150 site visits

$Y_{\text{Survey Responses}}$ = unweighted proportion from the survey responses for the 150 premises with site visits

The adjustment factor is then multiplied by the weighted number of survey responses for all premises to develop an adjusted distribution of responses across response categories. This new distribution is then used to calculate new proportions for the adjusted question.

Consider the following example:

The on-site visits found that 26% of premises (unweighted) have ice machines. By contrast, the unweighted phone survey responses provided by the same 150 premises reported that 40% have ice machines. Using these values, we first developed the adjustment factor for ice machines, as follows:

Have ice machine: $$Adjustment \quad Factor = \frac{26.0\%}{40.3\%} = 0.645$$

Do not have ice machine: $$Adjustment \quad Factor = \frac{74.0\%}{59.7\%} = 1.239$$

We then apply these adjustment factors to unweighted phone survey results by response category. Of all phone survey respondents, 120 reported that that they have an ice machine and 324 reported that they do not (valid n=444). Multiplying these responses by the adjustment factor yields:

Have ice machine: *Adjusted Value = 120 * 0.645 = 77*

[32] Judith T. Lessler and William D. Kalsbeek. Nonsampling Error in Surveys. 1992. p. 269.

Do not have ice machine: *Adjusted Value = 324*1.239 = 401*

When adjusting proportions, an additional adjustment step is necessary. When the data is categorical (including yes/no or present/not present), each category is adjusted separately. As a result, as is the case in the example above, the total number of responses no longer sums to the correct valid "n". To correct for this, we also adjust the base of our results to match the original "n".

Finally, we apply sample weights to these results to produce the final results presented in Volume 3 of this report.

2.2.3 Site Visits

The 150 on-site audits were designed to collect data to verify the telephone survey responses and to collect more detailed and technical data that customers are generally unable to report on during a telephone survey. We also collected energy use and behavioral information from these facilities. The objective of this data collection was primarily to gather information about the saturation and penetration of different types of equipment.

Our team of qualified technicians conducted the site audits between September and November 2014. They entered facility data using tablet computers and a comprehensive Excel-based data collection instrument. The data collection instrument covered the topics listed in Table 2-19.

Table 2-19.Types of Information Collected in C&I Site Visits

Business and Occupancy	Penetration and Saturation of Major End-Uses	Equipment Characteristics	Operations/Behaviors
▪ Seasonal occupancy ▪ Building age ▪ Square footage (facility and occupied) ▪ Conditioned space	▪ Lighting ▪ Cooling ▪ Ventilation ▪ Refrigeration ▪ Electric space heating ▪ Water heating (and fuel type) ▪ Motors, fans and pumps ▪ Compressed air ▪ Office equipment ▪ Electric food service equipment ▪ Wastewater treatment equipment	▪ Equipment type ▪ Nameplate information (make, model, age, size/capacity) ▪ Lighting wattage ▪ Efficiency rating (e.g., EER/SEER, AFUE, insulation levels) ▪ ENERGY STAR status ▪ Efficient and inefficient components (e.g., VFDs, demand-controlled ventilation, tank insulation)	▪ Monthly, weekly, and daily operation ▪ Lighting hours-of-use ▪ Equipment hours-of-use ▪ Control strategy (lighting: manual, EMS, occ. sensors, dimmers, daylighting, etc.; HVAC: thermostat, EMS, etc.)

Appendix 2 presents the final on-site audit data collection instrument.

Site Audit Weighting

To account for differences in segments and usage strata between the premises receiving site visits and the sample frame, we developed a two-step weighting scheme similar to the weighting scheme described above for the C&I telephone survey.

Similar to the C&I telephone survey, we developed and applied weights to ensure that the telephone survey results are representative of the population of premises in CLC's commercial and industrial sector. The site visit findings in this report are weighted to account for the following factors:

1) Differences in the distribution of customer counts by usage group within our sample compared with the sample frame (i.e., customer base), since we oversampled premises with high usage to collect information on electricity-using equipment typically only found in large facilities. For example, chillers are typically only found in large facilities and to collect enough information on this type of equipment, we needed to oversample large facilities (i.e., those with usage over 1,000 MWh/year).
2) Differences in the distribution of customer counts by segment, to account for variations in survey response rates by segment.

As with the C&I telephone survey, the sample weight is a product of the segment weight and the usage weight. After developing the site visit weights, we evaluated the weights for undesirable unequal weighting effects and found none. The weights applied to the C&I telephone survey results presented in this report are shown in the Sample Weight column in Table 2-20.

Table 2-20. C&I Site Visit Sample Weights

Usage Stratum	Segment	Population Count[a]	Responses	Sample Weight
<125 MWh/Year	Small Retail	2,436	20	1.3691
<125 MWh/Year	Office	2,248	16	1.5402
<125 MWh/Year	Restaurant	867	10	0.7842
<125 MWh/Year	Government or Education	1,094	12	0.7347
<125 MWh/Year	Lodging/Hospitality	3,372	15	1.9146
<125 MWh/Year	Health Services	663	5	0.9216
<125 MWh/Year	Grocery, Convenience or Large Retail	256	4	0.4370
<125 MWh/Year	Automotive, Warehouse/ Distribution or Industrial	2,505	21	1.1815
<125 MWh/Year	Other Commercial	2,060	9	2.0574
125 - 1000 MWh/Year	Small Retail	84	1	0.3429
125 - 1000 MWh/Year	Office	45	1	0.3858
125 - 1000 MWh/Year	Restaurant	163	5	0.1964
125 - 1000 MWh/Year	Government or Education	163	2	0.1840
125 - 1000 MWh/Year	Lodging/Hospitality	141	5	0.4796
125 - 1000 MWh/Year	Health Services	54	2	0.2308
125 - 1000 MWh/Year	Grocery, Convenience or Large Retail	98	4	0.1095

Usage Stratum	Segment	Population Count[a]	Responses	Sample Weight
125 - 1000 MWh/Year	Automotive, Warehouse/ Distribution or Industrial	84	4	0.2959
125 - 1000 MWh/Year	Other Commercial	104	3	0.5153
>1000 MWh/Year	Small Retail	0	0	--
>1000 MWh/Year	Office	2	0	--
>1000 MWh/Year	Restaurant	1	0	--
>1000 MWh/Year	Government or Education	31	6	0.0405
>1000 MWh/Year	Lodging/Hospitality	11	1	0.1056
>1000 MWh/Year	Health Services	10	2	0.0508
>1000 MWh/Year	Grocery, Convenience or Large Retail	29	2	0.0241
>1000 MWh/Year	Automotive, Warehouse/ Distribution or Industrial	0	0	--
>1000 MWh/Year	Other Commercial	0	0	--
Total		16,521	150	

[a] The population count for the <125 MWh/year usage stratum includes the Bottom 5% usage stratum

2.2.4 Manual Adjustments

In addition to adjusting phone survey results with information from the site visits, we also made some manual adjustments to the final data.

Square Footage

Square footage is a key input into the potential model. We asked each phone survey respondent about the size of their business in square feet and also collected this information during our on-site visits. Although telephone survey interviewers prompted respondents to give their best estimate, 37% of customers were still unable to estimate the square footage of their business. In these cases, we used the site visit estimate if available. Additionally, our initial review of the phone survey responses found that many of the estimates were not accurate. The telephone survey adjustment methodology used for many questions did not work in this case because the square footage estimates from the site visits may also have been incorrect, either from auditor error or from being provided by the same contact at the site who supplied the erroneous first estimate. Instead we used an alternate adjustment method consisting of randomly selecting a sample of 50 sites and researching the exact square footage of each site to develop an error correction factor of 93% to apply to the population. To find the square footage of these properties, we used public property records,[33] as well as aerial and satellite photographs along with a web-based application designed to obtain the square footage of a building from these photos.

Equipment Information

Whenever possible and reasonable, the site visit auditors collected detailed information (e.g., efficiency level of central air conditioning systems (SEER) and horsepower of motors) for the equipment found onsite. In cases where it was impossible to determine this information

[33] We used tax records found on the Massachusetts Office of Geographic Information (MassGIS) online mapping tool. (http://maps.massgis.state.ma.us/map_ol/oliver.php)

onsite, we used to the model number, collected during the site visit, to research this information following the site visit.[34]

2.3 Potential Modeling

2.3.1 General Methodology

Description of Model

We developed a CLC-specific potential model that estimates the electric energy and capacity saving potential in CLC's service territory. The model embeds CLC-specific inputs with respect to measure characteristics, equipment penetration and saturation, and measure adoption assumptions. We developed a flexible potential model structure that can produce the outputs and level of disaggregation specified by CLC – at the sector level (C&I, residential, and low income), for key market segments, etc. – and that allows for future modification of key model parameters by CLC staff to test different scenarios during the program planning process.

The scope of the study included development of three levels of potential: technical potential, economic potential, and achievable potential. They are defined as follows:

- Technical Potential: For each market,[35] the measure procuring the most energy savings per unit is selected. The technical potential is defined as the electricity savings from these measures multiplied by the theoretical maximum number of units per year.
- Economic Potential: For each market, the cost-effective measure procuring the most energy savings per unit is selected. The economic potential is defined as the electricity savings from these measures multiplied by the theoretical maximum number of units per year.
- Achievable Potential: The achievable potential is defined as the electricity savings from cost-effective measures adjusted by several factors to represent the potential that could be achieved through ambitious and comprehensive programs/initiatives.

Key concepts used in the estimation of potential are briefly described below.

- Inputs: The model requires several inputs at the measure level (e.g., energy and capacity savings, costs, effective useful life, net-to-gross factors, load profile, etc.), as

[34] In some cases, to minimize the time on-site and disruption to customers, auditors only collected the model numbers of equipment knowing that other nameplate information could be researched later. Auditors collected efficiency and capacity information for approximately 85% of systems onsite and looked up the other 15% after the visit.

[35] We use the words "market" or "market size" to describe the number of baseline equipment or buildings in a given segment that capture the opportunity for specific energy-efficient measures. For example, the number of sockets with incandescent bulbs in the non-seasonal residential sector would be an example of a "market" for CFLs or LEDs.

well as other inputs such as avoided costs, rates, electricity forecasts, markets, and initiatives.[36]

- Units per Year (theoretical maximum): Using inputs and calculations such as market size and growth, measure type, and natural replacement rates of existing equipment, the maximum number of units that could be replaced or installed per year is calculated.
- Cost-Effectiveness: The model calculates two types of cost-effectiveness ratios. Both tests can be calculated at the measure, initiative, segment, sector, and portfolio level.
  - The **Total Resource Cost test (TRC)** is used to screen measures for the economic and achievable potentials. A positive TRC result (net present value higher than zero or cost-benefit ratio higher than one) indicates that the energy efficiency measure (or initiative) will produce reductions in energy costs, as well as non-energy benefits, that are greater than the costs of implementing that measure (or initiative).
  - The **Participant Cost Test (PCT)** is an input for measure adoption rates. A positive PCT result means that the participant of an energy efficiency initiative will receive benefits – including energy bill savings and non-energy benefits – that are higher than net costs (i.e., the cost of the measure minus incentives received by the participant).
- Base Adoption Rate: The base adoption rate for determining the achievable potential is calculated using the cost-effectiveness of measures from the participants' point of view and levels of market barriers.
- Competing Measures: At the achievable potential level, multiple cost-effective measures can compete with each other for the same market. In that case, each measure is attributed a share of the overall market, based on its base adoption rate compared to other measures. An example would be CFL and LED bulbs competing for the same sockets where incandescent lighting is currently used. If both are cost-effective, both will be included in the achievable potential.
- Cumulative Annual Savings: Cumulative savings are calculated for each potential type and each year, using incremental savings potentials. Savings from individual measures are removed from the cumulative savings at the end of their effective useful life (EUL). For instance, a measure installed in Year 1 and with a EUL of two years would be removed from the cumulative potential starting in Year 3.
- Aggregate Results and Reporting: Measure-level energy and capacity savings, costs, and benefits are aggregated and can be displayed by sector, segment, end-use, measure-type, or initiative. Costs are reported from both the program administrator's and the service territory's perspectives. The program administrator's costs do not

[36] Initiatives are sub-components of programs that target specific opportunities. For instance, the Residential New Construction, Residential Multi-Family Retrofit, and Residential Behavior/Feedback initiatives are all part of the Residential Whole House Program.

include the participants' share of costs (i.e., costs that are not covered by incentives), nor do they include any adjustments for early retirement measures.

The following sections present more detailed descriptions of the modeling methodology. It should be noted that the rest of the methodology discussion focuses on achievable potential as it is the study's primary focus.

Sectors and Segments

The model reflects three different sectors and 13 segments, as detailed in Table 2-21 below. Measure inputs are differentiated by segment (e.g., lighting savings vary by commercial segment according to reported hours of use and seasonality adjustments). Results are reported at both the sector and segment levels.

Table 2-21. Sector and Segment Definition for Potential Model

Sector	Segment
Residential	Non-seasonal
	Seasonal
Low Income	Low Income
C&I	Small Retail
	Office
	Restaurant
	Government or Education
	Lodging/Hospitality
	Health Services
	Multifamily or Rental Housing
	Grocery, Convenience or Large Retail
	Other Commercial
	Automotive, Warehouse/Distribution or Industrial

End-Uses

The model includes 12 different end-uses, listed in Table 2-22 below (with examples of associated measures).

Table 2-22. End-Uses Included in Potential Model

End-Use	Examples of Measures
Lighting	LED light bulbs, lighting controls, efficient linear lighting
HVAC (Heating, Ventilation, Air Conditioning)	Thermostats, heat pumps, air conditioning units
Motors	Furnace fan motors, pool pumps, C&I ventilation & process motors
Refrigeration	Refrigerators, freezers, vending machine misers
Food Services	Ovens, dishwashers, fryers

Hot Water	Heat pump water heaters, low flow showerheads, spray rinse valves
Appliances	Clothes dryers
Products	Smart strips, TVs, Dehumidifiers
Behavior	Feedback, opt-In behavioral, basic educational measures
Envelope	Insulation, air sealing
CHP (Combined Heat and Power)	Combined heat and power
Other	Retro-commissioning, advanced energy analytics, cable boxes

Measures

We used the 2012 Massachusetts Technical Reference Manual (TRM) (Program Years 2013-2015) as a starting point for the list of measures to be included in this study. Amongst other factors, the expected relative importance of measures in CLC's potential was used to make decisions on aggregating TRM measures or breaking them out into sub-measures. As an example, lighting measures in the TRM are much more detailed than weatherization measures. We bundled measures mainly across initiatives that offer the same measure, using either assumptions for the most prevalent initiative or weighted averages for measure inputs.

The following measure categories were excluded from the scope of this study:

- Demand Response
- Fuel Switching
- Renewables
- Gas-saving measures that are covered by other PA's natural gas initiatives, which may also have an electric impact.

In addition to TRM measures, CLC expressed interest in investigating and screening new measures that are not currently offered in Massachusetts (as reflected by the TRM). We followed the process described below to identify new measures:

1. We reviewed a total of 13 Technical Reference Manuals to identify measures that are not already included in the Massachusetts TRM and are not currently offered by CLC programs.
2. We reviewed the program tracking database of an Emerging Technology program in California (which had close to 200 projects) to identify up-and-coming measures that currently have low market adoption rates but may evolve as a result of product development growth and market awareness for future implementation.
3. We reviewed a list of measures provided by the Massachusetts Technical Advisory Committee (MTAC).

After systematically considering new measures, we found that CLC already has a nearly complete suite of measures available within their portfolio. Many "missing" measures where in fact already included in CLC's initiatives as "custom measures" and were added to our list. We selected new electric measures for inclusion in this study based on the likelihood that they may represent a significant potential during the study period.

Table 2-23 lists new measures included in the study.

Table 2-23. New Measures Included in Potential Model

Residential / Low Income
Whole-House Fan
Residential Behavioral Opt-in[A]
Room Air Conditioning Recycling[B]
C&I
Linear LEDs without Ballast Change
Ultra High Efficiency Roof Top Units
Advanced Controller for Roof Top Units
Smart Thermostat (Cooling)
Advanced Refrigeration for Supermarkets – Glass Door Retrofits
Advanced Refrigeration for Supermarkets – Floating Head Pressure Control
Strip Curtains
Retro-commissioning and Advanced Energy Analytics
Advanced Lighting Controls
Early Replacement of Cable Boxes
Combined Heat and Power

[A] The Cape Light Compact has previously received information that might question the viability of this type of program, given the size of the population and its ability to participate in an initiative like this one.

B The Compact has previously offered room air conditioning recycling; however, because it is not currently being offered, it is referenced as a new measure here.

Calculation of Achievable Potential

As defined above, the achievable potential is defined as the electricity savings from cost-effective measures multiplied by the theoretical maximum number of units per year, the base adoption rates, the market share adjustments for competing measures, and other adjustments such as market applicability factors[37] and uptake factors.

We used adoption curves, based on the Department of Energy (DOE) adoption model, to determine the base adoption rate for each measure, by segment.[38] These curves provide a formula for relating customer cost-effectiveness to adoption rates, given different levels of market barriers. The DOE model is grounded in a qualitative assessment of market barriers and the calculation of a cost-benefit ratio to estimate the maximum achievable market penetration for energy efficient products. Based on this approach, measure cost-effectiveness and perceived barriers are the two primary factors affecting adoption rates. In our model, both

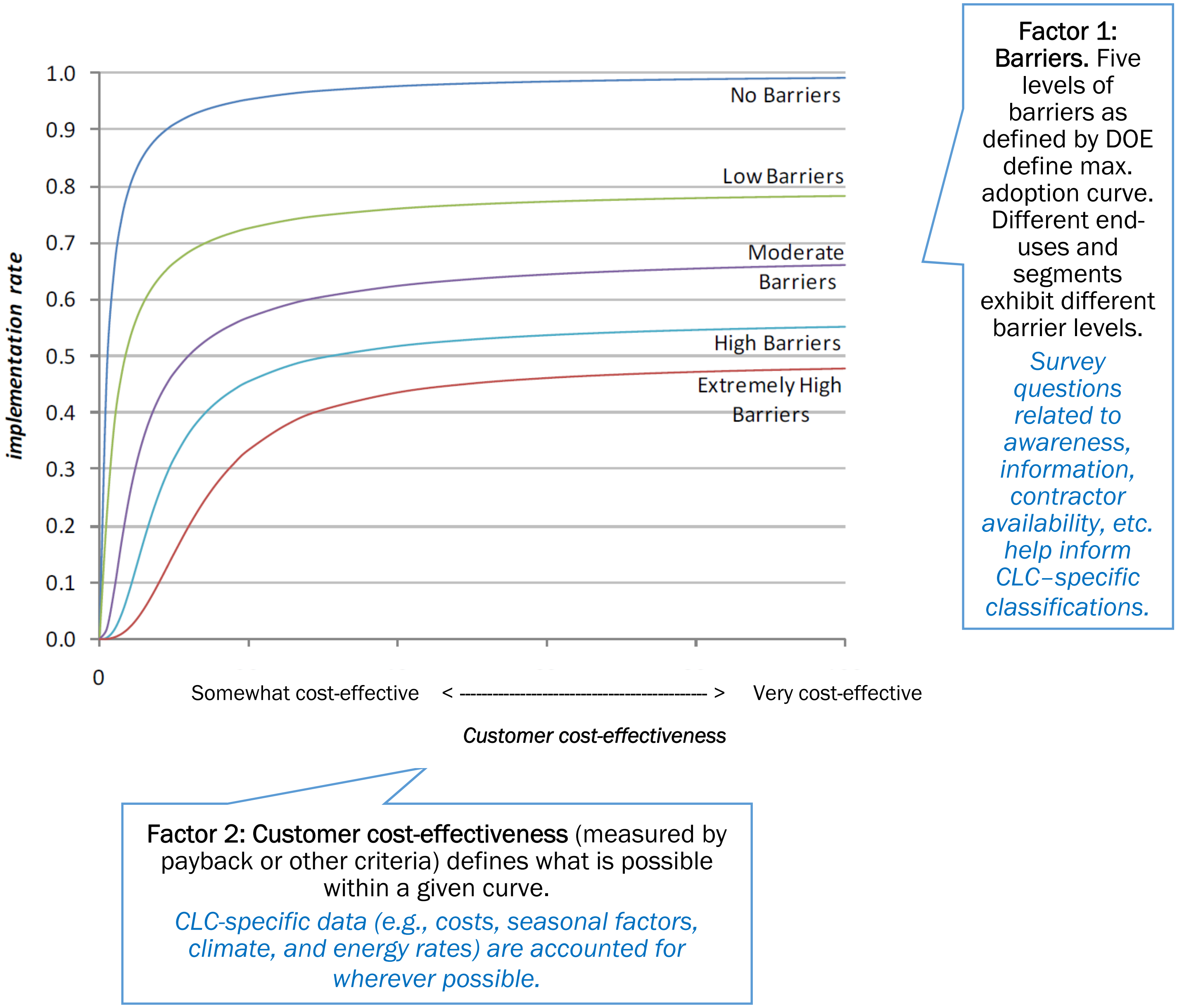
[37] Market applicability factors adjust the potential of some measures to account for specific technical barriers that prevent the application of that measure in a share of the potential market.

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

market barriers and the cost-effectiveness ratios encompass several CLC-specific inputs (see also Table 2-24, later in this section).

Figure 2-2 presents a schematic view of adoption curves.

Figure 2-2. US DOE Adoption Curves



The main steps for determining the adoption rate for each measure/segment are:

1. Selection of a curve, based on barriers level and benefit-cost criteria. Both barrier levels and the benefit-cost criteria (net present value vs simple payback period) were determined using survey inputs.

2. Calculation of customer cost-effectiveness, using the model's inputs, including measure characteristics (costs, savings, EUL, etc.), energy rates, and the incentive levels offered by modeled initiatives.
3. Calculation of the adoption rate, based on the selected curve and the cost-effectiveness value.

While our approach to determining the adoption rate is based on the US DOE model, we investigated the need for a few refinements: the choice of the cost-benefit criteria and short-term and long term adjustments. These refinements are described below.

Cost-Benefit Criteria

The DOE model assumes that participants make their decisions based on a benefit-cost ratio calculated using discounted values. While this may be true for more sophisticated customers (large institutional and C&I customers), many customers use much simpler decision criteria, including the payback period. This has implications on the choice of measures by the model, since the payback period ignores the value of money over time as well as any impacts after the break-even point has been reached. Thus, using the payback period, short-term benefits are favored over long-term benefits, creating a bias in favor of measures with a short effective useful life.[39]

To determine which cost-benefit criteria should be used for this study, the surveys gathered information on the criteria actually used by customers. Based on survey responses, we used the PCT ratio for the C&I sector (we did not observe clear differences by C&I segment) and the Simple Payback Period (SPP) for the Residential and Low Income sectors.

As a result, for the residential and low income sectors, we converted the DOE adoption curves to equivalent curves reflecting payback periods, based on discounted values. We assumed an average effective useful life of 15 years and used CLC's discount rate.

Short-term Adjustment

The DOE model determines the percentage of the informed market that will accept an energy efficiency measure based on the barrier level and the cost-effectiveness ratio – this is the "adoption rate" discussed above. The informed market is defined as the portion of the market that is aware and informed about the energy efficiency measure. Low awareness limits implementation of measures.

Furthermore, some programs may be limited in their ability to quickly increase participation after available rebates are increased because of delivery limitations. A good example would be a home retrofit program that requires skilled auditors and contractors: increasing capacity necessitates the enrollment and training of additional program vendors, which could take some time.

[39] Let's suppose a 3-year simple payback criteria is used by a customer. This means that a measure has to pay for itself within this 3-year period, regardless of its useful life. A measure with a payback of 4 years and a useful life of 20 years would be very cost-effective using a PCT ratio (with a cost-effectiveness ratio of approximately 3.5), but would be rejected using a simple payback criteria. On the other hand, a measure that is barely cost-effective (PCT ratio of 1) but has a very short useful life would be included.

These two factors, measure awareness and program delivery structure, can limit program participation, especially during the first few years, and result in lower participation than the maximum achievable implementation rates as calculated using the DOE model.

For this study, we made short-term adjustments to measure adoption on a case-by-case basis, using professional judgment. We adjusted few measures given that overall model results are within reasonable reach of the actual 2013-15 Plan.

Long-term Adjustment

The DOE model is based on the assessment of market barriers at a given point in time. These barriers are then assumed to remain static. In reality, barriers can be lowered in the long run, especially if programs use enabling strategies. Examples of enabling strategies include financing, labeling, and workforce training. For programs, measures, or market segments where specific barriers are prevalent, targeted strategies could, and likely would, be put in place.[40]

However, because the barrier levels, estimated using survey results, are already low (ranging from "low" to "moderate" for most of them), we only made long-term adjustment for LEDs in the residential sector to reflect anticipated evolving technology and better consumers' knowledge.

Chained Measures

Chained measures are measures that are installed in combination with one another. Chained measures require an adjustment in savings because the total savings of these measures is less than the sum of the savings of each individual measure. For example, if a customer installs a heat pump water heater as well as low flow showerheads and faucet aerators, the savings from the low flow showerheads and faucet aerators are smaller than if they were installed in a home with a less efficient water heater (less energy is lost for the same amount of wasted water). The adjustment to the chained measures' savings are calculated based on the different measures in the chain and entered for each individual measure.

CLC-Specific Adjustments

A key aspect of this study was to incorporate CLC-specific factors that differentiate CLC from the rest of Massachusetts.

The most important adjustment to measure inputs in this study was to account for seasonality. A large share of residential customers (31.7%), as well as many C&I customers (especially in the Restaurant and Lodging/Hospitality segments), show reduced occupancy or hours of operation, especially during the winter. Some customers even shut down completely during that period. Reduced activity is also observed during the spring and autumn seasons. For this study, we adjusted energy savings, peak savings, and load shapes to account for seasonality using survey and site visit data. The seasonality adjustment factors were calculated for each major end-use, taking into account the requirement to maintain a minimum temperature in

[40] Higher incentives are already implicitly taken into account in the cost-effectiveness ratio (higher incentives result in lower paybacks and higher Participant Cost Test ratios). To prevent double-counting, no adjustment have been made to market barriers because of higher incentives.

buildings to prevent freezing conditions. Reduced savings due to seasonality impact cost-effectiveness of measures, thus screening out some measures for specific segments and reducing adoption rates of remaining measures for segments with a strong seasonal profile.[41]

We also considered several other CLC-specific characteristics, such as business types and size, building stock, milder climate, and measure cost when developing the model's inputs.

Table 2-24 (next page) summarizes CLC-specific factors that were considered and how they were addressed in the model.

[41] In addition to the savings adjustment, we also increased market barriers for the opt-in behavioral measure in the Residential seasonal segment. Because this measure is more demanding, we expect that customers with secondary homes, presumably on leisure time, would show less interest.

Table 2-24. CLC-Specific Factors Considered in Potential Model

Factors Considered	Model addresses this through... Baseline Equipm. / Usage	Barriers	Costs	Savings	Other	Notes
Residential						
Seasonality A sizable proportion of the population and housing stock is seasonal, which means (a) they may use less energy compared to similarly-sized non-seasonal houses, (b) the savings they could get from a measure may be less, (c) the payback period may be longer, (d) they may have a different set of priorities for home improvements, or (e) CLC may have more limited time period and channels to intervene/promote programs.	✔	✔		✔		Seasonal and non-seasonal are treated as separate segments, with separate annual usage assumptions (based on actual data and survey) and measure characterization (from baseline study). We also adjusted savings for measures affected by seasonality, to reflect factors such as lower HOU. Our survey didn't find significant differences in barrier levels between seasonal and non-seasonal customers, so we did not adjust barriers with the only exception of opt-in behavioral, as this measure requires much more involvement than the other measures.
Age of population The CLC customer base is thought to be older than statewide average. This may result in lower likelihood to invest in EE (ROI calculus is off, fixed income, etc).		✔				Any lower likelihood to adopt EE measures as a result of age was captured in the barrier survey and is therefore reflected in the adoption curves.

Factors Considered	Model addresses this through... Baseline Equipm. / Usage	Barriers	Costs	Savings	Other	Notes
<u>Building stock</u> CLC believes that stock is newer than the rest of the state. That means that pre-weatherization barriers may be low (e.g., knob and tube wiring), and there may be many 1- or 2-story homes that are relatively easy to insulate and work on. Additionally, many 3-season homes are converted to 4 season homes, which presents lots of opportunity. However, this means that the required upgrades are significant, and it's possible that customers would rather renovate the kitchen or bath than spend the incremental dollars for high efficiency.	✔	✔				CLC-specific information on insulation levels and barriers levels were collected and integrated in the potential study.
Commercial						
<u>Seasonal business cycles</u> Cash flow for some business owners is concentrated in a few months of the year. Seasonable businesses have a smaller window of opportunity to actually complete EE retrofits. CLC has a narrow window to approach them to discuss the programs and EE retrofits that are available to them. Seasonality also affects savings - for businesses that are closed during the winter and much of the spring and fall, the payback period may be longer.		✔		✔		The model uses a weighted average of barrier levels by segment (including both seasonal and non-seasonal customers). We also adjusted savings to account for reduced hours of operation and/or shutdowns during the off-peak seasons.

Factors Considered	Model addresses this through... Baseline Equipm. / Usage	Barriers	Costs	Savings	Other	Notes
Business types Lots of retail, hospitality, and government buildings,[42] and relatively few office. Business owners whose income is tied to tourism may be more reluctant to spend on EE in the off season because they have a hard time forecasting how business will be next season.		✔				Since barriers levels are determined for each market segment, and modeling is performed at the segment level, the overall potential model results appropriately represent barriers for CLC's mix of businesses.
For many segments, commercial businesses are generally smaller than businesses in the rest of MA.	✔			✔		Each segment's average and total annual consumption is reflected in the measure characterization, which reflects any difference in equipment penetration/saturation (and equipment size, where relevant) related to small business size.
Building stock Many commercial operations are in structures originally built as residential, creating significant issues with measure applicability. CLC, along with the statewide programs in general, has limited commercial measure offerings for these building types as compared to the average MA commercial customer (though residential measures are offered).	✔				✔	We moved customers who are clearly "residential commercial" (as identified by CLC) into the residential study. Still, there is a fair number of small, house-like structures in other segments. The characteristics of these businesses are reflected in the measure characterisation and baseline equipment.

[42] Note that CLC pays 100% incentives for all projects in government buildings.

Factors Considered	Model addresses this through...					Notes
	Baseline Equipm. / Usage	Barriers	Costs	Savings	Other	
All Sectors						
<u>Climate</u> The climate is milder on the Cape and Vineyard relative to the rest of the state, so weather-dependent measures may have lower savings (and a longer payback)				✔		Savings have been adjusted using Cape Cod weather normals where relevant.

Model Calibration

Model calibration ensures that the overall estimated consumption levels determined by the model are in line with utility electricity forecasts. For this study, because of the amount and quality of primary data, model calibration is not as critical as for other potential studies that must rely on secondary sources to make broad assumptions on equipment saturation and building characteristics. The comprehensive primary data on penetration, saturation, and characteristics of equipment and buildings in each sector and segment greatly reduces the chance of underestimating or overestimating the load forecast because the modeled baseline does not fit the actual baseline and real consumption.

In the residential and low income sectors, we used annual energy consumption levels by equipment type – obtained through regression analyses of actual electric accounts as well as secondary sources – to ensure that our overall estimated consumption matches the electricity forecast for these sectors.

In the C&I sector, this approach would be too onerous due to the complexity and diversity of equipment and buildings. As both the potential markets and the baseline equipment were well defined due to extensive primary research, those elements were not deemed critical. We therefore used indirect approaches, including verification of lighting densities and average floor area, to validate our primary data.

2.3.2 Inputs and Assumptions

Measure Characterization

For existing measures, we reviewed measure assumptions (savings estimates or algorithms, cost, effective useful life, etc.) and assessed if they adequately reflect CLC's service territory and customer base.

We based savings assumptions on the Massachusetts TRM, where possible. For measures with algorithm-based or custom savings, we used primary data and engineering algorithms, historical program data, or program impact evaluations to derive the required inputs to calculate the savings. We also used evaluation results and participation data to validate measure assumptions.

Savings include other fuels impacts (oil, gas, propane). These other fuels savings or added consumption do not directly affect electric potential results (no "kWh-equivalent" savings/reductions were used) but are considered when calculating measure cost-effectiveness and may positively or negatively impact measure screening and adoption rates.

As discussed above, we made adjustments to savings for residential customers and C&I segments with high seasonality profiles. These adjustments were made for each major end-use, based on survey and site visit occupancy results and operational profiles during unoccupied periods use. For the C&I sector, this was supplemented with a billing analysis, to identify the proportion of businesses within a segment with seasonal consumption patterns. We derived seasonal adjustments from those results for winter peak and off-peak as well as summer peak and off-peak consumption. Overall energy and peak savings were adjusted accordingly.

We used CLC-specific incremental costs wherever those costs were available. For measures where only statewide cost assumptions were available, we considered making an adjustment to account for the difference between statewide and CLC costs. However, we did not find evidence of materially higher CLC costs, based on a comparison of CLC costs with other MA jurisdiction (where available), as well as a comparison of construction cost indexes for CLC's service territory versus the rest of MA. Thus, we made no CLC-specific adjustments.

Non-energy impacts (often referred to as "externalities"), as quantified in the Massachusetts' TRM,[43] are monetized in the potential model. Because they directly affect the cost-benefit ratio results, there is no need to adjust market barriers to account for non-energy impacts.

Types of measure

The model uses four types of measures: replacement on burnout (ROB), early retirement (ER), addition (ADD), and new construction/installation (NEW). Each of these measure types requires a different approach for determining the maximum yearly units available for potential calculations, as detailed in Table 2-25.

Table 2-25. Types of Measures Used in Potential Model

Measure Type	Description	Market Base	Yearly Units Calculation
Replace On Burnout (ROB)	Existing units are replaced by efficient units after they fail *Example: Replacing incandescent bulbs by LEDs*	Existing Units	Market/Effective Useful Life (EUL) *The EUL is set at a minimum of 6 years to spread installations over the potential study period. Alternate EULs can be used to calculate yearly units if baseline units have a different EUL than efficient units.*
Early Replacement (ER)	Existing units are replaced by efficient units before burnout *Example: Early replacement of functional but inefficient refrigerators*	Existing (Old) Units	Market (old units)/6 (study period) *The market is defined as the number of old units, not the total number of units (e.g., old refrigerators that could be retired early, not all existing refrigerators).*
Addition (ADD)	An EE measure is applied to existing equipment or structures	Existing Units	Market/6 (study period)

[43] Non-energy impacts are values that are estimated after the measures have been implemented, and as such may not represent exactly what consumers perceive as non-energy impacts at the time of investment decision-making. Our analyses using the potential model indicate, however, that non-energy impacts have a very small effect on results, meaning that this effect would not have a significant impact on potential results.

Measure Type	Description	Market Base	Yearly Units Calculation
	Example: Adding controls to existing lighting systems, adding insulation to existing buildings		
NEW	Measures not related to existing equipment *Example: new construction, installing a new heat pump (not replacing an existing heat pump)*	Custom	Market *Market base is measure-specific and defined as new units per year*

Early Retirement

Early retirement refers to efficiency measures (and program strategies) that seek to replace functional equipment before the end of its useful life. Refrigerator replacement is a common measure that falls into this category, but early retirement can also apply to any other equipment including other appliances, HVAC systems, and lighting.

In addition to the yearly unit calculations explained above, the first cost for early retirements is adjusted to reflect true economic costs. This adjustment is required because early retirements defer the need for new capital investment in the future. Assuming, for example, that there is an initial investment to buy a refrigerator in year 1 and this refrigerator would have been replaced anyway in year 5, the future investment that would have taken place in year 5 is now pushed forward in the future because the new fridge will last 15 years (instead of 5 years for the old fridge). Because the value of money decreases with time, there is an economic benefit in deferring future investments.[44]

We use the following formula to adjust costs for early retirements, which calculates the difference between the discounted values of two streams of investments:

$$PV = (C - incr)\left\{1 + \frac{1}{(1+dr)^{eul} - 1}\right\}\left\{1 - \frac{1}{(1+dr)^{erp}}\right\} + incr$$

Where:

PV = present value of initial cost and deferred future costs

[44] Note that because of this adjustment, the economic cost used by the model might be lower than the incentive in some cases.

C = initial capital cost

incr = Incremental cost (cost of efficient vs baseline unit)

dr = discount rate

eul = effective useful life of new unit

erp = early replacement period (remaining effective useful life of old unit)

During the initial “early retirement” period, the energy consumption of the new, efficient unit is compared to the old, retired unit to calculate savings. After the initial period, the new efficient unit is usually compared to a new “baseline” unit with standard efficiency. This “dual baseline” approach is widely used to calculate savings and cost-effectiveness for early retirement measures. However, in Massachusetts, the “single baseline” approach (constant savings for the full EUL) is still in use. As a result, CLC requested that this study use the single baseline approach to make CLC’s potential results comparable to those of other MA program administrators. This single baseline approach for savings has no impact on the method we use for economic costs described above.

Economic Parameters

The potential model incorporates several key economic parameters:

- The **cost-effectiveness** framework used in this study follows the Department’s directive in Energy Efficiency Guidelines (D.P.U. 08-50-A), as well as the “BCR Model” used internally by CLC. Before building the potential model, we ensured that our core calculations replicated the results of the BCR Model.
- **Avoided costs** in this study reflect the latest available information from the 2015 study by the Avoided-Energy-Supply-Component (AESC) Study Group.
- **Electricity rates**, used for participant cost-effectiveness calculations, are based on energy and capacity avoided costs for the wholesale portion, and on marginal retail rates for the retail portion. We assumed that the retail portion would grow at the same rate as the energy portion in the long term, reflecting pressures on the grid from renewable energy and aggressive EE targets. For non-electric fuel types (gas, oil, and propane), we used the avoided costs as a proxy of future fuel prices.
- We used a **real discount rate** of 0.44%, based on 2014 10-years Treasury rates.

Baseline Potential Markets

Markets are largely determined by our primary data collection. The surveys and site visits collected existing equipment and building characteristics in CLC’s service area. We used this information to quantify baseline equipment and building components to which energy efficient measures can be applied.

For new equipment (e.g., heat pumps that do not replace existing heat pumps), we conducted additional interviews with contractors to estimate the annual market size.

We estimated new construction in the residential sector using the “Annual New Privately-Owned Residential Building Permits (Estimates with Imputation)” from the U.S. Census Bureau. We extrapolated total 2013 building permits for Barnstable and Dukes counties into the future using a 4.6% annual growth rate, based on the observed 2009-2013 growth.

We estimated new construction in the commercial sector using a 2013 market assessment of Cape Cod, prepared by the Chesapeake Group for the Cape Cod Commission.[45] We used the total market growth for retail goods and services (0.12% per year over the next 10 years) as a starting point for evaluating the C&I New Construction market. We set a growth rate three times higher (0.37%) for health services, which the report (qualitatively) identified as a segment with higher growth potential because of the aging population. We then adjusted other segments to 0.09% in order to keep the added square footage per year at the same level (i.e., at an average overall growth rate of 0.12% per year).

We used the new square footage (about 126,000 square feet per year, estimated based on an average annual growth rate of 0.12%) for the advanced lighting design measure, and the annual growth rate (0.09% to 0.37%) for all the other markets except CHP and early retirement measures (i.e., T12 and motors).

[45] The Chesapeake Group (c.2013), “Market Assessment of Cape Cod, Massachusetts”.

3. Summary of Key Penetration and Saturation Results

A primary purpose of this portion of the study was to determine the penetration and saturation of key electricity-using equipment in homes and businesses. These two concepts are defined as follows:

- **Penetration:** A percentage representing the proportion of customers that have one or more of a particular piece of equipment. It is calculated by dividing the number of customers with one or more of a piece of equipment by the total number of customers responding to that question. For example, non-seasonal residential customers had an LED penetration rate of 49%, compared to only 21% of seasonal residential customers and 8% of low income customers.

- **Saturation:** A number representing how many of a particular piece of equipment exist, on average, among all customers. It is calculated by dividing the total number of a particular piece of equipment by the total number of customers responding to that question (regardless of whether they reported having the equipment or not). This ratio is at least equal to, but generally higher than the corresponding penetration of the equipment, because some customers will have more than one of the equipment. For example, the saturation rate of LEDs in non-seasonal homes was 5.1 LED bulbs on average across all non-seasonal homes, compared to an average of 1.5 LED bulbs across all seasonal residential customer homes and less than one across all low income homes.

Table 3-1 presents key equipment penetration and saturation data collected in the 2014 Residential Energy Use Survey and adjusted, where necessary, by site visit results. In some cases (footnoted), penetration and saturation data is based directly on site visit data. Penetration and saturation results are presented for the three study segments: residential seasonal (Res-S), non-seasonal (Res-NS), and low income (LI). The full adjusted results of the 2014 Residential Energy Use Survey are presented in Volume 2 of this report.

Table 3-1. 2014 Residential and Low Income Equipment Penetration and Saturation Results

Appliance/Equipment	Penetration			Saturation		
	Res - S	Res - NS	LI	Res - S	Res - NS	LI
Lighting[S]						
Incandescent	100%	100%	96%	27.5	30.0	16.1
CFL	83%	96%	93%	17.0	18.1	14.8
Fluorescent tube lighting	57%	76%	69%	2.9	6.1	3.3
Halogen	35%	44%	19%	1.3	2.4	1.5
LED	21%	49%	8%	1.5	5.1	0.5
Cooling						
Central air conditioning	36%	32%	13%			
Window units	39%	56%	68%	1.36	1.24	0.85
Programmable thermostats[S] *(of those with central AC)*	70%	71%	44%	1.12	1.09	0.67

Appliance/Equipment	Penetration			Saturation		
	Res - S	Res - NS	LI	Res - S	Res - NS	LI
WiFi thermostats[S] *(of those with central AC)*	4%	0%	0%	0.04	0.00	0.00
Space and Water Heating						
Space Heating (Primary)						
Electric	13%	8%	12%			
Natural Gas	51%	59%	48%			
Oil	25%	27%	34%			
Propane	8%	5%	5%			
Space Heating (Secondary)						
Electric	15%	22%	25%			
Wood	3%	9%	7%			
Propane	2%	3%	2%			
Any electric space heating	27%	29%	36%			
Boiler reset controls[S] *(of those with boilers)*	10%	30%	10%			
Water heating						
Electric	30%	19%	28%			
Natural Gas	47%	57%	44%			
Oil	14%	18%	21%			
Propane	9%	6%	7%			
Major Appliances						
Clothes washer *(private use only)*	87%	95%	84%			
Electric clothes dryer *(private use only)*	69%	69%	66%			
Refrigerator	100%	100%	100%	1.31	1.42	1.22
Secondary refrigerator	28%	37%	20%			
Standalone freezer	4%	26%	24%	0.04	0.28	0.25
Electric cooktop	53%	52%	67%			
Electric oven	60%	61%	69%			
Dishwasher	77%	88%	68%			
Electronics and Computing						
Television	96%	98%	99%	2.01	2.47	2.37
CRT TV	45%	44%	52%	0.73	0.73	0.84
Flat screen LCD TV	54%	59%	54%	1.03	1.30	1.15
Flat screen LED TV	19%	26%	23%	0.40	0.57	0.49
Flat screen plasma TV	7%	12%	10%	0.10	0.19	0.15
Projection TV	0%	1%	1%	0.01	0.01	0.01
Cable/satellite box with DVR	40%	57%	45%	0.52	0.79	0.64

Appliance/Equipment	Penetration			Saturation		
	Res - S	Res - NS	LI	Res - S	Res - NS	LI
Stand-alone cable/satellite box	54%	50%	46%	0.76	0.78	0.73
DVR separate from cable/satellite box	8%	9%	5%	0.08	0.11	0.07
Digital TV converter box	36%	34%	34%	0.57	0.57	0.57
TV streaming device	10%	19%	16%	0.11	0.22	0.20
Home theater system	8%	15%	12%	0.08	0.16	0.14
Video game player	8%	27%	37%	0.09	0.37	0.55
DVD or VCR player	63%	69%	70%	0.75	0.94	0.99
Stereo, CD player, iPod, or MP3	47%	58%	55%	0.58	0.94	0.94
Desktop computer	18%	53%	44%	0.20	0.63	0.53
Computer monitor[S]	27%	53%	44%	0.62	0.84	0.55
Laptop	56%	72%	59%	0.75	1.03	0.82
Tablet	39%	50%	40%	0.50	0.66	0.57
Printer, fax, scanner, copier, or multifunction device	37%	79%	61%	0.39	0.93	0.70
DSL/cable modem, WiFi routers, or home network	60%	78%	61%	0.62	0.83	0.66
Other Electric Equipment						
Electronic household air cleaner/humidifier	9%	27%	22%	0.12	0.32	0.26
Dehumidifier	53%	71%	48%	0.60	0.78	0.52
Hot tub/whirlpool	6%	12%	5%	0.06	0.12	0.05
Electric-powered exercise equipment	2%	16%	8%	0.02	0.18	0.09
Aquarium	1%	4%	8%	0.01	0.04	0.08
Water bed	<1%	<1%	1%	<0.01	<0.01	0.01
Well and/or sump pump	20%	18%	14%	0.21	0.19	0.15
Microwave oven	93%	94%	90%	0.96	0.98	0.94
Pools						
Pool	3%	6%	5%			
Pool pump *(of those with pool)*	97%	97%	94%	1.09	0.97	0.94
Pool timer *(of those with pool)*	97%	59%	42%			

Source: 2014 CLC Residential Mail Survey; 2014 Residential Site Visits

[S] Results are based on site visits.

Table 3-2 presents key equipment penetration and saturation data collected in the 2014 commercial and industrial telephone survey and on-site visits. The penetration results are based on data from either the phone survey and or the on-site visits, depending on the measure, while the saturation results for all measures are based on data collected as part of the site visits.[46]

Table 3-2. 2014 Commercial and Industrial Penetration and Saturation Results

End Use/Equipment Type	Penetration	Saturation
Lighting[a]		
All Light Fixtures	100%	113.10
Linear Fluorescent Light Fixtures	89%	39.72
T12 Linear Fluorescent Light Fixtures	54%	8.85
T10 Linear Fluorescent Light Fixtures	8%	1.11
T8 Linear Fluorescent Light Fixtures [b]	65%	28.42
T5 Linear Fluorescent Light Fixtures	4%	1.13
T5HO Linear Fluorescent Light Fixtures	2%	0.21
CFL Fixtures	70%	36.54
Incandescent Bulb Fixtures	72%	19.04
High Pressure Sodium Bulb Fixtures	14%	0.66
Mercury Vapor Bulb Fixtures	5%	0.21
Metal Halide Bulb Fixtures	23%	1.67
Halogen Bulb Fixtures	26%	2.41
LED Light Fixtures	38%	12.19
Neon (Cold Cathode) Light Fixtures	<1%	<0.01
Other Fixtures	3%	0.66
Cooling Equipment		
Packaged Units	19%	0.32
Split Systems	40%	1.10
Window/Wall Units	35%	2.58
Chillers	<1%	0.01
Ventilation		
Ventilation Hoods	8%	0.07
Demand Controlled Ventilation	<1%	
Process Ventilation	2%	
Motors and Compressed Air		
All Motors	20%	0.79
Overall Compressed Air	15%	
Compressors	15%	0.27
Refrigeration		
All Commercial Refrigeration	15%	

[46] We list the source of the results for each measure in Volume 3 of this report, which presents the C&I Penetration and Saturation Results spreadsheet.

End Use/Equipment Type	Penetration	Saturation
Standalone Refrigerator or Freezer	11%	1.86
Refrigerated Display Cases [c]	6%	0.11
Walk-in Coolers	10%	0.15
Walk-in Freezers	7%	0.08
Refrigeration Systems	15%	0.19
Refrigerated Vending Machines	9%	0.10
Ice Machines	9%	0.22
Electronics		
Computers (All Types)	88%	5.85
Desktops	87%	5.05
Laptops	31%	0.80
Large Printers	30%	0.51
Small Printers	80%	2.79
Televisions	53%	6.67
Cash Registers/POS Terminals	42%	0.65
Rack Mounted Servers	6%	
Cooking Equipment		
All Commercial Food Service Equipment	12%	
Electric Ovens	4%	0.26
Electric Griddles	3%	0.15
Electric Commercial Fryers	2%	0.04
Electric Food Holding Cabinets	1%	0.01
Electric Steam Cookers	<1%	<0.01
Dishwashers	8%	0.22
Water Heating		
All Electric Water Heating	47%	
Electric Resistance Water Heaters	41%	0.48
Heat Pump Water Heaters	1%	0.01
Low Flow Showerheads [d]	0%	0.00
Faucet Aerators [d]	37%	1.65

*Denotes fewer than 30 observations
[a] Lighting combines both indoor and outdoor overhead hardwired lighting, unless specified.
[b] T8 linear fluorescent lights include T8 Plus lights.
[c] Saturation refers to linear feet, not units
[d] Includes only showerheads and aerators served by electric water heating

4. Overall Potential Results

We estimate CLC's total achievable energy efficiency potential for the six-year period from 2016-2021 to be 246 annual GWh and 62 MW.[47] Achievable potential represents 51% of economic potential and 36% of technical potential. On average over the six-year period, achievable energy savings represent 1.98% of CLC annual forecasted sales. These savings would cost CLC $220 million (incentive and non-incentive program costs), an average of $37 million per year or $0.895/kWh.[48] The total cost (including the participants' net cost) amounts to $246 million (in 2016 dollars) for the six-year period. All of the 2016-2021 proposed investments are cost-effective, with a Total Resource Cost (TRC) ratio of 3.6 and a Program Administrator Cost (PAC) ratio of 2.8.

Table 4-1 summarizes these results for the six-year period 2016-2021, as well as for each of the next two three-year planning periods. Table 4-2 provides these results by sector.

Table 4-1. Key Potential Results – All Sectors, by Period

	2016-2021		2016-2018		2019-2021	
Potential (Total)	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**
Technical	675	163	343	86	332	77
Economic	480	117	246	63	234	54
Achievable	246	62	121	33	125	29
Potential (Yearly)	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**
Technical	112.5	27.1	114.4	28.7	110.6	25.5
Economic	80.0	19.5	81.9	21.1	78.0	18.0
Achievable	40.9	10.3	40.3	11.1	41.5	9.5
Annual Achievable as % of Sales	1.98%		1.94%		2.02%	
Cost						
Total (millions)	$246		$120		$126	
CLC (millions)	$220		$107		$113	
CLC Cost/kWh	$0.895		$0.882		$0.908	
Cost-Effectiveness						
Total Resource Cost Test	3.6		3.6		3.6	
Program Administrator Cost Test	2.8		2.8		2.9	

[47] These findings reflect the best information and assumptions available as of April 2015. Cape Light Compact and the Opinion Dynamics/Dunsky team plan to refresh these results, prior to the September Three Year Plan draft filing, to incorporate any newly available evaluation findings, as well as updates to non-incentive program costs.

[48] This compares to a projected average cost of $0.794/kWh during the 2013-2015 Three Year Plan Cycle. It should be noted that per kWh projected costs are relatively high for CLC due to a number of territory-specific reasons, including the small base of large C&I customers and the seasonal nature of many homes and businesses.

Table 4-2. Key 2016-2021 Potential Results by Sector

	All Sectors		Residential		Low Income		C&I	
Potential (Total)	GWh	MW	GWh	MW	GWh	MW	GWh	MW
Technical	675	163	420	85	31	12	224	66
Economic	480	117	244	46	22	10	214	61
Achievable	246	62	131	29	9	3	106	29
Potential (Yearly)	GWh	MW	GWh	MW	GWh	MW	GWh	MW
Technical	112.5	27.1	70.0	14.1	5.1	2.0	37.4	11.0
Economic	80.0	19.5	40.7	7.6	3.6	1.7	35.7	10.2
Achievable	40.9	10.3	21.8	4.8	1.5	0.6	17.6	4.9
Annual Achievable as % of Sales	1.98%		1.92%		2.16%		2.04%	
Cost								
Total (millions)	$246		$159		$11		$76	
CLC (millions)	$220		$135		$10		$75	
CLC Cost/kWh	$0.895		$1.029		$1.134		$0.710	
Cost-Effectiveness								
Total Resource Cost Test	3.6		3.0		4.2		4.8	
Program Administrator Cost Test	2.8		2.5		2.9		3.4	

Table 4-3 and Table 4-4 detail annual achievable potentials as a percentage of sales, by year and sector, for the first three-year period and the second three-year period, respectively.

Table 4-3. Achievable Potential as a Percentage of Forecasted Energy Sales – 2016 to 2018

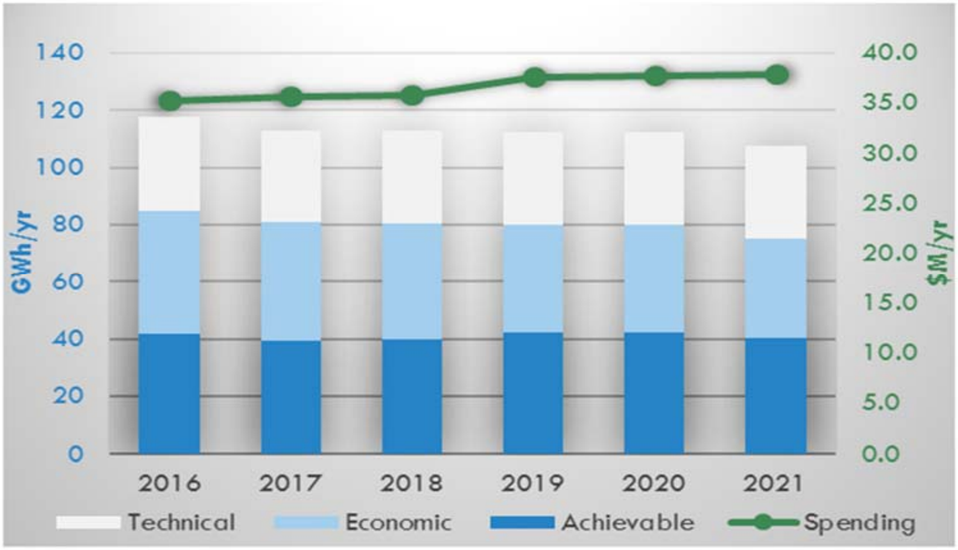
	2016	2017	2018	2016-2018
Residential	2.06%	1.80%	1.79%	1.88%
Low Income	2.39%	2.05%	2.04%	2.16%
Commercial	1.94%	2.00%	2.04%	1.99%
All Sectors	**2.02%**	**1.89%**	**1.90%**	**1.94%**

Table 4-4. Achievable Potential as a Percentage of Forecasted Energy Sales – 2019 to 2021

	2019	2020	2021	2019-2021
Residential	2.00%	2.01%	1.87%	1.96%
Low Income	2.18%	2.19%	2.12%	2.16%
Commercial	2.07%	2.11%	2.07%	2.09%
All Sectors	**2.03%**	**2.06%**	**1.96%**	**2.02%**

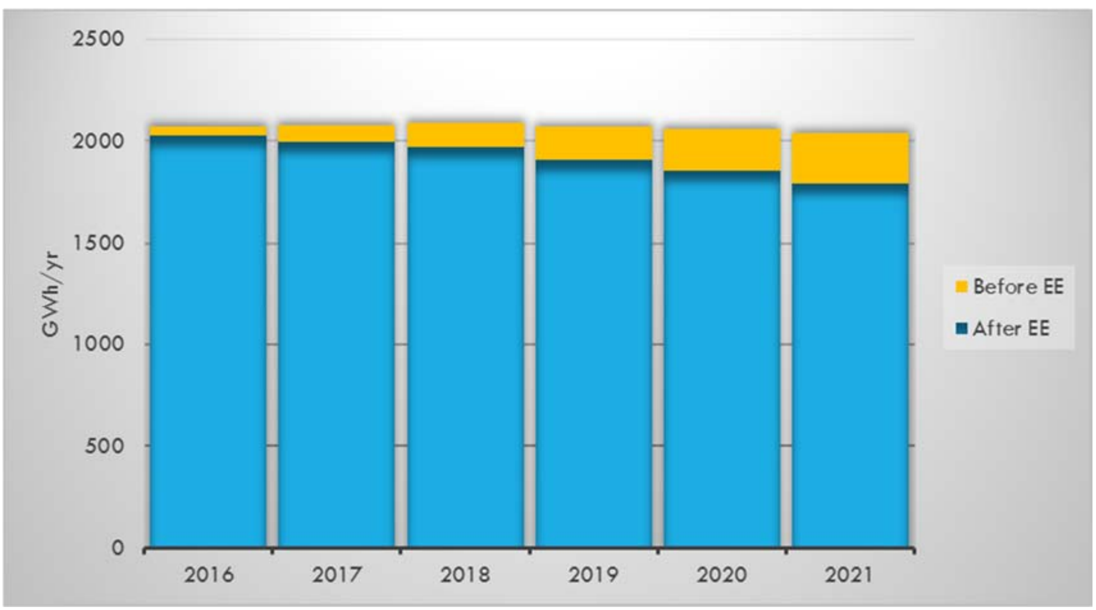
Figure 4-1 presents annual GWh savings for the three types of potential, as well as annual spending required to meet the achievable potential. The increase in spending during the second three-year period (2019–2021) is due to higher LED uptake, which results from an assumption of decreasing market barriers. While savings from LEDs are higher for that period, they are counterbalanced by somewhat lower savings for other measures.

Figure 4-1. Annual Savings and Spending



Eversource forecasts slightly declining energy sales, before energy efficiency (EE) efforts, over the six-year period, with total sales of 2,041 GWh in 2021 compared to 2,071 in 2016. With EE efforts at the level of the achievable potential, energy sales would decline faster, with 2021 sales amounting to 1,796 GWh, a drop of nearly 12% from 2016 sales (Figure 4-2).

Figure 4-2. Impact of Achievable Potential on Annual Sales

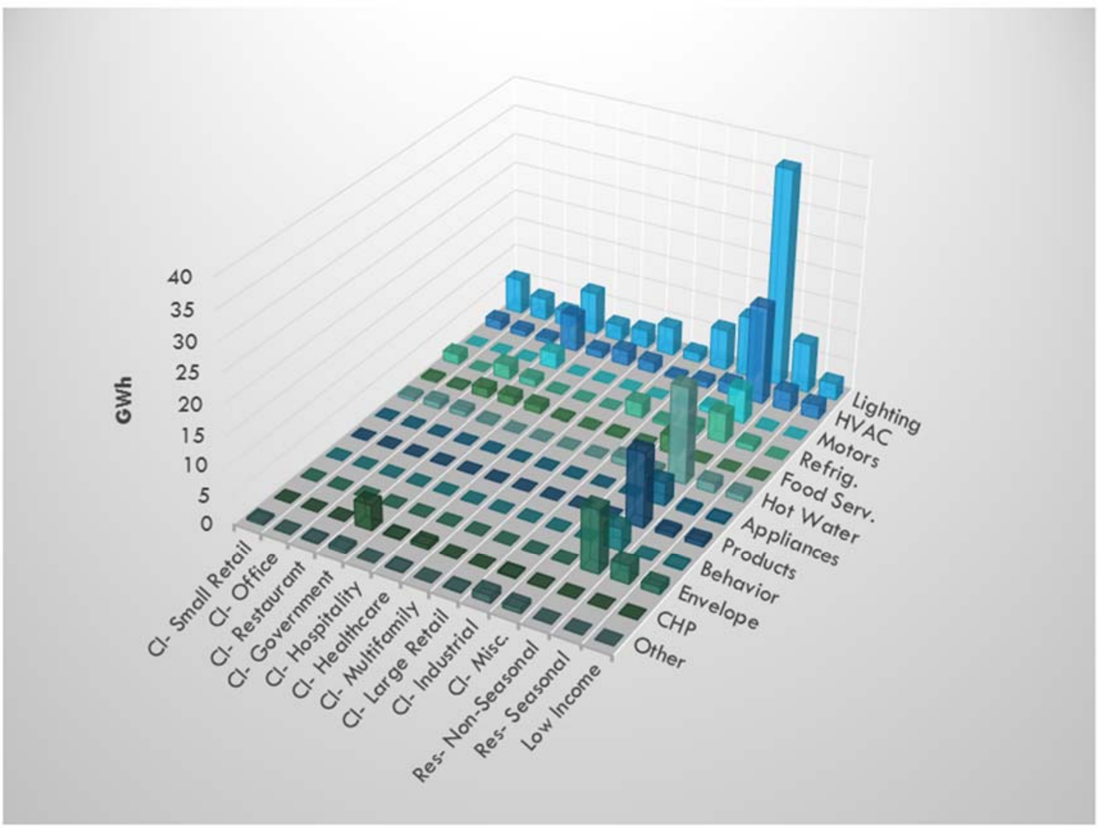


4.1 Results by Sector and End-Use

Over half of the achievable potential comes from the Residential Sector (54%). The Commercial & Industrial (C&I) Sector accounts for 42% of potential and the Low Income Sector for only 4%. The dominance of the Residential Sector, compared to C&I, reflects the economic structure of CLC's service territory, in which residential kWh sales comprise a higher proportion of CLC's total annual kWh sales (56%) than the statewide average (37%). The small contribution of the Low Income Sector is in line with the sector's number of accounts and annual energy sales (3%). (See Figure 4-3.)

Achievable potential associated with seasonal residential customers is rather low, even though they account for almost one-third (32%) of residential homes on Cape Cod and Martha's Vineyard and 23% of residential sector usage. This is mainly due to seasonal occupancy and its effect on annual savings (i.e., lower hours of use resulting in lower savings for the same measure). Some measures also do not pass the TRC test for seasonal customers because of reduced savings. Likewise, seasonality also has an effect on the commercial potential result, especially for segments such as hospitality and restaurants. Serving seasonal customers yields lower than average savings and higher cost per kWh because of lower hours of use.

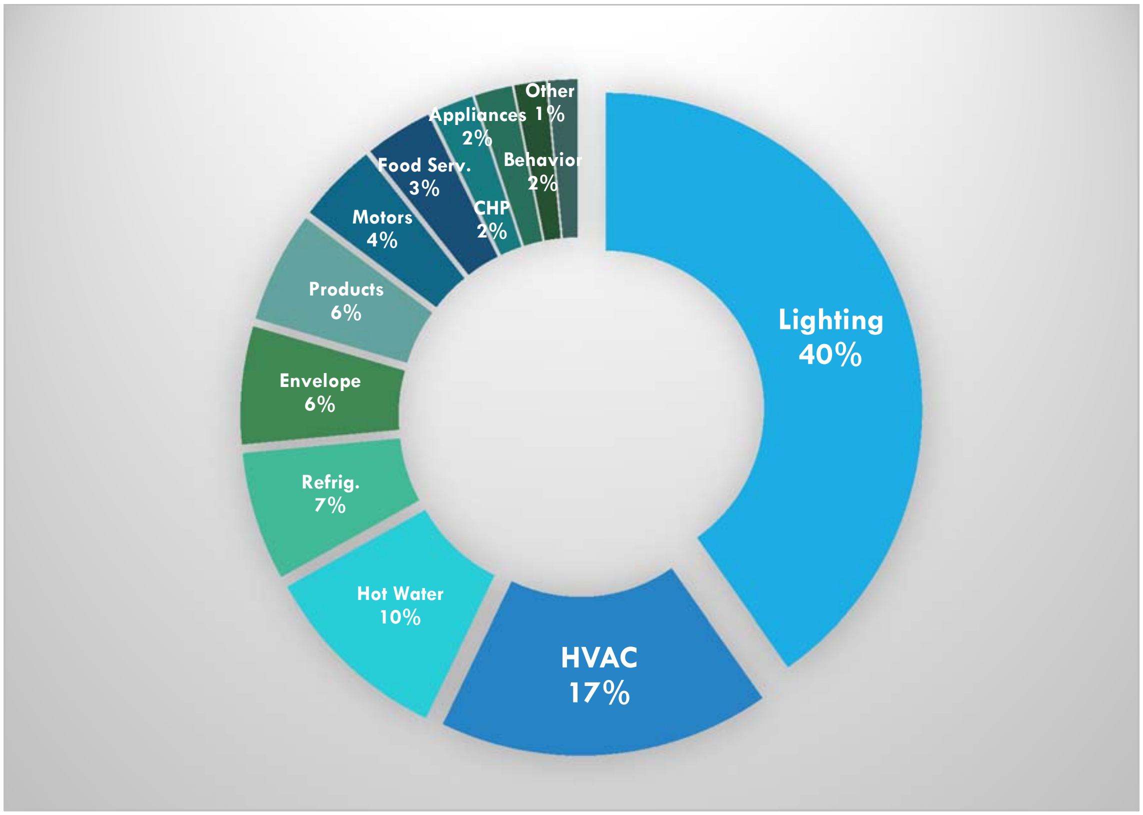
Figure 4-3. Six-Year Cumulative Achievable Potential (GWh)



The main end-use contributing to achievable potential is lighting (40%). Other significant end-uses are HVAC (17%), hot water (10%), refrigeration (7%), building envelope (6%), and products[49] (6%). (See Figure 4-4.)

[49] Including electronics, smart strips, and dehumidifiers.

Figure 4-4. Achievable Potential by End-Use



4.2 Top Five Measures

Three of the top five measure categories (across all sectors combined) are lighting measures, reflecting the large share of lighting savings in the overall achievable potential. LED bulbs are by far the highest energy-saving measure category, contributing 52.9 GWh of savings (22% of total achievable potential) over the six-year period. Linear lighting savings also include some savings from LED technology. Some potential for CFL savings remains, assuming that CLC continues to promote CFLs through its programs. CFLs and LEDs currently compete with each other for several types of baseline sockets/fixtures.

Hot water and building envelope measures also account for a substantial share of overall potential.

Table 4-5 summarizes the potential contribution by the top five measure categories, by sector.

Table 4-5. 2016-2021 Savings for Top Five Measure Categories by Sector

Rank	All Sectors		Residential		Low Income		C&I	
	Measure	GWh	Measure	GWh	Measure	GWh	Measure	GWh
1	LED Bulbs	52.9	LED Bulbs	28.6	Air Conditioning	2.0	LED Bulbs	22.4
2	Hot Water	18.4	CFL Bulbs	17.4	LED Bulbs	1.9	Linear Lighting	14.0
3	CFL Bulbs	18.3	Building Envelope	13.6	Building Envelope	1.2	Lighting Control	12.7
4	Building Envelope	14.8	Hot Water	13.5	CFL Bulbs	0.9	Refrigeration	10.0
5	Linear Lighting	14.0	Heat Pumps	11.6	Hot Water	0.8	Food service	9.1

4.3 Combined Heat & Power

Table 4-6 presents the annual potential results with and without Combined Heat & Power (CHP) in the C&I sector. C&I CHP has a relatively small impact on the overall achievable potential results, contributing only 5.4 GWh, or 2%, over the six-year period. A large part of the technical potential is not cost-effective with current inputs and assumptions, and high barriers result in a low adoption rate. When removing C&I CHP, the annual achievable potential drops from 1.98% to 1.93% of sales.

Table 4-6. Comparison of 2016-2021 Cumulative Achievable Potential: With and without C&I Combined Heat & Power

Potential	With C&I CHP		Without C&I CHP	
	GWh	MW	GWh	MW
Technical	675	163	494	126
Economic	480	117	447	114
Achievable	246	62	240	61

4.4 Comparison to Three Year Plan

In its April 30th 2015 draft of the Three-Year Plan for 2016-2018, CLC established a portfolio-wide savings goal of 156.3 GWh. This goal is 29% higher than our estimated achievable potential of 120.8 GWh for the same period.

When comparing CLC's published goal to our potential estimate, it is important to remember that the potential study is not meant to be a direct forecast of claimable savings, because some of the assumptions and inputs used to estimate potential are different from those used for setting goals and claiming savings. In particular, a key objective of our potential study was to reflect the unique circumstances of CLC's service territory and customer base, including the effects on achievable savings of having a large share of seasonal customers. To this end, we collected a wealth of primary data which is reflected in the potential study results. In contrast, the Massachusetts goal setting and savings claiming process requires consistency with TRM assumptions. As a result, the potential study results reflect certain CLC-specific information that is not mirrored in CLC's goals.

Further analysis of potential study results and Plan goals identified C&I upstream lighting as a key programmatic area where results are different: The April 30th Three-Year Plan estimates savings of 40.9 GWh from C&I upstream lighting whereas the potential model only estimates 8.7 GWh. The main drivers of this difference are assumptions about (1) the mix of baseline (replaced) bulbs (i.e., incandescent vs CFL units); (2) the size (wattage) of the baseline (replaced) bulbs; and (3) hours of use. The potential study used primary data for all of these factors, which showed:

1. higher penetration of CFL bulbs;[50]
2. lower wattage of baseline (replaced) bulbs; and
3. lower weekly hours of use during normal business operations

These differences lead to significantly lower savings estimates in the potential study compared to those used for planning purposes.

Another, but smaller, difference comes from consideration of seasonality in the potential study. While businesses on the Cape generally have shorter weekly hours of use during normal business weeks, which is reflected in the hours of use adjustment above, a number of businesses also have an additional reduction in their hours of operation during the off-peak season, especially winter.

In addition to differences stemming from the use of primary data, chaining – i.e., reduced savings from cumulative effects – also has an important effect because of high adoption rates for lighting controls in the potential study (resulting from high cost-effectiveness for these measures). When new lighting equipment is installed together with controls, the savings are smaller than the sum of each measure alone. Finally, small differences in net-to-gross and realization rate assumptions result in a negligible effect on savings compared to the Plan.

Table 4-7 below details the key differences in assumptions for C&I upstream lighting, and their impacts on 2016-2018 savings.

Table 4-7. Impact of Assumptions on Upstream Lighting Results

DESCRIPTION	Potential Study 3-Year Model (GWh)[51]	Increase /decrease (GWh)	Increase /decrease (% change)	3-Year Plan (GWh)
Base scenario (Potential Model)	8.7	---	---	40.9
Adjustment for seasonal customers removed	9.2	+0.5	+6%	
Hours of use adjusted to 3,901 per year (statewide assumption)	12.6	+3.4	+37%	
Mix of baseline incandescent/CFL set to 75%/25% for Type A bulbs	19.3	+6.7	+53%	

[50] For the potential study, we determined the mix of CFL versus incandescent bulbs being replaced using site visit and survey information, as well as natural replacement rates. This value is significantly different from the statewide TRM assumption.

[51] This column shows cumulative GWh from each assumption change.

Net-to-gross and realization rate factors set to same values as the 2016-18 CLC Plan	19.2	-0.1	-1%	
Chaining adjustment removed	25.3	+6.2	+32%	
Size of bulbs (watt difference between baseline and efficient bulbs for Type A bulbs) set to same value as CLC Plan	35.1	+9.8	+39%	

Using statewide assumptions and removing CLC-specific adjustments for C&I upstream lighting would increase our estimated C&I achievable potential by 26.5 GWh, from 52.5 GWh to 79.0 GWh. These additional 26.5 GWh would increase our estimated total achievable potential from 120.8 GWh to 147.3 GWh, in turn increasing the achievable potential as a percentage of sales from 1.94% in the base case to 2.36%. It should be noted, however, that even with these adjustments to C&I upstream lighting, Plan goals are not perfectly comparable to the achievable potential estimated in this study. The potential model also uses CLC-specific assumptions in the other sectors (residential and low income), which we did not vary for this analysis. However, the different assumptions for C&I upstream lighting can explain a significant portion of the difference between Plan goals and our estimated achievable potential.

4.5 Sensitivity Analysis

We conducted a sensitivity analysis to assess uncertainty regarding the 6-year GWh savings potential, using the following ranges:

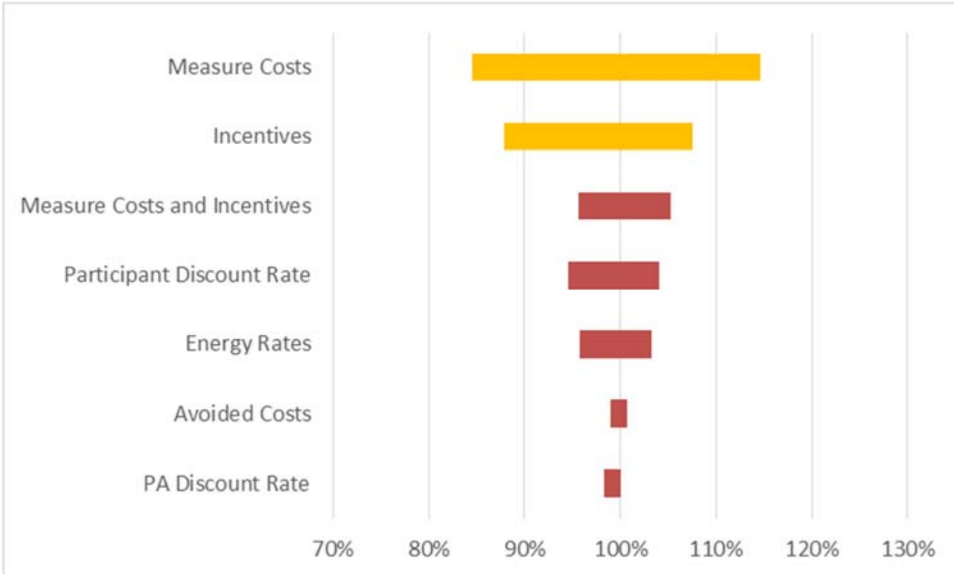
- Program administrator discount rate: 0% to 4%
- Participant discount rate: 0% to 10%
- Measure costs, incentives, energy rates, and avoided costs: -20% to +20%

Figure 4-5 presents the results of these analyses, as the percentage of savings under the lower and upper bounds for each factor, compared to the base scenario.

The potential model appears sensitive to measure costs and to incentives, because moving just one of these two parameters creates a discrepancy between costs and incentives (see orange bars in graph below). In reality, incentives are largely endogenous as they can be adjusted to evolving costs. As the graphic shows, adjusting measure costs and incentives at the same time (red bar) produces far less variability in results.

The potential savings appear robust, as all tested factors produce a variability of less than 20% compared to the base scenario.

Figure 4-5. 6-Year GWh Savings and Variability (Base Scenario = 100%)



4.6 Detailed Results

The following tables present additional detail on the results of the potential study, by type of potential, sector, segment, and end-use.

Table 4-8. Technical, Economic, and Achievable Potential by Year (GWh)

	2016	2017	2018	2019	2020	2021	2016-2018	2019-2021	2016-2021
Cumulative Annual									
Technical	117.5	230.2	343.1	455.2	567.5	675.0	343.1	331.9	**675.0**
Economic	84.6	165.1	245.6	325.5	405.0	479.8	245.6	234.1	**479.8**
Achievable	41.8	81.1	120.8	163.0	205.4	245.5	120.8	124.6	**245.5**
Incremental Annual									
Technical	117.5	112.8	112.9	112.1	112.3	107.5	343.1	331.9	**675.0**
Economic	84.6	80.6	80.5	79.8	79.5	74.8	245.6	234.1	**479.8**
Achievable	41.8	39.3	39.8	42.2	42.4	40.1	120.8	124.6	**245.5**
Incremental as % of Sales									
Technical	5.7%	5.4%	5.4%	5.4%	5.4%	5.3%	5.5%	5.4%	**5.4%**
Economic	4.1%	3.9%	3.9%	3.9%	3.9%	3.7%	3.9%	3.8%	**3.9%**
Achievable	2.0%	1.9%	1.9%	2.0%	2.1%	2.0%	1.9%	2.0%	**2.0%**

Table 4-9. Detailed Results by Sector, Segment, and End-Use (2016-2021 Cumulative Achievable Potential – GWh)

Segment	End-Use												
	Lighting	HVAC	Motors	Refrig.	Food Serv.	Hot Water	Appliances	Products	Behavior	Envelope	CHP	Other	TOTAL
CI- Small Retail	6.0	1.7	0.0	1.7	0.4	0.6	---	---	---	---	0.0	0.3	10.7
CI- Office	3.9	1.0	0.0	0.0	0.2	1.1	---	---	---	---	0.0	0.1	6.3
CI- Restaurant	2.4	0.8	0.1	2.2	1.4	0.9	---	---	---	---	0.0	0.2	8.0
CI- Government	7.9	6.3	3.0	1.4	1.6	0.3	---	---	---	---	4.3	0.7	25.5
CI- Hospitality	2.5	1.3	0.0	0.2	1.1	0.0	---	---	---	---	0.2	0.0	5.4
CI- Healthcare	3.3	2.6	0.2	0.1	0.2	0.1	---	---	---	---	0.6	0.2	7.2
CI- Multifamily	5.2	1.9	0.1	0.0	0.0	0.1	---	---	---	---	0.0	0.0	7.2
CI- Large Retail	1.6	0.4	0.0	2.6	0.3	0.1	---	---	---	---	0.0	0.1	5.1
CI- Industrial	7.4	1.1	0.0	0.5	0.1	1.2	---	---	---	---	0.2	1.2	11.7
CI- Misc.	10.0	2.0	1.0	1.3	3.0	0.6	---	---	---	---	0.0	0.8	18.7
CI- Subtotal	50.2	19.1	4.3	9.9	8.3	4.9	---	---	---	---	5.4	3.5	105.7
Res- Non-Seasonal	37.4	16.8	5.7	4.9	---	16.3	3.9	12.6	3.7	10.6	---	---	112.0
Res- Seasonal	8.6	3.3	0.1	1.1	---	1.6	0.5	0.6	0.0	3.0	---	---	18.8
Res- Subtotal	46.0	20.2	5.8	6.0	---	17.9	4.4	13.2	3.7	13.6	---	---	130.9
Low Income	2.9	2.3	0.1	0.1	---	1.0	0.3	0.7	0.2	1.2	---	---	8.8
Low Income - Subtotal	2.9	2.3	0.1	0.1	---	1.0	0.3	0.7	0.2	1.2	---	---	8.8
TOTAL	99.0	41.6	10.2	16.0	8.3	23.9	4.7	14.0	3.9	14.8	5.4	3.5	245.5

5. Residential Potential Results

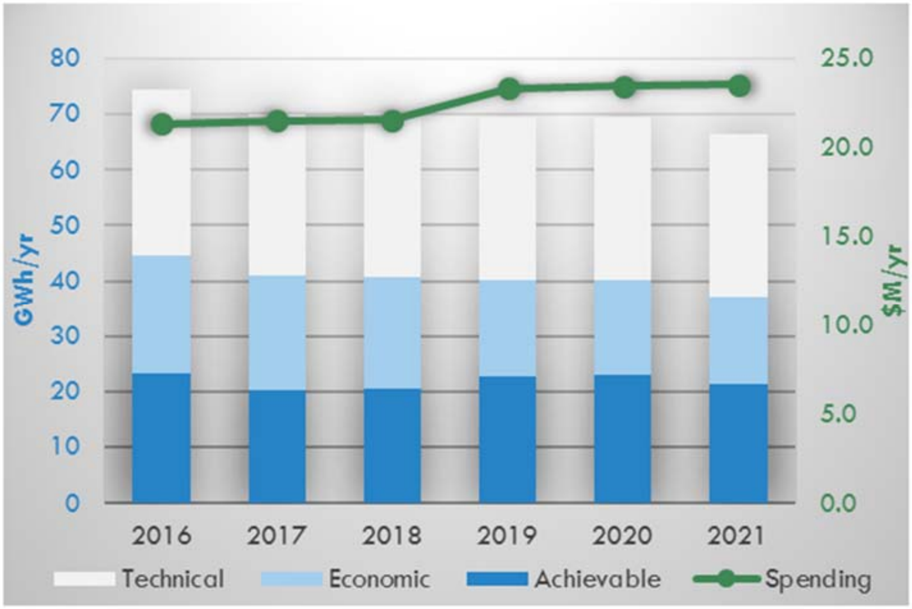
CLC's annual achievable energy efficiency potential for the residential sector is estimated at 131 GWh and 29 MW for the six-year period from 2016 to 2021. Achievable potential represents 54% of economic potential and 31% of technical potential. On average, achievable energy savings amount to 1.92% of CLC annual sales to the sector. These savings would cost CLC $135 million (incentive and non-incentive program costs), an average of $23 million per year. The total cost (including the participants' net cost) amounts to $159 million for the six-year period. These investments are cost-effective, with a Total Resource Cost (TRC) ratio of 3.0 and a Program Administrator Cost (PAC) ratio of 2.5. Table 5-1 summarizes these results.

Table 5-1. Key Potential Results – Residential Sector, by Period

	2016-2021		2016-2018		2019-2021	
Potential (Total)	GWh	MW	GWh	MW	GWh	MW
Technical	420	85	215	47	205	38
Economic	244	46	127	27	118	18
Achievable	131	29	64	17	67	12
Potential (Yearly)	GWh	MW	GWh	MW	GWh	MW
Technical	70.0	14.1	71.6	15.7	68.4	12.6
Economic	40.7	7.6	42.2	9.1	39.2	6.1
Achievable	21.8	4.8	21.3	5.5	22.3	4.1
Annual Achievable as % of Sales	1.92%		1.88%		1.96%	
Cost						
Total (millions)	$159		$77		$83	
CLC (millions)	$135		$64		$70	
CLC Cost/kWh	$1.029		$1.007		$1.050	
Cost-Effectiveness						
Total Resource Cost Test	3.0		2.9		3.0	
Program Administrator Cost Test	2.5		2.4		2.6	

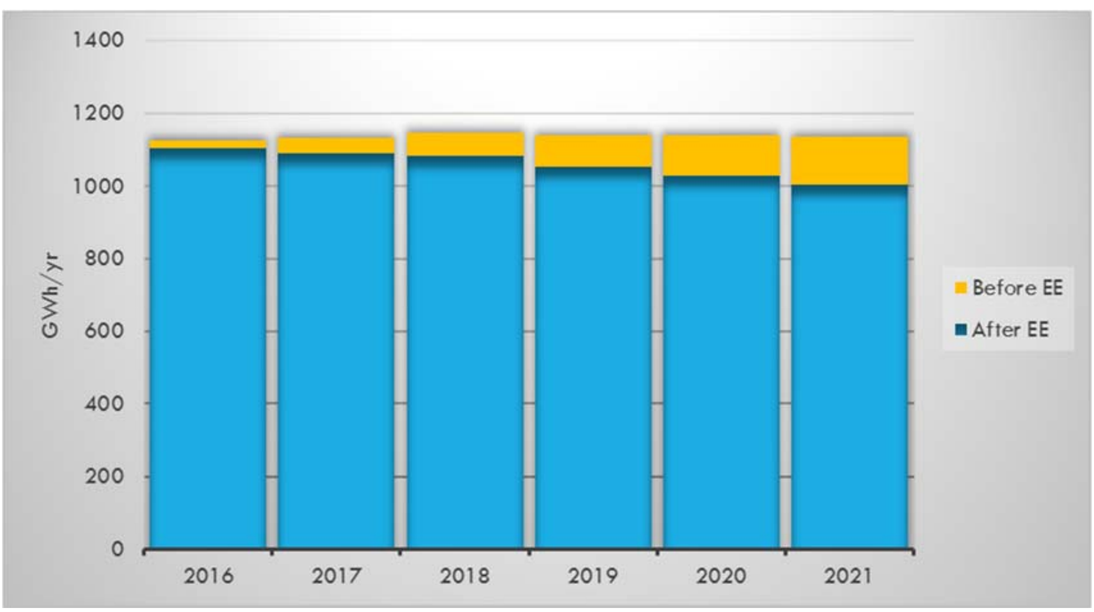
Figure 5-1 presents annual GWh savings for the three types of potential, as well as annual spending required to meet the achievable potential. As noted for the overall potential, the increase in spending during the second three-year period (2019–2021) is due to higher LED uptake, which results from an assumption of decreasing market barriers. While savings from LEDs are higher for that period, they are counterbalanced by somewhat lower savings for other measures.

Figure 5-1. Annual Savings and Spending for Residential Sector



Eversource forecasts slightly increasing energy sales for the residential sector, before energy efficiency (EE) efforts, over the six-year period, with total sales of 1,136 GWh in 2021 compared to 1,125 in 2016. With EE efforts at the level of the achievable potential, energy sales would decline, with 2021 sales amounting to 1,005 GWh, a drop of 11.5% from 2016 sales (Figure 5-2).

Figure 5-2. Impact of Achievable Potential on Annual GWh Residential Sales



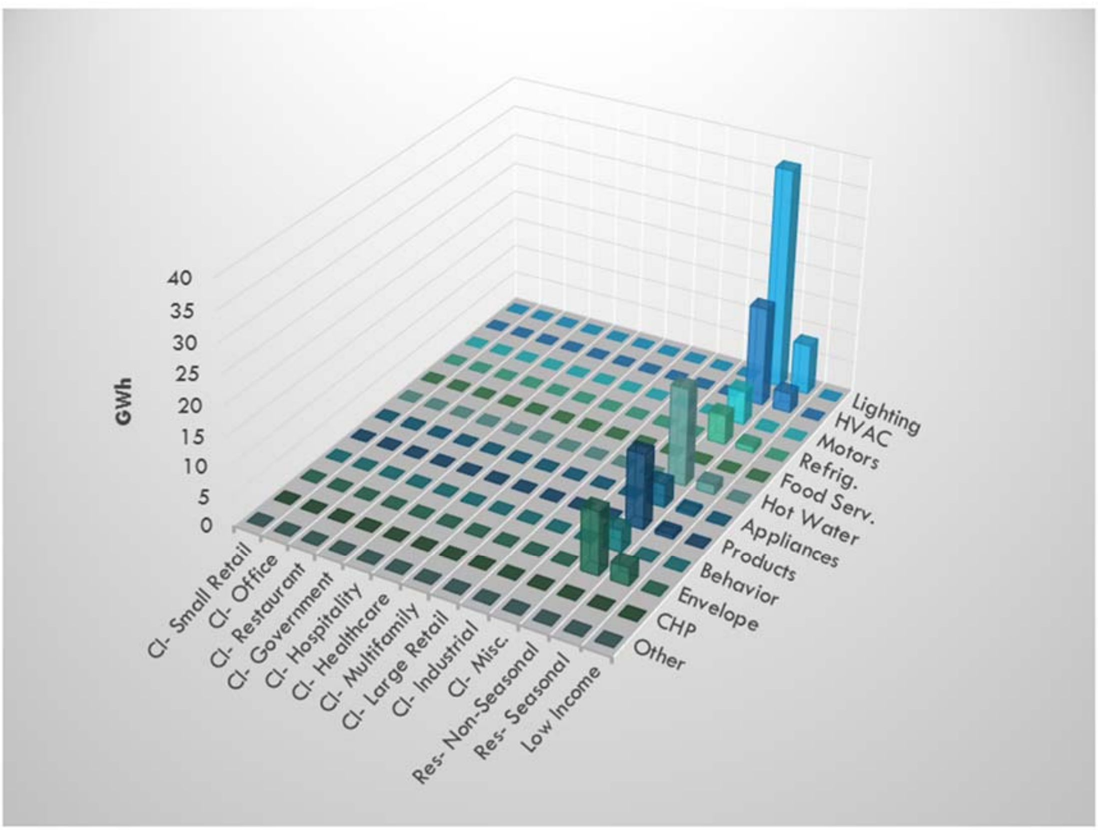
5.1 Results by Segment and End-Use for Residential Sector

Achievable potential associated with seasonal residential customers is rather low compared to non-seasonal residential customers. Over the six-year period, we estimate achievable energy savings of 2.14% of energy sales for non-seasonal customers and 1.19% of energy sales for seasonal customers.

This low potential is mainly due to the effect of seasonal occupancy on annual savings (i.e., lower hours of use resulting in lower savings for the same measure compared to non-seasonal customers). Several measures also do not pass the TRC for seasonal customers because of reduced savings, including important measures such as ENERGY STAR Homes - New Construction, heat pumps with lower efficiency levels, heat pump water heaters, and smaller LED bulbs that replace CFLs. Finally, because energy savings also affects the economics from the customer's point of view, lower Participant Cost Test (PCT) ratios will translate into lower adoption rates.

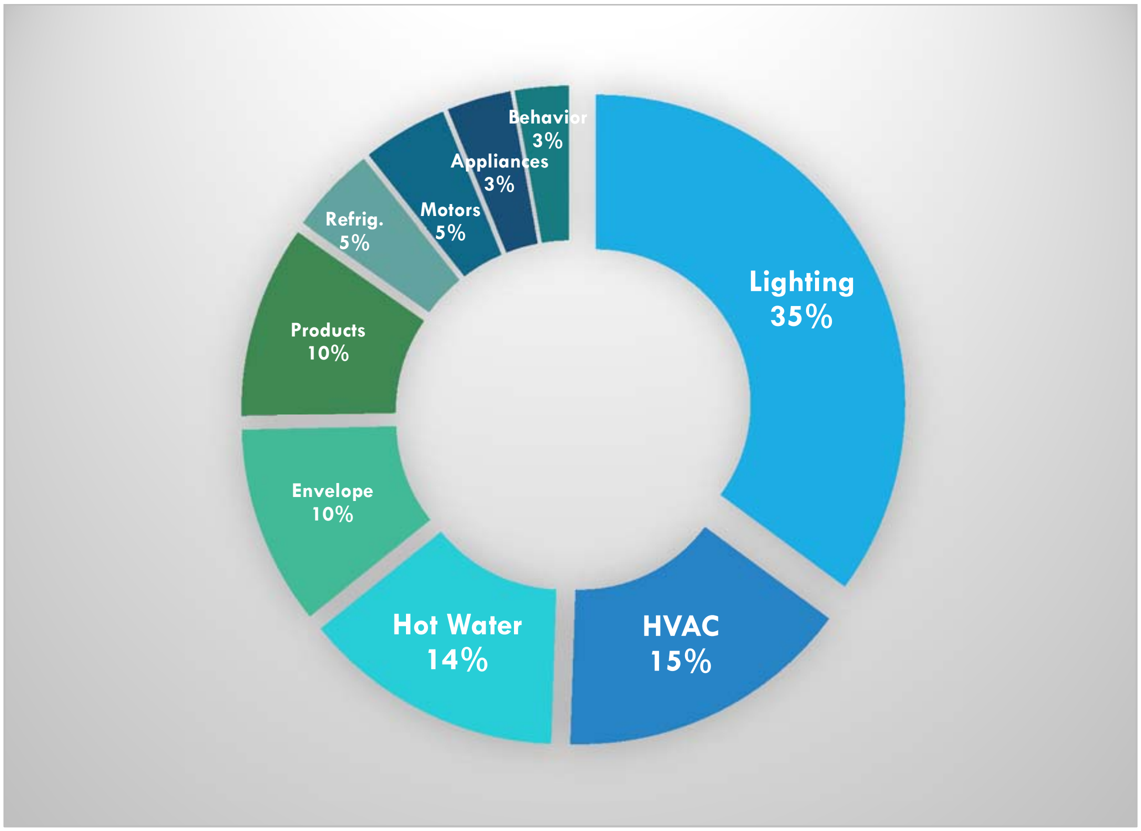
As can be seen on Figure 5-3, there are significant differences in the achievable savings patterns between seasonal and non-seasonal customers due to these factors.

Figure 5-3. 2016-2021 Cumulative Achievable Savings (GWh) for Residential Sector



The main end-uses contributing to achievable potential in the residential sector are lighting (35%), HVAC (15%) and hot water (14%). Other significant end-uses are building envelope (10%) and products (10%) (Figure 5-4).

Figure 5-4. 2016-2021 Achievable Potential by End-Use for Residential Sector



5.2 Top Five Measures for Residential Sector

The two top residential measures categories are lighting measures, reflecting the large share of lighting savings in the overall achievable potential. LED bulbs are the highest energy-saving measure, contributing 28.6 GWh of savings (22% of total achievable potential for the residential sector) over the six-year period, followed by CFL bulbs at 17.4 GWh (13%). CFLs and LEDs are competing with each other for several types of baseline sockets/fixtures.

Building envelope (13.6 GWh) and hot water (13.5 GWh) measures also account for a substantial share of overall potential.

Finally, heat pumps, including both new additions and replacements on burnout, are estimated to contribute 11.6 GWh to the six-year achievable potential.

Table 5-2. 2016-2021 Savings for Top Five Measure Categories in the Residential Sector

Rank	Measure	GWh
1	LED Bulbs	28.6
2	CFL Bulbs	17.4
3	Building Envelope	13.6
4	Hot Water	13.5
5	Heat Pumps	11.6

6. Low Income Potential

CLC's annual achievable energy efficiency potential for the low income sector is estimated at 9 GWh and 3 MW for the six-year period from 2016 to 2021. Achievable potential represents 41% of economic potential and 29% of technical potential. On average, achievable energy savings amount to 2.16% of CLC annual sales to the sector. These savings would cost CLC $10 million (incentive and non-incentive program costs), an average of $2 million per year. The total cost (including the participants' net cost) amounts to $11 million for the six-year period. These investments are cost-effective, with a Total Resource Cost (TRC) ratio of 4.2 and a Program Administrator Cost (PAC) ratio of 2.9. Table ES-1 summarizes these results.[52]

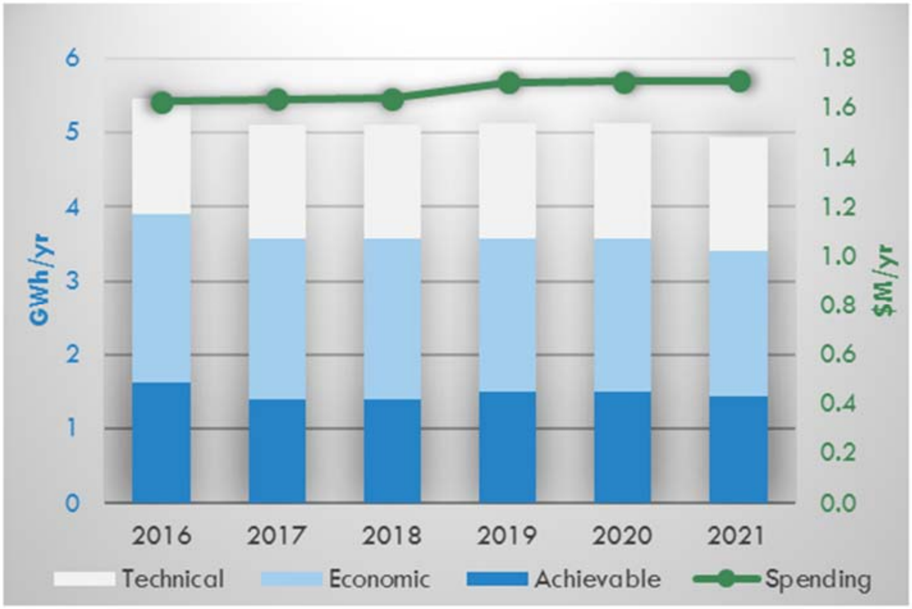
Table 6-1. Key Potential Results – Low Income Sector, by Period

	2016-2021		2016-2018		2019-2021	
Potential (Total)	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**
Technical	31	12	16	6	15	6
Economic	22	10	11	5	11	5
Achievable	9	3	4	2	4	1
Potential (Yearly)	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**
Technical	5.1	2.0	5.2	2.0	5.1	2.0
Economic	3.6	1.7	3.7	1.7	3.5	1.7
Achievable	1.5	0.6	1.5	0.7	1.5	0.5
Achievable as % of Sales	2.16%		2.16%		2.16%	
Cost						
Total (millions)	$11		$5		$5	
CLC (millions)	$10		$5		$5	
CLC Cost/kWh	$1.134		$1.112		$1.156	
Cost-Effectiveness						
Total Resource Cost Test	4.2		4.1		4.2	
Program Administrator Cost Test	2.9		2.9		3.0	

Figure 6-1 presents annual GWh savings for the three types of potential, as well as annual spending required to meet the achievable potential. Similar to the residential sector, the increase in spending during the second three-year period (2019–2021) is due to higher LED uptake over that period.

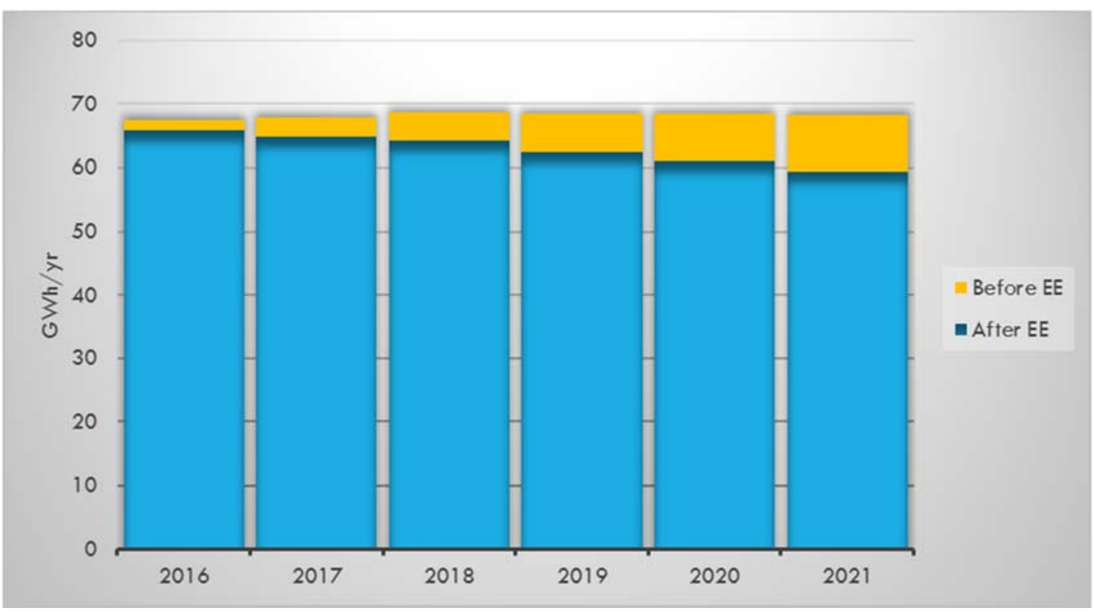
[52] Note that the indicated budget allocation for low income programs in the Potential Model is not 10% of the overall CLC budget, as required by Massachusetts Statute. In order to meet the statutory 10% requirement, CLC may need to expend additional budget without corresponding savings.

Figure 6-1. Annual Savings and Spending for the Low Income Sector



Eversource forecasts slightly increasing energy sales for the low income sector, before energy efficiency (EE) efforts, over the six-year period, with total sales of 68.2 GWh in 2021 compared to 67.6 in 2016. With EE efforts at the level of the achievable potential, energy sales would decline, with 2021 sales amounting to 59.4 GWh, a drop of nearly 9% from 2016 sales (Figure 6-2).

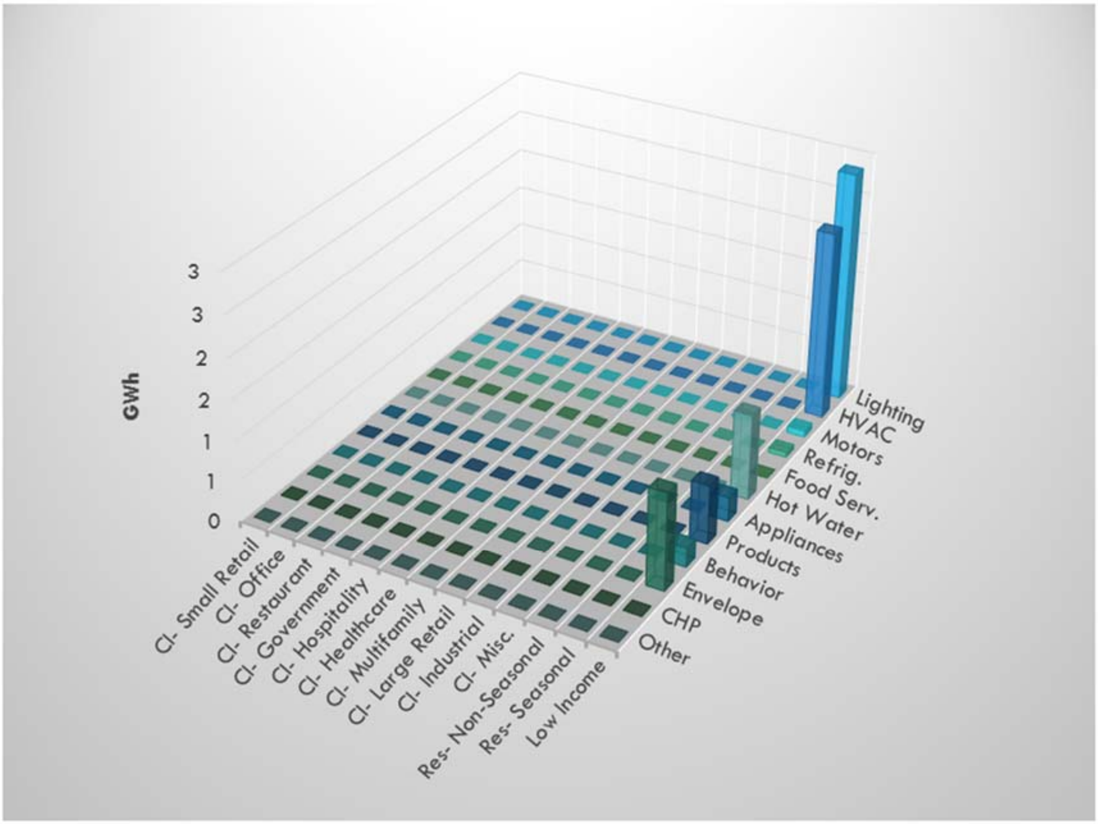
Figure 6-2. Impact of Achievable Potential on Annual Low Income GWh Sales



6.1 Results by End-Use for Low Income Sector

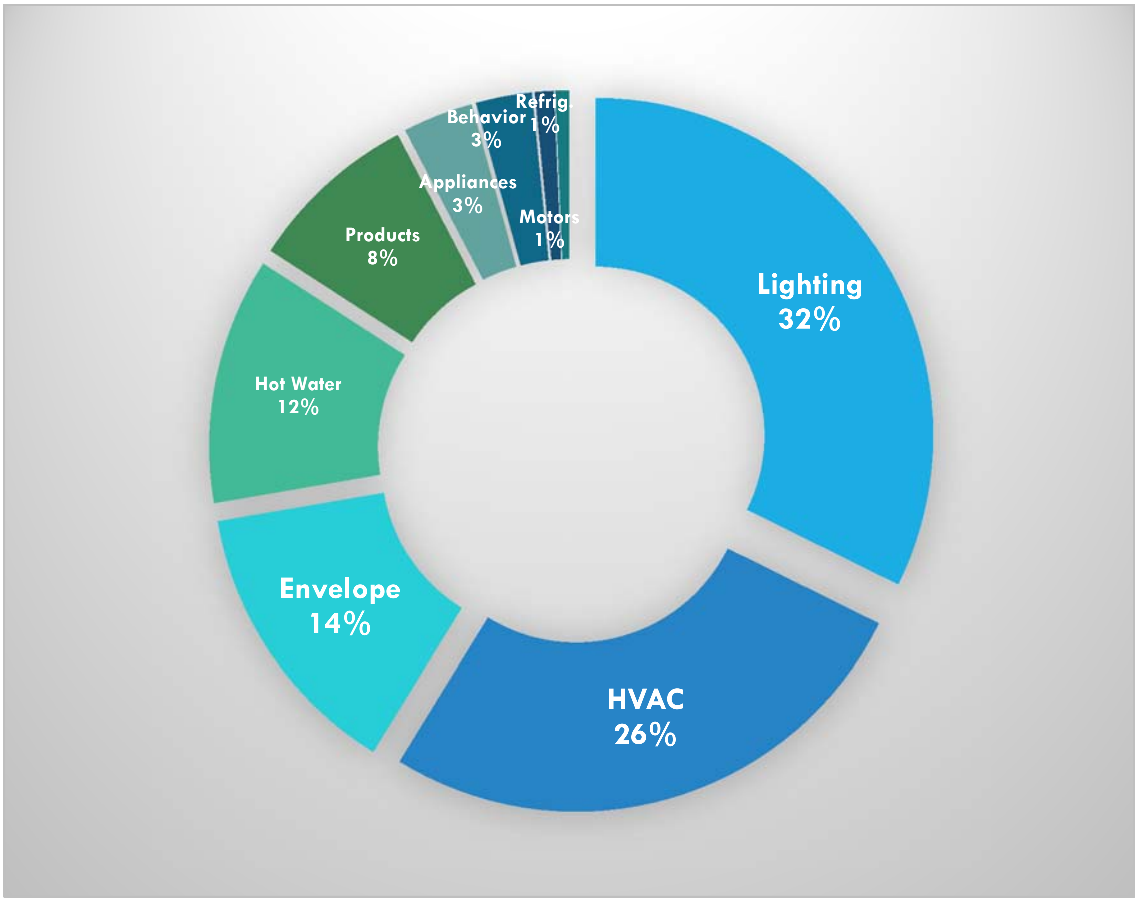
The small contribution of the Low Income Sector to overall achievable potential (4%) is in line with the sector's number of accounts and annual energy sales. This sector is not affected by seasonality, unlike the Residential and C&I sectors.

Figure 6-3. 2016-2021 Cumulative Achievable Savings (GWh) for the Low Income Sector



The main end-uses contributing to achievable potential are lighting (32%) and HVAC (26%). Other significant end-uses are building envelope (14%), and hot water (12%) (Figure 6-4).

Figure 6-4. 2016-2021 Achievable Potential by End-Use for the Low Income Sector



6.2 Top Five Measures for Low Income Sector

Two of the top five measure categories are lighting measures, reflecting the large share of lighting savings in the overall achievable potential. Air conditioning is the highest energy-saving measure, followed closely by LED bulbs. The importance of air conditioning saving potentials for the low income sector can be explained by the higher penetration of room air conditioning units compared to the residential sector, and by the existence of an income dependent initiative for room AC replacements. On the other hand, lighting savings are lower for the low income sector because low income households have fewer lightbulbs on average, and a larger proportion of them have already been replaced by CFLs. There still remains some potential for CFL savings, assuming that CLC continues to promote them through its programs. As noted above, CFLs and LEDs currently compete with each other for several types of baseline sockets/fixtures.

Hot water and building envelope measures also account for a substantial share of overall potential.

Table 6-2. 2016-2021 Savings for Top Five Measures in the Low Income Sector

Rank	Measure	GWh
1	Air Conditioning	2.0
2	LED Bulbs	1.9
3	Building Envelope	1.2
4	CFL Bulbs	0.9
5	Hot Water	0.8

7. Commercial & Industrial Potential Results

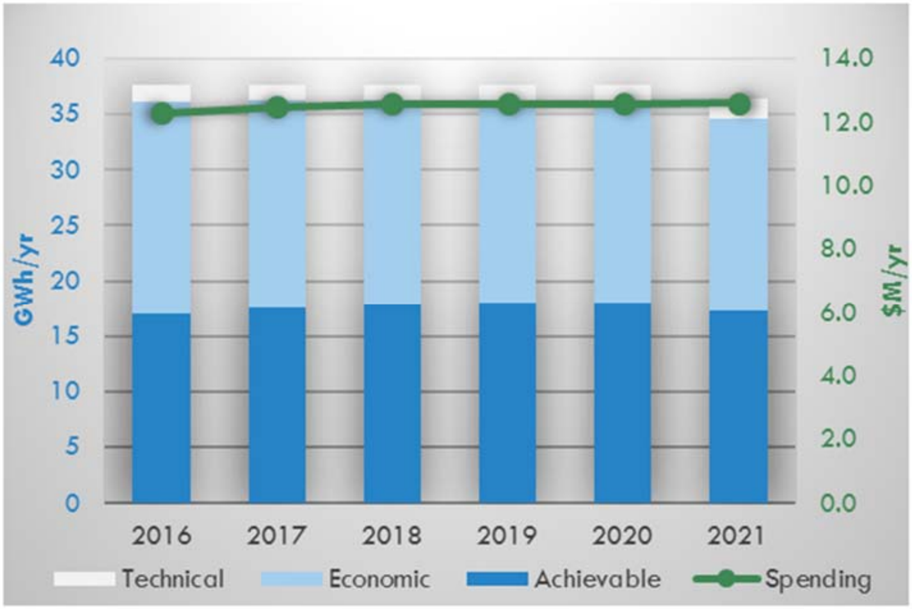
CLC's annual achievable energy efficiency potential for the commercial and industrial (C&I) sector is estimated at 106 GWh and 30 MW for the six-year period 2016 to 2021. Achievable potential represents 49% of economic potential and 47% of technical potential. On average, achievable energy savings amount to 2.04% of CLC annual sales to the sector. These savings would cost CLC $75 million (incentive and non-incentive program costs), an average of $13 million per year. The total cost (including the participants' net cost) amounts to $77 million for the six-year period. These investments are cost-effective, with a Total Resource Cost (TRC) ratio of 4.8 and a Program Administrator Cost (PAC) ratio of 3.4. Table ES-1 summarizes these results.

Table 7-1. Key Potential Results – C&I Sector, by Period

	2016-2021		2016-2018		2019-2021	
Potential (Total)	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**
Technical	224	66	113	33	111	33
Economic	214	61	108	31	106	30
Achievable	106	30	53	15	53	15
Potential (Yearly)	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**
Technical	37.4	11.0	37.6	11.0	37.1	11.0
Economic	35.7	10.2	36.1	10.3	35.3	10.2
Achievable	17.6	4.9	17.5	4.9	17.7	4.9
Achievable as % of Sales	2.04%		1.99%		2.09%	
Cost						
Total (millions)	$76		$38		$39	
CLC (millions)	$75		$37		$38	
CLC Cost/kWh	$0.710		$0.711		$0.710	
Cost-Effectiveness						
Total Resource Cost Test	4.8		4.9		4.8	
Program Administrator Cost Test	3.4		3.4		3.4	

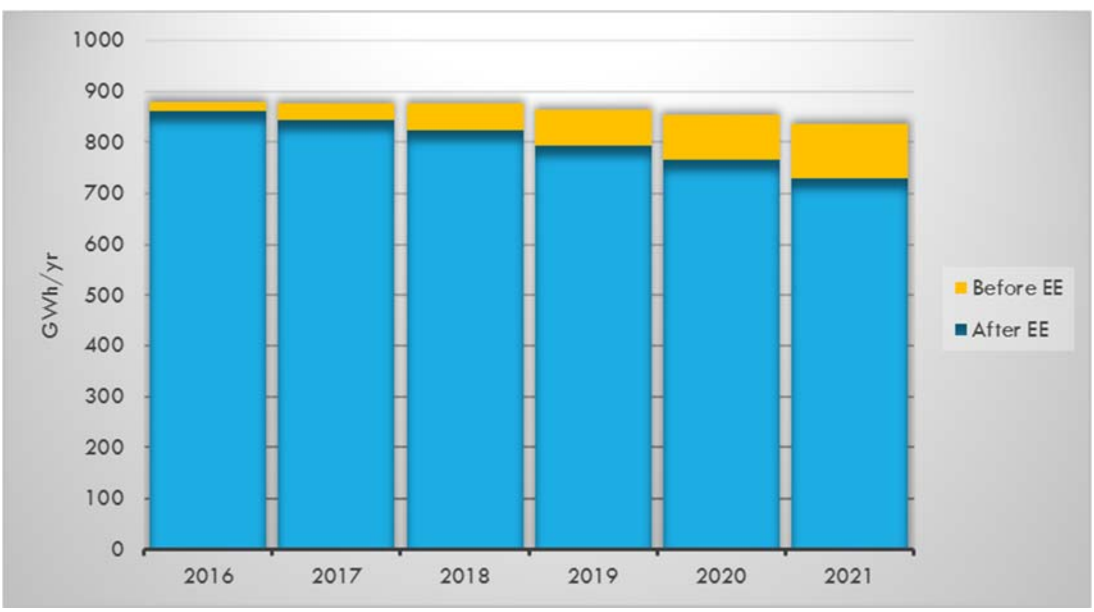
Figure 7-1 presents annual GWh savings for the three types of potential, as well as annual spending required to meet the achievable potential. Both spending and savings are rather flat during the six-year period.

Figure 7-1. Annual Savings and Spending for the C&I Sector



Eversource forecasts declining energy sales for the C&I sector, before energy efficiency (EE) efforts, over the six-year period, with total sales of 837 GWh in 2021 compared to 879 in 2016. With EE efforts at the level of the achievable potential, energy sales would decline faster, with 2021 sales amounting to 731 GWh, a drop of nearly 17% from 2016 sales (Figure 7-2).

Figure 7-2. Impact of Achievable Potential on Annual C&I GWh Sales

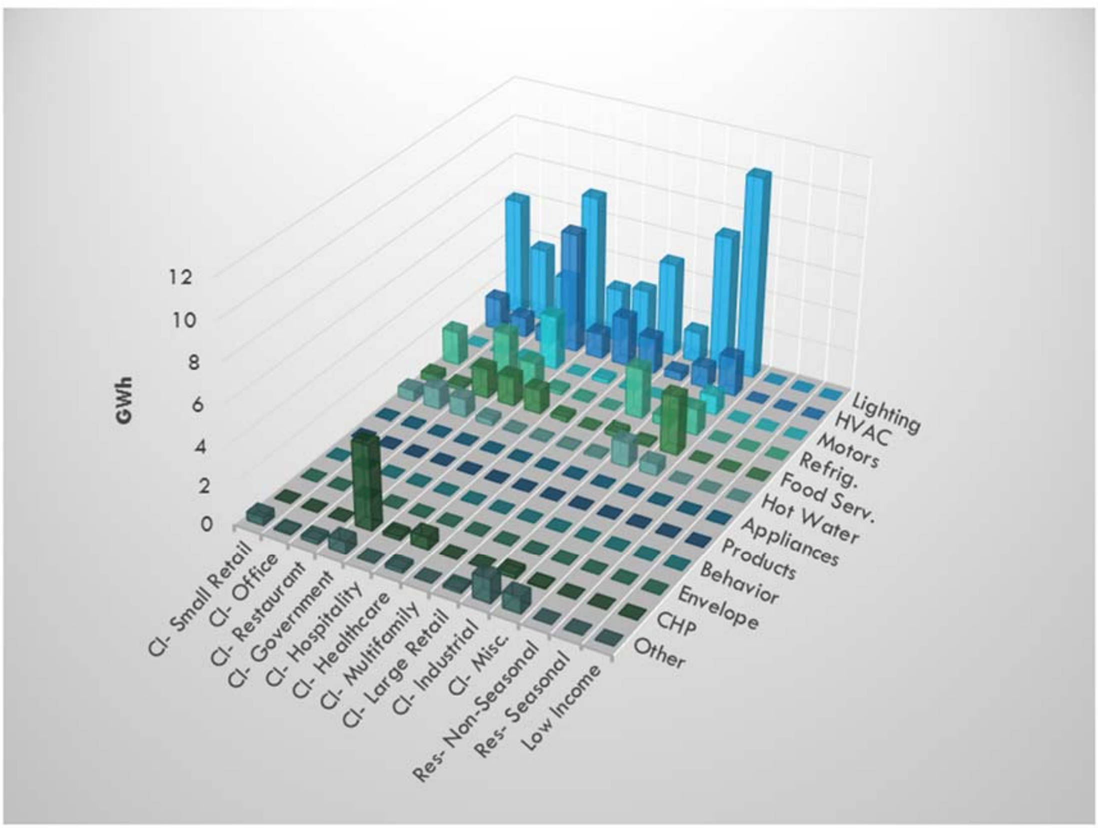


7.1 Results by Segment and End-Use for C&I Sector

The C&I sector accounts for 42% of the overall achievable potential. The relatively small contribution of the C&I sector, which compares to 57% of statewide C&I savings for the 2016-18 period, reflects the economic structure of Cape Cod and Martha's Vineyard. CLC's non-residential customer base is dominated by small businesses, with very few large commercial or industrial customers. This structure results in lower potential from the C&I sector as well as higher cost per kWh saved, as it is more expensive to serve smaller customers.

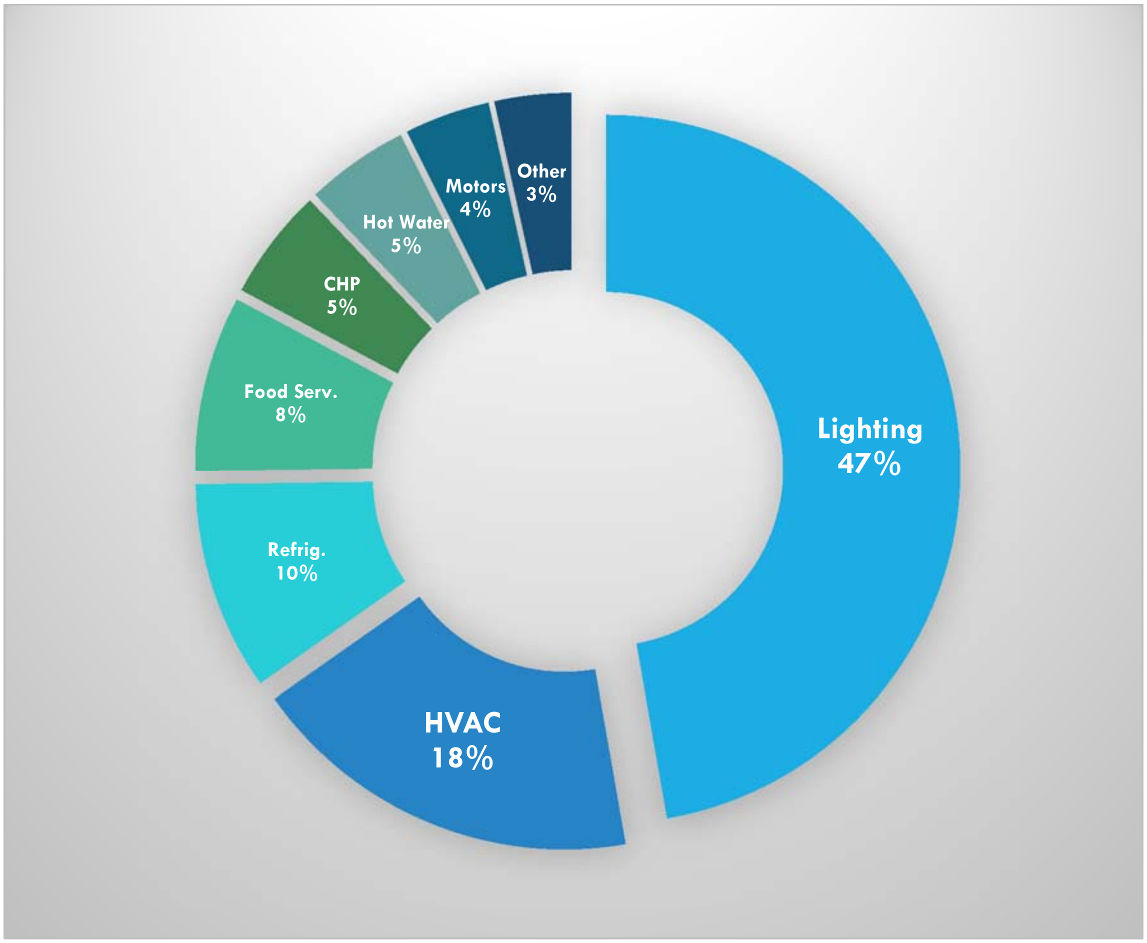
Achievable potential of the C&I sector is affected by seasonality, especially for the Restaurant and Hospitality segments. A large proportion of businesses have reduced hours of operation and/or occupancy during the off-peak season, and some even shut down completely during the winter.

Figure 7-3. 2016-2021 Cumulative Achievable Savings (GWh) for the C&I Sector



The main end-uses contributing to achievable potential are lighting (47%) and HVAC (18%). Other significant end-uses, which are specific to the C&I sector, are refrigeration (10%) and food service equipment (8%) (Figure 7-4).

Figure 7-4. 2016-2021 Achievable Potential by End-Use for C&I



7.2 Top Five Measures for C&I Sector

Three of the top five measure categories are lighting measures, reflecting the large share of lighting savings in the overall achievable potential. LED bulbs are by far the highest energy-saving measure, contributing 22.4 GWh of savings (21% of total achievable potential for the C&I sector) over the six-year period. Linear lighting savings also include some savings from LED technology.

Refrigeration and food service equipment also account for a substantial share of overall potential.

Table 7-2. 2016-2021 Savings for Top Five Measure Categories in the C&I Sector

Rank	Measure	GWh
1	LED Bulbs	22.4
2	Linear Lighting	14.0
3	Lighting Control	12.7
4	Refrigeration	10.0
5	Food service	9.1

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