DNV·GL

Massachusetts Commercial and Industrial Customer On-site Assessments

Interim Results Report

Massachusetts Program Administrators and Energy Efficiency Advisory Council Consultants

Itron ers Applied Public Policy Research APPRISE Institute for Study and Evaluation NMR Group, Inc.

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Table of Contents

List of Exhibits

1 EXECUTIVE SUMMARY

The Massachusetts Commercial and Industrial (C&I) Customer On-site Assessments and Market Share and Sales Trend Studies (MSST) are intended to collect primary data at non-residential facilities and provide primary research findings to be used by the PAs to inform and expand the Massachusetts energy efficiency programs.

The on-site data collection efforts focused primarily on collecting information on the major energy end-uses. Lighting, HVAC, and motors and drives remain the dominant sources of savings for the electric programs while HVAC and hot water production are the dominant sources of savings for gas programs. Information on refrigeration systems and compressed air systems was also collected.

The on-site data collection effort was divided into two segments:

- Wave 1 Data Collection – initiated in August, 2014 and concluded in November, 2014
- Wave 2 Data Collection – initiated in February, 2015 and will conclude in September, 2015

Field staff visited 350 sites in Wave 1 and collected raw data on equipment including age, condition and level of efficiency. Premise-level information, as well as operational schedules were also collected. The interim results are based on the results from 344 of those customers. The study team was not able to definitively associate the data with the sample from 6 customers. A 7th customer site was excluded from the interim results because of difficulties determining which equipment was associated with the sampled account. For the final analysis and report DNV GL will re-examine the customer sites that were excluded from the interim results to determine which data are associated with which accounts and include these sites in the final analysis.

The results for the Final Report will include data from all 800 planned on-sites. Due to the Phase 2 data collection and analysis, the final report results may differ from those presented in this Interim report.

The findings presented in this interim report focus on the highest priority end uses; lighting, HVAC, water heating, and refrigeration. Additional findings are also provided for kitchen equipment, office equipment, energy management systems (EMS), and on-site generation. Information is presented for the saturation of all of the end uses previously listed while recent purchase information (purchases from 2009-2014) is provided for lighting, HVAC, water heating, and EMS.

The distribution of the on-site visits in Wave 1 across the 14 business types is provided in Table 1-1. It should be noted that customers were recruited according to the business types indicated in study sample and that the recruitment team followed the designated quotas for each strata closely. This table presents the number of completed site visits according to the business types observed in the field and reallocates the previously “Unknown” customer classifications to the confirmed business type category.

Table 1-1: Number of On-site Visits Completed by Business Type (Not Weighted)

Business Type	On-sites Completed	Share of Completed On-sites
Campuses	9	3%
Education	31	9%
Food Sales	25	7%
Food Service	31	9%
Healthcare	19	6%
Hospitals	6	2%
Lodging	32	9%
Manufacturing or Industrial	23	7%
Office	55	16%
Other	24	7%
Public Assembly	32	9%
Retail	43	13%
Warehouse	13	4%
Total	**343**[1]	**100%**

The document consists largely of tables, graphs, and captions due to the short time frame available to clean and analyze the field data. Additional description and exposition has been provided in numerous sections to highlight some of the more significant and interesting findings. In general, estimates displayed in the tables and graphs are of the following types:

1. **Business-Level Weighted Estimates.** The sample of sites for this study were selected from a list (or sample frame) that was constructed from electric customer billing data obtained for the NGrid, Eversource (formerly NStar), Unitil, WMECO and CLC provider regions. The sample frame represents the target population for the study. The target population is the ultimate entity that the study is designed to draw inferences and conclusions about. The target population consisted of 205,442 businesses and accounted for a total annual energy consumption (from 2013 billing data) of 26,341,285 MWh[2]. In order to create unbiased estimates of the target population from the respondent data, two sample weights were created for each of the 344 respondent sites. The first of these weights, i.e. the business-level sample weight, was created in order to expand data from the 344 respondent sites back to the target population of 205,442 businesses. Business-level weighted estimates are estimates created using this sample weight.

2. **kWh-Level Weighted Estimates.** A second weight was created for each of the 344 responding sites that was designed to expand the respondent data back to the population of 26,341,285 MWh.

[1] The results presented here reflect responses received from 343 of 344 sites visits. 344 customers were included in the weighting of the results, however, the data from the customer site where we had difficulties associating the equipment with the sampled account was not included in the analysis and therefore was omitted from this table.
[2] MWh is kWh in 1,000's

This kWh-level weight was constructed from the business weight in order to keep business-level and kWh-level estimates as consistent as possible. kWh-level weighted estimates are estimates created using this sample weight.

3. **Un-weighted Estimates.** These are estimates created using the 343 completed sites. Data have not been expanded (or weighted) to reflect the target population in these estimates.

Business-level weighted estimates are appropriate for tables and graphs that display business-level statistics, such as the percent of businesses that have varying types of HVAC equipment. This weight is also appropriate for estimates of quantities of items, such as the distribution of total lamps in the target population. The kWh-level weighted estimates are appropriate for estimates designed to show the effect of something by energy consumed in the target population. For example, when one is interested in knowing what percent of the annual energy consumed is associated with sites that have a heat pump only type of HVAC heating system. The particular weight used in all weighted estimates presented in this report has been noted as a footnote to each table and graph. Additional detail on the construction of these weights and differences between a business-level and kWh-level estimate are provided in Section 2.4 and Appendix J.

The on-site data collection efforts from Wave 1 produced a wealth of information that can be used by the PA's and evaluation team to assess and guide energy efficiency programs for years to come. We present here the results from the Wave 1 data collection efforts that are defensible and relevant to the 2016-2018 joint state-wide energy efficiency planning effort. The following sections highlight some of the key findings related to the different types of equipment assessed. The main body of the report provides additional information on each of these end-uses.

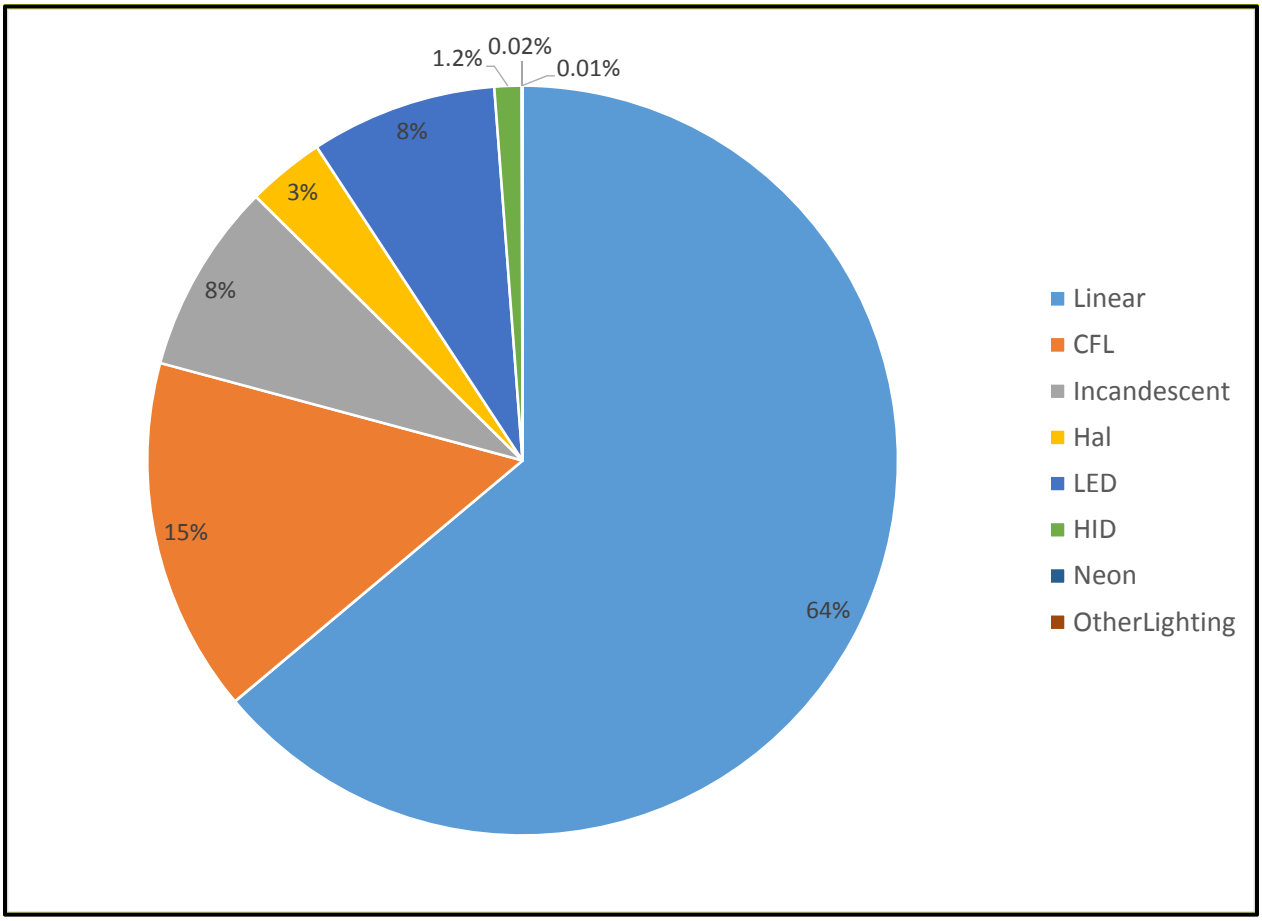
1.1 Lighting

Lighting represents one of the largest sources of energy use for many business types. The lighting data collected as part of the C&I Customer On-site Assessments and MSST Studies provide an indication of the progress achieved in replacing inefficient lighting with newer, more efficient technologies, and also provide information on the current lighting market.

Figure 1-1 shows the distribution of lighting technologies in buildings by lamp count, weighted by site[3]. The data suggest that approximately 64% of all non-residential lamps are linear fluorescents. The next most popular commercial lamp type is the CFL, at about 15%.

[3] The data presented in this Report are weighted unless the table or graph clearly indicates that the findings are not weighted. Weighting allows the non-random sample of sites to represent the population of non-residential sites. For this report, data that represent the count of technology or the share of technology available at a customer's facility are usually weighted by respondent weight while data that represent the existence of an attribute are weighted by kWh weight. The weighting will be describe in more detail in Section 2 and the Appendix.

Figure 1-1: Distribution of Lamps by Technology Type



* The results presented above are weighted using the business-level sample weight.

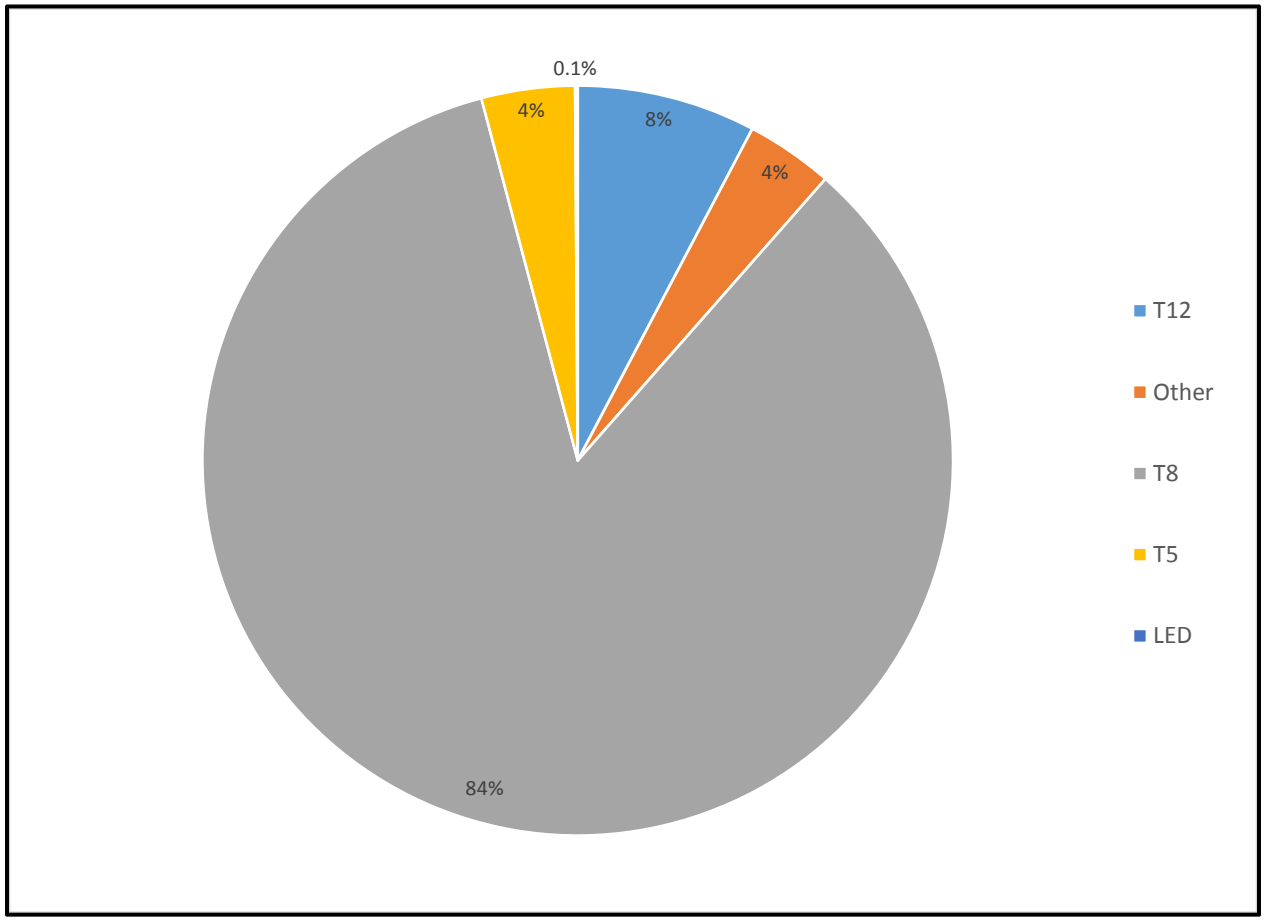
** These data represent lamp count data from 323 sites with linears,218 sites with CFLs, 175 sites with incandescents, 67 sites with halogens, 142 sites with LEDs, 141 sites with HIDs, 9 sites with neons and 11 sites with other lighting.

1.1.1 Linear Lighting

Figure 1-2 disaggregates the linear lamps into T12, T8, and T5 lamps.[4] T12 lamps represent older technologies with higher wattages while T8 and T5 lamps represent newer, more efficient forms of lighting. T8s are the most common type of linear lighting in Massachusetts businesses, at 84%.

[4] The Other efficiency grouping includes T10s and other types of linear lighting not already highlighted.

Figure 1-2: High Level Linear Efficiency Distribution



*The results presented above are weighted using the business-level sample weight. Lamps represent all linears

** These data represent 323 sites

The T8 linear lamps represent a wide range of technologies and efficiency levels. Make and model lookups undertaken for the C&I Customer On-site Assessments and MSST studies. The on-site form was designed to collect the make, model, size specifications, and wattage information from the linear bulbs. Lookup tables were developed using the data collected on-site to determine the efficiency level of the linear technologies.

The analysis found that nearly all T8 lamps are four foot lamps. Given that the focus of the linear lamp efficiency disaggregation is on the characterization of T8 lamps into their four efficiency types, the analysis of the existing stock of linear lamps focuses on four foot linear technologies.

It is possible to visually identify T12, T5 and LED linear lamps. The T12 lamps are classified as base efficiency, while T5 and LED and T5 lamps are classified as high efficiency. Analysis of the make and model numbers was used to disaggregate T8 lamps into four efficiency characterizations. Descriptions of the different types of T8 lamps going from least to most efficient are provided below:

- **700 Series T8 lamps or First Generation T8 Lamps**: These lamps usually provide an initial lumens of at most 2,800, use 32 watts, have a Color Rendering Index (CRI) of 75-78,[5] and typically have a 15,000-20,000 hour life rating. The lamps found in this study have a median mean lumens of 2,520. First generation T8 lamps have the lowest lumens and shortest life of any T8 lamp.
- **800 Series T8 lamps or Second Generation T8 Lamps:** These lamps are 32 watt lamps with initial lumens 2,800-3,000 lumens, 82-86 CRI, and 20,000-24,000 hour rated life. For this study, the median mean lumens observed for Second Generation T8 lamps was 2,773.
- **High Performance T8 Lamps or Third Generation T8 Lamps:** These lamps are classified by the Consortium for Energy Efficiency (CEE). These lamps are 32 watt lamps with a minimum initial lumens of 3,100, 82-86 CRI, and a life rating of at least 24,000 hours. The median mean lumens observed for all High Performance T8 lamps in this study is 2,915.
- **Reduced Wattage T8 Lamps or Fourth and Fifth Generation T8 Lamps:** These lamps are also classified by CEE. These lamps typically use 25-28 watts. Their CRI is typically 82-86 CRI, life ratings up to 30,000 hours with lumens from 2,285 to 2,650. Lamps included in this study have a median observed watts for reduced wattage T8 lamps of 28 and the median mean lumens are 2,350.

The descriptions of different types of T8 lamps illustrates that three of the four types of T8 lamps use 32 watts while Reduced Wattage or Fourth and Fifth Generation T8 lamps use 25-28 watts. Progressing from First Generation through Third Generation T8 lamps the efficacy of the lamps, or the lumens per watt, improves from approximately 87.5 to 97 lumens per watt while the CRI improves from 75-78 to 82-86. The improved lighting output (efficacy) and CRI allow customers to use either fewer lamps, lower ballast factors, or fewer fixtures when moving from First Generation T8 lamps to Third Generation lamps. A report from Consortium for Energy Efficiency (CEE) found that Third Generation T8 system wattage is "20% less than the standard 700-series T8 system, and 10% less than the 800-series T8."[6]

Figure 1-3 shows the efficiency distribution of these technologies for the existing stock and for recently purchased linear lighting.[7] The data clearly illustrate that of the existing stock of four foot T8s found in Massachusetts businesses, 700 Series T8s are the most common (48%) while four foot T12 lamps are relatively uncommon (4%). The recent purchase data indicates that Massachusetts businesses are turning to more efficient T8 lamps with nearly 54% of recent purchases representing High Performance T8 lamps and only 21% of recently purchased T8 lamps are 700 Series T8s.

The findings from the analysis of the existing stock and recent purchases of four foot linear technologies are consistent with the intent of the Energy Policy Act of 2005 (EPAct). With respect to linear lamps, EPAct's intent was to improve the efficiency of non-residential linear lighting. EPAct banned the production or importation of most four foot T12 lamps as of July 14, 2012 and First Generation or 700

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5 CRI is a measure of a lamps ability to render colors the same as sunlight. A CRI of 100 is equivalent to sunlight's rendering. An incandescent bulb typically has a CRI of 95. Higher CRI values are typically associated with better lighting characteristics.

6 Consortium for Energy Efficiency. November 2004. "High Performance Commercial Lighting Systems Initiative."

7 The data presented as existing stock incorporates those data that are also presented as recent purchases.

Series T8 lamps as of July 14, 2014. The results presented in Figure 1-3 and Table 1-2 clearly indicate that non-residential customers in Massachusetts are no longer purchasing T12 lamps (T12 share was 0.04%) and that the existing stock of T12 lamps is small (4%). The ban on the production or importation of 700 Series T8 lamps was implemented during the data collection period. The recent purchase share of 700 Series T8 lamps (21%), however, is substantially smaller than their share of the existing stock (48%). These data indicate that the 700 Series T8 share is likely to have a declining share of the existing stock in the future as non-residential customers increasingly purchase more efficient linear technologies.

Figure 1-3: Linear Efficiency Distribution, Missing Data Reallocated, Four Foot Lamps: Existing Stock and Recent Purchases

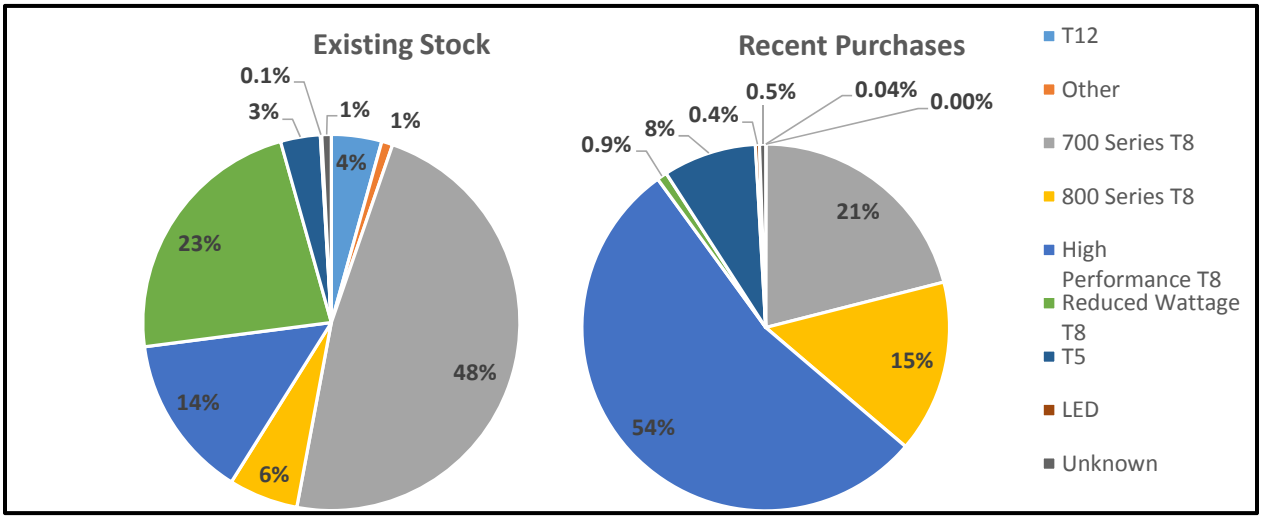


Table 1-2: Linear Efficiency Distribution, Missing Data Reallocated, Four Foot Lamps: Existing Stock and Recent Purchases

Linear Efficiencies	Existing Stock	Recent Purchases
T12	4%	0.04%
Other	1%	0%
700 Series T8	48%	21%
800 Series T8	6%	15%
High Performance T8	14%	54%
Reduced Wattage T8	23%	0.9%
T5	3%	8%
LED	0.1%	0.4%
Unknown	1%	0.5%

*The results presented above are weighted using the business-level sample weight. Recent purchase information represents lamps purchased from 2009-2014.

** These data represent 323 sites for Existing Stock and 107 sites for Recent Purchases.

The small share of linear lighting represented by T12 lamps implies that these lamps will provide little savings potential going forward. The market also appears to be making a change from installing First and Second Generation T8 lamps to installing more High Performance and Reduced Wattage T8s. The Massachusetts non-residential energy efficiency lighting programs will need to focus on High Performance, Reduced Wattage, T5 and LED linear technologies to help move the market to higher efficiency technologies. The very small share of recent purchases represented by Reduced Wattage T8s must be viewed with caution and may simply reflect the selection of sites visited during Phase 1 data collection and may not reflect the market as a whole.

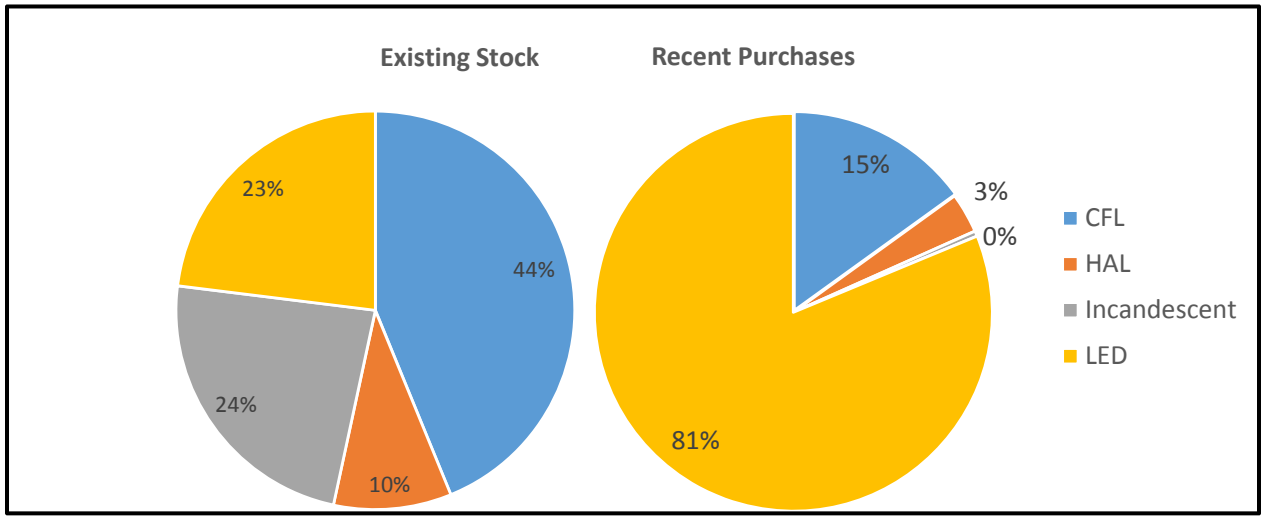
1.1.2 Incandescent, CFL, LED, and Halogen (ICLH) Lighting

The ICLH section presents information on incandescent, CFL, LED, and halogen technologies currently installed in businesses in Massachusetts (Existing Stock) and recent purchases (from 2009 to 2014) of ICLH lamps by businesses. These lighting technologies were grouped together because each of these technologies has similar lighting applications. The results in this section include outdoor lighting but do not include exit signs. Figure 1-4 presents the share of ICLH lamps in each technology group for the existing stock and for recent purchases. These data indicate that CFL, LED, and incandescent lamps each have over 20% representation in Massachusetts businesses with CFLs accounting for 44% of the baseline. The study data indicate that LED lamps are growing quickly as 81% of recent purchases are LEDs.[8]

CFL's 44% share of the existing stock and LED's 23% share indicate that non-residential customers in Massachusetts have made substantial progress toward replacing their inefficient incandescent lamps with more efficient alternatives. These findings imply that remaining energy efficiency savings potential associated with the installation of CFL and LED lamps may be substantially less than previously anticipated. The high share of LED lamps among recent purchases is consistent with their 23% share within the existing stock, but their 81% share for recent purchases remains startling. Given the interim nature of this finding, and the fact that the C&I Customer On-site Assessment Study will collect data from approximately 450 additional customers, it is prudent to wait for the completion of the second phase of data collection before forming strong conclusions concerning the share of LED's in recent purchases.

[8] The weighting developed for this project controls for the potential self-selection bias associated with energy efficiency program participation. The share of CFLs and LEDs found in Phase 1 is high, but the evaluation team does not believe that the finding is due to self-selection bias associated with prior energy efficiency program participation. There is always the potential that the weighting model needs additional adjustment or that other types of self-selection bias could be impacting the findings. Additional data from Phase II will help to determine if the high share of CFLs and LEDs persists.

Figure 1-4: ICLH Lamp Distribution: Existing Stock and Recent Purchases



*The results presented above are weighted using the business-level sample weight. Recent purchase data represents lamps purchased from 2009-2014.
** These data represent 302 sites for Existing Stock and 131 sites for Recent Purchases,

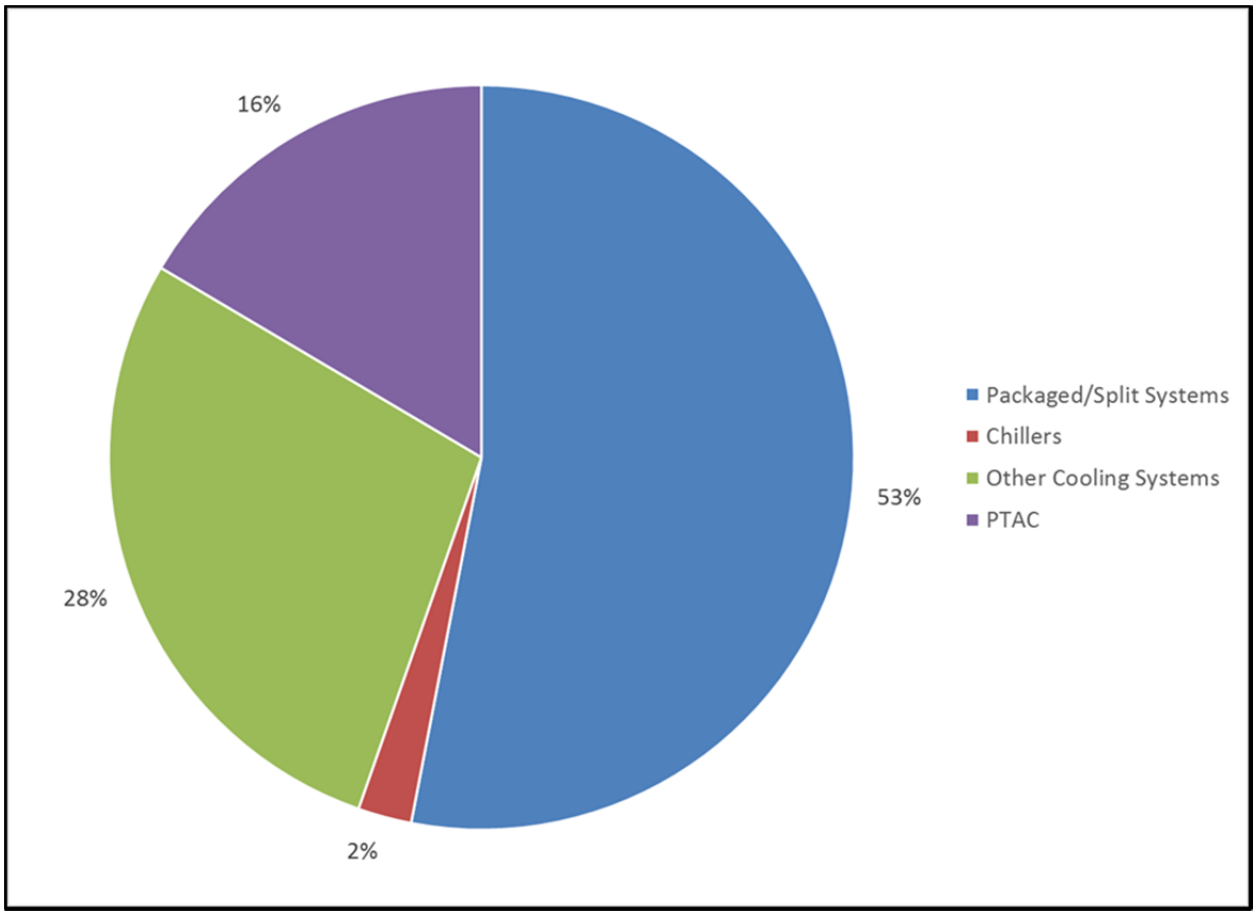
1.2 HVAC

Heating, ventilation, and air conditioning (HVAC) systems represent a significant fraction of energy use and peak demand within the non-residential sector. The C&I Customer On-site Assessment collected extensive information on HVAC systems. The data collected during these surveys provides information on the existing stock of HVAC systems from which it will be possible to measure progress toward achieving the goal of improved HVAC efficiency in the non-residential sector. The findings from the MSST Study's analysis for purchases of HVAC systems from 2009-2014 provides information on the efficiency of recently purchased systems.

1.2.1 Cooling

Figure 1-5

Figure 1-5: Distribution of Cooling Systems



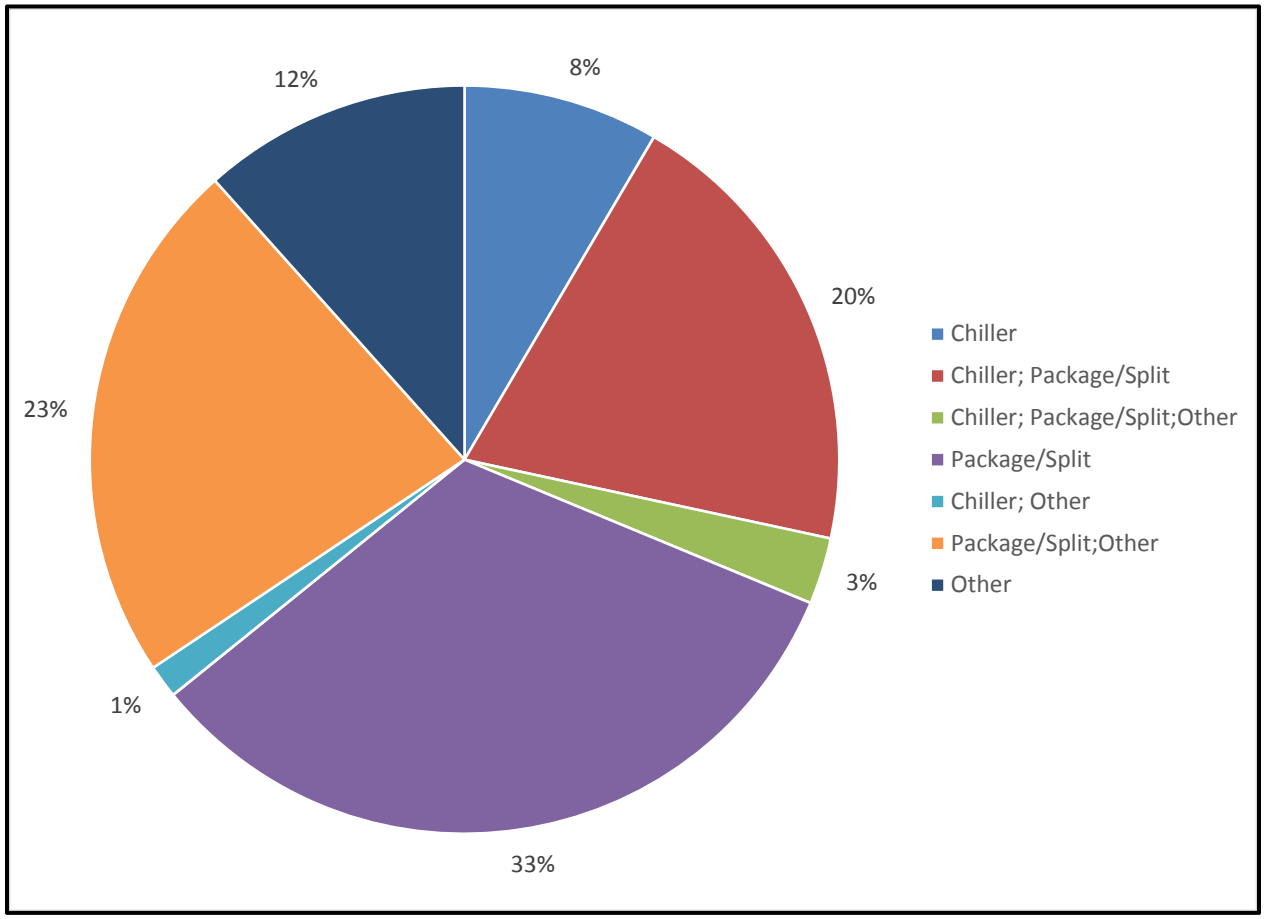
*The results presented above are weighted using the business-level sample weight.

** These data represent 295 sites.

***Heat pumps are included in the Packaged/Split systems category

Figure 1-6 illustrates the distribution of cooling system types by business square footage. Because a business, and its square footage, may have multiple cooling system types, the system types were combined to represent what was found on-site. For example, a facility may be cooled by a large chiller and several smaller packaged or split systems. For this example, the business would be represented by the chiller and packaged/split shares. Looking at cooling systems by square footage, packaged and split systems still represent the largest share of systems for businesses with only one system type. Examining the distribution of cooling systems by square footage, however, dramatically increases the influence of chillers.

Figure 1-6: Businesses Square Footage with Varying Types of Cooling Systems



*The results presented above are weighted using the business-level sample weight.

** These data represent 295 sites.

***Heat pumps are included in the Packaged/Split systems category

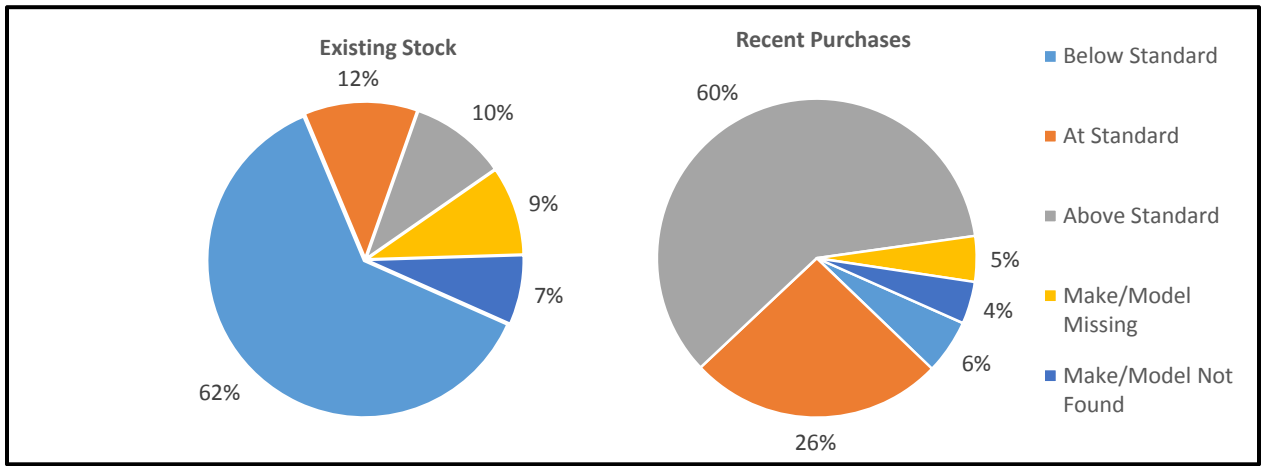
During the on-site data collection process field engineers collected make and model numbers from HVAC equipment where possible. For split and packaged air conditioning and heat pump systems the make and model numbers were looked up to help determine the efficiency of the system. The efficiency rating for these systems depends upon system type and size. The minimum efficiencies for these HVAC units are governed by Federal standards. Figure 1-7 illustrates the efficiency distribution for packaged and split cooling systems for the current stock of equipment and for recent purchases (2009-2014).

The efficiency for all of the equipment surveyed are compared to current efficiency standard levels. The efficiency requirements by cooling system size are presented in Section 3.4 of this report. Comparison to current standards is necessary because the purchase date of equipment is not available for all units and a comparison to current standards provides information on the energy efficiency savings potential relative to current standards. These data illustrate that most cooling systems within the existing stock are below current standard while most recent purchases (purchases from 2009-2014) exceed current efficiency standards. The 62% of cooling systems in the existing stock that are currently below standards largely represent cooling systems purchased several years ago (most cooling systems have a long expected

useful life). The efficiency requirements for all sizes of packaged and split systems have been updated within the last 10 years. These older, less efficient units within the existing stock represent technology whose future replacement will lead to electricity savings for Massachusetts customers.

The finding that 60% of recent purchases of packaged and split systems exceed current standards is remarkable. The high share of "Above Standard" purchases may be due in part to small sample sizes. The collection of additional data during the Phase 2 data collection period will help to clarify these findings.

Figure 1-7: Distribution of Efficiency for Packaged and Split Cooling Systems for Baseline and Recent Purchases



*The results presented above are weighted using the business-level sample weight.

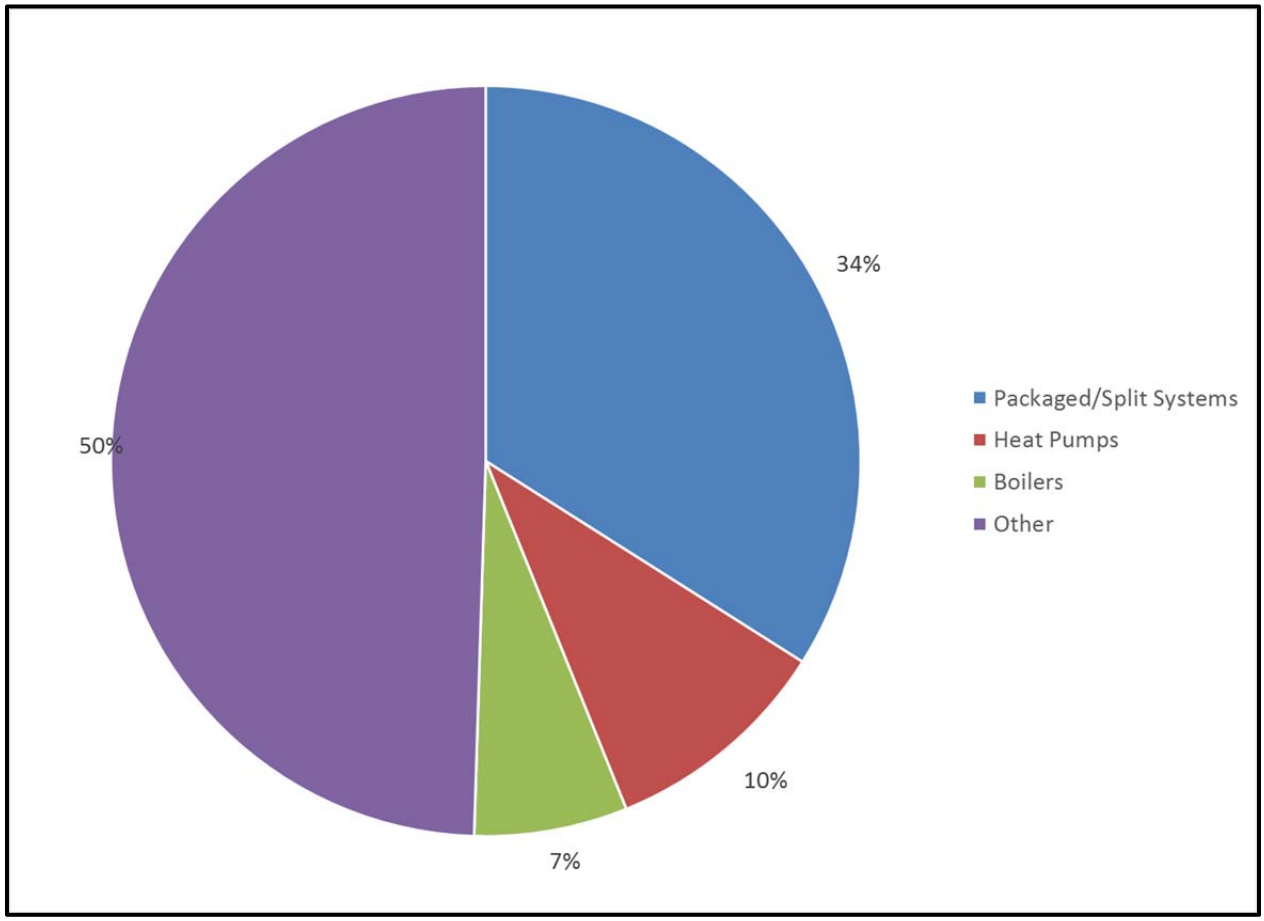
** These data represent 183 sites with Existing Stock and 60 sites with Recent Purchases.

*** Recent purchases are purchases between 2009 and 2014.

1.2.2 Heating

Figure 1-8 presents the distribution of heating system types by the heating system unit. In this graph, all of the shares describe a single system type. These data indicate that "other" systems are the most common system type. Other systems include baseboard heat, PTACs, window/wall units, unit heaters, and space heaters. It is likely that other systems are the most common system type because they typically heat only a single space and multiple units would be needed to heat a typical building. The second most common heating type is a split or packaged system. Applying the distribution of heating system types by square footage is not relevant since a business' square footage can be heated with multiple system types.

Figure 1-8: Distribution of Heating Systems

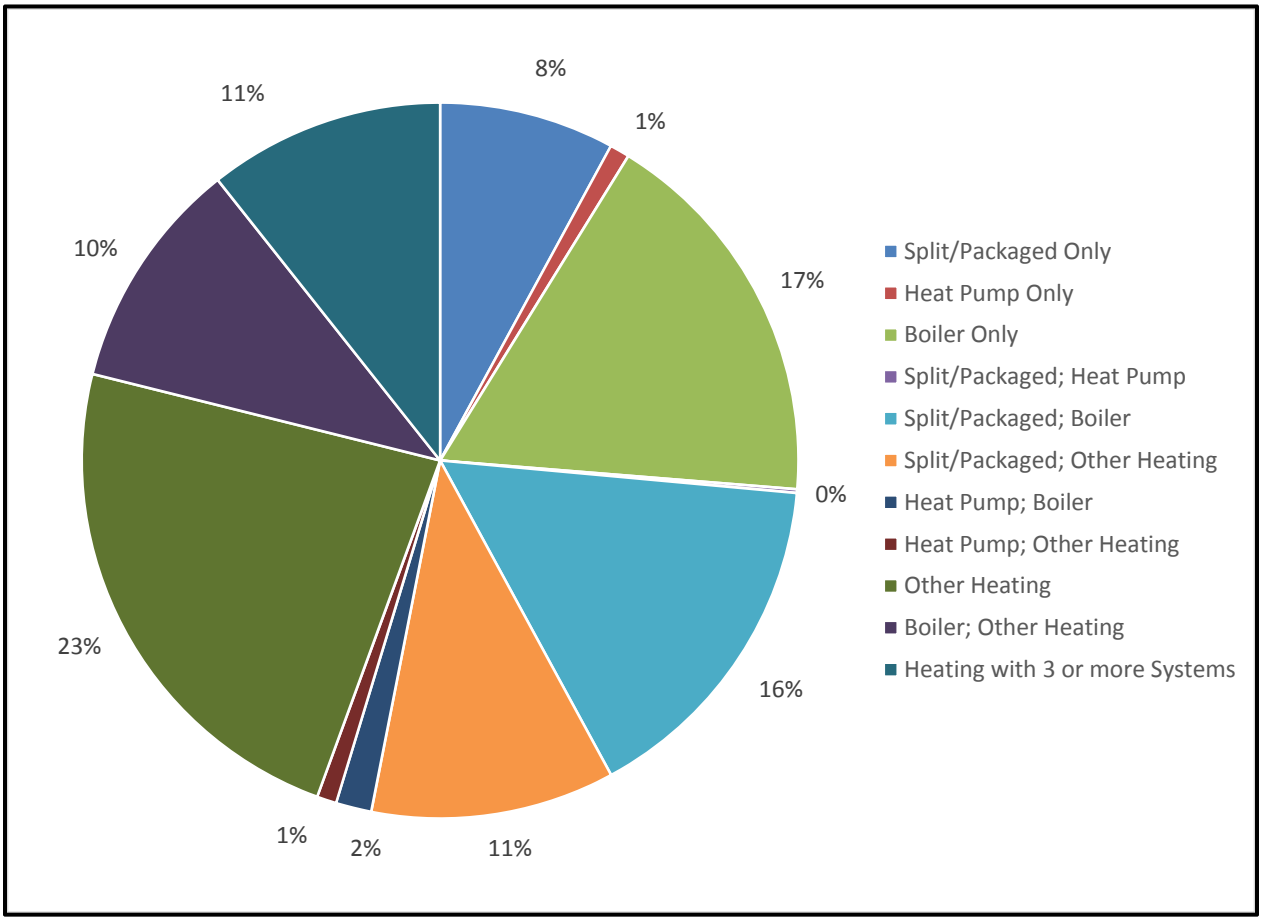


*The results presented above are weighted using the business-level sample weight.

** These data represent 318 sites.

Figure 1-9 illustrates the distribution of heating system types by business square footage. Because a business, and its square footage, may have multiple heating system types, all the system types have been combined to represent the combinations of system types of what was found on-site. Looking at heating systems by square footage, other heating still represents the largest share of systems for businesses with only one system type. Examining the distribution of heating systems by square footage, however, dramatically increases the influence of boilers. If all of the pie distributions associated with boilers are summed (boiler only, split/packaged; boiler, heat pump; boiler, and boiler; other), boilers contributed to the 44% of the non-residential square footage heating.

Figure 1-9: Percent of Square Feet with Varying Types of HVAC Heating Equipment



*The results presented above are weighted using the business-level sample weight.
** These data represent 318 sites.

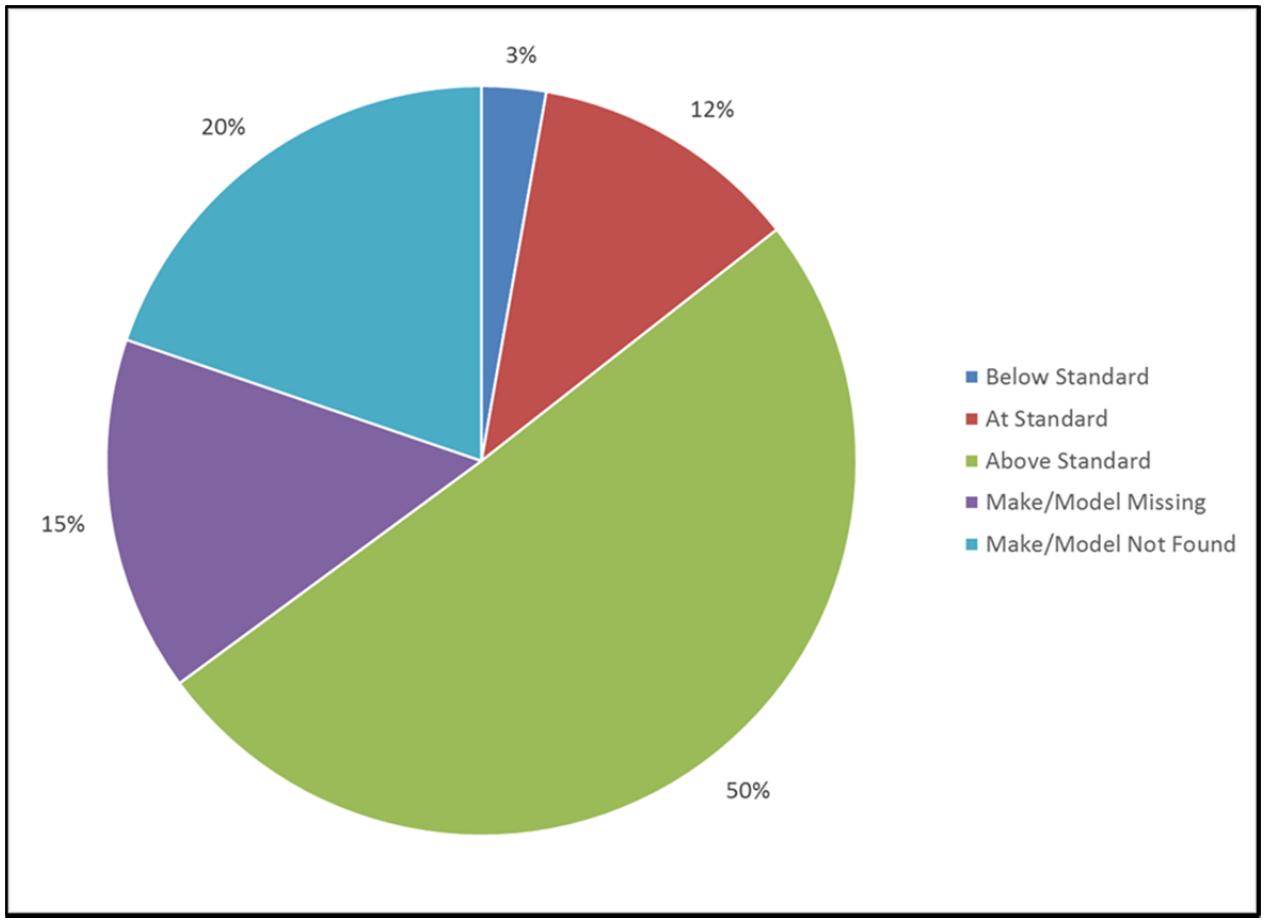
The on-site data collection process collected make and model numbers from HVAC equipment where possible. For split and packaged heating and heat pump systems the make and model numbers were looked up to help determine the efficiency of the system. The efficiency rating for these systems depends upon system type and size. The minimum efficiencies for these HVAC units are governed by federal appliance standards. Figure 1-10 illustrates the efficiency distribution for packaged and split heating systems.

The efficiency for all of the packaged and split heating equipment surveyed are compared to current efficiency standard levels. The efficiency requirements by heating system size, type, and fuel are presented in Section 4 of this report. Comparison to current standards is necessary because the purchase date of equipment is not available for all units and a comparison to current standards provides information on the energy efficiency savings potential relative to current standards. These data illustrate that 50% of the heating systems within the existing stock are above current standards. It is also quite likely that where efficiencies of equipment could not be assigned (20% of systems), that they represent older, less efficient

pieces of technology given that they could not be found in a search where it is relatively easier to find newer, more efficient models.

The finding that 50% of the existing stock of packaged and split systems exceeds current standards is remarkable. The standards used to classify these systems, however, have not been updated in several years (set from 1992-2010).9 During the evaluation period the standards for some heating systems will be updated. Given that the Final Report will include data associated with additional customers, the analysis may be able to present additional information on the efficiency by level by system type. Prior to drawing conclusions on the efficiency of heating and the remaining energy efficiency savings potential associated with non-residential heating, the additional heating data from Phase 2 should be reviewed in detail relative to both existing and new standards.

Figure 1-10: Efficiency Distribution for Split and Packaged Heating Systems



*The results presented above are weighted using the business-level sample weight.
** These data represent 210 sites.

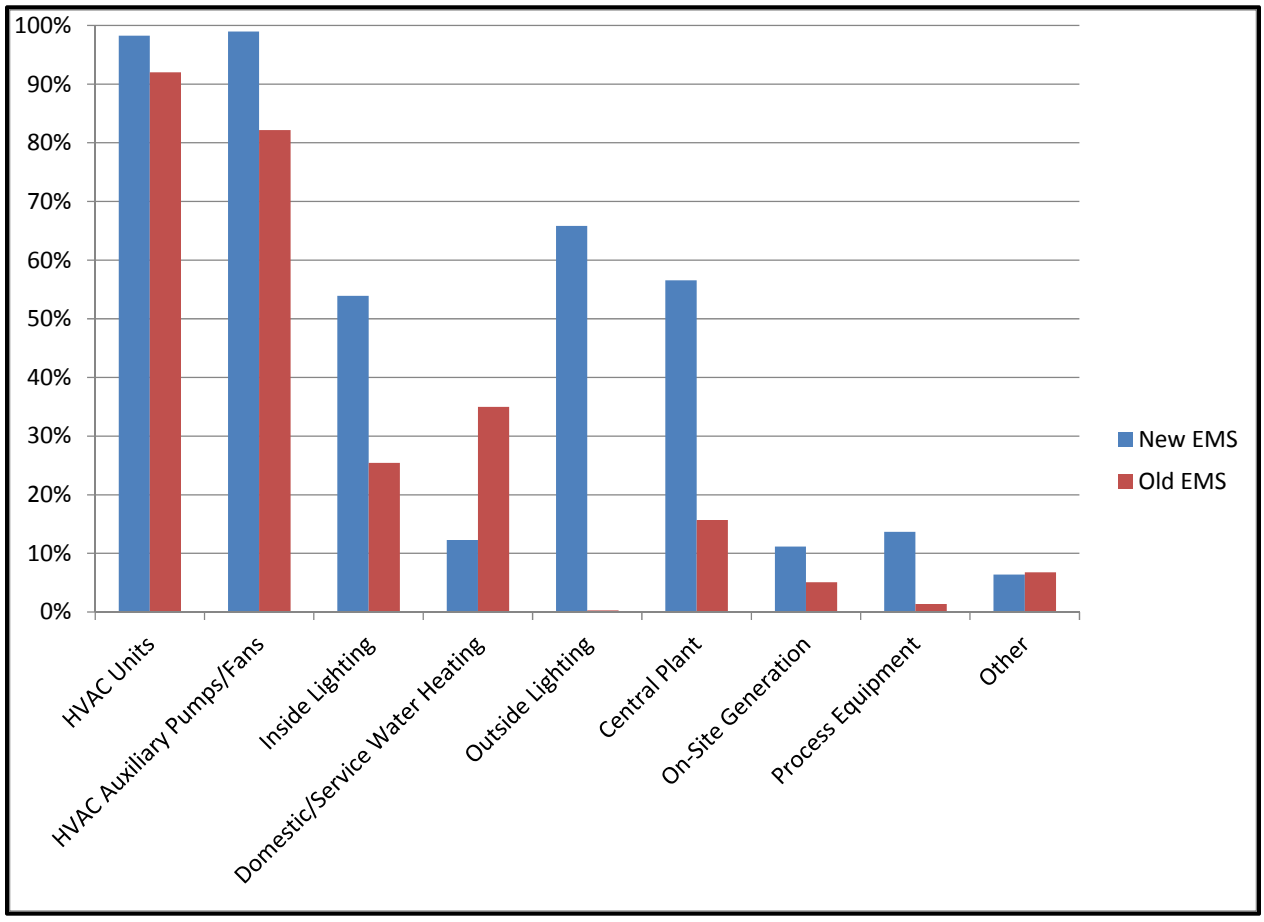
9 The heating system standards established in 2010 are for commercial heat pumps. Few heating systems used by non-residential customers are heat pumps. The majority of systems used in Massachusetts are governed by standards from 1992-2007.

1.3 Energy Management Systems

Energy Management Systems (EMS) consist of a network that combines local distributed control with centralized coordination and management to monitor, control, and optimize the energy usage throughout a business facility. We collected data on the existence of EMS systems and detailed data on EMS systems for businesses where EMS was found on-site. During the 2014 data collection efforts, 88 customers were found to have EMS.

The C&I Customer On-site Assessment field staff collected information on the end uses controlled by EMS for customers with an EMS. Figure 3-72 [Figure 3-72] illustrates the share of end uses controlled by EMS for newer (2009 or later) and older EMS. These data illustrate that HVAC units and HVAC pumps/fans are the most commonly EMS-controlled end uses. Newer EMSs control more end uses on an average (4.2) than older EMS (2.6). The data also indicate that indoor and outdoor lighting and central plant have a substantially higher share of customers controlling energy usage using newer EMS systems rather than older systems.

Figure 1-11: End Uses Controlled by Older and Newer EMS



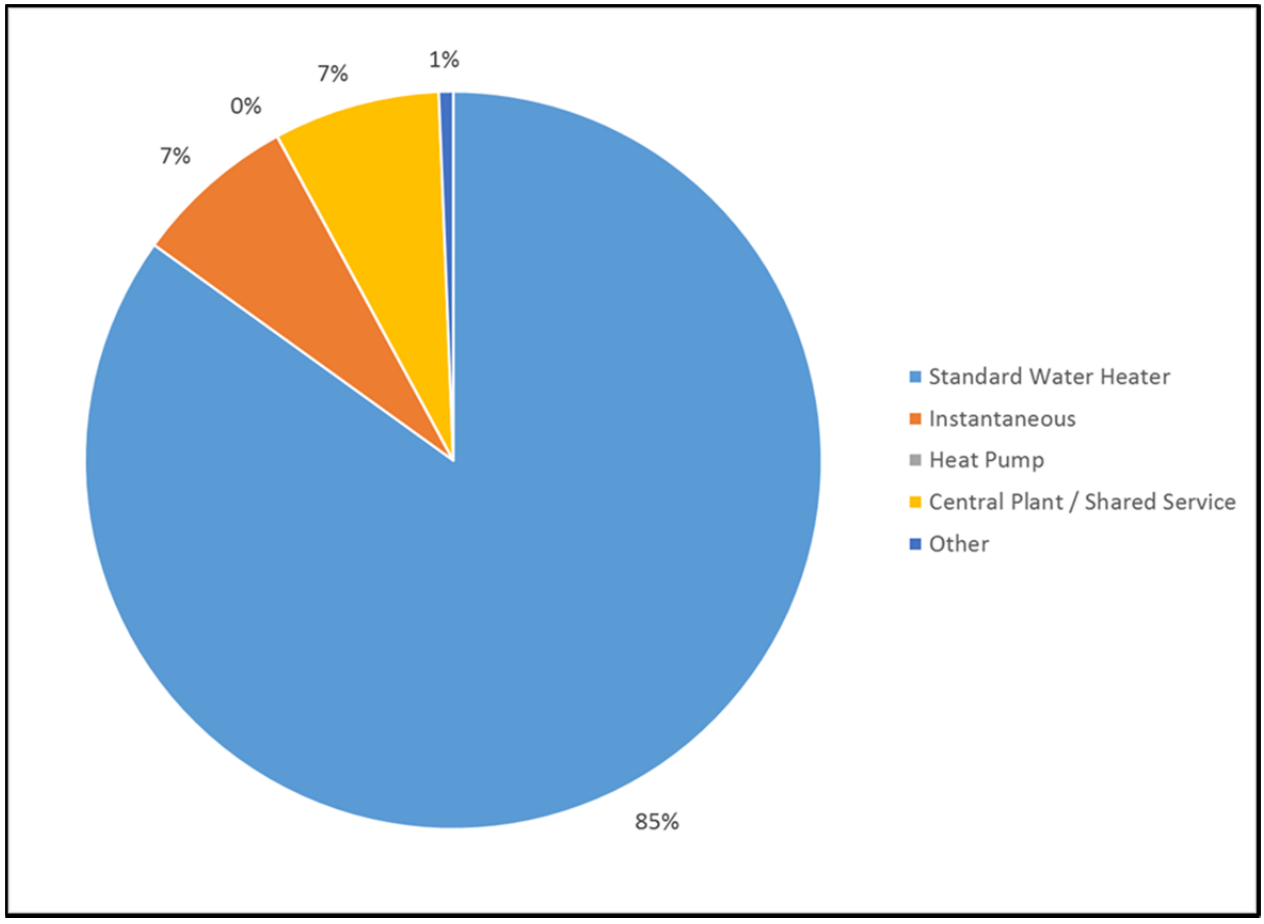
* The results presented above are weighted using the kWh-level sample weight.
** These data represent 88 sites.

1.4 Water Heating

The C&I Customer On-site Assessments Project and the MSST Study documents the baseline distribution of existing water heaters within businesses and the efficiency distribution of new water heater purchases. Water heaters analysed for this report are grouped as standard storage, instantaneous or tankless, heat pump, boiler/central plant, or other.

Figure 1-12 Figure 3-94presents the distribution of water heater system types. In this graph, all of the shares describe a single system type. Standard storage water heaters represent 85% of the water heating units in non-residential facilities in Massachusetts.

Figure 1-12: Water Heater System Type

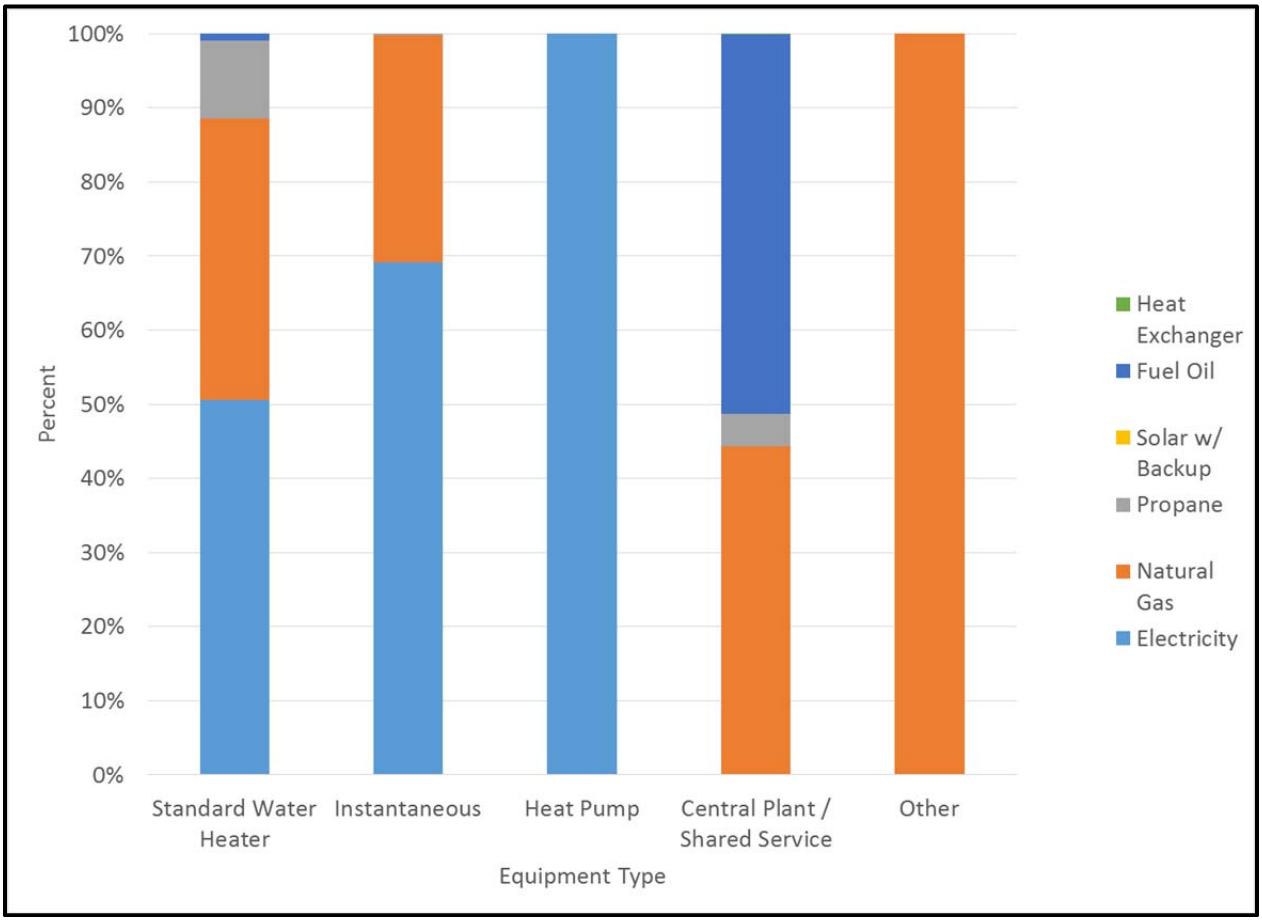


***** The results presented above are weighted using the business-level sample weight.

** These data represent 724 total systems.

Water heaters can use multiple fuel types. The C&I Customer On-site Assessments study collected information on the water heat fuel including electricity, natural gas, propane, fuel oil, solar with backup, and heat exchangers. Electricity is the most common fuel for water heaters in non-residential facilities in Massachusetts representing 48% of water heaters followed by natural gas at 38%. Figure 1-13 illustrates the distribution of water heater system type by their fuel type. Approximately 50% of standard tank water heaters use electricity.

Figure 1-13 : Share of Water Heater System Types by Water Heater Fuel



*The results presented above are weighted using the business-level sample weight.

** These data represent 724 total systems.

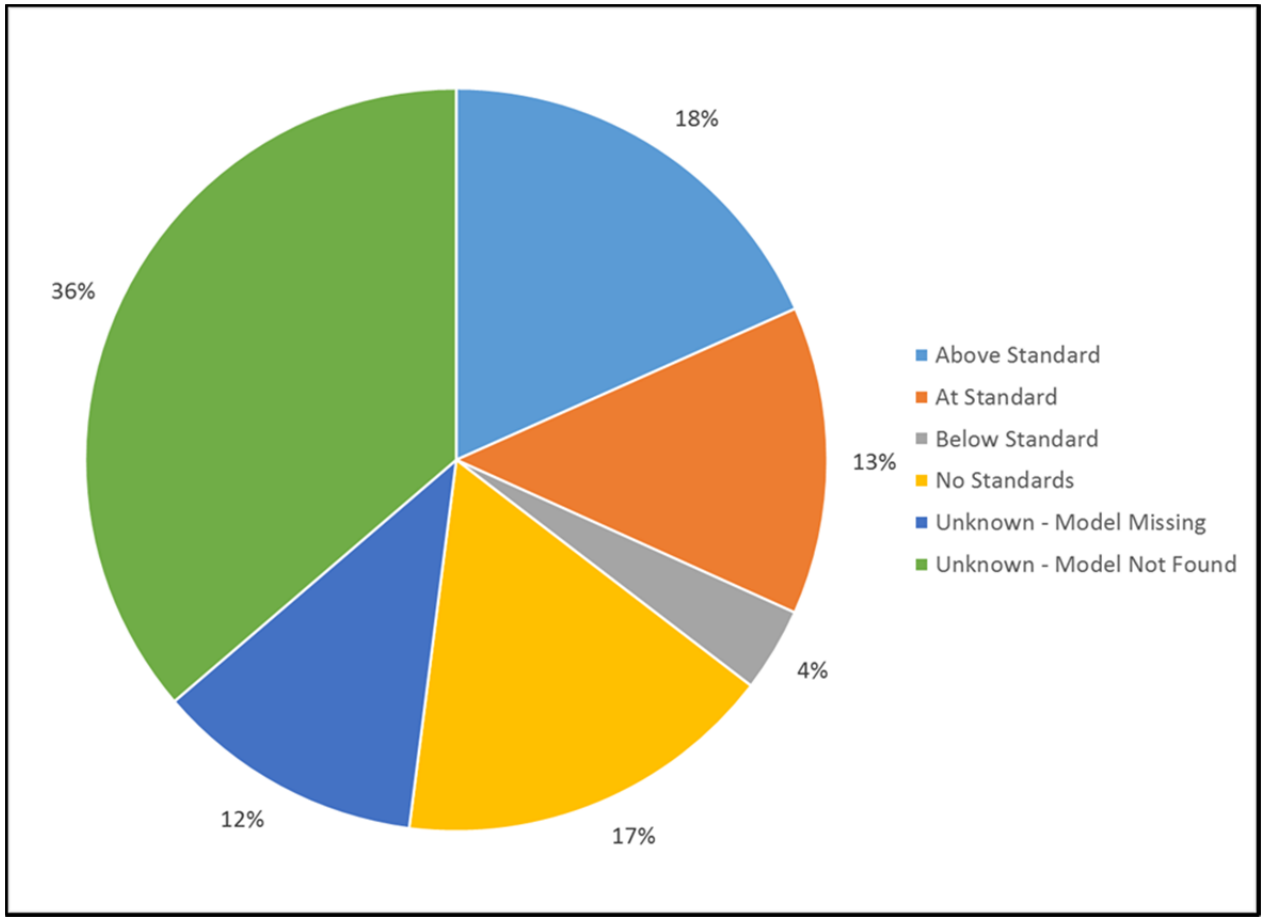
During the on-site data collection process the field staff collected make and model numbers from water heating equipment where possible. For standard tank and instantaneous systems the make and model numbers were looked up to determine the efficiency of the system. The efficiency rating for these systems depends upon equipment type, input capacity, fuel and tank capacity. The minimum efficiencies for these water heating units are governed by federal appliance standards. Figure 1-14 illustrates the efficiency distribution for standard tank and instantaneous water heating systems. The efficiencies for all of the water heating equipment surveyed are compared to current efficiency standard levels. The efficiency requirements by water heating system size, type, and fuel are presented in Section 3.6 of this report. Comparison to current standards is necessary because the purchase date of equipment is not available for all units and a comparison to current standards provides information on the energy efficiency savings potential relative to current standards.

These data illustrate that at least 18% of water heating systems in non-residential facilities in Massachusetts are above current federal energy efficiency standards. The C&I Customer On-site Assessments study also found that 17% of water heating units in non-residential facilities were less than 20 gallon systems that are not currently subject to federal energy efficiency standards. The standards

used to classify the water heating systems are from 2001 and 2004. The federal government is currently in the process of reviewing these standards for potential changes.

Given that the final report will include data associated with additional customers, the analysis may be able to present additional information on the efficiency level by system type. Prior to drawing conclusions on the efficiency of water heating and the remaining energy efficiency savings potential associated with non-residential water heating, the additional water heating data from Phase 2 should be reviewed in detail.

Figure 1-14: Water Heating Efficiency Distribution



*The results presented above are weighted using the business-level sample weight.

** These data represent 724 total systems.

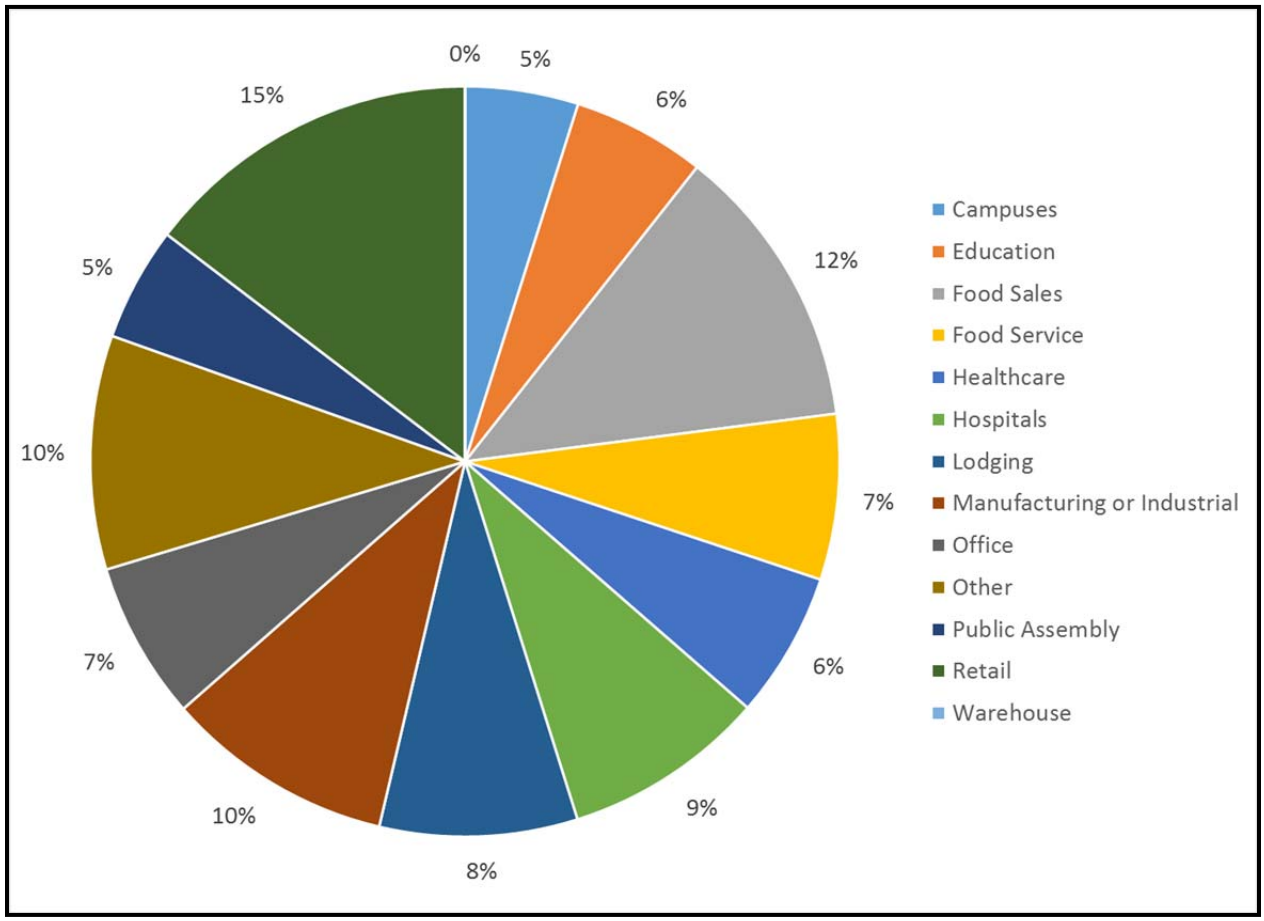
1.5 Refrigeration

Refrigeration systems represent a significant source of energy usage within the non-residential sector. Within select commercial segments refrigeration usage accounts for a significantly higher share of usage than for the average commercial business. Refrigeration systems account for a higher share of whole business electricity usage within food stores, refrigerated warehouses, and food service businesses.

Figure 1-15 illustrates the distribution of linear feet of refrigerated cases by business types. These data indicate that the largest share of refrigeration case linear feet is concentrated in the retail, food sales and

food service businesses. The retail category includes larger box-store type facilities that have sections of their stores dedicated to refrigerated items.

Figure 1-15: Distribution of Linear Feet of Refrigerated Cases by Businesses Type

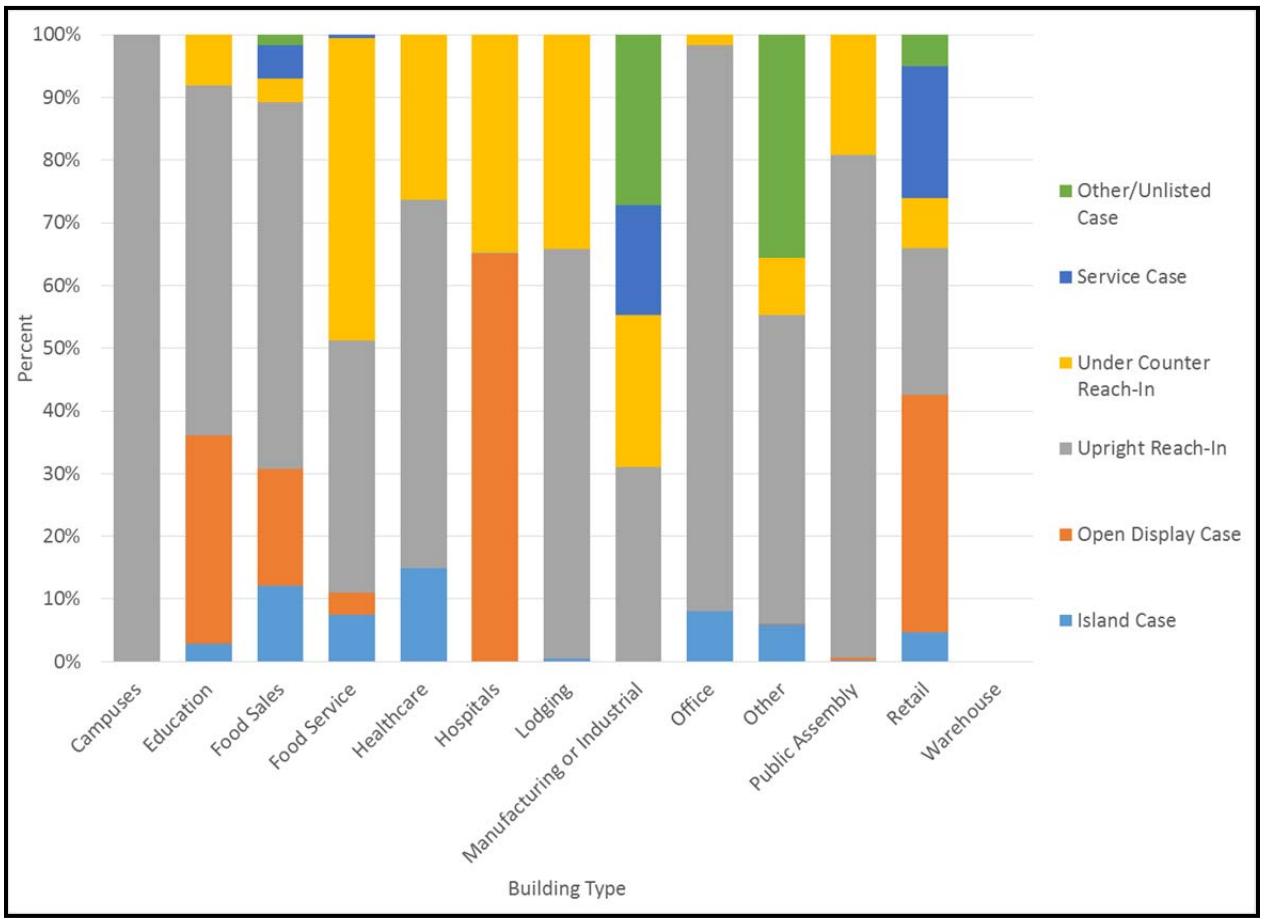


* The results presented above are weighted using the business-level sample weight.

** These data represent 278 sites with refrigeration

Figure 1-16 illustrates the distribution of the total linear feet of refrigerated cases by business kWh size and case type. The refrigeration section of this report contains a mapping of the descriptive on-site case categories to the aggregated or simplified case types shown below. These data illustrate that Upright Reach-in cases account for the largest share of linear feet of refrigerated cases for campuses, education, food sales, health care, lodging, office, and public assembly. For other businesses, "Other" cases have a large share of the linear feet of refrigerated cases where "Other" cases are primarily lab cases from a single site.

Figure 1-16: Distribution of Linear Feet of Refrigerated Cases by Business Type and Case Type



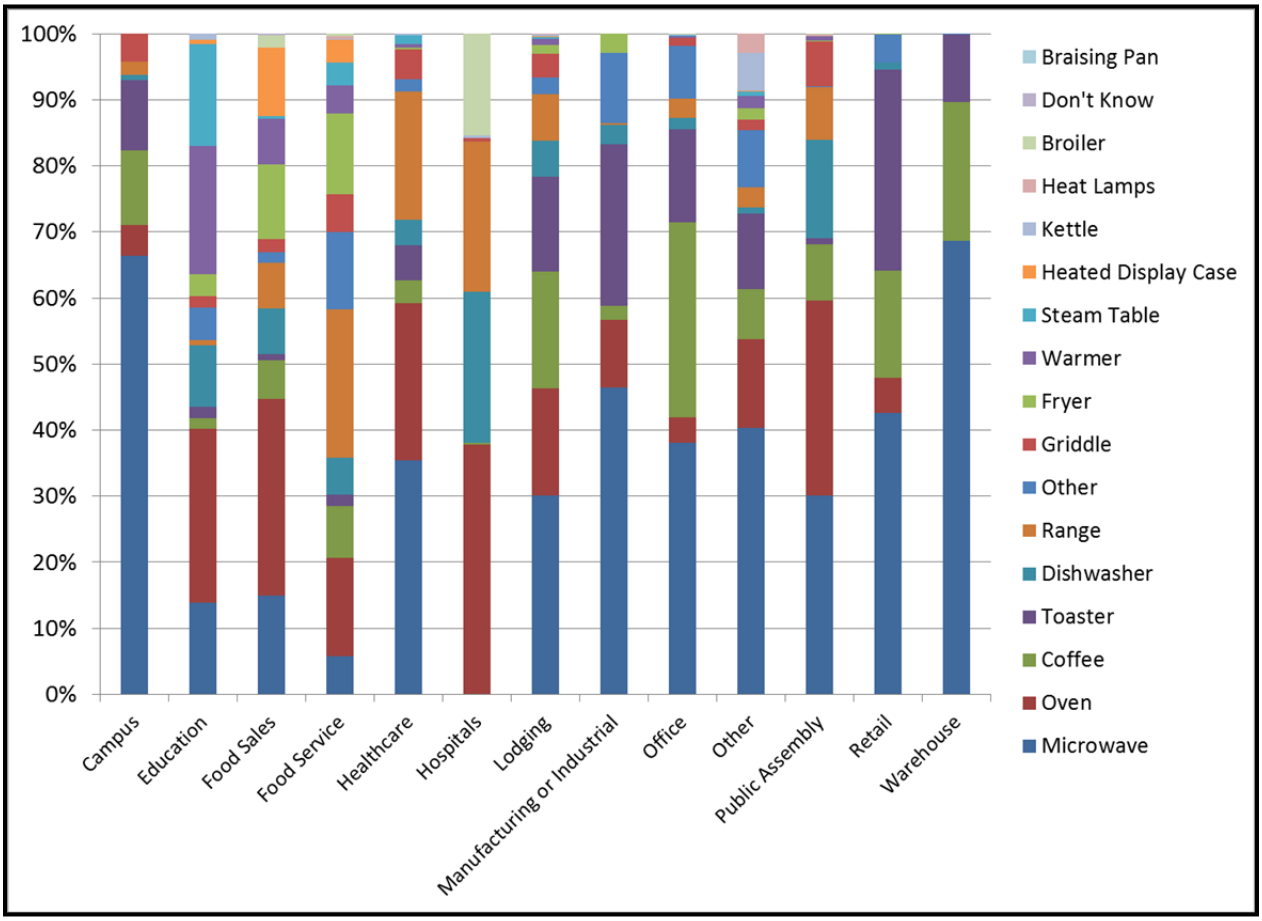
* The results presented above are weighted using the business-level sample weight.

** These data represent 278 sites with refrigeration

1.6 Kitchen Equipment

The C&I Customer On-site Assessments study documents the saturation of kitchen equipment in Massachusetts businesses. Figure 1-17 illustrates the distribution of the types of kitchen equipment by business type. These data illustrate that some non-residential segments have a wide range of kitchen equipment while others have only three to five different types of equipment. Warehouses and retail businesses largely have microwaves, toasters, coffee makers, ovens and dishwashers. Food service, food sales, and education businesses, however, are found to have a wide variety of kitchen equipment.

Figure 1-17: Distribution of Types of Kitchen Equipment by Business Type



* The results presented above are weighted using the business-level sample weight.

2 INTRODUCTION

The Commercial and Industrial (C&I) Customer On-site Assessments is part of the Massachusetts Existing Buildings Market Characterization and is being conducted as part of Massachusetts Commercial and Industrial Evaluation Contract (CIEC). This project is overseen by the Massachusetts Energy Efficiency Program Administrators (PAs) and the Energy Efficiency Advisory Council (EEAC) EM&V Consultants. The study is meant to collect and provide primary research data to the PA's that can be used to inform and expand the Massachusetts energy efficiency programs.

This study used a hybrid method for characterizing the commercial and industrial (C&I) market beginning with an initial telephone survey of C&I customers in Massachusetts and followed by a more focused on-site assessment customer sites. The telephone survey was conducted in the fall of 2013. The on-site assessments began in the summer of 2014.

This document provides the interim results from the initial wave of on-site assessments which occurred between August, 2014 and November, 2014. It is provided to help the PA's, the EEAC and policymakers set goals for the next planning period and inform the 2016-2018 Massachusetts Joint Statewide Three-Year Electric and Gas Energy Efficiency Plan. It includes the interim results for the Market Share Assessment Study (Project 50) and focuses on the highest priority end uses based on stakeholder feedback and attributable program savings; lighting, HVAC, water heating, and refrigeration. We also include information on other end uses, where appropriate but emphasize the high priority end uses.

Following the completion of the interim results, and the completion of the second wave of site visits, the analysis team will look more closely at additional field data in preparation for the Final Report. The Final Report will include additional information on both the high priority end uses and other end uses where data was collected. The Final Report will also incorporate more language to help describe the information presented in tables and graphs.

2.1 Background and Objectives

The C&I Customer On-Site Assessment project represents a major effort that will produce a wealth of information and help to guide the Massachusetts energy efficiency programs for years to come. It is a challenging effort involving site visits to hundreds of facilities and gathering information on all primary end use systems and technologies.

The principal goal of the C&I Customer On-site Assessments is to build upon the data collected in the C&I customer telephone surveys and gather additional on-site data that will help the energy efficiency programs continue to grow and expand current offerings by providing a clearer understanding of the existing C&I building market in Massachusetts. The overall objective is to collect and provide the data to the PA's that may be used to:

- Inform the 2016-2018 Massachusetts Joint Statewide Three-Year Electric and Gas Energy Efficiency Plan with equipment market penetration data and help set goals for the next planning period;
- Support updates to energy conservation measure baselines that were identified as outdated or no longer relevant;

- Assess sales trends and market share for recently purchased standard and high equipment;
- Assess prospective additional energy efficiency opportunities at program participant sites; and
- Validate and expand upon the results (e.g. equipment, decision making and purchasing practices) of the Existing Buildings Market Characterization C&I Customer Telephone Survey.

The on-site data collection efforts focus primarily on collecting information on major energy end-uses. Lighting, HVAC, and motors and drives remain the dominant sources of savings for the electric programs while HVAC and hot water production are the dominant sources of savings for gas programs. Information on refrigeration systems and compressed air systems was also collected from businesses where these systems were found.

Field data collection was divided into two segments:

- Wave 1 Data Collection – initiated in August, 2014 and concluded in November, 2014
- Wave 2 Data Collection – initiated in February, 2015 and will conclude in August, 2015

In order to develop the desired comprehensive data across a broad range of facility types, the DNV GL team will conduct a total of 800 site visits. DNV GL teamed with Energy & Resource Solutions, Inc. (ERS) to successfully complete the desired number of site visits. Field staff visited 350 sites in Wave 1 and collected raw data on equipment including age, condition and level of efficiency. Premise-level information, as well as operational schedules was also collected. This document provides the interim results from the Wave 1 Data collection effort.

2.2 Study Approach

Figure 2-1 provides the overall approach to the study. This process was developed based on guidance and feedback of the PAs and the EEAC consultants. The research agenda was developed to allow for the immediate execution of a phased on-site data collection approach, an interim results analysis at the conclusion of Wave 1, and final analysis and report following the Wave 2 data collection efforts.

With the approval of the project work plan, DNV GL devised a sample for the study and worked with the PA's, the EEAC consultants, and PA Implementation staff to develop a data collection instrument. The instrument was based on a similar instrument used in California for data comparison purposes. The instrument was designed to collect general premise-level information as well as extensive information on the major energy end using equipment within a building including:

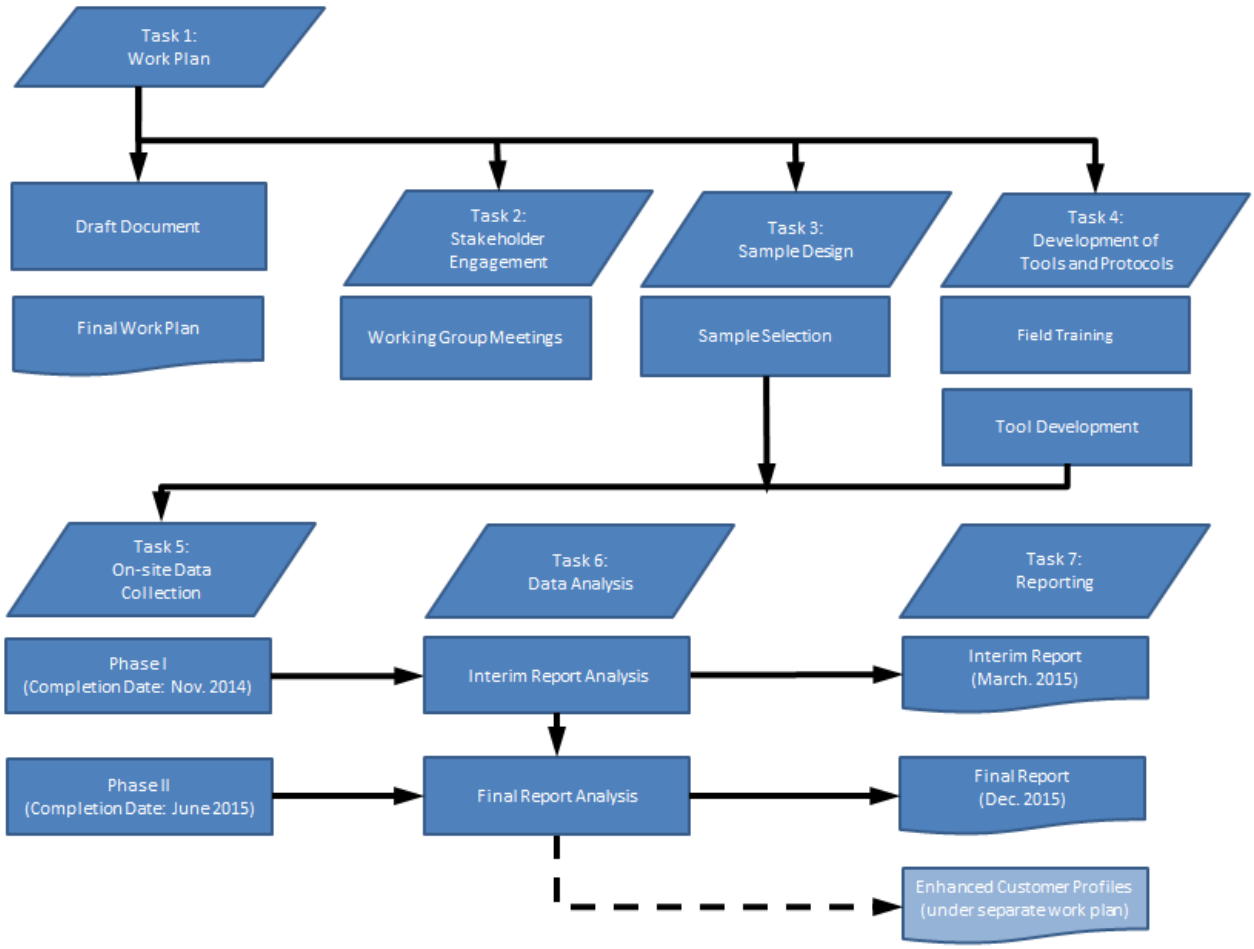
- Heating and Cooling Equipment
- Lighting
- On-site Generation Equipment
- Hot Water Systems
- Energy Management Systems
- Motors and Drives

These systems included the electric and gas prescriptive measure end-uses that resulted in the most energy savings for the energy efficiency programs according to 2012 program tracking data. Refrigeration and compressed air modules were also added to the instrument for buildings with those types of systems.

Upon approval of the data collection instrument, the DNV GL team initiated the Wave 1 data collection activities. This involved recruiting customers and coordination of recruitment and site visits across several concurrent study efforts in individual PA territories.

Data Collection for Wave 1 commenced in August, 2014 and concluded in November, 2014. The Wave 1 data collection efforts were planned to initially focus on smaller customers in order to ensure that practices and protocols were well understood by field staff and so that National Grid customers were prioritized in order to obtain the information needed for a separate but concurrent technical potential study. In addition, while the Wave 1 sample did not originally include larger complex sites such as hospitals, industrial facilities, and college campuses, field staff did visit a number of these sites in the because of the needs of the concurrent technical potential studies.

Figure 2-1: Overall Project Approach



Following the completion of the Wave 1 data collection efforts, DNV GL along with Itron, Inc. compiled and analyzed the data at the aggregate-level to determine market trends and penetration of equipment types in the commercial building market.

The interim results provided here are based on the information collected during the Wave 1 data collection efforts and is provided to help inform the Joint Massachusetts Three-year Electric and Gas Energy

Efficiency Plan. Upon the conclusion of the second phase (Wave 2), findings from both data collection efforts will be written into a Final Report that characterizes the Massachusetts existing buildings market.

The data from this study will be available for the use of other study efforts as well. In particular the data may be used to supplement the current C&I Customer Profile work by:

- Providing validation of PA provided data – Confirmed on-site data integrated back to the Evaluation Database will provide a higher degree of accuracy of the categorical attributes.
- Linking fuels and account IDs – Provides the PAs with validated existing pairings of gas and electric customers.
- Linking customer level data – Individual customers with multiple accounts at a single may now be captured in the database.
- Pairing the onsite equipment data with accounts in the Evaluation Database - As more data is accrued, it becomes possible to build more informed hypotheses and enhance our understanding of these customers.
- Joining the sample design and full billing population – By joining the sample design back to the full billing population and leveraging the data captured at the representative site we can provide coarse level geographic pictures of where technologies are likely to exist in Mass. The value here is identifying potential geographic sub clusters of specific technology that PAs may want to focus on.

2.3 Sample Design

DNV GL designed the original sample based on two separate frames, the 2013 C&I billing data and the 2011 C&I billing data. A third frame was added prior to commencing field data collection activities to accommodate the needs of a concurrent technical potential study in Cape Light Compact (CLC) territory. The sample represented customers geographically distributed across the state of Massachusetts. It was not based on PA customer territories. The key information required to develop the sample for the on-site assessments included business type and annual consumption.

The total population of electric accounts in the billing and tracking database was 313,340. To avoid contacting accounts with little to no energy consumption, DNV GL removed accounts with annual consumption of less than 2,000 kWh. This resulted in a decrease of 84,017 accounts in the population. The average annual energy usage in each of these accounts was less than 800 kWh and in total they represented less than 0.25% of the total annual consumption in the billing data. The resulting population from this exercise was 229,323 accounts.

There are certain challenges in collecting data from manufacturing/industrial, large hospitals, and college campuses as well as the potential interest in collecting additional process load information from these types of customers. Because of this and our understanding that the PA's currently work closely with these customers, these customer types were not prioritized for the 2014 data collection sample; however, the evaluation team did collect data from some of these types of customers due to the needs of concurrent individual PA technical potential studies. The shortfall from the desired total number of site visits for these customers will be made up in 2015. For the purposes of this report, the analysis of the data from any industrial, hospital, and college campus type customers collected in 2014 will take into account the under-representation of these customers and not impede the validity of the results.

According to the 2013 data set, approximately 78% of customer records were associated with a business type, with 85% associated among electric PAs and 64% associated among gas PAs.

A state-wide sample of 800 accounts was selected to represent the C&I Market including customers in CLC territory. The sample was allocated to strata in a manner that maximizes precision of resulting estimates. Strata in the sample was defined by business type and usage (kWh) categories.

DNV GL used our Model Based Statistical Sampling (MBSS) program to develop a stratified random sample of the population of C&I accounts in which business type and consumption category served as the strata. Our sample design comprised of fourteen business type categories, including other and unknown, and splits education and healthcare between campus and non-campus accounts and hospital and non-hospital accounts respectively. The design also included three consumption categories, with breaks set so that each group contains approximately one third of the population energy usage. Table 2-1 provides a breakdown of the account size groupings to be used in the sample.

Table 2-1 C&I Account Size Groupings

Size Grouping	MWh	Accounts	Percent of Population kWh
<500 MWh	8,887,382	221,325	32%
500 - 4,499 MWh	9,555,718	7,216	34%
>4,499 MWh	9,310,284	782	34%

Not every business type category contains accounts for every consumption category. We use MBSS to estimate the optimal sample size for each stratum based on the variability of the kWh between customer accounts within the stratum and the total stratum kWh.

Once sample sizes were established, members of each stratum were then randomly assigned a contact order for the on-site data collection. We also use this system to estimate expected relative precisions for the sample design, given a particular error ratio. DNV GL used an error ratio of 0.5 to estimate expected relative precisions, and an error ratio of 0.7 to estimate "worst case" expected relative precisions. For this study, acceptable relative precisions were considered to be approximately 20% or below. Table 2-2 provides an overview of the sample design according to business type.

Table 2-2: C&I Account On-site Survey Sample

Category	Estimated Relative Precisions: Error Ratio = 0.5 / Error Ratio = 0.7			Total Sample Accounts	POP Accounts	Pop kWh	Percent Pop kWh
Education	12%	/	17%	57	4,749	1,666,811,540	6%
Campuses	11%	/	16%	49	1,338	656,953,269	2%
Food Sales	12%	/	17%	57	5,315	1,398,450,191	5%
Food Service	13%	/	18%	55	11,069	1,131,448,176	4%
Healthcare	13%	/	18%	53	8,851	1,402,332,066	5%
Hospitals	11%	/	15%	41	578	566,177,884	2%
Lodging	13%	/	19%	55	2,543	717,456,796	3%
Manufacturing or Industrial	13%	/	18%	69	20,195	5,120,059,900	18%
Office	13%	/	18%	74	57,135	6,230,533,829	22%
Other	18%	/	25%	52	10,774	809,637,097	3%
Public Assembly	14%	/	19%	51	8,853	924,137,753	3%
Retail	12%	/	17%	69	71,175	4,872,514,695	18%
Unknown	14%	/	19%	80	25,435	1,572,227,707	6%
Warehouse	15%	/	20%	38	1,313	684,644,321	2%
Total	**5%**	**/**	**6%**	**800**	**229,323**	**27,753,385,223**	**100%**

During the Existing Building Market Characterization Telephone Survey (based on the 2011 C&I billing frame) DNV GL collected responses from 443 customers who indicated that they would be willing to participate in the on-site assessments. These customers were contacted first. A randomized sample of CLC customers were recruited by CLC and their contractor for their technical potential study. The DNV GL team joined the CLC representatives to collect data from 45 CLC customers. The remainder of the accounts required for this study was drawn from the 2013 C&I billing frame. These three samples were combined following the study and weighted accordingly. After the sample was selected, some additional editing of the sample frame was done to identify duplicate businesses as well as businesses that were otherwise out-of-scope of this evaluation. This reduced the target population down to 205,422 businesses with a total annual energy consumption of 26,341,285,385 kWh. The sample weighting discussed in the next section used this revised target population information in the development of the final sample weights.

2.4 Sample Weighting

To create population-based estimates from the Phase 1 data, sample weights were created for all sites that were considered respondents. In summary, data from 344 responding sites were used to generate the customer weights for this interim analysis. In most instances, a responding site reflected data for a single business. There were some cases where a responding site included data for more than one business. Data from the 344 responding sites in this study accounted for 347 businesses in the original target population.

In general, a sample weight is a numeric quantity assigned to each responding record that is greater than or equal to 1.00 and represents the amount of the target population that a particular responding site represents. The sample weight is greater than 1.00 so that each particular respondent represents at least themselves in the estimation process.

As noted in the previous section, the sample for this study was selected from three sources:

- P21 – MA C&I Customer Telephone Survey
- P41 – MA C&I Customer On-site Assessment Study
- Potential Study – Cape Light Compact Technical Potential Study

The samples from the P21 and P41 studies were randomly selected from a sample frame that covered the same target population, i.e. those areas covered by the NGrid, Eversource, Unitil and WMECO provider regions. The sample from the Potential Study was selected from a frame that covered businesses in the Cape Light Compact provider region. The important things to note are:

1. Sample from the three sources cover the entire target population of interest, i.e. businesses in the entire state of Massachusetts with annual energy consumption greater than 2,000 kWh.
2. Every business in the target population had some nonzero chance of being selected for this study. So estimates generated from the respondent data will not necessarily be biased because of some feature inherent in the sample design of this study. In other words, there is no target population coverage bias in the estimates generated from this study.

The target population for this study included 205,422 businesses. Billing data revealed these businesses had an annual energy consumption of 26,341,285 MWh.

Two sample weights were created for each of the 344[10] responding sites: one was created for business-level estimates and a second was created for kWh-level estimates. The **business-level weight** was created in a manner that allows data from the 344 responding sites to expand back to the business-level target population of interest, in other words the 205,422 businesses. This sample weight accounts for differences between the distribution of the respondents and the population by several characteristics of interest, such as building type (e.g. campuses, education, food sales, etc.) and provider region. This sample weight was used to create estimates of business-level statistics in this evaluation, such as percent of businesses by varying types of HVAC cooling and heating equipment and percent of businesses with an energy management system. This weight is also used to estimate the distribution of items in the population, such as lamp types, cooling systems, heating systems and distribution of total linear feet of refrigeration cases.

The **kWh-level weight** was built using the business-level weights so that the two weights were as consistent as possible. This sample weight included an additional factor (annual kWh consumed) and was created for selected statistics to show the impact of some characteristics or attributes with respect to the total kWh consumption in the population. For this sample weight, the energy consumption considered (kWh) was annual kWh consumption derived from billing records. And this sample weight was created so that the weighted total kWh consumption derived from the 344 responding sites equalled the corresponding population kWh totals by several characteristics of interest, such as building type and

[10] The estimates presented herein reflect responses received from 343 of 344 sites visits. 344 customers were included in the weighting of the results, however, the data from one customer site where we had difficulties associating the equipment with the sampled account was not included in the analysis and therefore was omitted from this report. Data from this customer is anticipated to be included in the Final Report.

provider region. This sample weight was used to create kWh-level estimates such as the percent of annual kWh consumed by businesses with varying types of heating and cooling equipment.

To illustrate the differences between estimates created using a business-level and kWh-level sample weight, consider the following excerpt from Appendix C, Tables 12 and 13. Table 2-3 shows estimates by varying types of HVAC heating equipment.

Table 2-3: Businesses with Varying Types of HVAC Heating Equipment

Heating System Combinations	Distribution Using	
	Business-Level Weight	kWh-Level Weight
Split/Packaged Only	41%	28%
Heat Pump Only	3%	4%
Boiler Only	9%	15%
Split/Packaged; Heat Pump	0%	1%
Split/Packaged; Boiler	9%	5%
Split/Packaged; Other Heating	8%	14%
Heat Pump; Boiler	3%	2%
Heat Pump; Other Heating	0%	2%
Other Heating	17%	13%
Boiler; Other Heating	8%	7%
Heating with 3 or more Systems	1%	10%
Total	100%	100%

Table 2-3 suggests estimates from this interim study indicate 41% of the businesses in the population use a split/packaged only type of heating system (for example). And 28% of the total annual energy consumed by the population is affiliated with businesses that use a split/packaged only type of HVAC heating system. Since the kWh level estimate is less than the business level estimate, one might surmise that this is because smaller businesses (those that use less energy) and/or businesses in building type categories that use less energy might be more likely to have a split/package only system. In a similar vein, notice 1% of the businesses in the population heat their space with 3 or more systems and these businesses account for 10% of the total annual energy consumed. Again, this is likely due to larger businesses in this category. Additional analyses would be needed to uncover the reasons for the differences between the two columns.

Both the business-level and kWh-level sample weights were created as the product of several factors. These factors included:

- A factor that reflected the sites' original probability of being selected into one of the three sources, i.e. the P21, P41 and Potential Study samples.
- A factor that accounted for P21 and P41 target population overlap.
- A factor that accounted for nonresponding sites.
- And finally, a factor that ultimately calibrated the business-level and kWh-level sample weights back to the original target population.

The final calibration of the sample weights corrected the weights so that they would sum to the appropriate business and kWh target population totals by building type (campuses, education, food sales,

etc.), by provider region, by kWh strata and by previous enrollment in an energy efficiency program. Additional technical details of the weight creation process are provided in Appendix J.

3 INTERIM RESULTS

This section provides the interim results from the Wave 1 C&I customer on-site assessments. The results are provided according to end-use and presented primarily by business types and energy consumption (kWh size). Where appropriate we have also provided results by business square-footage and program participation.

3.1 Introduction of the On-site Assessment Results

The C&I Customer Onsite Assessment work plan calls for on-site data collection at 800 sites over 2014 and 2015. During 2014, Wave 1 of on-site data collected information from 350 businesses. The interim results are based on the results from 343 of those customers. The study team was not able to definitively associate the data with the sample from six customers. A seventh customer site was excluded from the interim results because of difficulties determining which equipment was associated with the sampled account. The customer sites that were excluded from the interim results will be included in the final analysis and report.

These data are analyzed to describe the saturation of high priority end uses, systems, and measures within the non-residential sector in Massachusetts. End uses included in the study include lighting, HVAC, domestic water heating, refrigeration, office equipment, kitchen equipment, energy management systems (EMS), and distributed generation equipment. The study also collected information about the buildings occupied by the businesses visited.

The baseline analysis for the lighting, HVAC and water heating end-uses utilized make and model number efficiency look ups in addition to on-site data. The on-site data collection effort led to the development of information on the saturation and distribution of many electric and gas systems and measures. The information collected and analyzed in the study will provide a baseline estimate of the saturations and quantity of these technologies and information on the efficiency distribution for select measures. Combining the on-site data with utility energy efficiency (EE) program tracking data will enable the PA's to determine if the efficiency distribution of high priority measures differs from the participants in the energy efficiency programs from 2011 to 2013.

The C&I Customer On-site Assessments study collected on-site information from the following business types:

- Campuses
- Education
- Food Sales
- Food Service
- Healthcare
- Hospitals
- Lodging
- Manufacturing or Industrial
- Office
- Other
- Public Assembly
- Retail
- Warehouse
- Unclassified

Baseline information is presented for all of the end uses listed above, while recent purchase information is provided for lighting, HVAC, water heating, and EMS.

The results are organized to first provide an overview of the customers who participated in the Wave 1 assessments and then provide the results by equipment type. The sections of this report include:

- Presentation of the Business Characteristics
- Presentation of the Lighting results
- Presentation of the HVAC results
- Presentation of the Energy Management System results
- Presentation of the Water Heating results
- Presentation of the Refrigeration results
- Presentation of the Onsite Generation results
- Presentation of the Kitchen Equipment results
- Presentation of the Office Equipment results

The results at the end of each section relate specifically to the MSST Study. We have also included appendices containing the data used to support the tabular or graphical forms used throughout this report.

3.2 Customer Overview

The Wave 1 C&I Customer On-site Assessment data collection efforts collected information about the businesses and the buildings that were surveyed during the visits. This section provides an overview of those customers who participated in the Wave 1 efforts.

3.2.1 C&I Customer On-site Assessment Distribution (Un-weighted)

The distribution of the customers who participated in the on-site visits across the 14 business types is listed in Table 3-1. It should be noted that customers were recruited according to the business types indicated in study sample and that the recruitment team followed the designated quotas for each strata closely. This table presents the number of completed site visits according to the business types observed in the field and reallocates the previously “Unknown” customer classifications to the confirmed business type category. Overall approximately 11% of the sites visited were reclassified from the original classification to the field confirmed classification not including the “Unknown” category. The office business type category saw the greatest increase from the field confirmed classifications gaining 11 sites. The average was +/- 3.2 sites reclassified across the various business type categories.

Table 3-1: Number of On-site Visits Completed by Business Type

Business Type	On-sites Completed	Share of Completed On-sites
Campuses	9	3%
Education	31	9%
Food Sales	25	7%
Food Service	31	9%
Healthcare	19	6%
Hospitals	6	2%
Lodging	32	9%
Manufacturing or Industrial	23	7%
Office	55	16%
Other	24	7%
Public Assembly	32	9%
Retail	43	13%
Warehouse	13	4%
Total	**343**	**100%**

The 343 businesses with on-site data collection can also be viewed by energy consumption and square footage. The business kWh size is determined by the businesses' 2013 annual consumption. The initial phase of data collection included a large number of small and mid-sized businesses as described by their energy consumption (see Table 3-2). The eight unknowns in the table are customers from the C&I Customer Telephone Survey Sample whose annual consumption was not able to be identified at the time of the analysis. The study team has since determined the annual consumption. This will be updated for the Final Report. Disaggregating the businesses by square footage also indicates that many of the businesses have small and medium sized square footage (see Table 3-3).

Table 3-2: Number of On-site Visits Completed by Business kWh Size

kWh Size	On-sites Completed	Share of Completed On-sites	Overall Sample Targets
Unknown	8	2%	-
Less than 500,000	201	59%	293
500,000 to 4,500,000	113	33%	286
Larger than 4,500,000	21	6%	221
Total	343		800

Table 3-3: Number of On-site Visits Completed by Business Square Footage

Square Foot Size	On-sites Completed	Share of Completed On-sites
Unknown	1	0%
Less than 5,001	115	34%
5,001-10,000	38	11%
10,001-25,000	43	13%
25,001-50,000	42	12%
50,001-100,000	41	12%
100,001-200,000	37	11%
200,001-500,000	19	6%
Greater than 500,000	7	2%
Total	343	

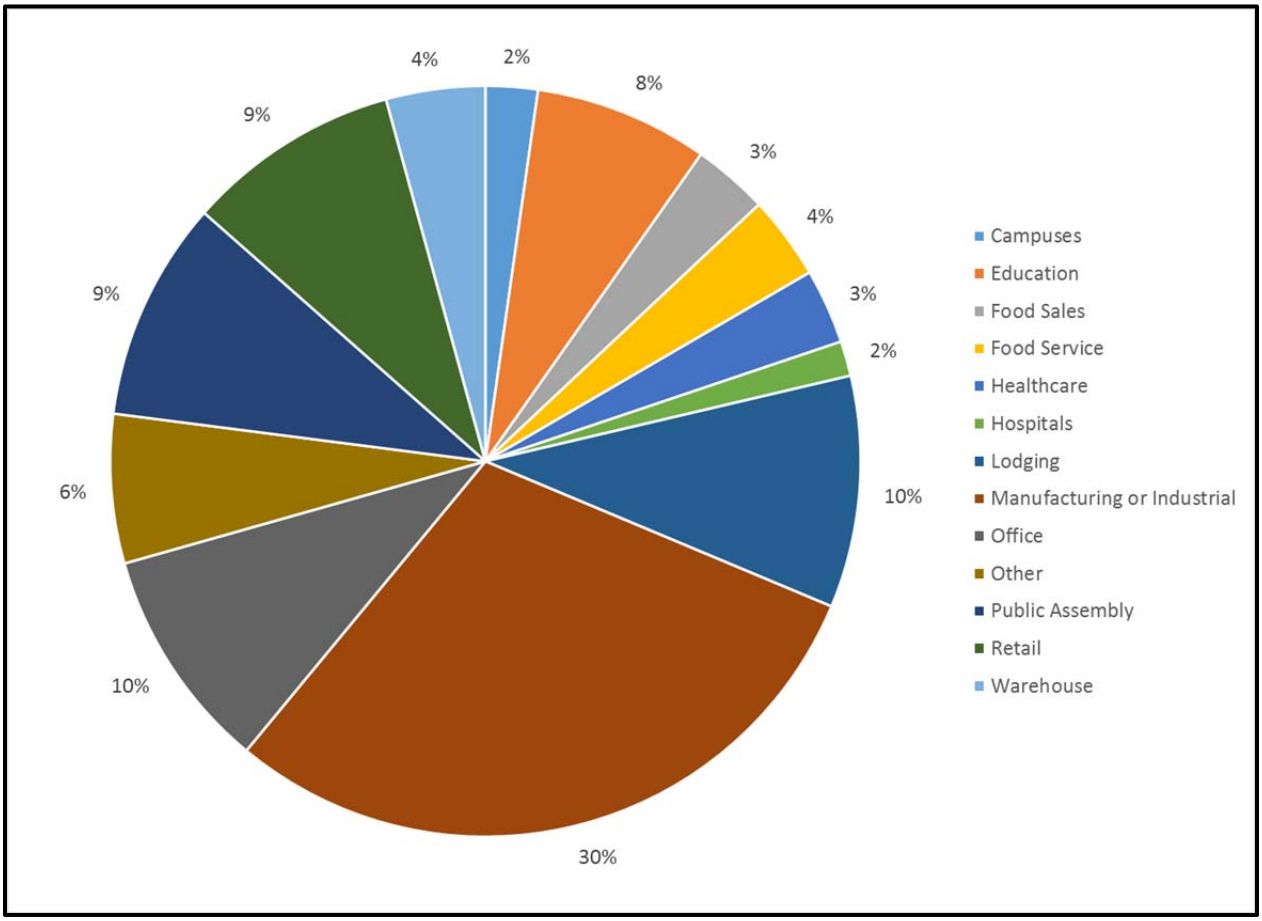
Characterizing the number of on-site visits by energy efficiency program participation, using program tracking data from 2011 to 2013, 299 (85%) of businesses did not participate in EE programs and 44 businesses were participants (15%). This is likely due to the high percentage of small and medium size customers who participated in Wave 1; however, it should be noted the lifetime participation is generally higher than this three-year timeframe.

3.2.2 C&I Customer On-site Assessments Distribution (Weighted)

Population based estimates of the types of businesses in Massachusetts were developed by applying weights to the C&I customer on-site sample,

Figure 3-1 illustrates the distribution of businesses in Massachusetts by business type. The kWh weighted distribution of businesses indicates that manufacturing or industrial are the most common business type with 30% of businesses followed by lodging and office, both at 10%.

Figure 3-1: Distribution of Businesses



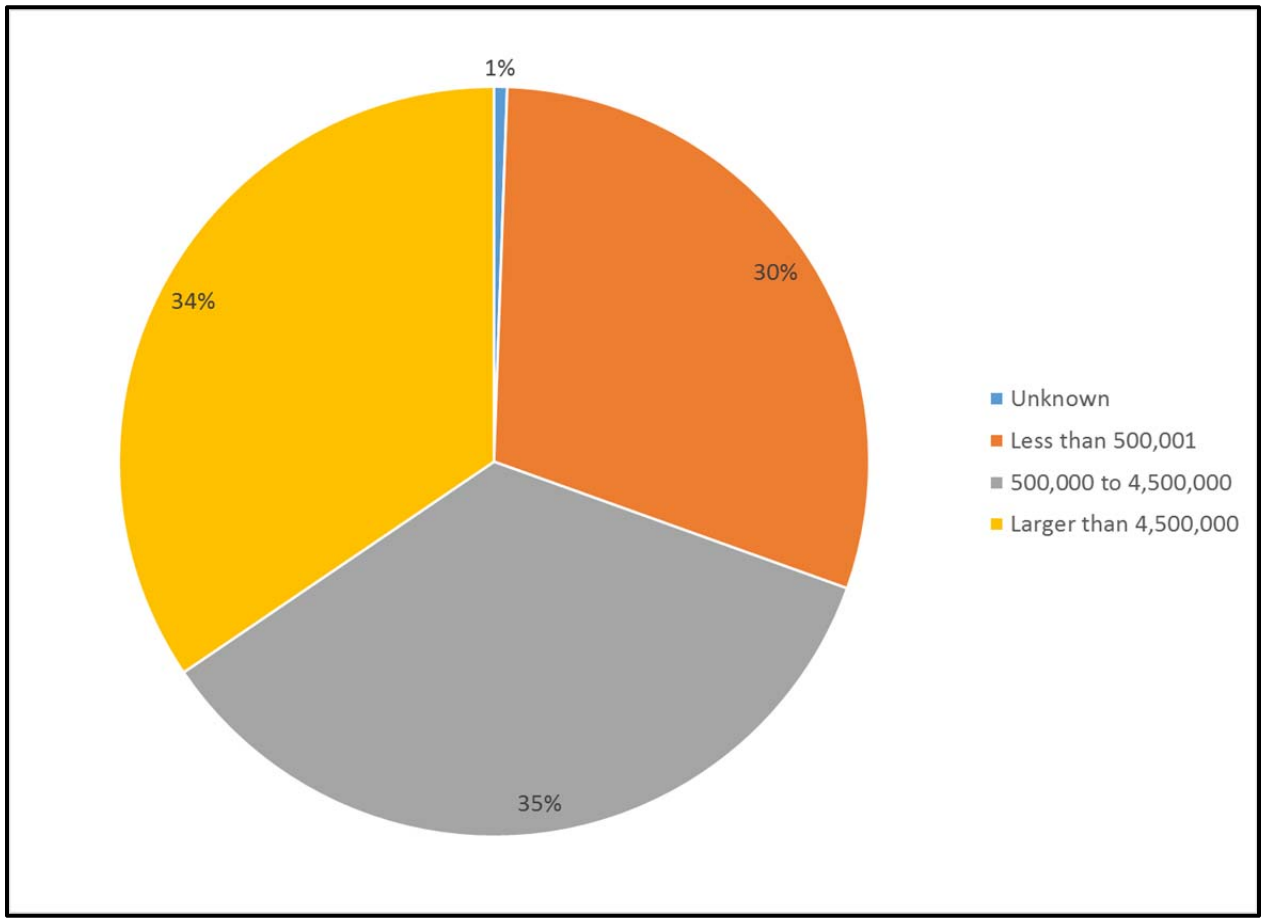
* Results are weighted using the kWh-level sample weight

** These data represent 343 total sites

Figure 3-2 and

Figure 3-3 illustrate the kWh weighted distribution of non-residential electricity consumption and square footage in Massachusetts businesses.

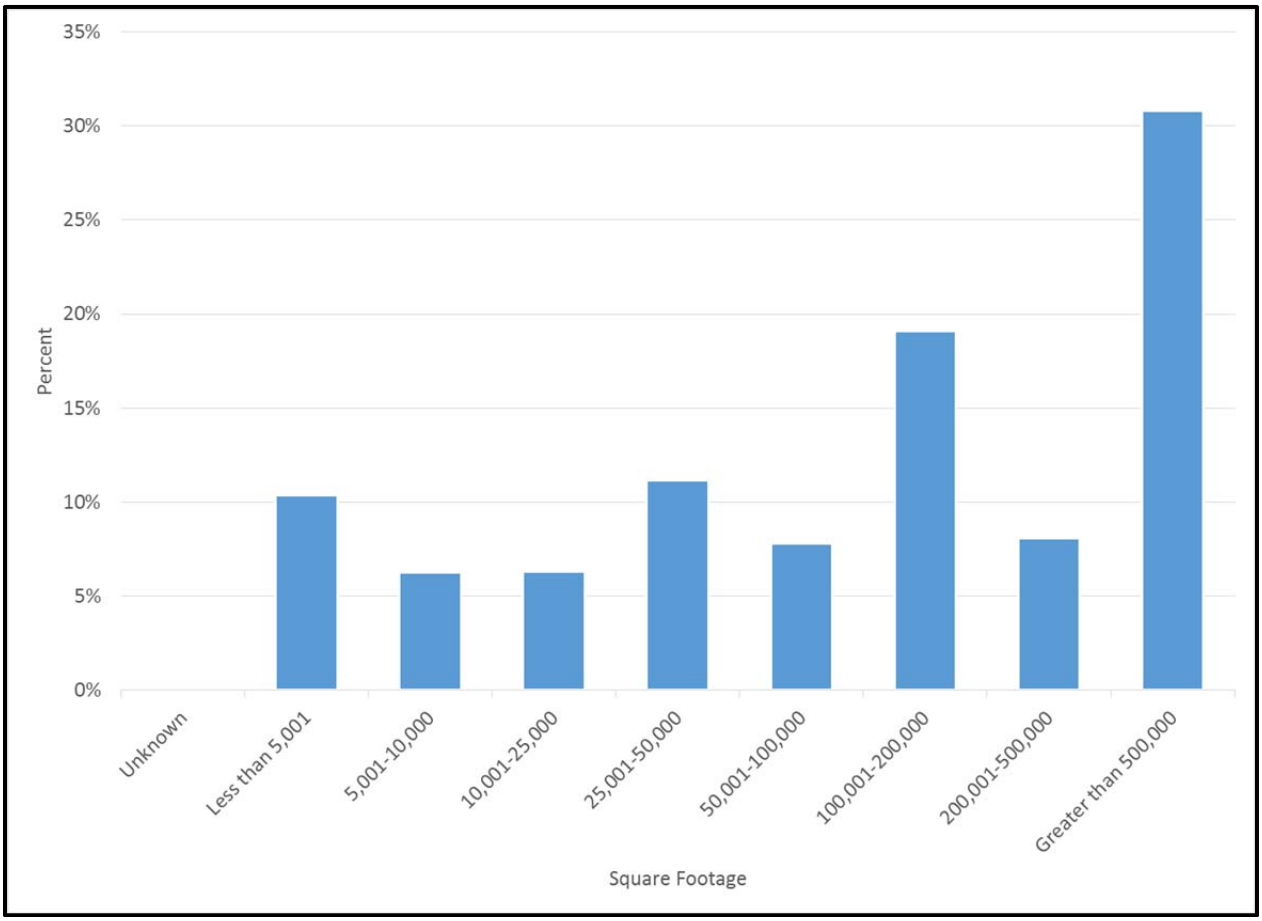
Figure 3-2: Distribution of Non-Residential Electricity (Annual kWh) Consumption



* Results are weighted using the kWh-level sample weight

** These data represent 343 total sites

Figure 3-3: Distribution of Non-Residential Square Footage



* Results are weighted using the kWh-level sample weight

** These data represent 343 total sites

3.2.3 Market Share and Sales Trend Study: On-site Customer Distribution with New Measures (Un-weighted)

The MSST Study uses data collected during the C&I Customer On-site Assessments to develop a better understanding of purchases from 2009-2014 by non-residential customers in Massachusetts. Table 3-4 depicts the number of businesses where on-sites were completed in 2014 (column 2) and the number of these businesses that purchased high priority equipment during the 2009 – 2014 timeframe to qualify them as recent purchasers (column 3). A given business may have purchased multiple types of high priority equipment.

Columns four through seven indicate the number of businesses that have recent purchases of high priority equipment by end use. These data indicate that of those businesses purchasing new equipment, lighting measures were most frequently purchased.

Table 3-4: Number of Businesses with Recent Purchases

Business Type	On-sites Completed	New Purchases (2009-2014)				
		All Sites	Lighting	HVAC	DHW	EMS
Campuses	9	9	5	7	6	4
Education	31	30	19	17	15	10
Food Sales	25	19	17	9	9	1
Food Service	31	22	15	10	13	0
Healthcare	19	15	9	9	8	1
Hospitals	6	6	3	4	3	4
Lodging	32	22	15	14	12	3
Manufacturing or Industrial	23	18	11	11	7	5
Office	55	40	22	22	15	7
Other	24	18	11	7	2	2
Public Assembly	32	23	19	14	6	3
Retail	43	28	20	10	13	4
Warehouse	0	0	0	0	0	0
Total	**343**	**259**	**174**	**138**	**114**	**46**

*The results presented above are un-weighted.

Table 3-5 provides information on the number of businesses making recent purchases by size of the business where size is determined by the business' 2013 electricity consumption. These data show that while small-sized businesses represent the largest share of all recent purchasers, they had the smallest share of completed on-sites where recent purchases of high priority equipment was found. The data in Table 3-5 show that 66% of the small sites where on-site data was collected had purchased equipment from 2009-2014 while 90% of medium sites and 86% of large sites were found to have recently purchased equipment. The very small sample of large sites in the sample and those purchasing new equipment warrants caution when drawing conclusions from these customers. Additional large sites will be surveyed during the second phase of data collection. These additional sites will help ease concerns about the representativeness of the large site findings.

Table 3-5: Number of businesses with Recent Purchases by kWh size

Business Type	On-sites Completed	New Purchases (2009-2014)				
		All Sites	Lighting	HVAC	DHW	EMS
Unknown	8	6	5	2	0	1
Less than 500,000	201	133	92	65	54	3
500,000 to 4,500,000	113	102	63	58	53	31
Larger than 4,500,000	21	18	14	13	7	11
Total	343	259	174	138	114	46

*The results presented above are un-weighted.

Table 3-6: Number of businesses with Recent Purchases by Business Square Footage

Business Type	On-sites Completed	New Purchases (2009-2014)				
		All Sites	Lighting	HVAC	DHW	EMS
Unknown	1	1	1	0	0	0
Less than 5,001	115	66	43	30	23	2
5,001-10,000	38	29	20	11	19	3
10,001-25,000	43	33	23	18	12	2
25,001-50,000	42	37	25	25	18	4
50,001-100,000	41	38	23	21	17	10
100,001-200,000	37	30	21	18	13	10
200,001-500,000	19	18	12	11	9	13
Greater than 500,000	7	7	6	4	3	2
Total	343	259	174	138	114	46

*The results presented above are un-weighted.

3.3 Lighting

Central goals of the C&I Customer On-site Assessments study and the MSST study are to document the baseline distribution of existing lighting measures within businesses and the efficiency distribution of new lighting purchases. Lighting represents one of the largest sources of energy use for many business types. In addition, lighting measures represent technology long targeted by energy efficiency programs and recent technology code updates.

The lighting data collected during the on-site assessments provides an indication of the progress achieved in replacing inefficient measures with newer, more efficient technologies and also provide information on the current lighting market. These data may also serve as inputs for future potential studies that could provide the PA's with a detailed picture of the remaining achievable energy savings potential.

3.3.1 Lighting Data

Table 3-7 provides a count of on-site survey completes by business type. The table also provides a count of on-site surveys completed for specific lighting technologies. These data provide some indication of the different types of lighting technology currently used in Massachusetts businesses.

Table 3-7: On-Site Survey Site Counts by Business Type – Lighting

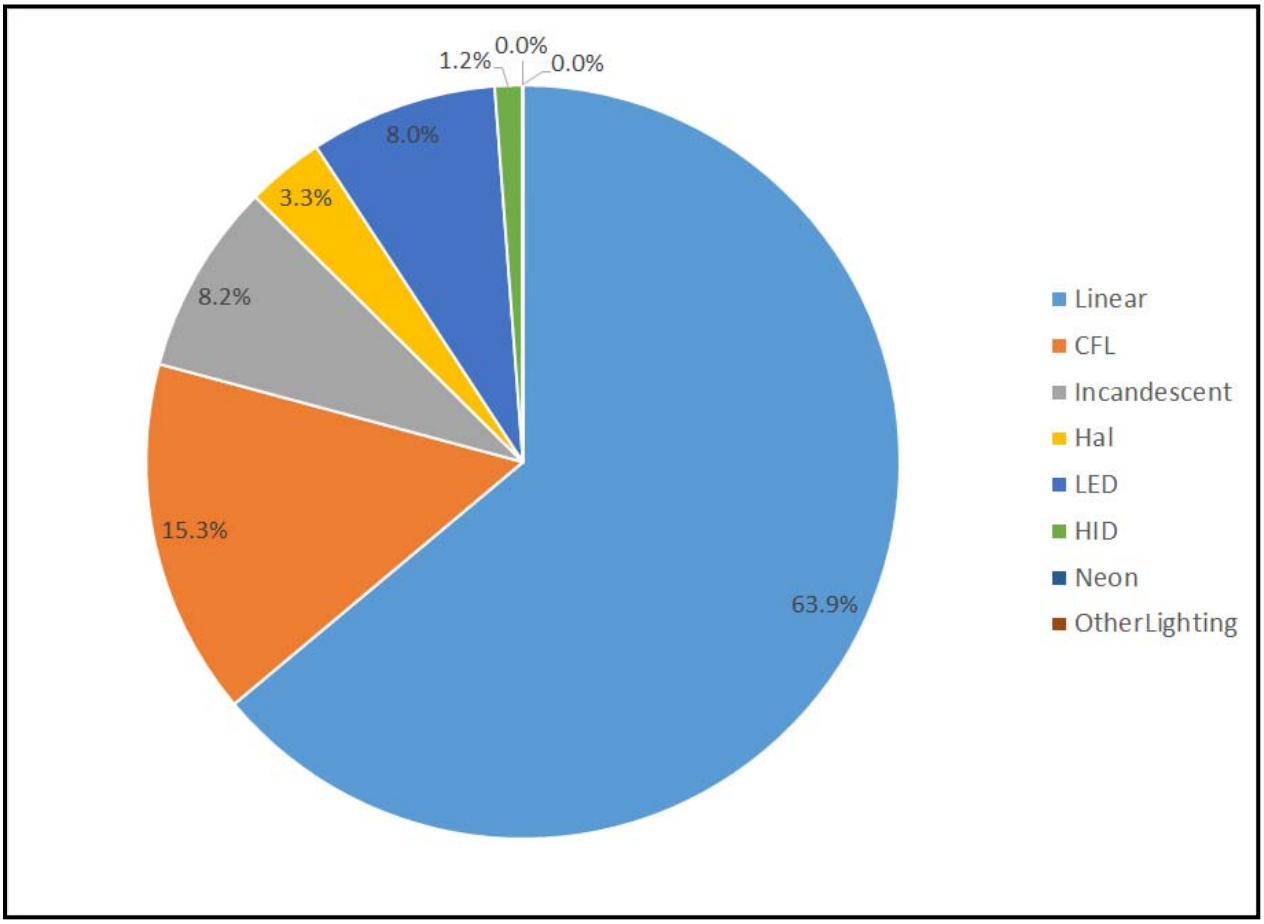
Business Type	Total Count	Linears	CFLs	Incan-descents	Halo-gens	LEDs	HIDs	Neon Lighting	Other Lighting
Campuses	9	9	8	4	0	5	8	0	0
Education	31	30	20	6	5	15	12	0	2
Food Sales	25	22	14	11	0	8	6	4	0
Food Service	31	30	19	21	12	14	10	4	1
Healthcare	19	19	17	14	8	7	9	0	0
Hospitals	6	6	5	2	2	5	4	0	1
Lodging	32	25	23	20	7	22	8	0	0
Manufacturing or Industrial	23	23	9	10	3	6	19	0	1
Office	55	54	30	25	8	15	11	0	2
Other	24	20	17	15	4	6	11	0	1
Public Assembly	32	31	26	23	10	16	16	0	2
Retail	43	41	24	19	5	19	19	1	1
Warehouse	13	13	6	4	3	4	8	0	0
n	**343**	**323**	**218**	**175**	**67**	**142**	**141**	**9**	**11**

*****The results presented above are un-weighted.

******The counts indicate the number of instances the technology was found in the buildings that were visited. For example, at least 1 HID lamp was found in 12 of the 31 Education-type buildings visited.

We begin the analysis of the lighting data by focusing on aggregate lighting, presenting some information on the saturations of the different types of lighting. Figure 3-4 illustrates the site-weighted lamp shares of lighting technologies as a percentage of total lamps found in businesses. As depicted, nearly 64% of all non-residential lamps are linear technologies, followed by CFLs at 15%.

Figure 3-4: Distribution of Lamps by Technology Type



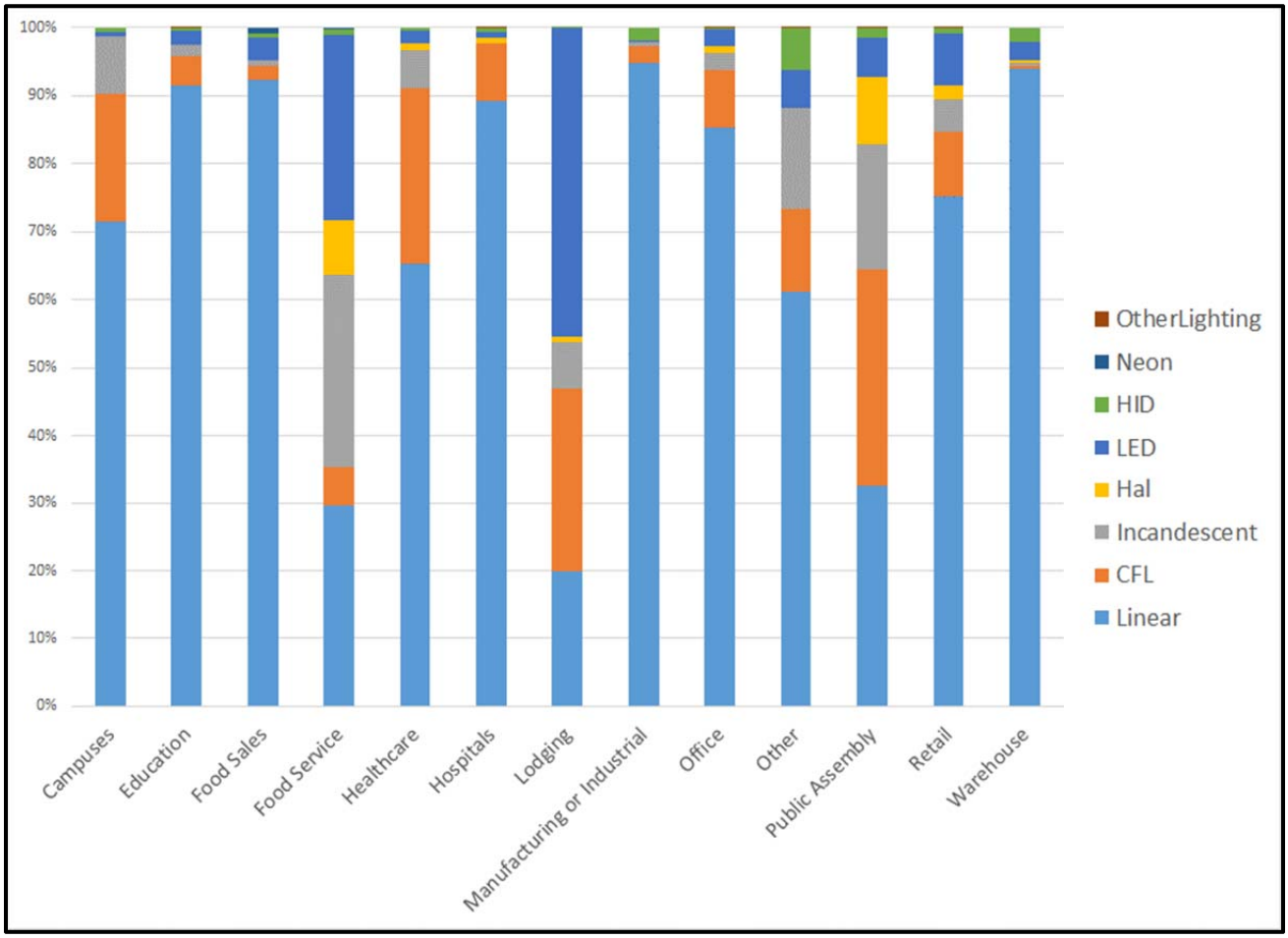
* The results presented above are weighted using the business-level sample weight.

** These data represent lamp count data from 323 sites with linears, 218 sites with CFLs, 175 sites with incandescents, 67 sites with halogens, 142 sites with LEDs, 141 sites with HIDs, 9 sites with neons and 11 sites with other Lighting.

*** Linear technologies include linear fluorescents and linear LEDs

Figure 3-5 illustrates the lamp share of lighting technologies by business type. These data indicate that linear fluorescents are the dominant lamp type for most business types, though food service has a high share of incandescent and LED lamps and lodging has a high share of LED and CFL lamps.

Figure 3-5: Distribution of Lamps by Technology Type and Business Type

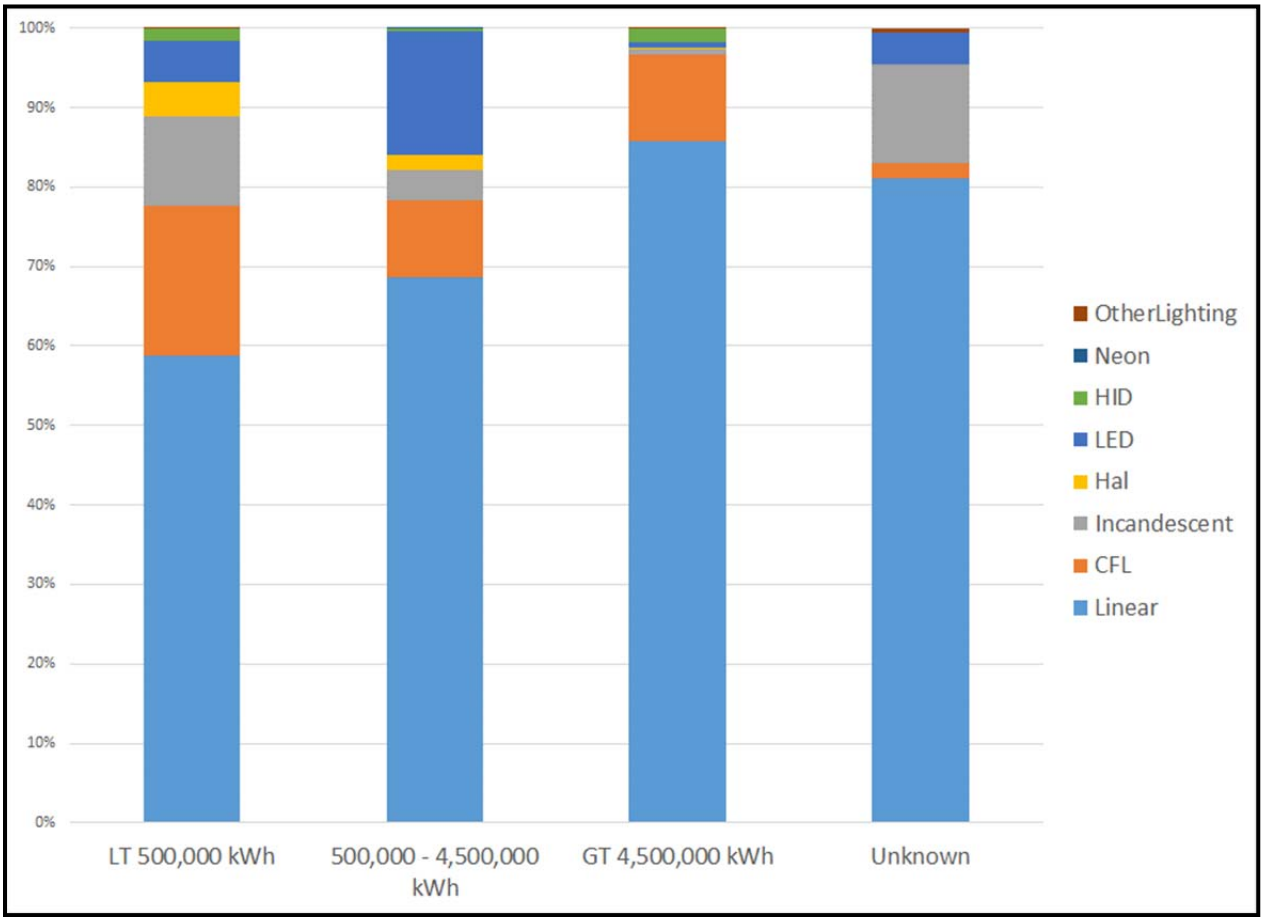


* The results presented above are weighted using the business-level sample weight.

** These data represent 9 sites for campuses, 30 education sites, 24 food sales, 31 food service sites, 19 healthcare sites, 6 hospitals, 32 lodging sites, 23 manufacturing or industrial sites, 55 offices, 24 other businesses, 32 sites for public assembly, 43 retail sites and 13 warehouses.

Figure 3-6 illustrates the distribution of lamps by technology type and business size. These data indicate that linear technologies dominate the distribution of lamps for all business sizes, few large sized businesses have a substantial number of incandescent lamps, and that incandescent and CFL lamps are more common in small-sized businesses.

Figure 3-6: Distribution of Lamps by Technology Type and Business Size



* The results presented above are weighted using the business-level sample weight.

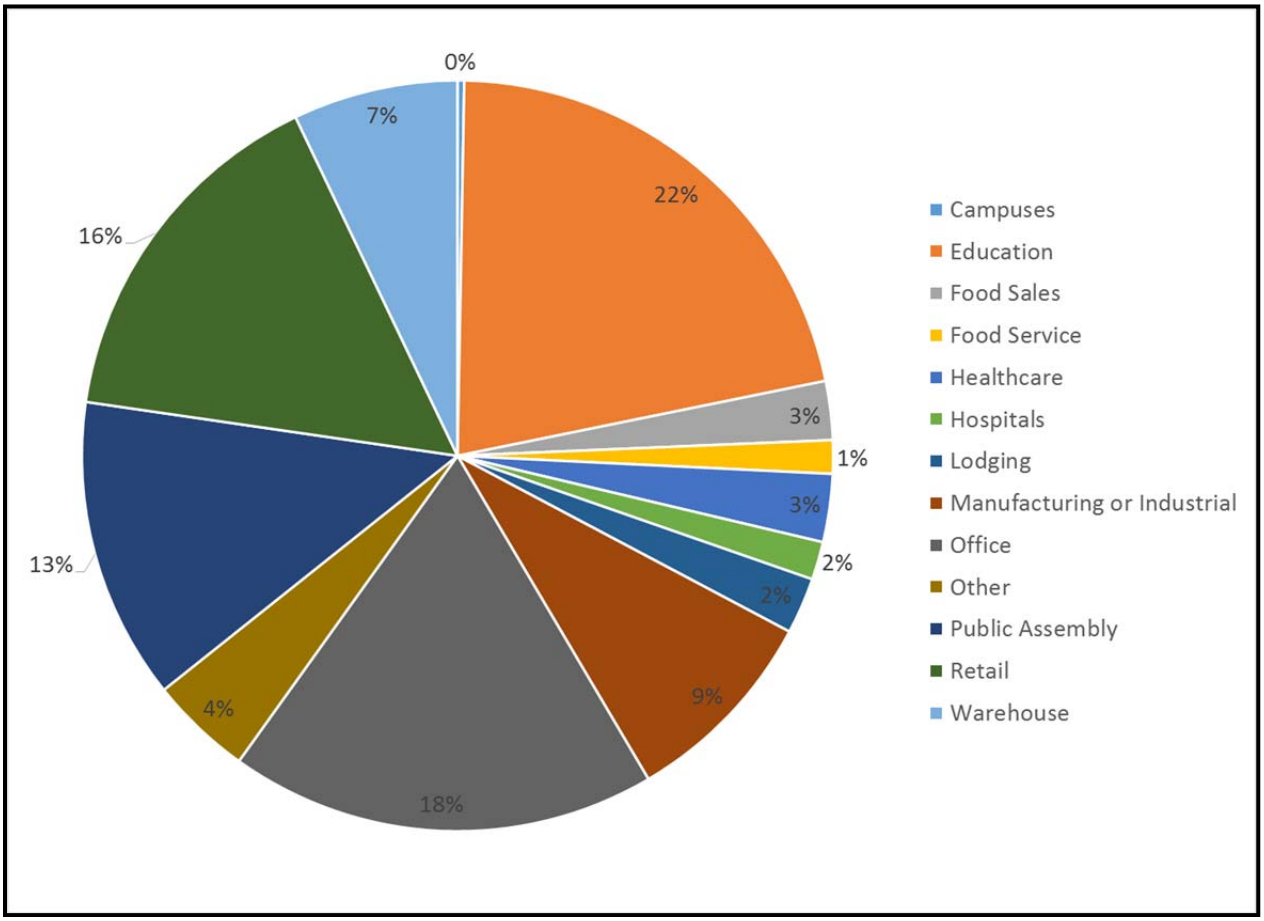
** These data represent 200 small sites, 112 mid-sized sites, 21 large sites and 8 unknown sites.

3.3.2 Linear Lighting

Linear lighting is a focus of the C&I Customer On-sites Assessments Study due to the fact that they are the dominant source of lighting for most business types. Linear technologies have also been the focus of significant energy efficiency programs and recent code updates. Figure 3-7 illustrates the distribution of all linear lamps across business types while Figure 3-8 provides similar information by business sizes.

These figures provide perspective on the relative magnitude of the distributions that follow. As shown below, the education segment of the commercial population comprise the greatest share of linear lamps of any business type, with 22% of all linear lamps installed in the education segment. Offices have 18% of linear lamps while retail has 16% and public assembly has 13%. Within business size, medium and small businesses represent the greatest share of linear lamps. While large businesses tend to have a higher volume of lamps per business, there are sufficiently fewer large businesses so they only make up 9% of the total share of indoor commercial linear lamps.

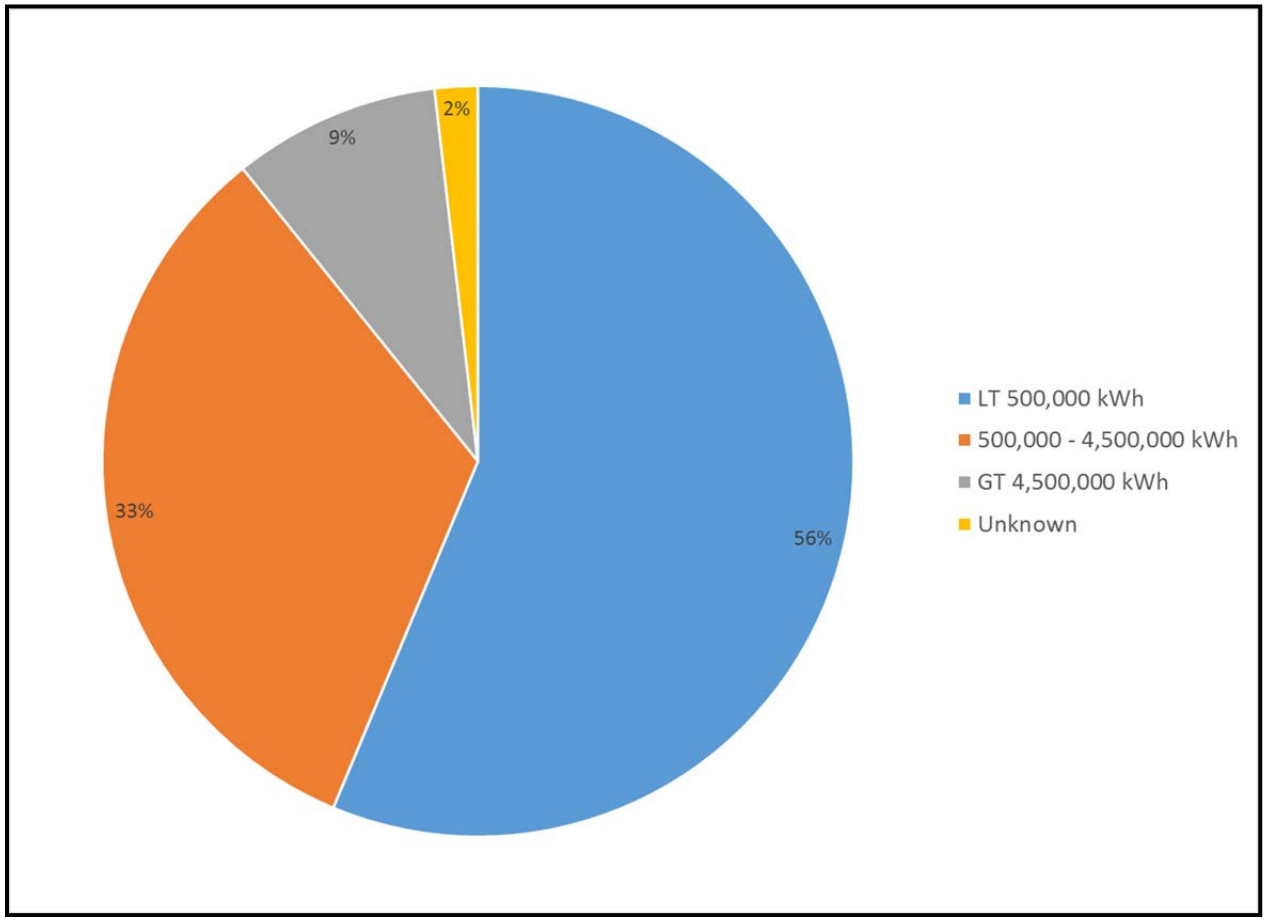
Figure 3-7: Distribution of Linear Lamps by Business Type



* The results presented above are weighted using the business-level sample weight. Lamps represent all linears

** These data represent 9 sites for campuses, 30 education sites, 24 food sales, 31 food service sites, 19 healthcare sites, 6 hospitals, 32 lodging sites, 23 manufacturing or industrial sites, 55 offices, 24 other businesses, 32 sites for public assembly, 43 retail sites and 13 warehouses.

Figure 3-8: Distribution of Linear Lamps by Business Size



* The results presented above are weighted using the business-level sample weight. Lamps represent all linears

** These data represent 185 small sites, 109 mid-sized sites, 21 large sites and 8 unknown sites.

Saturation of Linear Lamps by Performance Group

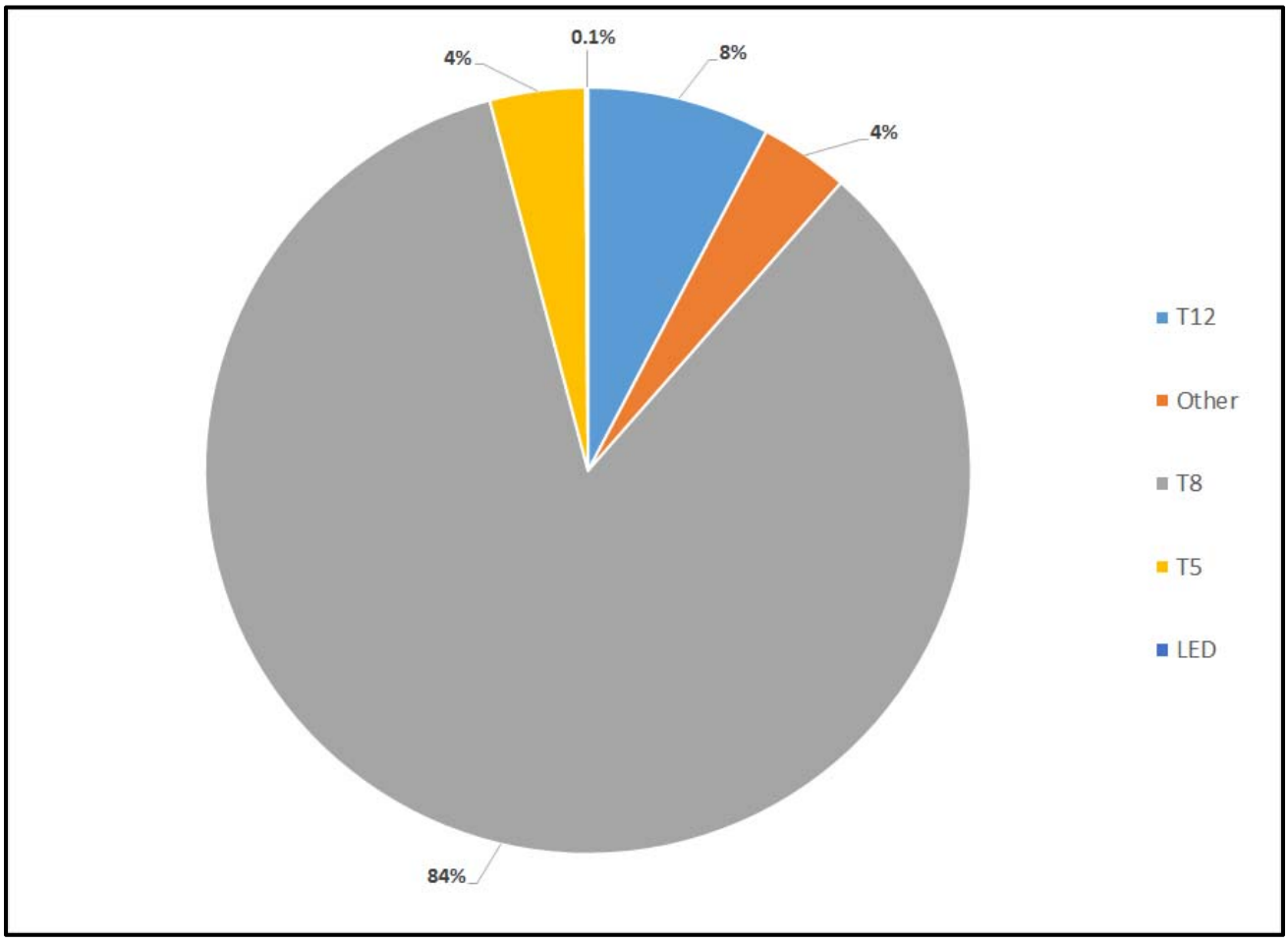
Traditionally linear lamps have been described as T12, T8, and T5 lamps. T12 lamps represent older technologies with higher wattages while T8 and T5 lamps have represented newer, more efficient forms of lighting. Figure 3-9 illustrates the distribution of T12, T8, and T5 lamps.[11] The current distribution of linear lighting in Massachusetts is largely T8 lamps (84%). T12 lamps represent 8% of linear lighting, T5 lamps are 4% and linear LEDs are only 0.1% of current linear lamps.

T8 lamps represent a wide range of technologies and efficiency levels. T8 lamps can be disaggregated into four levels of efficiency using classifications requiring look ups of the manufacturer make and model

[11] The Other efficiency grouping includes T10s and other types of linear lighting not already highlighted.

numbers.[12] Make and model lookups develop crucial secondary information needed to classify the efficiency level of Linear measures. The on-site form was designed to collect the make, model, size specifications, and wattage information from the linear bulbs. Lookup tables were developed using the data collected on-site to determine the efficiency level of the linear technologies.

Figure 3-9: High Level Linear Efficiency Distribution



*The results presented above are weighted using the business-level sample weight. Lamps represent all linears

**These data represent 323 sites

The final step of the make and model lookups is allocating the Linear Technologies to one of seven performance groups in order of highest to lowest efficiency. These technologies were also classified as being either high or base efficiency. Information on the allocation of linear lamps to base and high efficiency categories is listed below. Where wattage ranges are provided, these ranges are representative of four foot linear lamps.

[12] This section of the report uses the common term efficiency to represent what lighting designers would term efficacy. These two terms are very similar for lighting applications, with efficiency used by the wider community and efficacy used by lighting designers and other professionals.

High Efficiency technologies:

- LED: These are not linear fluorescent bulbs, but LED replacements for linear fluorescents, which will fit into the same fixture housing as the linear fluorescent bulbs.
- T5: T5 lighting systems. Based on make and model lookups, the lamps were typically found to have a wattage range of 28 to 54 watts.
- Reduced Wattage T8 also designated as Fourth and Fifth Generation T8 Lamps: These lamps were classified by the Consortium for Energy Efficiency (CEE). These lamps typically use 25-28 watts. Their Color Rendering Index (CRI) is typically 82-86, life ratings up to 30,000 hours with lumens from 2,285 to 2,650. Lamps included in this study have a median observed watts for Reduced Wattage T8 lamps of 28 and the median mean lumens are 2,350. Efficacy = 84 Lumens/watt.
- High Performance T8 also designated as Third Generation T8 lamps: These lamps are classified by CEE. These lamps are 32 watt lamps with a minimum initial lumens of 3,100, 82-86 CRI, and a life rating of at least 24,000 hours. The median mean lumens observed for all High Performance T8 lamps in this study is 2,915 with an efficacy of 91 lumens/watt.

Base Efficiency technologies:

- Standard 800 T8 also designated as Second Generation T8 Lamps: These lamps are 32 watt lamps with initial lumens 2,800-3,000 lumens, 82-86 CRI, and 20,000-24,000 hour rated life. For this study, the median mean lumens observed for Second Generation T8 lamps was 2,773. Efficacy = 87 lumens/watt.
- Standard 700 T8 also designated as First Generation T8 Lamps: These lamps usually provide an initial lumens of at most 2,800, use 32 watts, have a CRI of 75-78,13 and typically have a 15,000-20,000 hour life rating. Lamps found in this study have a median mean lumens of 2,520. First generation T8 lamps have the lowest lumens and shortest life of any T8 lamp with an efficacy of 79 lumens/watt.
- T12: These are T12 bulbs, which were phased out of production as of July 2012, but are still available or in storage.

The descriptions of different types of T8 lamps illustrate that three of the four types of T8 lamps use 32 watts while Reduced Wattage or Fourth and Fifth Generation T8 lamps use 25-28 watts. Progressing from First Generation through Third Generation T8 lamps the efficacy of the lamps, or the lumens per watt, improves from approximately 87.5 to 97 lumens per watt while the CRI improves from 75-78 to 82-86. The improved lighting output (efficacy) and CRI allow customers to use either fewer lamps, lower ballast factors, or fewer fixtures when moving from First Generation T8 lamps to Third Generation lamps. A report from CEE found that Third Generation T8 system wattage is "20% less than the standard 700-series T8 system, and 10% less than the 800-series T8."[14]

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[13] CRI is a measure of a lamps ability to render colors the same as sunlight. A CRI of 100 is equivalent to sunlight's rendering. An incandescent bulb typically has a CRI of 95. Higher CRI values are typically associated with better lighting characteristics.

[14] Consortium for Energy Efficiency. November 2004. "High Performance Commercial Lighting Systems Initiative."

Table 3-8 and Table B-6 list the efficiency and lamp length shares for linear technologies. The T8 technologies are allocated to 700 Series (First Generation), 800 Series (Second Generation), High Performance (Third Generation), and Reduced Wattage (Fourth Generation) for the four foot lamps. Four foot T8s, are also classified as "Model Not Found" and "Model Missing". The high share of lamps classified as "Model Missing" represent T8 lamps observed prior to the collection of make and model numbers (approximately 34.5% of linear data to date). The evaluation team expects the "Model Missing" share to decrease as the additional sites included in the final analysis will be surveyed for this information; however, "Model Missing" also includes lamps where it is not physically possible to collect make and model numbers.[15] The classification "Model Not Found" represents four foot T8s whose model number could not be matched with known databases (approximately 4.3% of linear data).[16] The T8 8 foot and other length lamps continue to be grouped into one classification.

The information presented in Table 3-8 illustrates that T12 lamps are nearly evenly divided between four foot and eight foot lamps. This differs substantially from what is observed in T8 lamps where nearly all T8s are four foot lamps.

Table 3-8: Linear Efficiency Distributions for Four Foot, Eight Foot, and Other Lamps

Linear Efficiency and Size	On-site Percentages
T12, 4 Feet	3.8%
Other, 4 Feet	0.8%
700 Series T8, 4 Feet	21.5%
800 Series T8, 4 Feet	2.7%
High Performance T8, 4 Feet	6.3%
Reduced Wattage T8, 4 Feet	10.2%
T5, 4 Feet	3.0%
LED, 4 Feet	0.1%
Unknown, 4 Feet	0.4%
T8 Model Not Found, 4 Feet	4.3%
T8 Model Missing, 4 Feet	34.5%
T12, 8 Feet	3.6%
T8, 8 Feet	0.8%
T5, 8 Feet	0.0%
T12, Other Length	0.3%
Other, Other Length	2.9%
T8, Other Length	3.7%
T5, Other Length	1.0%
LED, Other Length	0.0%

*The results presented above are weighted using the business-level sample weight.

**These data represent 323 sites.

Given the focus of the linear lamp efficiency disaggregation is on the characterization of T8 lamps into their four efficiency types, the remaining existing stock linear lamp analysis will focus on four foot linear technologies.

[15] Lamps in high bay lighting and in fixtures with covers represent challenging configurations for the collection of make and model numbers.

[16] Many of the "Model Not Found" represent lamps where incomplete model numbers were collected or where they surveyor mistakenly collected information to describe the lamp brand instead of the model number.

Saturation of Four Foot Linear Lamps by Performance Group

Table 3-9 lists the efficiency distribution of four foot linear technologies. During the initial phases of the 2014 on-site data collection, make and model numbers were not collected for Linear Technologies. Without make and model numbers, however, it is not possible to classify T8 lamps as Standard 700 Series (First Generation T8s), Standard 800 Series (Second Generation T8), High Performance T8 (Third Generation T8s), or Reduced Wattage T8 (Fourth Generation T8).

The efficiency distribution for all four foot linear technology data is presented in Table 3-9. The second column in Table 3-9 provides the distribution of T8s based on all of the 2014 data collection effort. The high share of lamps classified as "Model Missing" represent T8 lamps observed prior to the collection of make and model numbers (approximately 39% of linear data to date). The classification "Model Not Found" represents T8s whose model number could not be matched with known databases (approximately 5% of linear data).

The third column in Table 3-9 represents the allocation of linear technologies if the "Model Missing" and "Model Not Found" T8 lamps are distributed across the observed four foot T8 lamps in proportion to the observed efficiency distribution of four foot T8 lamps. This allocation implicitly assumes that the T8s without collected and known make and model numbers are allocated similar to those with collected make and model numbers. The study team cannot state unequivocally that the lamps with missing information are randomly distributed, due to the large number of small sites with missing information, combined with small sites being apparently more likely to have less efficient T8 lamps. Given that the second phase of data collection will collect make and model numbers whenever possible, the issues associated with the model missing will diminish in the final report.

The information in Table 3-9 indicates that only 4% of four foot Linear Technologies are T12 lamps, evidence that most Massachusetts businesses have replaced their four foot T12 lamps with newer more efficient technologies. The finding that few T12 lamps remain implies that Massachusetts businesses have updated to more efficient technologies leading to a decline in their lighting electricity consumption but it also reduces the remaining lighting energy efficiency potential. Data in the third column of Table 3-9 clearly illustrate that 700 Series T8s are the most common four foot T8 found in Massachusetts businesses while four foot T12 lamps are relatively uncommon. The results suggest that while there have been significant achievements with regards to adoption of high efficiency linear fluorescent technologies in the state, the dominance of 700 Series lamps indicate that there is also significant savings potential that remains associated with the replacement of First Generation T8 lamps. Previous research undertaken by CEE has shown that Third Generation systems use approximately 20% less energy than First Generation systems through a combination of fewer lamps, lower ballast factors, or fewer fixtures. However, it is linear LEDs that show the greatest promise for per lamp savings in the future. CEE reports that Linear LEDs "represent the market with the single greatest potential for energy savings if there were a complete switch to LEDs."[17]

[17] Consortium for Energy Efficiency. January 2015. "Commercial Lighting Systems Initiative." Found at http://library.cee1.org/sites/default/files/library/9539/CEE_Commercial_Lighting_Initiative_Jan2015_FINAL.pdf.

Table 3-9: Linear Efficiency Distribution, Four Foot Lamps

Linear Efficiencies	On-Site Data Percentages	Distribution of Known Performance
T12	4.3%	4.3%
Other	1.0%	1.0%
700 Series T8	24.5%	47.7%
800 Series T8	3.1%	6.0%
High Performance T8	7.2%	14.0%
Reduced Wattage T8	11.7%	22.7%
T5	3.4%	3.4%
LED	0.1%	0.1%
Unknown	0.4%	0.8%
Model Not Found	5.0%	
Model Missing	39.3%	
Total	100%	100%

* The results presented above are weighted using the business-level sample weight.

** These data represent 312 sites.

Four Foot Linear Lamp Efficiency and Business Size

Analyzing linear lamp efficiency by business size can help inform programs on which size of businesses still offer linear technology savings potential. Table 3-10 and Table 3-11 present the four foot linear technology efficiency distribution by business size. These data indicate that small sized businesses are substantially more likely to have four foot T12 lamps than large sized businesses. As seen in Table 3-10 medium sized businesses have larger adoptions of Reduced Wattage T8s, while High Performance T8s make up almost 75% of the 4 foot T8s at large businesses. The predominance of 700 Series T8s in small businesses brings to light the savings potential that remains to be achieved in this customer segment. The small sample sizes for large businesses within the Phase 1 data collection limits the ability to draw conclusions on the linear lighting efficiency for this customer segment.

Table 3-10: Linear Efficiency Distribution by Business Size – with Missing Data, Four Foot Lamps

Linear Efficiencies	LT 500,000 kWh	500,000 - 4,500,000 kWh	GT 4,500,000 kWh	Unknown
T12	6.4%	2.1%	0.2%	2.8%
Other	1.7%	0.0%	0.0%	0.0%
700 Series T8	35.1%	15.4%	0.8%	0.0%
800 Series T8	0.9%	3.9%	13.1%	0.0%
High Performance T8	0.3%	0.0%	74.8%	0.0%
Reduced Wattage T8	1.6%	32.0%	0.0%	0.0%
T5	2.6%	5.8%	0.0%	0.3%
LED	0.2%	0.0%	0.0%	0.7%
Unknown	0.8%	0.0%	0.0%	0.0%
Model Not Found	8.1%	1.4%	0.0%	0.1%
Model Missing	42.3%	39.2%	11.0%	96.2%
Total	100%	100%	100%	100%

*The results presented above are weighted using the business-level sample weight.

** These data represent 176 Small sites, 107 Mid-sized sites, 21 Large sites and 8 Unknown sites.

Using the data in Table 3-11, small businesses are more likely to have 700 Series T8s than large or mid-sized businesses while large businesses are more likely to have high performance. Figure 3-10 Figure 3-10: Linear Efficiency Distribution by Business Size – with Missing Data Allocated, Four Foot Lamps illustrates the data presented in Table 3-11. These results indicate that large customers have mostly High Performance T8s, medium customers have a relatively high share of Reduced Wattage T8s, while small sized customers have largely First and Second Generation T8s.

These findings for the distribution of T8s by their disaggregated category may be impacted by the second round of data collection. With additional make and model information and larger sample sizes, the share of individual technologies found in the specific customer segments may be subject to potential substantial change.

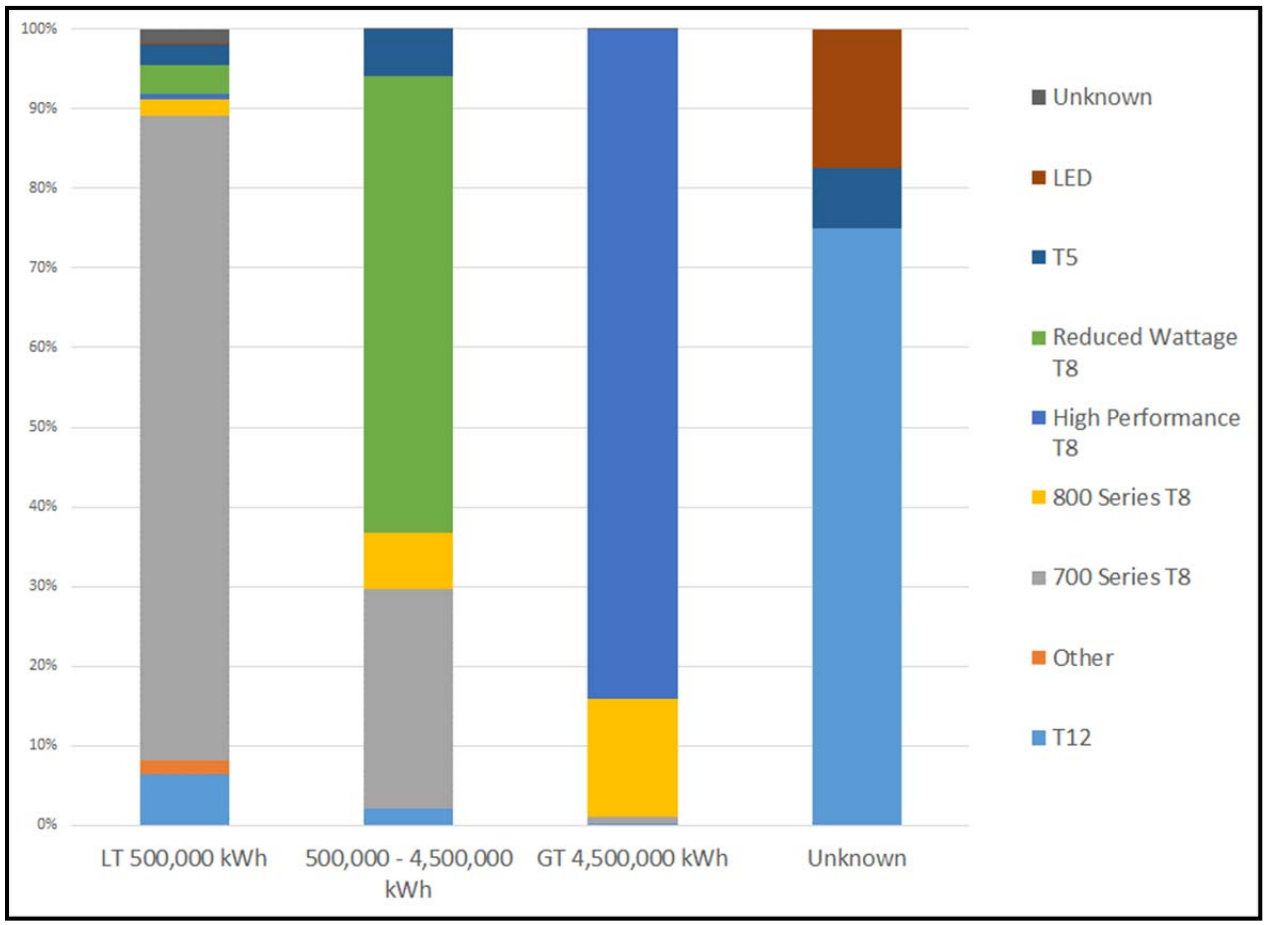
Table 3-11: Linear Efficiency Distribution by Business Size – with Missing Data Allocated, Four Foot Lamps

Linear Efficiencies	LT 500,000 kWh	500,000 - 4,500,000 kWh	GT 4,500,000 kWh	Unknown
T12	6.4%	2.1%	0.2%	2.8%
Other	1.7%	0.0%	0.0%	0.0%
700 Series T8	80.9%	27.6%	0.8%	0.0%
800 Series T8	2.1%	7.1%	14.8%	0.0%
High Performance T8	0.7%	0.1%	84.1%	0.0%
Reduced Wattage T8	3.6%	57.3%	0.0%	0.0%
T5	2.6%	5.8%	0.0%	0.3%
LED	0.2%	0.0%	0.0%	0.7%
Unknown	1.7%	0.0%	0.0%	0.0%
Total	100%	100%	100%	100%

*The results presented above are weighted using the business-level sample weight.

** These data represent 176 small sites, 107 mid-sized sites, 21 large sites and 8 unknown sites.

Figure 3-10: Linear Efficiency Distribution by Business Size – with Missing Data Allocated, Four Foot Lamps



*The results presented above are weighted using the business-level sample weight.

** These data represent 176 small sites, 107 mid-sized sites, 21 large sites and 8 unknown sites.

Four Foot Linear Lamp Efficiency and Energy Efficiency Program Participation

Energy efficiency program participation may be associated with a higher likelihood that the business has more efficient linear technologies. The data presented in Table 3-12 indicate that there is a substantial difference in the distribution of technologies of energy efficiency program participants and non-participants with four foot T12 lamps, with participant adoption of high efficiency T8s being significantly higher. Non-participant businesses have a 5.5% of their linear technologies as four foot T12s while participant businesses have 0.4%. Non-participant businesses also have a higher share of their linear technologies in 700 Series T8s while participant businesses have a higher share of Reduced Wattage T8 lamps.

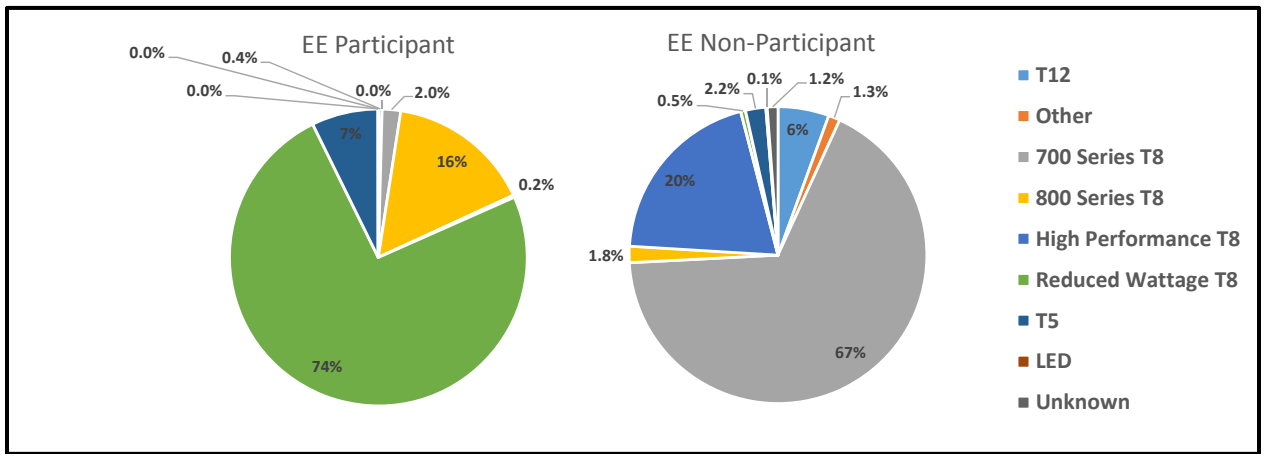
Table 3-12: Linear Efficiency Distribution by Energy Efficiency Program Participation, Four Foot Lamps

Linear Efficiencies	On-Site Data Percentages, EE Participant	Distribution of Known Performance, EE Participant	On-Site Data Percentages, EE Non-Participant	Distribution of Known Performance, EE Non-Participant
T12	0.4%	0.4%	5.5%	5.5%
Other	0.0%	0.0%	1.3%	1.3%
700 Series T8	1.3%	2.0%	31.8%	67. 4%
800 Series T8	10.1%	15.7%	0.8%	1.8%
High Performance T8	0.2%	0.2%	9.4%	20.0%
Reduced Wattage T8	48.2%	74.4%	0.2%	0.5%
T5	7.2%	7.2%	2.2%	2.2%
LED	0.0%	0.0%	0.1%	0.1%
Unknown	0.0%	0.0%	0.6%	1.2%
Model Not Found	2.0%		5.9%	
Model Missing	30.5%		42.1%	
Total	**100%**	**100%**	**100%**	**100%**
n	**85**		**227**	

*The results presented above are weighted using the business-level sample weight.

** These data represent 85 EE participant sites, and 227 non-participant sites.

Figure 3-11: Linear Efficiency Distribution by Energy Efficiency Program Participation – with Missing Data Allocated, Four Foot Lamps



*The results presented above are weighted using the business-level sample weight.

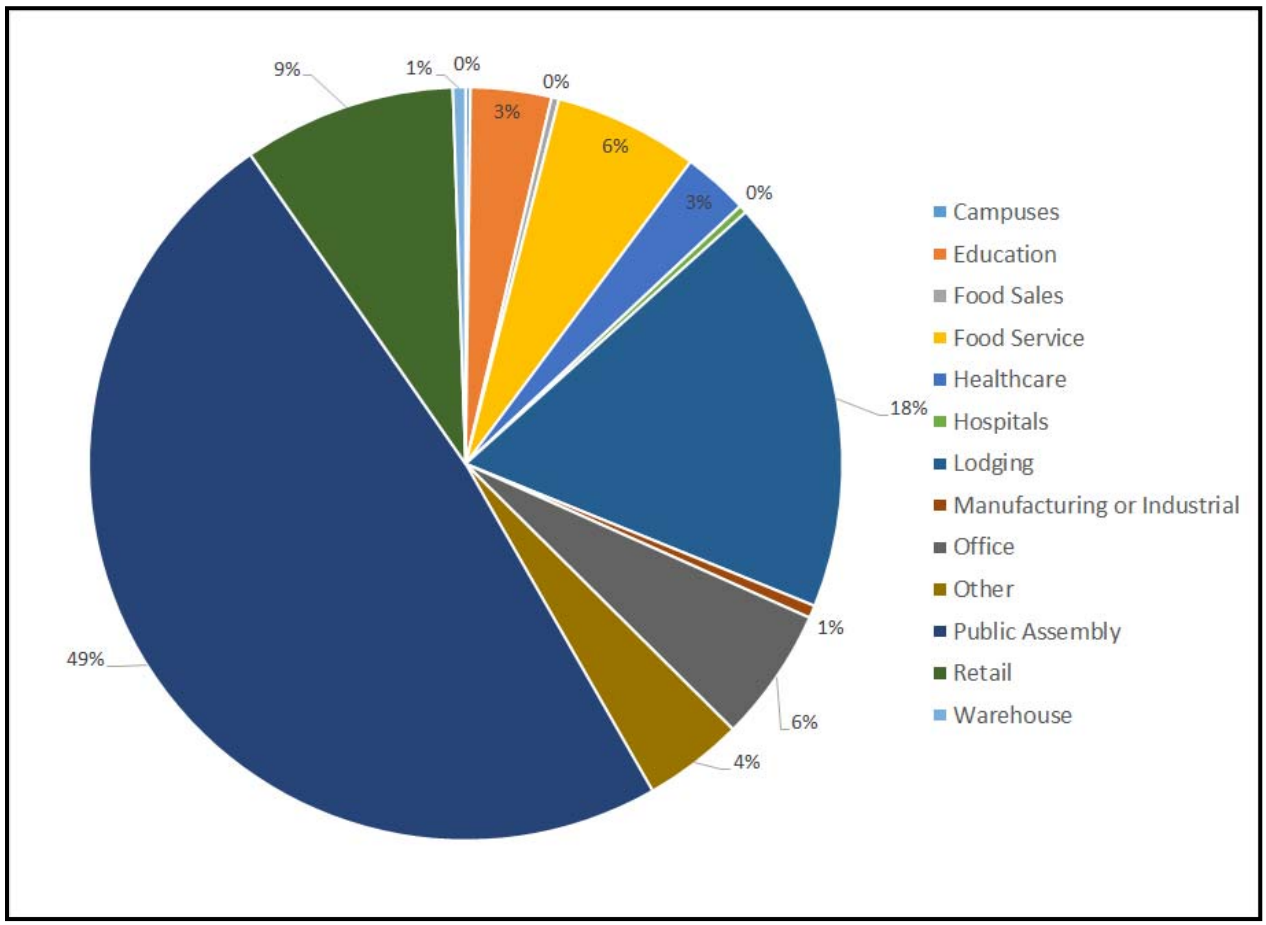
** These data represent 85 EE participant sites, and 227 non-participant sites.

3.3.3 Incandescent, CFL, LED, and Halogen (ICLH) Lamps

The ICLH section presents information on incandescent, CFL, LED, and halogen technologies currently installed in businesses in Massachusetts. These lighting technologies have been grouped together because each of these technologies have similar lighting applications. The results reported include outdoor lighting systems and do not include exit signs.

Figure 3-12 illustrates the distribution of ICLH lamps by business type. These data indicate that 18% of ICLH lamps are found in lodging, 9% in retail businesses, and 49% in public assembly. Figure 3-13 illustrates the distribution of ICLH lamps by business kWh size. These data indicate that 27% of ICLH lamps are found in medium-sized businesses and 70% in small-sized businesses.

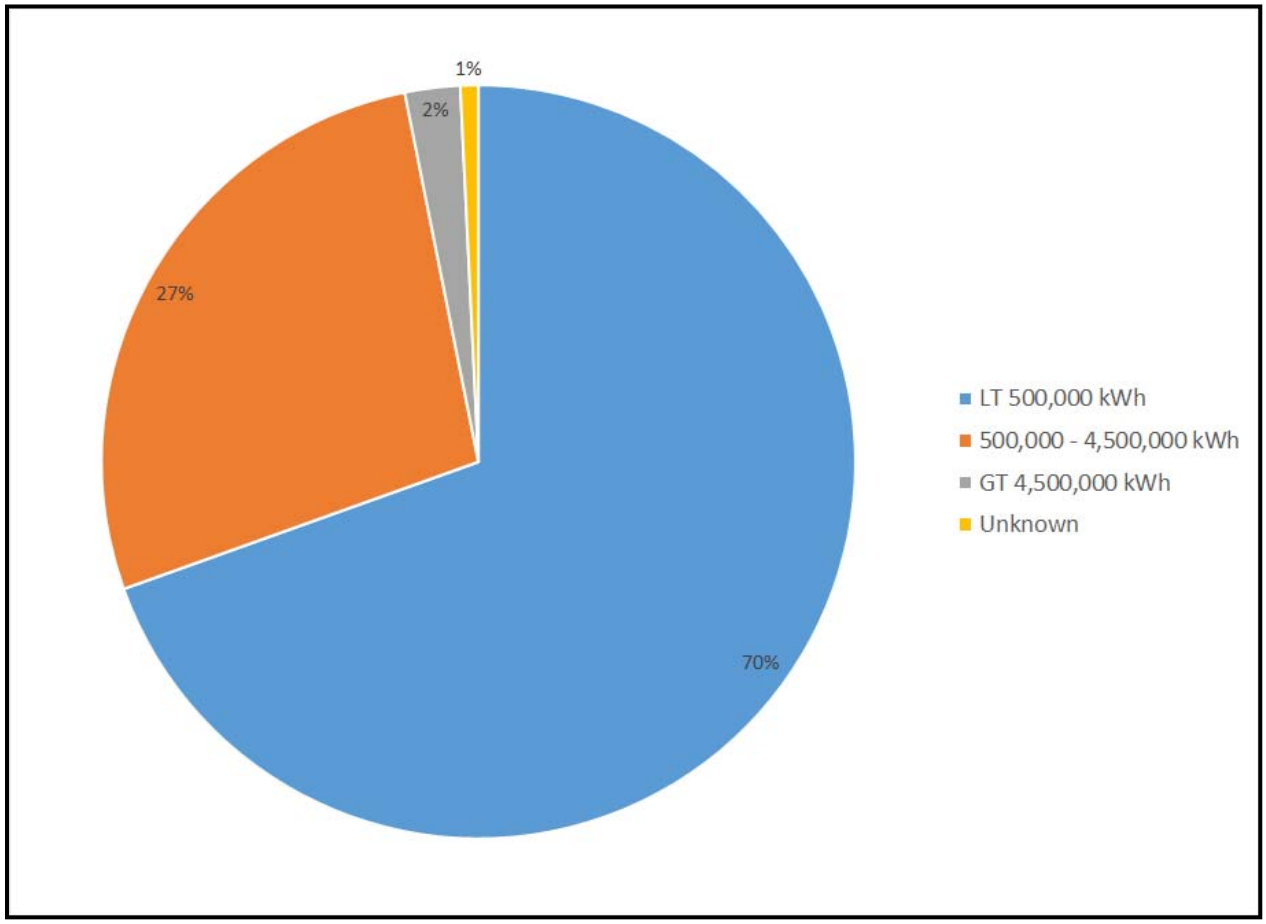
Figure 3-12: ICLH Distribution by Business Type



*The results presented above are weighted using the business-level sample weight.

** These data represent 9 sites for campuses, 24 education sites, 23 food Sales, 29 food Service sites, 19 healthcare sites, 6 hospitals, 30lLodging sites, 17 manufacturing or industrial sites, 44 offices, 22 other Businesses, 31 sites for public assembly, 38 retail sites and 10 warehouses.

Figure 3-13: ICLH Distribution by Business Size



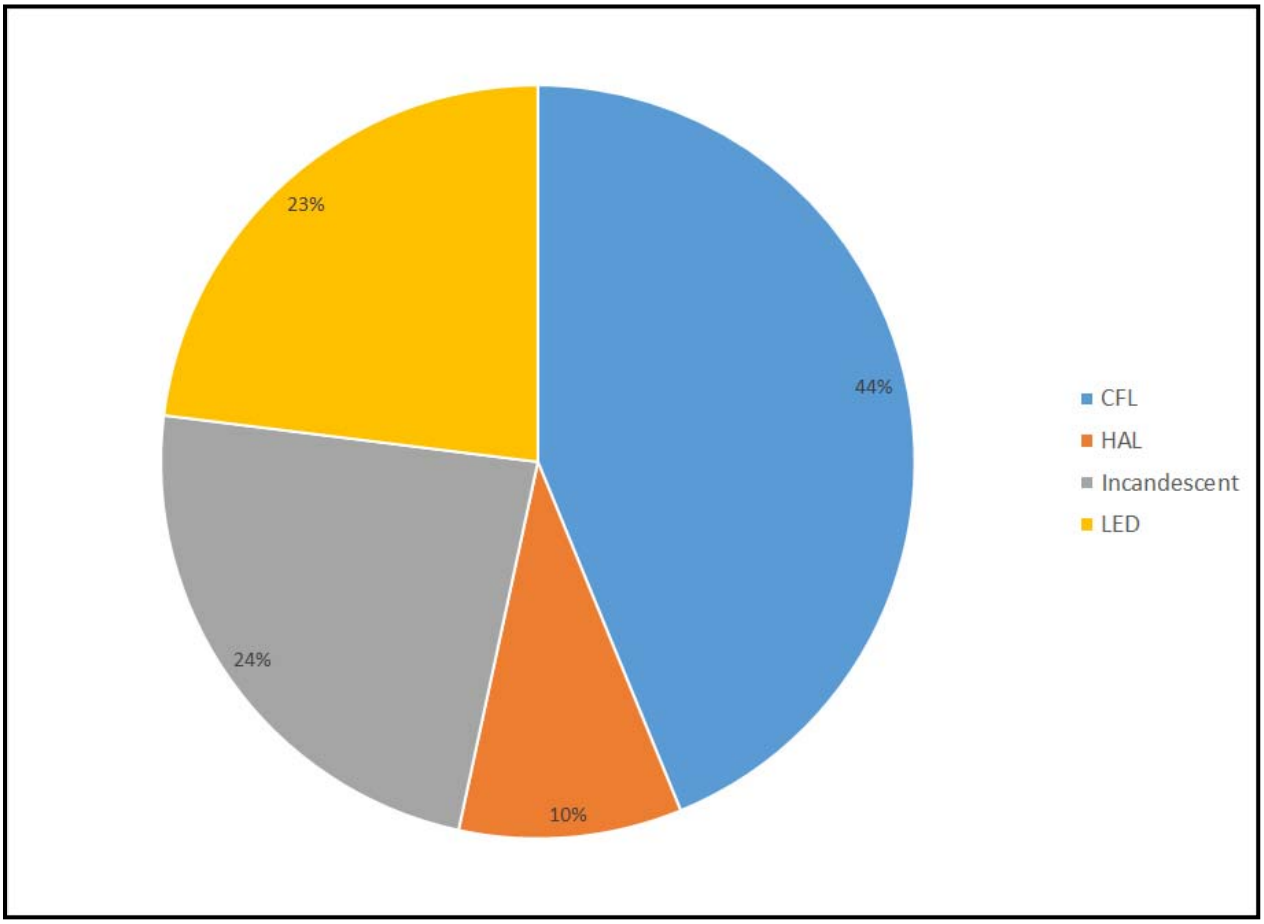
*The results presented above are weighted using the business-level sample weight.

** These data represent 175 small sites, 103 mid-sized sites, 18 large sites and 6 unknown sites.

ICLH Saturation by Performance Group

Figure 3-14 presents the share of ICLH lamps in each technology group. These data indicate that CFL, LED, and incandescent lamps each have over 20% of these lamps in Massachusetts businesses with CFLs representing approximately 44% of these lamps.

Figure 3-14: ICLH Lamp Distribution



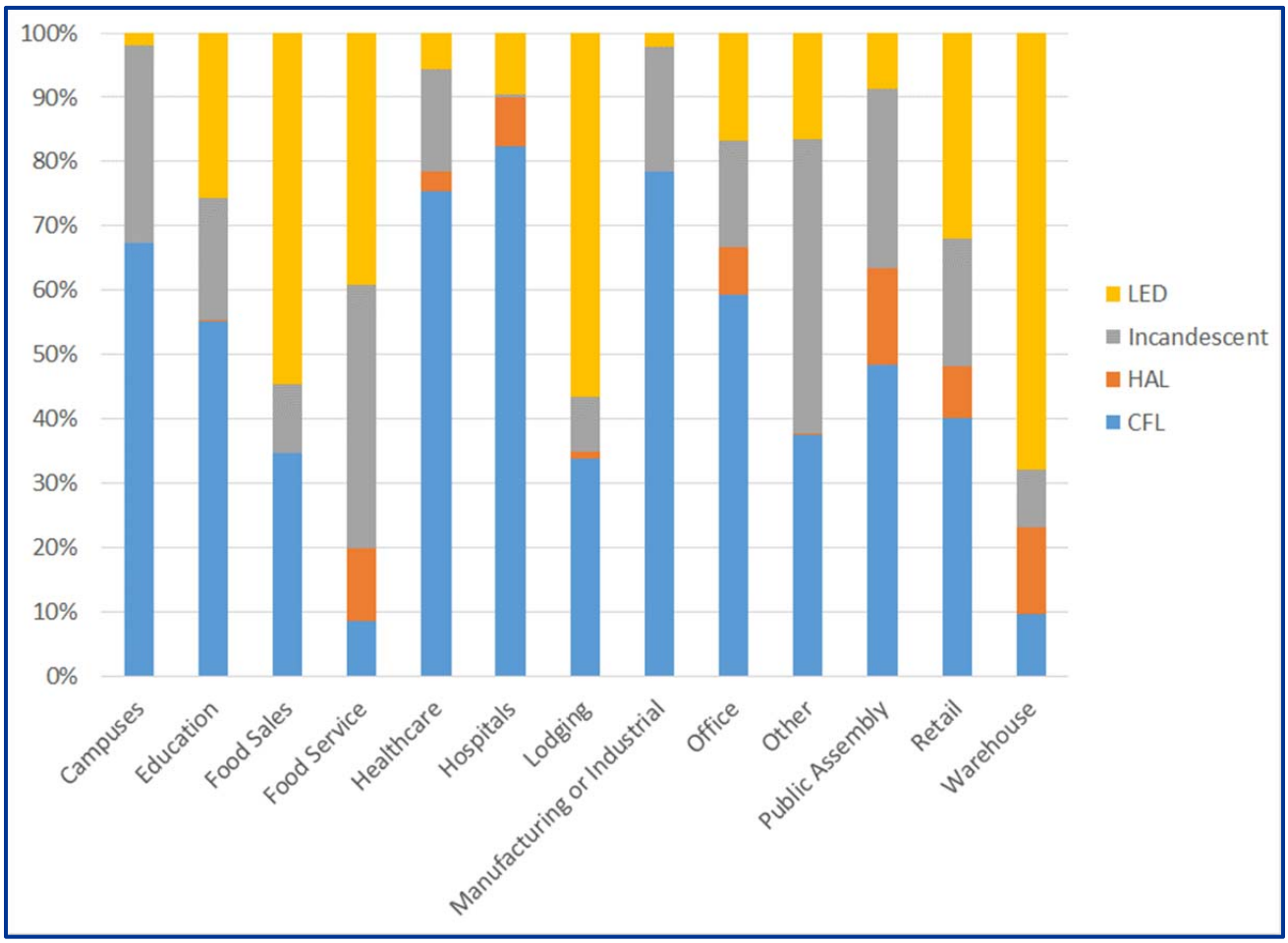
* The results presented above are weighted using the business-level sample weight.

** These data represent 302 sites.

ICLH Distribution by Business Type

Figure 3-15 presents the distribution of ICLH lamps by business type. These data indicate LEDs have over 50% of the ICLH lighting in food sales, lodging, and warehouses, CFLs are the dominant ICLH lamp for campuses, education, healthcare, hospitals, manufacturing, and offices, while incandescent lamps have a substantial share for food services and other business types. The small sample sizes for some business types such as campuses, health care, and warehouses limits the ability to apply the Phase 1 business type ICLH findings to the population of these businesses.

Figure 3-15: ICLH Lamp Distribution by Business Type



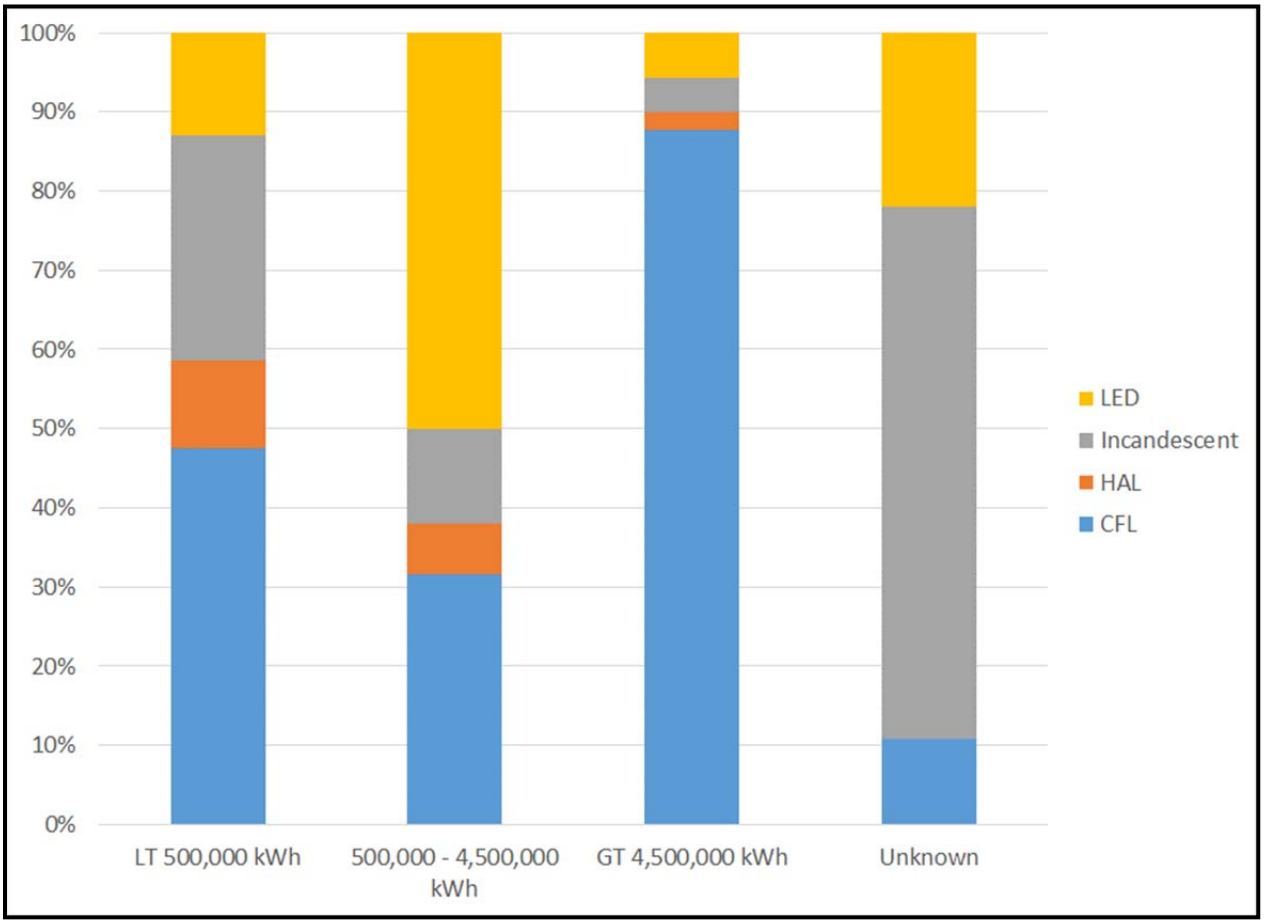
*The results presented above are weighted using the business-level sample weight.

** These data represent 9 sites for campuses, 30 education sites, 22 food sales, 30 food service sites, 19 healthcare sites, 6 hospitals, 25 lodging sites, 23 manufacturing or industrial sites, 54 offices, 20 other businesses, 31 sites for Public assembly, 41 retail sites and 13 warehouses.

ICLH Distribution by Business Size

Figure 3-16 presents the distribution of ICLH lamps by business size. These data indicate that small businesses have a larger share of incandescent bulbs than large or mid-sized businesses. Mid-sized businesses have a larger share of LED bulbs than either small or large-sized businesses, while large businesses' ICLH lamps are dominated by CFLs. Large businesses, however, have a very small sample size associated with the Phase 1 data collection. The Phase 2 data collection and analysis will provide additional data to determine if these findings are representative of the population of Massachusetts businesses.

Figure 3-16: ICLH Lamp Distribution by Business Size



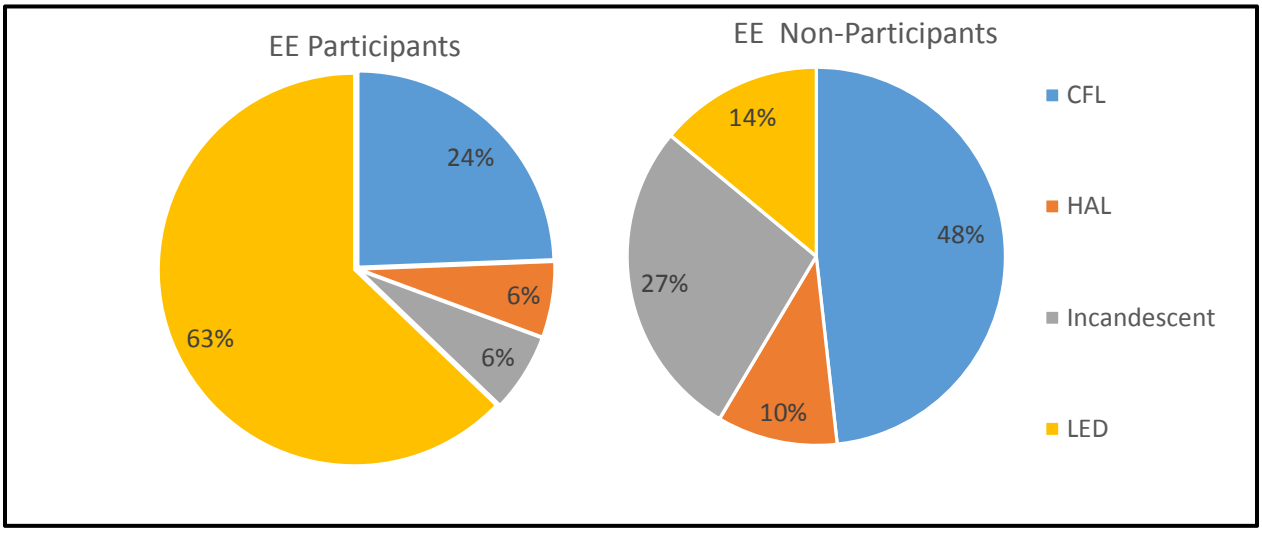
* The results presented above are weighted using the business-level sample weight.

** These data represent 175 small sites, 103 mid-sized sites, 18 large sites and 6 unknown sites.

ICLH Distribution by Energy Efficiency Program Participation

Figure 3-17 illustrates the distribution of ICLH lamps by program participation. These graphs illustrate that businesses that have not participated in EE programs from 2011-2013 have almost double the share of their ICLH lamps in CFLs (48%) as compared to participants (24%), but non-participants have a substantially smaller share of LED bulbs (14%) than participants (63%). Program participation appears to be positively associated with the share of LED lamps and negatively associated with incandescent and CFL lamps. Analysis of the Phase 1 data implies that program participants are substantially more likely to have LEDs than non-participants, although upstream program participants, where many LED lights are provided, are not included as participants in this analysis. Customers who received LED's through that program would not necessarily know they are program participants The Phase 2 data collection and analysis will help to determine if these findings are generalizable to the Massachusetts business population.

Figure 3-17: ICLH Lamp Distribution by Energy Efficiency Program Participation



*The results presented above are weighted using the business-level sample weight.

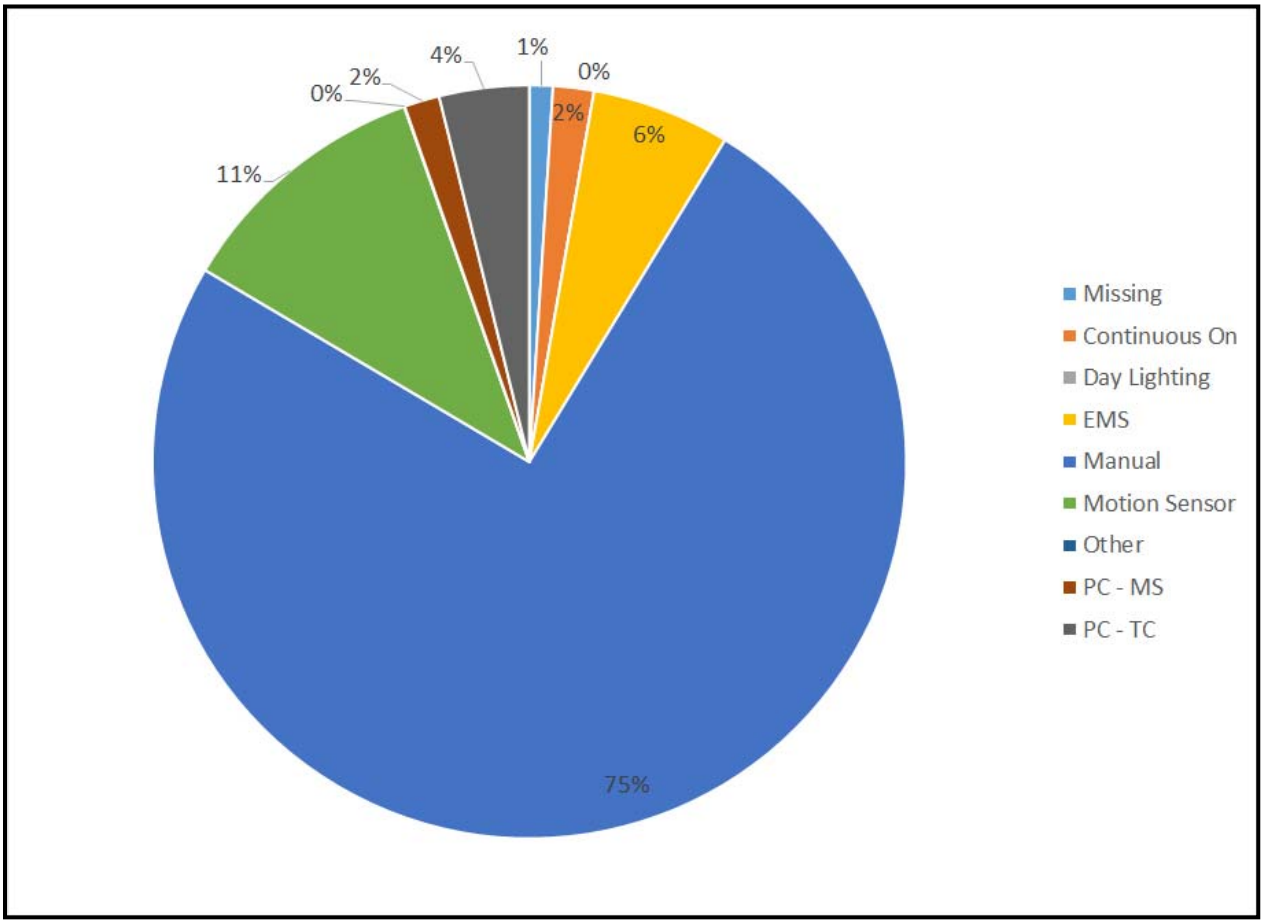
** These data represent 82 EE participant sites, and 220 non-participant sites.

3.3.4 Lighting Controls

During the C&I Customer On-site Assessments we collected information on the type of control used for lighting measures. Types of controls included manual switch, continuous on (lighting controls that regulate lighting systems that are on 24 hours per day, 7 days per week (e.g. emergency lighting)), EMS, motion sensor, photo cell motion sensor, photo cell time clock, daylighting, and other. For some lighting measures no information was collected on the type of control.

Figure 3-18 displays the distribution of lighting controls across all types of lighting. This graph indicates that most of the non-residential lighting in Massachusetts is manually controlled (75%) while 23% are controlled by either EMS, motion sensors, PC-motion sensors, or PC-time clock. Figure 3-19 illustrates the distribution of lighting controls for each type of lighting. These data indicate that linears, the most common type of lighting in Massachusetts businesses (see Figure 3-4) are most commonly manually controlled, though a substantial share of linear technologies are controlled by EMS or motion sensors. HID bulbs are the most common type of lighting on photo cell time clocks due to the substantial share of these lights in outdoor locations.

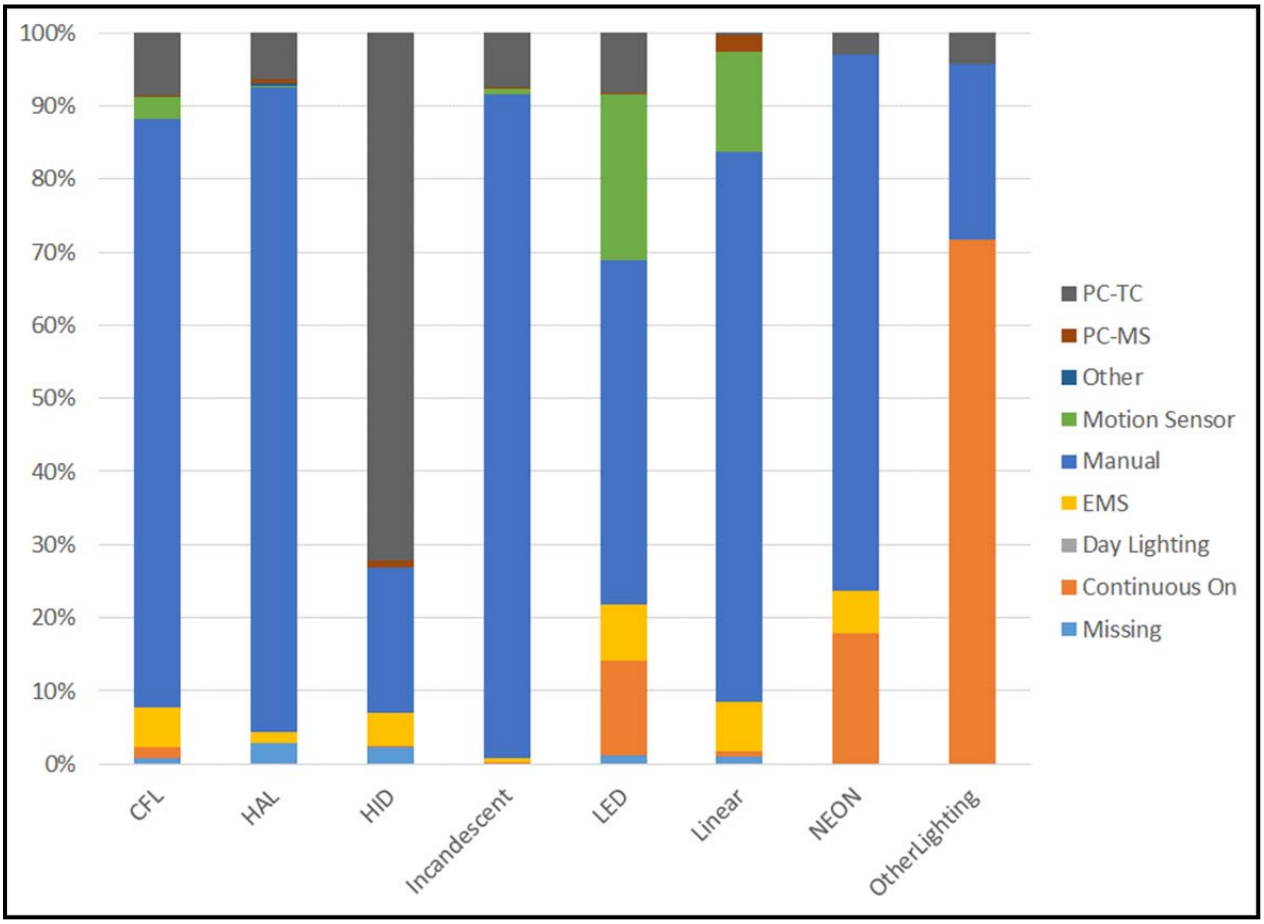
Figure 3-18: Share of Lighting Controlled by Alternative Lighting Controls



*The results presented above are weighted using the business-level sample weight.

** These data represent 341 sites.

Figure 3-19: Lighting Controls by Lamp Type

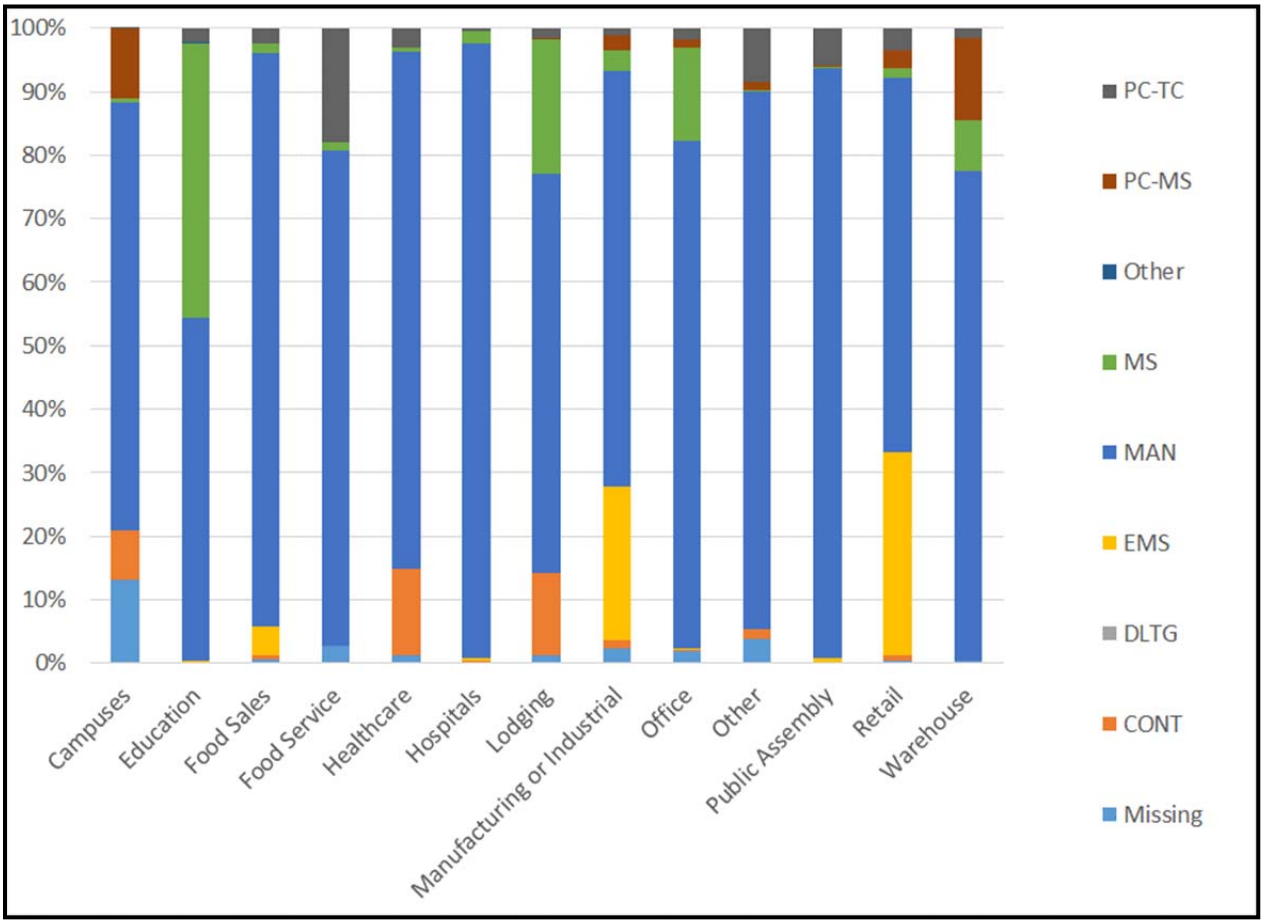


*The results presented above are weighted using the business-level sample weight.

** These data represent 341 sites.

Figure 3-20 presents information on the share of lighting controlled by business type. Manual controls are found to control more than 50% of the bulbs for all business types. Education and lodging have a relatively high share of their lighting controlled by motion sensors while manufacturing and retail have a relatively high share controlled by EMS.

Figure 3-20: Lighting Controls by Business Type

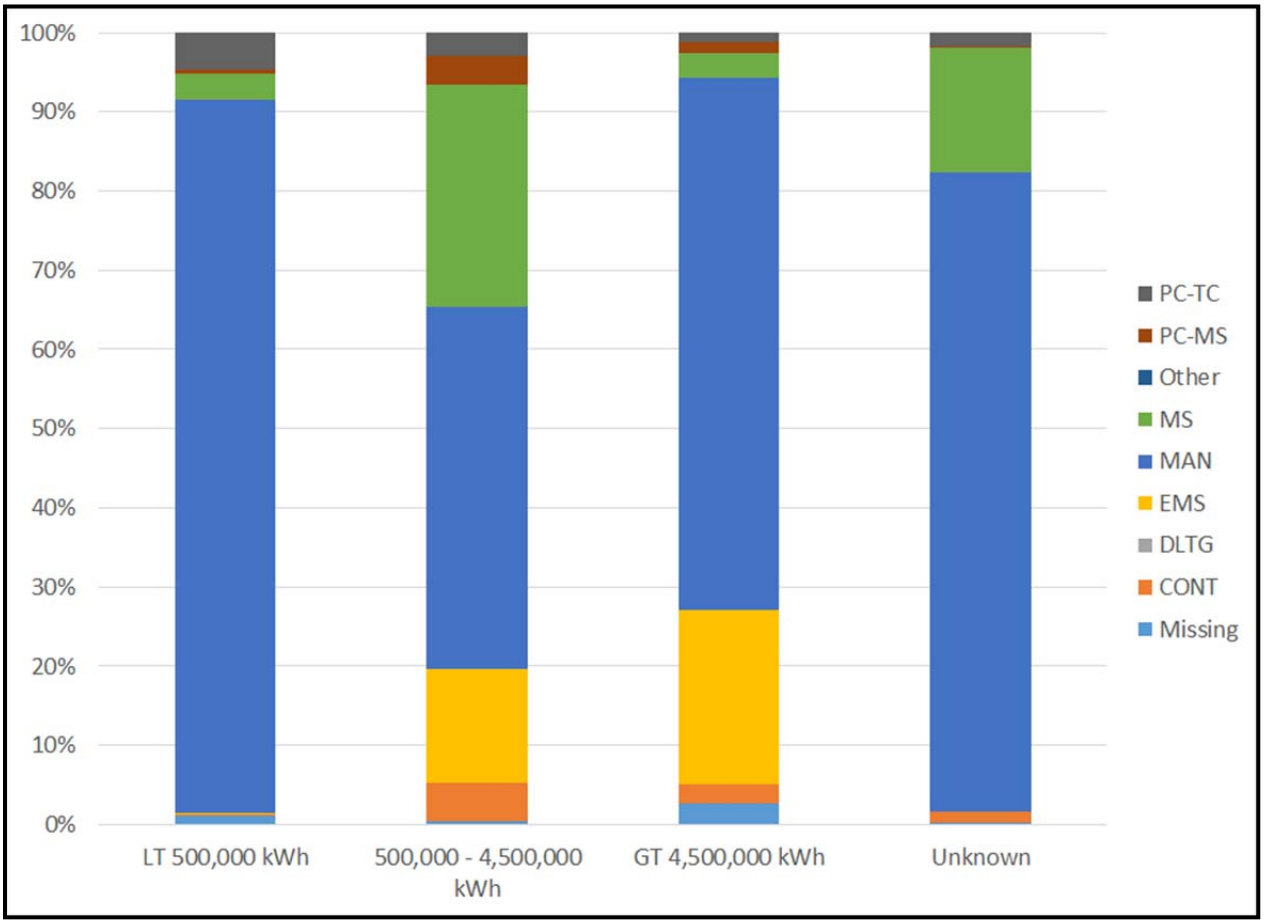


*The results presented above are weighted using the business-level sample weight.

** These data represent 9 sites for campuses, 30 education sites, 24 food sales, 31 food service sites, 19 healthcare sites, 6 hospitals, 32 lodging sites, 23 manufacturing or industrial sites, 55 offices, 24 other businesses, 32 sites for public assembly, 43 retail sites and 13 warehouses.

Figure 3-21 illustrates the distribution of lighting controls by business size. For all three business sizes analyzed (large, medium, and small), manual switches are the most common type of lighting control. Large-sized businesses are shown to have the highest share, relative to the other two business sizes, of their lighting controlled by EMS (22%) while medium-sized businesses have the highest share of lighting controlled by motion sensors.

Figure 3-21: Lighting Controls by Business Size

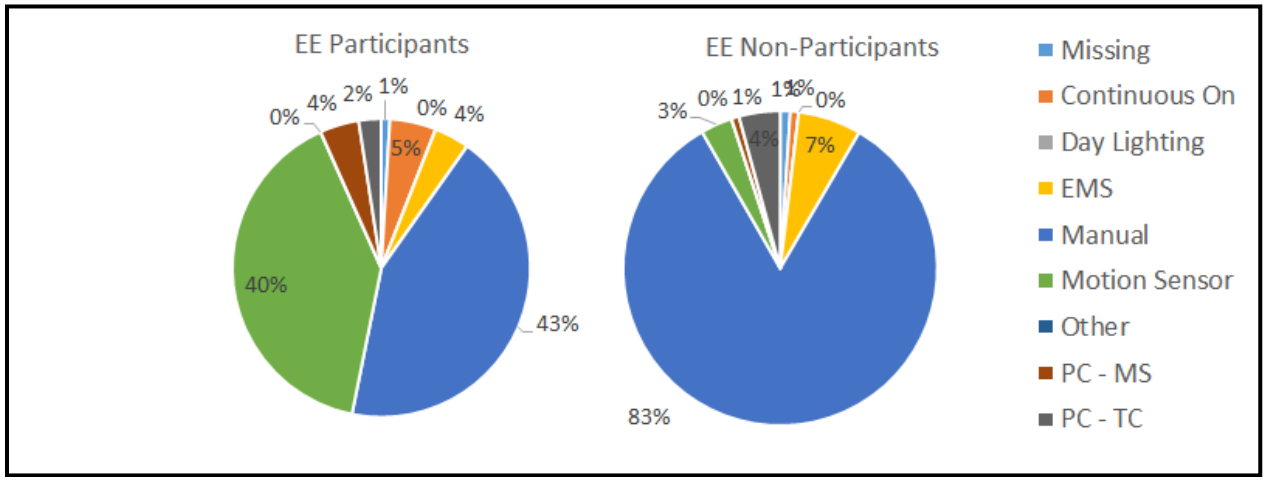


*The results presented above are weighted using the business-level sample weight.

** These data represent 200 small sites, 112mMid-sized sites, 21 large sites and 8 unknown sites.

Figure 3-22 illustrates the distribution of lighting controls by energy efficiency participation. This figure illustrates that customers who have participated in EE programs from 2011 to 2013 controlled a smaller share of their lamps with manual switches and a larger share with motion sensor and photo cell motion sensors than customer that had not participated in programs.

Figure 3-22: Lighting Controls by Energy Efficiency Participation



*The results presented above are weighted using the business-level sample weight.

** These data represent 93 EE participant sites, and 248 non-participant sites.

3.3.5 Recent Lighting Purchase Data

Table 3-13 lists the number of sites where on-sites were completed. For the Market Tracking study, the analysis presented in this section is focused on sites with lighting purchased from 2009 to 2014. Table 3-13 lists the number of on-sites were data was collected during the study on recent purchases of lighting measures by business type.

The lighting analysis will be disaggregated into recent purchases of linear lighting and ICLH bulbs. The recent purchase section will also describe the share of recently purchased bulbs by their lighting controls.

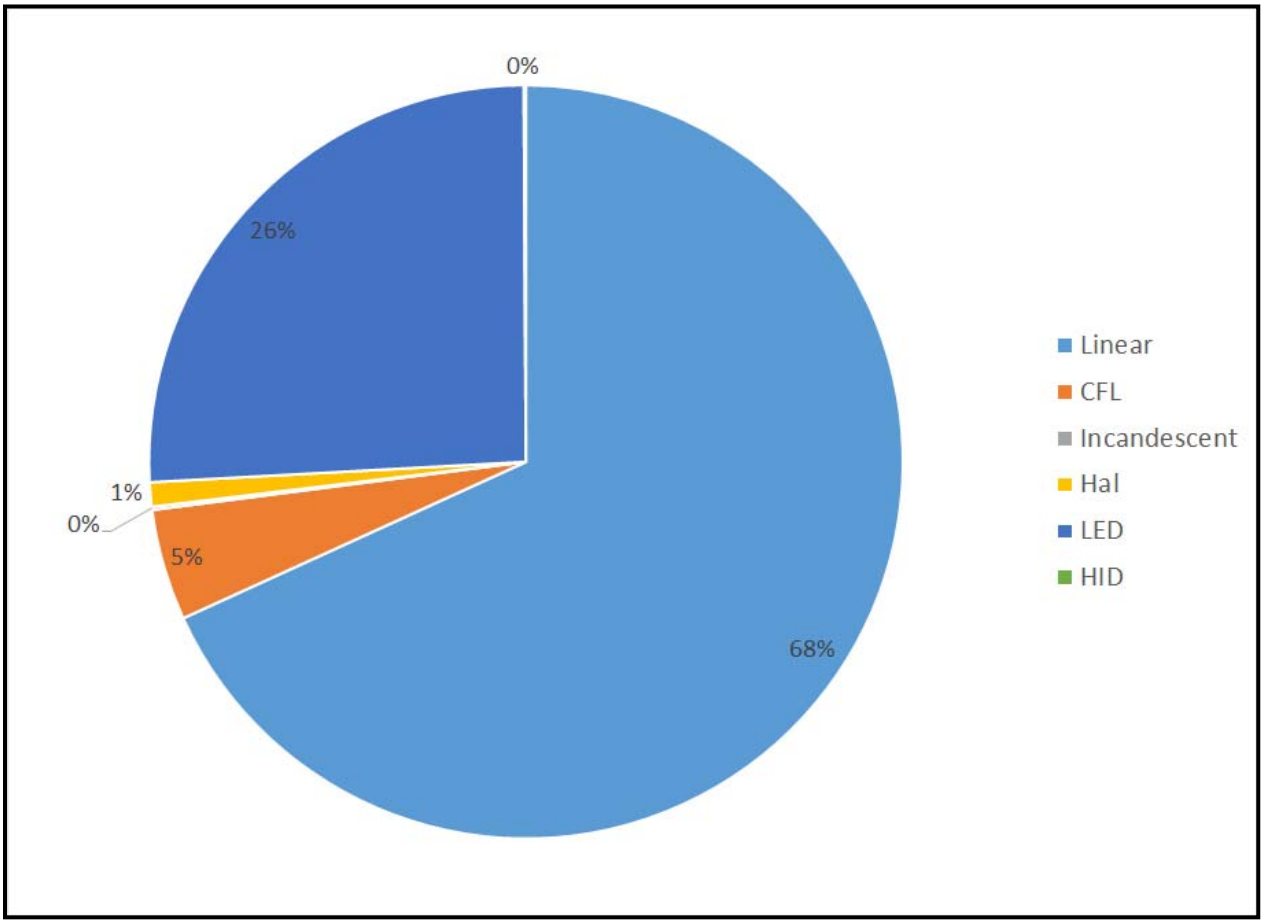
Table 3-13: On-sites with Recent Lighting Purchases (2009-2014)

Business Type	Total On-site Count with Recent Lighting Purchases	On-sites with Four Foot Linear Purchases	On-sites with ICLH Purchases
Campuses	5	3	3
Education	19	14	15
Food Sales	17	13	10
Food Service	15	7	13
Healthcare	9	6	7
Hospitals	3	2	3
Lodging	15	7	14
Manufacturing or Industrial	11	10	5
Office	22	13	17
Other	11	3	8
Public Assembly	19	13	15
Retail	20	12	16
Warehouse	8	4	5
Total	**174**	**107**	**131**

* The results presented above are Un-weighted.

The analysis of the lighting recent purchase data begins by focusing on aggregate lighting, presenting some information on the share of recent purchases by different types of lighting. Figure 3-23 illustrates the site-weighted lamp shares of recently purchased lighting technologies as a percentage of total lamp purchases found in businesses during the 2014 On-site data collection effort. As depicted, approximately 68% of all recently purchased non-residential lamps are linears. LEDs represent 26% of recently purchased lamps while very few recently purchased incandescent bulbs were found during the first wave of on-site data collection.

Figure 3-23: Recent Lighting Purchase Distribution by Lamp Type

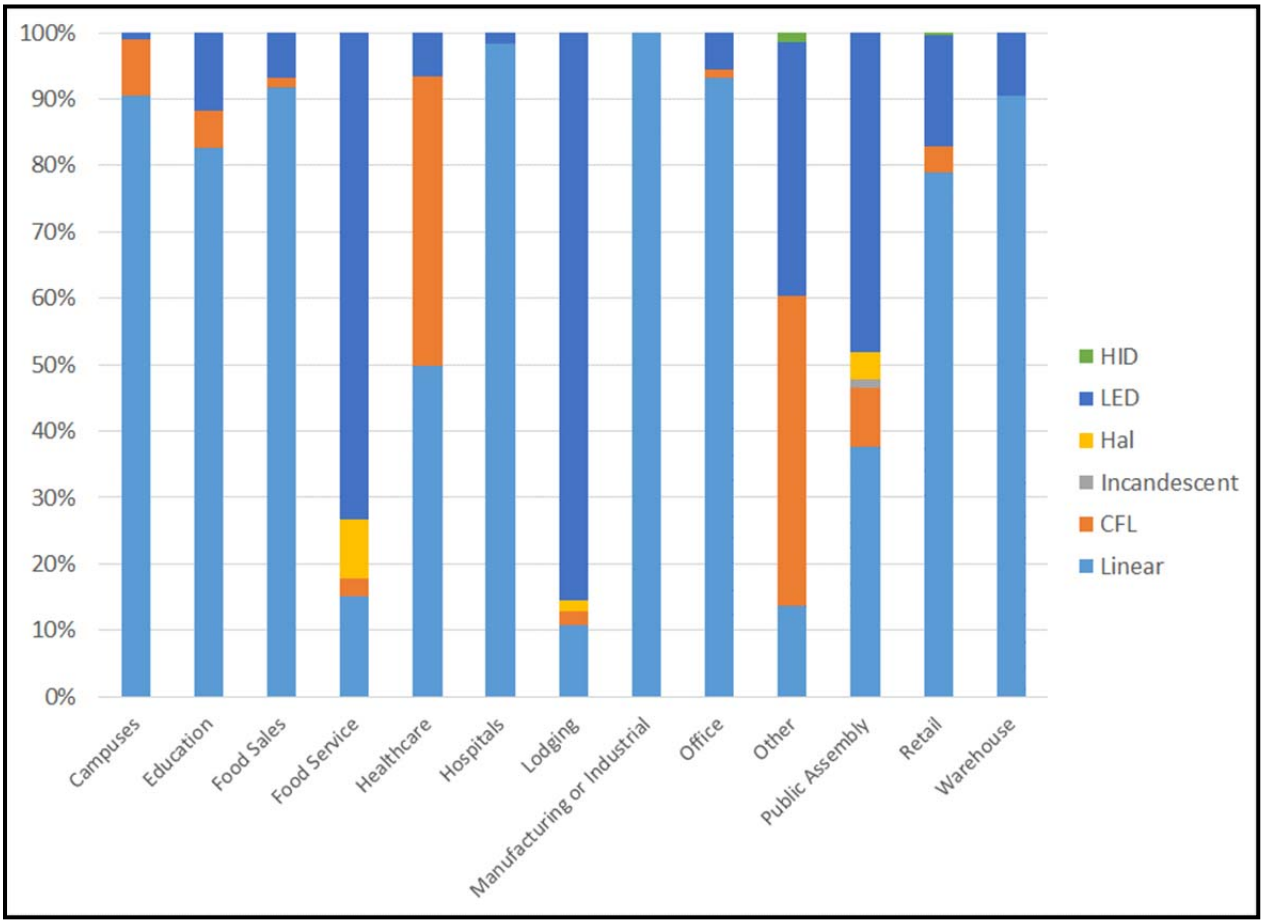


* The results presented above are weighted using the business-level sample weight.

** These data represent 174 sites. These data represent 112 sites with linears,54 sites with CFLs, 4 sites with incandescents, 4 sites with halogens, 99 sites with LEDs, 10 sites with HIDs, 1 site with neons and 1 site with other Lighting.

Figure 3-24 illustrates the share of recently purchased lighting technologies by business type. These data indicate that linear technologies are the dominant type of recently purchased lamp for most business types, except food service and lodging who have a very large share of recently purchased LED lamps.

Figure 3-24: Distribution of Recently Purchased Lamps by Technology Type and Business Type

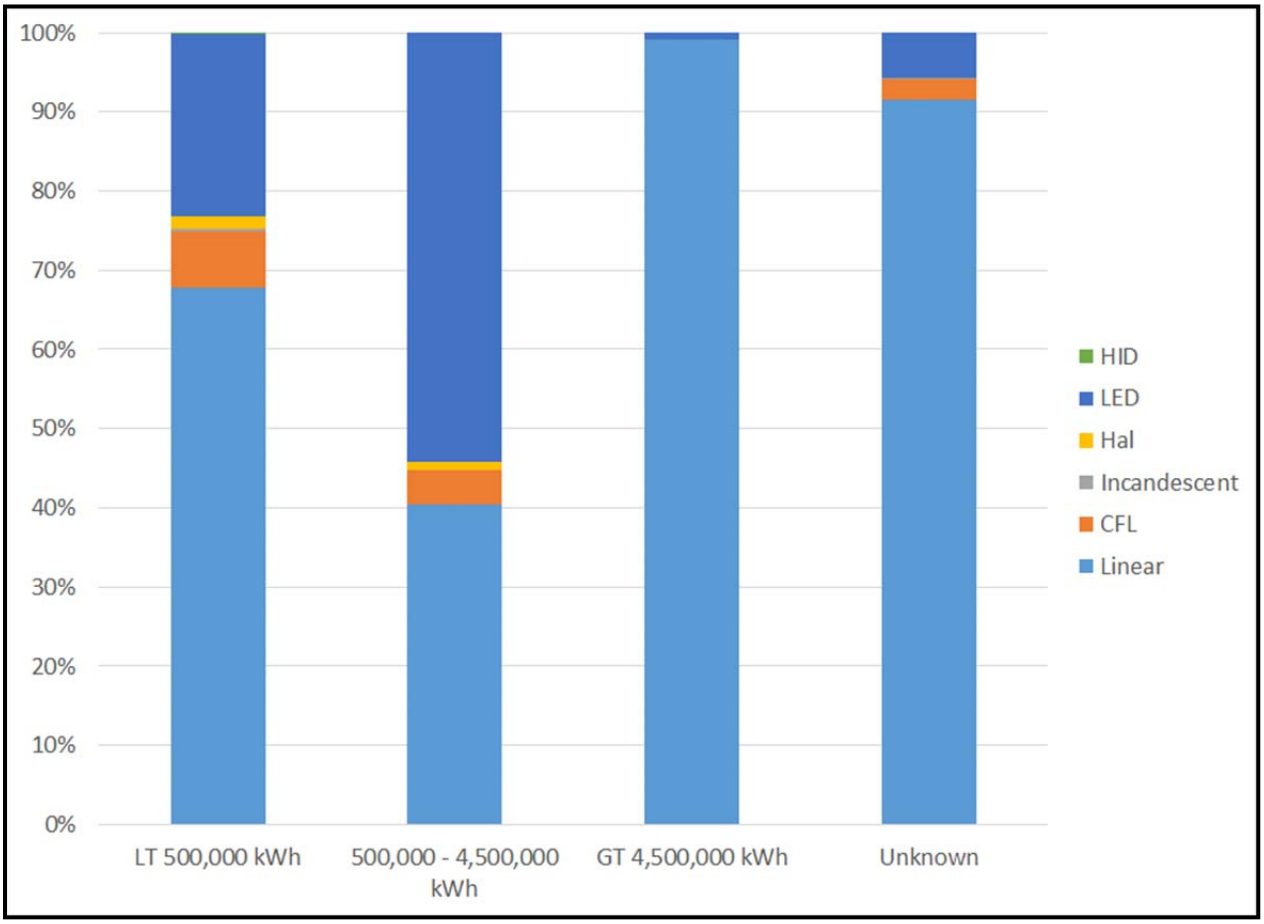


*The results presented above are weighted using the business-level sample weight. The lamps were purchased from 2009-2014.

** These data represent 5 sites for campuses, 19 education sites, 17 food sales, 15 food Service sites, 9 healthcare sites, 3 hospitals, 15 lodging sites, 11 manufacturing or industrial sites, 22 offices, 11 other businesses, 19 sites for public assembly, 20 retail sites and 8 warehouses.

Figure 3-25 illustrates the distribution of recently purchased lamps by technology type and business size. These data indicate that linear technologies dominate the distribution of recently purchased lamps for all business sizes. Medium-sized businesses have the largest share of recently purchased LEDs.

Figure 3-25: Distribution of Recently Purchased Lamps by Technology Type and Business Size



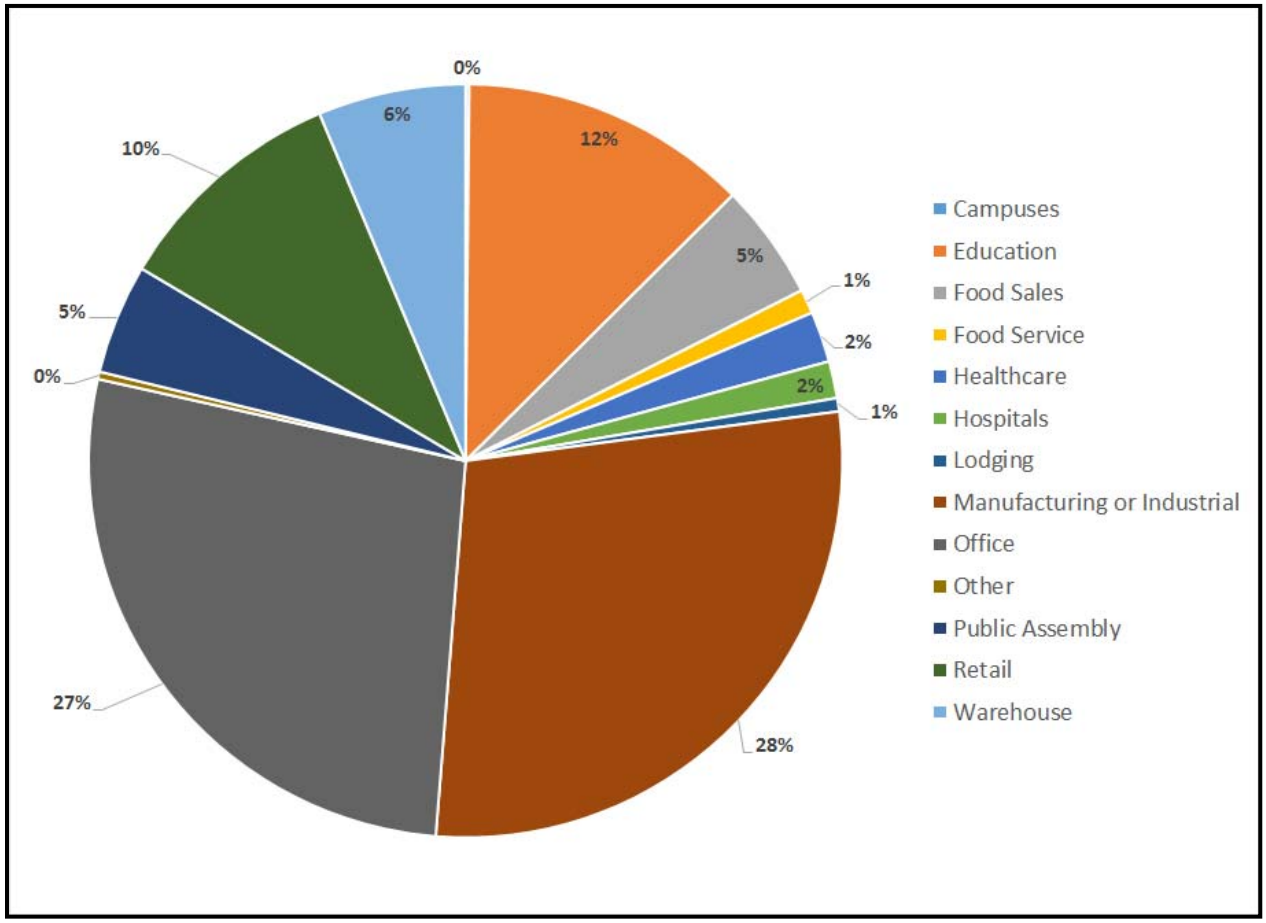
*The results presented above are weighted using the business-level sample weight. The lamps were purchased from 2009-2014.

** These data represent 92 small sites, 63 mid-sized sites, 14 large sites and 5 unknown sites.

3.3.6 Recent Purchases of Four Foot Linear Technologies

Linear lighting is a focus of the Market Share Project. Linear technologies, as shown in Figure 3-4, are the dominant source of lighting for non-residential customers. Linear technologies also dominate non-residential recent lighting purchases from 2009-2014 (see Figure 3-23). Figure 3-26 illustrates the distribution of recently purchased linear lamps by business type while Figure 3-27 provides similar information by business sizes. The data collected in Wave 1 indicate that manufacturing businesses and 0ffices purchased the largest share of linear technologies. The small samples sizes by business type for purchases of linear lighting from 2009 to 2014, however, leads to caution in generalizing these results across the population by business type.

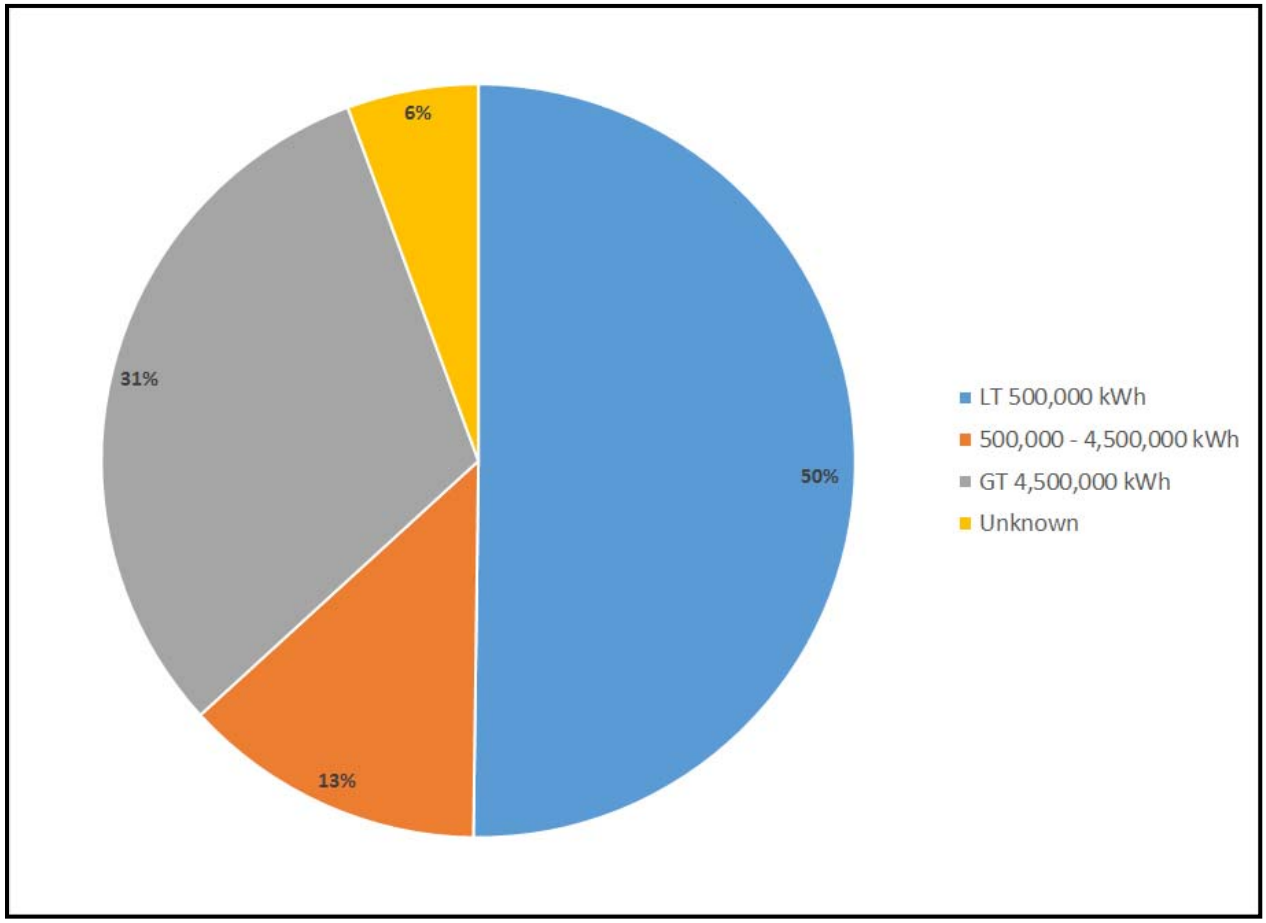
Figure 3-26: Distribution of Recently Purchased Linear Lamps by Business Type, Four Foot Lamps



*The results presented above are weighted using the business-level sample weight. The lamps were purchased from 2009-2014.

** These data represent 3 sites for campuses, 14 education sites, 13 food sales, 7 food service sites, 6 healthcare sites, 2 hospitals, 7 lodging sites, 10 manufacturing or industrial sites, 13 offices, 3 other Businesses, 13 sites for public assembly, 12 retail sites and 4 warehouses.

Figure 3-27: Distribution of Recently Purchased Linear Lamps by Business Size, Four Foot Lamps



*The results presented above are weighted using the business-level sample weight. These lamps were purchased from 2009 to 2014.

** These data represent 60 small sites, 36 mid-sized sites, 6 large sites and 5 unknown sites.

Recently Purchased Four Foot Linear Lamps by Performance Group

Table 3-14 lists the efficiency distribution of recently purchased Linear Technologies. During the initial stages of the 2014 on-site data collection, make and model numbers were not collected for linear technologies. Without make and model numbers it is not possible to classify T8 lamps as Standard 700 Series (First Generation T8s), Standard 800 Series (Second Generation T8), High Performance T8 (Third Generation T8s), or Reduced Wattage T8 (Fourth Generation T8).

The second column in Table 3-14 provides the distribution of T8s based on all of the 2014 data collection effort. The high share of lamps classified as "Model Missing" represent T8 lamps observed prior to the collection of make and model numbers. "Model Missing" also includes lamps where it was not physically possible to collect make and model numbers. The classification "Model Not Found" represents T8s whose model number could not be matched with known databases. Slightly over 48% of the recently purchased linear technologies were classified as "Model Missing" or "Model Not Found".

The third column in Table 3-14 represents the allocation of linear technologies if the "Model Missing" and "Model Not Found" T8 lamps are distributed across the observed T8 lamps in proportion to the observed T8 lamps. This allocation implicitly assumes that the T8s without collected and known make and model numbers are allocated similar to those with collected make and model numbers.[18]

The information in Table 3-14 indicates that almost none of the recently purchased linear technologies are T12 lamps. Figure 3-28 illustrates the information presented in the third column of Table 3-14. These data clearly illustrate that High Performance T8s are the most common T8 recently purchased by businesses in Massachusetts while a much smaller share of recently purchased T8s are 700 series or First Generation T8s.

Table 3-14: Recent Purchase Linear Efficiency Distribution

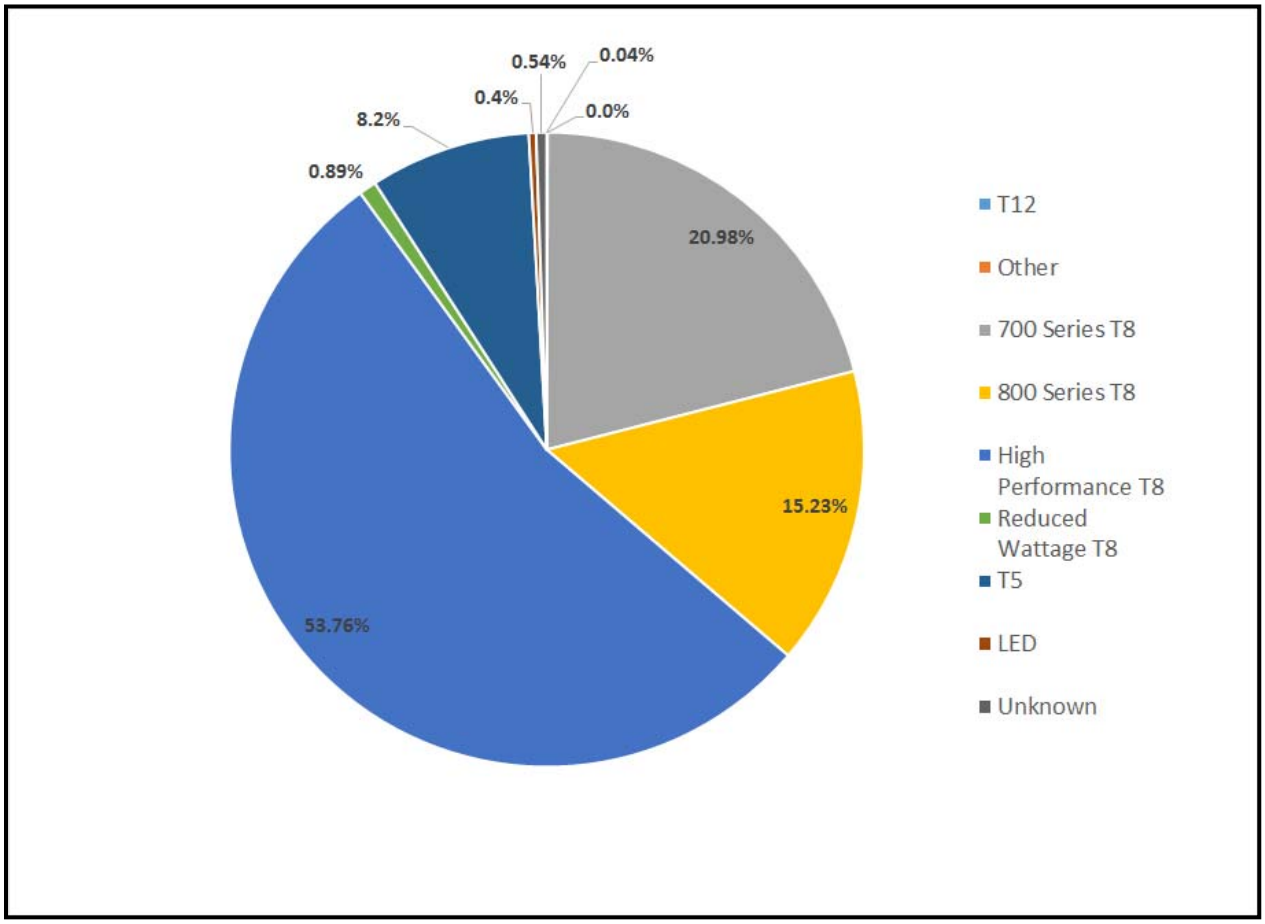
Linear Efficiencies	On-Site Data Percentages	Distribution of Known Performance
T12	0.04%	0.04%
Other	0.00%	0.0%
700 Series T8	9.71%	20.98%
800 Series T8	7.05%	15.23%
High Performance T8	24.88%	53.76%
Reduced Wattage T8	0.41%	0.89%
T5	8.20%	8.2%
LED	0.37%	0.4%
Unknown	0.25%	0.54%
Model Not Found	12.38%	
Model Missing	36.71%	
Total	**100%**	**100%**

*The results presented above are weighted using the business-level sample weight. These lamps were purchased from 2009 to 2014.

** These data represent 107 sites.

[18] The high share of recently purchased linear technologies without identifiable make and model numbers limits the ability to generalize the information developed from the observed make and model numbers. The market share analysis will not disaggregate the recent purchase information by business type due to the large share of recent purchase information without identifiable efficiency information. The second phase of data collection will attempt to collect make and model numbers at all sites.

Figure 3-28: Efficiency Distribution of Recently Purchased Linear Technologies



*The results presented above are weighted using the business-level sample weight. These lamps were purchased from 2009 to 2014.

** These data represent 107 sites.

Recently Purchased Four Foot Linear Efficiency Distribution by Business Size

Table 3-15 and Table 3-16 present the recent purchase linear technology efficiency distribution by business size. Figure 3-29 illustrates the data presented in Table 3-16. These data indicate that small-sized businesses purchased a higher share of 700 series T8 than medium and large-sized businesses, Medium-sized businesses purchased more 800 series T8 and T5 lamps, while large-sized businesses purchased a large share of High Performance T8 lamps. The small sample sizes for large-sized businesses and the large share of model missing for small-sized businesses limit the ability to generalize these findings to the Massachusetts businesses community by business size. Additional data from the Phase 2 data collection will provide additional information to determine if these findings are generalizable.

Table 3-15: Recent Purchase Linear Efficiency Distribution by Business Size – with Missing Data, Four Foot Lamps

Linear Efficiencies	LT 500,000 kWh	500,000 - 4,500,000 kWh	GT 4,500,000 kWh	Unknown
T12	0.1%	0.0%	0.0%	0.0%
Other	0.0%	0.0%	0.0%	0.0%
700 Series T8	19.1%	1.1%	0.0%	0.0%
800 Series T8	0.0%	30.1%	10.1%	0.0%
High Performance T8	0.0%	0.0%	79.9%	0.0%
Reduced Wattage T8	0.7%	0.4%	0.0%	0.0%
T5	3.9%	47.8%	0.0%	0.3%
LED	0.6%	0.0%	0.0%	0.8%
Unknown	0.5%	0.0%	0.0%	0.0%
Model Not Found	21.5%	12.2%	0.0%	0.1%
Model Missing	53.6%	8.5%	10.1%	98.8%
Total	**100%**	**100%**	**100%**	**100%**

*The results presented above are weighted using the business-level sample weight. These lamps were purchased from 2009 to 2014.

** These data represent 60 small sites, 36 mid-sized sites, 6 large sites and 5 unknown sites.

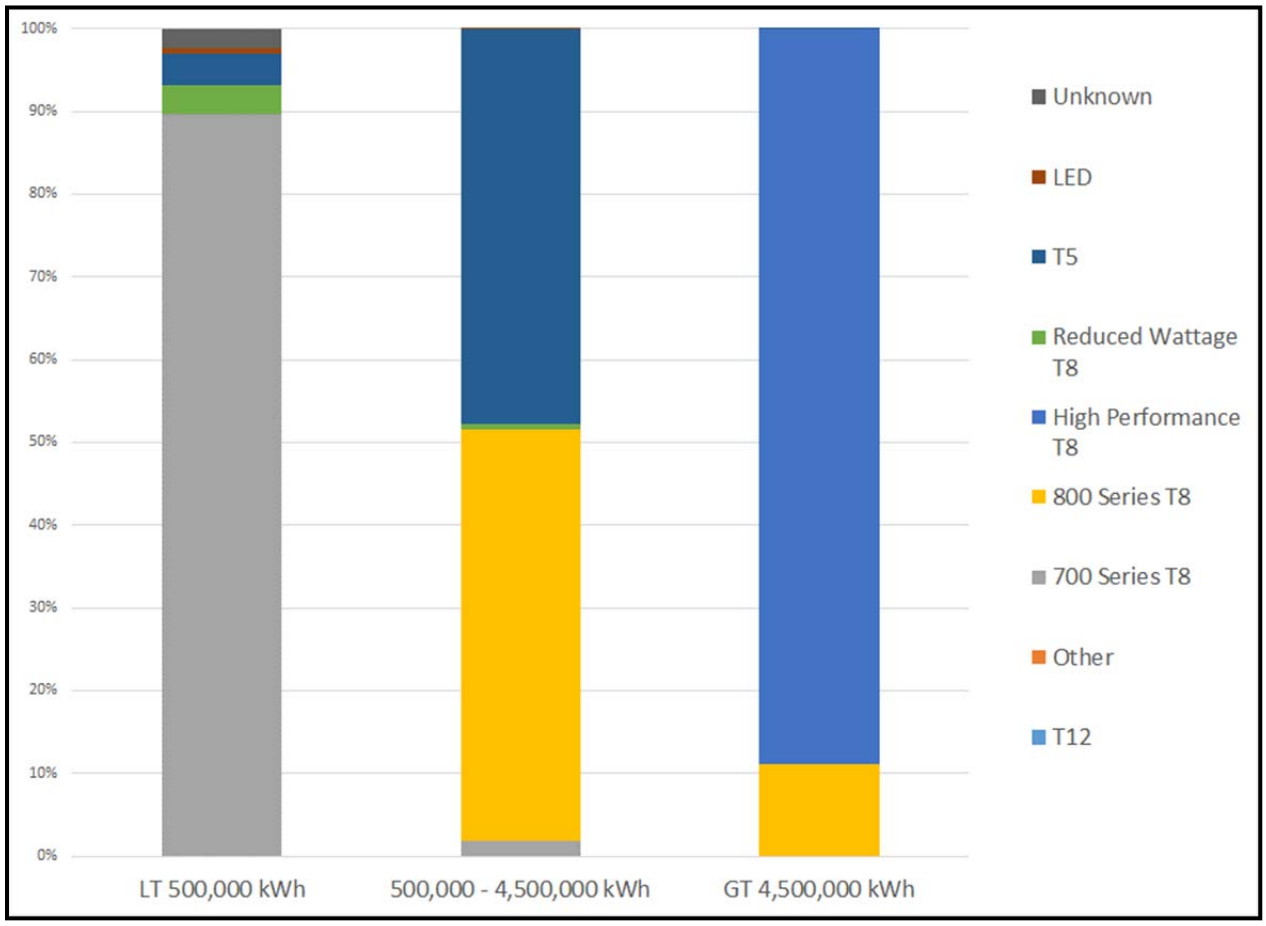
Table 3-16: Recent Purchase Linear Efficiency Distribution by Business Size – with Missing Data Allocated, Four Foot Lamps

Linear Efficiencies	LT 500,000 kWh	500,000 - 4,500,000 kWh	GT 4,500,000 kWh	Unknown
T12	0.1%	0.0%	0.0%	0.0%
Other	0.0%	0.0%	0.0%	0.0%
700 Series T8	89.6%	1.8%	0.0%	0.0%
800 Series T8	0.0%	49.9%	11.2%	0.0%
High Performance T8	0.0%	0.0%	88.8%	0.0%
Reduced Wattage T8	3.4%	0.6%	0.0%	0.0%
T5	3.9%	47.8%	0.0%	0.3%
LED	0.6%	0.0%	0.0%	0.8%
Unknown	2.3%	0.0%	0.0%	0.0%
Total	**100%**	**100%**	**100%**	

*The results presented above are weighted using the business-level sample weight. These lamps were purchased from 2009 to 2014.

** These data represent 60 small sites, 36 mid-sized sites, 6 large sites and 5 unknown sites.

Figure 3-29: Efficiency Distribution of Recently Purchased Linear Technologies by Business Size – with Missing Data Allocated, Four Foot Lamps



*The results presented above are weighted using the business-level sample weight. These lamps were purchased from 2009 to 2014.

** These data represent 60 small sites, 36 mid-sized sites, 6 large sites.

Recently Purchased Four Foot Linear Efficiency Distribution by Energy Efficiency Program Participation

Energy efficiency program participation may be associated with a higher likelihood that the business has recently purchased high efficiency linear technologies. The data collected during Wave 1, however, indicate that businesses participating EE programs from 2011-2013 were less likely to purchase High Performance and Reduced Wattage T8s than non- participants. EE program participants did purchase a higher share of T5 lamps than non-participants. Additional data from the Wave 2 on-site assessments will help verify the accuracy of these results.

The EE program participation flag indicates if the business participated in EE programs from 2011-2013. The EE program participation flag is not specific to lighting or linear fluorescents. The recent purchase data is from 2009-2014. The difference in the length of time covered by the EE participation flag and the recent purchase data may help to explain the findings in

Table 3-17. The lack of specificity in the EE participation flag may also cause this analysis to produce findings indicating that participants purchased less efficient T8 lamps than non-participants. The Final Report will investigate these findings by year and program participation end use if the data are sufficient to support this analysis. The Final Report will also have additional data to help determine if these findings are generalizable.

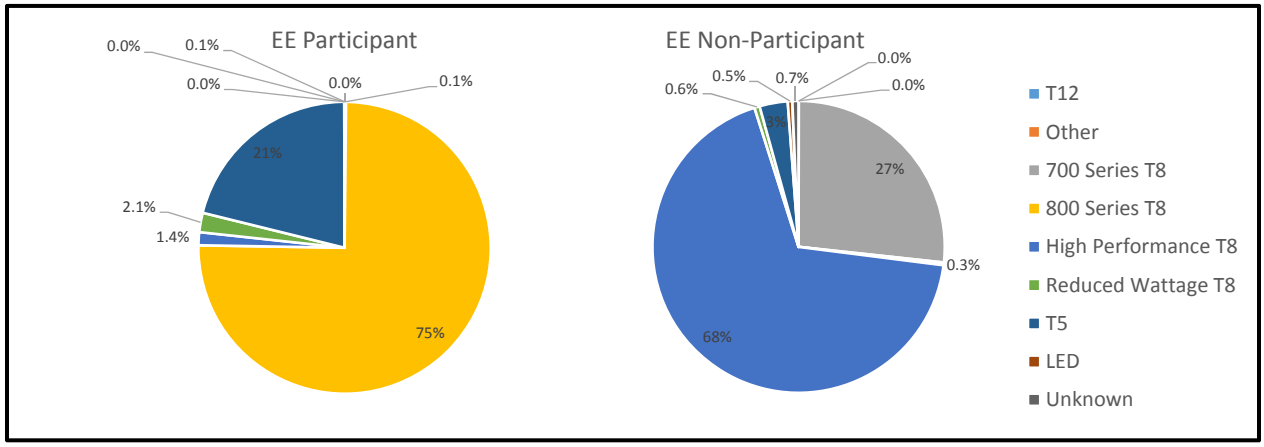
Table 3-17: Recent Purchase Linear Efficiency Distribution by Energy Efficiency Program Participation, Four Foot Lamps

Linear Efficiencies	On-Site Data Percentages, EE Participant	Distribution of Known Performance, EE Participant	On-Site Data Percentages, EE Non-Participant	Distribution of Known Performance, EE Non-Participant
T12	0.1%	0.1%	0.0%	0.0%
Other	0.0%	0.0%	0.0%	0.0%
700 Series T8	0.0%	0.1%	13.5%	26.7%
800 Series T8	24.5%	75.1%	0.2%	0.3%
High Performance T8	0.5%	1.4%	34.5%	68.1%
Reduced Wattage T8	0.7%	2.1%	0.3%	0.6%
T5	21.1%	21.1%	3.1%	3.1%
LED	0.0%	0.0%	0.5%	0.5%
Unknown	0.0%	0.0%	0.3%	0.7%
Model Not Found	5.6%		15.0%	
Model Missing	47.4%		32.5%	
Total	**100%**	**100%**	**100%**	**100%**

*The results presented above are weighted using the business-level sample weight. These lamps were purchased from 2009 to 2014.

** These data represent 44 EE participant sites, and 63 non-participant sites.

Figure 3-30: Recent Purchase Linear Efficiency Distribution by Energy Efficiency Program Participation – with Missing Data Allocated, Four Foot Lamps



*The results presented above have been weighted using the business-level sample weight. These lamps were purchased from 2009 to 2014.

** These data represent 44 EE participant sites, and 63 non-participant sites.

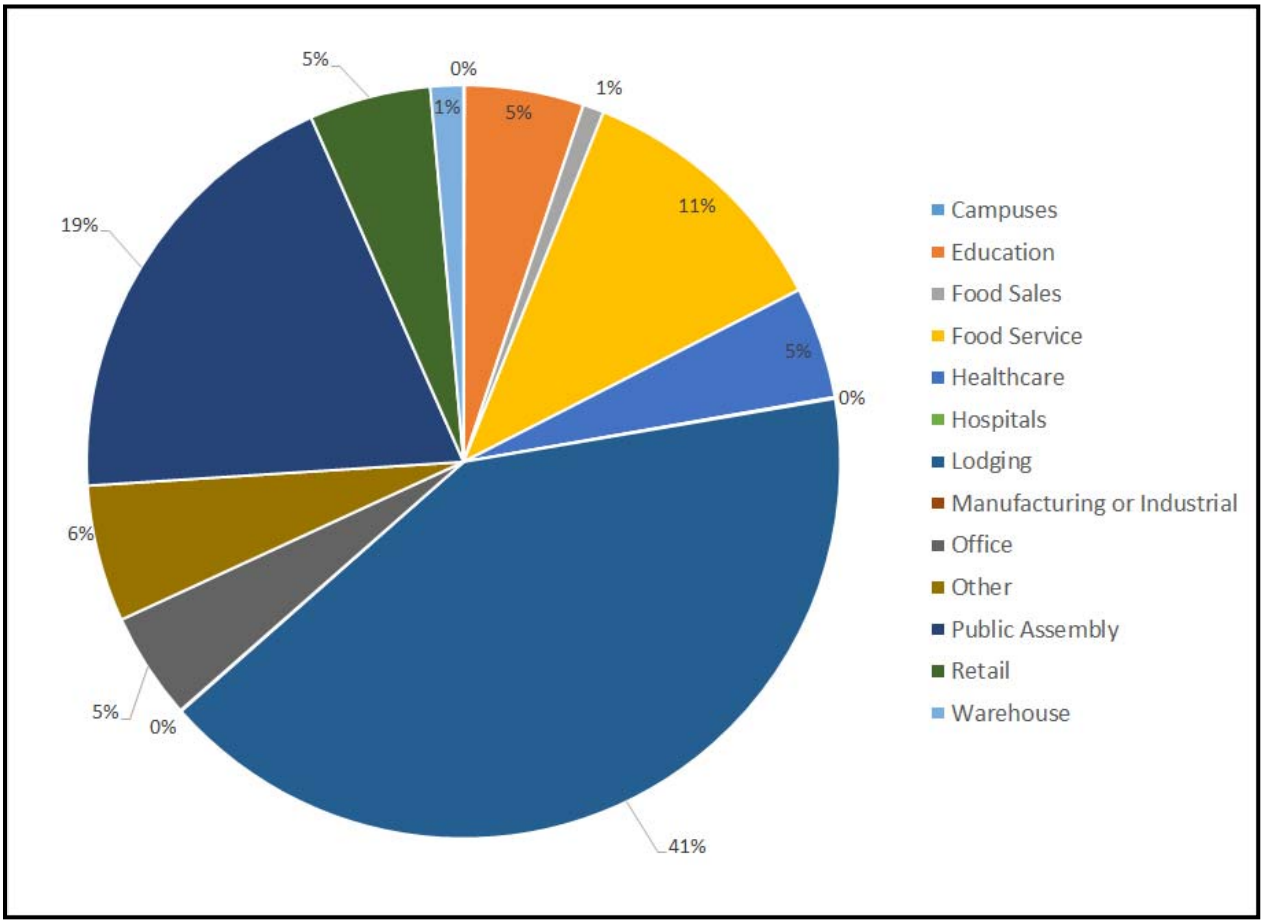
3.3.7 Recent Purchases of ICLH Technologies

The ICLH recent purchase (2009 to 2014) section presents information on recent purchases of incandescent, CFL, LED, and halogen technologies by businesses in Massachusetts. These technologies represent approximately 35% of the lighting technologies used by non-residential customers (Figure 3-4). Given that the ICLH technologies represent a relatively small share of non-residential lighting technologies, the recent purchase information collected Wave 1 does not provide sufficient data to reliably disaggregate by domains of interest. Limited information will be presented in the Interim Report, with more information available in the Final Report.

The ICLH data illustrated in Figure 3-31 indicates that the lodging and public assembly segments have made substantial recent purchases of ICLH lamps. The data illustrated in Figure 3-32 shows that small and medium-sized businesses have purchased a nearly all of the recently purchased ICLH lamps observed during the Wave 1 data collection efforts. Figure 3-33 shows that LED lamps represent most of ICLH recent purchases. The small number of sites found to be purchasing Incandescent lamps during the Phase 1 data was surprising. The additional data collection associated with Phase 2 will help to determine if the recent purchase findings from the interim report are generalizable.

The small sample sizes associated with the recent purchase data for ICLH lamps make the application of these findings to the larger community of Massachusetts businesses questionable. Specifically, many of the business types illustrated in Figure 3-28 have less than 10 sample businesses. Additional data from Phase 2 will help to determine if these findings are generalizable.

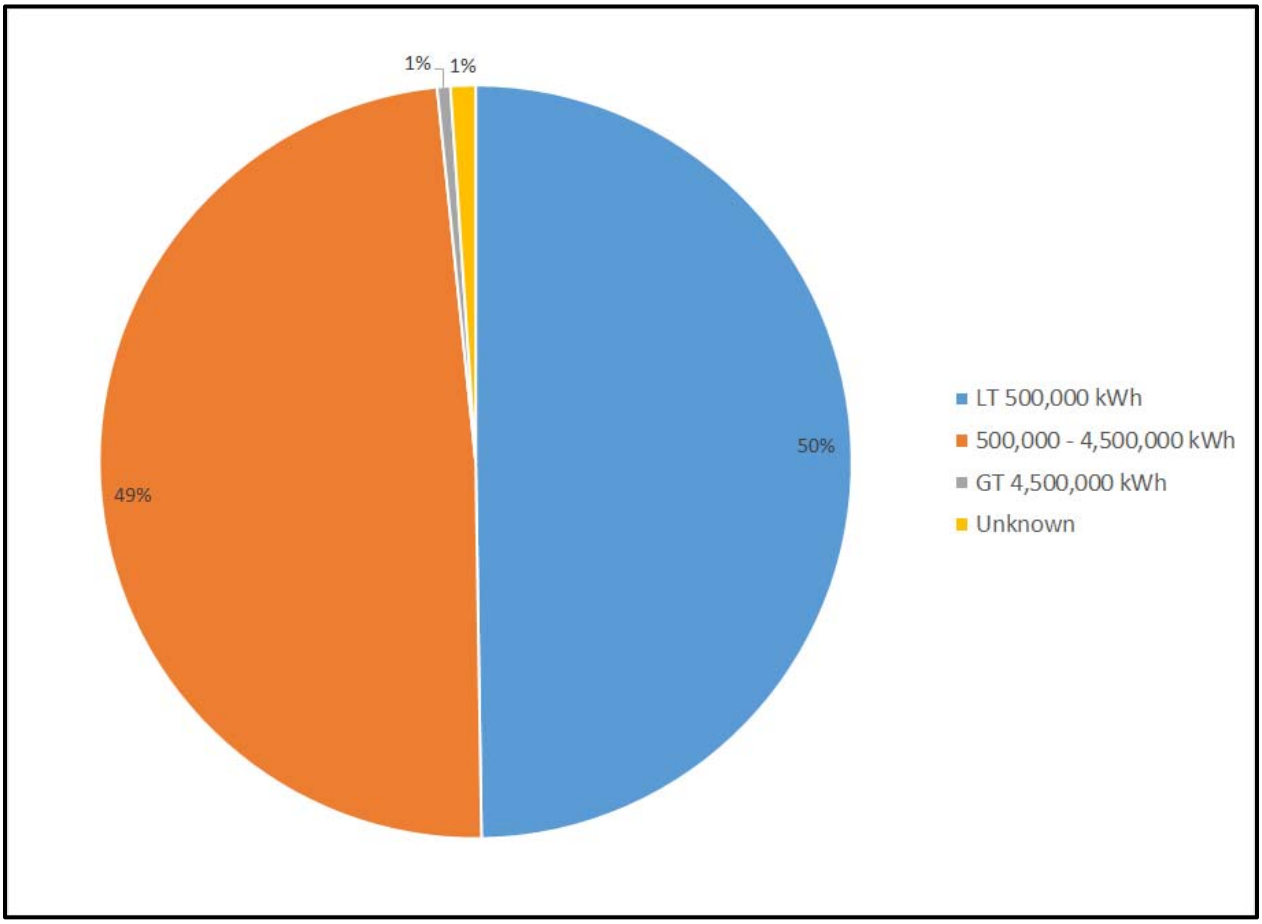
Figure 3-31: Recent Purchase ICLH Distribution by Business Type



*The results presented above are weighted using the business-level sample weight. These lamps were purchased from 2009 to 2014.

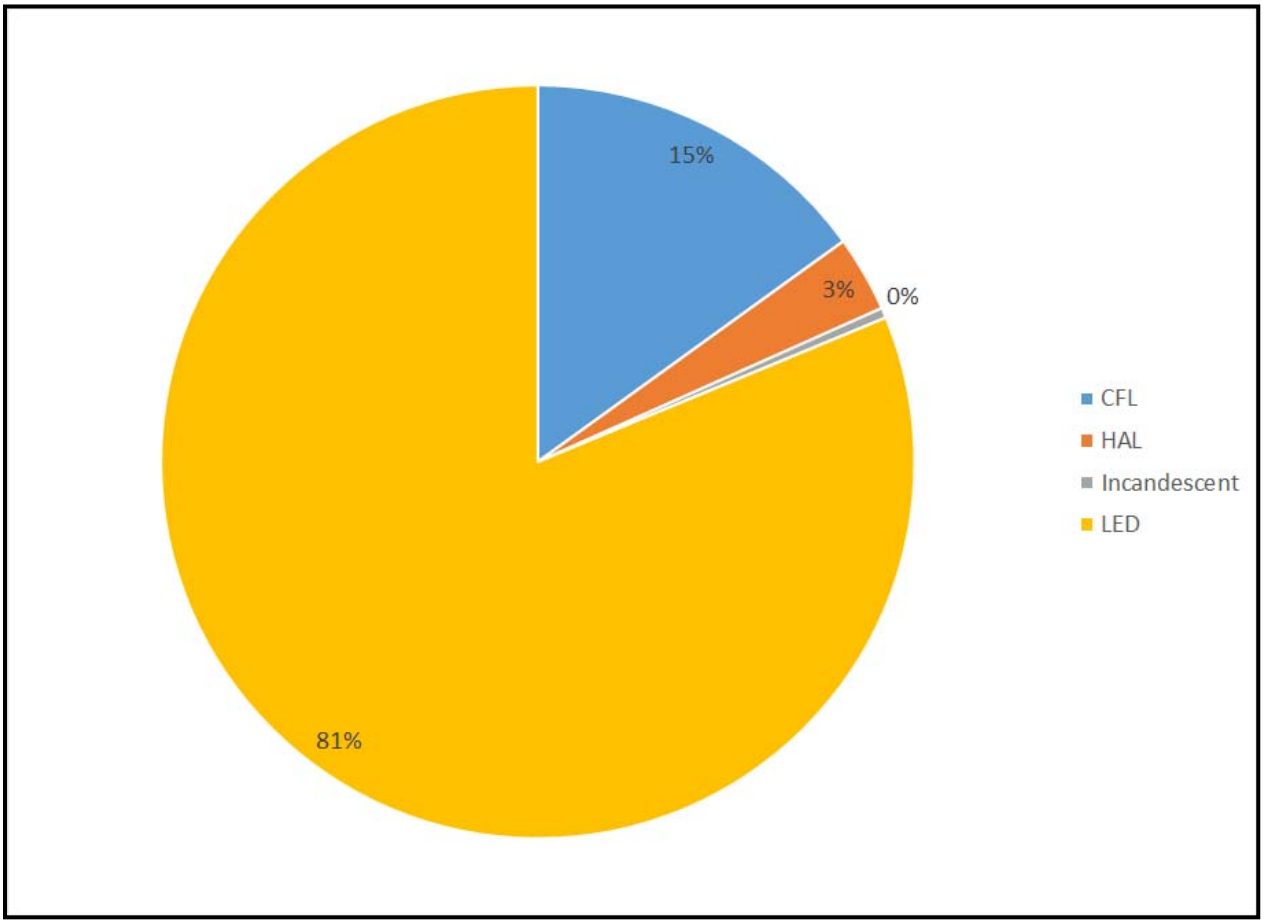
** These data represent 3 sites for campuses, 15 education sites, 10 food sales, 13 food service sites, 7 healthcare sites, 3 hospitals, 14 lodging sites, 5 manufacturing or industrial sites, 17 offices, 8 other businesses, 15 sites for public assembly, 16 retail sites and 5 warehouses.

Figure 3-32: Recent Purchase ICLH Distribution by Business Size



* The results presented above are weighted using the business-level sample weight. These lamps were purchased from 2009 to 2014.
** These data represent 66 small sites, 50 mid-sized sites, 12 arge sites and 3 unknown sites.

Figure 3-33: Recent Purchase Efficiency Distribution of ICLH Lamps



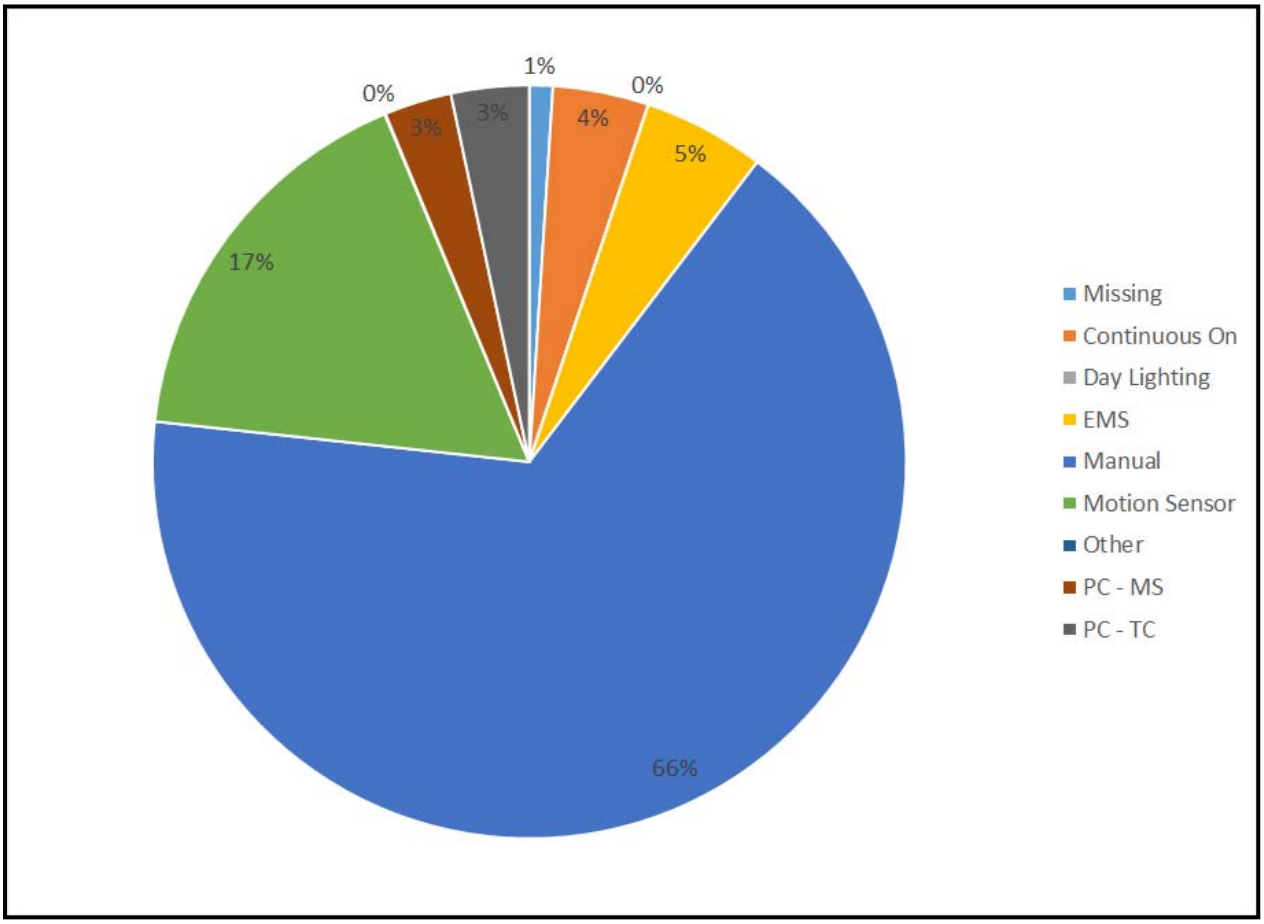
*The results presented above are weighted using the business-level sample weight. These lamps were purchased from 2009 to 2014.
** These data represent 131 sites.

3.3.8 Lighting Controls on Recently Purchased Lighting

During the C&I Customer On-site Assessments we collected information on the type of control used for lighting measures. Types of controls included manual switch, continuous on, EMS, motion sensor, photo cell motion sensor, photo cell time clock, daylighting, and other. For some lighting measures, no information was collected on the type of control.

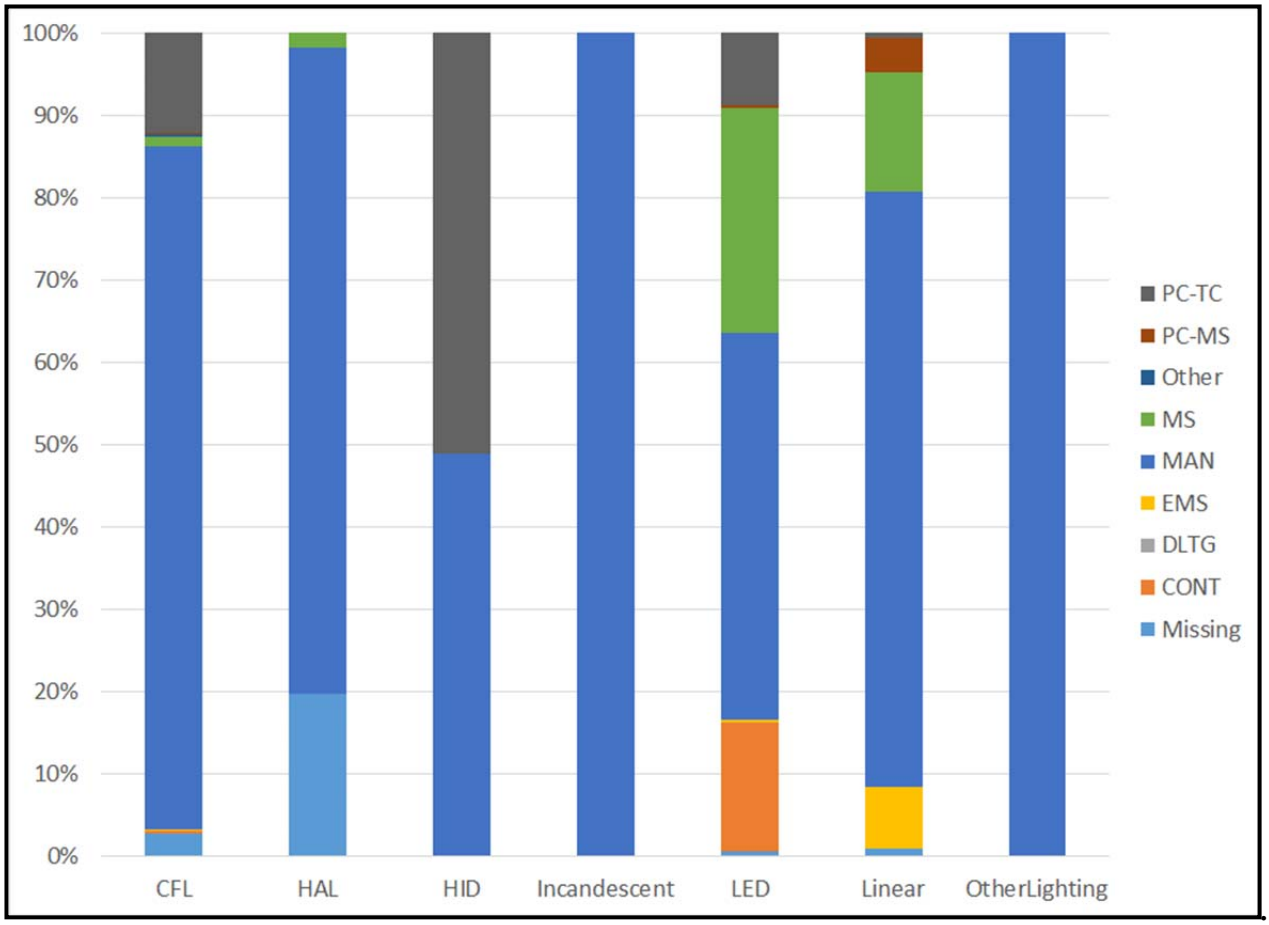
Figure 3-34 displays the distribution of lighting controls across all types of lighting for recently purchased lighting. This graph indicates that the largest share of recently purchased non-residential lighting in Massachusetts (66%) is manually controlled while 28% are controlled by either EMS, motion sensors, PC-motion sensors, or PC-time clock. Figure 3-35 illustrates the distribution of lighting controls on recently purchased lamps for each type of lighting. These data indicate that recently purchased LEDs and HIDs are the least likely to be manually controlled.

Figure 3-34: Share of Recently Purchased Lighting Controlled by Alternative Lighting Controls



*The results presented above are weighted using the business-level sample weight. hese controls were analyzed from lamps purchased from 2009 to 2014.
** These data represent 174 sites.

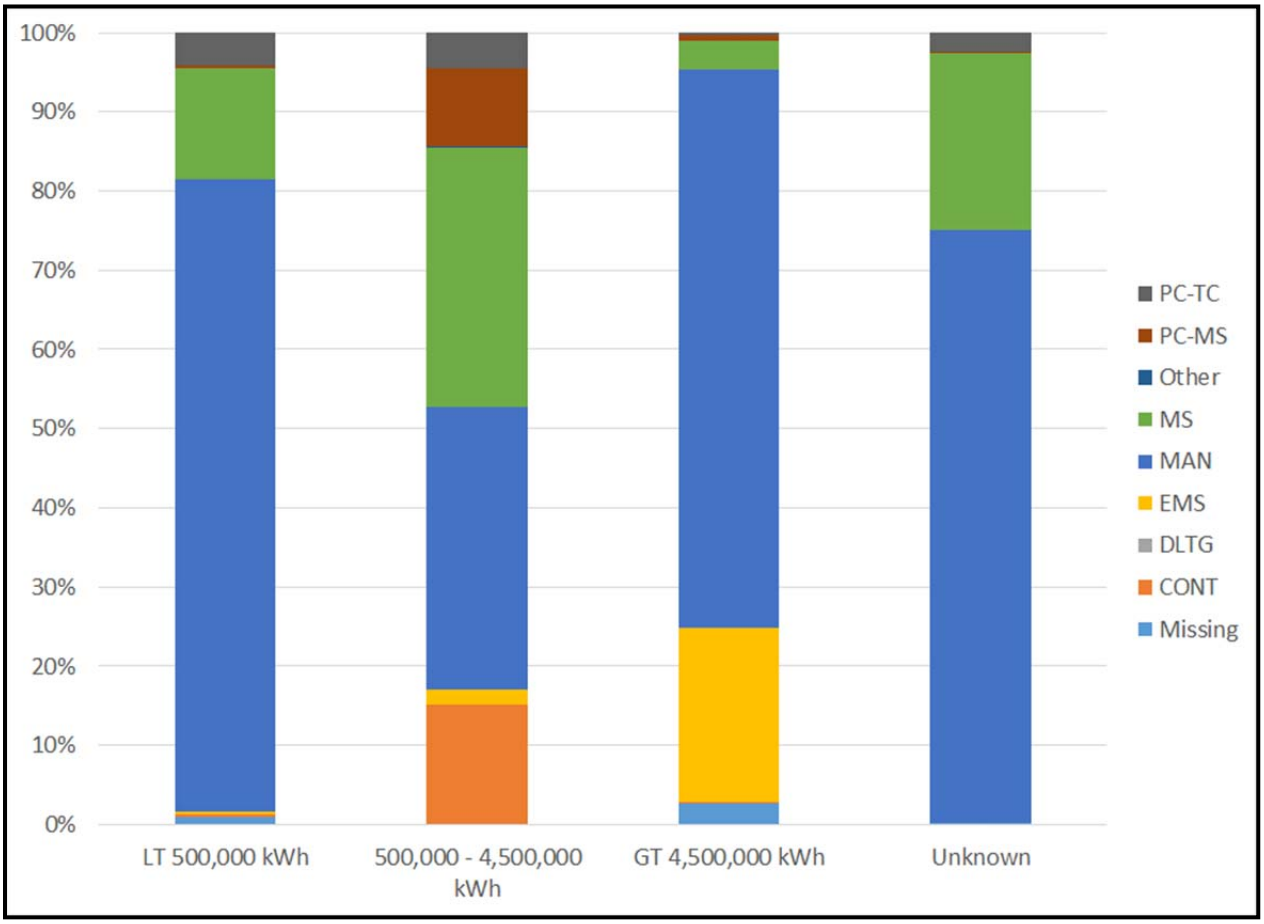
Figure 3-35: Lighting Controls on Recently Purchased Lamps by Lamp Type



*The results presented above are weighted using the business-level sample weight. These controls were analyzed from lamps purchased from 2009 to 2014.
** These data represent 174 sites.

Figure 3-36 illustrates the distribution of lighting controls on recently purchased lighting by business size. For recently purchased lighting, manual control was the most common lighting control for small and large businesses.

Figure 3-36: Lighting Controls on Recently Purchased Lighting by Business Size



*The results presented above are weighted using the business-level sample weight. These controls were analyzed from lamps purchased from 2009 to 2014.
** These data represent 92 small sites, 63 mid-sized sites, 14 large sites and 5 unknown sites

3.4 HVAC

Heating, ventilation, and air conditioning (HVAC) systems represent a significant fraction of energy use and peak demand within the non-residential sector. The C&I Customer On-site Assessment study collected extensive information on HVAC systems. The data collected during these surveys provides information on the existing stock of equipment from which it will be possible to measure progress toward achieving the goal of improved HVAC efficiency in the non-residential sector. This section provides information on HVAC cooling and cooling purchases from 2009 to 2014.This section also provides information about HVAC system maintenance programs, as self-reported by customers during the on-site survey.

3.4.1 HVAC Equipment

Table 3-18 presents Un-weighted information on the number of on-sites completed during Wave 1 data collection efforts by business type. These data indicate that 343 businesses were analyzed for the phase

one interim memo. Cooling information was collected at 295 businesses while 319 businesses provided heating information.[19] The final two columns provide information on the number of businesses by cooling and heating equipment where some make and model information was collected. The make and model information for certain equipment was looked up and analyzed to provide information on the efficiency distribution of these equipment.

Table 3-18: On-sites by Business Type and HVAC Equipment

Business Type	Count of Completed On-site Surveys	Has Cooling Info	Has Heating Info	Has Make and Model Data Collected for Cooling	Has Make and Model Data Collected for Heating
All Businesses	344	295	319	206	185
Campuses	9	8	9	7	3
Education	31	28	31	22	15
Food Sales	25	21	23	15	16
Food Service	31	29	27	16	14
Healthcare	19	18	18	16	11
Hospitals	6	6	6	6	4
Lodging	32	27	30	19	21
Manufacturing or Industrial	23	23	21	17	10
Office	55	51	51	37	28
Other	24	18	21	11	10
Public Assembly	32	26	30	17	23
Retail	44	33	40	17	22
Warehouse	13	7	12	6	8

* The results presented above are un-weighted.

**The counts indicate the number of instances the technology was found in the buildings that were visited.

3.4.2 Cooling Equipment

During the Wave 1 data collection efforts, field staff collected information on the type of cooling equipment. The types of cooling equipment included in the study include the following

- Split System AC
- Spilt System Heat Pump
- Package System AC
- Package System HP

[19] While it is likely that all or nearly all businesses have heating equipment and nearly all businesses have cooling equipment, the on-site surveyor was not granted roof access at some businesses where the HVAC equipment was on the roof.

- Window/Wall
- Mini Split
- PTAC

ChillerFigure 3-37 illustrates the distribution of cooling systems by the number of businesses with a given system. Because a business may have multiple system types, the figure includes combinations of the various systems. The cooling systems illustrated in Figure 3-37 include the following groupings[20]

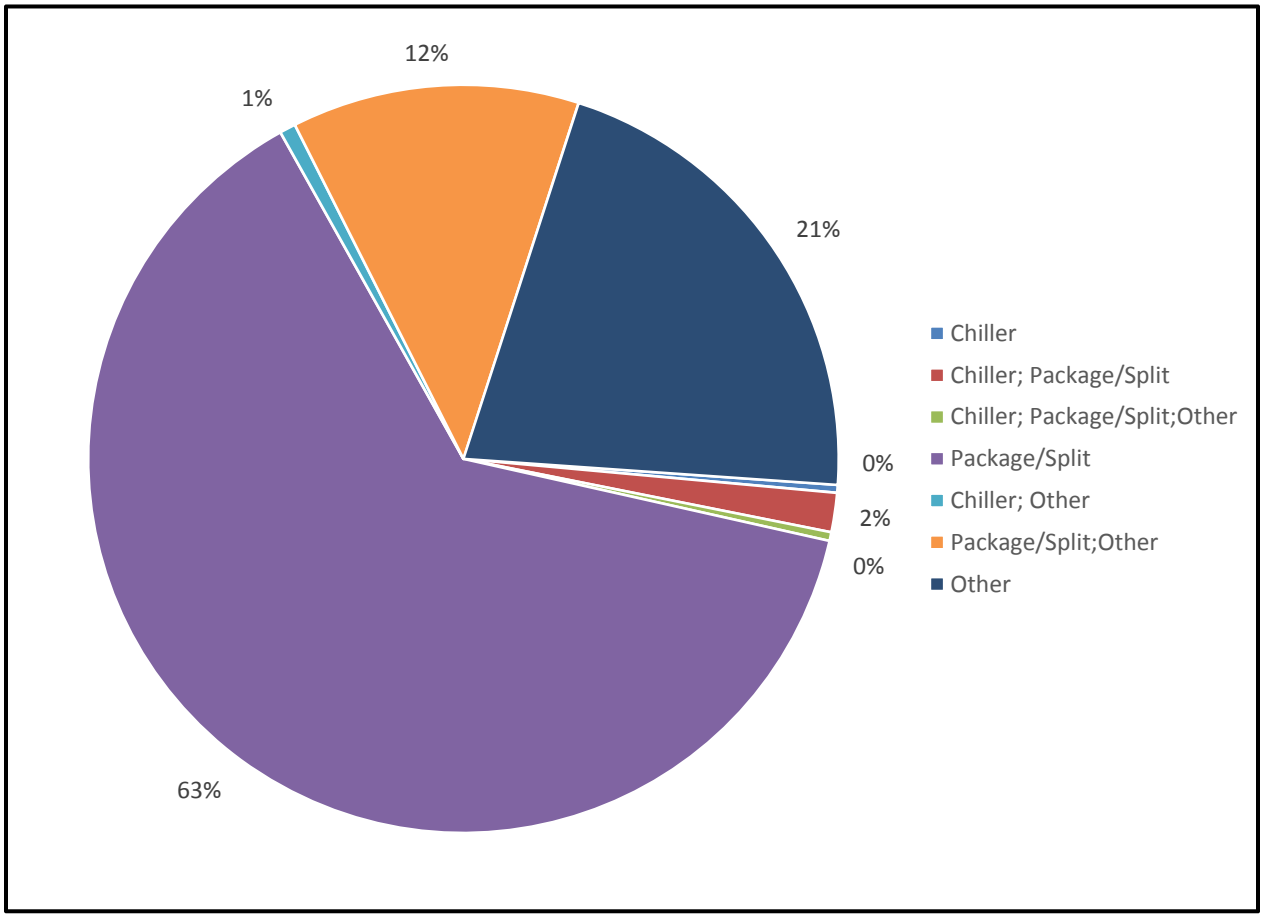
- Package/Split = the business only has packaged and split AC or HP cooling systems
- Chiller = the business only has chillers
- Other = the business has some combination of window/wall, mini split, and PTAC
- Chiller; Package/Split = the business has a combination of Package/Split and Chiller
- Chiller; Other = the business has a combination of Chiller and Other
- Package/Split; Other = the business has a combination of Package/Split and Other
- Chiller; Package/Split; Other = the business has a combination of Chiller, Package/Split, and Other.

The business-level weighted data presented in Figure 3-37 indicate that having only packaged and split systems (63%) is the most common cooling configuration for non-residential customers in Massachusetts. Figure 3-38 illustrates the distribution of businesses with various cooling systems weighted using the kWh-level sample weights instead of with the business-level weights.

Using kWh-level weighting, the most common type of cooling systems for non-residential customers in Massachusetts remains the packaged and split systems (25%). The kWh-level weighting increases considerably the share of businesses with chillers. In Figure 3-37 the share of businesses using chillers as part of their cooling systems is approximately 3% compared to approximately 50% when businesses are kWh weighted in Figure 3-38.

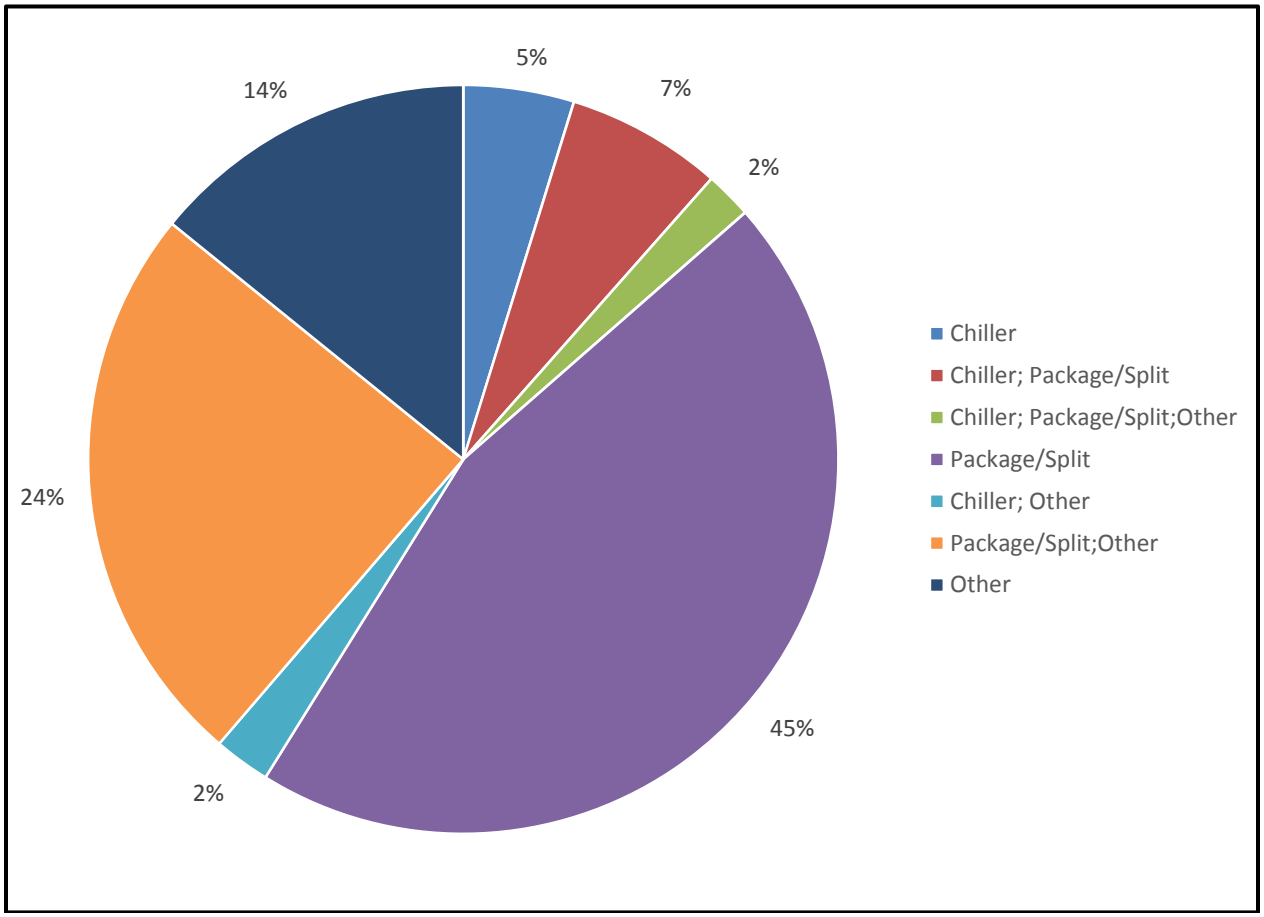
[20] Cooling information was not collected at 48 of the 343 sites in Phase 1. For the analysis of cooling equipment, sites without cooling equipment are dropped from the analysis. Dropping sites is analogous to assuming that sites without recorded cooling equipment actually do have equipment and their cooling equipment is distributed in a way that is consistent with the observed sites.

Figure 3-37: Businesses with Varying Types of HVAC Cooling Equipment



*The results presented above are weighted using the business-level sample weight.
** These data represent 295 sites.

Figure 3-38: Businesses with Varying Types of HVAC Cooling Equipment

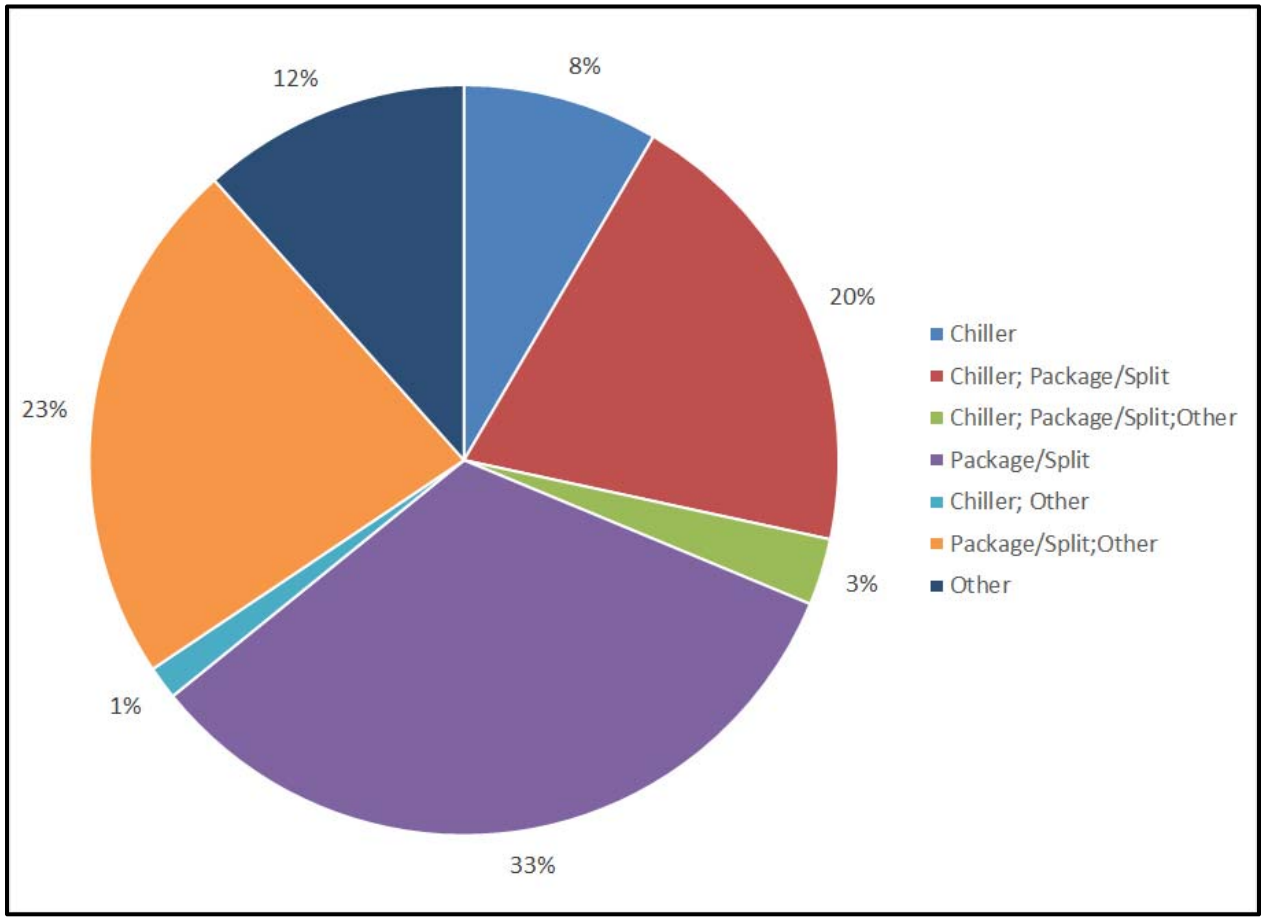


*The results presented above are weighted using the kWh-level sample weight
** These data represent 295 sites.

Figure 3-37 and Figure 3-38 present the distribution of cooling systems by the share of businesses with a given type of system based on business-level and kWh-level weighting. Some types of systems, for example chillers, are designed to provide cooling for a substantially larger floor area than other types of systems (for example PTACs or a packaged or split system). Figure 3-39 presents information on the distribution of cooling system type by the business square footage.

Comparing the findings from Figure 3-37 and Figure 3-38 with those in Figure 3-39, system types with chillers have a larger share of the distribution when the distribution is analyzed by square footage than during the site weighted analysis but a smaller share of the distribution than in the kWh weighted analysis. The square footage distribution implies that approximately 33% of the square footage of businesses in Massachusetts use a chiller (note other HVAC may also be used).

Figure 3-39: Percent of Square Feet with HVAC Cooling Systems

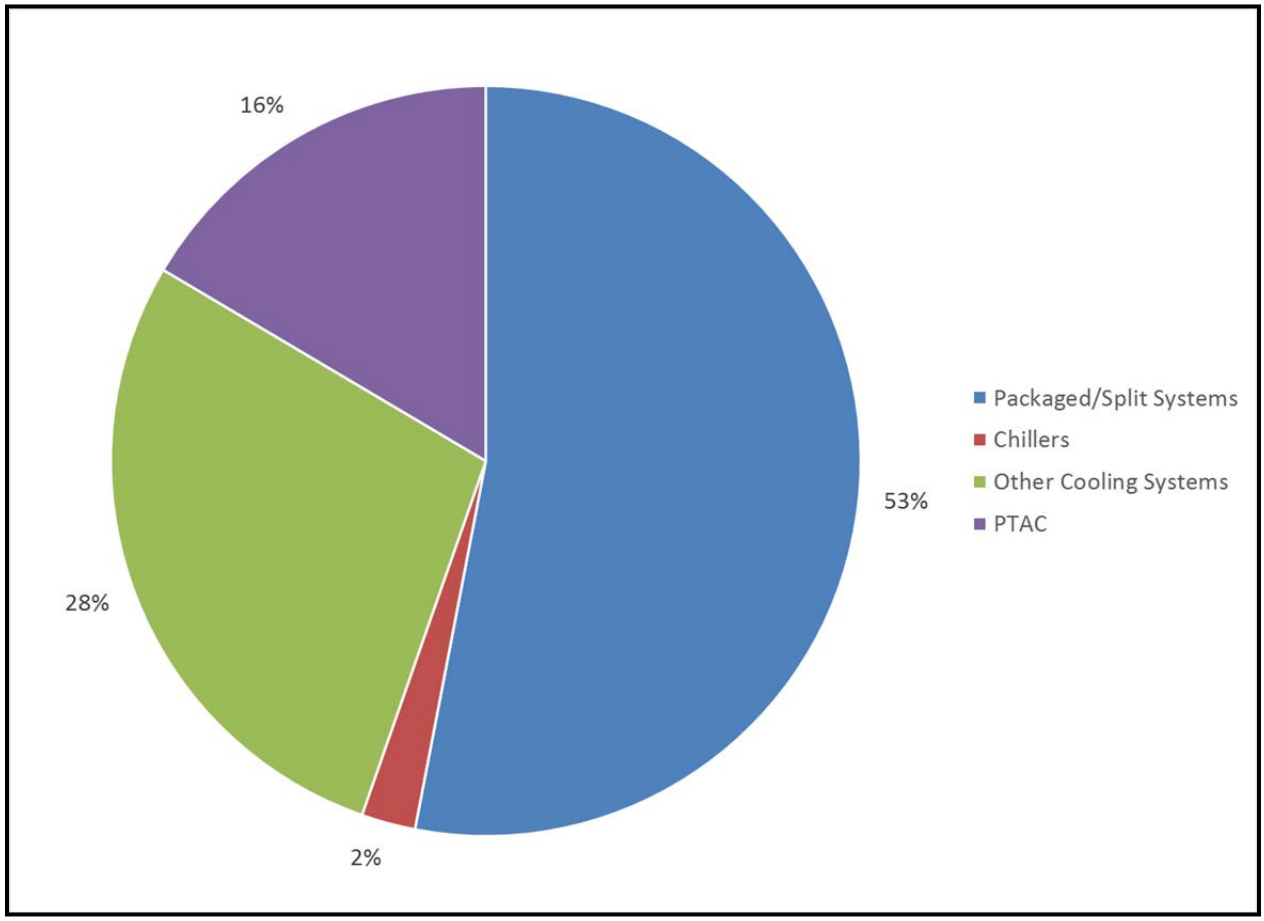


*The results presented above are weighted using the business-level sample weight.
** These data represent 295 sites.

Figure 3-40 presents the distribution of cooling system types by the cooling system unit instead of the business. In this graph, all of the shares describe a single system type. These data indicate that packaged and split systems are the most common system type (53%). For The findings in Figure 3-40 are consistent with the description of cooling system types by businesses when the data is weighted by business type (see Figure 3-37).

When looking at the distribution of cooling system types we found it was not possible to look at the distribution systems by square footage. This is because many times a business' square footage was associated with multiple system types. While field staff did make an attempt to associate HVAC systems with portions of buildings and the estimated square footage of those portions, it is not always clear which units are associated with which areas.

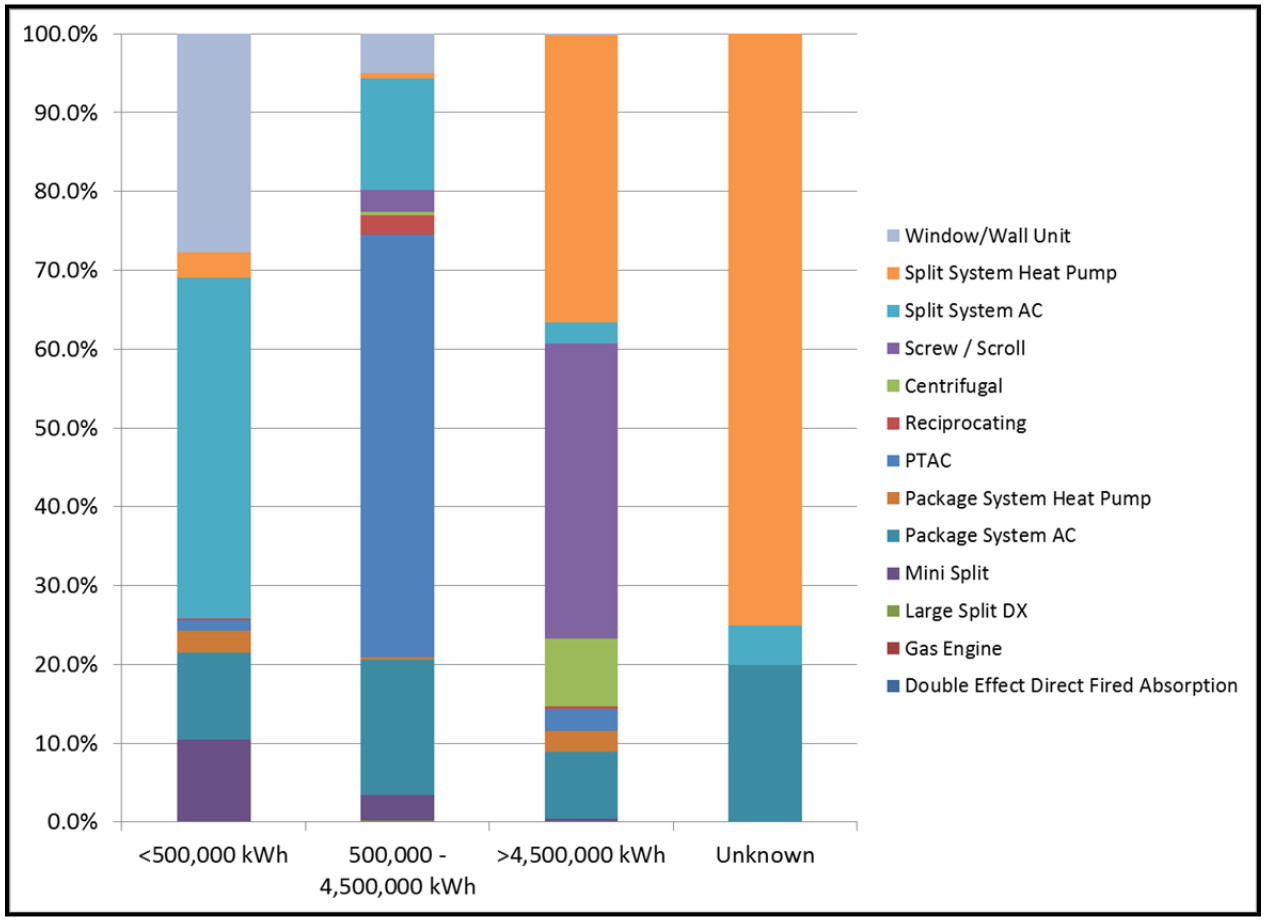
Figure 3-40: Percent of HVAC Cooling Systems by Type



*The results presented above are weighted using the business-level sample weight.
** These data represent 295 sites.
***Heat pumps are included in the packaged/split systems category

Figure 3-41 illustrates the distribution of cooling system type by business kWh size. These data indicate that the distribution of cooling systems differs substantially by the size of the business. The most common type of cooling systems in small-sized businesses is split systems (43%) followed by window/wall units at (28%). For medium-sized businesses PTACs (53%) are the most common cooling system followed by packaged air conditioning (17%). Screw/scroll chillers (37%) are the most common cooling system for large sized businesses followed by split system heat pumps (36%).

Figure 3-41: Percent of HVAC Cooling Systems by Business Size



* The results presented above are weighted using the business-level sample weight.
** These data represent 159 sites <500,000 kWh, 107 sites 500,000 – 4,500,000 kWh, 21 sites > 4,500,000 kWh, and 8 Unknown sites.

The HVAC cooling system type analysis implies that packaged and split cooling systems are the most common in Massachusetts but chillers are associated with a larger kWh and square footage allocation. These findings are consistent with expectations given the larger capacity of chillers while packaged and spilt systems provide flexibility for the cooling of smaller spaces. These findings also highlight the importance of maintaining energy efficiency programs that help move the market for both packaged and split systems and for larger chiller cooling systems.

Air Conditioning and Heat Pump Split and Packaged System Efficiencies

During the on-site data collection process we collected make and model numbers from HVAC equipment where possible. For split and packaged air conditioning and heat pump systems the make and model numbers were looked up to help determine the efficiency of the system. The efficiency rating for these systems depends upon system type and size. The minimum efficiencies for these HVAC units are set by the U.S. Department of Energy, Energy Efficiency and Renewable Energy (EERE). The efficiency for all of the cooling equipment in the analysis are compared to current efficiency standard levels. Comparison to

current standards is necessary because the purchase date of equipment is not available for all units and a comparison to current standards provides information on the energy efficiency savings potential relative to current standards. Table 3-19 lists the federal efficiency standards used to classify systems for this report. Systems with efficiency levels below those listed in Table 3-19 were listed as below standards and systems with efficiencies above those listed were categorized as above standards.[21]

Table 3-19: AC and Heat Pump Efficiency Standards

System Type	System Size	Standard Efficiency	Year of Compliance
Residential AC or Heat Pump	Less than 65 kBtu/h	13 SEER, 11.1-11.5 EER[22]	2008 [23]
Small Commercial AC/HP	65 – 135 kBtu/h	10.8-11.2 EER	2010
Medium Commercial AC/HP	135 - 240 kBtu/h	10.4-11 EER	2010
Large Commercial AC/HP	240+ kBtuh	9.3-10 EER	2010

The make and model lookup process begins with the collection on-site of the cooling systems make and model numbers. For some systems it is not possible to collect this information. The nameplate may be worn off due to age and exposure to the elements or the systems may be positioned in a way that does not allow for data collection. Units whose make and model numbers were not collected on-site are described as "Make/Model Missing" in Figure 3-42.

Once the make and model number is collected these numbers are looked up to determine the efficiency of the units. HVAC make and models are exceptionally hard to decipher as each manufacturer has a different numbering scheme, and every different letter, number, or dash could mean something specific about the HVAC system. The efficiency lookup incorporated specification sheets from manufacturers, web searches, and efficiency data bases for high efficiency units including Energy Star, The Preston Guide, the CEE, and the CEC product list. For many model numbers it was not possible to assign an efficiency rating. Occasionally the model number collected on-site was gathered from the air-handling unit, not the AC unit, the model number may be incomplete, or the equipment was old and efficiency information was no longer available. For many model numbers, searches determined that the model number was accurate but no efficiency information was available. For air conditioning systems where information was provided in the model number field but no efficiency information on the air conditioning unit was found, "Model not Found" is designated in Figure 3-42.

In Figure 3-42 the pies labeled below standards, at standards, and above standards represent the efficiency levels of air conditioning units where efficiency classifications were possible. These data indicate

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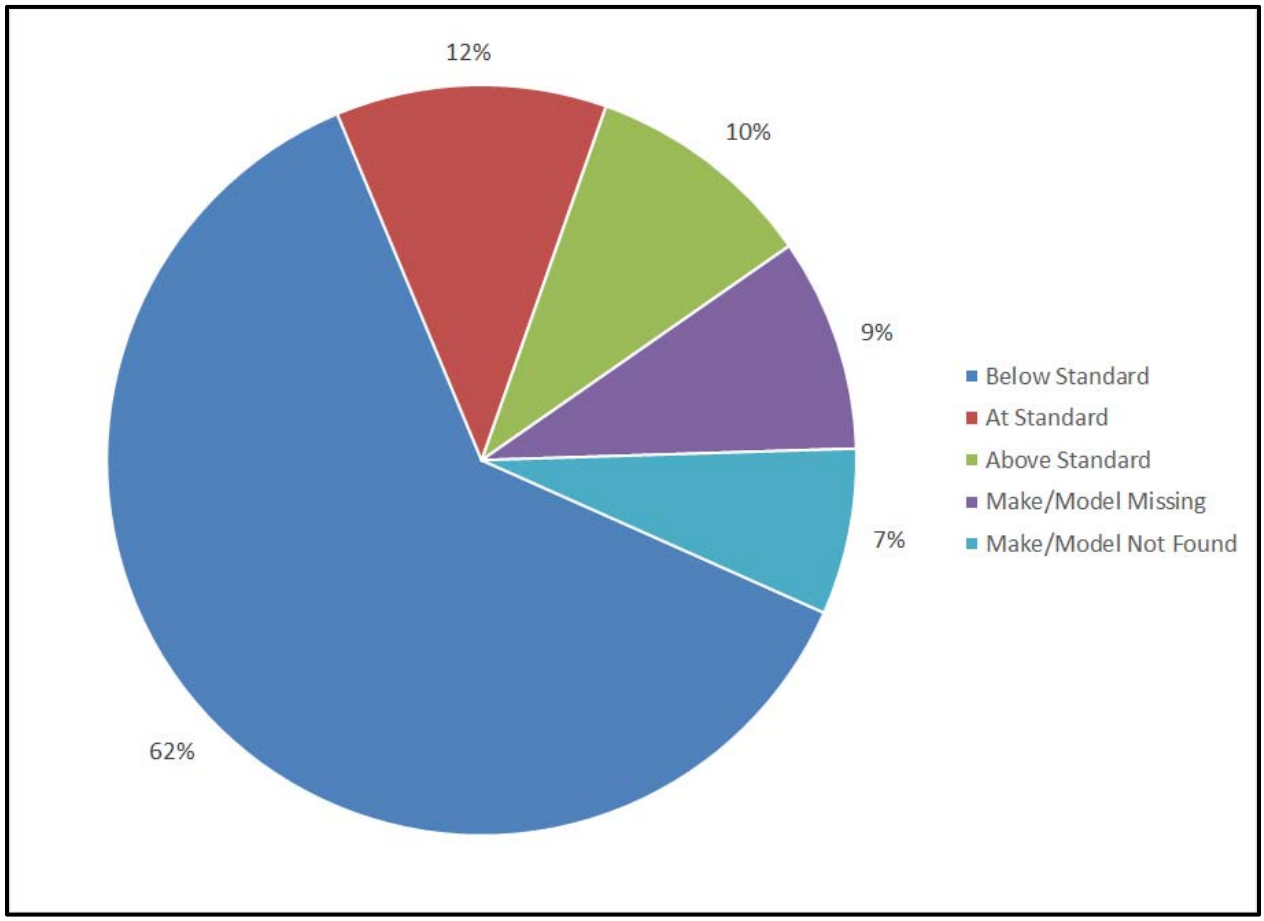
21 The heating standards for heat pumps are listed in the heating section.

22 The efficiency standards for small sized air conditioning units is regulated in SEER. During the make and model lookup process we found several small sized air conditioning units where only EER information was available. Instead of having these units be categorized as model not found, we developed an EER standard for this group. This classification can be adjusted.

23 Standards for split system heat pumps and single packaged AC/HPs are raised to a minimum SEER of 14, effective January 2015.

that the majority of classified air conditioning units in non-residential facilities in Massachusetts are below standards.

Figure 3-42: Air Conditioning Efficiency Ratings for Split/Packaged Systems

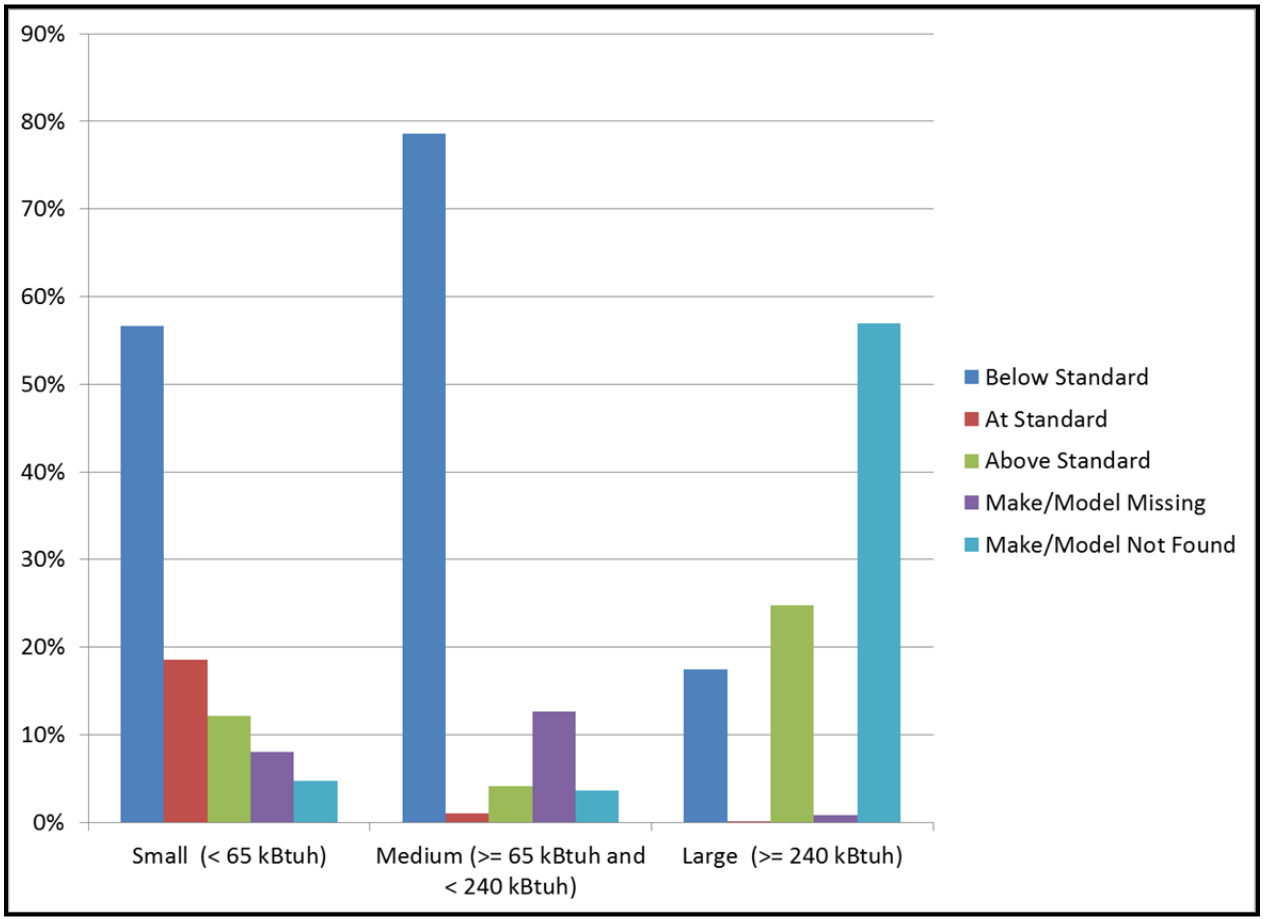


*The results presented above are weighted using the business-level sample weight.
** These data represent 183 sites.

Figure 3-43 illustrates the efficiency rating of split and packaged air conditioning systems by system size. For the interim memo, the systems are grouped into Small (less than 65 kBtu/h – residential systems from Table 3-19), medium (65-24 kBtu/h or small and medium commercial from Table 3-19), and large (240+ kBtu/h). These data indicate that most small and medium-sized units have data that allowed for the specification of the efficiency level and that the efficiency level was not found for many large sized units.[24] For medium and small-sized systems, the most common efficiency level was below standard with 79% of medium-sized and 57% of small-sized units below standards.

[24] The inability to describe the efficiency for large-sized units is largely due to the small sample size associated with large units and a few of the unidentified systems having large weights. The collection of additional data within Phase II will lead to a better understanding of the current efficiency of larger cooling systems.

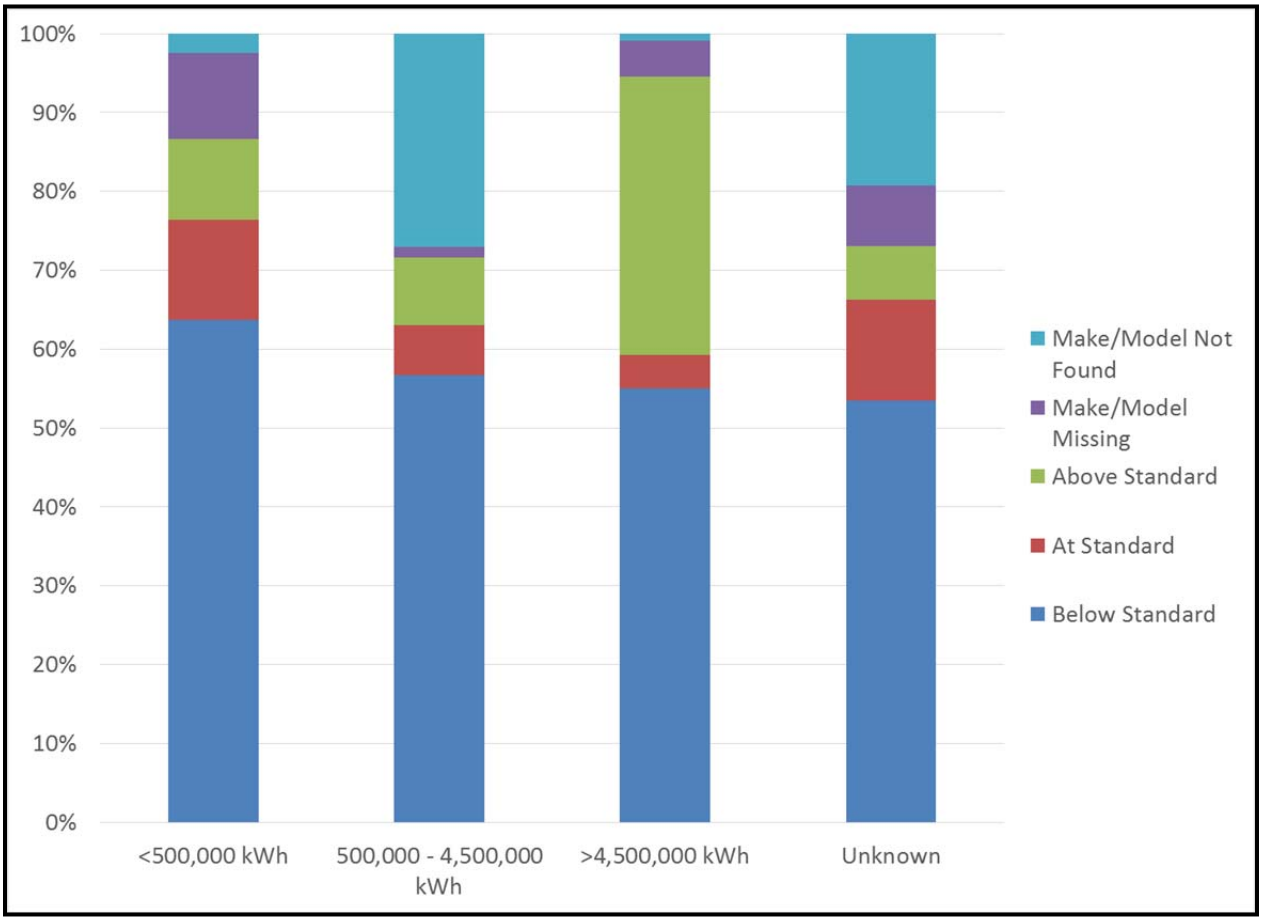
Figure 3-43: Air Conditioning Efficiency Ratings by System Size



*The results presented above are weighted using the business-level sample weight.
** These data represent 143 small sites, 33 medium sites, and 7 large sites.

Figure 3-44 illustrates air conditioning efficiency distributions by business kWh size.

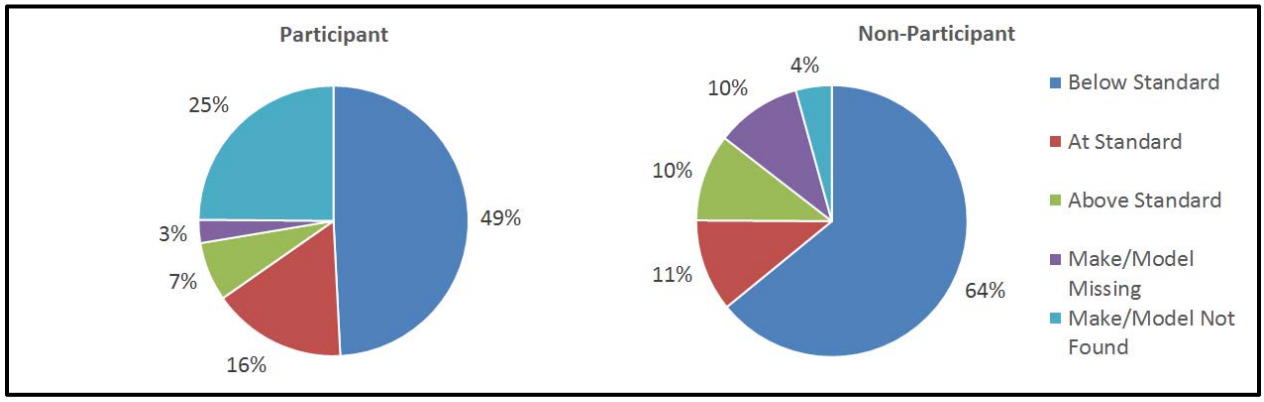
Figure 3-44: Air Conditioning Efficiency Ratings by Business Size



*The results presented above are weighted using the business-level sample weight.
** These data represent 85 sites <500,000 kWh, 77 sites 500,000 – 4,500,000 kWh, 15 sites > 4,500,000 kWh, and 6 Unknown sites.

Figure 3-45 illustrates the efficiency distribution of air conditioning systems by energy efficiency participation. Energy efficiency participants were businesses that had participated in an energy efficiency program during the 2011-2013 period. The upstream records in the tracking database are not associated with an account number so upstream participants are not reflected in the program participants rates. Given the differential share of data for "Model Missing" and "Model Not Found", it is difficult to determine the relationship between program participation and cooling efficiency levels.

Figure 3-45: Efficiency Ratings by EE Participation, Non-Participants



*The results presented above are weighted using the business-level sample weight.
** These data represent 121 non-participant sites and 62 participant sites.

3.4.3 Recent HVAC Cooling Purchases

HVAC Cooling

Table 3-20 lists the number of completed on-sites, the number of sites where cooling system data was collected on-site, the number of sites where newly purchased cooling equipment was recorded and the number of sites were make and model numbers were collected for newly purchased cooling equipment.

Table 3-20: Number of Business Surveyed, Cooling Systems, and Recent Cooling System Purchases

Business Type	Count of Completed On-site Surveys	Has Cooling Information	Has New Cooling Equipment	Has Make and Model Data Collected for Cooling
All Businesses	344	295	106	79
Campuses	9	8	6	4
Education	31	28	11	8
Food Sales	25	21	7	6
Food Service	31	29	9	7
Healthcare	19	18	8	8
Hospitals	6	6	4	1
Lodging	32	27	8	6
Manufacturing or Industrial	23	23	10	8
Office	55	51	18	14
Other	24	18	5	3
Public Assembly	32	26	10	5
Retail	44	33	7	6
Warehouse	13	7	3	3

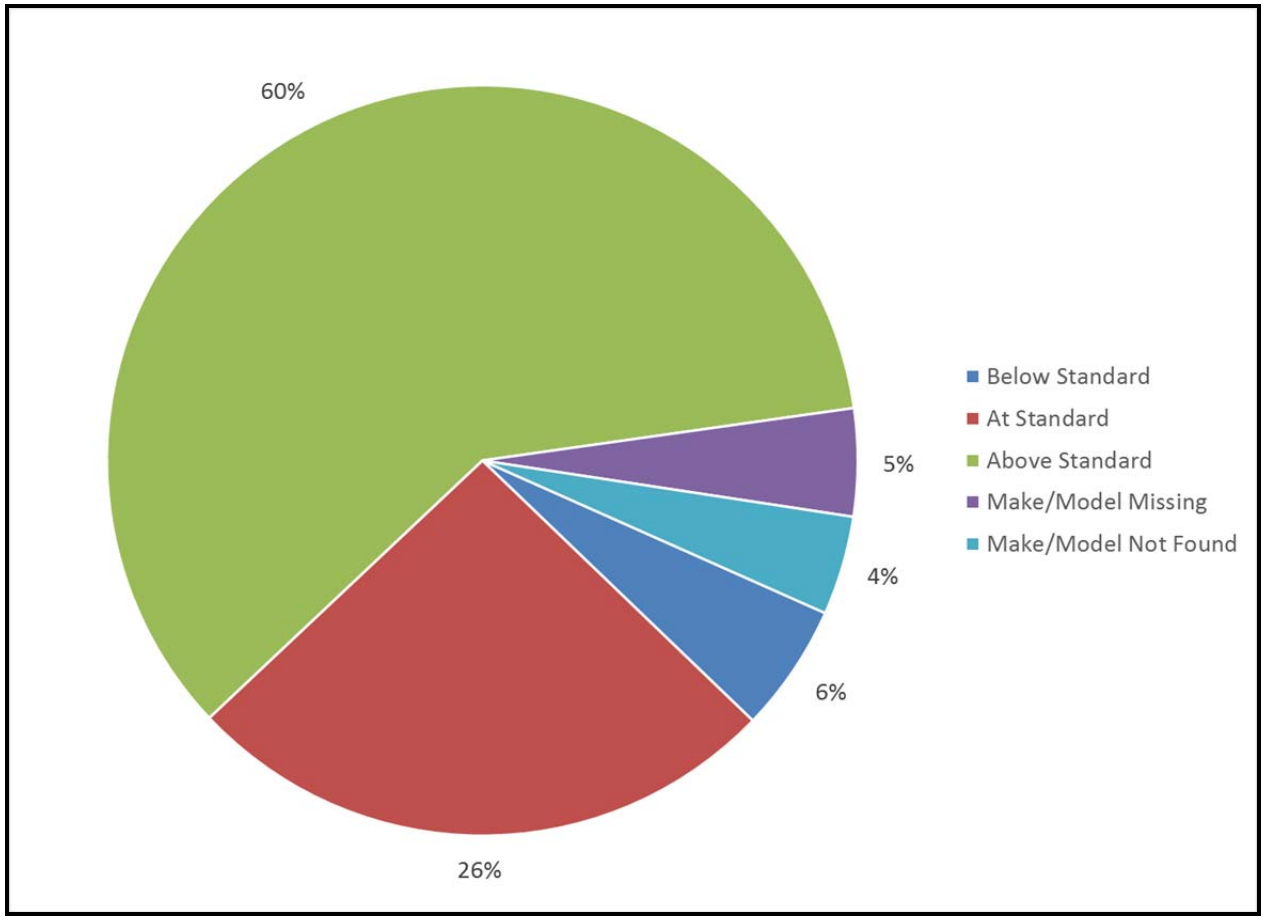
* The results presented above are Un-weighted.

**The counts indicate the number of instances the technology was found in the buildings that were visited.

Recent Purchases for HVAC Split and Packaged Systems

The data collected during the C&I Customer On-site Assessments study allows for the identification of recent purchases and the lookup of make and model numbers to determine the efficiency distribution of recent purchases. Figure 3-46 illustrates the efficiency distribution for recently purchased split and packaged cooling systems. The standards efficiency rating information for these systems is provided in Table 3-19. The data presented in Figure 3-46 indicates that only 6% of recent purchases were found to be below current standards while 60% of recent purchases exceeded current standards.

Figure 3-46: Efficiency Ratings for Recently Purchased Split/Packaged Systems

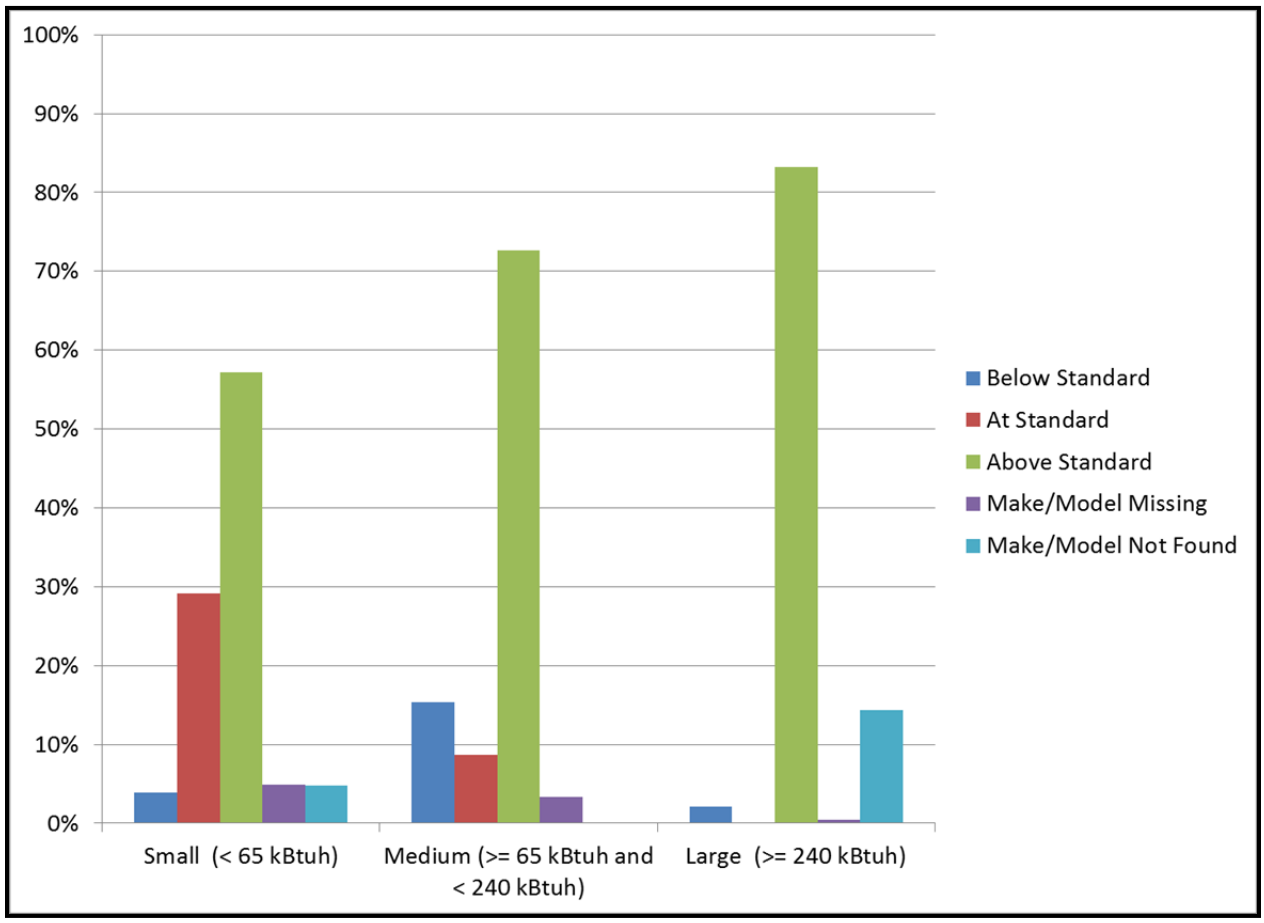


* The results presented above are weighted using the business-level sample weight.

** These data represent 60 sites.

Figure 3-47 illustrates the distribution of efficiency for recently purchased split and packaged systems by system size. These data indicate that large-sized systems had the largest share of recently purchased systems above standards but all three system sizes have over 50% of recent purchases above current standards.

Figure 3-47: Efficiency Ratings for Recently Purchased Split and Packaged Systems by System Size

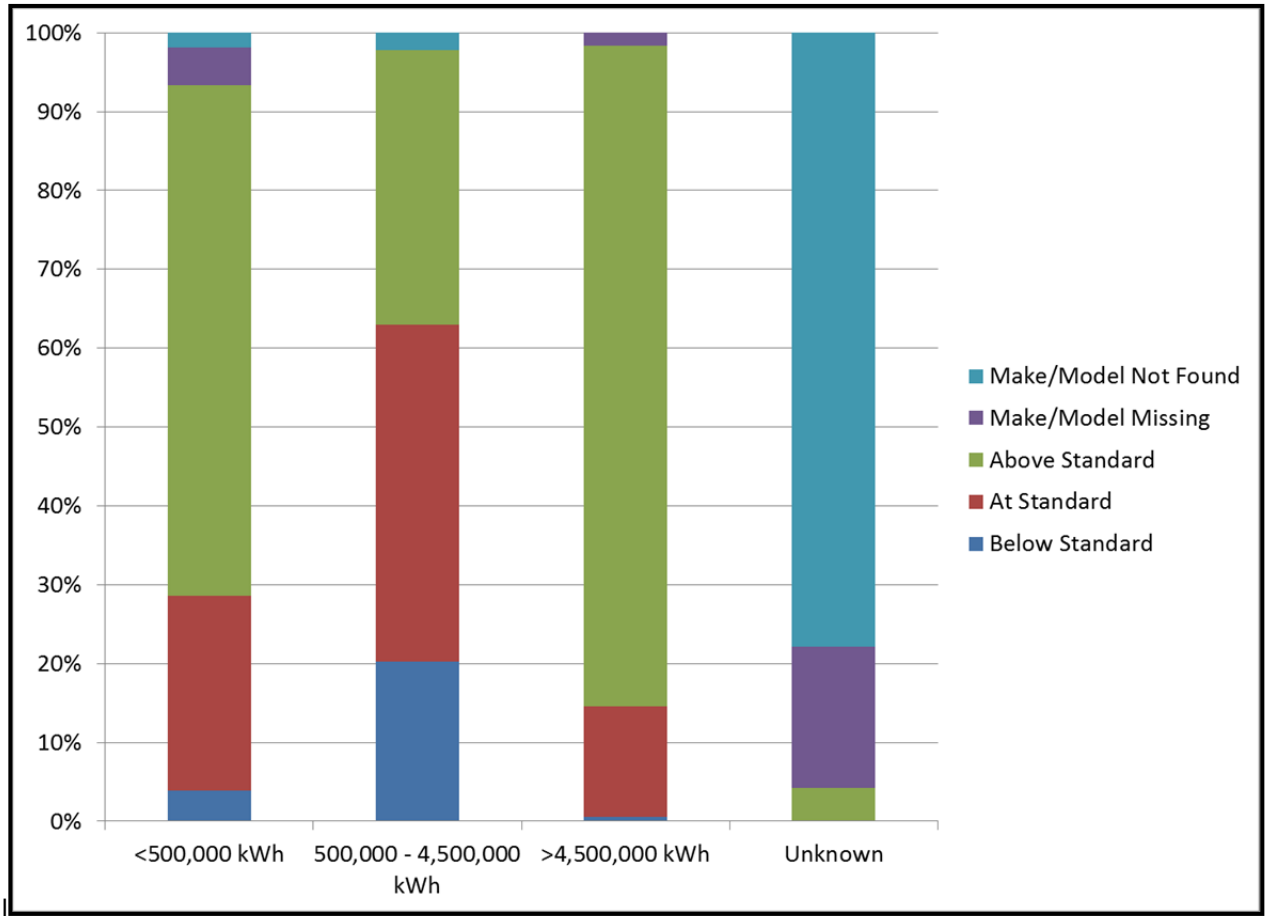


* The results presented above are weighted using the business-level sample weight.

** These data represent 41 small sites, 14 medium sites, and 5 large sites.

Figure 3-48 illustrates the efficiency distribution for recently purchased split and packaged cooling systems by business size. These data indicate that medium-sized businesses have the largest share of below standards recent purchases. The largest share of recently purchased equipment for small and large sized businesses are above standards.

Figure 3-48: Efficiency Ratings for Recently Purchased Split and Packaged Systems by Business Size



* The results presented above are weighted using the business-level sample weight.

** These data represent 24 sites < 500,000 kWh, 25 sites 500,000 – 4,500,000 kWh, 9 sites > 4,500,000 kWh, and 2 Unknown sites.

3.4.4 Heating Equipment

The C&I Customer On-site Assessments study collected information on the type of heating equipment in the business and the type of fuel used by the heating equipment. Types of heating equipment analyzed in the Study include

- Split Forced Air Furnaces
- Packaged Furnaces
- Air Source Heat Pumps
- Packaged Air Source Heat Pumps
- Geothermal Heat Pumps
- Water Source Heat Pumps
- Baseboard Heaters
- PTAC

- Window/Wall Units
- Unit Heaters
- Space Heaters

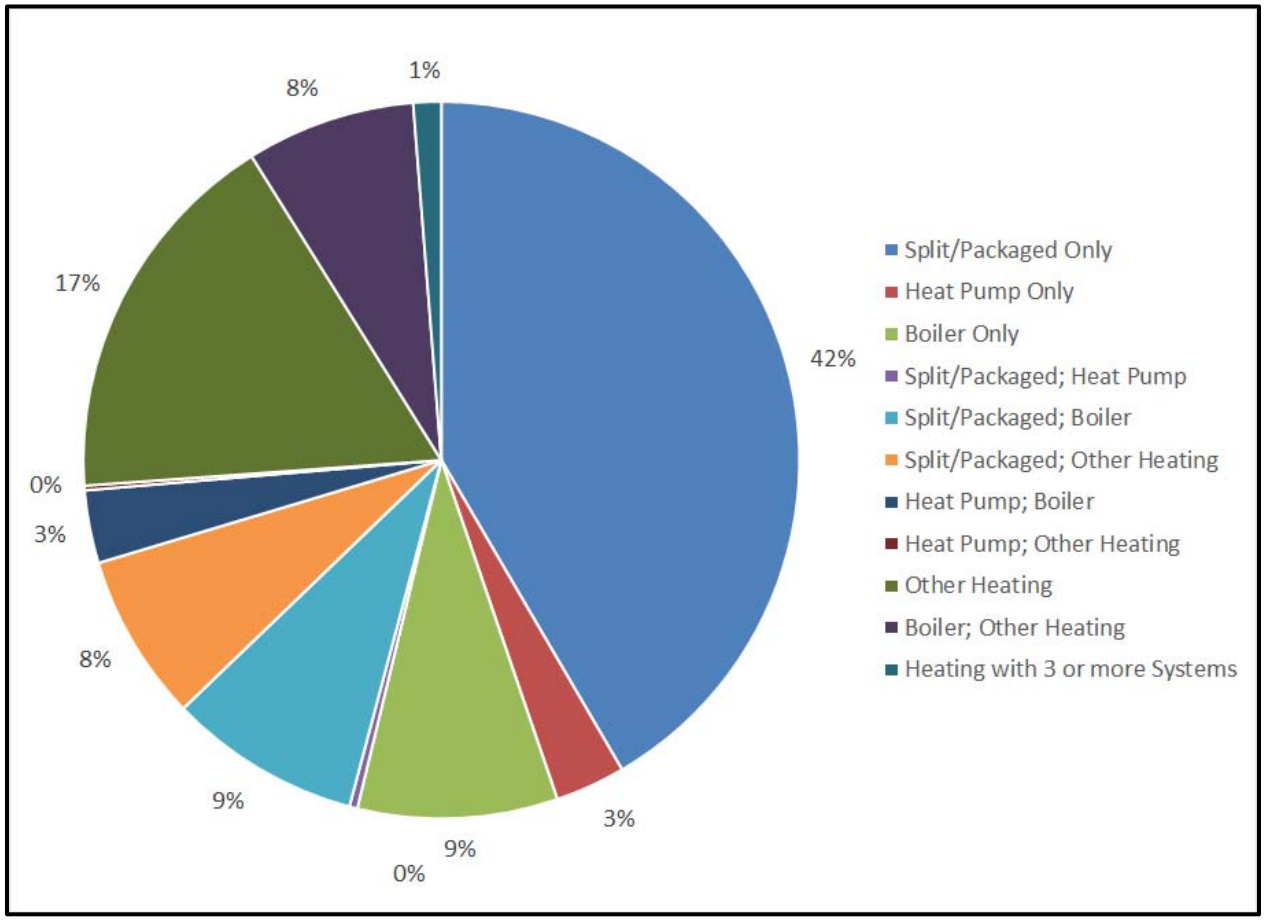
BoilersFigure 3-62 illustrates the distribution of heating systems by the number of businesses with a given system. Because a business may have multiple system types, the figure includes combinations of the various systems. The heating systems illustrated in Figure 3-49 include the following groupings[25]

- Package/Split = the business only has packaged and split heating systems
- Heat Pumps = the business only has heat pumps
- Boiler = the business only has boilers
- Other = the business has some combination of baseboard heating, PTAC, window/wall, unit heating, and space heating
- Package/Split; Heat Pump = the business has a combination of Package/Split and Heat Pumps
- Package/Split; Boiler = the business has a combination of Package/Split and Boilers
- Package/Split; Other = the business has a combination of Package/Split and Other
- Heat Pump; Boiler = the business has a combination of Heat Pump and Boiler
- Heat Pump; Other = the business has a combination of Heat Pump and Other
- Boiler; Other = the business has a combination of Boiler and Other.
- Heating with 3 or more systems = the business has a combination of at least 3 system types

The business-level weighted data presented in Figure 3-49 indicate that having only packaged and split systems (41.5%) is the most common heating configuration for non-residential customers in Massachusetts. Figure 3-50 illustrates the distribution of businesses with various heating systems weighted using the kWh-level weights instead of with the business-level sample weights. Using kWh weighting, the most common type of heating systems for non-residential customers in Massachusetts remains the packaged and split systems (23%). The kWh weighting increases the share of businesses with boilers from 29% to 52% and decreased the share of businesses with spilt and packaged systems combined with other systems from 58% to 34%.

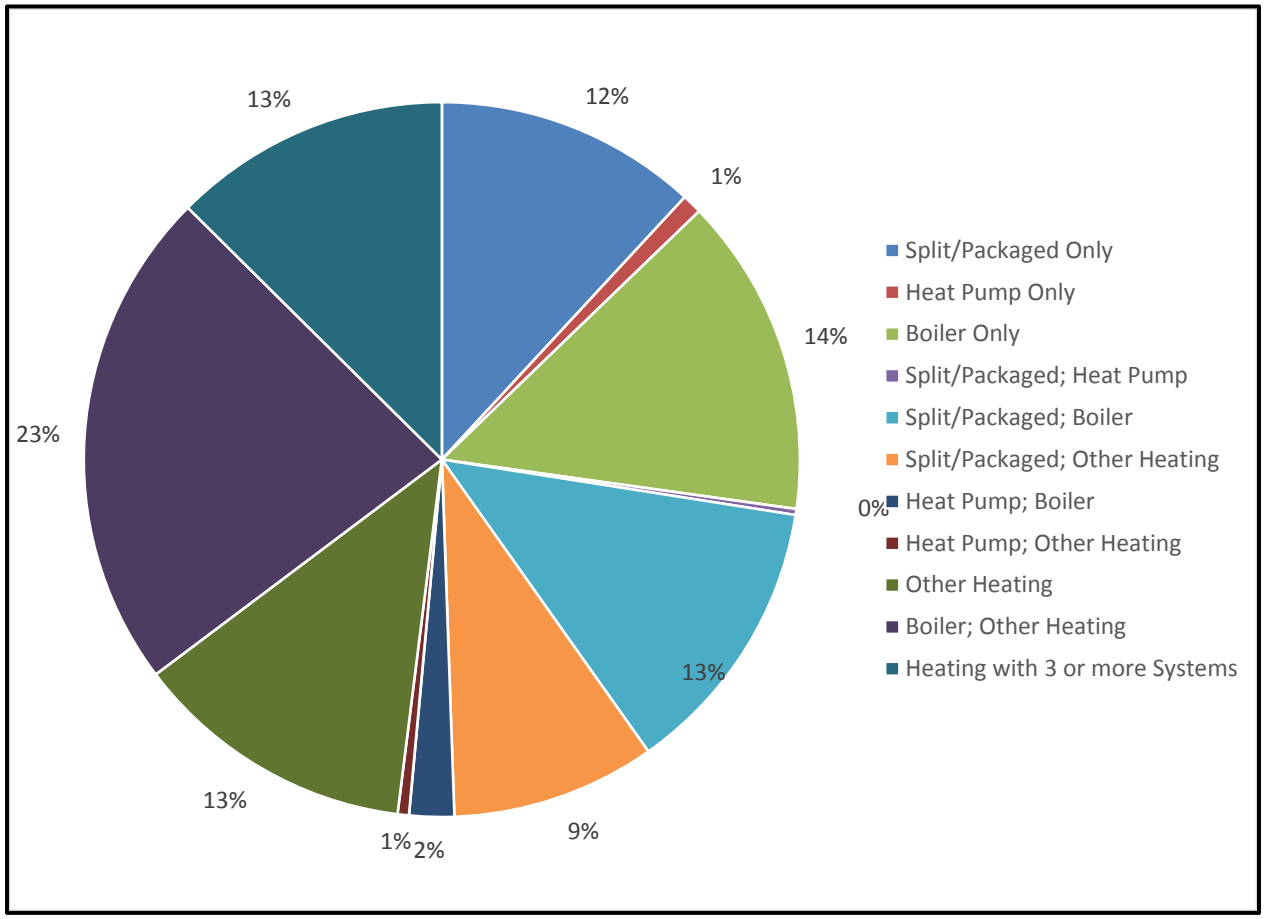
[25] The Phase 1 on-site survey collected heating information from 318 of 343 sites. For the heating analysis, sites with no heating information were dropped from the analysis. Dropping sites with no heating information is analogous to assuming that all of the sites without heating information actually have heating systems and these systems are distributed consistent with those sites where information was collected.

Figure 3-49 Businesses with Varying Types of HVAC Heating Equipment



*The results presented above are weighted using the business-level sample weight.
** These data represent 318 sites.

Figure 3-50: Businesses with Varying Types of HVAC Heating Equipment

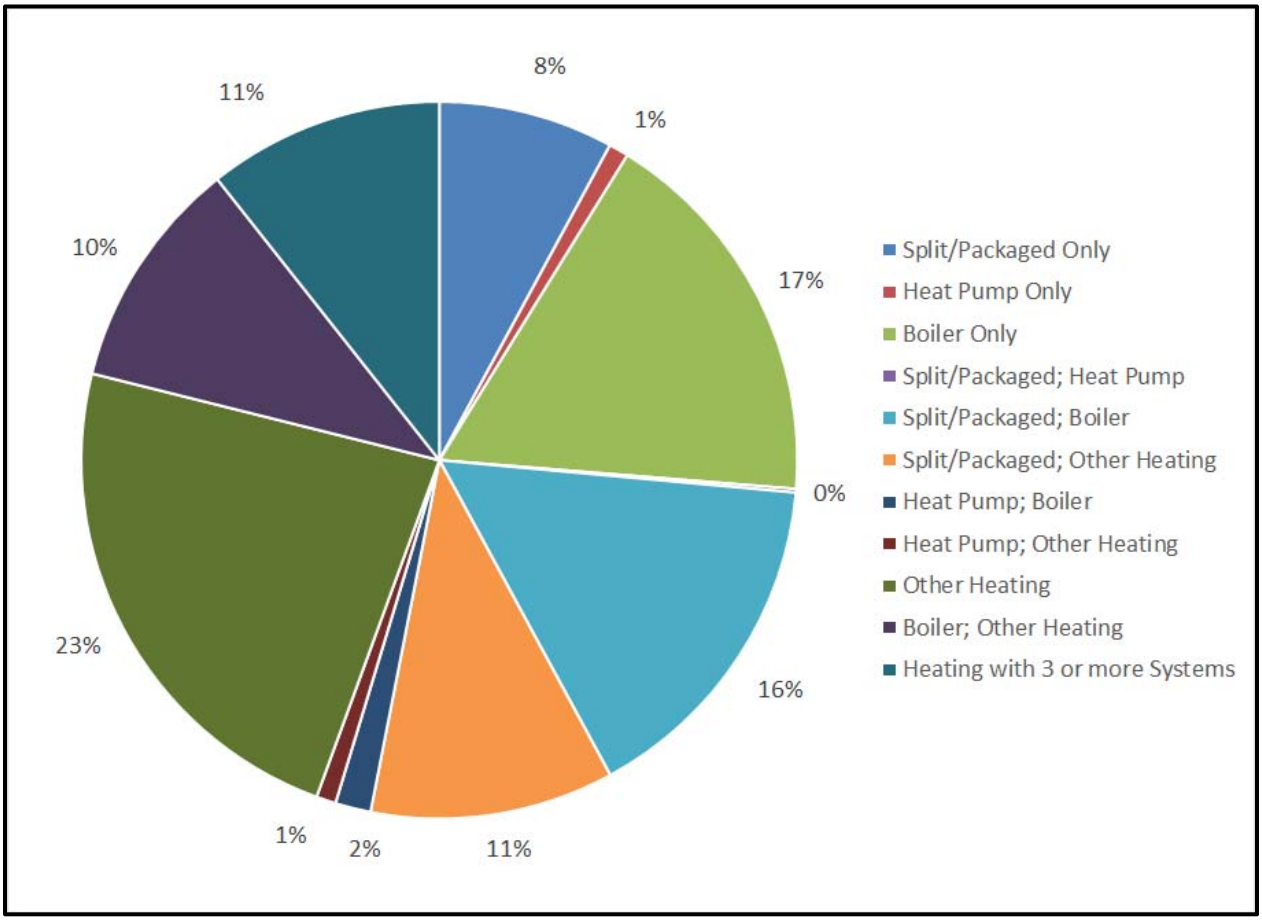


*The results presented above are weighted using the kWh-level sample weight
** These data represent 318 sites.

Figure 3-49 and Figure 3-50 present the distribution of heating systems by the share of businesses with a given type of system based on business-level and kWh-level weighting. Some types of systems are designed to provide heating for a substantially larger floor area than other types of systems. Figure 3-51 presents information on the distribution of heating system type by the business square footage. Comparing the findings from Figure 3-49 and Figure 3-50 with those in Figure 3-51, system types with boilers are included in approximately 29% of the respondent weighted systems, 52% of the kWh weighted systems, and 44% of the square footage weighted systems. These data imply that approximately 44% of the square footage of businesses in Massachusetts and 52% of the business kWh use a boiler as one source of their heating (note other HVAC may also be used).[26]

[26] While weighting heating systems by the businesses kWh consumption may appear odd, the kWh weighting and respondent weight provides a consistent weighting scheme for the EBMC study.

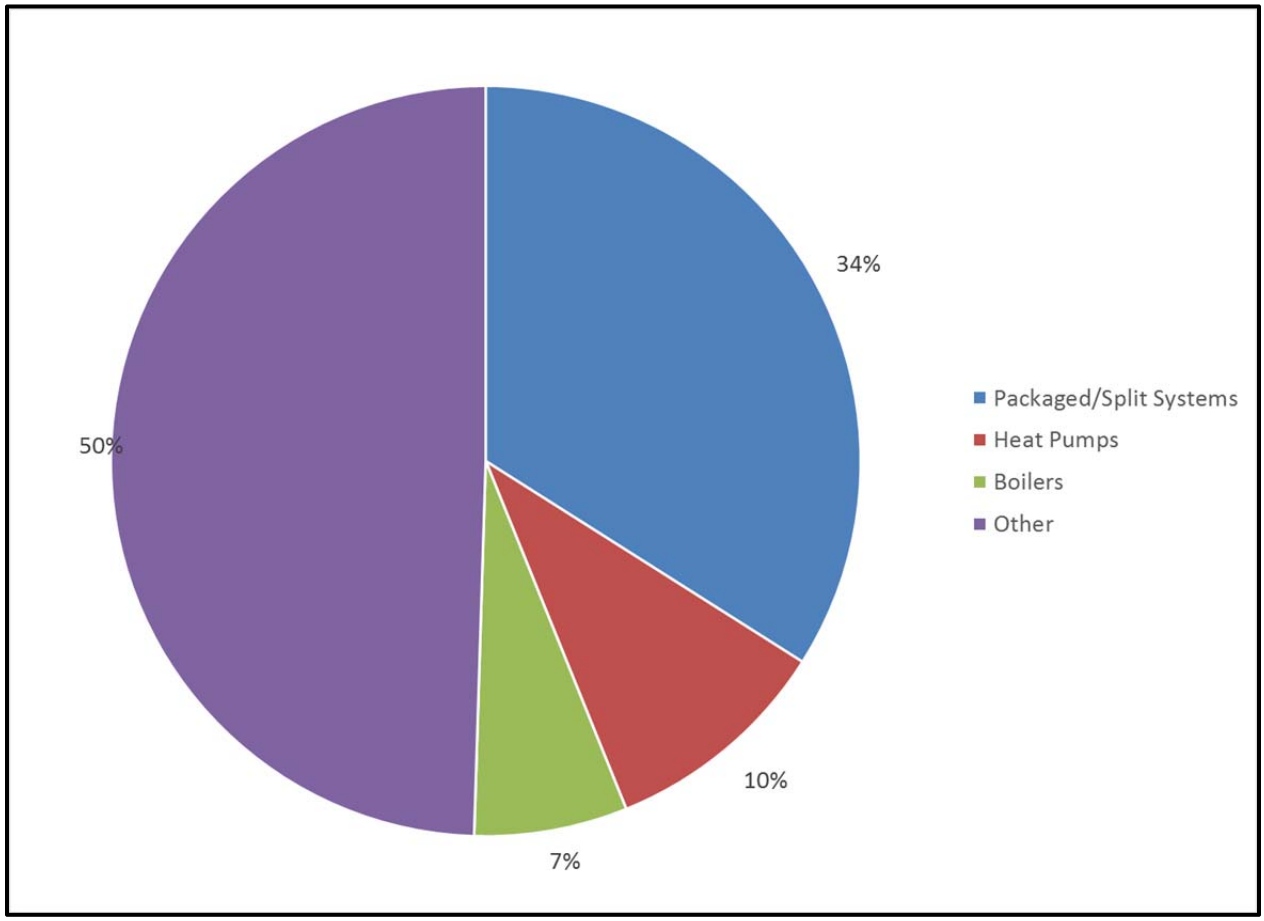
Figure 3-51: Percent of Square Feet with Varying Types of HVAC Heating Equipment



*The results presented above are weighted using the business-level sample weight.
** These data represent 318 sites.

Figure 3-52 presents the distribution of heating system types by the heating system unit instead of the business. In this graph, all of the shares describe a single system type. These data indicate that other systems are the most common system type. Using the distribution of heating system types it is not possible to look at the distribution by square footage because a business' square footage can be associated with multiple system types. Other heating includes businesses heated by baseboard heat, PTAC, window/wall units, unit heating, and space heating. Other heating represent the largest count of systems because these systems are common, but they generally provide heat to relatively smaller spaces or floor area.

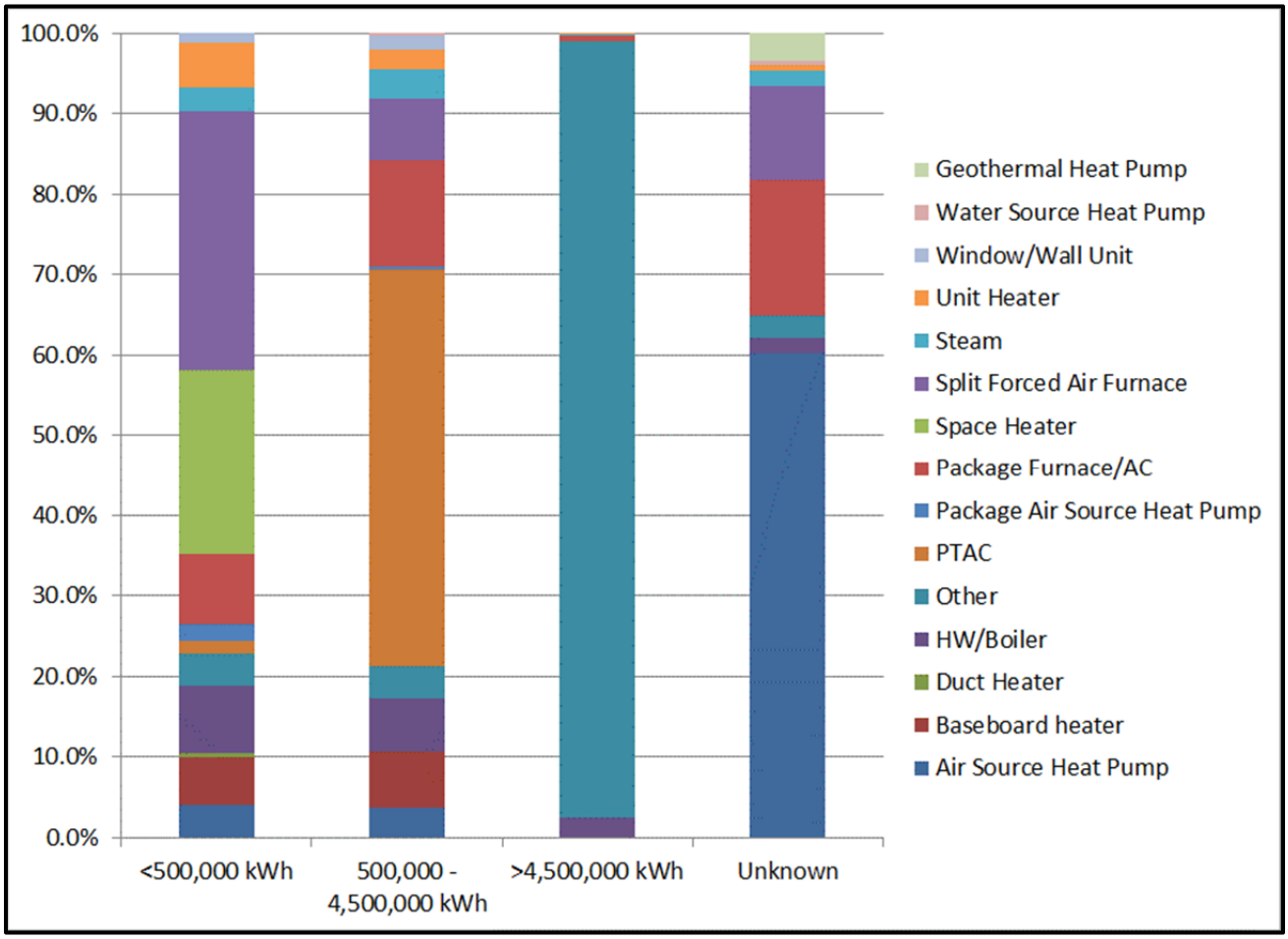
Figure 3-52: Percent of HVAC Heating Systems by Type



*The results presented above are weighted using the business-level sample weight.
** These data represent 318 sites.

Figure 3-53 illustrates the distribution of heating system type by business kWh size. These data indicate that the distribution of heating systems differs substantially by the size of the business.

Figure 3-53: Percent of HVAC Heating Systems by Business Size



*The results presented above are weighted using the business-level sample weight.
** These data represent 181 sites < 500,000 kWh, 110 sites 500,000 – 4,500,000 kWh, 19 sites > 4,500,000 kWh, and 8 Unknown sites.
***Baseboard heater could be electric or served by a boiler

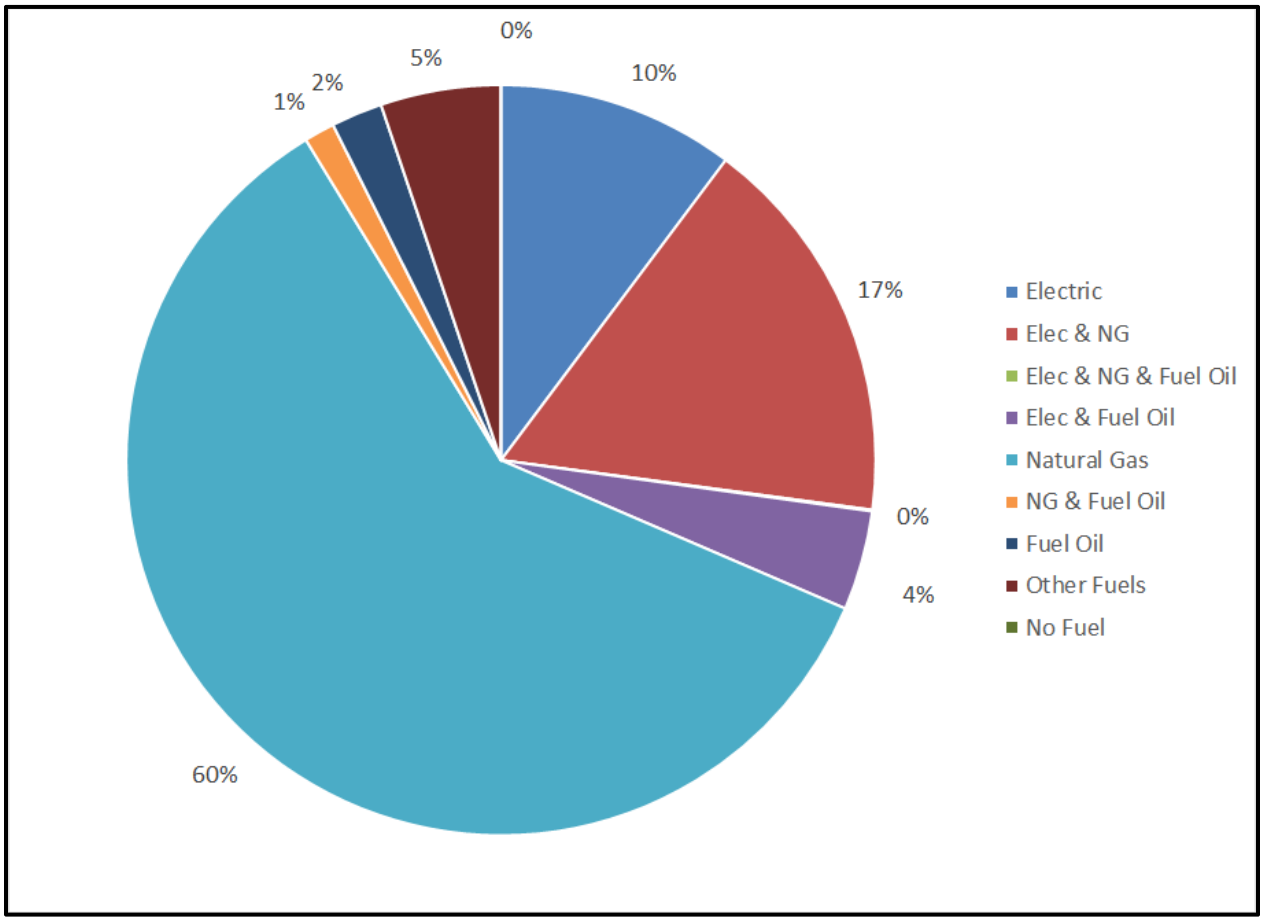
The HVAC heating system type analysis implies that "Other" (a combination of baseboard heating, PTAC, window/wall, unit heating, and space heating) and packaged and split heating systems are the most common systems in Massachusetts but boilers are associated with a larger kWh and square footage allocation. These findings are consistent with expectations given the larger capacity of Boilers while packaged/spilt and other systems provide flexibility for the heating of smaller spaces. These findings also highlight the importance of maintaining energy efficiency programs that help move the market for both packaged/split and other systems and for larger boiler heating systems.

3.4.5 Heating System Fuels

Potential fuels for the heating equipment include natural gas, electric, fuel oil, propane, or wood. Figure 3-54 illustrates the distribution of fuel types using the business-level weight. The respondent weighted heating fuels distribution shows that approximately 60% of businesses heat using only natural gas. Analyzing the distribution of heating fuel by business square footage (see Figure 3-55), natural gas heating share increases to 72% for businesses that heat using only one fuel and 89% if businesses using

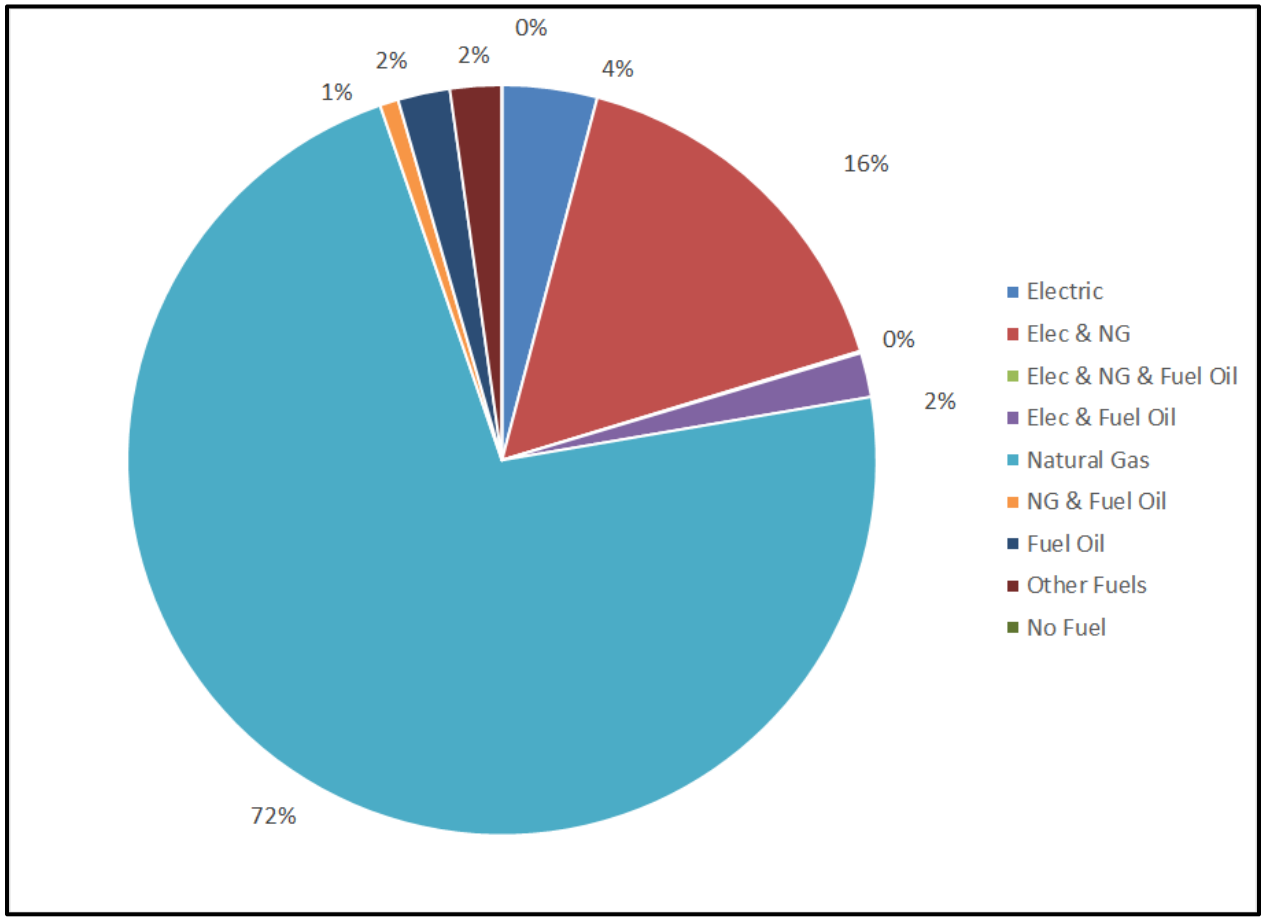
natural gas and other fuels for heating are included. For Massachusetts businesses natural gas is the most common heating fuel.

Figure 3-54: Distribution of Business by Heating Fuel Types and Combinations



*The results presented above are weighted using the business-level sample weight.
** These data represent 318 sites.

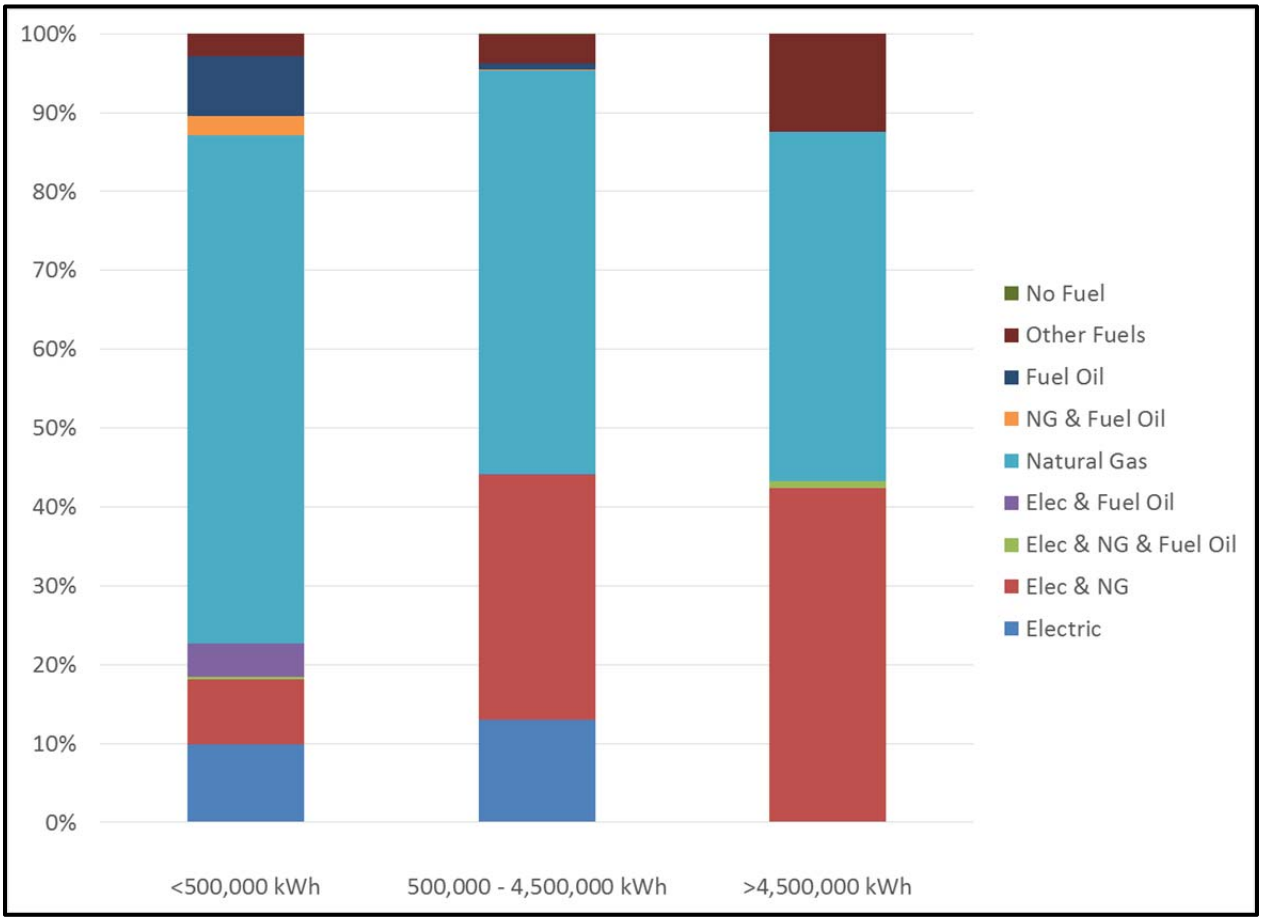
Figure 3-55: Distribution Heating Fuel Types and Combinations by Square Feet



*The results presented above are weighted using the business-level sample weight.
** These data represent 318 sites.

Figure 3-56 illustrates the distribution of heating fuels by business kWh size. These data indicate that small and large businesses are most likely to heat with natural gas while medium-sized businesses have a large share of businesses that heat with electric or a combination of natural gas and electric. The dominance of natural gas for heating small and large-sized businesses while medium-sized businesses use multiple fuels may have implications for how energy efficiency programs target customers to install more efficient heating systems. The collection of additional information during the Phase 2 study will help to determine if the heating fuel allocation described in the Interim Report represents the distribution in Massachusetts businesses.

Figure 3-56: Distribution of Heating Fuel Types and Combinations by Business Size (kWh)



*The results presented above are weighted using the business-level sample weight.
** These data represent 181 sites < 500,000 kWh, 110 sites 500,000 – 4,500,000 kWh, 19 sites > 4,500,000 kWh, and 8 Unknown sites.

3.4.6 Heating System Efficiency

During the on-site data collection effort, the surveyors collected make and model number information to help determine the efficiency distribution of packaged and split system heating in Massachusetts businesses. The make and model numbers for the packaged and split system heaters and heat pump systems were looked up and efficiency information was collected. These data were compared to information on federal standards. Table 3-21 lists the federal heating efficiency standards used in the make and model lookup efficiency determinations. The standards for heating systems vary by system type, capacity, fuel, and size. The efficiency for all of the packaged and split heating equipment in the analysis are compared to current efficiency standard levels. Comparison to current standards is necessary because the purchase date of equipment is not available for all units and a comparison to current standards provides information on the energy efficiency savings potential relative to current standards.

During the make and model lookup it became apparent that finding all of the information needed to determine the efficiency of heating systems was very difficult. It was also found that many of the systems were rated in efficiency units that are not consistent with the efficiency standards presented in Table 3-21. It was necessary to transform heat pump HSPF into COP and COP into HSPF. To make this transformation,

the HSPF*.2908 = COP was used. The efficiency units for furnaces also did not use consistent efficiency units. Large and small units were labelled in AFUE, thermal efficiency, and steady state. While these units do not appear to be directly comparable, the efficiency analysis has used these units interchangeably to maximize the number of observed units where efficiency information could be classified.

The efficiency for all of the packaged and split heating equipment surveyed are compared to current efficiency standard levels. Comparison to current standards is necessary because the purchase date of equipment is not available for all units and a comparison to current standards provides information on the energy efficiency savings potential relative to current standards. Figure 3-20 includes information on the timing of when the standards used in the analysis were implemented. The heating efficiency standards used for the Interim analysis were implemented between 1992 and 2010. In addition, two of the heating efficiency standards either have been updated or will be updated shortly. These changes in standards will impact the efficiency distributions for the Final Report. If the data available for the final report is sufficient, the efficiency distribution will include more detailed information on efficiency than the above, at, and below standards groupings used below. The multiple standard levels associated with the different fuels and system size makes the presentation of efficiency information by efficiency data difficult with small sample sizes.

Table 3-21: Heating Efficiency Parameters and Standards[27]

Standard Type	Equipment Type	Input Capacity	Input Capacity Units	Fuel Type	Efficiency Minimum	Efficiency Units	Year of Compliance
Com - HP	Air Cooled Heat Pump	< 65	kBtuh	Ele	7.7	HSPF	2008
Com - HP	Air Cooled Heat Pump	≥ 65 and < 135	kBtuh	Ele	3.3	COP	2010
Com - HP	Air Cooled Heat Pump	≥ 135 and < 240	kBtuh	Ele	3.2	COP	2010
Com - HP	Air Cooled Heat Pump	≥ 240 +	kBtuh	Ele	3.2	COP	2010
Com - HP	Water Cooled Heat Pump	< 135	kBtuh	Ele	4.2	COP	2003
Res – Gas Furnace[28]		< 225	kBtuh	Nat Gas	78	AFUE	2007
Res – Oil Furnace[29]		< 225	kBtuh	Fuel Oil	78	AFUE	2007
Res – Ele Furnace		< 225	kBtuh	Ele	78	AFUE	1992
Com – Gas Furnace		≥ 225	kBtuh	Nat Gas	80	Thermal Efficiency	2004
Com – Oil Furnace		≥ 225	kBtuh	Fuel Oil	81	Thermal Efficiency	2004

Figure 3-70 illustrates the efficiency distribution for heating systems in non-residential facilities in Massachusetts. The distribution includes 15% "model missing" for units where a model number was not collected on-site and 20% "model not found" for heating units where efficiency information was not available following the make and model lookup.[30] These data indicate that 50% of existing stock heating

27 The commercial heat pump standards are from http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/77. The residential furnace standards are from http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/72. The commercial furnace standards are from http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/71.

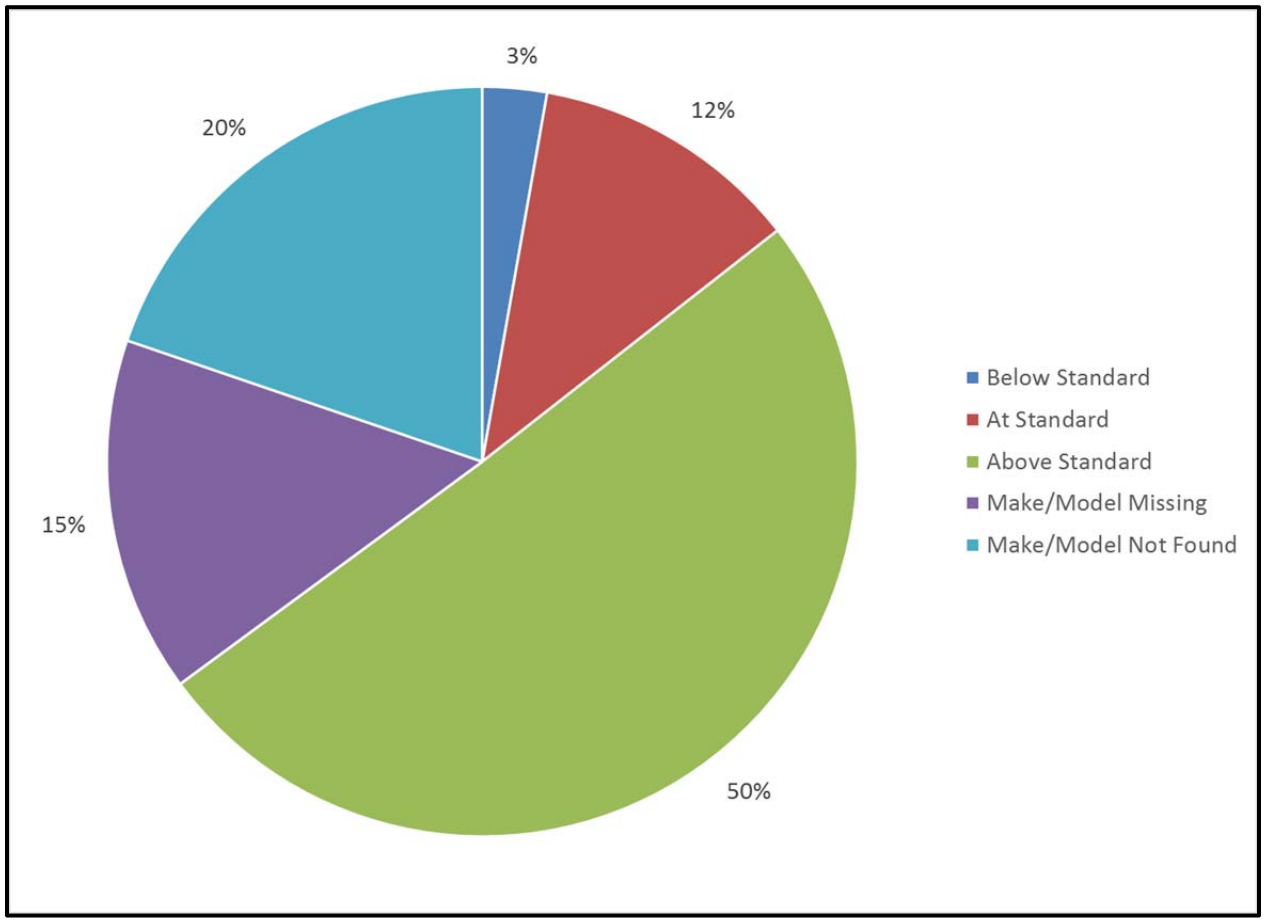
29 Standards are based on input capacities and the commercial systems found in this study were small enough to fall under residential standards. Residential furnace standards are based on non-weatherized systems. The standards for oil-fired furnaces were updated in 2013 to an AFUE of 83, and gas furnaces will be updated in November 2015 to an AFUE of 80. Because the standards were updated during the middle of the evaluation period (2009-2014), the standards listed here are based on the older 2007 standards. The on-site data included 30 oil-fired furnaces that were < 225 kBtuh. Of the 30 furnaces, only seven included information that allowed for the development of efficiency information. For the Interim Report, all seven units are high efficiency (six with an AFUE of 81 and one with and AFUE of 86). For the Final Report, only one will be classified as high efficiency.

30 For the Interim Report we have not eliminated the model missing or model not found for the heating analysis. Generally, model missing and model not found for heating equipment does not imply that these units have an efficiency that is identical to the units with observed efficiency (assumption used in the linear lighting analysis). For heating equipment, model missing and model not found is often, though not always, associated with older units whose efficiency may differ from the rest of the existing stock. For the Final Report, we will compare the age

systems in non-residential facilities in Massachusetts are currently above standards, 12% at standards, and only 3% below standards.

The finding that 50% of existing stock of packaged and split systems exceed current standards is remarkable. The standards used to classify these systems, however, have not been updated in several years (set from 1992-2010). During the evaluation period the standards for some heating systems will be updated. Given that the Final Report will include data associated with additional customers, the analysis may be able to present additional information on the efficiency by level, by system type. Prior to drawing conclusions on the efficiency of heating and the remaining energy efficiency savings potential associated with non-residential heating, the additional heating data from Phase 2 should be reviewed in detail relative to both existing and new standards.

Figure 3-57: Efficiency Ratings Distribution for Heating Systems



*The results presented above are weighted using the business-level sample weight.
** These data represent 210 sites.

Figure 3-71 illustrates the heating system efficiency by utility energy efficiency program participation. Participants have participated in an energy efficiency program from 2011 to 2013. These data indicate

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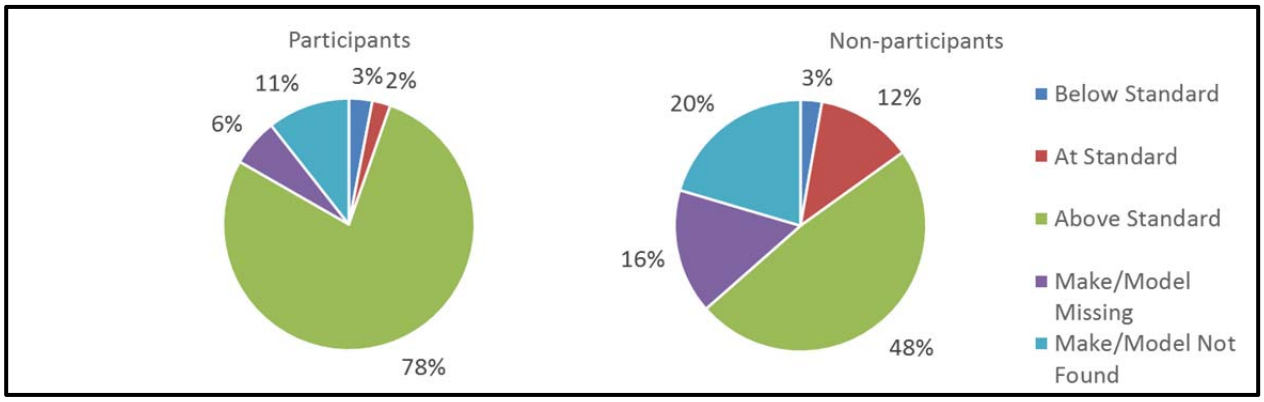
of the model missing and model not found to the age of the rest of the stock. If the age distributions are similar, we will eliminate these units from the efficiency analysis.

that program participants have a high proportion heating systems that exceed standard efficiency. While the share of participant packaged and split heating systems that are above standards is extremely high, the additional sample provided under the Phase 2 data collection will help to ensure that the findings presented below accurately represent the participant/non-participant distribution in Massachusetts businesses.

Figure 3-58: Efficiency Ratings by EE Participation



*The results presented above are weighted using the business-level sample weight.
** These data represent 147 non-participants and 63 participants.

3.4.7 Recent HVAC Heating Purchases

For the Market Tracking study, the analysis presented in this section is focused on sites with new heating systems installed from 2009 to 2014.

HVAC Heating

Table 3-27 lists the number of completed on-sites, the number of sites where heating system data was collected on-site, the number of sites where newly purchased heating equipment was recorded and the number of sites were make and model numbers were collected for newly purchased heating equipment. These data indicate that 101 of the 318 sites where heating equipment was recorded had at least one new heating system on-site. For the new heating systems, however, only 44 sites have recorded make and model numbers.[31] The lack of information on heating make and model numbers, combined with the difficulty finding some units with make and model numbers will limit the information available from the efficiency distribution analysis of recent purchases. The analysis for the Final Report will benefit from additional on-site data collection.

[31] The 44 sites where make and model numbers were collected reflect more than 44 make and model numbers as a site may have multiple new units and the units may differ. Collecting make and model numbers for HVAC units can be difficult due to the location of the units. Some site contacts will not allow surveyors into mechanical rooms or onto the roof.

Table 3-22: Number of Business with New HVAC Heating Systems

Business Type	Completed On-site Surveys	Count of Bldgs with Heating Information	Has New Heating Equipment	Has Make and Model Data Collected for Heating
All Businesses	343	318	101	44
Campuses	9	9	6	1
Education	31	31	14	3
Food Sales	25	23	7	5
Food Service	31	27	7	4
Healthcare	19	18	5	3
Hospitals	6	6	2	1
Lodging	32	30	13	4
Manufacturing or Industrial	23	21	8	4
Office	55	50	15	7
Other	24	21	3	0
Public Assembly	32	30	10	6
Retail	43	40	7	2
Warehouse	13	12	4	4

* The results presented above are Un-weighted.

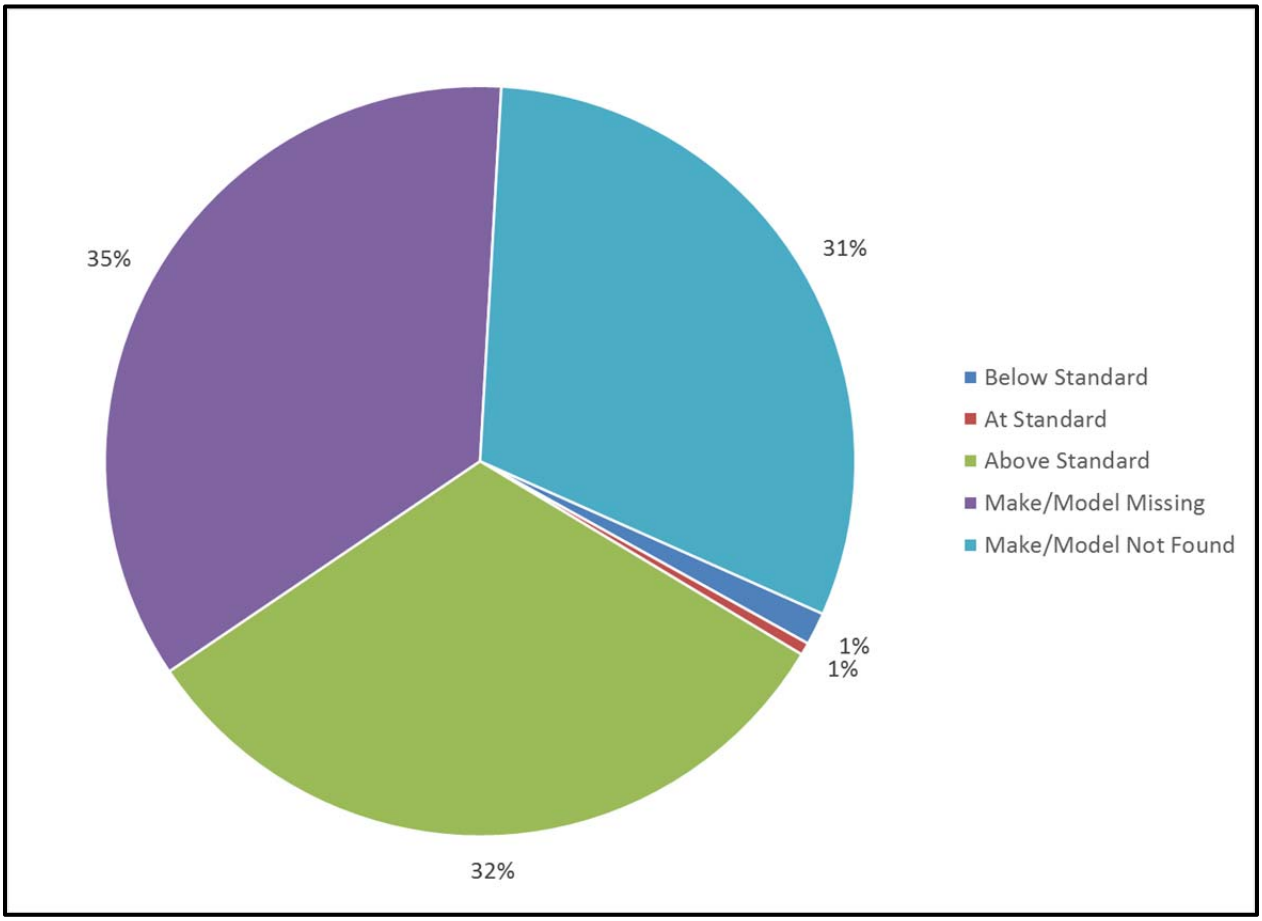
**The counts indicate the number of instances the technology was found in the buildings that were visited.

Recent Purchases for HVAC Heating Split and Packaged Systems

The data collected during the C&I Customer On-site Assessments study allows for the identification of recent purchases (from 2009 to 2014) and the lookup of make and model numbers to determine the efficiency distribution of recent purchases. Figure 3-59 illustrates the efficiency distribution for recently purchased split and packaged heating systems. The standard efficiency rating information for these systems is provided in Table 3-19. The data presented in Figure 3-59 indicates that it was not possible to identify the efficiency level for the majority of recent purchases, 31% of recent purchases were “Model not Found” while 35% of purchases were “Model Missing”. For the recently purchased heating units where it was possible to identify an efficiency level, nearly all units exceeded current efficiency standards for heating systems.

The finding that nearly all recently purchased packaged and split system heating units exceed current efficiency standards is remarkable. These findings, however are based on information from very few recently purchased heating systems representing only 55 customers. Prior to concluding that the market of packaged and split heating systems currently exceeds the high efficiency standards, it is prudent to wait until the recent purchase information from Phase 2 is analyzed. The preliminary information, however, provide preliminary data to support the conclusion that businesses in Massachusetts are currently installing high efficiency heating systems in excess of what is required by standards.

Figure 3-59: Efficiency Ratings for Recently Purchased Split/Packaged Heating Systems

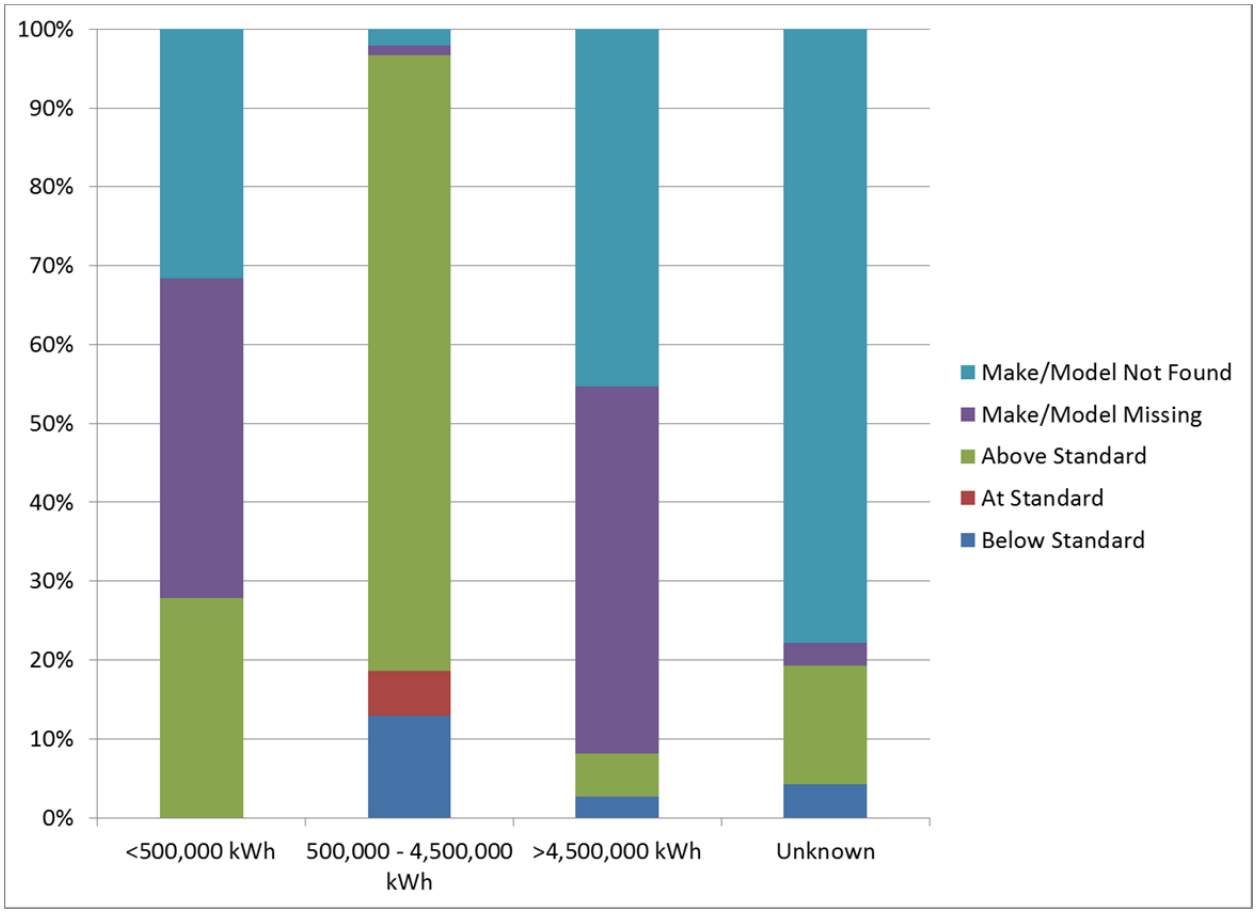


*The results presented above are weighted using the business-level sample weight. These data represent Packaged and Split system heating purchased from 2009 to 2014.

** These data represent 55 sites.

Figure 3-60 illustrates the efficiency distribution of recently purchased split and packaged heating systems by customer size. These data indicate that the majority of the Make and Model Missing and Model not Found are in small and large sized businesses. The majority of recently purchased heating systems in medium-sized businesses are identified as exceeding current efficiency standards.

Figure 3-60: Efficiency Ratings for Recently Purchased Split/Packaged Heating Systems by Business Size



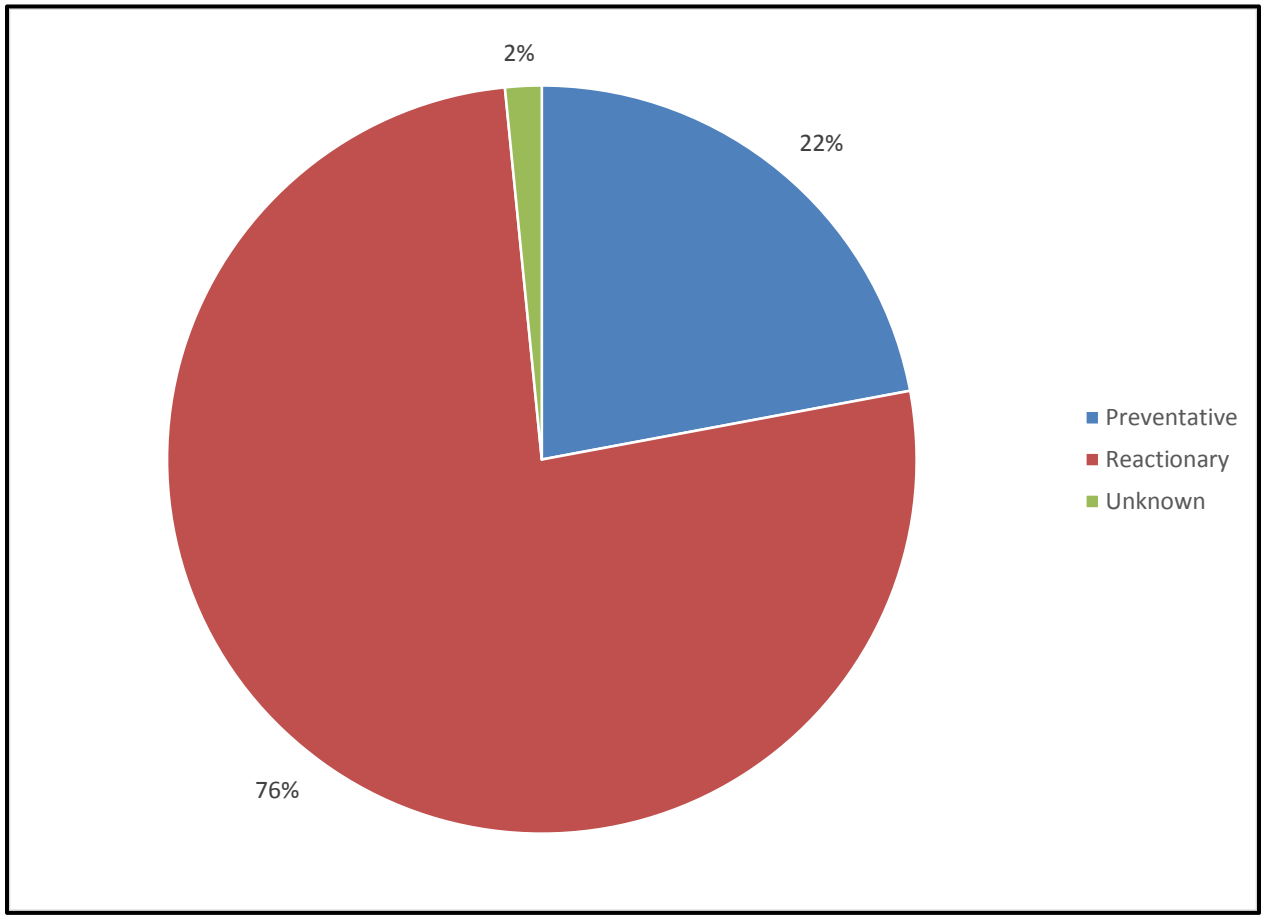
* The results presented above are weighted using the business-level sample weight. These data represent package and split system heating purchased from 2009-2014.

** These data represent 27 sites < 500,000 kWh, 19 sites 500,000 – 4,500,000 kWh, 7 sites > 4,500,000 kWh, and 2 Unknown sites.

3.4.8 HVAC Maintenance

The C&I Customer On-site Assessments study collected information on the maintenance of HVAC systems. Figure 3-61 illustrates the distribution of maintenance as preventative, reactionary, and unknown. The majority of maintenance is described as reactionary though 38% is listed as preventative.

Figure 3-61: HVAC Maintenance



*The results presented above are weighted using the kWh-level sample weight

** These data represent 343 sites.

3.5 Energy Management Systems

Energy Management Systems (EMS) consist of a network that combines local distributed control with centralized coordination and management to monitor, control, and optimize energy usage throughout a business facility. EMS can be used to control and monitor the energy use of appliances and equipment at a site including lighting, HVAC, water heating and process equipment. EMS systems can also be used to control systems during demand response events. The C&I Customer On-site Assessment data on EMS provides the PAs with a better understanding of the current baseline of EMS saturation. This information is useful for future program planning for Energy Efficiency (EE) and Demand Response (DR) and for future potential studies.[32]

[32] The results presented in the EMS section are weighted with the kWh-level sample weights.

3.5.1 Energy Management System Data

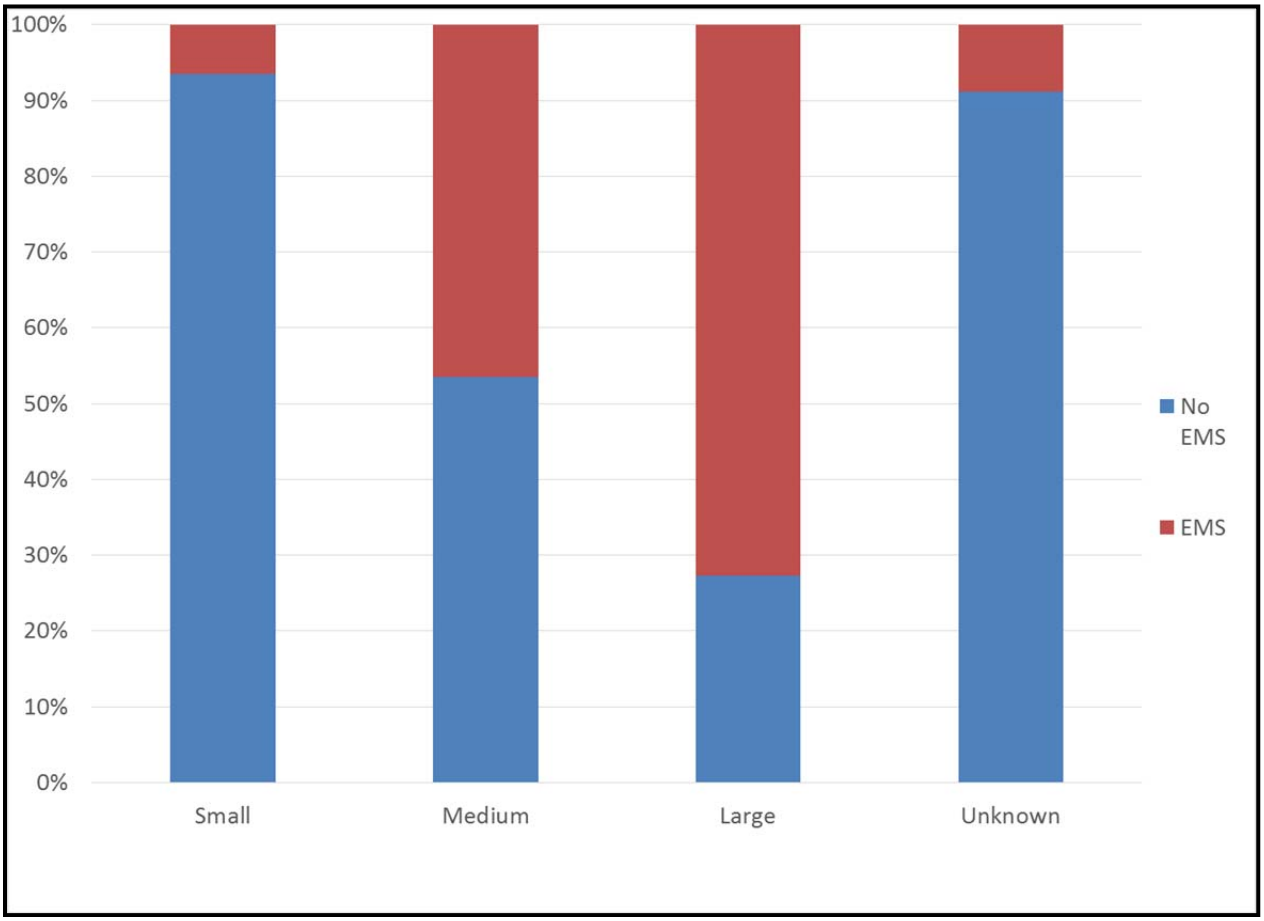
During Wave 1, field staff collected data on the existence of EMS systems and detailed data on EMS systems for businesses where EMS were found on-site. In all, 88 customers were found to have EMS.

Figure 3-62 and Figure 3-63 illustrates the distribution of EMS systems by the business kWh size and business square feet.[33] Both of these illustrations clearly indicate that medium and large-sized businesses are more likely to have EMS than smaller businesses with less energy consumption or square footage. Surprisingly, the analysis found that medium and large-sized businesses were equally likely to have EMS. This finding may indicate that there is remaining EMS savings potential associated with both Large and Medium-sized businesses. The additional data being collected as part of the Phase 2 implementation will help to clarify this issue.

Figure 3-64 presents the share of businesses with EMS by energy efficiency program participation (Participated during 2011-2013). These illustrations indicate that energy efficiency program participates have a nearly equal share of businesses with EMS as non-participants. This finding may indicate that energy efficiency programs are not currently driving the installation of EMS.

[33] The information presented in this section of the report provides information on all EMS, both old and newer systems. Information on newer systems will be highlighted later in the section.

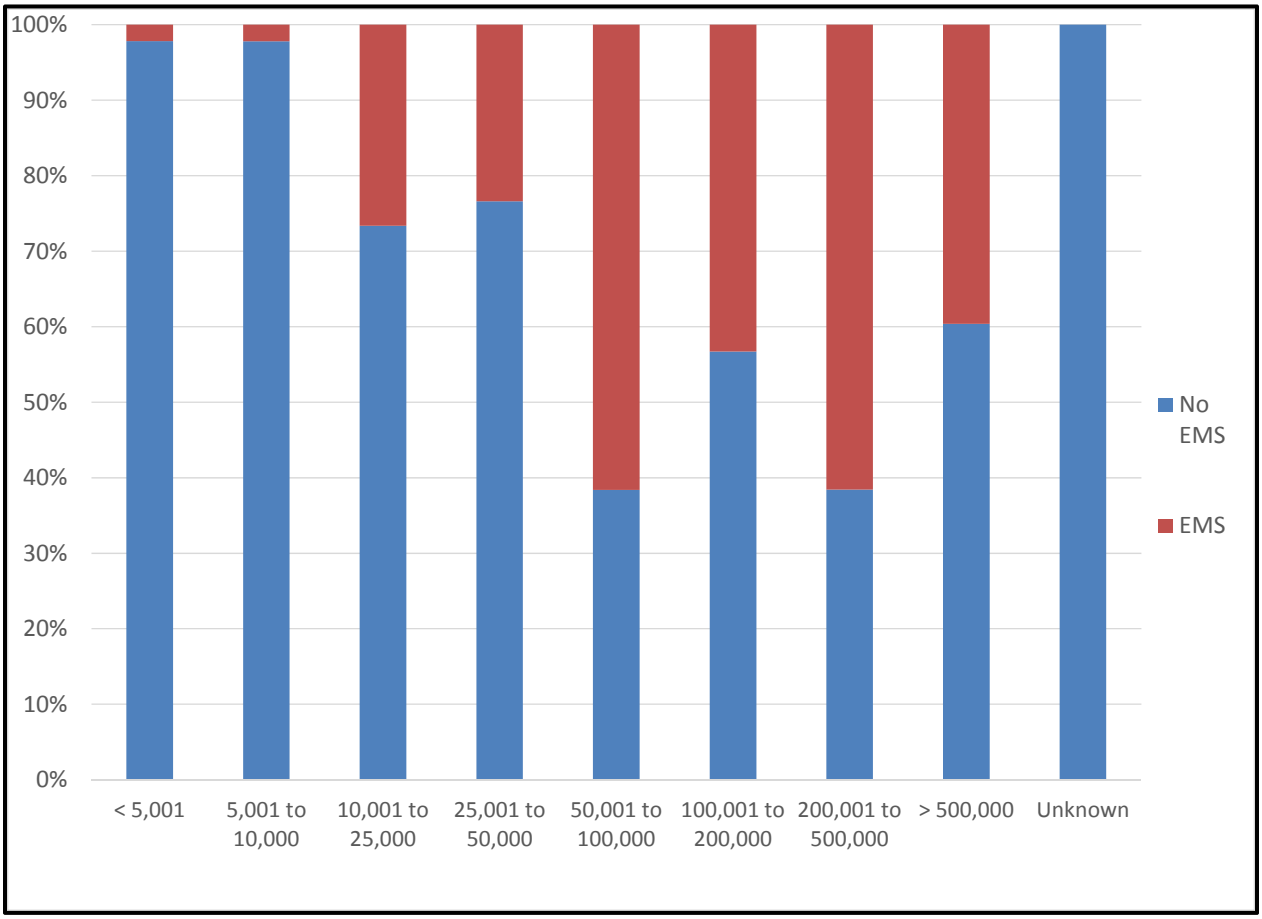
Figure 3-62 Distribution of EMS by Business kWh Size



*The results presented above are weighted using the kWh-level sample weight

** These data represent 201 small, 113 medium, 21 large, and 8 unknown sized sites.

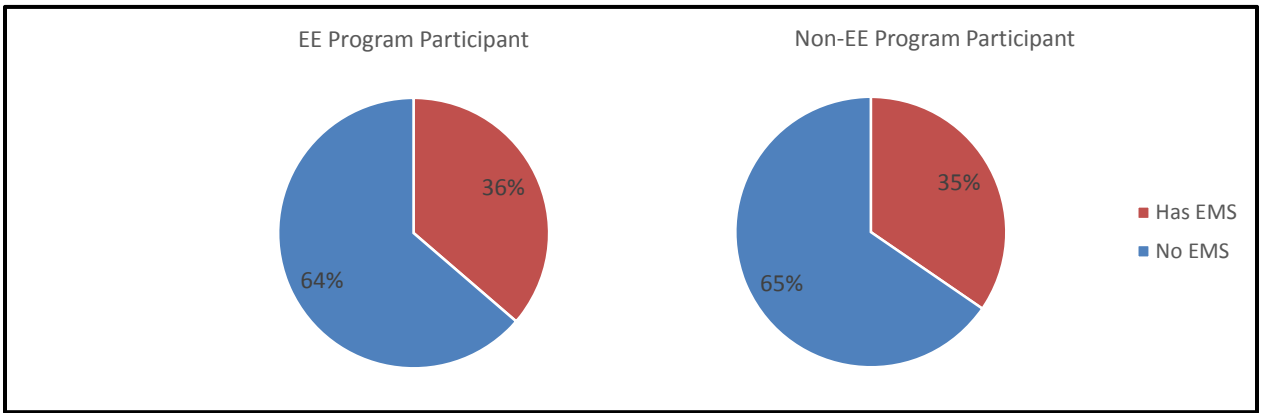
Figure 3-63: Distribution of EMS by Business Square Footage



*The results presented above are weighted using the kWh-level sample weight

** These data represent 343 sites.

Figure 3-64: Distribution of EMS by Energy Efficiency Program Participation



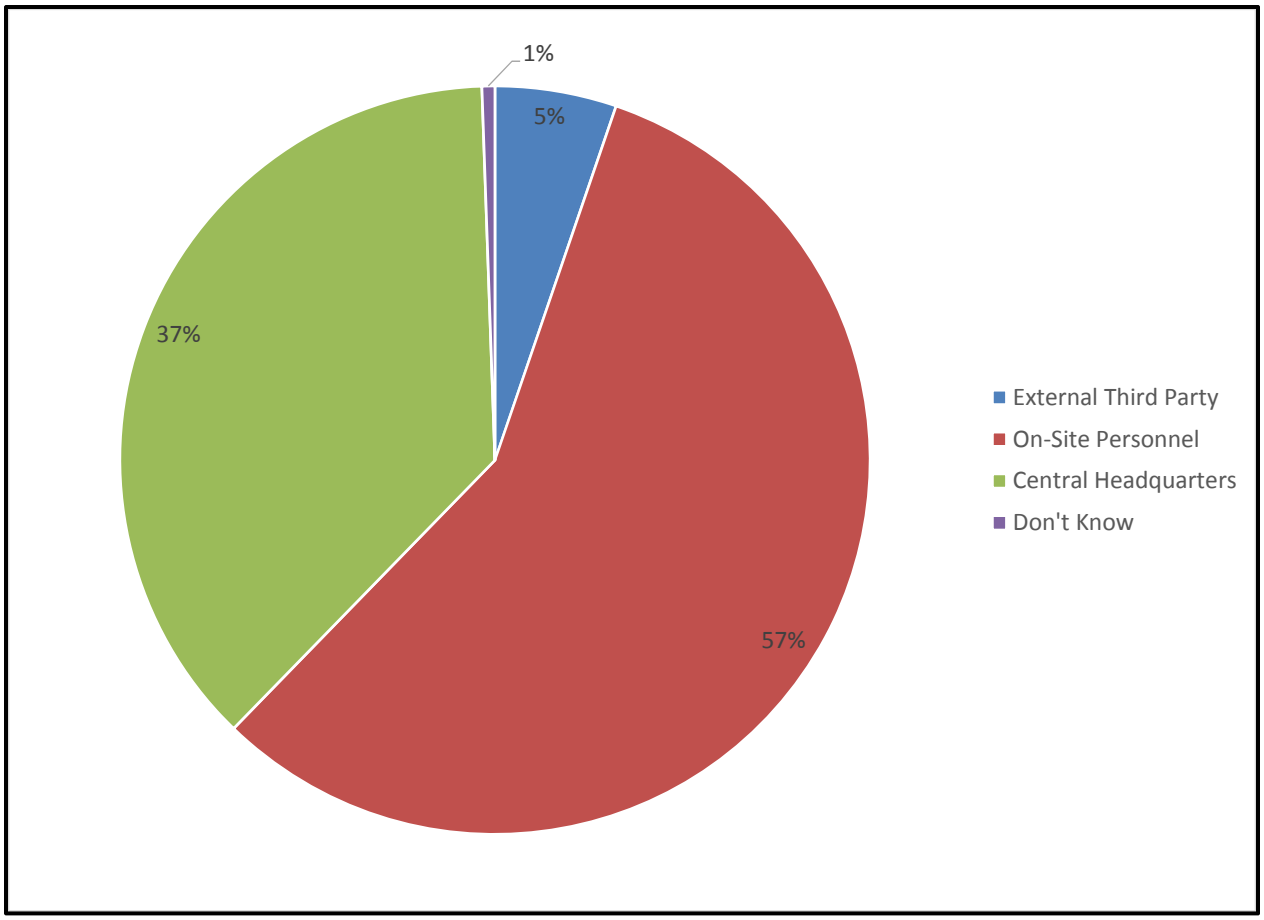
*The results presented above are weighted using the kWh-level sample weight

** These data represent 93 EE program participant and 250 non-participant sites.

3.5.2 EMS Controlling Entity

The Study collected information on the entity controlling the EMS.Figure 3-65 illustrates that the largest share of EMS are controlled by on-site personnel. The study also collected data on the EMS system layout, if the system is centrally controlled or has distributed control. See Figure 3-66 for an illustration of the system layout.

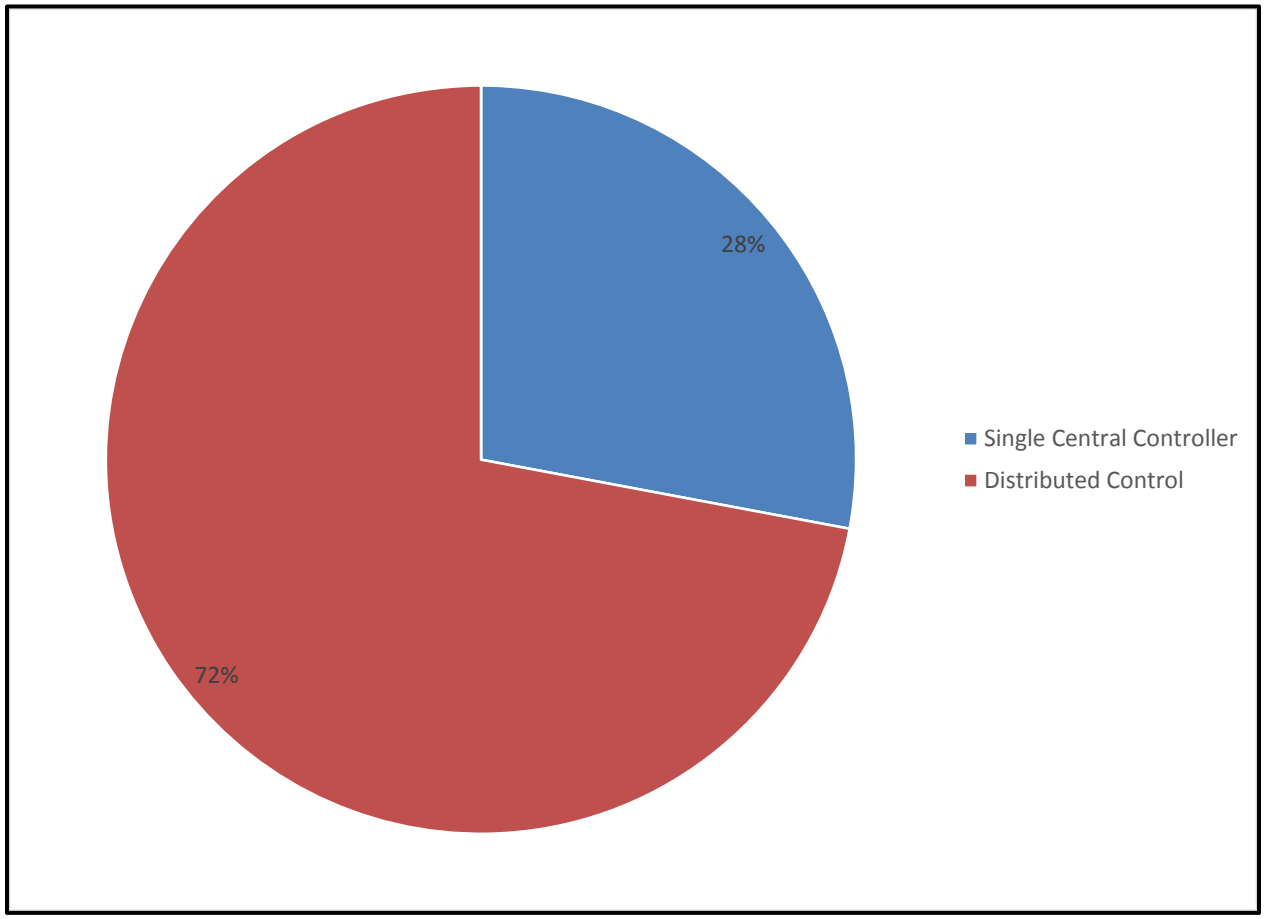
Figure 3-65: EMS Controlling Entity



*The results presented above are weighted using the kWh-level sample weight

** These data represent 88 sites.

Figure 3-66: EMS System Layout



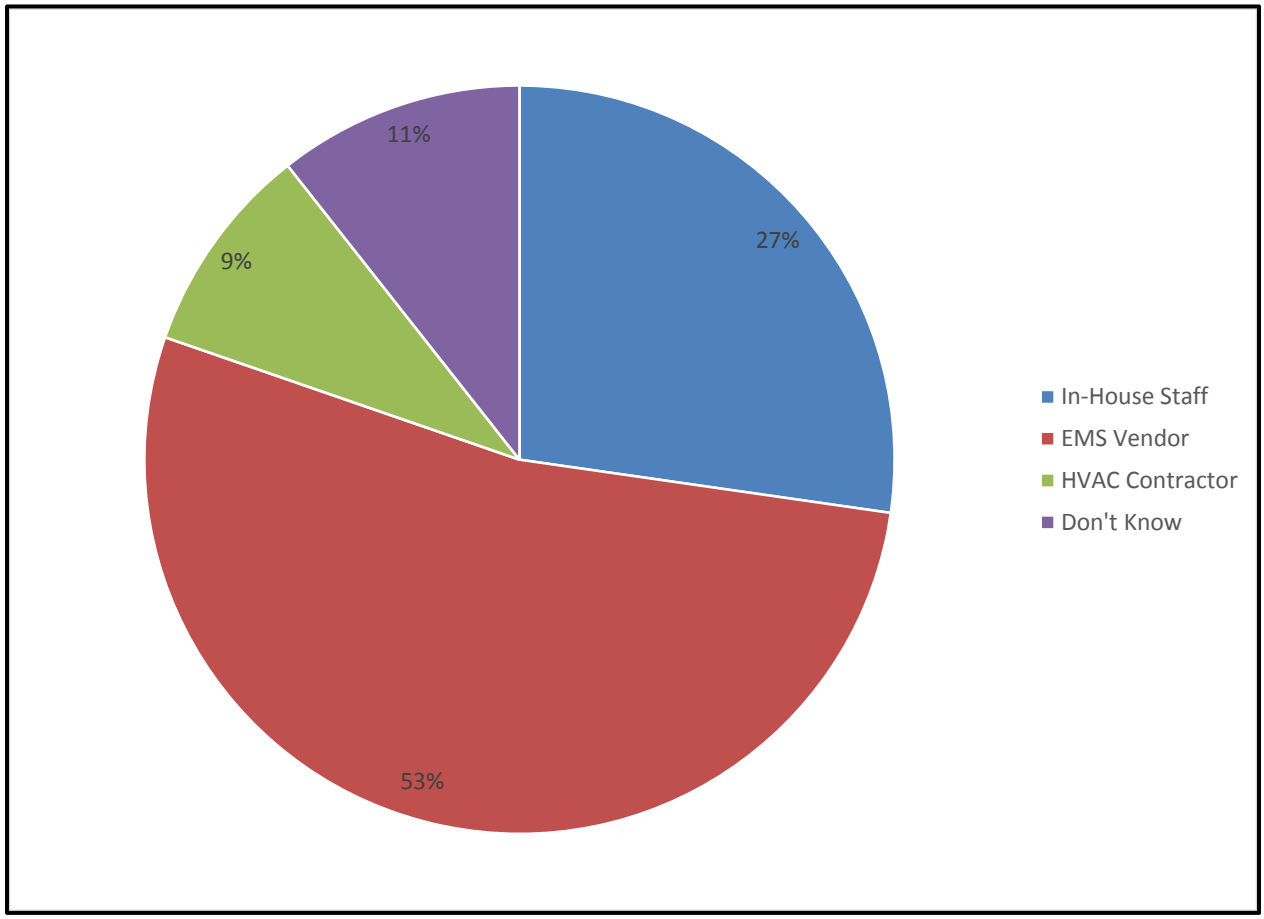
*The results presented above are weighted using the kWh-level sample weight

** These data represent 81 sites.

3.5.3 EMS Training

The C&I Customer On-site Assessments field staff collected information on EMS training for those sites where the EMS was controlled by on-site personnel. We collected information on the entity providing EMS training. Figure 3-67 presents information on the distribution of the EMS training entity for businesses where the EMS is controlled by on-site personnel. Nearly all training is provided by on-site personnel or the EMS vendor. Information on who is providing EMS training can be used to help focus EMS education programs designed to optimize the energy savings potential of EMS.

Figure 3-67: EMS Training



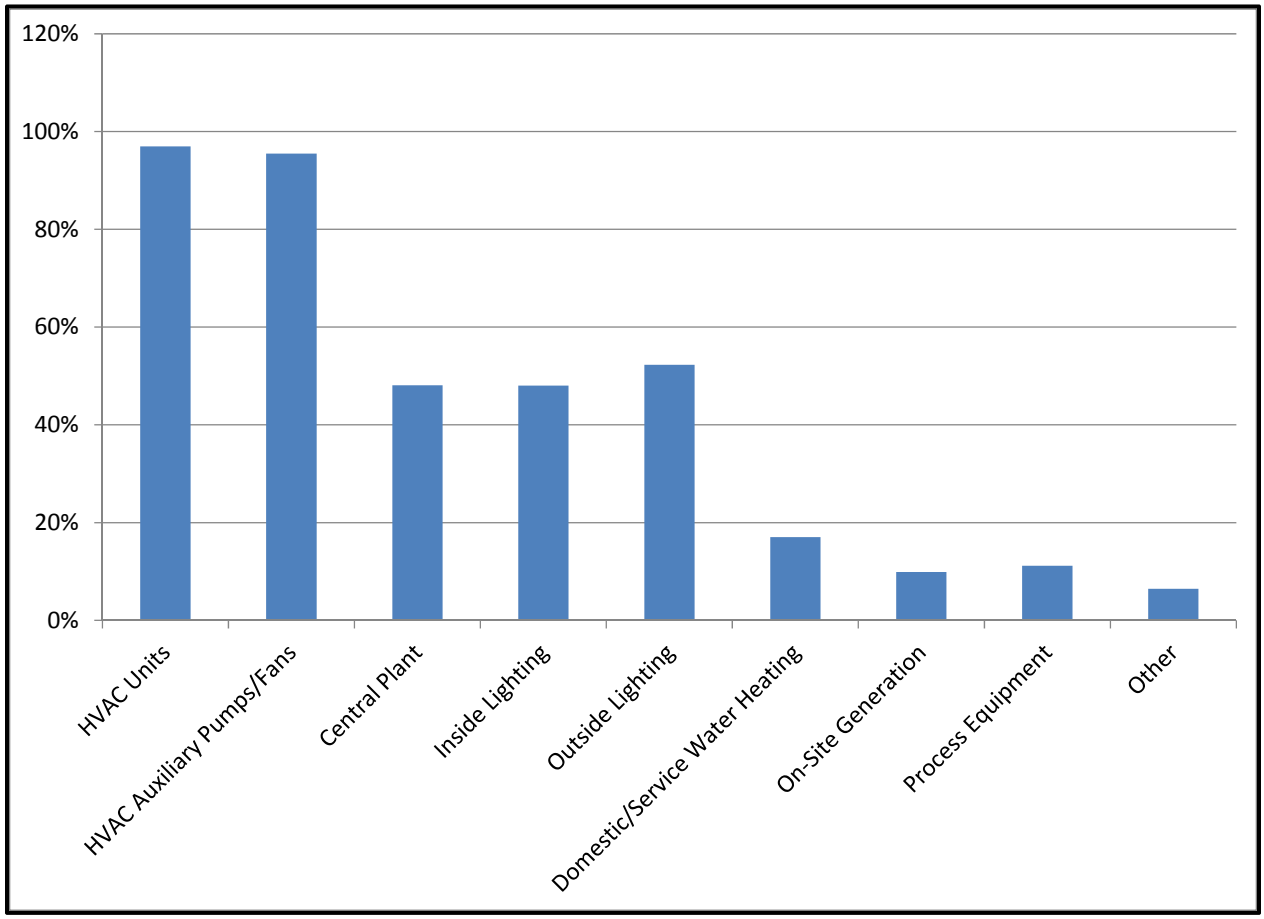
*The results presented above have been weighted using the kWh-level sample weight

** These data represent 66 sites.

3.5.4 End Uses Controlled by EMS

The Wave 1 on-site data collection effort obtained information on the end uses controlled by EMS for customers with an EMS. Figure 3-68 presents information on the end uses controlled by EMS. For customers with EMS, 85% of businesses control their HVAC units with their EMS. Sixty seven percent of customers with EMS use their EMS to control their HVAC auxiliary pumps and fans, but less than 50% of businesses with EMS control any other end uses.

Figure 3-68: End Uses Controlled by EMS



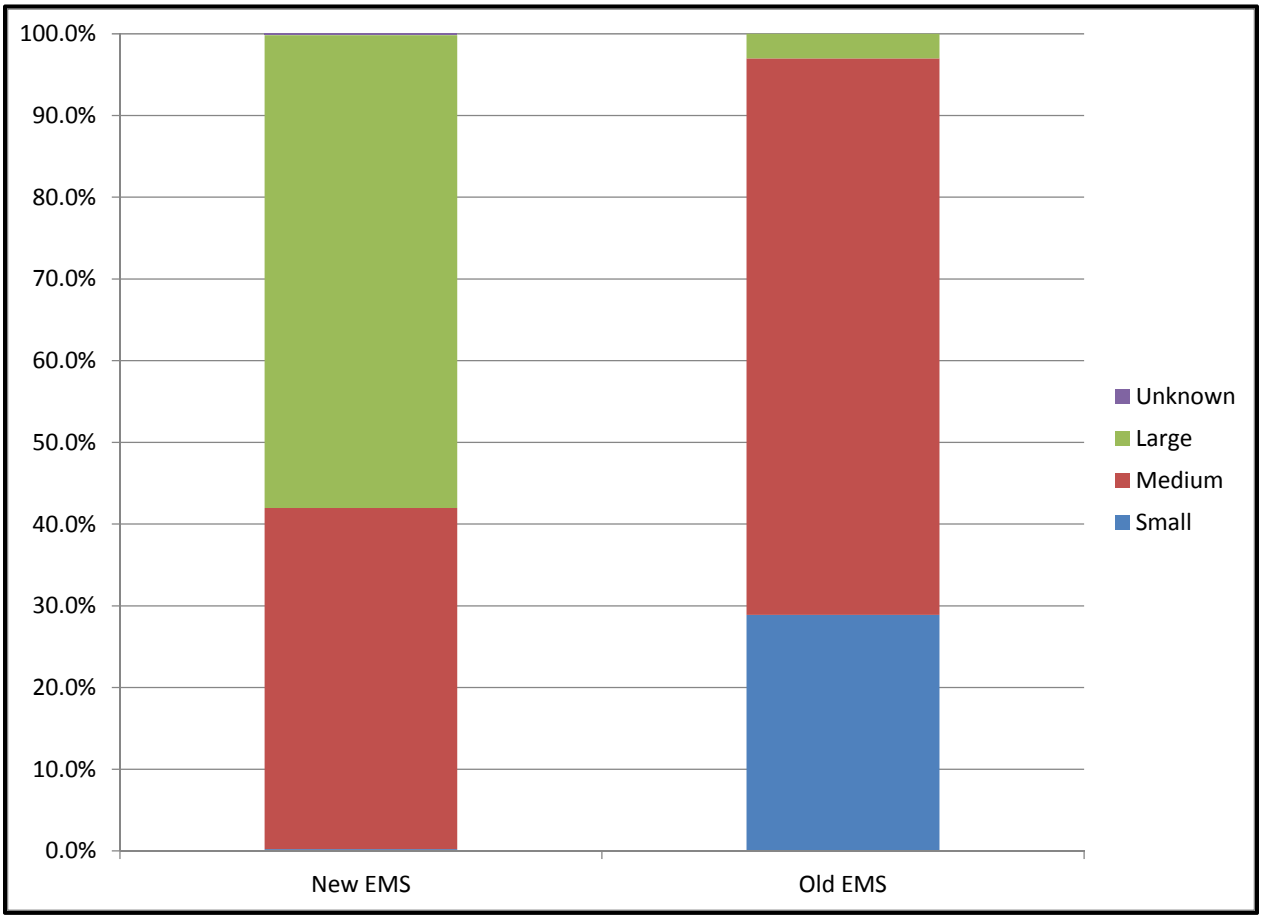
*The results presented above are weighted using the kWh-level sample weight

** These data represent 88 sites.

3.5.5 New Energy Management Systems

The on-site data collection gathered information on the age of the EMS. Systems purchased from 2009 through 2014 are considered new EMS. Of the 88 businesses with EMS, 46 businesses have new EMS. Figure 3-69 illustrates the distribution of old and new EMS by business kWh size for businesses with EMS. Alternatively, Figure 3-70 illustrates the distribution of EMS across old and new by each of the business kWh size categories. Figure 3-70 clearly indicates that medium and large-sized businesses are more likely to have newer EMS.

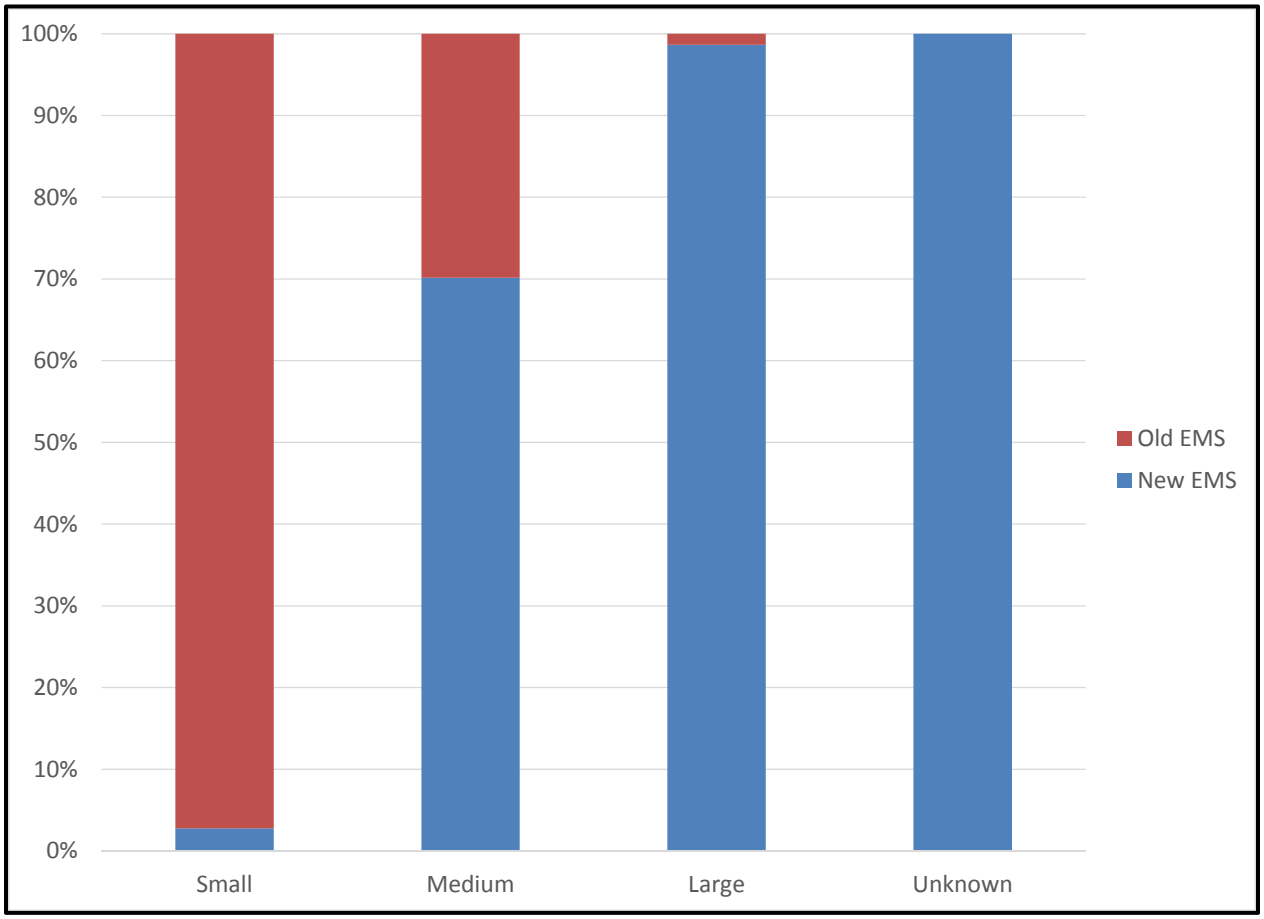
Figure 3-69: Distribution of Old and New EMS by Business kWh Size for Businesses with EMS



*The results presented above are weighted using the kWh-level sample weight

** These data represent 13 small, 58 medium, 16 large, and 1 unknown sized sites.

Figure 3-70: Distribution of Old and New EMS by Business Size, Share of Businesses with EMS



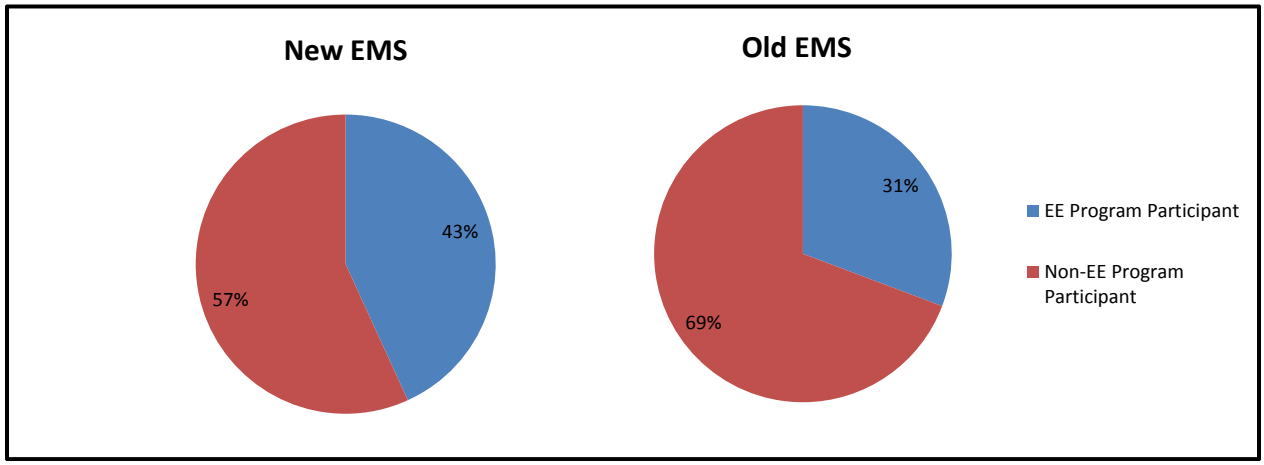
*The results presented above are weighted using the kWh-level sample weight

** These data represent 13 small, 58 medium, 16 large, and 1 unknown sized sites.

Of the 88 businesses in the first wave of data collection with EMS, 38 of these businesses participated in energy efficiency programs from 2011-2013 while 50 sites had not participated during this time period. Figure 3-71 illustrates the distribution of new and older EMS by program participation. Customers with newer EMS have a larger share of recent program participants than customers with older EMS. These data indicate that energy efficiency programs may be influencing the decision to install an EMS, however, more than half of customers installing new EMS were not program participants.

In the Phase 1 data collection there were only 88 sites with EMS. The small sample size does potentially lead to questions concerning the ability to generalize the EMS results. Preliminary findings, however, point to the opportunity for energy efficiency programs to influence additional EMS installations.

Figure 3-71: Old and New EMS by Program Participation



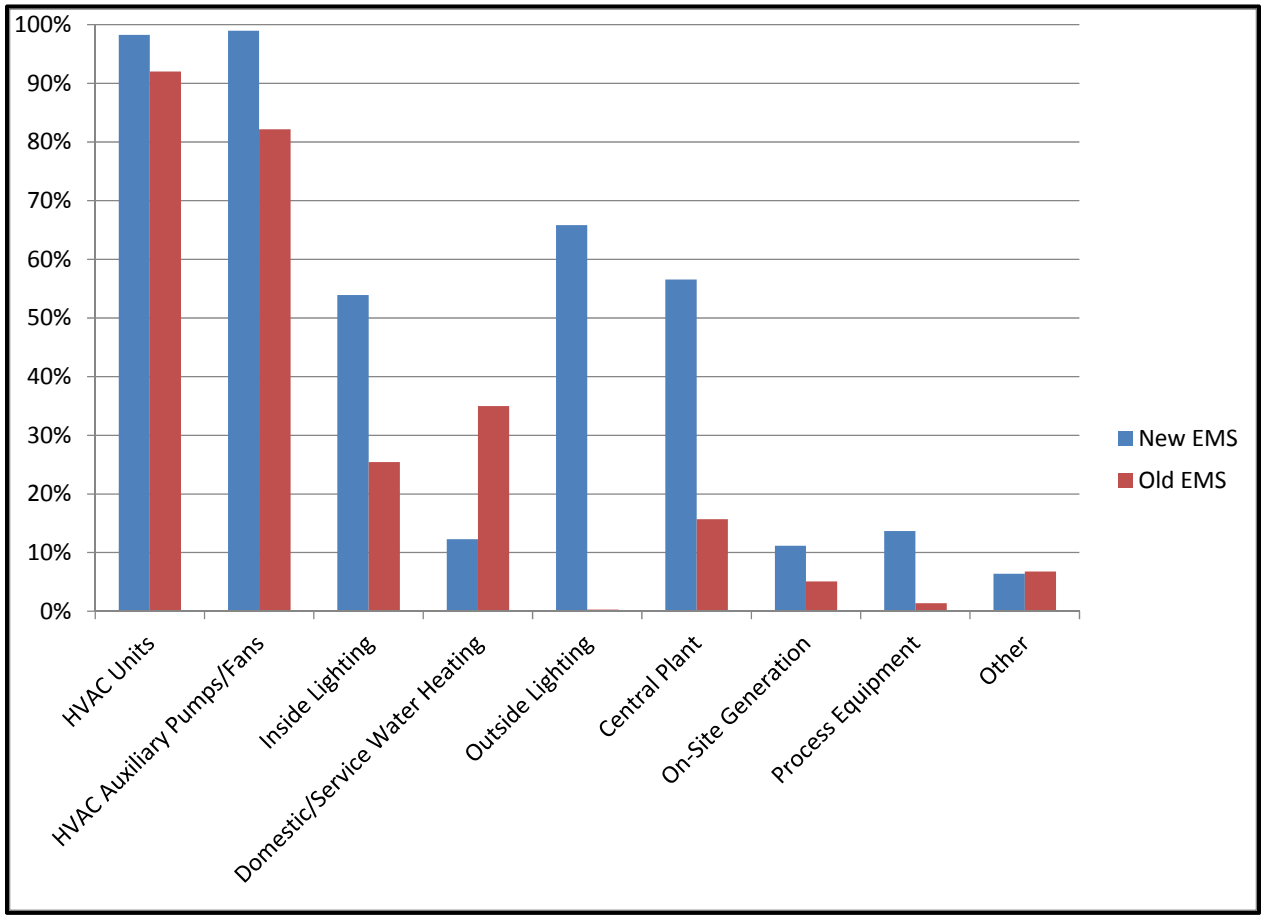
*The results presented above are weighted using the kWh-level sample weight

** These data represent 38 EE program participant and 50 non-EE program participant sites.

3.5.6 End Uses Controlled by New EMS

Disaggregating the EMS into newer versus older systems it is possible to determine if the end uses controlled by the systems differ by the age of the system. The on-site data indicate that the average number of end uses controlled by newer systems is 4.2 while older systems on average only control 2.6 systems. Figure 3-72 illustrates the share of end uses controlled by EMS for newer and older EMS. These data illustrate that newer EMS control more systems and that inside and outdoor lighting and central plant have a substantially higher share of customers controlling with newer EMS systems.

Figure 3-72: End Uses Controlled by Older and Newer EMS



*The results presented above are weighted using the kWh-level sample weight

** These data represent 88 sites.

3.6 Water Heating

The Existing Buildings Market Characterization Project and the Market Share and Sales Trend Study document the baseline distribution of existing water heaters within businesses and the efficiency distribution of new water heater purchases. Water heaters analyzed for this report are grouped as standard storage, instantaneous or tank-less, heat pump, boiler/central plant, or other.

3.6.1 Water Heating Data

Table 3-28 presents information on the total number of on-sites by business type and the number of on-sites where information on water heating equipment was collected. The on-site data collection recorded water heating manufacturer and model numbers where possible. These data will be used in energy efficiency lookups to characterize the efficiency distribution of water heaters in Massachusetts' businesses. The two right-most columns in Table 3-28 list the share of water heating units where manufacturer and model information were recorded.

For example, one campus site that we visited did not have a water heater serving the account premise, so on-site data was collected from eight of the nine campus sites visited. Of the eight campus sites where water heating information was present, 78% of the water heating systems had manufacturer and model number collected.

Table 3-23: On-site Survey Customer Counts by Business Type and Water Heater Data

Building Type	On-sites	Counts of On-sites with Hot Water	Percent of WHs with available Make and Model
Campuses	9	8	78%
Education	31	31	76%
Food Sales	25	24	69%
Food Service	31	31	84%
Healthcare	19	19	74%
Hospitals	6	5	83%
Lodging	32	32	80%
Manufacturing or Industrial	23	19	69%
Office	55	45	71%
Other	24	16	61%
Public Assembly	32	28	72%
Retail	43	36	63%
Warehouse	13	11	73%
Total	**343**	**305**	**72%**

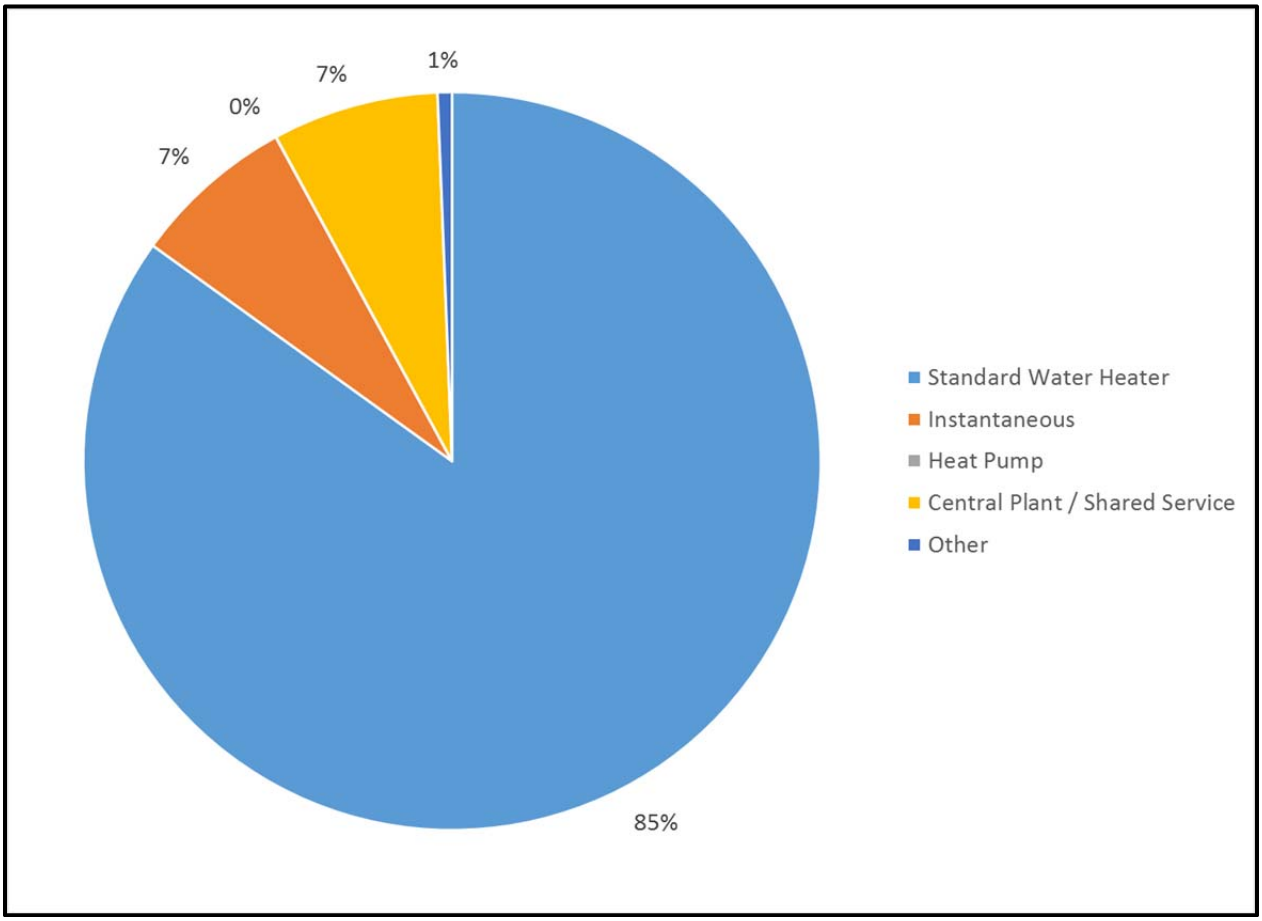
* The results presented above are Un-weighted.

**The counts indicate the number of instances the technology was found in the buildings that were visited.

3.6.2 Water Heater System Type

As part of the on-site data collection process, water heaters were classified as standard storage, instantaneous or tank-less, heat pump, boiler/central plant, or other. Figure 3-73 illustrates the distribution of these system types across the non-residential sector in Massachusetts. Standard storage water heaters are the most common type of water heater in the Massachusetts non-residential sector.

Figure 3-73: Water Heater System Type

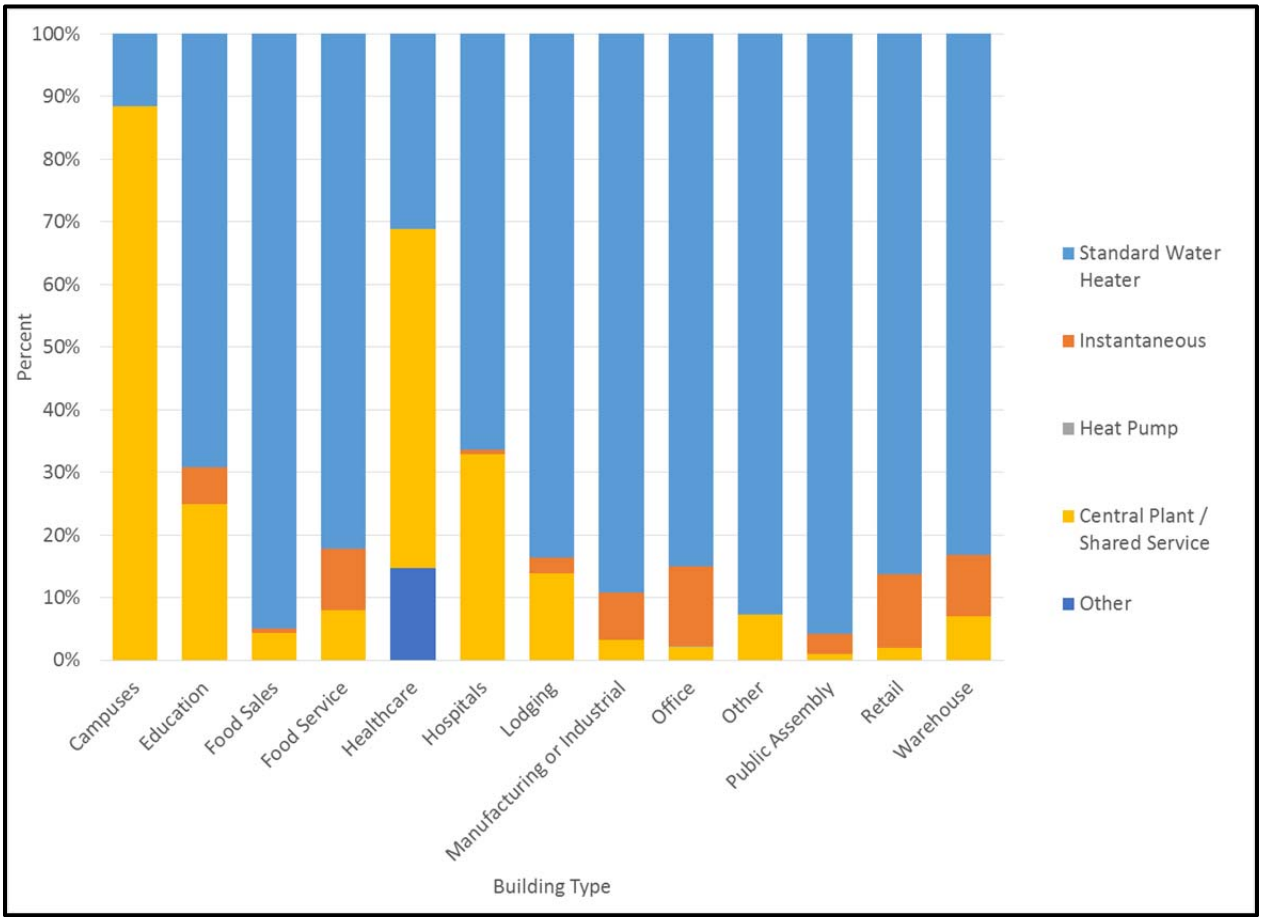


* The results are weighted using the business-level sample weight.

** These data represent 305 total sites.

Figure 3-74 provides information on the distribution of water heating system types by business type. These data indicate that standard storage water heaters represent the majority of systems for all business types other than campuses and healthcare; central plant hot water systems (including boilers) and shared services are the dominant form of hot water systems for these entities.

Figure 3-74: Water Heating System Types by Business Type

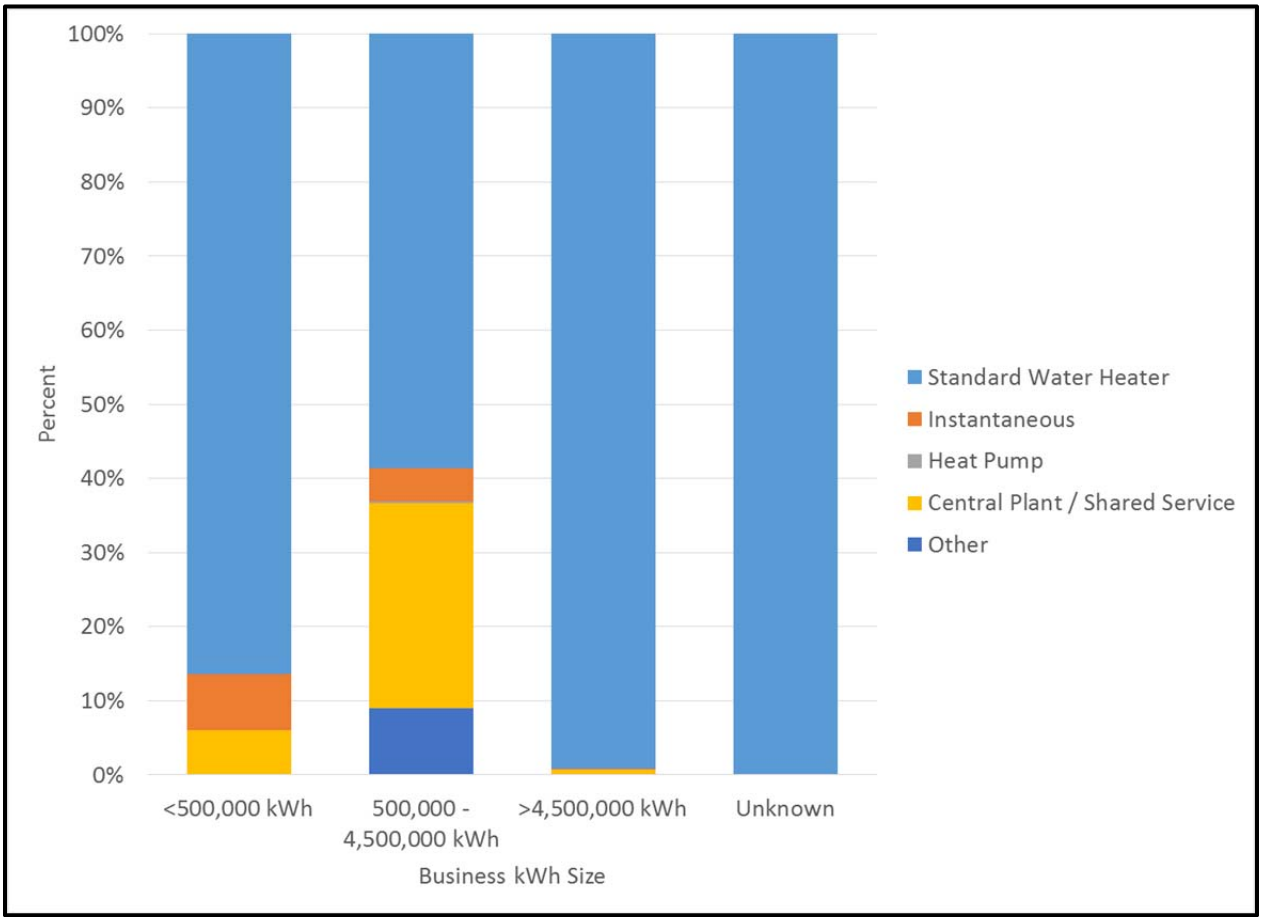


* The results are weighted using the business-level sample weight.

** These data represent 230 standard water heaters, 25 instantaneous water heaters, 1 heat pump water heater, 66 central plant/shared service systems, and 2 classified as other.

Figure 3-75 illustrates the water heater type by business size. The standard tank system is the most common water heater type for all business sizes. The greatest presence for central plants is seen in medium-sized businesses. Given the small sample size of large-sized businesses, it is necessary to wait to determine the distribution of central plant water heating systems for this segment of the business population until the additional data from Phase 2 is analyzed.

Figure 3-75: Water Heater System Type by Business Size



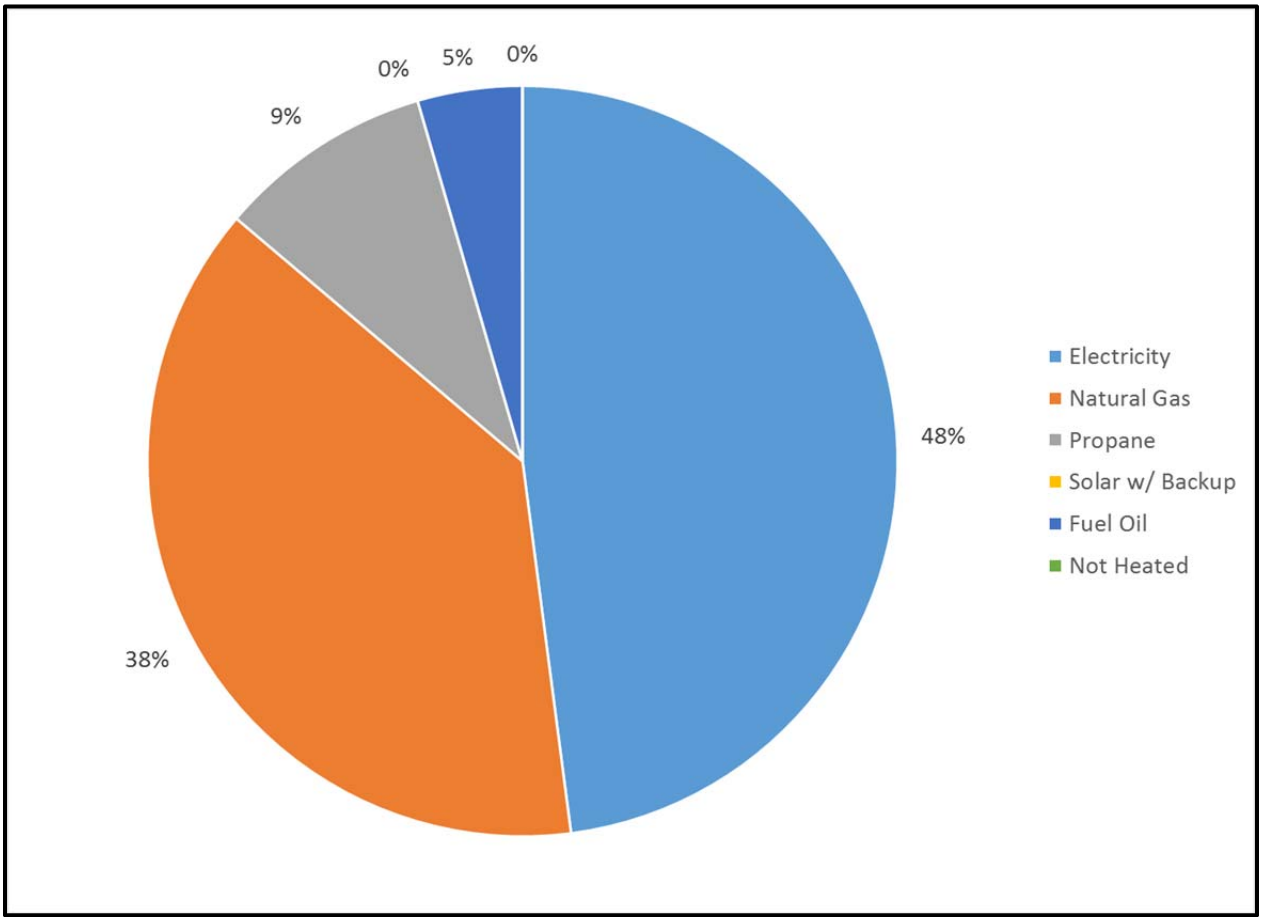
* The results are weighted using the business-level sample weight.

** These data represent 173 sites <500,000 kWh, 108 sites 500,000 – 4,500,000 kWh, 16 sites > 4,500,000 kWh, and 8 sites with an unknown size.

3.6.3 Water Heater Fuel

Figure 3-76 lists the fuel used for non-residential water heaters in Massachusetts. Non-residential water heaters in Massachusetts commonly use electricity or natural gas as a fuel source.

Figure 3-76: Water Heater Fuel



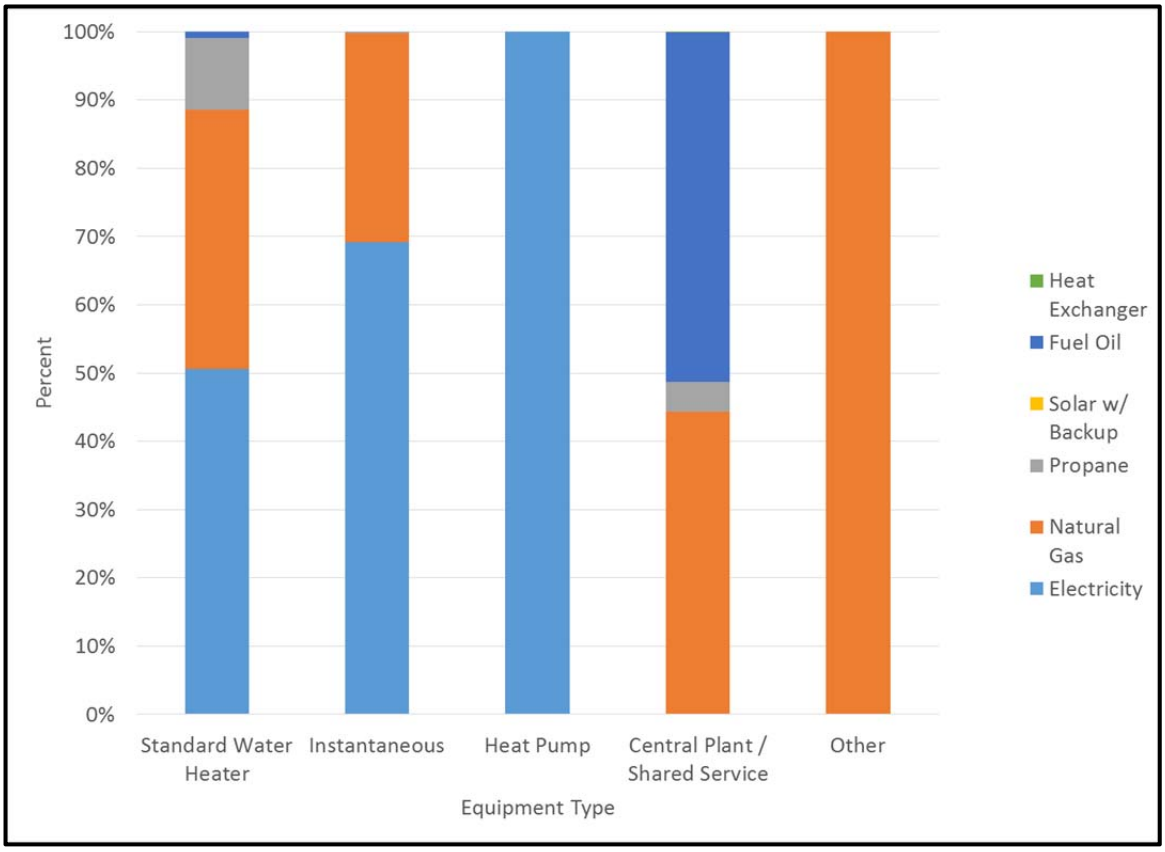
* The results are weighted using the business-level sample weight.

** These data represent 305 total sites.

3.6.4 Water Heater Fuel and System Type

Figure 3-77 illustrates the distribution of fuel types across water heater systems. Storage systems are slightly more than 50% electric, but due to the dominance of this system type (approximately 85% of water heater systems are standard storage water heaters), 90% of all electric fuel water heating systems are storage water heaters. In comparison, 100% of heat pump water heaters are electric, but only 0.03% of electric water heaters are heat pumps. Boiler and central plant water heaters are commonly fueled by natural gas (44%) or fuel oil (51%).

Figure 3-77: Share of Water Heaters System Types by Water Heater Fuel



*

*The results are weighted using the business-level sample weight.

** These data represent 230 standard water heaters, 25 instantaneous water heaters, 1 heat pump water heater, 66 central plant/shared service systems, and 2 classified as other.

3.6.5 Water Heater Efficiency Information

During the on-site data collection effort, the surveyors collected make and model number information to help determine the efficiency distribution of water heaters in Massachusetts businesses. The make and model numbers for the standard tank and tankless systems were looked up and efficiency information was collected. These data were compared to information on federal water heater standards. . The efficiencies for all of the water heating equipment in the analysis are compared to current efficiency standard levels. Comparison to current standards is necessary because the purchase date of equipment is not available for all units and a comparison to current standards provides information on the energy efficiency savings potential relative to current standards.

Table 3-29 lists the federal water heater efficiency standards used in the make and model lookup efficiency determinations. The standards for water heaters vary by system type, capacity fuel, size, and system usage (domestic hot water and service hot water). As **Table** 3-29 illustrates, the water heater efficiency standards are very complicated. Careful review of the water heater standards also indicate that

water heaters with a tank capacity under 20 gallons are not currently regulated. These types of water heaters will appear as water heaters with "No Standards" in the efficiency presentation.

Table 3-24: Water Heater Efficiency Parameters and Standards[34]

Standard Type	Equipment Type	Input Capacity	Input Capacity Units	Fuel Type	Tank Capacity	Efficiency Minimum	Efficiency Units	Year of Compliance
Res - WH	Standard Water Heater	≤ 75	kBtuh	Nat Gas	20 to 100 gal	0.67-(0.0019* tank Cap)	Energy Factor (EF)	2004*
Res - WH	Standard Water Heater	≥ 105	kBtuh	Fuel Oil	≤ 50 gal	0.59-(0.0019* tank Cap)	Energy Factor (EF)	2004*
Res - WH	Standard Water Heater	≤ 12	kW	Ele	20 to 120 gal	0.97-(0.00132* tank Cap)	Energy Factor (EF)	2004*
Res - WH	Instantaneous	< 200	kBtuh	Nat Gas / Propane	N/A	0.62-(0.0019* tank Cap)	Energy Factor (EF)	2004*
Res - WH	Instantaneous	≤ 12	kW	Ele	N/A	0.93-(0.00132* tank Cap)	Energy Factor (EF)	2004*
Com - WH	Standard Water Heater	N/A	N/A	Nat Gas	> 100 gal	0.8	Thermal Efficiency (Et)	2001
Com - WH	Standard Water Heater	> 75	kBtuh	Nat Gas	N/A	0.8	Thermal Efficiency (Et)	2001
Com - WH	Standard Water Heater	N/A	N/A	Fuel Oil	> 50 gal	0.78	Thermal Efficiency (Et)	2001
Com - WH	Standard Water Heater	> 105	kBtuh	Fuel Oil	N/A	0.78	Thermal Efficiency (Et)	2001
Com - WH	Instantaneous	≥ 200	kBtuh	Nat Gas / Propane	N/A	0.8	Thermal Efficiency (Et)	2001
Com - WH	Instantaneous	> 210	kBtuh	Fuel Oil	N/A	0.78	Thermal Efficiency (Et)	2001

* Amended standards have been provided for compliance starting April 2015, with updates made to the Efficiency Minimum.

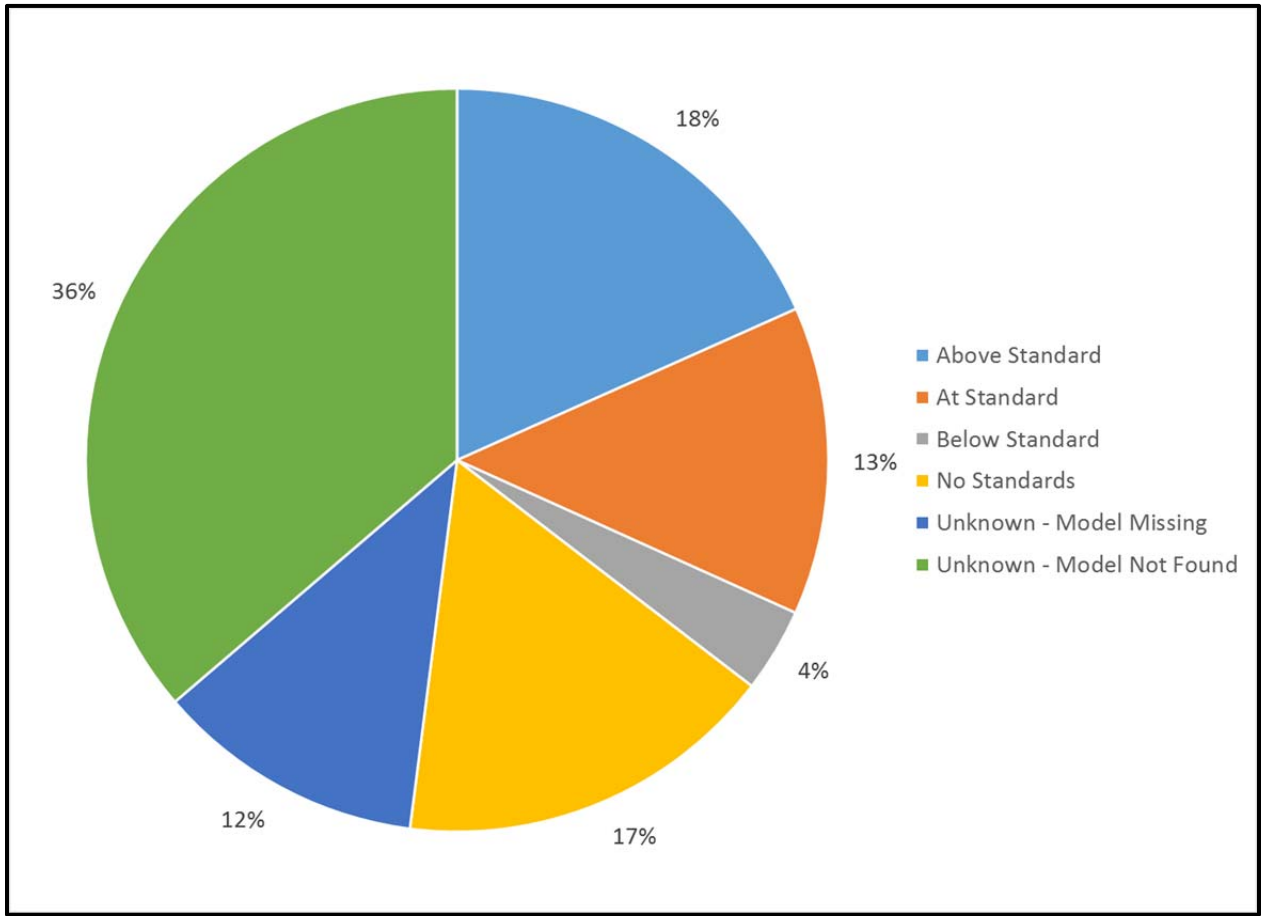
To allow for a comparison across the various domains of interest, the presentation of water heater efficiency is presented with systems classified as above standards, at standards, and below current standards. Figure 3-78 illustrates the efficiency distribution of water heaters observed during Wave 1 data collection. These data indicate that the largest share of water heaters is represented by "Model Not Found". These are units where the make and model numbers were collected, but efficiency information on these units was unavailable or other information needed to classify the unit was missing. "Model Missing" represents units where model numbers could not be collected during the on-site effort. For units where efficiency was assigned, the largest share of units were found to be above current efficiency standards (18%) though models with "no standards" are nearly as common as models above standard (17%).

[34] The residential water heater standards are from http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27. The residential boiler standers are from http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/product/72. The commercial water heater and boiler specifications come from http://www.regulations.gov/#!documentDetail;D-EERE-2014-BT-STD-0041-0001. The central plant efficiency specification are from http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/74.

Finding that very few water heaters are below current standards is remarkable given the long expected lives of water heaters. As shown in Table 3-24, however, water heater energy efficiency standards are relatively old, having been implemented from 2001-2004. The water heater standards associated with residential sized water heaters are being updated April 2015. This update may lead to a change in the above, at, and below standard distribution. For the Final Report, a review of the number of units by size and fuel will be undertaken to determine if it is possible to present information on actual efficiencies given the samples sized following Phase 2 data collection.

Finding that a substantial share of commercial water heaters are not covered by current standards could have implications for energy consumption if these units use substantial energy to supply hot water. Developing a better understanding of the energy usage associated with water heaters not currently covered by energy efficiency standards could help determine if these units should or can be incorporated into energy efficiency programs in the future.

Figure 3-78: Water Heater Efficiency Distribution

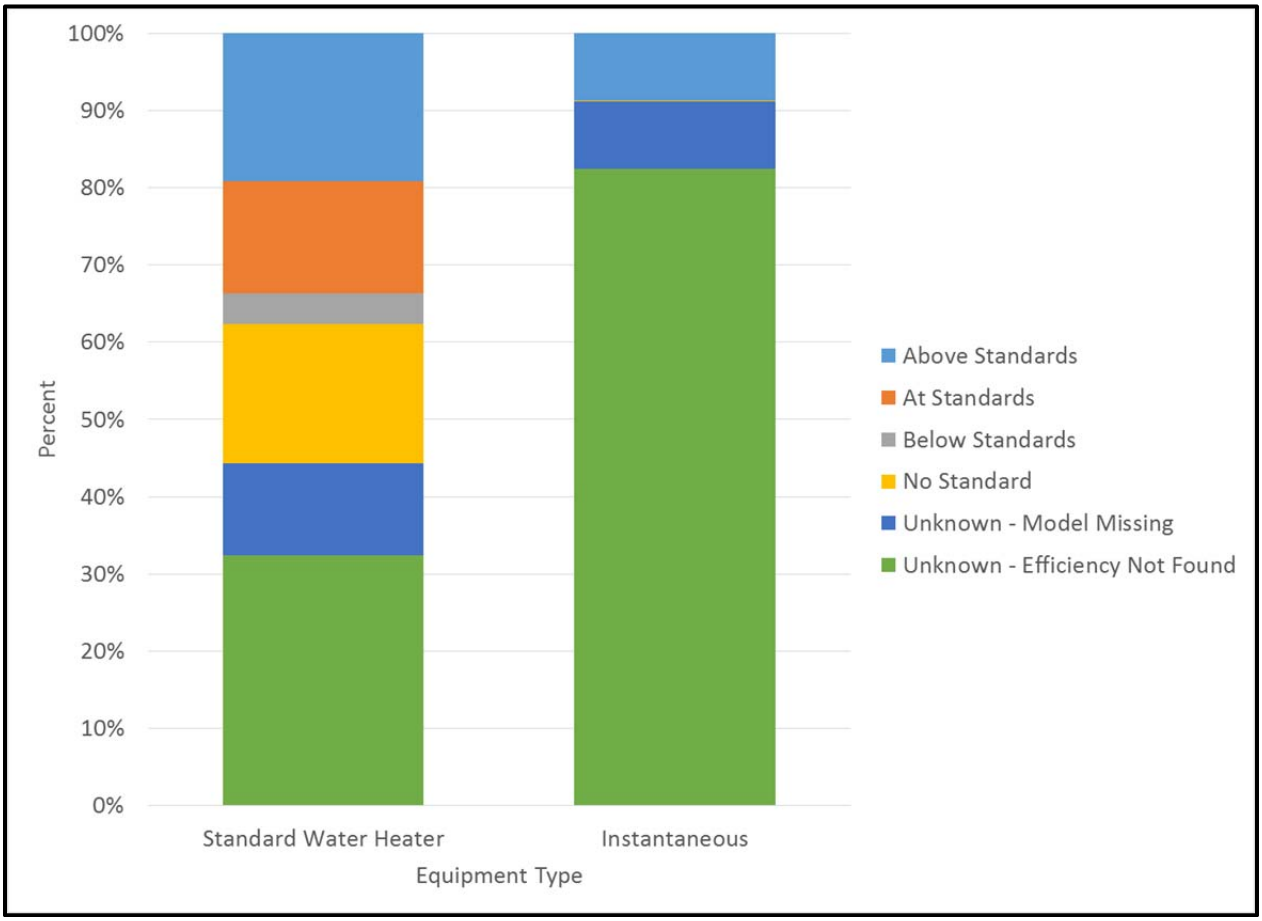


* The results are weighted using the business-level sample weight.

** These data represent 305 total sites.

Figure 3-79 illustrates the distribution of known efficiency by system standard tank and instantaneous systems. Standard tank hot water heaters have a larger known efficiency distribution than any other water heater system type. These data clearly indicate that finding the efficiency of tankless systems is difficult.

Figure 3-79: Water Heater Efficiency Distribution by System Type



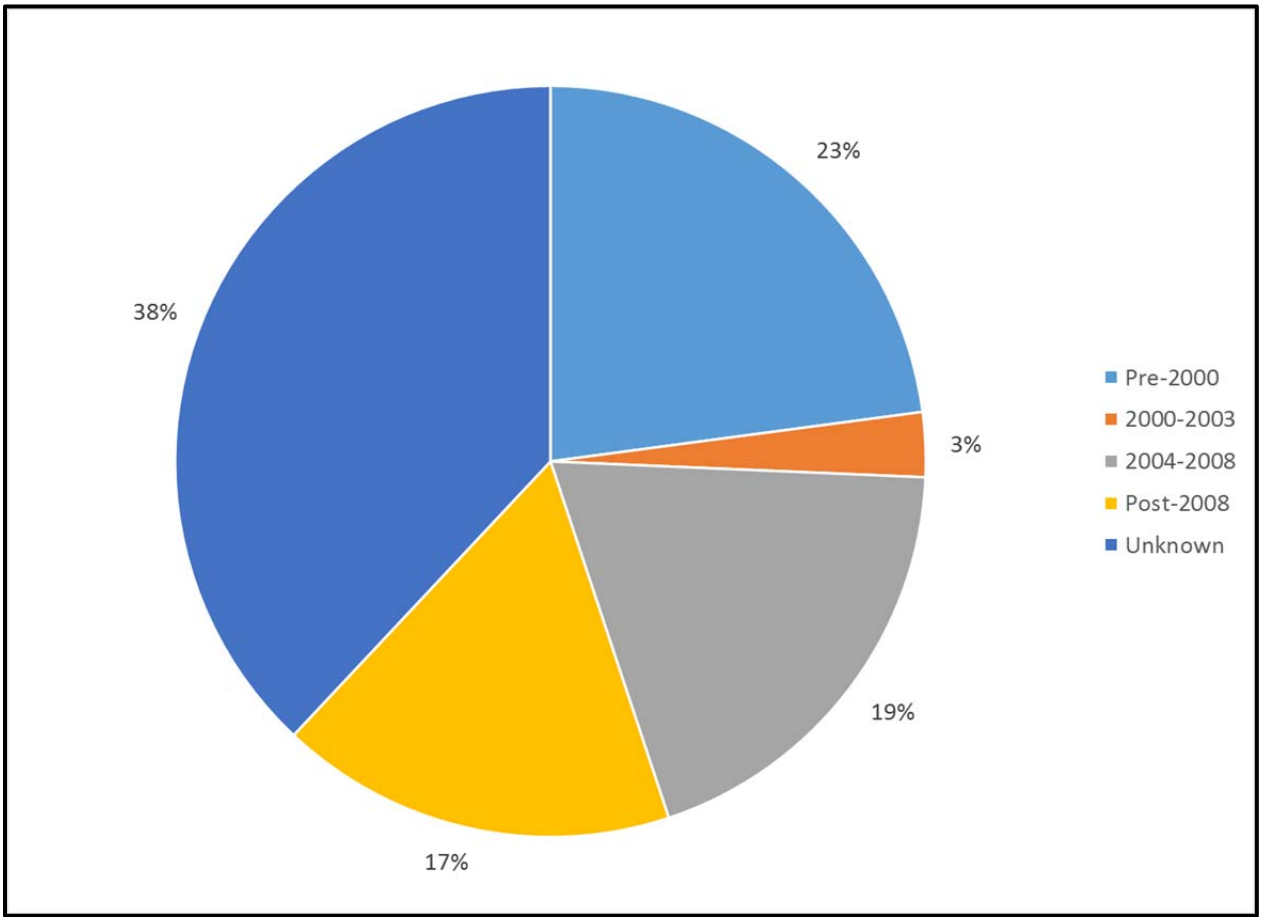
* The results are weighted using the business-level sample weight.

** These data represent 230 standard water heaters and 25 instantaneous water heaters.

3.6.6 Water Heater Age

The C&I Customer On-site Assessments study collected information on the water heater age. If field staff were unable to collect information on the ages of water heaters, they were instructed to ask the site contact if the water heater was purchased after January 1, 2009. Figure 3-80 illustrates the water heater age distribution while Figure 3-81 illustrates the water heater age distribution by business type. These data indicate that 17% of observed water heaters were designated as newer water heaters or installed Post 2008.

Figure 3-80: Water Heater Age Distribution

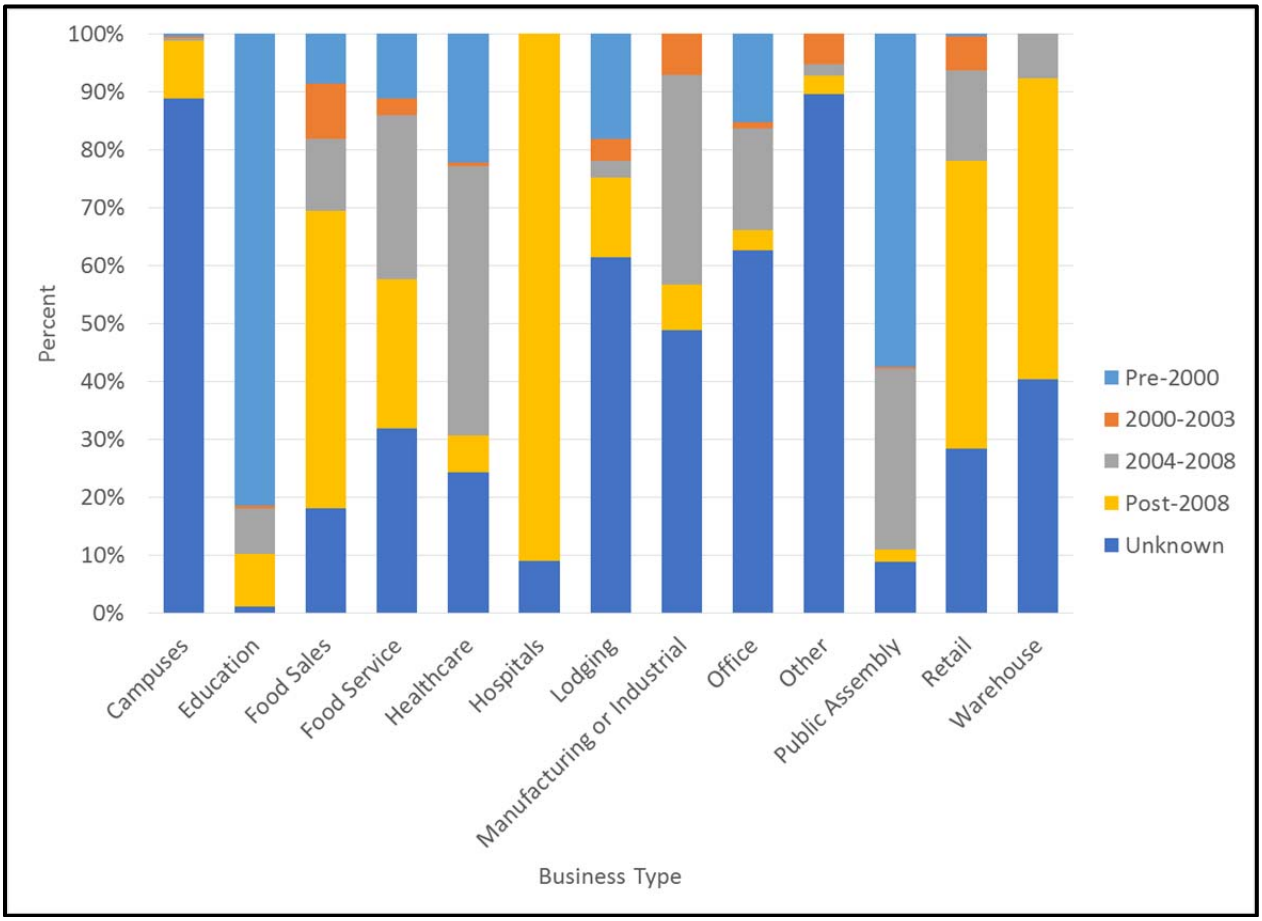


* The results are weighted using the business-level sample weight.

** These data represent 357 total systems.

Figure 3-81 illustrates the water heater age distribution by business type. The business type information indicates that food sales, hospitals, retail, and warehouses have a large share of new water heating while water heating systems in education and public assembly are largely older systems. Figure 3-82 determined, medium sized businesses are found to have the largest share of new water heaters, while small businesses tend to have older water heating systems.

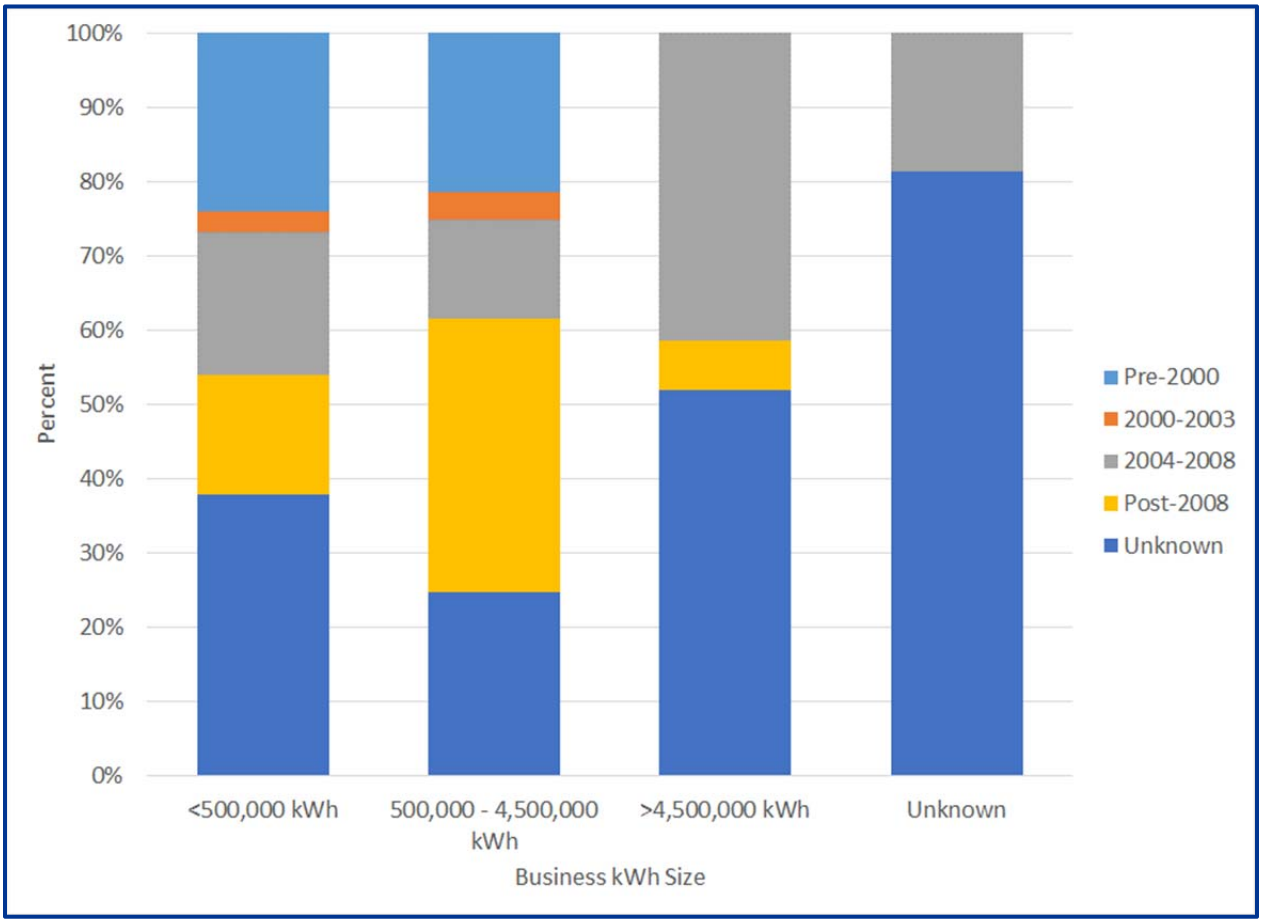
Figure 3-81: Water Heater Age Distribution by Business Type



* The results are weighted using the business-level sample weight.

** These data represent 35 systems pre-2000, 27 systems aged 2000-2003, 54 systems aged 2004-2008, 105 systems post-2008, and 136 systems with unknown age.

Figure 3-82: Water Heater Age by Business Size



* The results are weighted using the business-level sample weight.

** These data represent 173 sites <500,000 kWh, 108 sites 500,000 to 4,500,000 kWh, 16 sites > 4,500,000 kWh, and 8 sites of unknown kWh size.

3.6.7 New Water Heaters

In this section, the data from the on-site data collection is analyzed to develop a better understanding of recent sales of non-residential water heater systems in Massachusetts in the MSST. For the MSST study, the analysis presented in this section is focused on sites with water heaters installed from 2009 to 2014. Table 3-30 presents information on the number of on-sites completed, the number of on-sites with at least one new hot water heating systems, and the manufacturer and model information of these systems that could be recorded on-site. The two right-most columns in Table 3-30 list the share of new water heating units where manufacturer and model information were recorded, and the share of sites with new water heating where at least one record contained manufacturer and model information.

Table 3-25: New Water Heater On-site Survey Customer Counts by Business Type and Water Heater Data

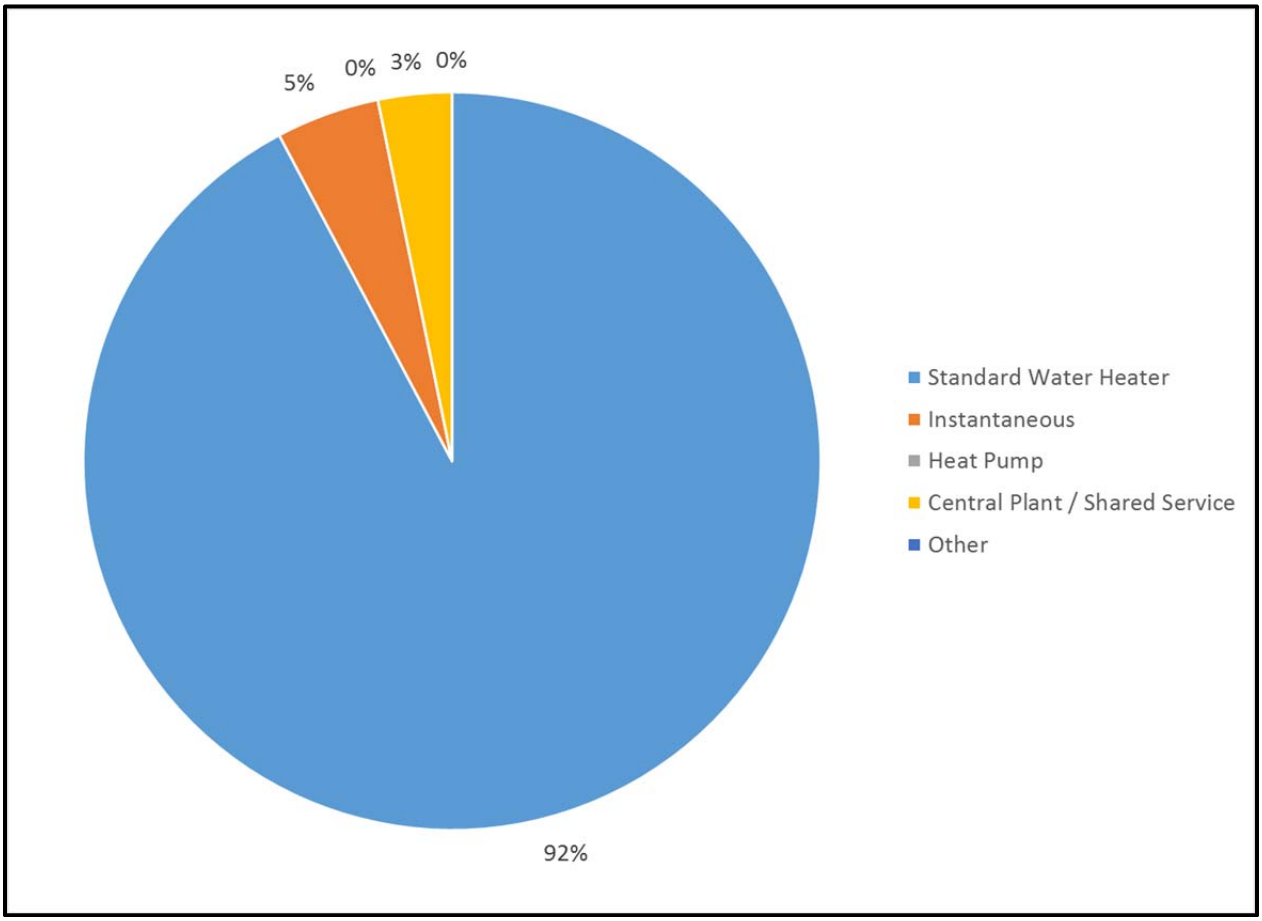
Building Type	On-sites	On-sites with New Hot Water Systems	Percent of new WHs with available Make and Model	Percent of Sites with New WHs with Make and Model
Campuses	9	5	86%	80%
Education	31	13	86%	85%
Food Sales	25	9	89%	89%
Food Service	31	13	93%	92%
Healthcare	19	7	86%	86%
Hospitals	6	4	100%	100%
Lodging	32	10	100%	100%
Manufacturing or Industrial	23	7	78%	71%
Office	55	12	100%	100%
Other	24	2	100%	100%
Public Assembly	32	5	100%	100%
Retail	43	13	82%	85%
Warehouse	13	5	83%	80%
Total	**343**	**105**	**90%**	**90%**

* The results presented above are Un-weighted.

New Water Heater System Type

Figure 3-83 illustrates the system type distribution for new water heaters. These data indicate that the large majority of newly purchased water heaters are standard tank water heating systems.

Figure 3-83: New Water Heater System Type Distribution



* The results are weighted using the business-level sample weight.

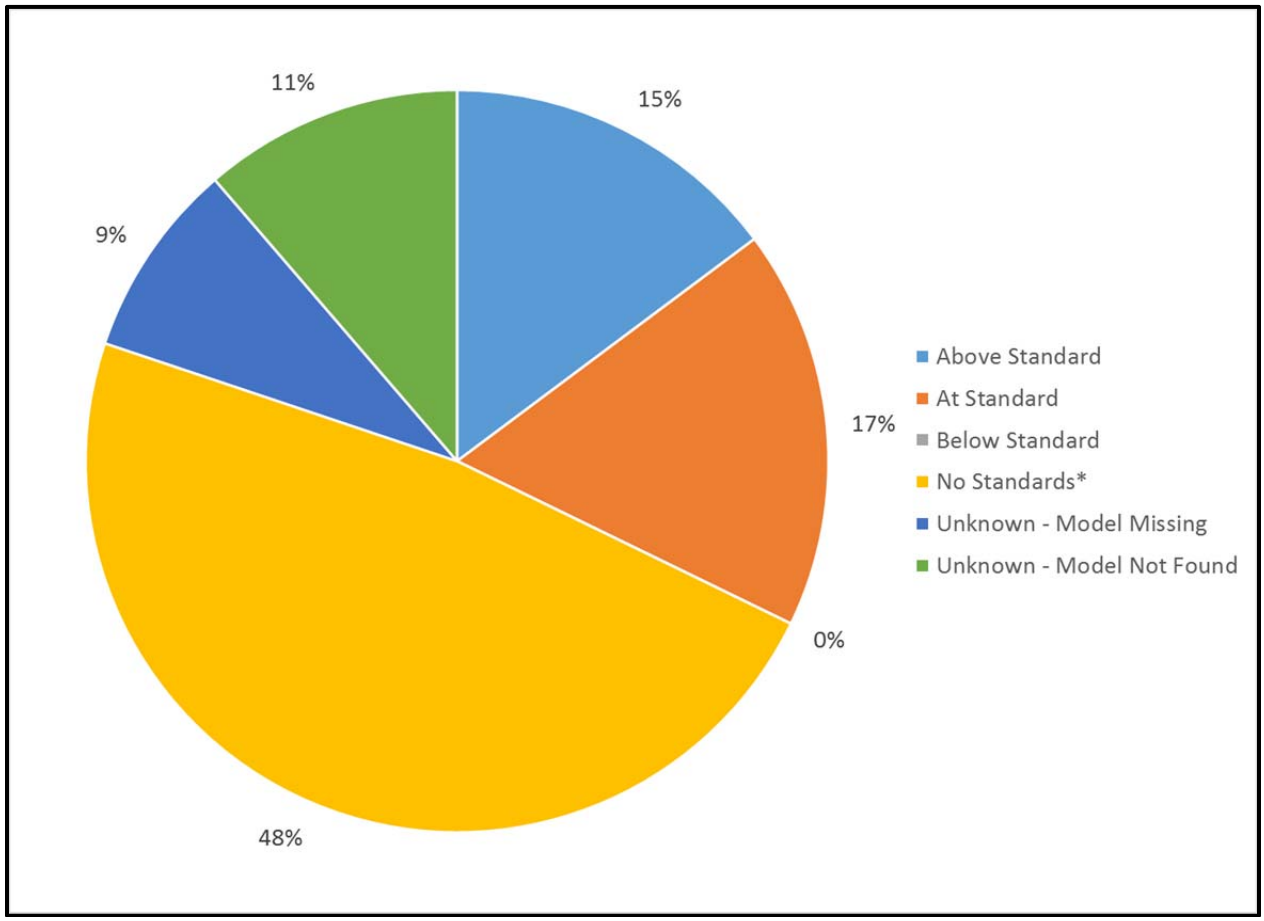
** These data represent 105 sites

Efficiency Distribution for New Standard Tank and Instantaneous Water Heaters

During the on-site data collection effort, the surveyors collected make and model number information to help determine the efficiency distribution of newly purchased standard tank and instantaneous water heaters in Massachusetts businesses. The make and model numbers were looked up and efficiency information was collected. These data were compared to information on federal water heater standards (see Table 3-24). Figure 3-84 illustrates the efficiency distribution of water heaters observed during the Phase 1 data collection. These data indicate that the largest share of water heaters is represented by "No Standards". These are units whose tank capacity is less than 20 gallons and there are not efficiency standards governing these units. New water heaters were fairly similarly likely to be above and at standards. From the available data, new water heaters do not appear to be significantly more energy efficient than existing water heaters.

Given that the recent purchase information is for a small number of sites and that large weights within these sites are leading to dramatic swings in the efficiency distribution, it is necessary to wait until additional data is collected in Phase 2 to draw conclusions for the efficiency distribution of new water heaters.

Figure 3-84: New Water Heater Efficiency Distribution for Standard and Instantaneous Water Heaters



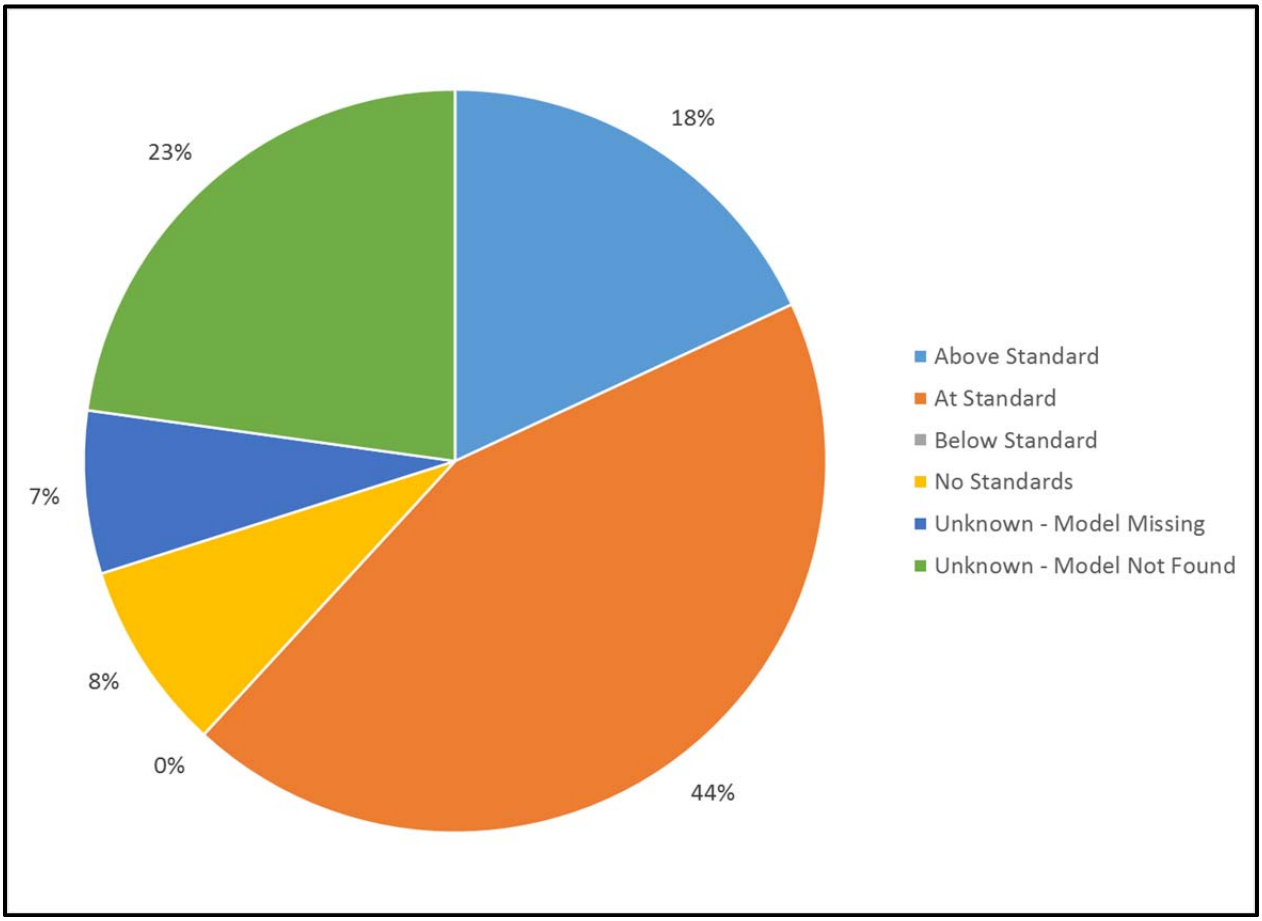
* The large weighted percent is based off of a single small (<500,000 kWh) retail site with a very large business-level weight

** The results are weighted using the business-level sample weight. These data are for water heaters purchased from 2009-2014.

*** These data represent 90 sites

Figure 3-85 illustrates the efficiency distribution of new water heaters for PA energy efficiency program participants. As seen, program participants for water heating equipment of known efficiency are likely to install equipment at or above standards. Figure 3-86 similarly shows efficiency distributions of water heating equipment for EE program non-participants. A large share of the equipment is found to be of unknown efficiency. Additional data of recent water heater purchases are needed to draw conclusions on the efficiency distribution of recent purchases.

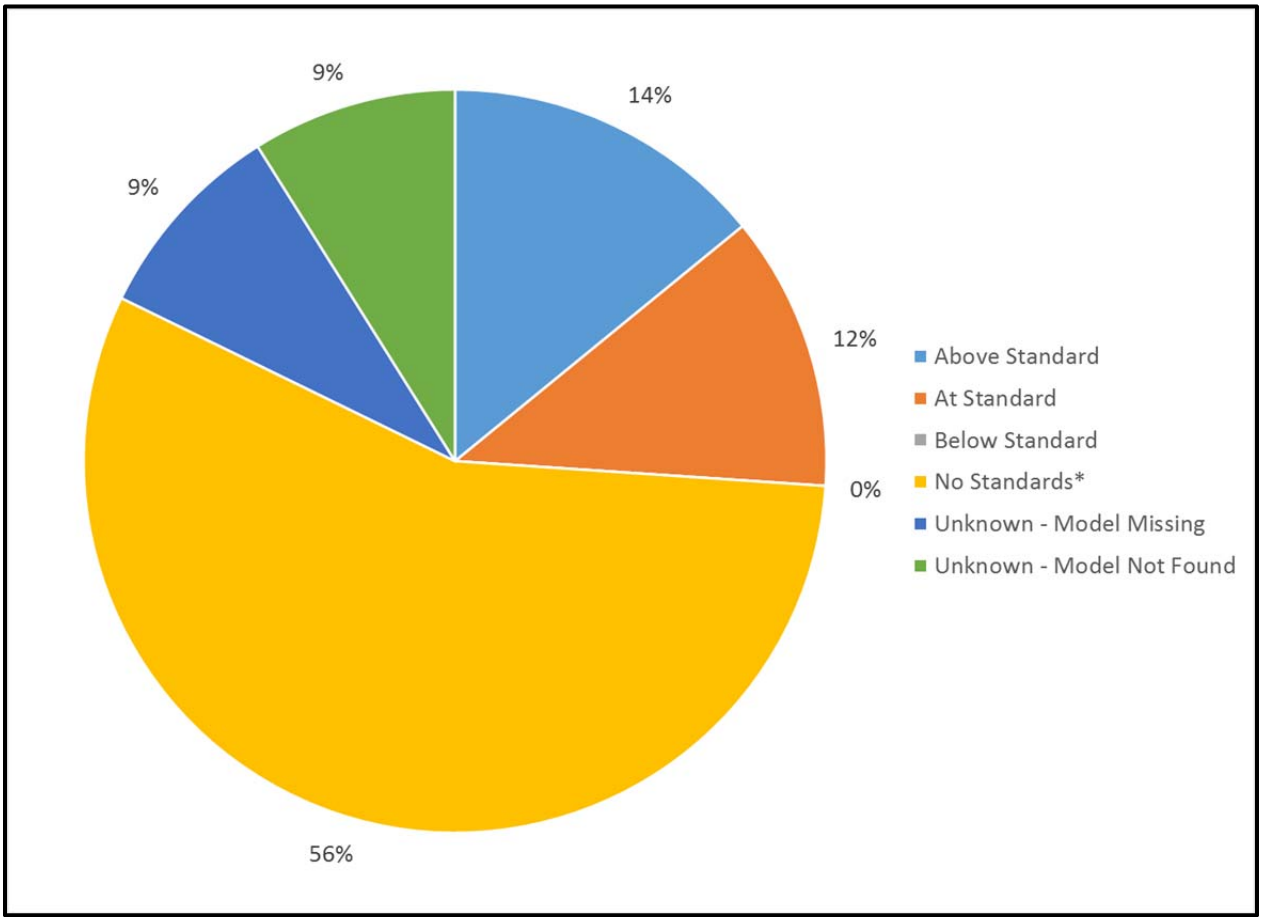
Figure 3-85: New Water Heater Efficiency Distribution of Participants



* The results are weighted using the business-level sample weight. These data are for water heaters purchased from 2009-2014.

** These data represent 33 sites

Figure 3-86: New Water Heater Efficiency Distribution of Non-Participants



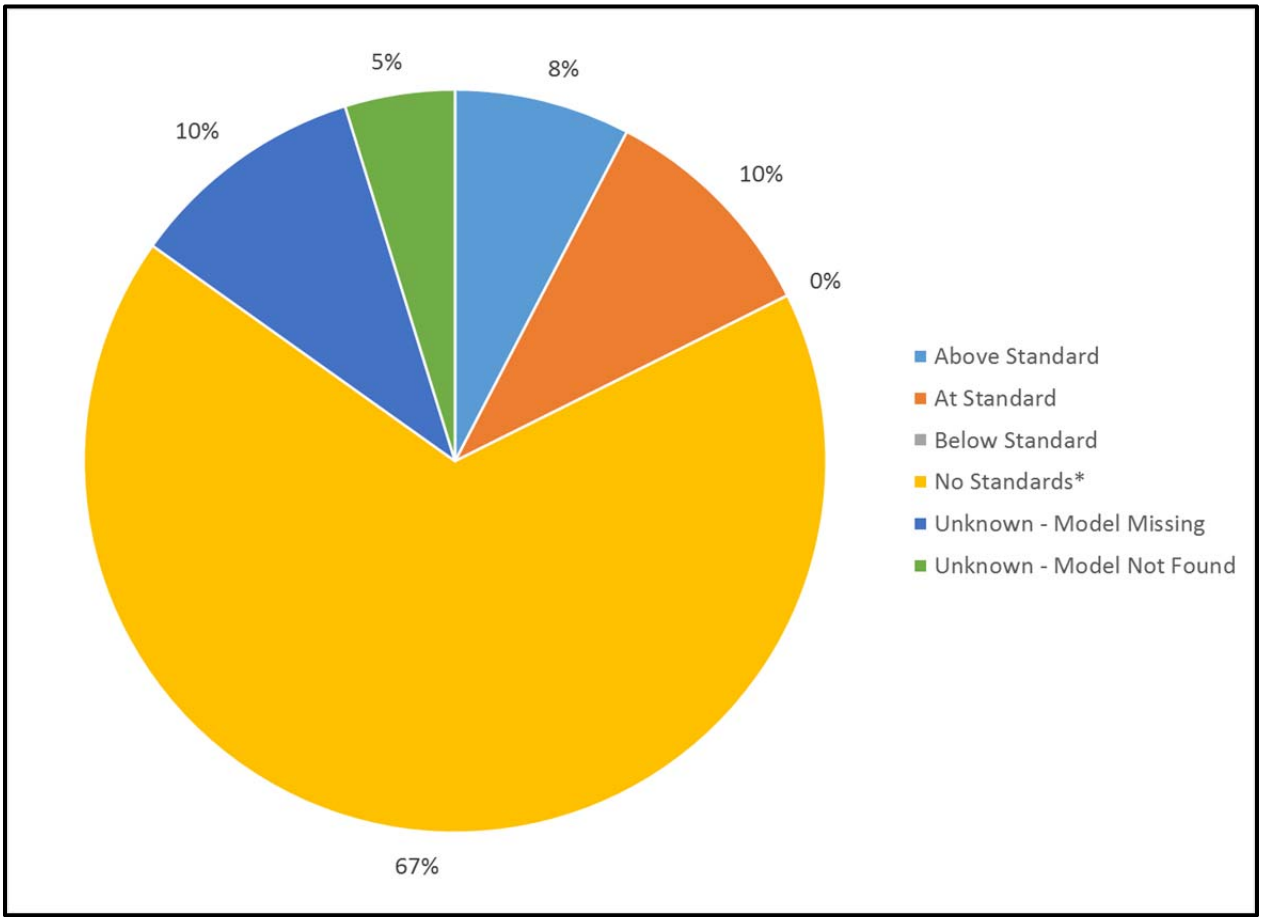
* The large weighted percent is based off of a single small (<500,000 kWh) retail site with a very large business-level weight

** The results are weighted using the business-level sample weight. These data are for water heaters purchased from 2009-2014.

*** These data represent 57 sites

Figure 3-87 and Figure 3-88 illustrate the efficiency distribution of new electric and gas water heaters collected during the Phase 1 of the data collection effort respectively. As seen, the highest share of the electric distribution is held by the "No Standards" category. Where efficiency could be determined, most new electric water heaters were found to be at standards or above standards. Gas water heaters on the other hand were found to be mostly at or above standards.

Figure 3-87: New Water Heater Efficiency Distribution of Electric Units

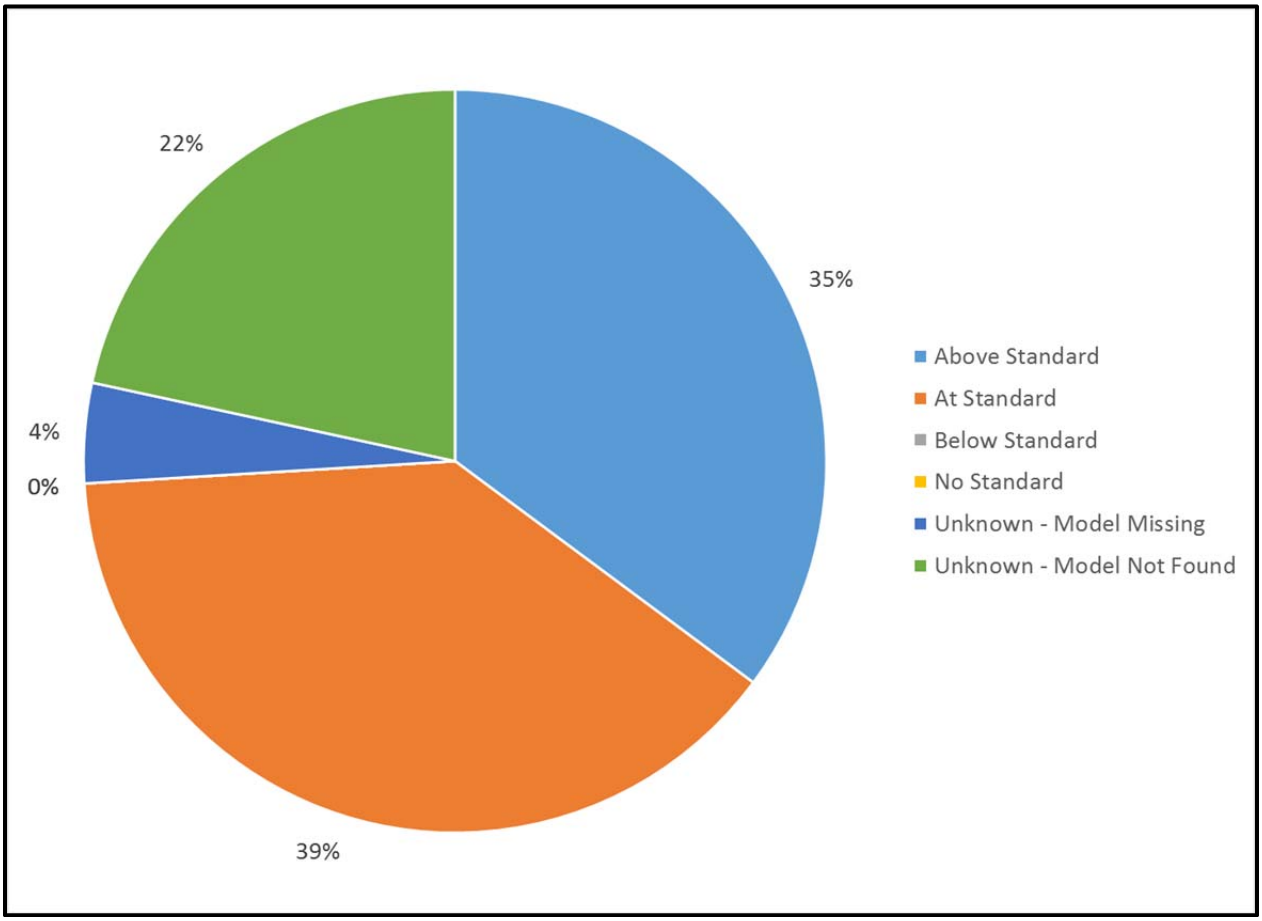


* The large weighted percent is based off of a single small (<500,000 kWh) retail site with a very large business-level weight

** The results are weighted using the business-level sample weight. These data are for water heaters purchased from 2009-2014.

*** These data represent 45 sites

Figure 3-88: New Water Heater Efficiency Distribution of Gas Units

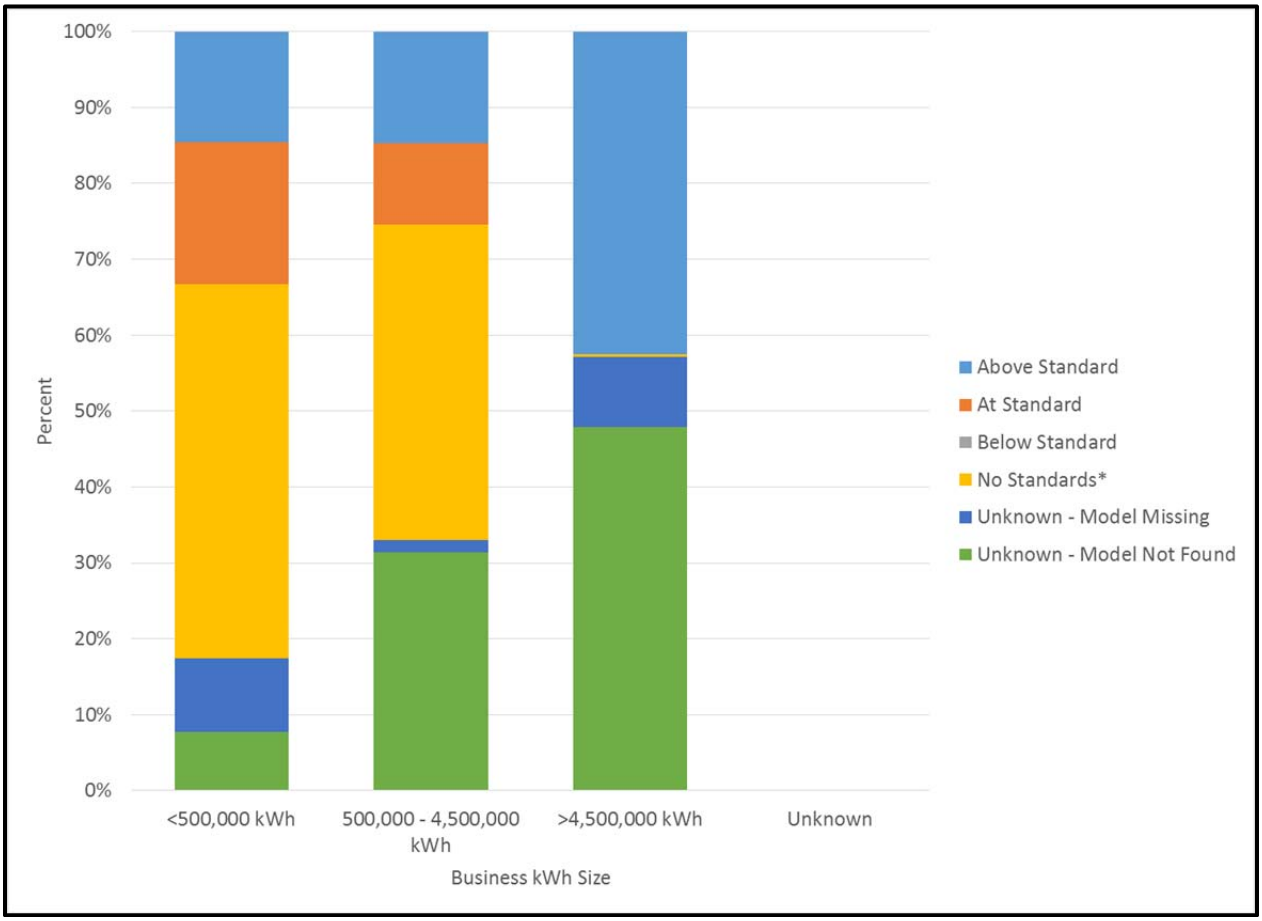


* The results are weighted using the business-level sample weight. These data are for water heaters purchased from 2009-2014.

** These data represent 49 sites

Figure 3-89 represents the efficiency of recently purchased water heating equipment at commercial establishments by size of the business. Large businesses have the greatest share of above standard equipment of all the size categories.

Figure 3-89: New Water Heater Efficiency Distribution by kWh Business Size



* The large weighted percent is based off of a single small (<500,000 kWh) retail site with a very large business-level weight

** The results are weighted using the business-level sample weight. These data are for water heaters purchased from 2009-2014.

*** These data represent 90 sites.

3.7 Refrigeration

Refrigeration systems represent a significant source of energy usage within the non-residential sector. Within select commercial segments refrigeration usage accounts for a significantly higher share of usage than for the average commercial business. Refrigeration systems account for a higher share of whole business electricity usage within food stores, refrigerated warehouses, and food service. Collecting information on the saturation, distribution, and quantity of refrigeration systems, technologies, and measures will help the PAs and evaluation team better understand how refrigeration energy usage is linked to existing equipment and how programs can be improved to help reduce refrigeration energy usage.

3.7.1 Refrigeration Data

Table 3-26 presents information on the total number of on-sites completed during 2014 and the number of on-sites where refrigeration data were collected. These data indicate that refrigeration information was collected for 100% of the food sales and service businesses while refrigeration data was collected for only 78% of campusesThe final column in Table 3-26 provides information on the share of all sites with refrigeration. These data imply that education sites account for 10% of the on-sites where refrigeration equipment was observed.

Table 3-26: On-site Survey Customer Counts by Business Type and Refrigeration Data

Building Type	On-sites	Counts of Sites with Refrigeration	Share of Sites with Refrigeration by Business Type	Share of all Sites with Refrigeration
Campuses	9	7	78%	3%
Education	31	28	90%	10%
Food Sales	25	25	100%	9%
Food Service	31	31	100%	11%
Healthcare	19	17	89%	6%
Hospitals	6	6	100%	2%
Lodging	32	27	84%	10%
Manufacturing or Industrial	23	17	74%	6%
Office	55	37	67%	13%
Other	24	19	79%	7%
Public Assembly	32	25	78%	9%
Retail	43	31	72%	11%
Warehouses	13	8	62%	3%
Total	343	278	81%	100%

* The results presented above are Un-weighted.

**The counts indicate the number of instances the technology was found in the buildings that were visited

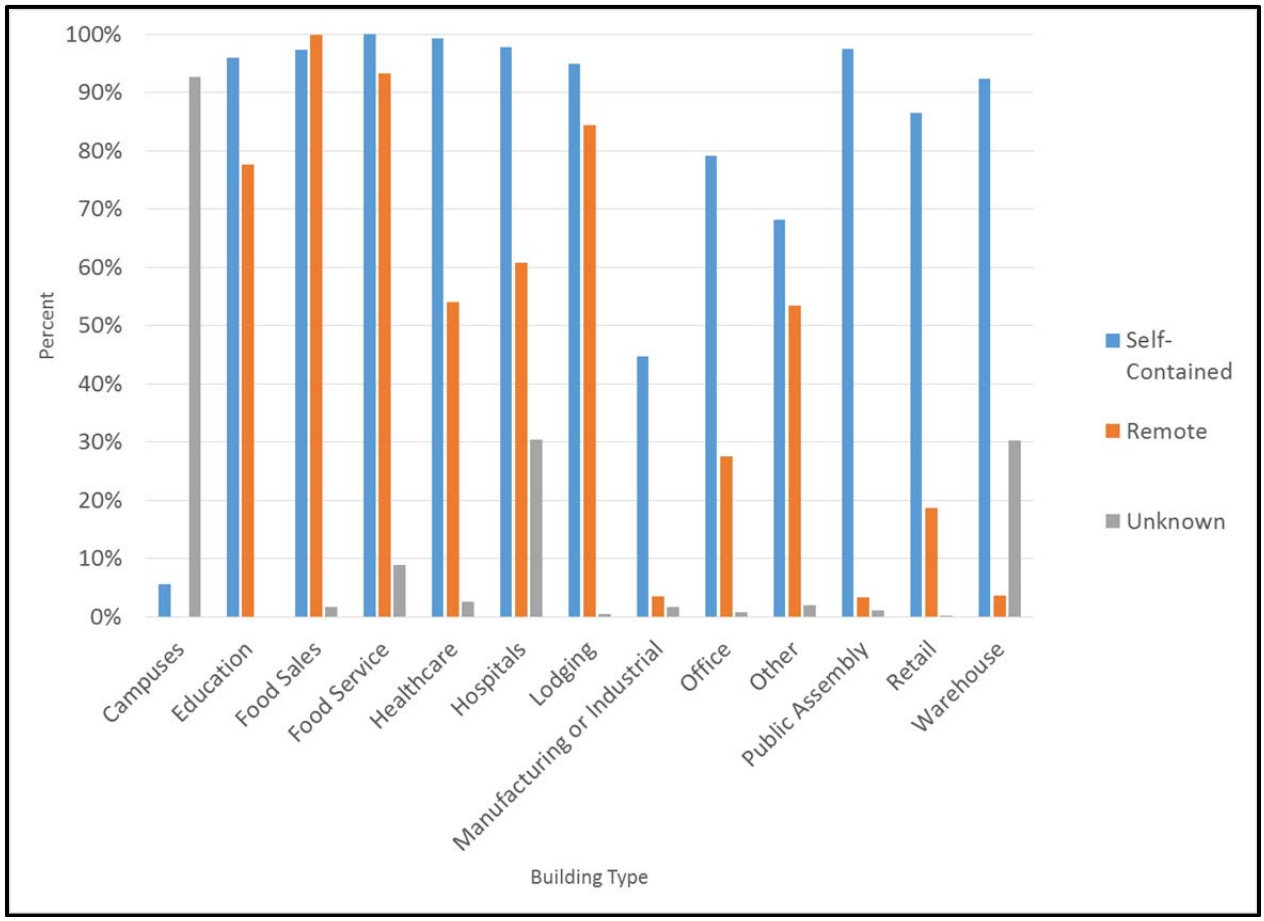
3.7.2 Refrigeration Equipment

For this study, refrigeration systems were broken down into different types of refrigeration: remote refrigeration and self-contained refrigeration. Remote refrigeration systems refer to systems where the compressor/condenser are located outside the refrigeration unit itself. This includes systems that have a single compressor/condenser serving the individual unit itself, as well as central rack systems that serve multiple refrigeration units. Self-contained refrigeration refers to units where all refrigeration components are housed within the unit itself. Systems where the on-site data collection did not provide clarification of the system type are described as unknown for the interim report. Figure 3-90 presents information on the share of businesses with different types of refrigeration systems by business type. Note that remote refrigeration systems are concentrated in the food sales, food services, lodging and education.[35] Self-

[35] The information in Figure 3-90: Percent of Businesses with Refrigeration by Type of presents the share of sites with a specific type of refrigeration. Later results will indicate that while few warehouses have remote refrigeration, warehouse RR systems are very large.

contained refrigeration systems are more common and are found in all business segments, but the highest percentages are in food services, food sales, healthcare, and hospitals.

Figure 3-90: Percent of Businesses with Refrigeration by Type of Refrigeration



* The results are weighted using the kWh-level sample weight

** These data reflect 265 self-contained units, 115 remote refrigeration units, and 22 unknown units.

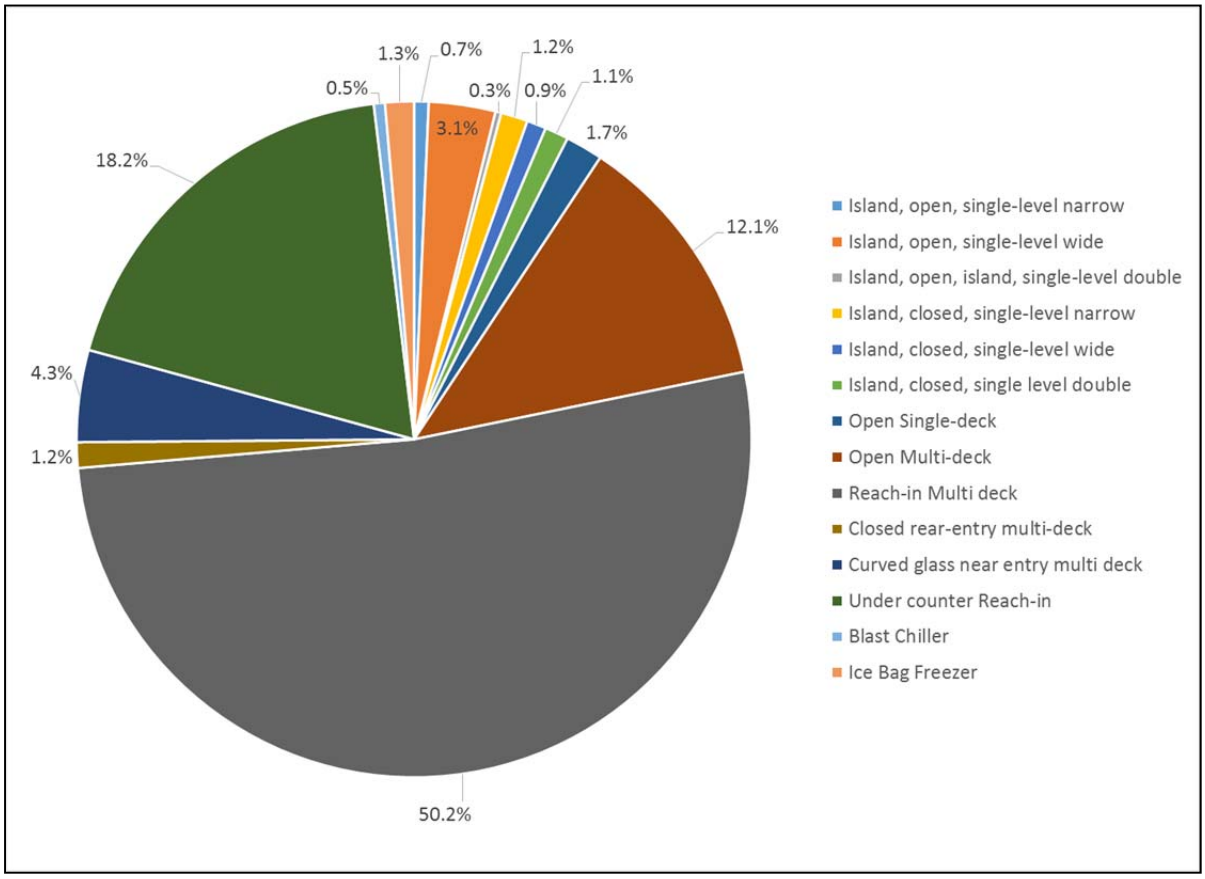
*** Of the nine campuses visited during wave one, none of the sampled buildings included cafeterias.

3.7.3 Refrigerated Cases

The on-site survey collected information on many different types of cases, for both remote refrigeration and self-contained refrigeration case types. Figure 3-91 illustrates the distribution of total linear feet of cases by the on-site survey highly disaggregated case descriptions. In Figure 3-91 reach-in multi-deck cases represent approximately 50% of the linear feet of refrigerated cases with under the counter reach-in cases having the second highest linear feet with 18%. Table 3-27 provides a mapping of the descriptive on-site case categories to a set of aggregated or simplified case types. In the mapping the under the counter reach-in remains the same while the reach-in multi-deck becomes an up-right reach-in case.

Figure 3-92 depicts the distribution of total linear feet of cases by the aggregated or simplified cast types.

Figure 3-91: Distribution of Total Linear Feet of Cases



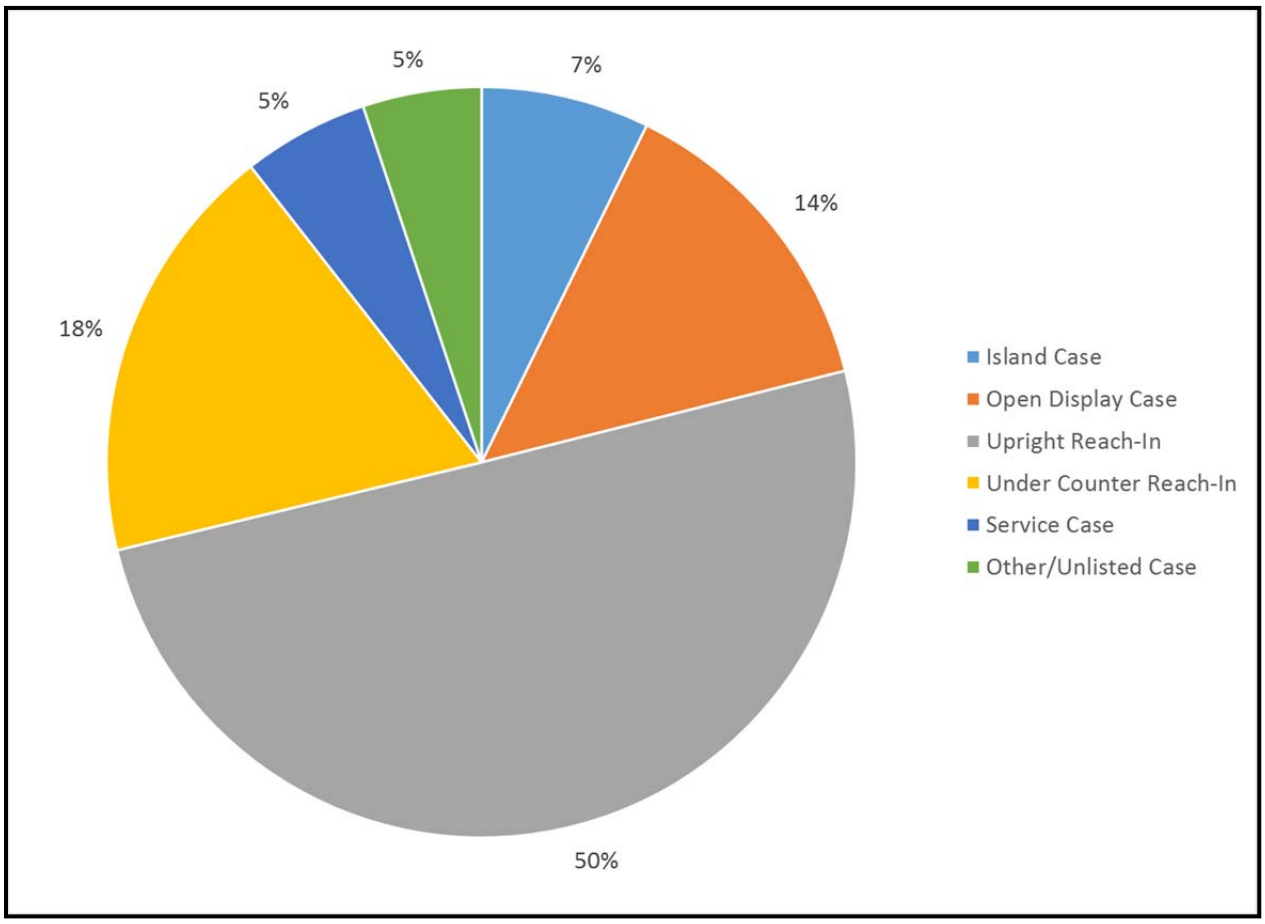
*The results are weighted using the business-level sample weight

** These data represent 278 sites with refrigeration

Table 3-27: Refrigeration Survey Description and Mapping to Simplified Case Type

Survey Refrigeration Description	Simplified Case Type
Island, open, single-level narrow	Island Case
Island, open, single-level wide	Island Case
Island, open, island, single-level double	Island Case
Island, closed, single-level narrow	Island Case
Island, closed, single-level wide	Island Case
Island, closed, single level double	Island Case
Open Single-Deck	Open Display Case
Open Multi-Deck	Open Display Case
Reach-in Multi-Deck	Upright Reach-in
Closed rear-entry Multi-Deck	Service Case
Curved glass near entry multi deck	Service Case
Under counter Reach-in	Under Counter Reach-In
Blast Chiller	Other/Unlisted Case
Ice Bag Freezer	Other/Unlisted Case
Lab-Grade Case	Other/Unlisted Case

Figure 3-92: Distribution of Total Linear Feet of Refrigeration Cases, Simplified Case Type



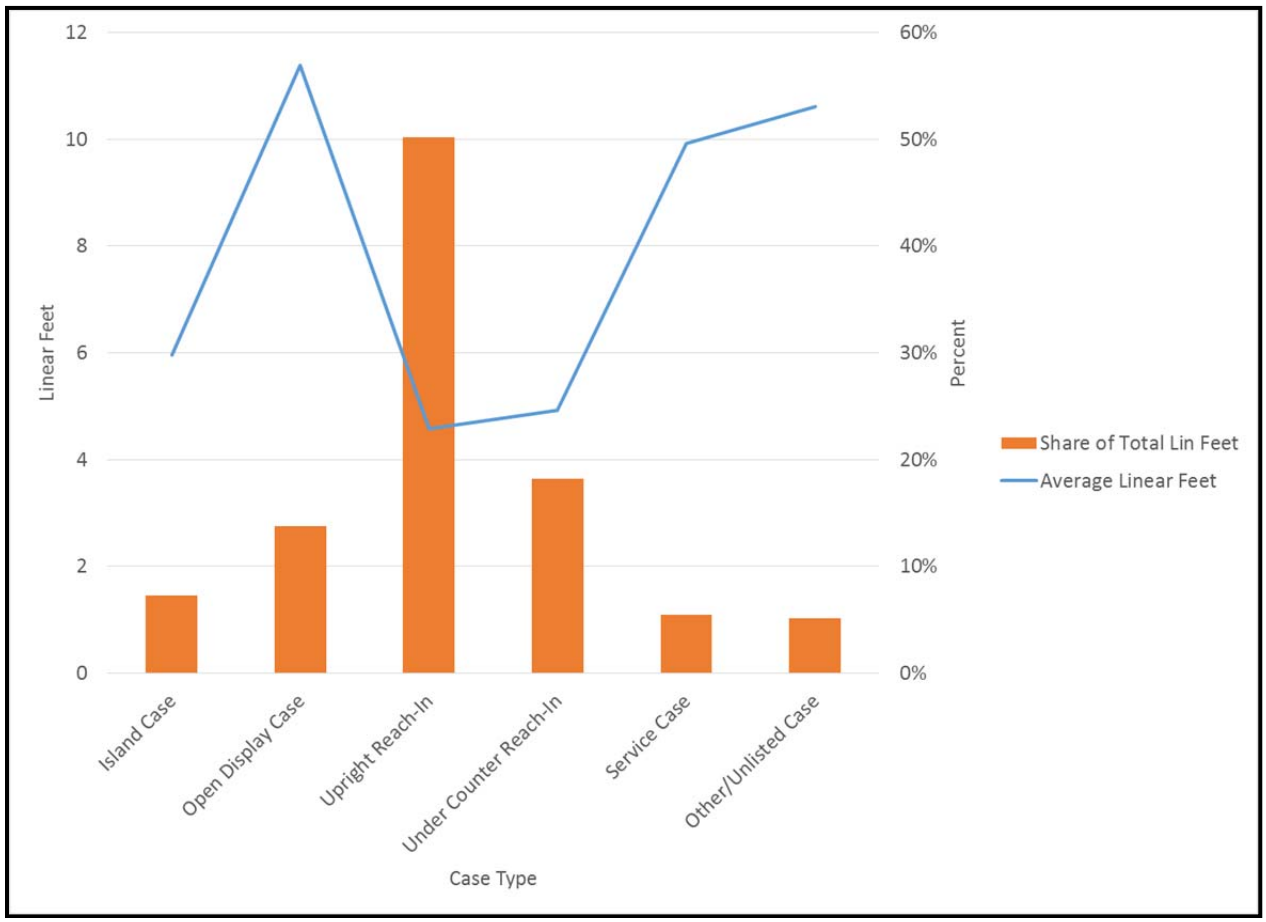
*The results are weighted using the business-level sample weight

** These data represent 278 sites with refrigeration

The distribution of refrigerated cases illustrated in Figure 3-93 shows that upright reach-in cases account for 50.2% of the linear feet of refrigeration cases. Upright reach-in cases may dominate the distribution of refrigerated cases because a high share of businesses with refrigeration have this type of case, the average business with this type of cases has a substantial share of linear feet of these cases or both.

Figure 3-93 illustrates the share of linear feet and the average linear feet of the different types of refrigerated cases per business with refrigerated cases by case types. The data illustrated in Figure 3-93 indicates that many businesses with refrigerated cases have Upright Reach-in cases (50% of businesses with refrigerated cases). Upright case types dominate the distribution of cases even though the average linear feet of upright reach-in cases is relatively low (4.6 feet). In contrast, open display cases account for 14% of linear feet of cases while the average open display case is over 11 feet in length.

Figure 3-93 Distribution of the Share of Total Linear Feet and the Average Linear Feet of Refrigerated Casesby Case Type

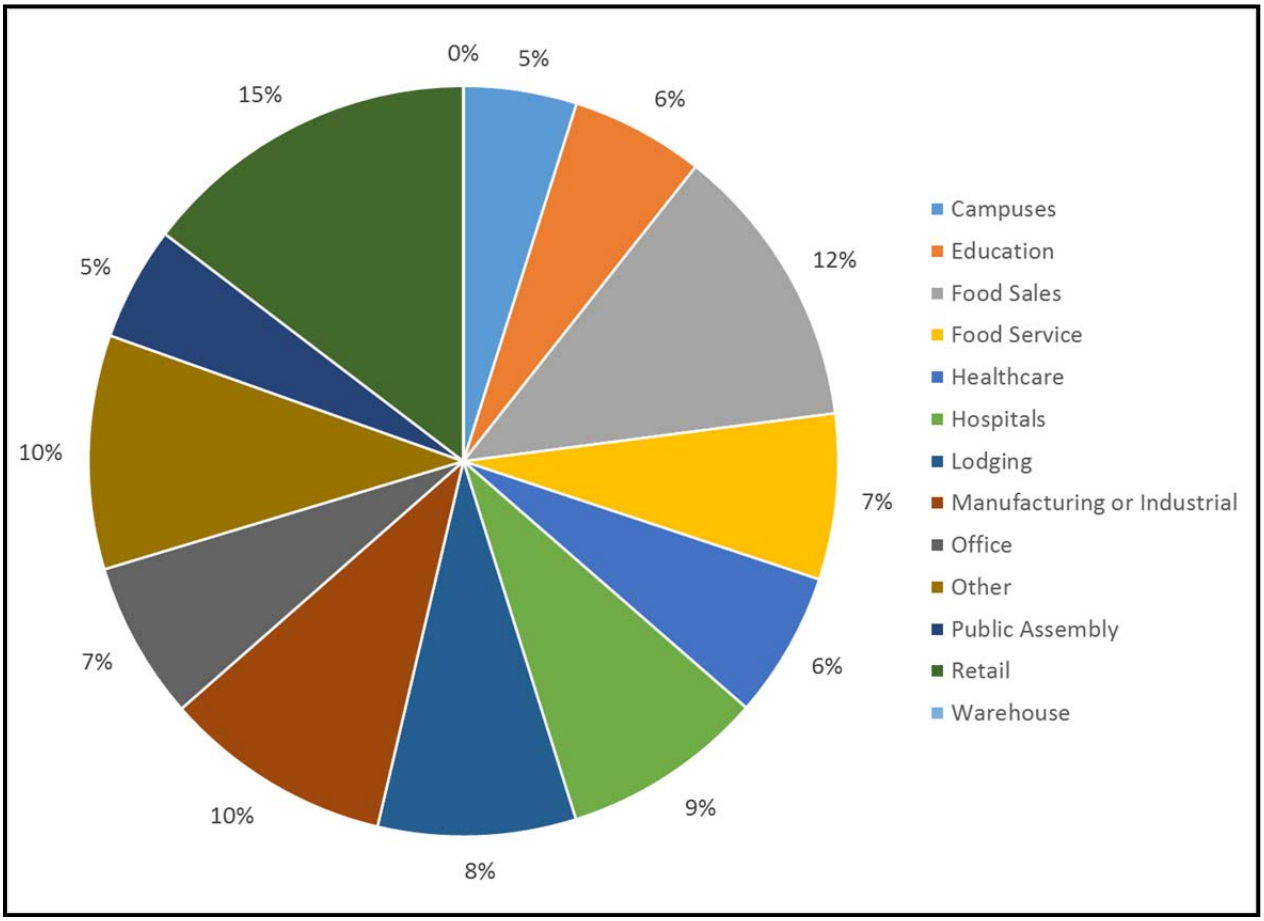


*The results are weighted using the business-level sample weight.

** These data represent 278 sites with refrigeration

Figure 3-94 illustrates the distribution of linear feet of refrigerated cases by business types. These data indicate that many business segments have a substantial share of refrigerated case linear feet with Retail businesses having the largest share of linear feet of refrigerated cases. This finding may indicate the share of large retail or variety stores that have moved into the food sales market.

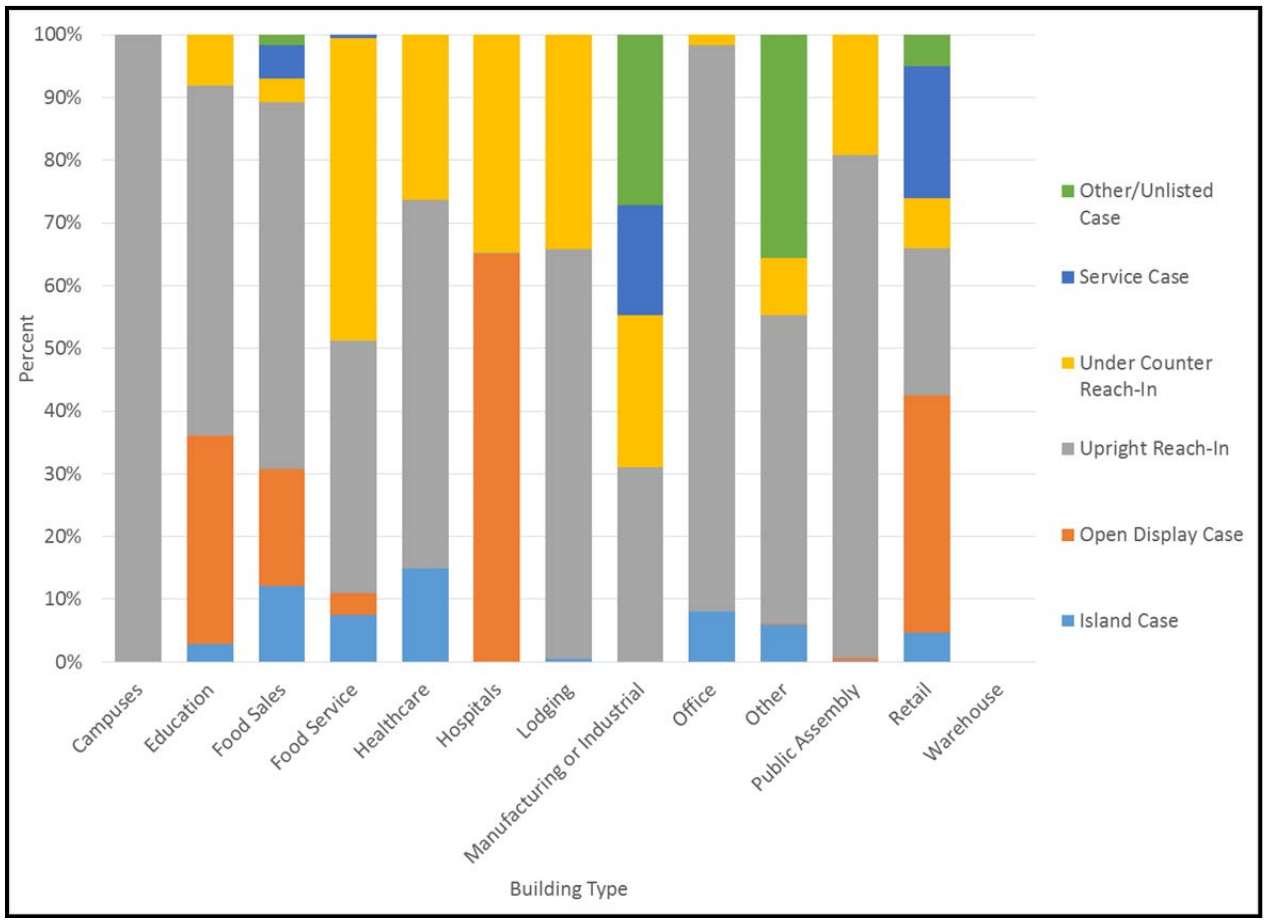
Figure 3-94: Distribution of Linear Feet of Refrigerated Cases by Businesses Type



*The results are weighted using the business-level sample weight

Figure 3-95 illustrates the distribution of linear feet of refrigerated cases by business type and case type. These data illustrate that the largest share of refrigeration case linear feet are concentrated in the food Sales and food service businesses.

Figure 3-95: Distribution of Linear Feet of Refrigeration Cases by Business Type and Simplified Case Type

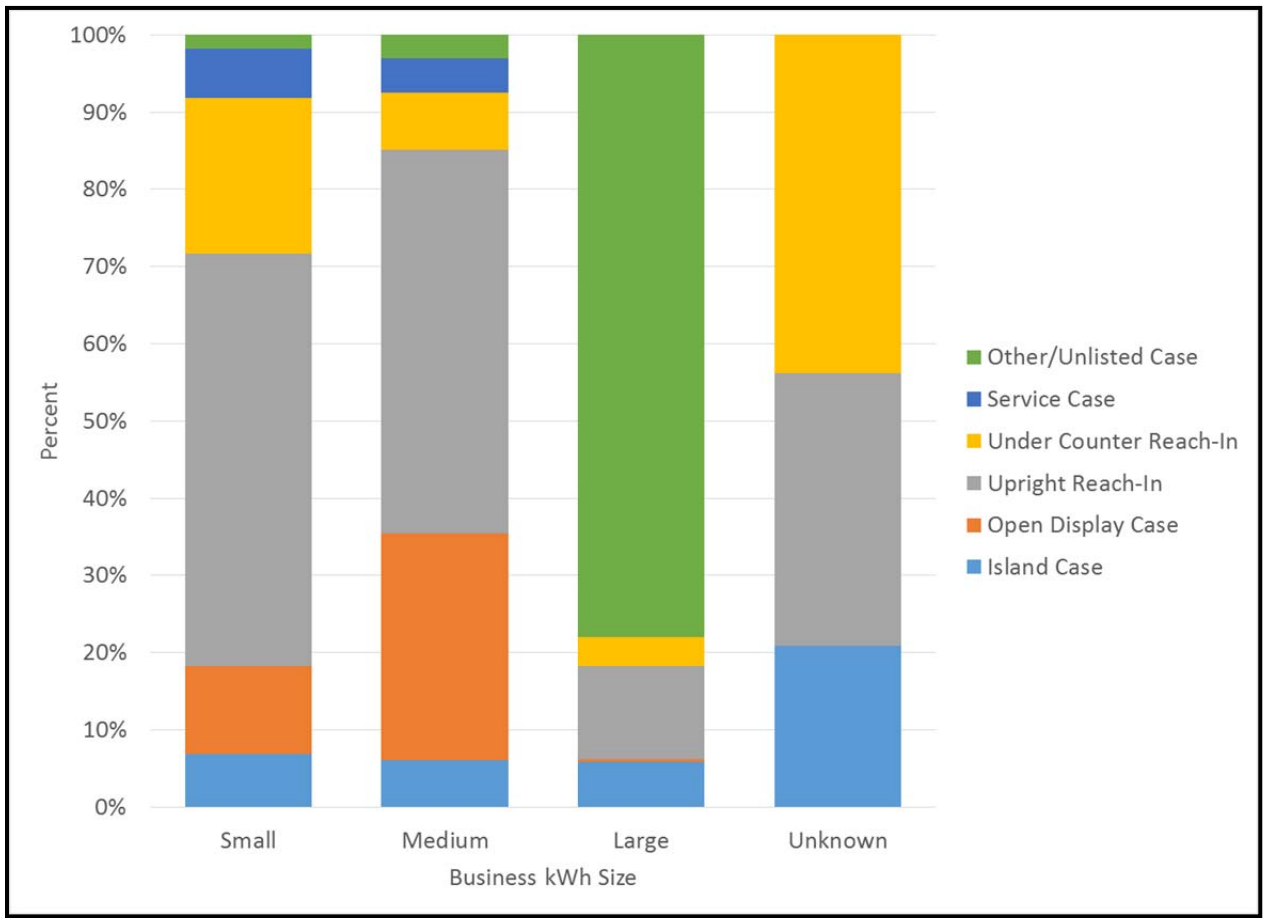


*The results are weighted using the business-level sample weight.

** These data reflect 2 campuses, 22 education, 22 food sales, 31 food service, 7 healthcare, 3 hospitals, 19 lodging, 5 manufacturing or industrial, 8 offices, 8 other, 16 public assembly, 10 retail, and 0 warehouses.

Figure 3-96 illustrates the distribution of the total linear feet of refrigerated cases by business kWh size and simplified case type. These data illustrate that upright reach-in cases account for the largest share of linear feet of refrigeration cases for small and mid-sized businesses. For large businesses, Other cases dominate the linear feet of refrigerated cases. The large number of "Other" cases are primarily lab cases from a single site.

Figure 3-96: Distribution of Linear Feet of Refrigerated Cases by Business Size and Simplified Case Type

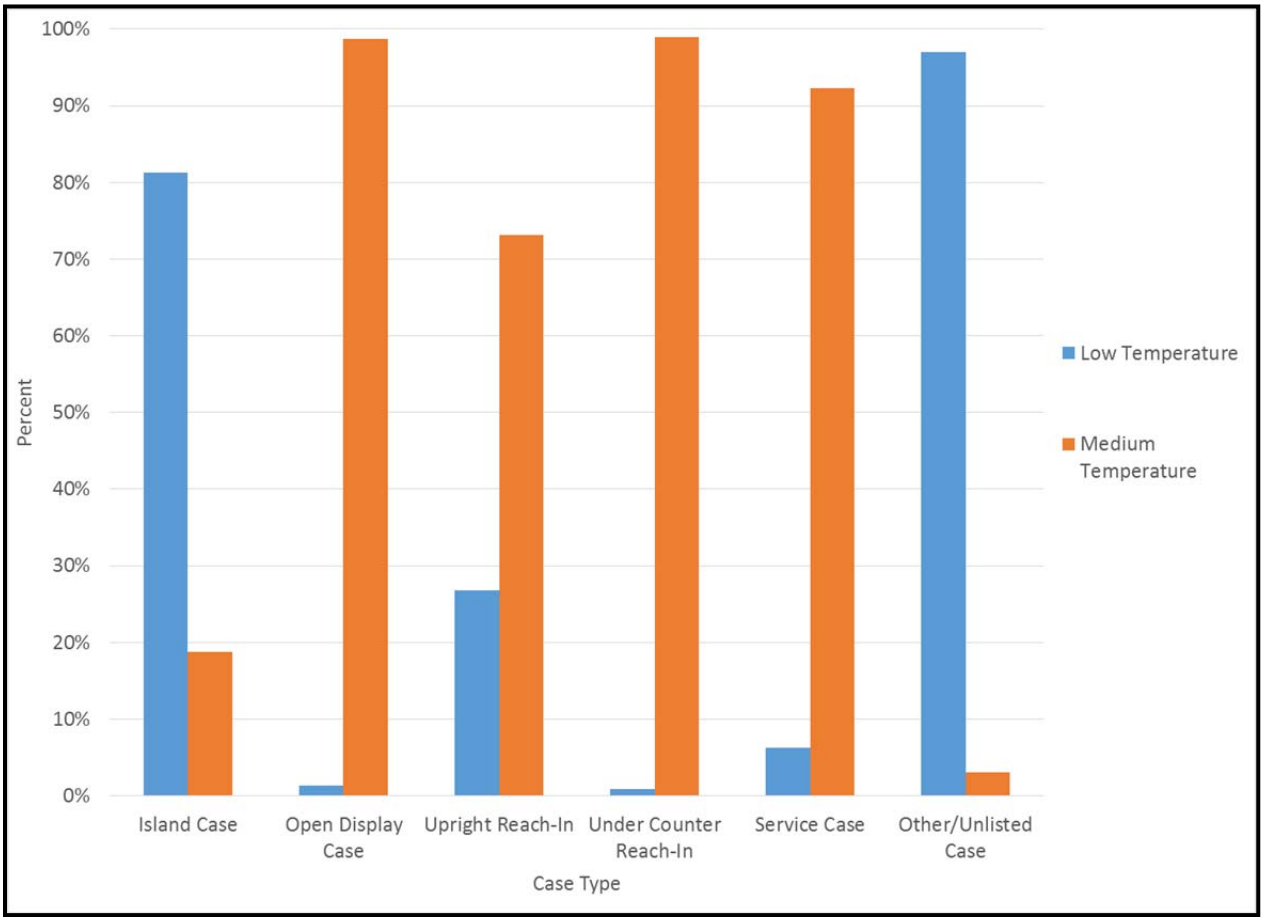


*The results are weighted using the business-level sample weight.

**These data reflect 79 small, 59 medium, 12 large, and 4 unknown sites

Figure 3-97 illustrates the distribution of refrigerated cases by temperature and simplified case type. Cases are disaggregated into low and medium temperature cases. Low temperature cases are associated with temperatures needed for freezing their contents while medium temperature cases are more often associated with refrigeration.

Figure 3-97: Distribution of Refrigerated Cases by Temperature and Simplified Case Type



*The results are weighted using the business-level sample weight.

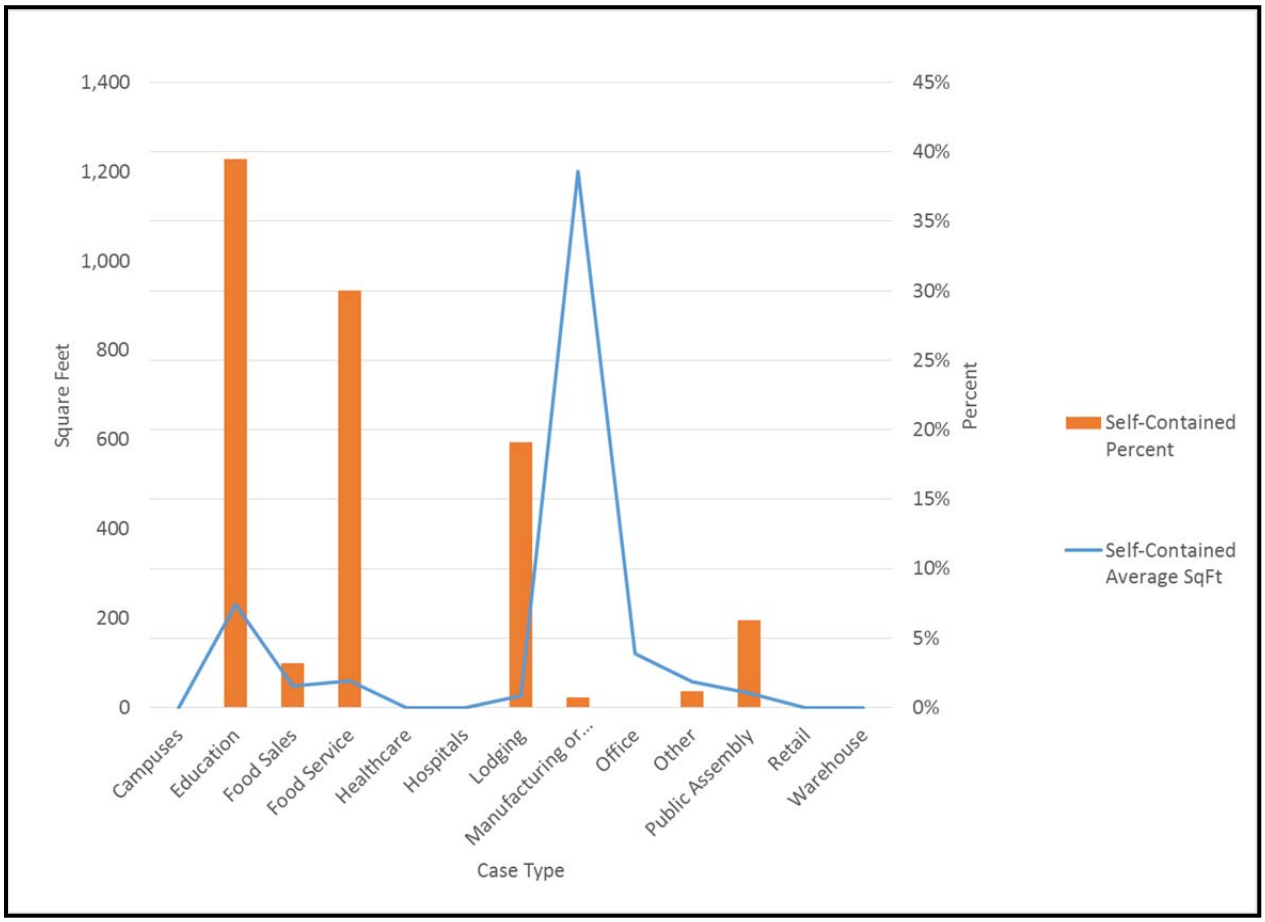
**These data reflect 79 low temperature units and 143 medium temperature units.

3.7.4 Walk-In Refrigeration

Walk-in coolers and freezers can be either self-contained or remote refrigeration walk-ins. The size and distribution of walk-ins varies substantially by self-contained versus remote, so their statistics will be presented separately.

Figure 3-98 illustrates the percent of floor area in self-contained walk-ins by business type and the average square footage for walk-ins by business type. A business type can have a large share of the floor area of self-contained walk-ins if there are a large number of businesses in the business type with walk-ins, if the floor area of walk-ins for the business type is high, or both. The data presented in Figure 3-98 indicate that education, food service, and lodging businesses have a high share of the square footage of walk-ins while the average square footage per walk-in is relatively low for these businesses. Self-contained walk-ins in the manufacturing or Industrial segment, however, have a high average square footage per walk-in, but the total percentage of square footage of the segment is lower than found in education, food service, and lodging. These findings imply that there are few self-contained walk-ins found in the manufacturing or industrial segments but these walk-ins are large.

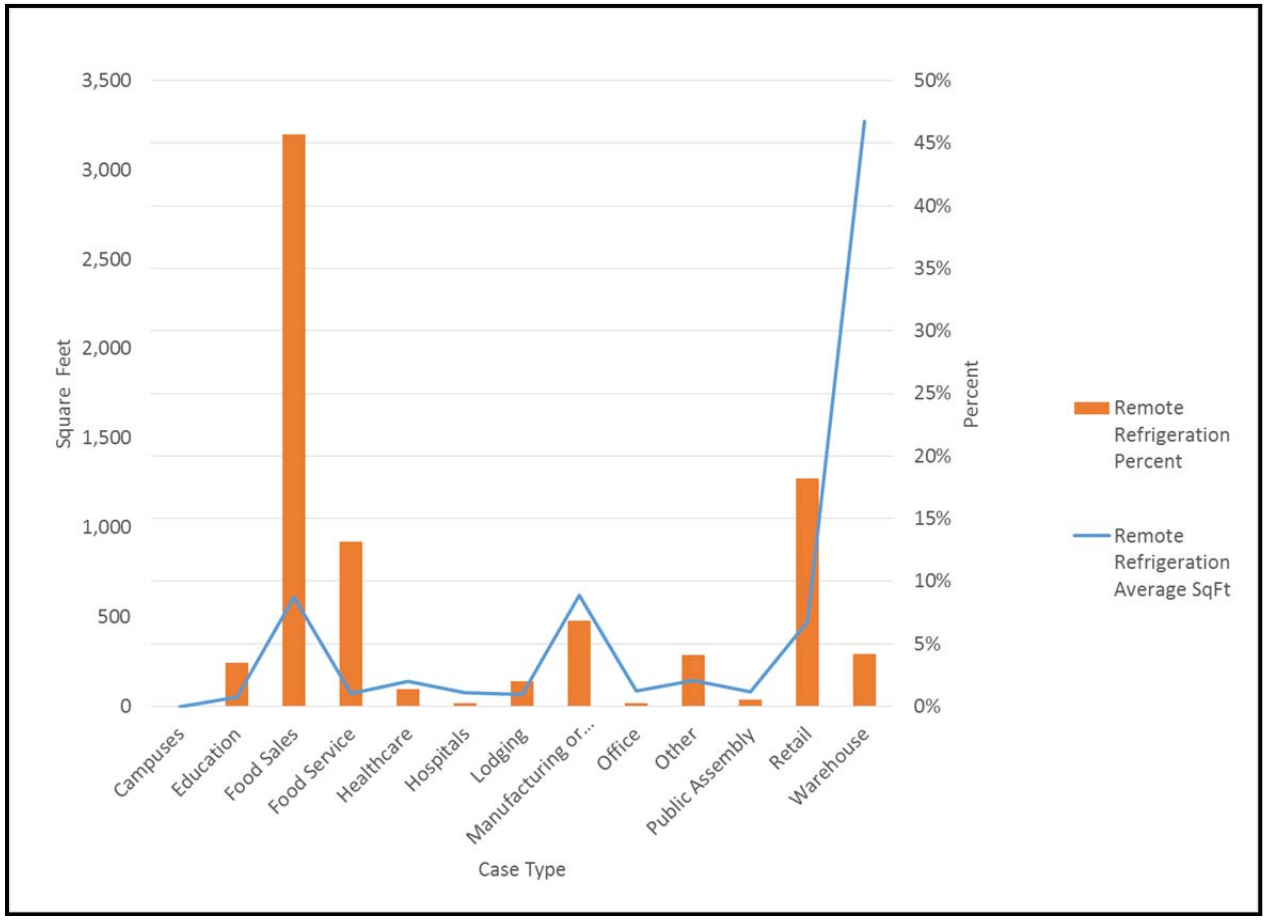
Figure 3-98: Self-Contained Walk-ins Square Footage Percent by Business Type and Average Square Feet per Business with Walk-ins



*The results are weighted using the business-level sample weight.

Figure 3-99 illustrates the percent of remote refrigeration square footage by business type and the average square footage per walk-in by business type. These indicate that food sales has a high share of the square footage of remote refrigeration walk-ins while the average square footage per walk-in is relatively low for food stores and relatively large for warehouses.

Figure 3-99: Remote Refrigeration Walk-ins Square Footage Percent by Business Type and Average Square Feet per Business with Walk-ins



*The results are weighted using the business-level sample weight.

3.8 On-Site Generation

During the customer on-site assessments, field staff collected information on the on-site generation equipment in use in Massachusetts non-residential facilities. Table 3-28 lists the number of sites from the on-site data collection effort with on-site generation. The on-site generation is characterized as backup or emergency generation, renewable or self-generation, co-generation (combined heat and power, CHP) and non-power generation systems (solar thermal, geothermal heat pumps, and biomass boilers). These data indicate that the largest share of on-site generation is for backup or emergency generation.

Table 3-28: On-Site Generation

Building Type	Counts of Emergency / Backup Generation Systems	Counts of Renewable / Self Generation	Counts of Co-Generation	Counts of Non-Power Generation Systems
Campuses	5	0	1	0
Education	20	3	0	0
Food Sales	3	0	0	0
Food Service	0	0	0	0
Healthcare	10	0	0	0
Hospitals	5	0	0	0
Lodging	13	1	4	2
Manufacturing or Industrial	11	1	0	0
Office	19	0	0	0
Other	6	1	0	1
Public Assembly	9	2	0	1
Retail	4	1	0	0
Unknown	0	0	0	0
Warehouse	4	1	0	0
Total	**109**	**10**	**5**	**4**

* The results presented above are Un-weighted.

**The counts indicate the number of instances the technology was found in the buildings that were visited.

3.8.1 Backup or Emergency Generation

The backup or emergency generation can be fueled by natural gas, bio gas, diesel, fuel oil, gasoline or a combination of fuels. Table 3-29 lists both the Un-weighted number of systems observed on-site and the weighted share of systems by fuel type. The on-site data indicates that the majority of the backup systems are fueled by diesel. Using business-level weights, the largest share of emergency or backup systems are fueled by natural gas.

The kWh-level weighted results, however, indicate that the largest share of emergency or backup systems are fueled by Diesel. The on-site data collection in 2014 found emergency generation systems fueled by natural gas, diesel, fuel oil, and gasoline and unknown. Gasoline and unknown are grouped together as other in Table 3-29.

Table 3-29: Fuel Types for Emergency and Back-up Generation

Fuel Types	Number of Systems Observed On-site	Business Weighted Share of Systems	kWh Weighted Share of Systems
Natural Gas	35	45%	28%
Diesel	68	19%	55%
Fuel Oil	6	6%	14%
Other	8	17%	2%
Unknown	2	13%	1%
Total	**119**	**100%**	**100%**

*The results are weighted using the business-level and kWh-level sample weight.

3.8.2 Renewable and Self-Generation

The C&I Customer On-site Assessments combined on-site generation that was not used for backup or emergency generation and generation that was not CHP, into self-generation. The types of renewable and self-generation systems found during the on-site data collection are listed in Table 3-30.

Table 3-30: System Types for Renewable and Self-Generation Systems

System Types	Number of Systems Observed On-site	Business Weighted Share of Systems
Solar Array/PV	10	100%
Wind	1	0%
Total	11	100%

*The results are weighted using the business-level sample weight.

3.8.3 Combined Heat and Power

During Wave 1, on-site data collection efforts found only five sites with CHP systems during the 2014 on-site data collection. All of these systems were fueled by natural gas.

3.9 Kitchen Equipment

The C&I Customer On-site Assessment efforts documented the baseline of existing kitchen equipment. Table 3-31 lists the types of kitchen equipment observed on-site, the aggregated appliance type that will be used for graphs in this section, and the Un-weighted count of appliance units observed during the on-site data collection. * The results presented above are Un-weighted.

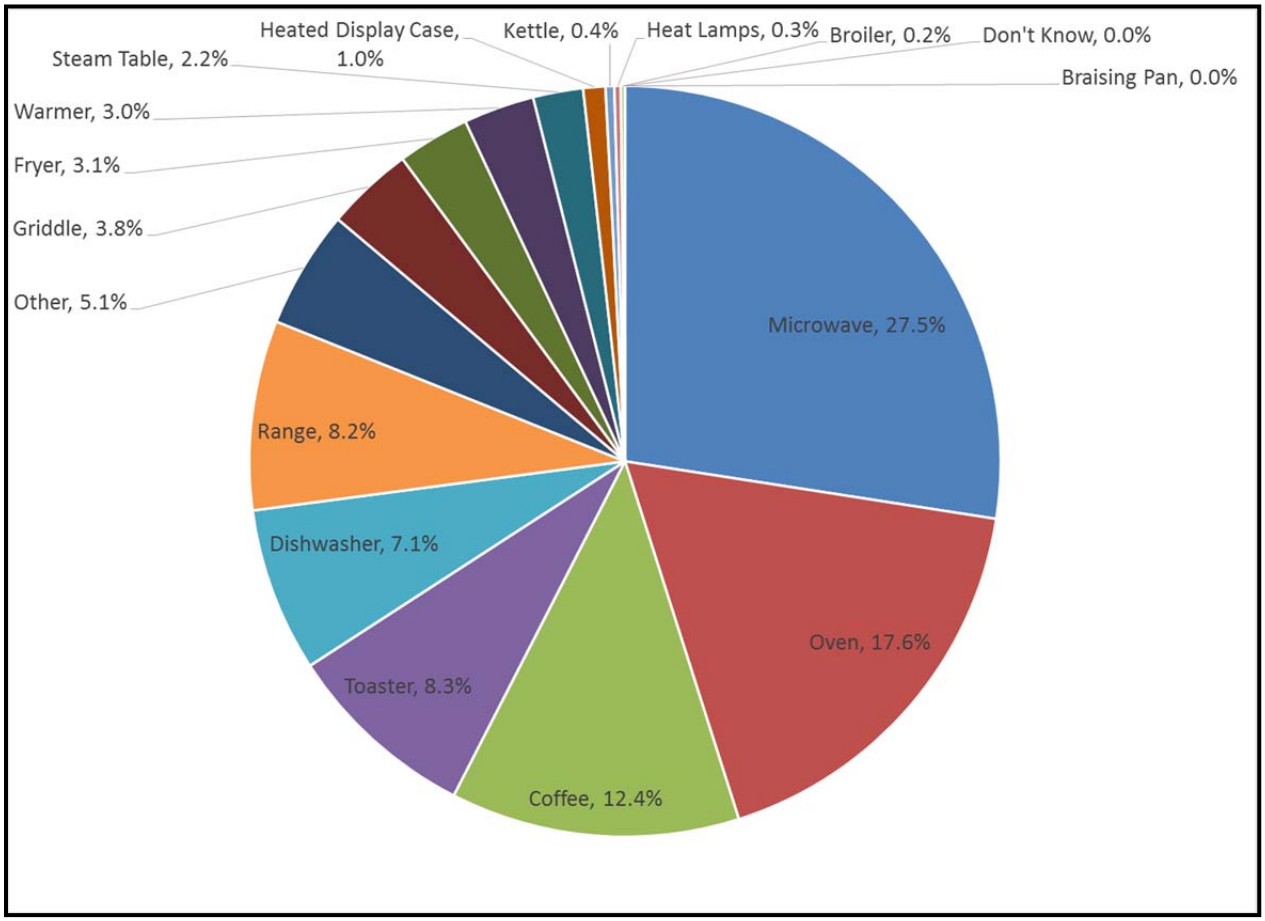
Figure 3-100 illustrates the weighted distribution.

Table 3-31: Kitchen Equipment Data

Detailed Appliance Type	Aggregated Appliance Type	Units Observed On-site
Broiler/Cheese Melter	Broiler	5
Char Broiler	Broiler	17
Griddle, Single Sided	Griddle	69
Griddle, Clam Shell	Griddle	16
Fryer, Countertop	Fryer	14
Fryer, Freestanding	Fryer	116
Fryer, Pressure	Fryer	3
Fryer, Donut	Fryer	1
Kettle, Pasta Cooker	Kettle	10
Heat Lamps	Heat	44
Range Top	Range	210
Oven, Pizza or Bake	Oven	150
Oven, Conveyer	Oven	15
Oven, Range	Oven	177
Oven, Convection, Comb, or Retherm	Oven	211
Food Warmer	Warmer	732
Heated Display Case	Heated	33
Microwave	Microwave	1,065
Toaster, Popup	Toaster	195
Toaster, Conveyer	Toaster	69
Coffee Pot	Coffee	1,042
Steam Jacketed Kettle	Kettle	65
Braising Pan/Skillet	Braising Pan	3
Steam Table	Steam Table	146
Dishwasher, Single Tank	Dishwasher	164
Dishwasher, Conveyer	Dishwasher	112
Don't Know	Don't Know	1
Other	Other	159

* The results presented above are Un-weighted.

Figure 3-100: Kitchen Appliance Distribution (weighted)

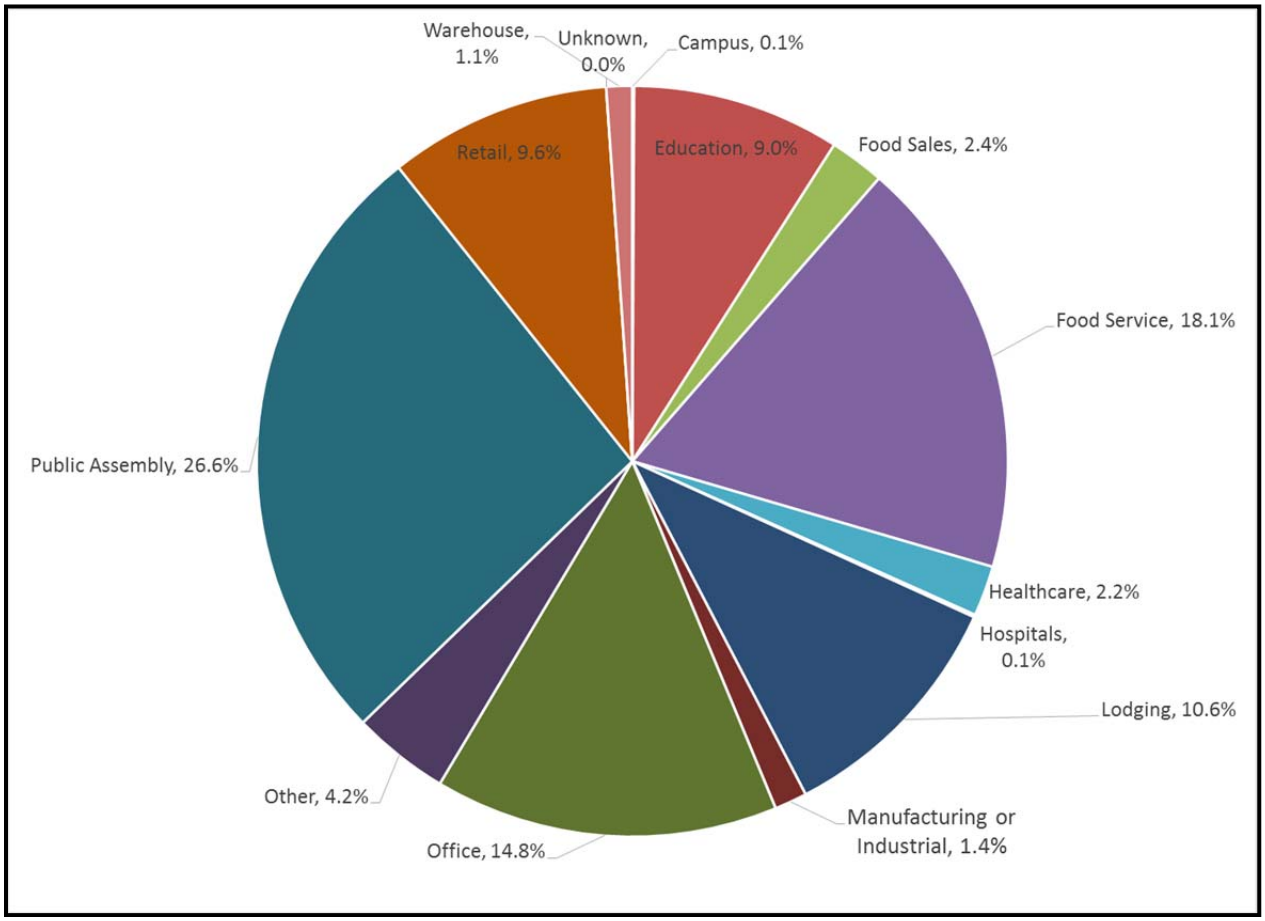


*The results presented above are weighted using the business-level sample weight.

3.9.1 Kitchen Equipment by Business Type

The count of kitchen equipment was disaggregated by business type in Figure 3-101. These data indicate that public assembly, food service, and offices have the highest share of kitchen equipment.

Figure 3-101: Share of Kitchen Equipment by Business Type

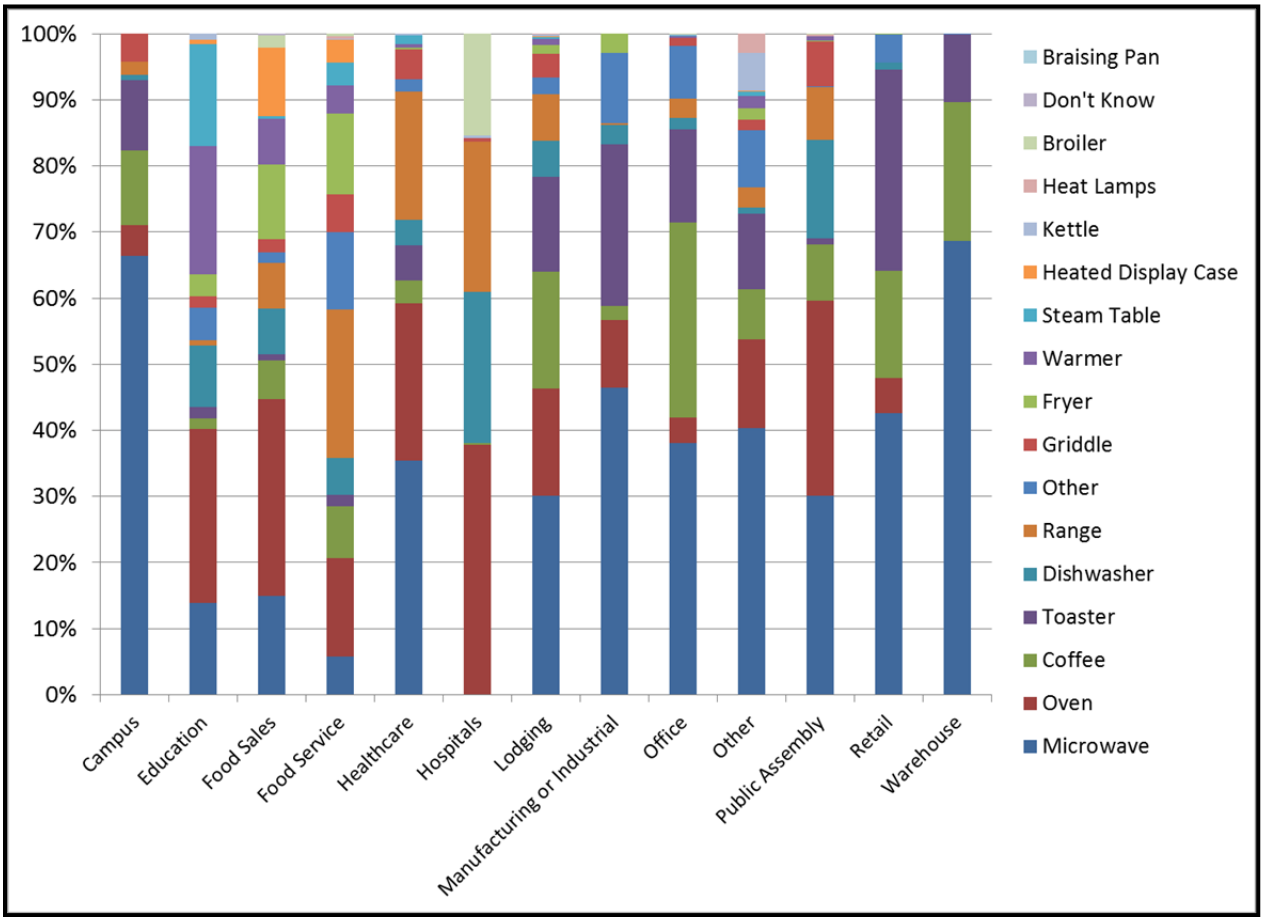


*The results presented above are weighted using the business-level sample weight.

** These data represent 5 campus, 27 education, 16 food sales, 30 food service, 16 healthcare, 4 hospitals, 27 lodging, 13manufacturing/industrial, 38 office, 17 other, 28 public assembly, 24 retail, and 6 warehouse sites.

Figure 3-102 illustrates the distribution of the types of kitchen equipment by business type. These data illustrate that some non-residential segments have a wide range of kitchen equipment while others have only three to five different types of equipment. Warehouses and retail businesses largely have microwaves, toasters, coffee makers, ovens and dishwashers. Food service, food sales, and education businesses, however, are found to have a wide variety of kitchen equipment.

Figure 3-102: Distribution of Types of Kitchen Equipment by Business Type



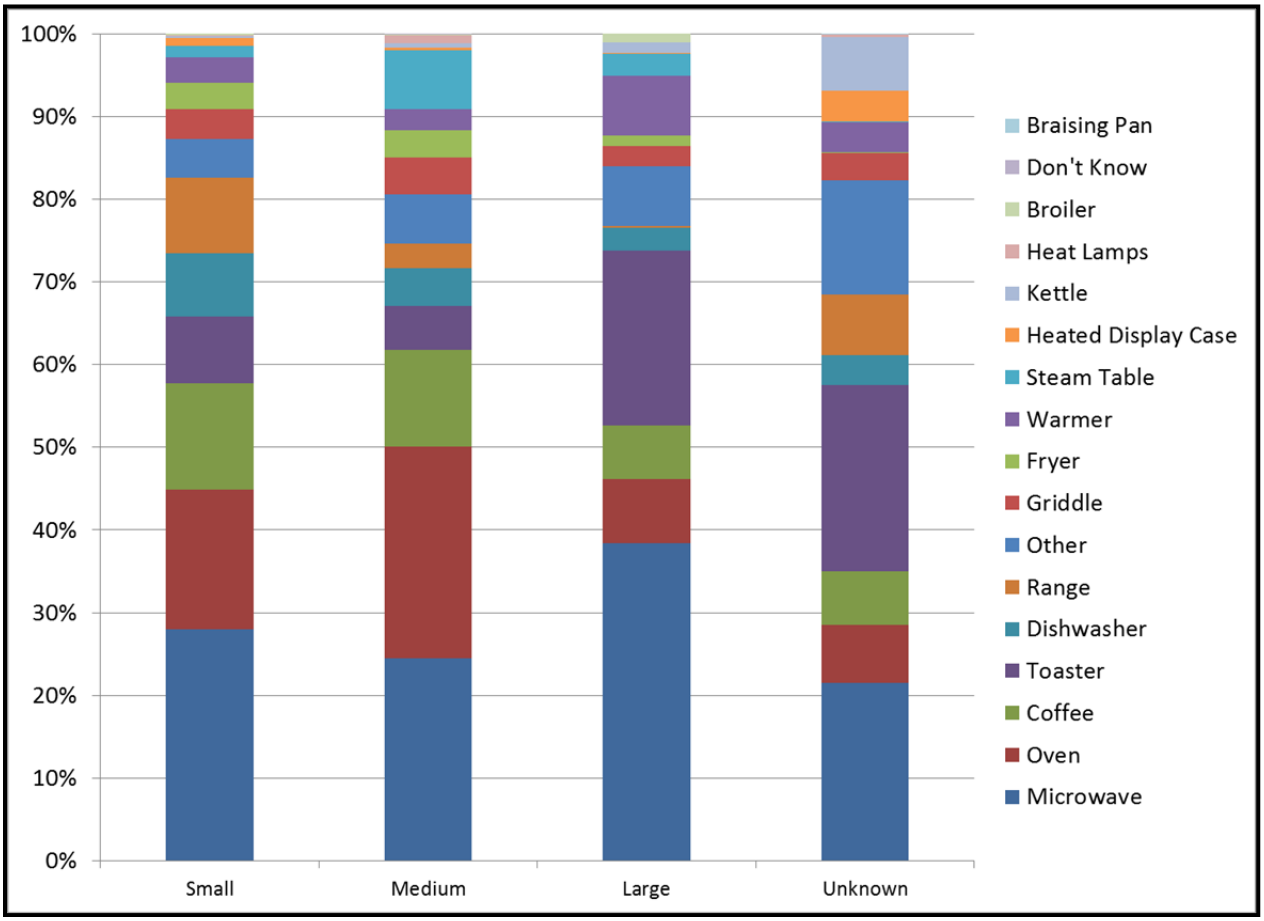
*The results presented above are weighted using the business-level sample weight.

** These data represent 5 campus, 27 education, 16 food sales, 30 food service, 16 healthcare, 4 hospitals, 27 lodging, 13 manufacturing/industrial, 38 office, 17 other, 28 public assembly, 24 retail, and 6 warehouse sites.

3.9.2 Kitchen Equipment by Business Size

Figure 3-103 illustrates the distribution of types of kitchen equipment by business size.

Figure 3-103: Distribution of Types of Kitchen Equipment by Business Size



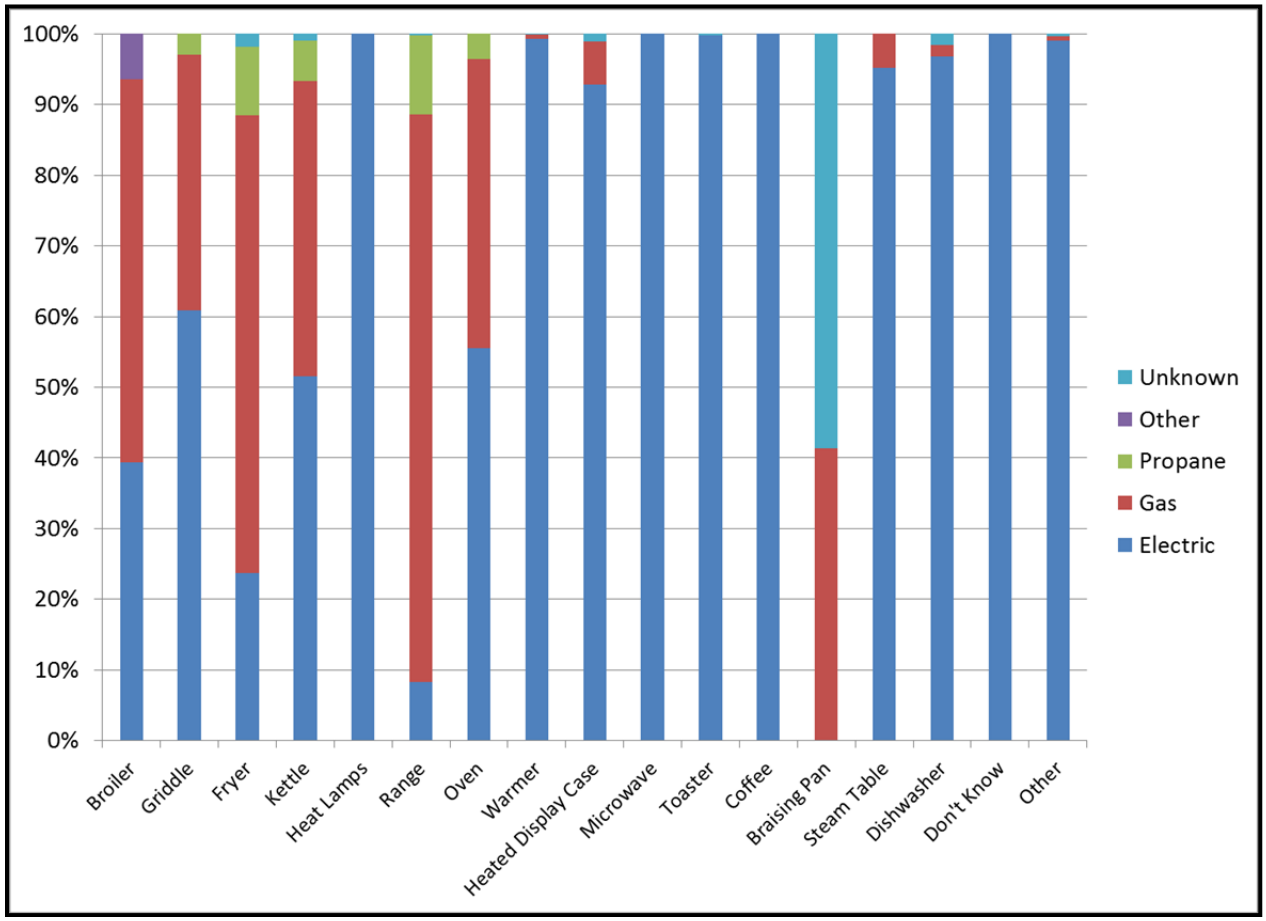
*The results presented above are weighted using the business-level sample weight.

** These data represent 138 small, 89 medium, 17 large, and 7 unknown sized sites.

3.9.3 Kitchen Equipment and Fuel Type

Some kitchen equipment, such as microwaves and coffee pots are only powered by electricity, other equipment, such as ranges and ovens, can be powered by multiple types of fuel. Figure 3-104 illustrates the different types of fuels used by various types of kitchen equipment.

Figure 3-104: Kitchen Equipment by Fuel Type



*The results presented above are weighted using the business-level sample weight.

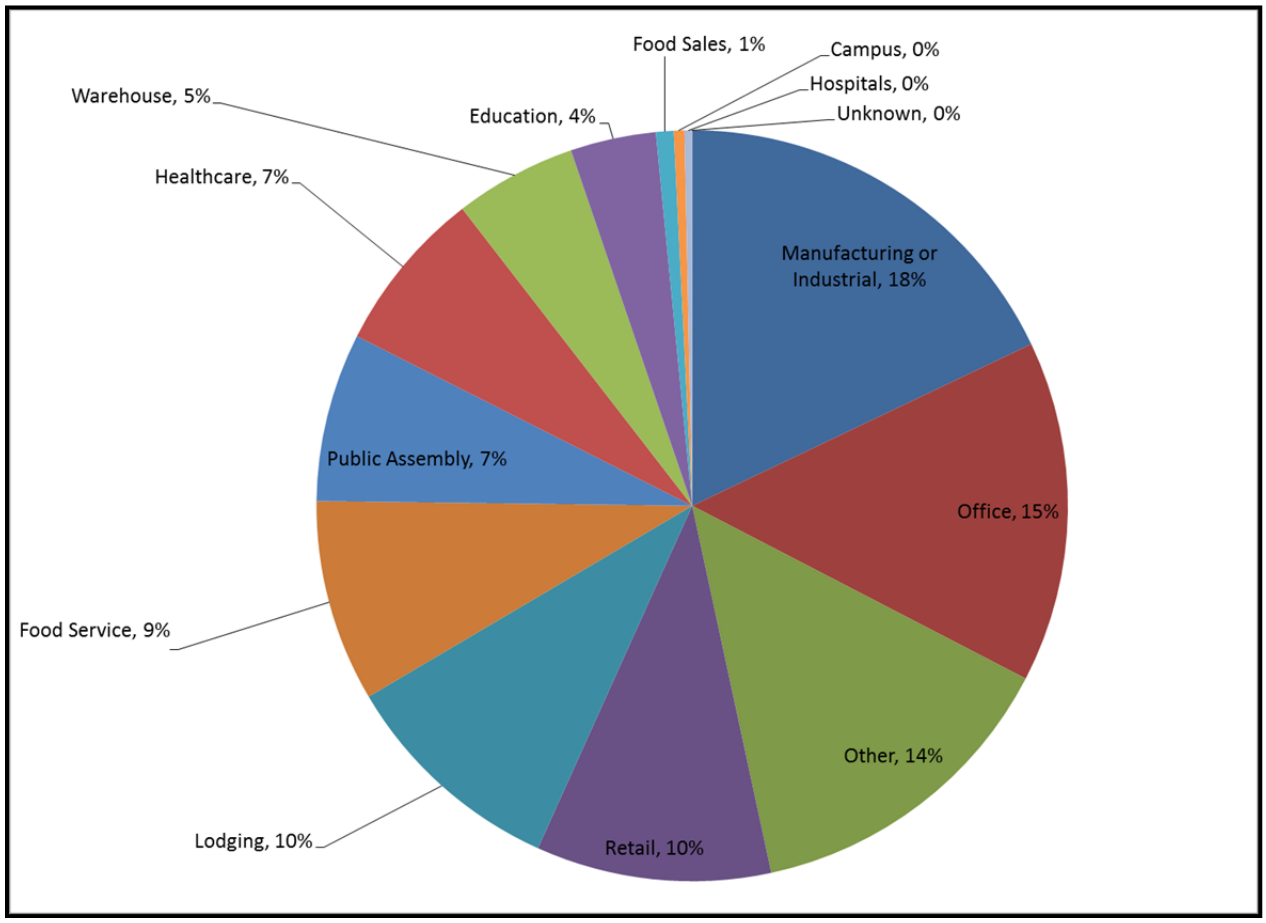
** These data represent 251 sites.

3.9.4 Vending Machines

The Existing Building Market Characterization Study also collected information on the number of refrigerated vending machines at a business. The weighted distribution of vending machines by business type is presented in Figure 3-105.

Figure 3-106 illustrates the distribution of vending machines by business size.

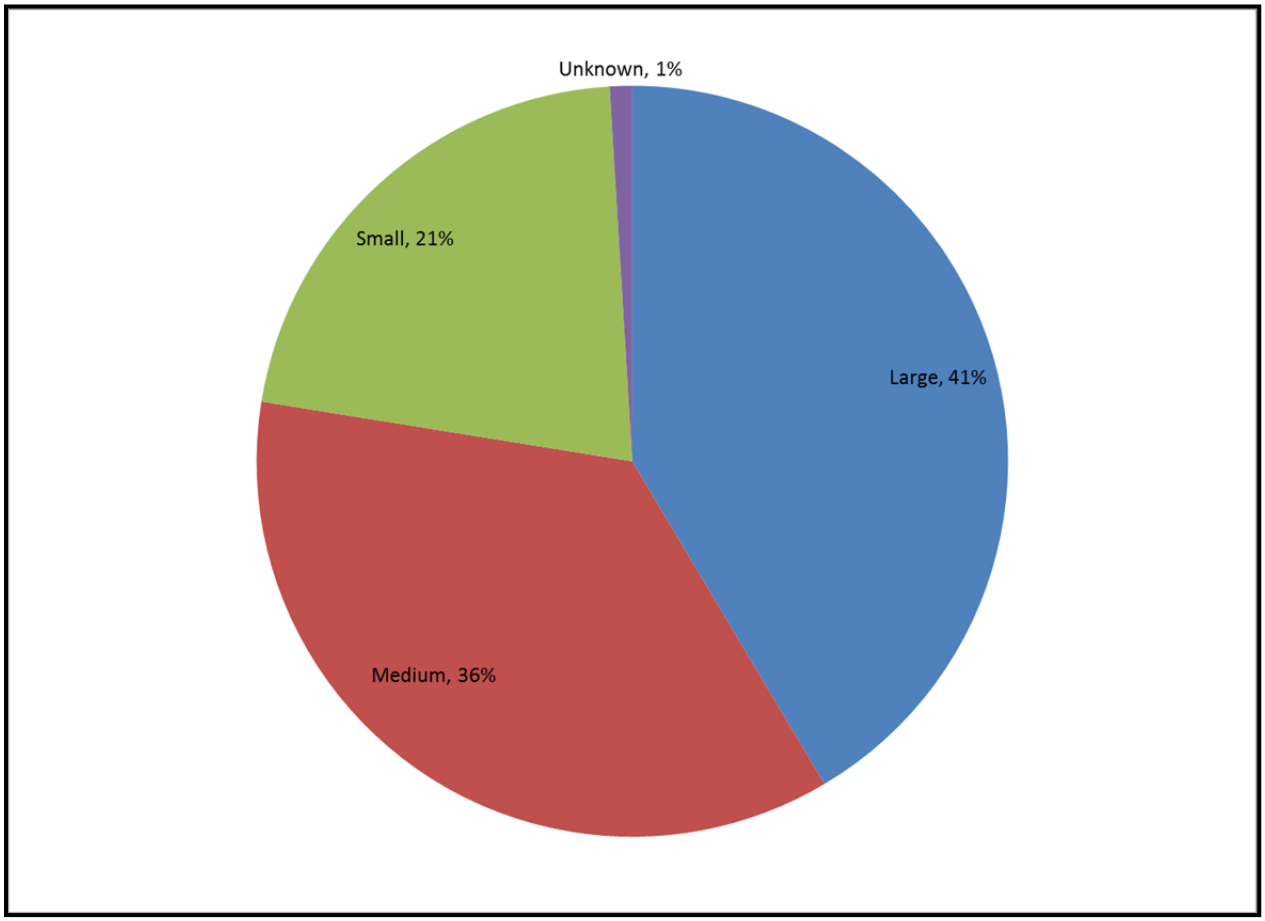
Figure 3-105: Distribution of Vending Machines by Business Type



*The results presented above are weighted using the business-level sample weight.

** These data represent 10 Manufacturing/Industrial, 16 Office, 7 Other, 10 Retail, 14 Lodging, 5 Food Service, 10 Public Assembly, 9 Healthcare, 6 Warehouse, 14 Education, 3 Food Sales, 3 Campus, and 4 Hospital sites.

Figure 3-106: Distribution of Vending Machines by Business Size



*The results presented above are weighted using the business-level sample weight.

** These data represent 29 Small, 64 Medium, 15 Large, and 3 Unknown sized sites.

3.10 Office Equipment

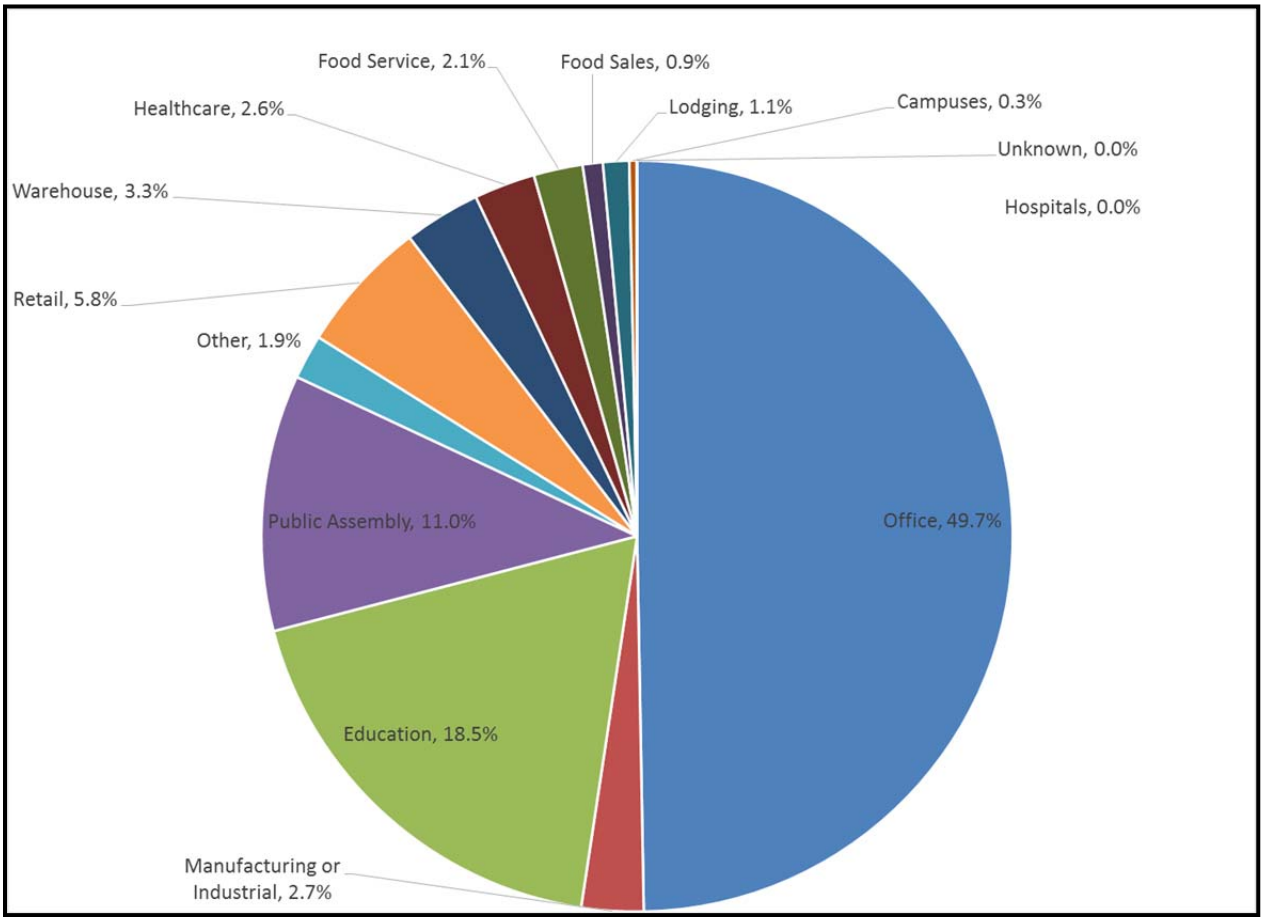
In Wave 1 of the on-site data collection efforts, field staff documented the baseline distribution of computer monitors and power management equipment within businesses.

3.10.1 Computer Monitors

The computer monitors were divided into older CRT monitors and LCD/LED monitors. The data from the on-sites imply that over 99.8% of monitors in Massachusetts businesses are LCD/LED monitors.[36] Figure 3-107 illustrates the distribution of computer monitors by business type. These data clearly indicate that the largest share of monitors is found in the office segment.

[36] Laptops are not a type of monitor.

Figure 3-107: Distribution of Computer Monitors by Business Type

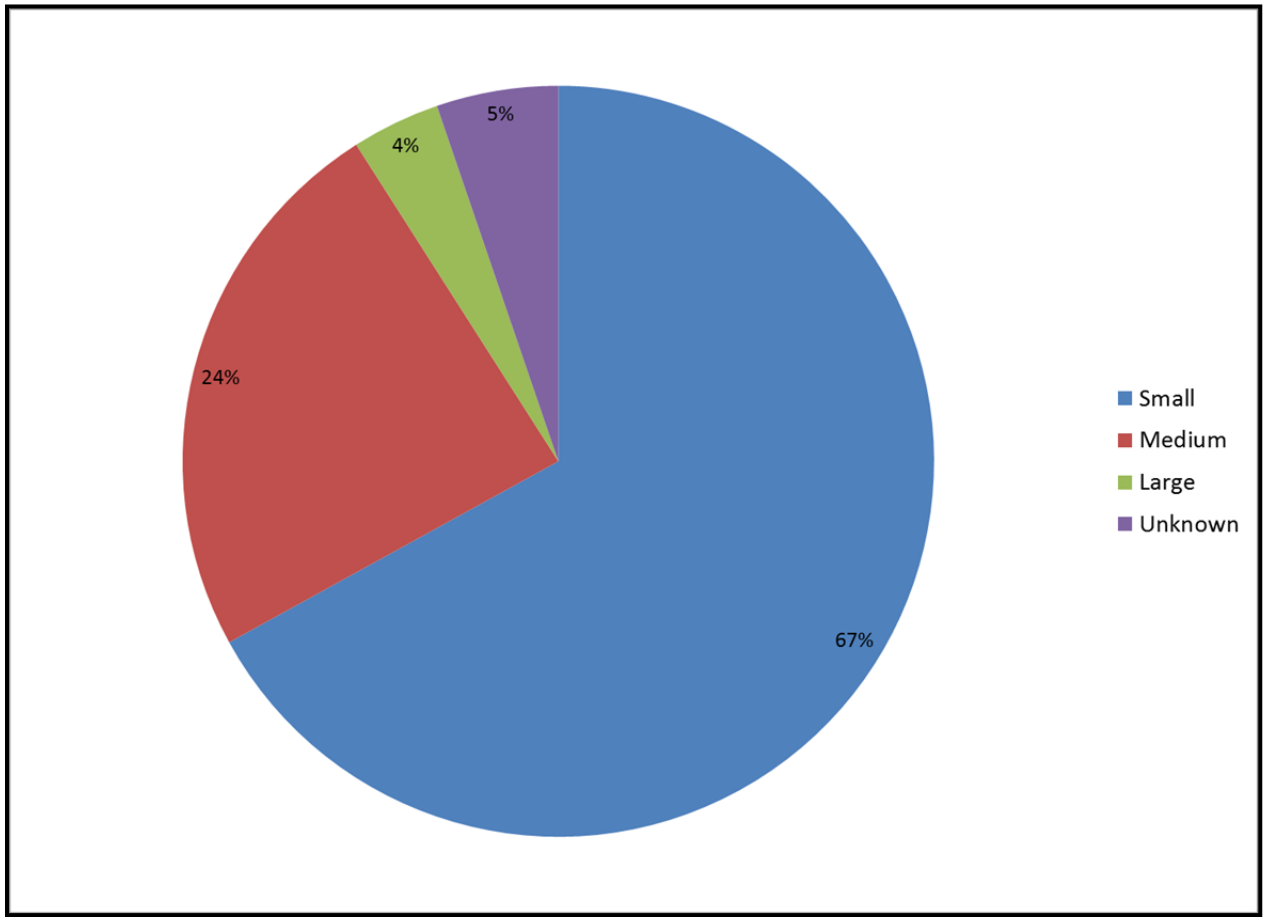


*The results presented above are weighted using the business-level sample weight.

** These data represent 23 office, 12 manufacturing/industrial, 9 education, 14 public assembly, 9 other, 22 retail, 4 warehouse, 9 Healthcare, 21 food service, 12 food sales, 18 lodging, and 2 campus sites.

Figure 3-108 illustrates the distribution of computer monitors by business size. These data indicate that the majority of monitors are in small sized businesses.

Figure 3-108: Distribution of Computer Monitors by Business Size



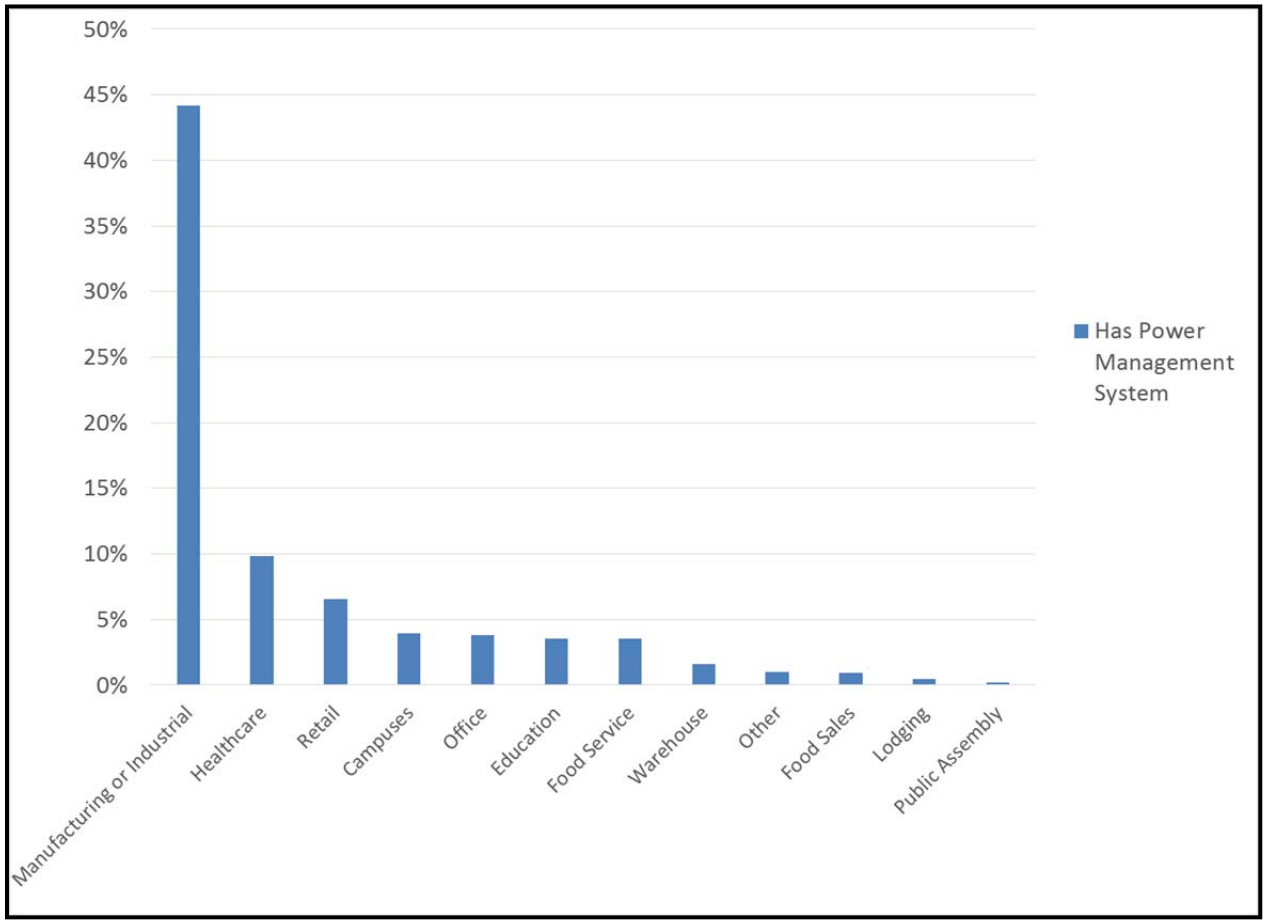
*The results presented above are weighted using the business-level sample weight.

** These data represent 95 small, 51 medium, 6 large, and 3 unknown sized sites.

3.10.2 Power Management Systems

The on-site data collection efforts found that 4% of businesses have computer power management systems. These systems however are not equally distributed across business types or business size. Figure 3-109 illustrates the distribution of power management systems by business type. Figure 3-110 illustrates the distribution of power management systems by business size.

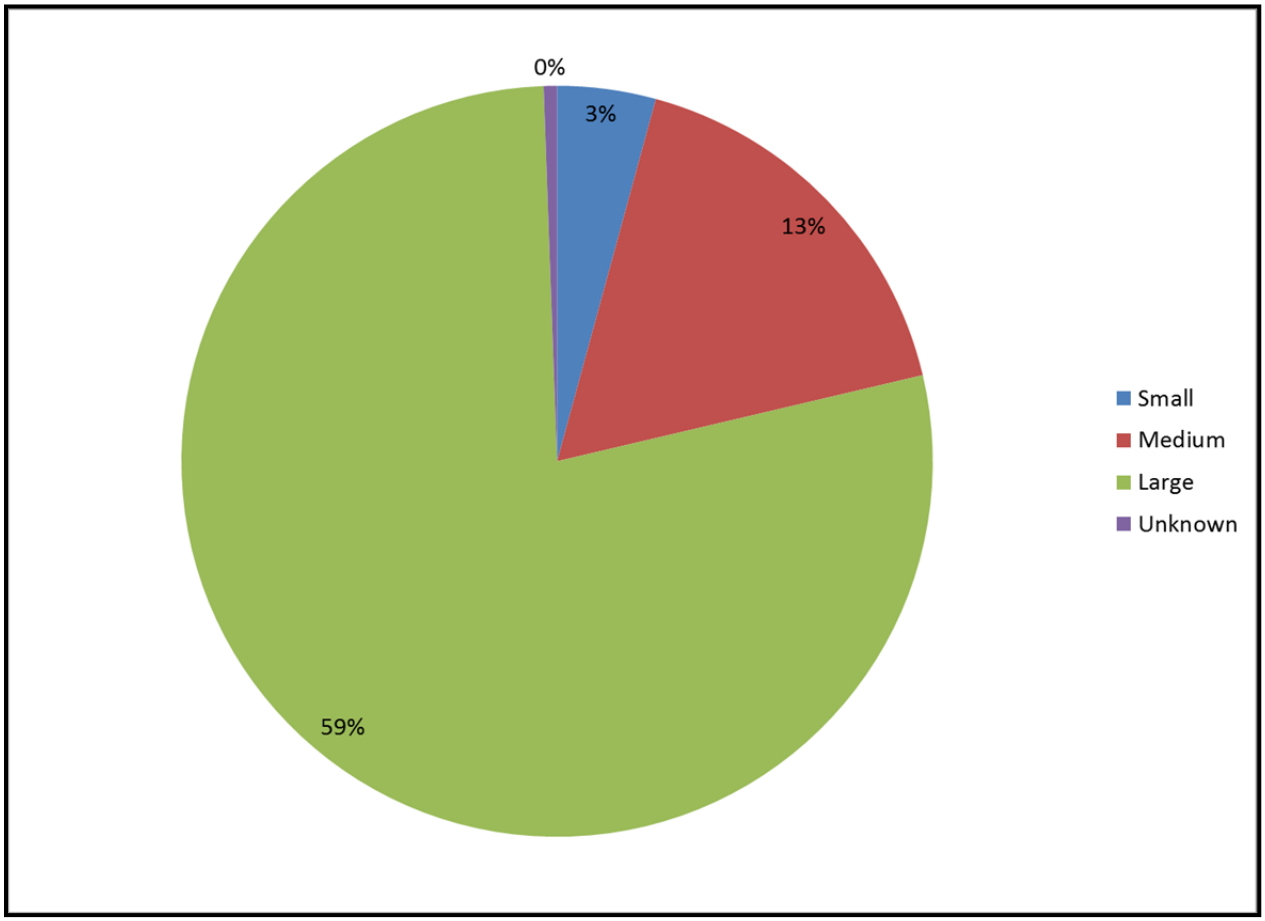
Figure 3-109: Share of Businesses with Power Management Systems



*****The results presented above are weighted by the business-level sample weight.

** These data represent 4 manufacturing/industrial, 3 healthcare, 5 retail, 2 campus, 6 office, 5 education, 1 food service, 1 warehouse, 2 other, 1 food sales, 4 lodging, and 4 public assembly sites.

Figure 3-110: Share of Businesses with Power Management Systems by Business Size



*The results presented above are weighted with the business-level sample weight.

** These data represent 14 small, 17 medium, 6 large, and 1 unknown sized sites.

A CUSTOMER LEVEL INFORMATION

Table A-1: Distribution of Businesses

Business Type	Share of Completed On-sites (kWh wt)	Standard Error
Campuses	2%	2%
Education	8%	5%
Food Sales	3%	1%
Food Service	4%	1%
Healthcare	3%	1%
Hospitals	1%	1%
Lodging	10%	6%
Manufacturing or Industrial	30%	15%
Office	10%	4%
Other	6%	3%
Public Assembly	9%	6%
Retail	9%	4%
Warehouse	4%	3%
Total Sites	**343**	

Table A-2: Distribution of Non-Residential Electricity Consumption

kWh Size	Share of Completed On-sites (kWh wt)	Standard Error
Unknown	1%	< 1%
Less than 500,001	30%	8%
500,000 to 4,500,000	35%	9%
Larger than 4,500,000	34%	14%
Total Sites	**343**	

Table A-3: Distribution of Non-Residential Square Footage

Square Foot Size	Share of Completed On-sites (kWh wt)	Standard Error
Unknown	< 1%	< 1%
Less than 5,001	10%	3%
5,001-10,000	6%	3%
10,001-25,000	6%	2%
25,001-50,000	11%	6%
50,001-100,000	8%	3%
100,001-200,000	19%	8%
200,001-500,000	8%	4%
Greater than 500,000	31%	15%
Total Sites	**343**	

B LIGHTING

B.1 Lighting Data

Table B-1: Distribution of Lamps by Technology Type

Lamp Type	On-site Percentages	Standard Error
Linears	63.9%	4.8%
CFLs	15.3%	4.3%
Incandescents	8.2%	2.3%
Halogens	3.3%	1.3%
LED	8.0%	2.0%
HID	1.2%	0.4%
Neon Lighting	0.0%	0.0%
Other Lighting	0.0%	0.0%

*** The results presented above have been weighted by respondent weight.**

Table B-2: Distribution of Lamps by Technology Type and Business Type

Lamp Type	Campuses	Education	Food Sales	Food Service	Health care	Hospitals	Lodging	Manufacturing or Industrial	Office	Other	Public Assembly	Retail	Warehouse
Linears	71%	91%	92%	30%	65%	89%	20%	95%	85%	61%	32%	75%	94%
CFLs	19%	4%	2%	6%	26%	8%	27%	3%	9%	12%	32%	10%	0%
Incandescents	9%	2%	1%	28%	5%	0%	7%	1%	2%	15%	18%	5%	0%
Halogens	0%	0%	0%	8%	1%	1%	1%	0%	1%	0%	10%	2%	1%
LED	1%	2%	3%	27%	2%	1%	45%	0%	2%	5%	6%	8%	3%
HID	1%	0%	1%	1%	0%	1%	0%	2%	0%	6%	1%	1%	2%
Neon Lighting	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other Lighting	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

* **The results presented above have been weighted by respondent weight.**

-Standard Errors

Lamp Type	Campuses	Education	Food Sales	Food Service	Health care	Hospitals	Lodging	Manufacturing or Industrial	Office	Other	Public Assembly	Retail	Warehouse
Linears	11.5%	3.7%	3.2%	7.7%	7.0%	6.2%	6.1%	3.1%	3.5%	7.9%	14.8%	4.8%	2.9%
CFLs	9.3%	2.5%	1.1%	1.9%	6.4%	5.8%	8.4%	2.4%	3.1%	2.6%	14.8%	3.1%	0.3%
Incandescents	6.6%	1.2%	0.3%	11.9%	1.5%	0.0%	3.3%	0.5%	0.7%	8.0%	8.9%	1.8%	0.2%
Halogens	0.0%	0.0%	0.0%	3.2%	0.6%	0.7%	0.8%	0.0%	0.4%	0.0%	5.6%	1.4%	0.4%
LED	0.4%	1.1%	2.0%	11.0%	0.9%	0.6%	12.1%	0.0%	0.8%	3.8%	4.4%	2.7%	1.8%
HID	0.6%	0.4%	0.3%	0.5%	0.2%	0.4%	0.1%	1.2%	0.1%	4.0%	1.5%	0.3%	1.2%
Neon Lighting	0.0%	0.0%	0.8%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other Lighting	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
n	**9**	**30**	**24**	**31**	**19**	**6**	**32**	**23**	**55**	**24**	**32**	**43**	**13**

Table B-3: Distribution of Lamps by Technology Type and Size

Lamp Type	LT 500,000 kWh		500,000 - 4,500,000 kWh		GT 4,500,000 kWh		Unknown	
	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.
Linears	59%	6.9%	69%	5.8%	86%	7.0%	81%	9.9%
CFLs	19%	6.8%	10%	2.3%	11%	6.3%	2%	0.9%
Incandescents	11%	3.7%	4%	1.7%	1%	0.4%	12%	9.7%
Halogens	4%	2.2%	2%	0.6%	0%	0.2%	0%	0.0%
LED	5%	2.0%	16%	5.0%	1%	0.4%	4%	2.1%
HID	2%	0.7%	0%	0.1%	2%	1.0%	0%	0.0%
Neon Lighting	0%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%
Other Lighting	0%	0.0%	0%	0.0%	0%	0.0%	1%	0.6%
n	**200**		**112**		**21**		**8**	

* **The results presented above have been weighted by respondent weight.**

Table B-4: Distribution of Linear Fluorescent Lamps by Technology Type and Business Type

Business Type	On-site Percentages	Standard Error	*n*
Campuses	0%	0.1%	9
Education	22%	6.3%	30
Food Sales	3%	0.9%	22
Food Service	1%	0.3%	30
Healthcare	3%	0.6%	19
Hospitals	2%	0.6%	6
Lodging	2%	0.6%	25
Manufacturing or Industrial	9%	3.4%	23
Office	18%	3.1%	54
Other	4%	0.9%	20
Public Assembly	13%	6.6%	31
Retail	16%	2.7%	41
Warehouse	7%	2.7%	13
	100%		**323**

* **The results presented above have been weighted by respondent weight.**

Table B-5: Distribution of Linear Fluorescent Lamps by Technology Type and Business Size

Business Size	On-site Percentages	Standard Error	*n*
LT 500,000 kWh	56%	5.9%	185
500,000 - 4,500,000 kWh	33%	5.3%	109
GT 4,500,000 kWh	9%	3.5%	21
Unknown	2%	0.6%	8

*** The results presented above have been weighted by respondent weight.**

Table B-6: Linear Efficiency Distributions for Four Foot, Eight Foot, and Other Lamps

Linear Efficiency and Size	On-site Percentages	Standard Error
T12, 4 Feet	3.8%	0.8%
Other, 4 Feet	0.8%	0.8%
700 Series T8, 4 Feet	21.5%	6.6%
800 Series T8, 4 Feet	2.7%	0.9%
High Performance T8, 4 Feet	6.3%	3.3%
Reduced Wattage T8, 4 Feet	10.2%	4.6%
T5, 4 Feet	3.0%	1.4%
LED, 4 Feet	0.1%	0.0%
Unknown, 4 Feet	0.4%	0.3%
T8 Model Not Found, 4 Feet	4.3%	2.1%
T8 Model Missing, 4 Feet	34.5%	5.5%
T12, 8 Feet	3.6%	1.3%
T8, 8 Feet	0.8%	0.2%
T5, 8 Feet	0.0%	0.0%
T12, Other Length	0.3%	0.1%
Other, Other Length	2.9%	0.9%
T8, Other Length	3.7%	1.1%
T5, Other Length	1.0%	0.6%
LED, Other Length	0.0%	0.0%

*** The results presented above have been weighted by Respondent weight.**

Table B-7: Linear Efficiency Distribution, Four Foot Lamps

Linear Efficiencies	On-Site Data Percentages	Standard Error
T12	4.3%	0.9%
Other	1.0%	1.0%
700 Series T8	24.5%	7.4%
800 Series T8	3.1%	1.0%
High Performance T8	7.2%	3.8%
Reduced Wattage T8	11.7%	5.2%
T5	3.4%	1.5%
LED	0.1%	0.1%
Unknown	0.4%	0.4%
Model Not Found	5.0%	2.4%
Model Missing	39.3%	6.3%

*** The results presented above have been weighted by Respondent weight.**

Table B-8: Linear Efficiency Distribution by Business Size, Four Foot Lamps

	LT 500,000 kWh		500,000 - 4,500,000 kWh		GT 4,500,000 kWh		Unknown	
Linear Efficiency	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.
T12	6.4%	1.7%	2.1%	1.0%	0.2%	0.2%	2.8%	1.9%
Other	1.7%	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
700 Series T8	35.1%	10.9%	15.4%	6.9%	0.8%	0.4%	0.0%	0.0%
800 Series T8	0.9%	0.5%	3.9%	1.5%	13.1%	8.6%	0.0%	0.0%
High Performance T8	0.3%	0.3%	0.0%	0.0%	74.8%	12.9%	0.0%	0.0%
Reduced Wattage T8	1.6%	0.8%	32.0%	11.8%	0.0%	0.0%	0.0%	0.0%
T5	2.6%	1.7%	5.8%	3.6%	0.0%	0.0%	0.3%	0.3%
LED	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.7%	0.5%
Unknown	0.8%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Model Not Found	8.1%	4.4%	1.4%	0.6%	0.0%	0.0%	0.1%	0.1%
Model Missing	42.3%	9.8%	39.2%	8.3%	11.0%	7.8%	96.2%	2.2%
n	176		107		21		8	

*** The results presented above have been weighted by respondent weight.**

Table B-9: Linear Efficiency Distribution by Energy Efficiency Program Participation, Four Foot Lamps

	EE Participant		EE Non-Participant	
Linear Efficiencies	On-Site Data Percentages	Standard Err	On-Site Data Percentages	Standard Err
T12	0.4%	0.2%	5.5%	1.3%
Other	0.0%	0.0%	1.3%	1.3%
700 Series T8	1.3%	0.5%	31.8%	9.0%
800 Series T8	10.1%	4.1%	0.8%	0.4%
High Performance T8	0.2%	0.1%	9.4%	4.9%
Reduced Wattage T8	48.2%	13.1%	0.2%	0.1%
T5	7.2%	5.1%	2.2%	1.2%
LED	0.0%	0.0%	0.1%	0.1%
Unknown	0.0%	0.0%	0.6%	0.5%
Model Not Found	2.0%	0.9%	5.9%	3.2%
Model Missing	30.5%	8.9%	42.1%	7.7%
n	85		227	

*** The results presented above have been weighted by Respondent weight.**

Table B-10: ICLH Distribution by Business Type

Business Type	On-site Percentages	Standard Error	*n*
Campuses	0.2%	0.1%	9
Education	3.5%	1.1%	24
Food Sales	0.3%	0.1%	23
Food Service	6.2%	2.0%	29
Healthcare	2.8%	0.7%	19
Hospitals	0.3%	0.2%	6
Lodging	17.8%	4.8%	30
Manufacturing or Industrial	0.5%	0.4%	17
Office	5.7%	1.5%	44
Other	4.3%	1.6%	22
Public Assembly	48.6%	8.0%	31
Retail	9.1%	2.0%	38
Warehouse	0.5%	0.2%	10

*** The results presented above have been weighted by respondent weight.**

Table B-11: ICLH Distribution by Business Size

Business Size	On-site Percentages	Standard Error	n
LT 500,000 kWh	70%	5.8%	175
500,000 - 4,500,000 kWh	27%	5.5%	103
GT 4,500,000 kWh	2%	1.1%	18
Unknown	1%	0.5%	6

* The results presented above have been weighted by respondent weight.

Table B-12: ICLH Distribution by Lamp Type

Lamp Type	On-site Percentages	Standard Error
CFL	44%	9%
HAL	10%	4%
Incandescent	24%	6%
LED	23%	6%

*** The results presented above have been weighted by respondent weight.**

Table B-13: Distribution of ICLH Lamps by Technology Type and Business Type

Lamp Type	Campuses	Education	Food Sales	Food Service	Healthcare	Hospitals	Lodging	Manufacturing or Industrial	Office	Other	Public Assembly	Retail	Warehouse
Linears	67%	55%	35%	8%	75%	82%	34%	78%	59%	37%	48%	40%	10%
CFLs	0%	0%	0%	12%	3%	7%	1%	0%	7%	0%	15%	8%	13%
Incandescents	31%	19%	11%	41%	16%	0%	8%	19%	17%	46%	28%	20%	9%
Halogens	2%	26%	55%	39%	6%	10%	57%	2%	17%	17%	9%	32%	68%

-Standard Errors

Lamp Type	Campuses	Education	Food Sales	Food Service	Healthcare	Hospitals	Lodging	Manufacturing or Industrial	Office	Other	Public Assembly	Retail	Warehouse
Linears	18.9%	15.4%	14.0%	2.8%	6.3%	11.6%	10.6%	20.2%	9.0%	12.2%	17.1%	9.9%	5.9%
CFLs	0.0%	0.3%	0.0%	4.7%	1.7%	6.9%	1.1%	0.0%	3.0%	0.1%	8.4%	5.6%	8.1%
Incandescents	19.1%	12.0%	3.3%	13.8%	4.6%	0.4%	4.3%	19.1%	4.9%	16.6%	13.0%	6.7%	4.5%
Halogens	1.7%	11.0%	15.2%	10.2%	2.8%	7.2%	12.5%	1.4%	5.3%	11.3%	6.6%	8.8%	13.3%
n	9	24	23	29	19	6	30	17	44	22	31	38	10

*** The results presented above have been weighted by respondent weight.**

Table B-14: ICLH Lamp Distribution by Business Size

Lamp Type	LT 500,000 kWh		500,000 - 4,500,000 kWh		GT 4,500,000 kWh		Unknown	
	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.
CFL	48%	12.1%	32%	7.2%	88%	6.8%	11%	7.1%
HAL	11%	5.6%	6%	2.1%	2%	1.7%	0%	0.0%
Incandescent	28%	9.2%	12%	5.3%	4%	3.4%	67%	19.5%
LED	13%	5.0%	50%	9.7%	6%	3.4%	22%	13.7%
n	175		103		18		6	

*** The results presented above have been weighted by respondent weight.**

Table B-15: ICLH Lamp Distribution by Energy Efficiency Program Participation

Lamp Type	EE Participants		EE Non-Participants	
	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.
CFL	24%	8.2%	48%	10.3%
HAL	6%	2.7%	10%	4.8%
Incandescent	6%	3.6%	27%	7.9%
LED	63%	10.7%	14%	4.6%
n	82		220	

*** The results presented above have been weighted by respondent weight.**

Table B-16: Share of Lighting Controlled by Alternative Lighting Controls

Lamp Type	On-site Percentages	Standard Error
Missing	1%	0.3%
Continuous On	2%	0.8%
Day Lighting	0%	0.0%
EMS	6%	1.3%
Manual	75%	3.8%
Motion Sensor	11%	3.4%
Other	0%	0.0%
PC – MS	2%	0.7%
PC – TC	4%	1.1%

*** The results presented above have been weighted by respondent weight.**

Table B-17: Lighting Controls by Lamp Type

Business Type	Missing	Continuous On	Day Lighting	EMS	Manual	Motion Sensor	Other	PC - MS	PC - TC
CFL	1%	1%	0%	6%	80%	3%	0%	0%	9%
HAL	3%	0%	0%	2%	88%	0%	0%	1%	6%
HID	2%	0%	0%	5%	20%	0%	0%	1%	72%
Incandescent	0%	0%	0%	0%	91%	1%	0%	0%	7%
LED	1%	13%	0%	8%	47%	23%	0%	0%	8%
Linear	1%	1%	0%	7%	75%	14%	0%	2%	0%
NEON	0%	18%	0%	6%	73%	0%	0%	0%	3%
Other Lighting	0%	72%	0%	0%	24%	0%	0%	0%	4%

-Standard Errors

Business Type	Missing	Continuous On	Day Lighting	EMS	Manual	Motion Sensor	Other	PC - MS	PC - TC
CFL	0.4%	1.1%	0.0%	2.6%	8.0%	2.1%	0.0%	0.2%	5.8%
HAL	1.8%	0.0%	0.0%	1.7%	7.9%	0.1%	0.3%	0.6%	6.4%
HID	2.2%	0.1%	0.0%	3.5%	8.0%	0.0%	0.0%	1.0%	10.9%
Incandescent	0.1%	0.1%	0.0%	0.3%	5.7%	0.7%	0.0%	0.2%	5.6%
LED	0.8%	8.7%	0.0%	4.1%	12.6%	14.1%	0.0%	0.2%	3.3%
Linear	0.4%	0.3%	0.0%	1.9%	5.1%	4.8%	0.0%	1.1%	0.2%
NEON	0.0%	5.1%	0.0%	0.1%	5.0%	0.0%	0.0%	0.0%	0.2%
Other Lighting	0.0%	18.6%	0.0%	0.0%	19.0%	0.0%	0.0%	0.0%	0.5%

*** The results presented above have been weighted by respondent weight.**

Table B-18: Lighting Controls by Business Size

Lamp Type	LT 500,000 kWh		500,000 - 4,500,000 kWh		GT 4,500,000 kWh		Unknown	
	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.
Missing	1%	0.4%	0%	0.2%	3%	2.1%	0%	0.1%
Continuous On	0%	0.1%	5%	2.5%	2%	1.4%	2%	1.2%
Day Lighting	0%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%
EMS	0%	0.1%	14%	3.5%	22%	10.8%	0%	0.0%
Manual	90%	2.4%	46%	6.7%	67%	13.2%	81%	8.6%
Motion Sensor	3%	1.5%	28%	8.6%	3%	1.8%	16%	8.3%
Other	0%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%
PC - MS	0%	0.3%	4%	2.2%	1%	0.7%	0%	0.1%
PC - TC	5%	1.6%	3%	1.6%	1%	0.7%	2%	1.1%
n	200		112		21		8	

* The results presented above have been weighted by respondent weight.

Table B-19: Lighting Controls by Energy Efficiency Participation

Lamp Type	EE Participants		EE Non-Participants	
	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.
Missing	1%	0.5%	1%	0.3%
Continuous On	5%	3.5%	1%	0.3%
Day Lighting	0%	0.0%	0%	0.0%
EMS	4%	1.9%	7%	1.6%
Manual	43%	8.3%	83%	2.8%
Motion Sensor	40%	10.4%	3%	1.2%
Other	0%	0.0%	0%	0.0%
PC - MS	4%	3.0%	1%	0.3%
PC - TC	2%	0.9%	4%	1.4%
Missing	1%	0.5%	1%	0.3%
n	93		248	

* The results presented above have been weighted by respondent weight.

Table B-20: Lighting Controls by Business Type

Lamp Type	Campuses	Education	Food Sales	Food Service	Healthcare	Hospitals	Lodging	Manufacturing or Industrial	Office	Other	Public Assembly	Retail	Warehouse
Missing	13%	0%	1%	3%	1%	0%	1%	2%	2%	4%	0%	0%	0%
Continuous On	8%	0%	1%	0%	14%	0%	13%	1%	0%	2%	0%	1%	0%
Day Lighting	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
EMS	0%	0%	5%	0%	0%	0%	0%	24%	0%	0%	1%	32%	0%
Manual	67%	54%	90%	78%	81%	97%	63%	66%	80%	85%	93%	59%	77%
Motion Sensor	1%	43%	2%	1%	1%	2%	21%	3%	15%	0%	0%	1%	8%
Other	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PC - MS	11%	0%	0%	0%	0%	0%	0%	2%	1%	1%	0%	3%	13%
PC - TC	0%	2%	2%	18%	3%	0%	1%	1%	2%	8%	6%	3%	2%

-Standard Errors

Lamp Type	Campuses	Education	Food Sales	Food Service	Healthcare	Hospitals	Lodging	Manufacturing or Industrial	Office	Other	Public Assembly	Retail	Warehouse
Missing	7.6%	0.0%	0.4%	1.7%	0.6%	0.1%	0.7%	2.3%	1.4%	2.0%	0.1%	0.4%	0.5%
Continuous On	3.5%	0.1%	0.3%	0.1%	6.3%	0.3%	8.8%	0.9%	0.1%	1.2%	0.0%	0.5%	0.0%
Day Lighting	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
EMS	0.1%	0.1%	2.7%	0.0%	0.0%	0.3%	0.0%	12.4%	0.0%	0.0%	0.3%	6.4%	0.0%
Manual	10.5%	16.3%	4.1%	12.2%	6.4%	2.1%	13.3%	15.1%	5.8%	5.7%	3.9%	6.4%	13.3%
Motion Sensor	0.5%	16.3%	1.0%	0.9%	0.3%	1.9%	14.3%	2.0%	5.6%	0.2%	0.1%	0.6%	6.8%
Other	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
PC - MS	6.4%	0.0%	0.2%	0.1%	0.0%	0.0%	0.2%	1.8%	1.3%	0.7%	0.1%	1.6%	12.2%
PC - TC	0.0%	1.2%	1.3%	12.6%	1.2%	0.2%	0.6%	0.7%	1.1%	5.3%	3.8%	1.4%	0.9%
n	9	30	24	31	19	6	32	23	55	24	32	43	13

* The results presented above have been weighted by respondent weight.

B.2 Recent Lighting Purchase Data

Table B-21: Recent Lighting Purchase Distribution of Lamps by Technology Type

Lamp Type	On-site Percentages	Standard Error
Linears	68%	6%
CFLs	5%	1%
Incandescents	<1%	<1%
Halogens	1%	<1%
LED	26%	6%
HID	<1%	<1%

*** The results presented above have been weighted by respondent weight.**

Table B-22: Recent Lighting Purchase Distribution of Lamps by Technology Type and Business Type

Lamp Type	Campuses	Education	Food Sales	Food Service	Healthcare	Hospitals	Lodging	Manufacturing or Industrial	Office	Other	Public Assembly	Retail	Warehouse
Linears	90%	83%	92%	15%	50%	98%	11%	100%	93%	14%	38%	79%	91%
CFLs	9%	6%	1%	3%	44%	<1%	2%	0%	1%	47%	9%	4%	0%
Incandescents	0%	0%	0%	0%	0%	0%	<1%	0%	0%	0%	1 %	0%	0%
Halogens	0%	0%	0%	9%	0%	0%	2%	0%	0%	0%	4%	0%	0%
LED	1%	12%	7%	73%	7%	2%	86%	<1%	6%	38%	48%	17%	9%
HID	<1%	0.00%	<1%	<1%	0%	0%	0%	0%	0%	2%	<1%	<1%	<1%

-Standard Errors

Lamp Type	Campuses	Education	Food Sales	Food Service	Healthcare	Hospitals	Lodging	Manufacturing or Industrial	Office	Other	Public Assembly	Retail	Warehouse
Linears	6%	10%	4%	9%	14%	1%	7%	0%	2%	4%	7%	7%	8%
CFLs	5%	5%	1%	1%	13%	0%	1%	0%	1%	2%	3%	3%	<1%
Incandescents	0%	0%	0%	0%	0%	0%	<1%	0%	0%	0%	1%	0%	0%
Halogens	0%	0%	0%	6%	0%	0%	2%	0%	0%	0%	2%	0%	0%
LED	1%	8%	4%	13%	4%	1%	9%	0%	2%	2%	5%	6%	8%
HID	<1%	0%	<1%	<1%	0%	0%	0%	0%	0%	1%	<1%	1%	<1%
n	**5**	**19**	**17**	**15**	**9**	**3**	**15**	**11**	**22**	**11**	**19**	**20**	**8**

Table B-23: Distribution of Recently Purchased Lamps by Technology Type and Business Size

Lamp Type	LT 500,000 kWh		500,000 - 4,500,000 kWh		GT 4,500,000 kWh		Unknown	
	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.
Linears	68%	8%	40%	12%	99%	<1%	92%	4%
CFLs	7%	2%	4%	2%	0.1%	0%	3%	1%
Incandescents	<1%	<1%	0%	0%	0%	0%	<1%	<1%
Halogens	2%	1%	1%	1%	0%	0%	0%	0%
LED	23%	8%	54%	13%	0.8%	<1%	6%	3%
HID	<1%	<1%	0%	0%	0%	0%	0%	0%
Neon Lighting	68%	8%	40%	12%	99%	<1%	92%	4%
Other Lighting	7%	2%	4%	2%	0.1%	0%	3%	1%
n	**92**		**63**		**14**		**5**	

Table B-24: Distribution of Recently Purchased Linear Lamps by Business Type, Four Foot Lamps

Business Type	On-site Percentages	Standard Error	*n*
Campuses	<1%	<1%	3
Education	12%	7%	14
Food Sales	5%	2%	13
Food Service	1%	<1%	7
Healthcare	2%	1%	6
Hospitals	2%	1%	2
Lodging	1%	0%	7
Manufacturing or Industrial	28%	11%	10
Office	27%	7%	13
Other	<1%	<1%	3
Public Assembly	5%	2%	13
Retail	10%	3%	12
Warehouse	6%	4%	4
	100%		**107**

*** The results presented above have been weighted by respondent weight.**

Table B-25: Distribution of Recently Purchased Linear Fluorescent Lamps by Technology Type and Business Size

Business Size	On-site Percentages	Standard Error	*n*
LT 500,000 kWh	50%	9%	60
500,000 - 4,500,000 kWh	13%	4%	36
GT 4,500,000 kWh	31%	11%	6
Unknown	6%	2%	5

*** The results presented above have been weighted by Respondent weight.**

Table B-26: Recent Purchase Linear Efficiency Distribution

Linear Efficiencies	On-Site Data Percentages	Standard Errors
T12	<1%	<1%
Other	0%	0%
700 Series T8	10%	5%
800 Series T8	7%	3%
High Performance T8	25%	11%
Reduced Wattage T8	<1%	<1%
T5	8%	4%
LED	<1%	<1%
Unknown	<1%	<1%
Model Not Found	12%	8%
Model Missing	37%	7%

*** The results presented above have been weighted by Respondent weight.**

Table B-27: Recent Purchase Linear Efficiency Distribution by Business Size – with Missing Data, Four Foot Lamps

	LT 500,000 kWh		500,000 - 4,500,000 kWh		GT 4,500,000 kWh		Unknown	
Lamp Type	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.
T12	<1%	<1%	0%	<1%	0%	0%	0%	0%
Other	0%	0%	0%	0%	0%	0%	0%	0%
700 Series T8	19%	9%	1%	<1%	0%	0%	0%	0%
800 Series T8	0%	0%	30%	13%	10%	8%	0%	0%
High Performance T8	0%	0%	0%	0%	80%	12%	0%	0%
Reduced	<1%	<1%	<1%	<1%	0%	0%	0%	0%

Wattage T8								
T5	4%	2%	48%	18%	<1%	<1%	<1%	<1%
LED	<1%	<1%	0%	<1%	0%	0%	<1%	<1%
Unknown	<1%	<1%	0%	0%	0%	0%	0%	0%
Model Not Found	21%	13%	12%	5%	0%	0%	<1%	<1%
Model Missing	54%	11%	8%	4%	10%	7%	99%	<1%
Total	**60**		**36**		**6**		**5**	

*** The results presented above have been weighted by Respondent weight.**

Table B-28: Recent Purchase Linear Efficiency Distribution by Energy Efficiency Program Participation, Four Foot Lamps

Linear Efficiencies	On-Site Data Percentages, EE Participant	Standard Error	On-Site Data Percentages, EE Non-Participant	Standard Error
T12	<1%	<1%	<1%	<1%
Other	0%	0%	0%	0%
700 Series T8	<1%	<1%	14%	7%
800 Series T8	25%	9%	0.2%	0.13%
High Performance T8	<1%	<1%	35%	14%
Reduced Wattage T8	<1%	<1%	<1%	<1%
T5	21%	12%	3%	2%
LED	<1%	<1%	<1%	<1%
Unknown	0%	0%	<1%	<1%
Model Not Found	6%	2%	15%	10%
Model Missing	47%	10%	32%	8%
Total	**44**		**63**	

*** The results presented above have been weighted by Respondent weight.**

Table B-29: Recent Purchase ICLH Distribution by Business Type

Business Type	On-site Percentages	Standard Error	*n*
Campuses	<1%	<1%	3
Education	5%	2%	15
Food Sales	1%	<1%	10
Food Service	11%	5%	13
Healthcare	5%	1%	7
Hospitals	<1%	<1%	3
Lodging	41%	12%	14
Manufacturing or Industrial	<1%	<1%	5
Office	5%	2%	17
Other	6%	4%	8
Public Assembly	19%	11%	15
Retail	5%	2%	16
Warehouse	1%	1%	5

*** The results presented above have been weighted by respondent weight.**

Table B-30: Recent Purchase ICLH Distribution by Business kWh Size

Business Size	On-site Percentages	Standard Error	*n*
LT 500,000 kWh	50%	11%	66
500,000 - 4,500,000 kWh	49%	12%	50
GT 4,500,000 kWh	1%	<1%	12
Unknown	1%	<1%	3

*** The results presented above have been weighted by Respondent weight.**

Table B-31: Recent Purchase Technology Distribution of ICLH Lamps

Lamp Type	On-site Percentages	Standard Error
CFL	15%	5%
HAL	3%	1%
Incandescent	<1%	<1%
LED	81%	5%

*** The results presented above have been weighted by respondent weight.**

Table B-32: Share of Recently Purchased Lighting Controlled by Alternative Lighting Controls

Lamp Type	Percent	Standard Error
Missing	1%	1%
Continuous On	4%	3%
Day Lighting	0%	0%
EMS	5%	2%
Manual	66%	7%
Motion Sensor	17%	6%
Other	0%	0%
PC - MS	3%	2%
PC - TC	3%	1%

*** The results presented above have been weighted by Respondent weight.**

Table B-33: Lighting Controls on Recently Purchased Lamps by Lamp Type

Lamp Type	Missing	Continuous	Daylighting	EMS	Manual	Motion Sensor	Other	Photo-Controlled MS	Photo Controlled Time Clock
CFL	3%	<1%	0%	<1%	83%	1%	<1%	<1%	12%
HAL	20%	0%	0%	0%	79%	2%	0%	0%	0%
HID	0%	0%	0%	0%	49%	0%	0%	0%	51%
Incandescent	0%	0%	0%	0%	100%	0%	0%	0%	0%
LED	1%	16%	0%	0%	47%	27%	0%	<1%	9%
Linear	1%	<1%	0%	7%	72%	14%	<1%	4%	1%
OtherLighting	0%	0%	0%	0%	100%	0%	0%	0%	0%

Standard Errors

Lamp Type	Missing	Continuous	Daylighting	EMS	Manual	Motion Sensor	Other	Photo-Controlled MS	Photo Controlled Time Clock
CFL	1%	<1%	0%	<1%	5%	<1%	<1%	<1%	5%
HAL	18%	0%	0%	0%	18%	2%	0%	0%	0%
HID	0%	0%	0%	0%	13%	0%	0%	0%	13%
Incandescent	0%	0%	0%	0%	0%	0%	0%	0%	0%
LED	<1%	11%	0%	<1%	15%	17%	0%	<1%	4%
Linear	<1%	0%	0%	4%	7%	5%	0%	4%	<1%
OtherLighting	0%	0%	0%	0%	0%	0%	0%	0%	0%

*** The results presented above have been weighted by Respondent weight.**

Table B-34: Lighting Controls on Recently Purchased Lamps by Business kWh Size

Linear Efficiency	LT 500,000 kWh		500,000 - 4,500,000 kWh		GT 4,500,000 kWh		Unknown	
	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.	On-site Percentages	Standard Err.
Missing	<1%	<1%	<1%	<1%	3%	3%	<1%	<1%
Continuous On	<1%	<1%	15%	11%	<1%	<1%	0%	0%
Day Lighting	0%	0%	0%	0.01%	0.00%	0%	0%	0%
EMS	<1%	<1%	2%	1%	22%	13%	0%	0%
Manual	80%	6%	36%	11%	70%	15%	75%	13%
Motion Sensor	14%	6%	33%	16%	4%	2%	22%	12%
Other	<1%	<1%	<1%	<1%	0%	0%	0%	0%
PC - MS	<1%	<1%	10%	9%	<1%	<1%	<1%	<1%
PC - TC	4%	1%	5%	2%	<1%	<1%	2%	2%
n	**92**		**63**		**14**		**5**	

*** The results presented above have been weighted by respondent weight.**

C HVAC

C.1 Cooling Statistics

Table C-1: Businesses with Varying Types of HVAC Cooling Equipment

HVAC System Combinations	Site Weight		kWh Weight	
	Percent	Std. Err.	Percent	Std. Err.
Chiller	0%	0.2%	20%	13.9%
Chiller; Package/Split	2%	0.9%	22%	11.5%
Chiller; Package/Split;Other	0%	0.3%	7%	6.0%
Chiller; Other	1%	0.7%	0%	0.3%
Package/Split	63%	8.1%	25%	8.2%
Package/Split;Other	12%	4.8%	19%	6.5%
Other	21%	6.1%	5%	2.1%
None	0%	0.1%	0%	0.1%

* The results presented above have been weighted as labeled.

Table C-2: Percent of Square Feet with HVAC Cooling Systems

HVAC System Combinations	Percent	Std. Err.
Chiller	8%	4.9%
Chiller; Package/Split	20%	10.7%
Chiller; Package/Split;Other	3%	2.4%
Package/Split	33%	12.5%
Chiller; Other	1%	1.2%
Package/Split;Other	23%	8.1%
Other	12%	5.2%
None	0%	0.0%

* The results presented above have been weighted by respondent weight.

Table C-3: Percent of HVAC Cooling Systems by Type

Cooling System Groups	Percent	Std. Err.
Packaged/Split Systems	53%	9.8%
Chillers	2%	1.1%
Other Cooling Systems	28%	8.1%
PTAC	16%	8.5%

* The results presented above have been weighted by respondent weight.

Table C-4: Percent of HVAC Cooling Systems by Business Size

HVAC System Type	<500,000 kWh		500,000 - 4,500,000 kWh		>4,500,000 kWh		Unknown	
	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.
Package System AC	11%	3.2%	17%	9.2%	9%	7.6%	20%	14.0%
Package System Heat Pump	3%	2.0%	0%	0.3%	3%	1.8%	0%	0.0%
Split System AC	43%	12.5%	14%	9.8%	3%	2.3%	5%	1.5%
Split System Heat Pump	3%	1.7%	1%	0.4%	36%	31.3%	75%	13.3%
PTAC	1%	0.7%	54%	17.4%	3%	2.7%	0%	0.0%
Window/Wall Unit	28%	10.5%	5%	2.7%	0%	0.2%	0%	0.0%
Double Effect Direct Fired Absorption	0%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%
Gas Engine	0%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%
Large Split DX	0%	0.1%	0%	0.1%	0%	0.1%	0%	0.0%
Mini Split	10%	5.1%	3%	1.8%	0%	0.2%	0%	0.0%
Reciprocating	0%	0.2%	2%	2.4%	0%	0.3%	0%	0.0%
Centrifugal	0%	0.0%	0%	0.4%	9%	7.4%	0%	0.0%
Screw / Scroll	0%	0.0%	3%	2.4%	37%	28.9%	0%	0.0%
n	**159**		**107**		**21**		**8**	

***** The results presented above have been weighted by respondent weight.

Table C-5: Air Conditioning Efficiency Ratings for Split/Packaged Systems

Efficiency Groups	Percent	Std. Err.
Below Standard	62%	12.5%
At Standard	12%	4.4%
Above Standard	10%	3.8%
Make/Model Missing	9%	4.9%
Make/Model Not Found	7%	3.4%

* The results presented above have been weighted by respondent weight.

Table C-6: Air Conditioning Efficiency Ratings by System Size

System Size Groups	Small (< 65 kBtuh)		Medium (>= 65 kBtuh and < 240 kBtuh)		Large (>= 240 kBtuh)	
	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.
At Standard	19%	5.2%	1%	0.7%	0%	0.0%
Above Standard	12%	2.9%	4%	4.1%	25%	15.5%
Make/Model Missing	8%	3.4%	13%	12.6%	1%	0.6%
Make/Model Not Found	5%	1.9%	4%	2.5%	57%	5.2%
Below Standard	57%	9.3%	79%	16.5%	17%	10.4%
N	**143**		**33**		**7**	

***** The results presented above have been weighted by respondent weight.

Table C-7: Air Conditioning Efficiency Ratings by Business Size

System Size Groups	<500,000 kWh		500,000 - 4,500,000 kWh		>4,500,000 kWh		Unknown	
	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.
Below Standard	64%	15.0%	57%	16.4%	55%	3.2%	53%	29.5%
At Standard	13%	5.8%	6%	3.1%	4%	2.9%	13%	15.0%
Above Standard	10%	4.9%	9%	4.4%	35%	5.9%	7%	8.1%
Make/Model Missing	11%	6.3%	1%	1.2%	5%	2.5%	8%	8.5%
Make/Model Not Found	2%	1.4%	27%	14.9%	1%	0.6%	19%	13.2%
N	**85**		**77**		**15**		**6**	

***** The results presented above have been weighted by respondent weight.

Table C-8: Efficiency Ratings by EE Participation, Non-Participants

System Size Groups	Non-Participant		Participant	
	Percent	Std. Err.	Percent	Std. Err.
Below Standard	64%	3.9%	49%	5.5%
At Standard	11%	3.5%	16%	3.1%
Above Standard	10%	3.2%	7%	1.5%
Make/Model Missing	10%	1.6%	3%	13.5%
Make/Model Not Found	4%	9.6%	25%	15.0%
n	**121**		**62**	

***** The results presented above have been weighted by respondent weight.

C.2 Cooling Statistics – Recent Purchases

Table C-9: Efficiency Ratings for Recently Purchased Split/Packaged Systems

Efficiency Groups	Percent	Std. Err.
Below Standard	5.5%	2.5%
At Standard	25.8%	6.8%
Above Standard	59.8%	4.2%
Make/Model Missing	4.6%	3.9%
Make/Model Not Found	4.3%	2.6%

***** The results presented above have been weighted by respondent weight.

Table C-10: Efficiency Ratings for Recently Purchased Split and Packaged Systems by System Size

	Small (< 65 kBtuh)		Medium (>= 65 kBtuh and < 240 kBtuh)		Large (>= 240 kBtuh)	
Efficiency Groups	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**
Below Standard	3.9%	2.4%	15.4%	7.1%	2.1%	0.2%
At Standard	29.2%	7.7%	8.6%	0.5%	0.0%	0.0%
Above Standard	57.2%	4.1%	72.6%	6.8%	83.2%	8.6%
Make/Model Missing	4.9%	4.6%	3.4%	0.2%	0.4%	0.2%
Make/Model Not Found	4.8%	3.1%	0.0%	0.0%	14.3%	8.5%
N	**41**		**14**		**5**	

* The results presented above have been weighted by respondent weight.

Table C-11: Efficiency Ratings for Recently Purchased Split and Packaged Systems by Business Size

	<500,000 kWh		500,000 - 4,500,000 kWh		>4,500,000 kWh		Unknown	
Efficiency Groups	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**
Below Standard	3.9%	1.9%	20.2%	17.6%	0.5%	0.6%	0.0%	0.0%
At Standard	24.7%	7.8%	42.8%	13.4%	14.0%	13.9%	0.0%	0.0%
Above Standard	64.8%	3.8%	34.8%	23.5%	83.8%	14.4%	4.2%	6.4%
Make/Model Missing	4.8%	4.6%	0.0%	0.1%	1.6%	0.6%	17.9%	15.0%
Make/Model Not Found	1.9%	1.4%	2.1%	1.6%	0.0%	0.0%	77.8%	20.0%
N	**24**		**25**		**9**		**2**	

* The results presented above have been weighted by respondent weight.

C.3 Heating Statistics

Table C-12: Businesses with Varying Types of HVAC Heating Equipment

Heating System Combinations	Percent	Std. Err.
Split/Packaged Only	42%	8.3%
Heat Pump Only	3%	2.0%
Boiler Only	9%	3.0%
Split/Packaged; Heat Pump	0%	0.3%
Split/Packaged; Boiler	9%	7.3%
Split/Packaged; Other Heating	8%	2.0%
Heat Pump; Boiler	3%	1.5%
Heat Pump; Other Heating	0%	0.1%
Other Heating	17%	5.6%
Boiler; Other Heating	8%	4.3%
Heating with 3 or more Systems	1%	0.4%

* The results presented above have been weighted by respondent weight.

Table C-13: Businesses with Varying Types of HVAC Heating Equipment

Heating System Combinations	Percent	Std. Err.
Split/Packaged Only	12%	3.0%
Heat Pump Only	1%	0.4%
Boiler Only	14%	6.5%
Split/Packaged; Heat Pump	0%	0.2%
Split/Packaged; Boiler	13%	7.1%
Split/Packaged; Other Heating	9%	4.1%
Heat Pump; Boiler	2%	1.0%
Heat Pump; Other Heating	1%	0.3%
Other Heating	13%	7.4%
Boiler; Other Heating	23%	12.5%
Heating with 3 or more Systems	13%	4.9%

* The results presented above have been weighted by kWh weight.

Table C-14: Percent of Square Feet with Varying Types of HVAC Heating Equipment

HVAC System Types	Percent	Std. Err.
Split/Packaged Only	8%	2.5%
Heat Pump Only	1%	0.5%
Boiler Only	17%	7.6%
Split/Packaged; Heat Pump	0%	0.1%
Split/Packaged; Boiler	16%	12.3%
Split/Packaged; Other Heating	11%	6.1%
Heat Pump; Boiler	2%	0.9%
Heat Pump; Other Heating	1%	0.8%
Other Heating	25%	14.3%
Boiler; Other Heating	10%	7.9%
Heating with 3 or more Systems	11%	5.3%

* The results presented above have been weighted by respondent weight.

Table C-15: Percent of HVAC Heating Systems by Type

Heating System Groups	Percent	Std. Err.
Packaged/Split Systems	33%	10.1%
Heat Pumps	10%	4.2%
Boilers	7%	2.4%
Other	50%	11.2%

* The results presented above have been weighted by respondent weight.

Table C-16: Percent of HVAC Heating Systems by Business Size

HVAC System Type	<500,000 kWh		500,000 - 4,500,000 kWh		>4,500,000 kWh		Unknown	
	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.
Other	4%	1.8%	4%	3.0%	96%	5.7%	3%	2.8%
PTAC	2%	1.0%	49%	18.8%	0%	0.0%	0%	0.0%
Steam	3%	1.6%	4%	2.3%	0%	0.2%	2%	2.0%
Unit Heater	6%	1.9%	2%	1.3%	0%	0.2%	1%	0.6%
Package Air Source Heat Pump	2%	1.6%	0%	0.2%	0%	0.1%	0%	0.0%
Window/Wall Unit	1%	0.9%	2%	1.7%	0%	0.0%	0%	0.0%
Air Source Heat Pump	4%	2.2%	4%	2.5%	0%	0.0%	60%	9.5%
Baseboard heater	6%	3.0%	7%	4.9%	0%	0.0%	0%	0.0%
Duct Heater	1%	0.6%	0%	0.0%	0%	0.0%	0%	0.0%
HW	8%	5.2%	7%	3.3%	2%	4.7%	2%	2.0%
Package Furnace/AC	9%	2.3%	13%	7.2%	1%	0.8%	17%	11.9%
Space Heater	23%	12.5%	0%	0.0%	0%	0.0%	0%	0.0%
Split Forced Air Furnace	32%	12.1%	8%	4.9%	0%	0.0%	12%	1.9%
Water Source Heat Pump	0%	0.0%	0%	0.4%	0%	0.1%	1%	0.6%
Geothermal Heat Pump	0%	0.0%	0%	0.0%	0%	0.0%	3%	3.3%
n	**180**		**110**		**19**		**8**	

* The results presented above have been weighted by respondent weight.

Table C-17: Distribution of Business by Heating Fuel Types and Combinations

Fuel Combinations	Percent	Std. Err.
Electric	10%	7.0%
Elec & NG	17%	5.7%
Elec & NG & Fuel Oil	0%	0.0%
Elec & Fuel Oil	4%	3.9%
Natural Gas	60%	8.7%
NG & Fuel Oil	1%	1.1%
Fuel Oil	2%	0.9%
Other Fuels	5%	3.1%
No Fuel	0%	0.0%

* The results presented above have been weighted by kWh weight.

Table C-18: Distribution Heating Fuel Types and Combinations by Square Feet

Fuel Combinations	Percent	Std. Err.
Electric	4%	2.3%
Elec & NG	16%	7.4%
Elec & NG & Fuel Oil	0%	0.1%
Natural Gas	72%	8.6%
Elec & Fuel Oil	2%	1.4%
NG & Fuel Oil	1%	0.5%
Fuel Oil	2%	1.0%
Other Fuels	2%	1.6%
No Fuel	0%	0.0%

* The results presented above have been weighted by square feet weight.

Table C-19: Distribution of Heating Fuel Types and Combinations by Business Size (kWh)

Fuel Combinations	<500,000 kWh		500,000 - 4,500,000 kWh		>4,500,000 kWh		Unknown	
	Percent	Std Error	Percent	Std Error	Percent	Std Error	Percent	Std Error
Electric	4%	1.8%	20%	14.8%	0%	0.0%	46%	5.4%
Elec & NG	5%	2.3%	26%	9.1%	18%	2.8%	10%	1.2%
Elec & NG & Fuel Oil	0%	0.1%	0%	0.0%	0%	0.0%	0%	0.0%
Elec & Fuel Oil	12%	10.4%	0%	0.0%	0%	0.0%	1%	1.0%
Natural Gas	66%	9.8%	47%	12.5%	75%	6.2%	44%	7.2%
NG & Fuel Oil	4%	3.0%	0%	0.0%	0%	0.0%	0%	0.0%
Fuel Oil	5%	2.1%	1%	1.3%	0%	0.0%	0%	0.0%
Other Fuels	3%	1.7%	6%	5.9%	7%	6.7%	0%	0.0%
No Fuel	0%	0.0%	0%	0.0%	0%	0.0%	0%	0.0%
n	**180**		**110**		**19**		**8**	

***** The results presented above have been weighted by kWh weight.

Table C-20: Efficiency Ratings Distribution for Heating Systems

Efficiency Groups	Percent	Std. Err.
Below Standard	3%	2.0%
At Standard	12%	7.3%
Above Standard	50%	11.6%
Make/Model Missing	15%	3.7%
Make/Model Not Found	20%	9.5%

* The results presented above have been weighted by respondent weight.

Table C-21: Efficiency Ratings by EE Participation

	Non-participants		Participants	
Efficiency Groups	Percent	Std. Err.	Percent	Std. Err.
Below Standard	3%	2.2%	3%	2.2%
At Standard	12%	8.0%	2%	1.4%
Above Standard	48%	12.4%	78%	6.2%
Make/Model Missing	16%	4.0%	6%	2.2%
Make/Model Not Found	20%	10.0%	11%	5.5%
n	**147**		**63**	

* The results presented above have been weighted by respondent weight.

Table C-22: HVAC Maintenance

Maintenance Type	Percent	Std. Err.
Preventative	22.1%	6.5%
Reactionary	76.4%	6.8%
Unknown	1.6%	0.7%

* The results presented above have been weighted by kWh weight.

C.4 Heating Statistics – Recent Purchases

Table C-23: Efficiency Ratings for Recently Purchased Split/Packaged Heating Systems

Efficiency Groups	Percent	Std. Err.
Below Standard	1.4%	1.3%
At Standard	0.5%	0.4%
Above Standard	31.9%	6.7%
Make/Model Missing	35.4%	5.9%
Make/Model Not Found	30.8%	4.5%

* The results presented above have been weighted by respondent weight.

Table C-24: Efficiency Ratings for Recently Purchased Split/Packaged Heating Systems by Business Size

	<500,000 kWh		500,000 - 4,500,000 kWh		>4,500,000 kWh		Unknown	
Efficiency Groups	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**
Below Standard	0.0%	0.0%	12.9%	18.3%	2.7%	2.8%	4.2%	6.4%
At Standard	0.0%	0.0%	5.7%	5.0%	0.0%	0.0%	0.0%	0.0%
Above Standard	27.8%	6.1%	78.1%	22.6%	5.4%	5.2%	15.1%	11.2%
Make/Model Missing	40.6%	5.7%	1.3%	1.0%	46.5%	20.5%	2.8%	4.3%
Make/Model Not Found	31.6%	4.1%	2.0%	1.8%	45.3%	24.8%	77.8%	20.0%
n	**27**		**19**		**7**		**2**	

* The results presented above have been weighted by respondent weight.

D ENERGY MANAGEMENT SYSTEMS

Table D-1: Businesses with EMS

EMS	Count	Percent	Std. Err.
Has EMS	88	35%	*11.2%*
No EMS	255	65%	
Total	**343**	**100%**	

* The results presented above have been weighted by kWh weight.

Table D-2: Businesses with EMS, by kWh Size

	Small		Medium		Large		Unknown	
	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.
EMS	7%	*5.8%*	48%	*12.2%*	48%	*22.7%*	9%	*1.0%*
No EMS	93%		52%		52%		91%	
n	**201**		**113**		**21**		**8**	

* The results presented above have been weighted by kWh weight.

Table D-3: Businesses with EMS, by Square Footage Size

Business Size (Sq.Ft.)	No EMS	EMS	Std. Err.	*n*
< 5,001	98%	2%	*1.2%*	**115**
5,001 to 10,000	98%	2%	*1.3%*	**38**
10,001 to 25,000	73%	27%	*3.2%*	**43**
25,001 to 50,000	77%	23%	*21.2%*	**42**
50,001 to 100,000	38%	62%	*11.8%*	**41**
100,001 to 200,000	57%	43%	*16.1%*	**37**
200,001 to 500,000	38%	62%	*8.3%*	**20**
> 500,000	60%	40%	-	**6**
Unknown	100%	0%	-	**1**

* The results presented above have been weighted by kWh weight.

Table D-4: Businesses with EMS, by EE Program Participation

	EE Program Participant		Non-EE Program Participant	
	Percent	Std. Err.	Percent	Std. Err.
Has EMS	36%	*18.1%*	35%	*14.5%*
No EMS	64%		65%	
n	**93**		**250**	

* The results presented above have been weighted by kWh weight.

Table D-5: End Uses Controlled by EMS

End Use	Percent of Systems	Std. Err.	Count of Systems
HVAC Units	97%	*1.8%*	75
HVAC Auxiliary Pumps/Fans	95%	*2.2%*	59
Central Plant	48%	*19.5%*	28
Inside Lighting	48%	*19.5%*	27
Outside Lighting	52%	*18.6%*	24
Domestic/Service Water Heating	17%	*9.6%*	21
On-Site Generation	10%	*7.7%*	14
Process Equipment	11%	*8.0%*	9
Other	6%	*5.3%*	7

* The results presented above have been weighted by kWh weight.

Table D-6: EMS System Layout Distribution

System Layout	Percent	Std. Err.	Count
Single Central Controller	28%	*3.8%*	45
Distributed Control	72%	*10.9%*	36
Total	**100%**		**81**

* The results presented above have been weighted by kWh weight.

Table D-7: EMS Controlling Entity

EMS Controlled By	Percent	Std. Err.	Count
External Third Party	5%	*3.3%*	8
On-Site Personnel	57%	*18.8%*	64
Central Headquarters	37%	*20.1%*	13
Don't Know	1%	*0.3%*	3
Total	**100%**		**88**

* The results presented above have been weighted by kWh weight.

Table D-8: EMS Training Providers

EMS Training Provider	Percent	Std. Err.	Count
In-House Staff	51%	*15.4%*	18
EMS Vendor	34%	*11.1%*	35
HVAC Contractor	13%	*10.0%*	6
Don't Know	1%	*0.9%*	7
Total	**100%**		**66**

* The results presented above have been weighted by kWh weight.

Table D-9: Businesses with New EMS (2009 or later)

	Count	Percent	Std. Err.
New EMS	46	79%	*10.1%*
Old EMS	42	21%	
Total	**88**	**100%**	

* The results presented above have been weighted by kWh weight.

Table D-10: Businesses with New EMS, by kWh Size

	Small		Medium		Large		Unknown	
	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.
New EMS	0.2%	*0.1%*	42%	*17.7%*	58%	*17.9%*	0.2%	*0.2%*
Old EMS	29%	*1.0%*	68%	*1.0%*	3%	*0.1%*	0.0%	*0.0%*
n	**13**		**58**		**16**		**1**	

***** The results presented above have been weighted by kWh weight.

Table D-11: Businesses with New EMS, by EE Program Participation

	EE Program Participant	Non-EE Program Participant	Std. Err.	n
New EMS	43%	57%	*18.5%*	46
Old EMS	31%	69%	*6.2%*	42

* The results presented above have been weighted by kWh weight.

Table D-12: End Uses Controlled by New EMS

	New EMS		Old EMS	
End Use	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**
HVAC Units	98%	*1.7%*	92%	*4.5%*
HVAC Auxiliary Pumps/Fans	99%	*0.7%*	82%	*8.3%*
Inside Lighting	54%	*22.9%*	25%	*16.8%*
Domestic/Service Water Heating	12%	*10.1%*	35%	*17.2%*
Outside Lighting	66%	*19.8%*	0%	*0.2%*
Central Plant	57%	*22.2%*	16%	*8.7%*
On-Site Generation	11%	*9.9%*	5%	*4.4%*
Process Equipment	14%	*10.6%*	1%	*1.1%*
Other	6%	*6.5%*	7%	*6.0%*
Average # End Uses Controlled	**4.2**		**2.6**	

***** The results presented above have been weighted by kWh weight.

E WATER HEATING

Table E-1: Water Heater System Type

Fuel Type	Percent	Standard Error
Standard Water Heater	85%	4%
Instantaneous	7%	3%
Heat Pump	< 1%	< 1%
Central Plant / Shared Service	7%	2%
Other	1%	1%
Total Sites	**305**	

Table E-2: Water Heater Fuel

Fuel Type	Percent	Standard Error
Electricity	48%	7%
Natural Gas	38%	7%
Propane	9%	6%
Solar w/ Backup	0%	0%
Fuel Oil	5%	2%
Not Heated	< 1%	< 1%
Total Sites	**305**	

Table E-3: Share of Water Heaters System Types by Water Heater Fuel

Fuel	Standard Water Heater	Instantaneous	Heat Pump	Central Plant / Shared Service	Other
Electricity	51%	69%	100%	0%	0%
Natural Gas	38%	31%	0%	44%	100%
Propane	11%	0%	0%	4%	0%
Solar w/ Backup	0%	0%	0%	0%	0%
Fuel Oil	1%	0%	0%	51%	0%
Heat Exchanger	0%	0%	0%	< 1%	0%
Total Sites*	**230**	**25**	**1**	**66**	**2**

** The sum of the total sites by equipment type does not equal the total number of sites with water heating, as some sites have more than one type of water heating at the facility.*

Table E-4: Standard Error of Water Heaters System Types by Water Heater Fuel

Fuel	Standard Water Heater	Instantaneous	Heat Pump	Central Plant / Shared Service	Other
Electricity	8%	1%	0%	0%	0%
Natural Gas	8%	1%	0%	11%	0%
Propane	7%	0%	0%	< 1%	0%
Solar w/ Backup	0%	0%	0%	0%	0%
Fuel Oil	< 1%	0%	0%	11%	0%
Heat Exchanger	0%	0%	0%	< 1%	0%
Total Sites*	**230**	**25**	**1**	**66**	**2**

** The sum of the total sites by equipment type does not equal the total number of sites with water heating, as some sites have more than one type of water heating at the facility.*

Table E-5: Share of Water Heaters System Types by Building Type

Fuel	Standard Water Heater	Instantaneous	Heat Pump	Central Plant / Shared Service	Other
Campuses	12%	0%	0%	88%	0%
Education	69%	6%	0%	25%	0%
Food Sales	95%	1%	0%	4%	0%
Food Service	82%	10%	0%	8%	0%
Healthcare	31%	0%	0%	54%	15%
Hospitals	66%	1%	0%	33%	0%
Lodging	84%	2%	0%	14%	0%
Manufacturing or Industrial	89%	8%	0%	3%	0%
Office	85%	13%	<1%	2%	0%
Other	93%	0%	0%	7%	0%
Public Assembly	96%	3%	0%	1%	0%
Retail	86%	12%	0%	2%	0%
Warehouse	83%	10%	0%	7%	0%
Total Sites*	**230**	**25**	**1**	**66**	**2**

** The sum of the total sites by equipment type does not equal the total number of sites with water heating, as some sites have more than one type of water heating at the facility.*

Table E-6: Standard Errors of Water Heaters System Types by Building Type

Fuel	Standard Water Heater	Instantaneous	Heat Pump	Central Plant / Shared Service	Other
Campuses	5%	0%	0%	5%	0%
Education	18%	6%	0%	17%	0%
Food Sales	3%	1%	0%	3%	0%
Food Service	8%	7%	0%	6%	0%
Healthcare	15%	0%	0%	16%	13%
Hospitals	27%	<1%	0%	27%	0%
Lodging	6%	2%	0%	5%	0%
Manufacturing or Industrial	3%	2%	0%	1%	0%
Office	10%	10%	<1%	2%	0%
Other	1%	<1%	0%	1%	0%
Public Assembly	1%	1%	0%	1%	0%
Retail	11%	11%	0%	2%	0%
Warehouse	11%	9%	0%	7%	0%
Total Sites*	**230**	**25**	**1**	**66**	**2**

** The sum of the total sites by equipment type does not equal the total number of sites with water heating, as some sites have more than one type of water heating at the facility.*

Table E-7: Share of Water Heater System Type by Business Size

Equipment Type	<500,000 kWh	500,000 - 4,500,000 kWh	>4,500,000 kWh	Unknown
Standard Water Heater	86%	59%	99%	100%
Instantaneous	8%	5%	<1%	0%
Heat Pump	0%	<1%	0%	0%
Central Plant / Shared Service	6%	28%	1%	0%
Other	0%	9%	0%	0%
Total Sites	**173**	**108**	**16**	**8**

Table E-8: Standard Errors of Water Heater System Type by Business Size

Equipment Type	<500,000 kWh	500,000 - 4,500,000 kWh	>4,500,000 kWh	Unknown
Standard Water Heater	4%	11%	1%	0%
Instantaneous	4%	2%	0%	0%
Heat Pump	0%	<1%	0%	0%
Central Plant / Shared Service	2%	11%	1%	0%
Other	0%	8%	0%	0%
Total Sites	**173**	**108**	**16**	**8**

Table E-9: Water Heater Efficiency Distribution

Efficiency Level	Percent	Standard Error
Above Standard	18%	7%
At Standard	14%	4%
Below Standard	3%	2%
No Standards	17%	6%
Unknown - Model Missing	12%	3%
Unknown - Model Not Found	36%	9%
Total Sites	**255**	

Table E-10: Water Heater Efficiency Distribution and Standard Errors by System Type

Efficiency Level	Standard Water Heater	Standard Error	Instantaneous	Standard Error
Above Standard	19%	8%	9%	0.3%
At Standard	15%	4%	0%	0%
Below Standard	3%	2%	0%	0%
No Standards	18%	7%	<1%	<1%
Unknown - Model Missing	12%	3%	9%	1%
Unknown - Model Not Found	32%	9%	82%	1%
Total Sites	**230**		**25**	

Table E-11: Water Heater Age Distribution

Efficiency Level	Percent	Standard Error
Above Standard	23%	8%
At Standard	3%	1%
Below Standard	19%	6%
No Standards	17%	6%
Unknown - Model Missing	38%	6%
Unknown - Model Not Found	23%	8%
Total Sites	**305**	

Table E-12: Share of Water Heater Age Distribution by Business Type

Building Type	Pre-2000	2000-2003	2004-2008	Post-2008	Unknown
Campuses	<1%	<1%	<1%	10%	89%
Education	81%	1%	8%	9%	1%
Food Sales	9%	9%	12%	51%	18%
Food Service	11%	3%	28%	26%	32%
Healthcare	22%	1%	47%	6%	24%
Hospitals	0%	0%	0%	91%	9%
Lodging	18%	4%	3%	14%	61%
Manufacturing or Industrial	0%	7%	36%	8%	49%
Office	15%	1%	18%	3%	63%
Other	0%	5%	2%	3%	90%
Public Assembly	58%	<1%	31%	2%	9%
Retail	<1%	6%	16%	50%	28%
Warehouse	0%	0%	8%	52%	40%
Total Sites*	**35**	**27**	**54**	**105**	**136**

** The sum of the total sites by equipment age does not equal the total number of sites with water heating, as some sites have more than one water heater equipment at the facility.*

Table E-13: Standard Error of Water Heater Age Distribution by Business Type

Building Type	Pre-2000	2000-2003	2004-2008	Post-2008	Unknown
Campuses	<1%	<1%	<1%	5%	5%
Education	11%	<1%	6%	7%	1%
Food Sales	6%	2%	8%	11%	9%
Food Service	11%	2%	12%	11%	9%
Healthcare	19%	1%	21%	2%	14%
Hospitals	0%	0%	0%	11%	11%
Lodging	10%	3%	1%	5%	11%
Manufacturing or Industrial	0%	2%	26%	2%	27%
Office	3%	<1%	9%	0%	9%
Other	0%	1%	1%	2%	2%
Public Assembly	27%	<1%	27%	1%	1%
Retail	<1%	2%	12%	13%	12%
Warehouse	0%	0%	8%	12%	9%
Total Sites*	**35**	**27**	**54**	**105**	**136**

** The sum of the total sites by equipment age does not equal the total number of sites with water heating, as some sites have more than one water heater equipment at the facility.*

Table E-14: Share of Water Heater System Type by Business Size

Equipment Type	<500,000 kWh	500,000 - 4,500,000 kWh	>4,500,000 kWh	Unknown
Pre-2000	24%	21%	<1%	0%
2000-2003	3%	4%	0%	0%
2004-2008	19%	13%	41%	19%
Post-2008	16%	37%	7%	0%
Unknown	38%	25%	52%	81%
Total Sites	**173**	**108**	**16**	**8**

Table E-15: Standard Errors of Water Heater System Type by Business Size

Equipment Type	<500,000 kWh	500,000 - 4,500,000 kWh	>4,500,000 kWh	Unknown
Pre-2000	9%	12%	<1%	0%
2000-2003	1%	3%	0%	0%
2004-2008	7%	8%	30%	1%
Post-2008	7%	7%	2%	0%
Unknown	6%	6%	30%	1%
Total Sites	**173**	**108**	**16**	**8**

Table E-16: New Water Heater System Type Distribution

Efficiency Level	Percent	Standard Error
Standard Water Heater	92%	2%
Instantaneous	5%	1%
Heat Pump	0%	0%
Central Plant / Shared Service	3%	1%
Other	0%	0%
Standard Water Heater	92%	2%
Total Sites	**105**	

Table E-17: New Water Heater Efficiency Distribution

Efficiency Level	Percent	Standard Error
Above Standard	15%	7%
At Standard	17%	8%
Below Standard	0%	0%
No Standards	48%	19%
Unknown - Model Missing	9%	6%
Unknown - Model Not Found	11%	5%
Total Sites	**90**	

Table E-18: New Water Heater Efficiency Distribution of Participants

Efficiency Level	Percent	Standard Error
Above Standard	18%	9%
At Standard	44%	18%
Below Standard	0%	0%
No Standards	8%	8%
Unknown - Model Missing	7%	5%
Unknown - Model Not Found	23%	11%
Total Sites	**33**	

Table E-19: New Water Heater Efficiency Distribution of Non-Participants

Efficiency Level	Percent	Standard Error
Above Standard	14%	8%
At Standard	12%	7%
Below Standard	0%	0%
No Standards	56%	20%
Unknown - Model Missing	9%	7%
Unknown - Model Not Found	9%	6%
Total Sites	**57**	

Table E-20: New Water Heater Efficiency Distribution of Electric Units

Efficiency Level	Percent	Standard Error
Above Standard	8%	6%
At Standard	10%	7%
Below Standard	0%	0%
No Standards	67%	18%
Unknown - Model Missing	10%	9%
Unknown - Model Not Found	5%	3%
Total Sites	**45**	

Table E-21: New Water Heater Efficiency Distribution of Gas Units

Efficiency Level	Percent	Standard Error
Above Standard	35%	13%
At Standard	39%	14%
Below Standard	0%	0%
No Standards	0%	0%
Unknown - Model Missing	4%	3%
Unknown - Model Not Found	22%	11%
Total Sites	**49**	

Table E-22: Share of New Water Heater Efficiency Distribution by kWh Business Size

Equipment Type	<500,000 kWh	500,000 - 4,500,000 kWh	>4,500,000 kWh	Unknown
Above Standard	15%	15%	43%	0%
At Standard	19%	11%	0%	0%
Below Standard	0%	0%	0%	0%
No Standards	49%	42%	<1%	0%
Unknown - Model Missing	10%	2%	9%	0%
Unknown - Model Not Found	8%	31%	48%	0%
Total Sites	**42**	**41**	**7**	**0**

Table E-23: Standard Error of New Water Heater Efficiency Distribution by kWh Business Size

Equipment Type	<500,000 kWh	500,000 - 4,500,000 kWh	>4,500,000 kWh	Unknown
Above Standard	8%	9%	32%	0%
At Standard	10%	7%	0%	0%
Below Standard	0%	0%	0%	0%
No Standards*	22%	26%	<1%	0%
Unknown - Model Missing	7%	1%	11%	0%
Unknown - Model Not Found	5%	16%	32%	0%
Total Sites	**42**	**41**	**7**	**0**

F REFRIGERATION

Table F-1: Percent of Businesses with Refrigeration by Type of Refrigeration (kWh weighted)

Building Type	Self-Contained	Standard Error	Remote	Standard Error	Unknown	Standard Error
Campuses	6%	8%	0%	0%	93%	10%
Education	96%	5%	78%	21%	0%	0%
Food Sales	97%	3%	100%	0%	2%	1%
Food Service	100%	0%	93%	2%	9%	4%
Healthcare	99%	0%	54%	27%	3%	3%
Hospitals	98%	3%	61%	29%	30%	27%
Lodging	95%	4%	84%	9%	0%	1%
Manufacturing or Industrial	45%	24%	4%	2%	2%	2%
Office	79%	5%	27%	4%	1%	0%
Other	68%	13%	53%	19%	2%	1%
Public Assembly	98%	1%	3%	1%	1%	1%
Retail	86%	5%	19%	6%	0%	0%
Warehouse	92%	5%	4%	2%	30%	17%
Total Sites	**265**		**115**		**22**	

Table F-2: Distribution of Total Linear Feet of Cases

Case Type	Cases (avg lin ft)	Standard Error	Share of Total Lin Feet	Standard Error
Island, open, single-level narrow	6.0	0%	0.7%	1%
Island, open, single-level wide	6.0	0%	3.1%	1%
Island, open, island, single-level double	8.8	1%	0.3%	0%
Island, closed, single-level narrow	6.1	1%	1.2%	1%
Island, closed, single-level wide	5.3	0%	0.9%	0%
Island, closed, single level double	5.9	0%	1.1%	1%
Open Single-deck	10.6	5%	1.7%	1%
Open Multi-deck	11.5	3%	12.1%	3%
Reach-in Multi deck	4.6	0%	50.2%	5%
Closed rear-entry multi-deck	7.3	1%	1.2%	1%
Curved glass near entry multi deck	11.0	4%	4.3%	2%
Under counter Reach-in	4.9	0%	18.2%	3%
Blast Chiller	20.0	0%	0.5%	0%
Ice Bag Freezer	5.8	0%	1.3%	1%
Lab Grade Cases	14.5	1%	3.3%	3%

Table F-3: Distribution of Total Linear Feet of Refrigeration Cases, Simplified Case Type

Case Type	Cases (avg lin ft)	Standard Error	Share of Total Lin Feet	Standard Error
Island Case	6.0	0%	7%	2%
Open Display Case	11.4	3%	14%	4%
Upright Reach-In	4.6	0%	50%	5%
Under Counter Reach-In	4.9	0%	18%	3%
Service Case	9.9	3%	5%	2%
Other/Unlisted Case	10.6	2%	5%	3%

Table F-4: Distribution of Linear Feet of Refrigeration Cases by Businesses Type

Case Type	Cases (avg lin ft)	Standard Error	Share of Total Lin Feet	Standard Error
Campuses	3.0	0%	0%	0%
Education	3.5	0%	1%	0%
Food Sales	7.6	1%	33%	3%
Food Service	4.4	0%	23%	3%
Healthcare	3.9	0%	0%	0%
Hospitals	5.4	5%	1%	0%
Lodging	5.2	1%	3%	1%
Manufacturing or Industrial	6.1	0%	2%	1%
Office	4.2	0%	3%	1%
Other	6.2	1%	9%	4%
Public Assembly	3.0	0%	9%	3%
Retail	9.0	2%	15%	3%
Warehouse	-	0%	0%	0%

Table F-5: Distribution of Linear Feet of Refrigeration Cases by Business Type and Simplified Case Type

Case Type	Campuses	Education	Food Sales	Food Service	Healthcare	Hospitals	Lodging	Manufacturing or Industrial	Office	Other	Public Assembly	Retail	Warehouse
Island Case	0%	3%	12%	8%	15%	0%	0%	0%	8%	6%	0%	5%	0%
Open Display Case	0%	33%	19%	3%	0%	65%	0%	0%	0%	0%	0%	38%	0%
Upright Reach-In	100%	56%	58%	40%	59%	0%	65%	31%	90%	49%	80%	23%	0%
Under Counter Reach-In	0%	8%	4%	48%	26%	35%	34%	24%	2%	9%	19%	8%	0%
Service Case	0%	0%	5%	1%	0%	0%	0%	18%	0%	0%	0%	21%	0%
Other/Unlisted Case	0%	0%	2%	0%	0%	0%	0%	27%	0%	36%	0%	5%	0%
Total Sites	**2**	**22**	**22**	**31**	**7**	**3**	**19**	**6**	**8**	**8**	**16**	**10**	**0**

Table F-6: Standard Errors of Distribution of Linear Feet of Refrigeration Cases by Business Type and Simplified Case Type

Case Type	Campuses	Education	Food Sales	Food Service	Healthcare	Hospitals	Lodging	Manufacturing or Industrial	Office	Other	Public Assembly	Retail	Warehouse
Island Case	0%	1%	4%	4%	9%	0%	0%	0%	6%	2%	0%	3%	0%
Open Display Case	0%	12%	6%	2%	0%	35%	0%	0%	0%	0%	0%	15%	0%
Upright Reach-In	0%	15%	8%	7%	13%	0%	31%	16%	6%	18%	6%	9%	0%
Under Counter Reach-In	0%	8%	3%	7%	12%	35%	31%	18%	2%	9%	6%	8%	0%
Service Case	0%	0%	3%	1%	0%	0%	0%	16%	0%	0%	0%	13%	0%
Other/Unlisted Case	0%	0%	1%	0%	0%	0%	0%	5%	0%	21%	0%	3%	0%
Total Sites	**2**	**22**	**22**	**31**	**7**	**3**	**19**	**6**	**8**	**8**	**16**	**10**	**0**

Table F-7: Distribution of Linear Feet of Refrigeration Cases by Business Size and Simplified Case Type

Case Type	Small	Medium	Large	Unknown
Island Case	7%	6%	6%	21%
Open Display Case	11%	29%	0%	0%
Upright Reach-In	53%	50%	12%	35%
Under Counter Reach-In	20%	7%	4%	44%
Service Case	6%	4%	0%	0%
Other/Unlisted Case	2%	3%	78%	0%
Total Sites	**79**	**59**	**12**	**4**

Table F-8: Standard Errors of Distribution of Linear Feet of Refrigeration Cases by Business Size and Simplified Case Type

Case Type	Small – Standard Error	Medium – Standard Error	Large – Standard Error	Unknown – Standard Error
Island Case	2%	3%	6%	9%
Open Display Case	4%	10%	0%	0%
Upright Reach-In	6%	11%	10%	16%
Under Counter Reach-In	4%	4%	3%	17%
Service Case	3%	3%	0%	0%
Other/Unlisted Case	1%	2%	17%	0%
Total Sites	**79**	**59**	**12**	**4**

Table F-9: Distribution of Refrigeration Cases by Temperature and Simplified Case Type

Case Type	Low Temperature	Standard Error	Medium Temperature	Standard Error
Island Case	81%	4%	19%	4%
Open Display Case	1%	1%	99%	1%
Upright Reach-In	27%	8%	73%	8%
Under Counter Reach-In	1%	1%	99%	1%
Service Case	6%	4%	92%	4%
Other/Unlisted Case	97%	3%	3%	3%
Total Sites	**79**		**143**	

Table F-10: Self-Contained Walk-ins Square Footage Percent by Business Type and Average Square Feet per Business with Walk-ins

Building Type	Average SqFt	Standard Error	Percent	Standard Error
Campuses	-	0%	0%	0%
Education	231	2%	39%	5%
Food Sales	48	0%	3%	0%
Food Service	60	4%	30%	14%
Healthcare	-	0%	0%	0%
Hospitals	-	0%	0%	0%
Lodging	27	3%	19%	6%
Manufacturing or Industrial	1,200	0%	1%	0%
Office	120	0%	0%	0%
Other	59	0%	1%	0%
Public Assembly	32	2%	6%	6%
Retail	-	0%	0%	0%
Warehouse	-	0%	0%	0%

Table F-11: Remote Refrigeration Walk-ins Square Footage Percent by Business Type and Average Square Feet per Business with Walk-ins

Building Type	Average SqFt	Standard Error	Percent	Standard Error
Campuses	-	0%	0%	0%
Education	52	4%	3%	1%
Food Sales	612	153%	46%	8%
Food Service	70	10%	13%	3%
Healthcare	142	18%	1%	0%
Hospitals	78	3%	0%	0%
Lodging	66	3%	2%	1%
Manufacturing or Industrial	623	251%	7%	4%
Office	85	2%	0%	0%
Other	146	48%	4%	2%
Public Assembly	79	1%	1%	0%
Retail	475	156%	18%	6%
Warehouse	3,273	80%	4%	1%

G ON-SITE GENERATION

Table G-1: Fuel Types for Emergency and Back-up Generation

Fuel Types	Respondent Weighted Share of Systems	Standard Error	kWh Weighted Share of Systems	Standard Error
Natural Gas	45%	20%	28%	11%
Diesel	19%	9%	55%	12%
Fuel Oil	6%	3%	14%	12%
Other	17%	6%	2%	1%
Unknown	13%	4%	1%	0%
Total Sites	**106**			

Table G-2: Fuel Types for Emergency and Back-up Generation

System Types	Respondent Weighted Share of Systems	Standard Error
Solar Array/PV	100%	<1%
Wind	<1%	<1%
Total Sites	**11**	

H KITCHEN EQUIPMENT

Table H-1: Kitchen Equipment Appliance Types

Appliance Type	Count	Percent	Std. Err.
Broiler/Cheese Melter	5	0.0%	*0.0%*
Char Broiler	17	0.1%	*0.1%*
Griddle, Single Sided	69	4%	*1.8%*
Griddle, Clam Shell	16	0.2%	*0.1%*
Fryer, Countertop	14	0.2%	*0.1%*
Fryer, Freestanding	116	3%	*0.7%*
Fryer, Pressure	3	0.0%	*0.0%*
Fryer, Donut	1	0.0%	*0.0%*
Kettle, Pasta Cooker	10	0.0%	*0.0%*
Heat Lamps	44	0.3%	*0.1%*
Range Top	210	8%	*3.2%*
Oven, Pizza or Bake	150	7%	*3.5%*
Oven, Conveyer	15	0.3%	*0.2%*
Oven, Range	177	6%	*2.5%*
Oven, Convec, Comb, or Retherm	211	5%	*1.4%*
Food Warmer	732	3%	*1.2%*
Heated Display Case	33	1.0%	*0.6%*
Microwave	1,065	27%	*5.3%*
Toaster, Popup	195	8%	*2.2%*
Toaster, Conveyer	69	0.4%	*0.2%*
Coffee Pot	1,042	12%	*2.6%*
Steam Jacketed Kettle	65	0.4%	*0.2%*
Braising Pan/Skillet	3	0.0%	*0.0%*
Steam Table	146	2%	*1.1%*
Dishwasher, Single Tank	164	4%	*1.8%*
Dishwasher, Conveyer	112	3%	*1.8%*
Don't Know	1	0.0%	*0.0%*
Other	159	5%	*1.0%*
Total	**4,845**	**100%**	

* The results presented above have been weighted by respondent weight.

Table H-2: Kitchen Equipment Appliance Types, by Building Type

	Campus	Education	Food Sales	Food Service	Healthcare	Hospitals	Lodging	Manufacturing or Industrial	Office	Other	Public Assembly	Retail	Warehouse
Broiler/Cheese Melter	-	-	-	0.1%	-	-	0.0%	-	0.1%	-	0.0%	-	-
Char Broiler	-	0.0%	2%	0.3%	-	15%	-	-	-	0.0%	0.1%	0.0%	-
Griddle, Single Sided	-	2%	2%	5%	4%	0.4%	4%	-	1%	1%	7%	0.0%	-
Griddle, Clam Shell	4%	-	-	0.8%	-	0.2%	-	-	0.1%	0.1%	0.0%	0.0%	-
Fryer, Countertop	-	0.0%	-	0.3%	-	-	0.9%	-	-	0.3%	-	-	-
Fryer, Freestanding	-	3%	11%	12%	0.2%	-	0.4%	-	0.1%	1%	0.2%	0.0%	-
Fryer, Pressure	-	-	-	0.2%	-	-	0.0%	-	-	-	-	-	-
Fryer, Donut	-	-	-	-	-	-	-	3%	-	-	-	-	-
Kettle, Pasta Cooker	-	0.1%	-	-	-	0.2%	0.1%	-	-	-	-	-	-
Heat Lamps	-	0.0%	-	0.4%	-	-	0.1%	-	-	3%	0.3%	-	-
Range Top	2%	0.8%	7%	23%	19%	23%	7%	0.2%	3%	3%	8%	0.0%	-
Oven, Pizza or Bake	-	11%	14%	7%	0.9%	30%	0.9%	6%	0.8%	5%	13%	0.0%	-

Oven, Conveyer	-	0.0%	2%	1%	-	-	0.0%	-	-	-	-	0.0 %	-
Oven, Range	5%	1%	4%	3%	6%	8%	2%	2%	2%	0.1 %	15%	1%	-
Oven, Convec, Comb, or Retherm	-	15%	10 %	4%	17%	0.2%	14%	3%	1.0 %	9%	1%	4%	-
Food Warmer	-	20%	7%	4%	0.6%	-	0.9%	-	0.2 %	2%	0.6%	0.0 %	-
Heated Display Case	-	0.7%	10 %	3%	-	-	0.1%	-	-	0.0 %	0.0%	-	-
Microwave	66%	14%	15 %	6%	35%	-	30%	46%	38%	40 %	30%	43 %	69%
Toaster, Popup	11%	1%	0.9 %	1%	4%	-	13%	19%	14%	11 %	0.8%	30 %	7%
Toaster, Conveyer	-	0.7%	-	0.4%	1%	-	1%	6%	0.0 %	0.0 %	0.1%	0.0 %	3%
Coffee Pot	11%	2%	6%	8%	3%	0.2%	18%	2%	29%	8%	9%	16 %	21%
Steam Jacketed Kettle	-	0.7%	-	0.1%	0.2%	0.1%	0.2%	-	0.1 %	6%	0.0%	-	-
Braising Pan/Skillet	-	0.0%	-	-	-	-	0.0%	-	-	-	-	-	-
Steam Table	-	15%	0.4 %	4%	1%	-	0.2%	-	0.2 %	0.7 %	0.0%	0.0 %	-
Dishwasher, Single Tank	0.8%	2%	7%	5%	1.0%	-	5%	3%	2%	0.1 %	8%	1%	-
Dishwasher, Conveyer	-	8%	-	0.0%	3%	23%	0.6%	-	0.1 %	0.8 %	7%	-	-
Don't	-	-	0.2	-	-	-	-	-	-	-	-	-	-

Know			%										
Other	-	5%	2%	12%	2%	-	3%	11%	8%	9%	0.2%	4%	0.1%
n	**299**	**409**	**80**	**370**	**157**	**31**	**1,088**	**84**	**483**	**185**	**1,463**	**143**	**53**

***** The results presented above have been weighted by respondent weight.

- **Table H-3: Kitchen Equipment Appliance Types, by Building Type - Standard Errors**

	Campus	Education	Food Sales	Food Service	Healthcare	Hospitals	Lodging	Manufacturing or Industrial	Office	Other	Public Assembly	Retail	Unknown	Warehouse
Broiler/Cheese Melter	-	-	-	0.1%	-	-	0.0%	-	0.1%	-	0.0%	-	-	-
Char Broiler	-	0.0%	1.9%	0.2%	-	14.3%	-	-	-	0.0%	0.1%	0.0%	-	-
Griddle, Single Sided	-	1.7%	1.9%	1.8%	4.4%	0.2%	2.1%	-	1.0%	1.5%	6.8%	0.0%	-	-
Griddle, Clam Shell	4.4%	-	-	0.6%	-	0.2%	-	-	0.1%	0.1%	0.0%	0.0%	-	-
Fryer, Countertop	-	0.0%	-	0.3%	-	-	0.9%	-	-	0.3%	-	-	-	-
Fryer, Freestanding	-	3.3%	7.9%	3.7%	0.2%	-	0.3%	-	0.1%	1.5%	0.1%	0.0%	-	-
Fryer, Pressure	-	-	-	0.2%	-	-	0.0%	-	-	-	-	-	-	-
Fryer, Donut	-	-	-	-	-	-	-	3.0%	-	-	-	-	-	-
Kettle, Pasta Cooker	-	0.1%	-	-	-	0.3%	0.0%	-	-	-	-	-	-	-
Heat Lamps	-	0.0%	-	0.2%	-	-	0.1%	-	-	3.0%	0.3%	-	-	-
Range Top	2.2%	0.7%	6.9%	11.9%	11.9%	15.3%	3.7%	0.2%	1.6%	3.0%	6.9%	0.0%	-	-
Oven, Pizza or Bake	-	9.0%	8.6%	2.4%	0.7%	17.5%	0.7%	5.8%	0.5%	3.3%	12.6%	0.0%	-	-
Oven, Conveyer	-	0.0%	0.1%	0.9%	-	-	0.0%	-	-	-	-	0.0%	-	-
Oven, Range	4.5%	0.7%	2.2%	1.7%	4.5%	7.5%	1.0%	1.4%	1.3%	0.1%	9.9%	1.1%	-	-
Oven, Convec, Comb, or Retherm	-	10.7%	7.2%	1.6%	10.8%	0.2%	6.9%	3.0%	0.9%	4.5%	0.7%	1.4%	-	-

Food Warmer	-	11.2%	6.9 %	2.0%	0.4%	-	0.6%	-	0.2 %	1.2 %	0.4%	0.0 %	-	-
Heated Display Case	-	0.7%	7.3 %	3.0%	-	-	0.1%	-	-	0.0 %	0.0%	-	-	-
Microwave	14.4 %	10.5%	8.0 %	2.7%	13.6%	-	11.3 %	17.2%	7.4 %	18.8 %	17.5%	17.0 %	-	24.9%
Toaster, Popup	8.3%	0.8%	0.4 %	0.9%	2.4%	-	7.6%	13.4%	5.4 %	7.6 %	0.4%	17.1 %	-	7.4%
Toaster, Conveyer	-	0.7%	-	0.3%	0.5%	-	0.9%	5.8%	0.0 %	0.0 %	0.1%	0.0 %	-	3.7%
Coffee Pot	8.8%	1.7%	2.8 %	3.1%	1.3%	0.2%	7.8%	1.5%	7.7 %	3.9 %	6.9%	10.0 %	-	20.5%
Steam Jacketed Kettle	-	0.7%	-	0.1%	0.2%	0.1%	0.2%	-	0.1 %	4.7 %	0.0%	-	-	-
Braising Pan/Skillet	-	0.0%	-	-	-	-	0.0%	-	-	-	-	-	-	-
Steam Table	-	10.4%	0.3 %	3.0%	0.6%	-	0.2%	-	0.2 %	0.8 %	0.0%	0.0 %	-	-
Dishwasher, Single Tank	0.9%	1.0%	6.9 %	2.2%	0.4%	-	2.5%	3.0%	1.1 %	0.0 %	6.9%	1.0 %	-	-
Dishwasher, Conveyer	-	5.9%	-	0.0%	2.3%	12.9%	0.3%	-	0.1 %	0.8 %	6.8%	-	-	-
Don't Know	-	-	0.2 %	-	-	-	-	-	-	-	-	-	-	-
Other	-	3.6%	0.8 %	3.9%	0.6%	-	1.0%	9.1%	3.3 %	5.4 %	0.1%	2.9 %	-	0.1%

* The results presented above have been weighted using the business-level sample weight.

Table H-4: Kitchen Equipment Appliance Types, by Business Size

	Small		Medium		Large		Unknown	
	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.
Broiler/Cheese Melter	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%	-	-
Char Broiler	0.1%	0.1%	0.2%	0.1%	0.0%	0.0%	-	-
Griddle, Single Sided	4%	2.2%	4%	2.1%	1%	1.0%	3%	3.3%
Griddle, Clam Shell	0.2%	0.1%	0.0%	0.0%	1%	1.1%	-	-
Fryer, Countertop	0.2%	0.1%	0.1%	0.1%	0.2%	0.2%	-	-
Fryer, Freestanding	3%	0.8%	3%	2.2%	1%	1.0%	0.2%	0.2%
Fryer, Pressure	0.0%	0.0%	0.0%	0.0%	-	-	-	-
Fryer, Donut	0.0%	0.1%	-	-	-	-	-	-
Kettle, Pasta Cooker	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
Heat Lamps	0.2%	0.1%	0.9%	0.9%	0.0%	0.0%	0.3%	0.3%
Range Top	9%	3.8%	3%	1.3%	0.2%	0.2%	7%	5.7%
Oven, Pizza or Bake	6%	4.2%	10%	6.2%	4%	2.9%	3%	3.2%
Oven, Conveyer	0.4%	0.2%	0.0%	0.0%	-	-	-	-
Oven, Range	6%	3.1%	2%	0.9%	3%	3.1%	0.4%	0.4%
Oven, Convec, Comb, or Retherm	4%	1.4%	13%	5.5%	0.1%	0.0%	3%	3.3%
Food Warmer	3%	1.4%	2%	0.9%	7%	5.4%	4%	3.3%
Heated Display Case	1.0%	0.7%	0.3%	0.2%	0.1%	0.1%	4%	3.4%
Microwave	28%	6.3%	24%	8.5%	38%	19.7%	22%	13.3%
Toaster, Popup	8%	2.6%	5%	2.3%	21%	14.5%	22%	14.7%
Toaster, Conveyer	0.4%	0.2%	0.7%	0.4%	0.4%	0.3%	0.7%	0.7%
Coffee Pot	13%	3.2%	12%	3.7%	6%	4.4%	7%	4.7%
Steam Jacketed Kettle	0.1%	0.1%	0.5%	0.5%	1%	1.1%	6%	6.2%
Braising Pan/Skillet	-	-	0.0%	0.0%	-	-	0.1%	0.1%
Steam Table	1%	0.9%	7%	6.2%	3%	2.2%	0.1%	0.1%
Dishwasher, Single Tank	5%	2.2%	2%	1.1%	1%	1.0%	3%	3.4%
Dishwasher, Conveyer	3%	2.2%	2%	1.2%	2%	1.2%	0.1%	0.1%
Don't Know	-	-	0.0%	0.0%	-	-	-	-
Other	5%	1.1%	6%	2.6%	7%	7.8%	14%	7.7%
n	1,113		2,227		1,425		80	

* The results presented above have been weighted by respondent weight

Table H-5: Kitchen Equipment Appliance Types, by Fuel Type

	Electric		Gas		Propane		Other		Unknown		
	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.	Percent	Std. Err.	*n*
Broiler/Cheese Melter	52%	-	48%	-	0.3%	-	-	-	-	-	**5**
Char Broiler	36%	*6.5%*	56%	*10.3%*	-	-	8%	*8.2%*	-	-	**17**
Griddle, Single Sided	60%	*4.5%*	37%	*3.7%*	3%	*2.5%*	-	-	-	-	**69**
Griddle, Clam Shell	90%	*1.6%*	10%	*1.6%*	-	-	-	-	-	-	**16**
Fryer, Countertop	0.1%	-	9%	-	56%	-	-	-	35%	-	**14**
Fryer, Freestanding	26%	*9.0%*	67%	*9.6%*	7%	*1.9%*	-	-	-	-	**116**
Fryer, Pressure	-	-	100%	-	-	-	-	-	-	-	**3**
Fryer, Donut	-	-	100%	-	-	-	-	-	-	-	**1**
Kettle, Pasta Cooker	54%	-	17%	-	-	-	-	-	29%	-	**10**
Heat Lamps	100%	*0.0%*	-	-	-	-	-	-	-	-	**44**
Range Top	8%	*4.3%*	80%	*7.4%*	11%	*5.3%*	-	-	0.2%	*0.1%*	**210**
Oven, Pizza or Bake	79%	*5.2%*	19%	*5.1%*	3%	*0.3%*	-	-	-	-	**150**
Oven, Conveyer	22%	*8.6%*	78%	*8.6%*	-	-	-	-	-	-	**15**
Oven, Range	46%	*3.3%*	53%	*3.3%*	1%	*0.1%*	0.0%	*0.0%*	-	-	**177**
Oven, Convec, Comb, or Retherm	39%	*13.3%*	54%	*12.2%*	7%	*3.7%*	-	-	-	-	**211**
Food Warmer	99%	*0.5%*	0.6%	*0.4%*	-	-	-	-	0.1%	*0.1%*	**732**
Heated Display Case	93%	*0.6%*	6%	*0.2%*	-	-	-	-	1%	*0.6%*	**33**
Microwave	100%	*0.0%*	-	-	-	-	-	-	-	-	**1,065**
Toaster, Popup	100%	*0.0%*	-	-	-	-	-	-	-	-	**195**
Toaster, Conveyer	96%	*0.1%*	-	-	-	-	-	-	4%	*0.1%*	**69**
Coffee Pot	100%	*0.0%*	-	-	-	-	-	-	-	-	**1,042**

Steam Jacketed Kettle	51%	*7.7%*	43%	*11.1%*	6%	*6.1%*	-	-	-	-	**65**
Braising Pan/Skillet	-	-	41%	-	-	-	-	-	59%	-	**3**
Steam Table	95%	*2.2%*	5%	*2.2%*	-	-	-	-	-	-	**146**
Dishwasher, Single Tank	96%	*2.6%*	2%	*1.4%*	-	-	-	-	2%	*2.2%*	**164**
Dishwasher, Conveyer	99%	*0.6%*	0.9%	*0.5%*	-	-	-	-	0.3%	*0.3%*	**112**
Don't Know	100%	-	-	-	-	-	-	-	-	-	**1**
Other	99%	*0.6%*	0.7%	*0.6%*	-	-	-	-	0.3%	*0.0%*	**159**

***** The results presented above have been weighted by respondent weight.

Table H-6: Refrigerated Vending Machines, by Business Type

Business Type	Count	Percent	Std. Err.
Campus	40	0.5%	*0.3%*
Education	54	4%	*1.5%*
Food Sales	9	0.8%	*0.2%*
Food Service	6	9%	*6.6%*
Healthcare	17	7%	*4.1%*
Hospitals	9	0.3%	*0.2%*
Lodging	52	10%	*4.8%*
Manufacturing or Industrial	26	18%	*14.0%*
Office	42	15%	*5.6%*
Other	19	14%	*2.9%*
Public Assembly	121	7%	*4.3%*
Retail	18	10%	*5.6%*
Unknown	-	0%	*0.0%*
Warehouse	11	5%	*1.9%*
Total	**424**	**100%**	

* The results presented above have been weighted by respondent weight.

Table H-7: Refrigerated Vending Machines, by kWh Size

kWh Size	Count	Percent	Std. Err.
Large	189	41%	*9.3%*
Medium	52	36%	*8.6%*
Small	180	21%	*13.8%*
Unknown	3	1%	*0.2%*
Total	**424**	**100%**	

* The results presented above have been weighted by respondent weight.

I OFFICE EQUIPMENT

Table I-1: Types of Monitors Found On-Site

Equipment Type	Count	Percent
CRT	91	0.2%
LCD/LED	6,530	99.8%
Total	**6,621**	**100%**

* The results presented above have been weighted by respondent weight.

Table I-2: Types of Monitors Found On-Site, by Business Type

	CRT		LCD/LED		Total	
Business Type	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**
Office	-	-	50%	*17.5%*	**50%**	*17.5%*
Manufacturing or Industrial	3%	*0.0%*	3%	*3.0%*	**3%**	*3.0%*
Education	3%	*0.0%*	19%	*7.5%*	**19%**	*7.5%*
Public Assembly	0%	*0.2%*	11%	*10.0%*	**11%**	*9.9%*
Other	30%	*0.1%*	2%	*1.2%*	**2%**	*1.2%*
Retail	31%	*0.0%*	6%	*2.2%*	**6%**	*2.2%*
Warehouse	-	-	3%	*3.0%*	**3%**	*3.0%*
Healthcare	15%	*0.0%*	3%	*1.0%*	**3%**	*1.0%*
Food Service	2%	*0.0%*	2%	*0.8%*	**2%**	*0.8%*
Food Sales	16%	*0.0%*	1%	*0.3%*	**1%**	*0.3%*
Lodging	-	-	1%	*0.8%*	**1%**	*0.8%*
Campuses	-	-	0%	*0.1%*	**0%**	*0.1%*
Unknown	-	-	-	-	**0%**	-
Hospitals	-	-	-	-	**0%**	-
n	**91**		**6,530**		**6,621**	

* The results presented above have been weighted by respondent weight.

Table I-3: Types of Monitors Found On-Site, by Business Size

	CRT		LCD/LED		Total	
Business Size	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**	**Percent**	**Std. Err.**
Small	38%	*0.1%*	67%	*11.7%*	**67%**	*11.7%*
Medium	31%	*0.1%*	24%	*8.4%*	**24%**	*8.4%*
Large	30%	*0.0%*	4%	*3.3%*	**4%**	*3.3%*
Unknown	0%	-	5%	-	**5%**	-
n	**91**		**6,530**		**6,621**	

* The results presented above have been weighted using the business-level sample weight.

Table I-4: Power Management Systems Found On-Site

	Count	Percent	Std. Err.
Has PMS	38	4%	*1.4%*
No PMS	305	96%	

* The results presented above have been weighted by site weight.

Table I-5: Power Management Systems Found On-Site, by Business Type

Building Type	Has PMS	No PMS	Std. Err.	*n*
Campuses	4%	96%	*3.3%*	**9**
Education	4%	96%	*4.7%*	**31**
Food Sales	1%	99%	*0.9%*	**25**
Food Service	4%	96%	*3.5%*	**31**
Healthcare	10%	90%	*5.2%*	**19**
Hospitals	0%	100%	*0.0%*	**6**
Lodging	0%	100%	*0.3%*	**32**
Manufacturing or Industrial	44%	56%	*5.1%*	**23**
Office	4%	96%	*2.2%*	**55**
Other	1%	99%	*1.0%*	**24**
Public Assembly	0%	100%	*0.1%*	**32**
Retail	7%	93%	*5.4%*	**43**
Unknown	0%	0%	*0.0%*	**0**
Warehouse	2%	98%	*0.1%*	**13**

* The results presented above have been weighted by site weight.

Table I-6: Power Management Systems Found On-Site, by Business Size

Business Size	Has PMS	No PMS	Std. Err.
Small	3%	97%	*1.4%*
Medium	13%	87%	*6.9%*
Large	59%	41%	*11.7%*
Unknown	0%	100%	*0.0%*
n	**38**	**305**	

* The results presented above have been weighted by site weight.

J SAMPLE WEIGHTING

To create population-based estimates from the Phase 1 data, sample weights were created for all sites that were considered respondents at the time this interim analysis process began. In summary, data from 344 responding sites were used in this interim analysis. In most instances, a responding site reflected data for a single business. There were some cases where a responding site included data for more than one business. Data from the 344 responding sites in this study accounted for 347 businesses in the original target population.

In general, a sample weight is a numeric quantity assigned to each responding record that is greater than or equal to 1.00 and represents the amount of the target population that a particular responding site represents. The sample weight is greater than 1.00 so that each particular respondent represents at least themselves in the estimation process.

The sample for this study was selected from three sources:

- P21 – MA C&I Customer Telephone Survey
- P41 – MA C&I Customer On-site Assessment Study
- Potential Study – Cape Light Compact Technical Potential Study

The samples from the P21 and P41 studies were randomly selected from a sample frame that covered the same target population, i.e. those areas covered by the NGrid, Eversource, Unitil and WMECO provider regions. And the sample from the Potential Study was selected from a frame that covered businesses in the Cape Light Compact provider region. The important things to note are:

1. Sample from the three sources cover the entire target population of interest, i.e. businesses in the entire state of Massachusetts with annual energy consumption greater than 2,000 kWh.

2. Every business in the target population had some nonzero chance of being selected for this study. So estimates generated from the respondent data will not necessarily be biased because of some feature inherent in the sample design of this study. In other words, there is no target population coverage bias in the estimates generated from this study.

The target population for this study included 205,422 businesses. Billing data revealed these businesses had an annual energy consumption of 26,341,285 MWh[37].

Two sample weights were created for each of the 344 responding sites: one was created for business-level estimates and a second was created for kWh-level estimates. The **business-level weight** was created in a manner that allows data from the 344 responding sites to expand back to the business-level target population of interest, in other words the 205,422 businesses. This sample weight accounts for differences between the distribution of the respondents and the population by several characteristics of interest, such as building type (e.g. campuses, education, food sales, etc.) and provider region. This sample weight was used to create estimates of business-level statistics in this evaluation, such as percent of businesses by varying types of HVAC cooling and heating equipment and percent of businesses with an energy management system. This weight is also used to estimate the distribution of items in the population, such as lamp types, cooling systems, heating systems and distribution of total linear feet of refrigeration cases.

[37] MWh is kWh in 1,000's.

The **kWh-level weight** was built using the business-level weights so that the two weights were as consistent as possible. This sample weight included an additional factor (annual kWh consumed) and was created for selected statistics that show the impact of some characteristic or attribute with respect to the total kWh consumption in the population. For this sample weight, the energy consumption considered (kWh) was annual kWh consumption derived from billing records. And this sample weight was created so that the weighted total kWh consumption derived from the 344 responding sites equalled the corresponding population kWh totals by several characteristics of interest, such as building type and provider region. This sample weight was used to create kWh-level estimates such as the percent of annual kWh consumed by businesses with varying types of heating and cooling equipment.

To illustrate the differences between estimates created using a business-level and kWh-level sample weight, consider the following excerpt from Appendix C, Tables 12 and 13. Table J-1 shows estimates by varying types of HVAC heating equipment.

Table J-1: Businesses with Varying Types of HVAC Heating Equipment

Heating System Combinations	Distribution Using	
	Business-Level Weight	kWh-Level Weight
Split/Packaged Only	41%	28%
Heat Pump Only	3%	4%
Boiler Only	9%	15%
Split/Packaged; Heat Pump	0%	1%
Split/Packaged; Boiler	9%	5%
Split/Packaged; Other Heating	8%	14%
Heat Pump; Boiler	3%	2%
Heat Pump; Other Heating	0%	2%
Other Heating	17%	13%
Boiler; Other Heating	8%	7%
Heating with 3 or more Systems	1%	10%
Total	100%	100%

Table J-1 suggests estimates from this interim study indicate 41% of the businesses in the population use a split/packaged only type of heating system (for example). And 28% of the total annual energy consumed by the population is affiliated with businesses that use a split/packaged only type of HVAC heating system. Since the kWh level estimate is less than the business level estimate, one might surmise that this is because smaller businesses (those that use less energy) and/or businesses in building type categories that use less energy might be more likely to have a split/package only system. In a similar vein, notice 1% of the businesses in the population heat with 3 or more systems and these businesses account for 10% of the total annual energy consumed. Again, this is likely due to larger businesses in this category. Additional analyses would be needed to uncover the reasons for the differences between the two columns.

The business-level weight for each of the 344 responding sites was created as the product of four factors:

1. The inverse of the probability of selecting a site into the particular study under consideration (P21, P41 or Potential Study).

2. An adjustment was created to account for nonresponding sites within each of the three studies. This adjustment was created independently between the three studies, so that

ultimately after this step, the sample weights expanded the respondents from each study back to their full appropriate target population.

3. An adjustment was created to account for the overlap of coverage between the P21 and P41 studies. This was not needed for the Potential Study because this study was the only one whose sample covered the Cape Light Compact region.

4. And finally, an adjustment was made to the weights to calibrate the final, full sample of respondents over all studies back to the original target population.

The nonresponse adjustment #2 and the calibration adjustment #4 was created using a model-based, calibration technique for deriving the adjustments [see Folsom and Singh (2000)[38]]. This method has numerous advantages over other ways of deriving a weight adjustment, such as the Weighting Class approach that involves applying a simple ratio adjustment within groups (called weighting classes). These advantages include:

- More variables can be used in the adjustment process than what can be used with the standard weighting class ratio adjustment. The use of a greater number of variables can reduce the non-response and coverage bias associated with the final estimates.
- Since adjustments are created using a modelling approach, one can test for and include the statistically significant predictors for each adjustment.
- Unlike the weighting class approach, continuous variables can be used in the adjustment process.
- There is no need to include higher order interactions of variables in the adjustment which would be needed with a standard weighting class ratio adjustment. Using just lower order interactions of variables helps minimize the effects of unequal weighting, which in turn maximizes precision of the final estimate by keeping sampling errors as low as possible.
- With the model-based approach there is no need to collapse weighting class cells. To overcome the problem of cells not having enough respondents the corresponding interaction term in the adjustment is simply excluded.

For this study, variables used in the adjustment process included the following main effect and interaction variables:

Main Effects:
Building Type
Provider
Categorized annual kWh consumption
Indicator whether the site participated in a previous efficiency program or not
Annual energy consumption (kWh)
Number of Businesses

[38] Folsom, R.E. and Singh A.C. (2000) "The generalized exponential model for sampling weight calibration for extreme values, nonresponse, and poststratification." *Proceeding of the* 2000 *American Statistical Association, Survey Research Methods Section*, pp.598-603.

Two-Way Interactions:
Annual energy consumption (kWh) by Building Type
Annual energy consumption (kWh) by Provider
Annual energy consumption (kWh) by Categorized annual kWh consumption
Annual energy consumption (kWh) by Indicator whether the site participated in a previous efficiency program or not

Additional main effect and multi-way interaction terms were not included in the adjustment because of the relatively small respondent sample size and the desire to keep the effects of subsequent unequal weighting to a minimum.

Note that "Number of Businesses" is included as a main effect term in the model. Data collected from some respondent sites represented more than one business. This term is included in the adjustment process to account for these multi-business respondents.

The adjustments were created so that they would simultaneously satisfy two important conditions:

1. The final weighted number of businesses by each of the above categories would equal the corresponding target population total. This was achieved in the modeling/calibration process by including the above mentioned main effect terms in the weight adjustment models.

2. And these same adjustments were created so that that the final weighted kWh estimate in each of the above categories would equal the corresponding target population kWh values. This was achieved in the modeling/calibration process by including the above mentioned two-way interaction terms in the weight adjustment models.

Creating a single weight that simultaneously accounted for both the number of business and annual kWh in the target population across a large number of main effect variables reflected the main advantages of using the model-based, calibration approach to deriving the adjustments as noted above. This approach was used to maximize precision in both business-level and kWh-level estimates produced from the respondent data.

The kWh-level weight for each of the 344 responding sites was created as the product of the final business-level weight and the annual kWh consumed by the responding site. As noted above, adjustments made to the business-level weights were created so that the final weighted kWh would sum to the appropriate population totals. So no additional adjustment was necessary for the kWh-level sample weight – estimates of weighted energy consumed would already sum to correct population totals.

Table J-2 provides a summary of the un-weighted Un-weighted sample, the target population and the weighted sample by several characteristics. **Table J-3** provides a similar table that shows the column percents. These tables show several things about the weighting process that are summarized below.

1. Table J-2 shows that the interim analysis concluded with 344 responding sites. These accounted for 347 businesses and 384,960 MWh (annual kWh in 1,000's). The target population for this study has 205,439 sites, 205,442 businesses and these businesses had a total annual consumption of 26,341,285 MWh. So the sample covered 347/205,439=.17% of the businesses and 1.46% of the energy consumed in the target population.

2. Table J-2 shows the weighted number of business and the weighted estimates of annual energy consumed (MWh). These estimates were created using the final business-level and kWh-level sample weights describe above. Notice how the weighted number of businesses and the weighted MWh estimates exactly equals the target population parameters for characteristics A through E (Total, Building Type, Region, KWH Strata, and Previous Efficiency Program). This equality reflects the benefit of using the model-based weight adjustments discussed above. These same characteristics were used as main effects and two-way interactions in the calibration model that was estimated in order to obtain the final weight adjustments. So seeing this equality is what one would expect.

   On the other hand, Table J-2 shows that weighted estimates by the interaction of kWh strata and building type (characteristic F in the table) do not equal population totals exactly. This interaction was included in this table for illustration purposes only. This shows that equality between the weighted sample and the target population will not necessarily be achieved for variables not included in the modeling process. These variables were not included in the modeling process because of the small number of respondents in this analysis. It's important to note, however, that not including variables like this in the weight adjustment process does not necessarily mean that estimates from this study will be biased in any manner. Not including variables like this can increase the variance of estimates but not necessarily lead to bias.

3. The unequal weighting effect in Table J-2 is essentially the coefficient of variation of the sample weights among respondents. This is a measure of the proportional increase in variance one might expect in the estimates because of the unequal weighting. This statistic ignores the beneficial effects of stratification but does provide a good measure of the impact of the weighting process on the precision of estimates. Looking at the entire sample, the unequal weighting effect is 7.32. This means one might expect the variance of estimates to be 7.32 greater than what would be observed with a sample of this same size (344 sites) assuming all of these sites had the exact same sample weight. Additional information on the unequal weighting effect can be found in Kish (Section 11.7b, 1995)[39]. In general, site-level studies typically yield unequal weighting effects around the 3.00 to 4.00 range so the 7.32 is higher than desired. A good portion of the unequal weighing is due to the variation in the original probabilities of selection and is a result of drawing the sample from the three sources noted above (i.e. the P21, P41 and Potential Studies).

   Unequal weighting effects tended to be greater for sites in the manufacturing or other building types, for sites in the NGrid and Eversource provider regions, for sites in the larger kWh strata and for sites who were not in a previous energy efficiency program. So we would expect the precision of estimates to be less for these groups due to the weighting process.

4. Table J-3 is included to show the impact of using the sample weights over Un-weighted estimates. The table shows that the business and MWh percents in the weighted sample columns equal the corresponding target population totals for characteristics A through E and again this is expected because the totals noted in Table J-2 are exactly equal. The interesting thing in this table is in the difference between the Un-weighted sample and target population.

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[39] Kish, Leslie (1995) Survey Sampling. New York: John Wiley & Sons, Inc.

For example, 12% of the responding businesses are in retail building type, 11% are unknown and 10% are offices. These account for 9%, 7% and 19% of the Un-weighted MWh in the sample. However, the target population data show that 30% of the businesses in the population are in the retail building type, 12% are unknown and 24% are offices. And these account for 17%, 6% and 22% of the annual energy consumed. The sample weights correct for differences like this since building type was included in the weight adjustment process. But this shows that (1) businesses were not sampled and not responding equally across groups of interest such as building type, and (2) using the sample weights in the estimation process that were constructed to correct for distributional differences between the responding sample and the target population is important and will likely yield very difference results compared to Un-weighted estimates.

Table J-2. Summary of the Target Population and Sample, Total Estimates

Characteristic	Responding Sample			Target Population			Weighted Sample		
	Sites	Busi-nesses	MWh[1]	Sites	Busi-nesses	MWh[1]	Busi-nesses	MWh[1]	Unequal Weighting Effect
A. Total									
Total	344	347	384,960	205,439	205,442	26,341,285	205,439	26,341,285	7.32
B. Building Type									
Campuses	10	10	46,528	1,079	1,079	591,200	1,079	591,200	3.23
Education	24	24	20,032	4,327	4,327	1,621,158	4,327	1,621,158	3.57
Food Sales	30	30	10,826	4,993	4,993	1,265,867	4,993	1,265,867	1.91
Food Service	28	28	8,738	10,500	10,500	1,069,067	10,500	1,069,067	1.90
Healthcare	16	16	15,163	8,556	8,556	1,346,101	8,556	1,346,101	3.04
Hospitals	7	8	15,761	527	528	519,606	527	519,606	1.94
Lodging	29	29	18,341	2,403	2,403	706,112	2,403	706,112	3.01
Manufacturing or Industrial	21	21	70,964	19,323	19,323	5,025,648	19,323	5,025,648	5.16
Office	35	35	74,255	49,342	49,342	5,796,354	49,342	5,796,354	4.67
Other	27	27	15,973	7,808	7,808	724,732	7,808	724,732	6.18
Public Assembly	26	27	24,707	8,601	8,602	911,451	8,601	911,451	3.43
Retail	41	41	35,030	62,458	62,458	4,545,584	62,458	4,545,584	4.18
Unknown	39	39	26,371	24,258	24,258	1,536,163	24,258	1,536,163	2.17
Warehouse	11	12	2,271	1,264	1,265	682,243	1,264	682,243	1.92
C. Provider Region									
Cape Light Compact	45	46	8,113	18,352	18,353	835,185	18,352	835,185	2.00
NGrid	206	208	318,828	109,410	109,412	12,092,833	109,410	12,092,833	6.16
Eversource	61	61	35,167	59,591	59,591	11,097,623	59,591	11,097,623	8.20
Unitil	10	10	11,867	2,179	2,179	218,932	2,179	218,932	2.70
WMECO	22	22	10,985	15,907	15,907	2,096,712	15,907	2,096,712	4.08
D. KWH Strata									
<500,000 kWh	208	209	18,081	197,706	197,707	8,054,886	197,706	8,054,886	4.76
500,000 - 4,500,000 kWh	115	115	140,947	6,963	6,963	9,219,622	6,963	9,219,622	6.85
>4,500,000 kWh	21	23	225,932	770	772	9,066,778	770	9,066,778	7.84
E. Previous Efficiency Program									
No	249	250	154,449	191,443	191,444	15,874,687	191,443	15,874,687	6.05
Yes	95	97	230,511	13,996	13,998	10,466,598	13,996	10,466,598	3.89

Characteristic	Responding Sample			Target Population			Weighted Sample		
	Sites	Busi-nesses	MWh[1]	Sites	Busi-nesses	MWh[1]	Busi-nesses	MWh[1]	Unequal Weighting Effect
F. KWH Strata by Building Type									
<500,000 kWh: Campuses	3	3	60	901	901	73,219	1,047	19,209	1.03
<500,000 kWh: Education	10	10	1,314	3,688	3,688	314,006	2,898	121,397	1.67
<500,000 kWh: Food Sales	24	24	2,192	4,572	4,572	404,576	4,473	340,870	1.83
<500,000 kWh: Food Service	24	24	2,512	10,277	10,277	892,148	9,690	478,367	1.81
<500,000 kWh: Healthcare	6	6	164	8,132	8,132	310,731	7,834	171,364	1.34
<500,000 kWh: Hospitals	1	1	4	434	434	25,781	61	232	1.00
<500,000 kWh: Lodging	13	13	946	2,053	2,053	133,135	1,937	54,494	1.84
<500,000 kWh: Manufacturing or Industrial	10	10	951	18,133	18,133	707,361	19,159	705,372	2.50
<500,000 kWh: Office	18	18	1,229	47,531	47,531	1,720,402	48,617	2,291,080	2.47
<500,000 kWh: Other	21	21	1,949	7,582	7,582	259,911	7,534	154,710	5.14
<500,000 kWh: Public Assembly	16	16	1,679	8,303	8,303	380,806	8,194	382,659	2.29
<500,000 kWh: Retail	28	28	2,125	61,094	61,094	2,164,347	61,360	2,086,027	2.96
<500,000 kWh: Unknown	24	24	2,392	23,795	23,795	629,673	24,015	1,209,819	1.36
<500,000 kWh: Warehouse	10	11	566	1,211	1,212	38,789	887	39,285	1.74
500,000 - 4,500,000 kWh: Campuses	5	5	5,086	152	152	231,705	5	5,315	1.01
500,000 - 4,500,000 kWh: Education	13	13	14,195	609	609	707,784	1,428	1,495,237	8.83
500,000 - 4,500,000 kWh: Food Sales	6	6	8,635	399	399	766,926	520	924,996	1.38
500,000 - 4,500,000 kWh: Food Service	4	4	6,226	222	222	172,143	810	590,700	2.38
500,000 - 4,500,000 kWh: Healthcare	8	8	6,348	375	375	405,196	603	495,854	3.31
500,000 - 4,500,000 kWh: Hospitals	5	5	7,046	62	62	94,069	465	510,663	1.70
500,000 - 4,500,000 kWh: Lodging	16	16	17,395	327	327	398,134	466	651,618	4.97
500,000 - 4,500,000 kWh: Manufacturing or Industrial	7	7	14,264	962	962	1,450,656	10	17,000	1.33
500,000 - 4,500,000 kWh: Office	11	11	10,962	1,607	1,607	2,135,603	281	162,985	6.47
500,000 - 4,500,000 kWh: Other	5	5	8,455	212	212	241,324	273	564,454	4.05
500,000 - 4,500,000 kWh: Public Assembly	9	9	7,720	279	279	335,961	406	513,483	8.24
500,000 - 4,500,000 kWh: Retail	11	11	15,077	1,298	1,298	1,683,300	1,096	2,441,728	3.21
500,000 - 4,500,000 kWh: Unknown	14	14	17,832	431	431	550,549	223	202,630	2.30
500,000 - 4,500,000 kWh: Warehouse	1	1	1,705	28	28	46,272	377	642,958	1.00

Characteristic	Responding Sample			Target Population			Weighted Sample		
	Sites	Busi-nesses	MWh[1]	Sites	Busi-nesses	MWh[1]	Busi-nesses	MWh[1]	Unequal Weighting Effect
>4,500,000 kWh: Campuses	2	2	41,382	26	26	286,277	26	566,676	1.85
>4,500,000 kWh: Education	1	1	4,524	30	30	599,368	1	4,524	1.00
>4,500,000 kWh: Food Sales	0	0	0	22	22	94,365	0	0	1.00
>4,500,000 kWh: Food Service	0	0	0	1	1	4,776	0	0	1.00
>4,500,000 kWh: Healthcare	2	2	8,651	49	49	630,174	119	678,883	1.97
>4,500,000 kWh: Hospitals	1	2	8,711	31	32	399,756	1	8,711	1.00
>4,500,000 kWh: Lodging	0	0	0	23	23	174,843	0	0	1.00
>4,500,000 kWh: Manufacturing or Industrial	4	4	55,750	228	228	2,867,630	155	4,303,275	3.85
>4,500,000 kWh: Office	6	6	62,063	204	204	1,940,348	444	3,342,289	5.58
>4,500,000 kWh: Other	1	1	5,569	14	14	223,498	1	5,569	1.00
>4,500,000 kWh: Public Assembly	1	2	15,308	19	20	194,684	1	15,309	1.00
>4,500,000 kWh: Retail	2	2	17,828	66	66	697,937	2	17,828	1.00
>4,500,000 kWh: Unknown	1	1	6,147	32	32	355,941	20	123,715	1.00
>4,500,000 kWh: Warehouse	0	0	0	25	25	597,181	0	0	1.00

[1]kWh in 1,000's.

Table J-3. Summary of the Target Population and Sample, Column Percents

Characteristic	Responding Sample			Target Population			Weighted Sample	
	Sites	Busi-nesses	MWh[1]	Sites	Busi-nesses	MWh[1]	Busi-nesses	MWh[1]
A. Total								
Total	100%	100%	100%	100%	100%	100%	100%	100%
B. Building Type								
Campuses	3%	3%	12%	1%	1%	2%	1%	2%
Education	7%	7%	5%	2%	2%	6%	2%	6%
Food Sales	9%	9%	3%	2%	2%	5%	2%	5%
Food Service	8%	8%	2%	5%	5%	4%	5%	4%
Healthcare	5%	5%	4%	4%	4%	5%	4%	5%
Hospitals	2%	2%	4%	0%	0%	2%	0%	2%
Lodging	8%	8%	5%	1%	1%	3%	1%	3%
Manufacturing or Industrial	6%	6%	18%	9%	9%	19%	9%	19%
Office	10%	10%	19%	24%	24%	22%	24%	22%
Other	8%	8%	4%	4%	4%	3%	4%	3%
Public Assembly	8%	8%	6%	4%	4%	3%	4%	3%
Retail	12%	12%	9%	30%	30%	17%	30%	17%
Unknown	11%	11%	7%	12%	12%	6%	12%	6%
Warehouse	3%	3%	1%	1%	1%	3%	1%	3%
C. Provider Region								
Cape Light Compact	13%	13%	2%	9%	9%	3%	9%	3%
NGrid	60%	60%	83%	53%	53%	46%	53%	46%
Eversource	18%	18%	9%	29%	29%	42%	29%	42%
Unitil	3%	3%	3%	1%	1%	1%	1%	1%
WMECO	6%	6%	3%	8%	8%	8%	8%	8%
D. KWH Strata								
<500,000 kWh	60%	60%	5%	96%	96%	31%	96%	31%
500,000 - 4,500,000 kWh	33%	33%	37%	3%	3%	35%	3%	35%
>4,500,000 kWh	6%	7%	59%	0%	0%	34%	0%	34%
E. Previous Efficiency Program								
No	72%	72%	40%	93%	93%	60%	93%	60%
Yes	28%	28%	60%	7%	7%	40%	7%	40%

Characteristic	Responding Sample			Target Population			Weighted Sample	
	Sites	Busi-nesses	MWh[1]	Sites	Busi-nesses	MWh[1]	Busi-nesses	MWh[1]
F. KWH Strata by Building Type								
<500,000 kWh: Campuses	1%	1%	0%	0%	0%	0%	1%	0%
<500,000 kWh: Education	3%	3%	0%	2%	2%	1%	1%	0%
<500,000 kWh: Food Sales	7%	7%	1%	2%	2%	2%	2%	1%
<500,000 kWh: Food Service	7%	7%	1%	5%	5%	3%	5%	2%
<500,000 kWh: Healthcare	2%	2%	0%	4%	4%	1%	4%	1%
<500,000 kWh: Hospitals	0%	0%	0%	0%	0%	0%	0%	0%
<500,000 kWh: Lodging	4%	4%	0%	1%	1%	1%	1%	0%
<500,000 kWh: Manufacturing or Industrial	3%	3%	0%	9%	9%	3%	9%	3%
<500,000 kWh: Office	5%	5%	0%	23%	23%	7%	24%	9%
<500,000 kWh: Other	6%	6%	1%	4%	4%	1%	4%	1%
<500,000 kWh: Public Assembly	5%	5%	0%	4%	4%	1%	4%	1%
<500,000 kWh: Retail	8%	8%	1%	30%	30%	8%	30%	8%
<500,000 kWh: Unknown	7%	7%	1%	12%	12%	2%	12%	5%
<500,000 kWh: Warehouse	3%	3%	0%	1%	1%	0%	0%	0%
500,000 - 4,500,000 kWh: Campuses	1%	1%	1%	0%	0%	1%	0%	0%
500,000 - 4,500,000 kWh: Education	4%	4%	4%	0%	0%	3%	1%	6%
500,000 - 4,500,000 kWh: Food Sales	2%	2%	2%	0%	0%	3%	0%	4%
500,000 - 4,500,000 kWh: Food Service	1%	1%	2%	0%	0%	1%	0%	2%
500,000 - 4,500,000 kWh: Healthcare	2%	2%	2%	0%	0%	2%	0%	2%
500,000 - 4,500,000 kWh: Hospitals	1%	1%	2%	0%	0%	0%	0%	2%
500,000 - 4,500,000 kWh: Lodging	5%	5%	5%	0%	0%	2%	0%	2%
500,000 - 4,500,000 kWh: Manufacturing or Industrial	2%	2%	4%	0%	0%	6%	0%	0%
500,000 - 4,500,000 kWh: Office	3%	3%	3%	1%	1%	8%	0%	1%
500,000 - 4,500,000 kWh: Other	1%	1%	2%	0%	0%	1%	0%	2%
500,000 - 4,500,000 kWh: Public Assembly	3%	3%	2%	0%	0%	1%	0%	2%
500,000 - 4,500,000 kWh: Retail	3%	3%	4%	1%	1%	6%	1%	9%
500,000 - 4,500,000 kWh: Unknown	4%	4%	5%	0%	0%	2%	0%	1%
500,000 - 4,500,000 kWh: Warehouse	0%	0%	0%	0%	0%	0%	0%	2%

Characteristic	Responding Sample			Target Population			Weighted Sample	
	Sites	Busi-nesses	MWh[1]	Sites	Busi-nesses	MWh[1]	Busi-nesses	MWh[1]
>4,500,000 kWh: Campuses	1%	1%	11%	0%	0%	1%	0%	2%
>4,500,000 kWh: Education	0%	0%	1%	0%	0%	2%	0%	0%
>4,500,000 kWh: Food Sales	0%	0%	0%	0%	0%	0%	0%	0%
>4,500,000 kWh: Food Service	0%	0%	0%	0%	0%	0%	0%	0%
>4,500,000 kWh: Healthcare	1%	1%	2%	0%	0%	2%	0%	3%
>4,500,000 kWh: Hospitals	0%	1%	2%	0%	0%	2%	0%	0%
>4,500,000 kWh: Lodging	0%	0%	0%	0%	0%	1%	0%	0%
>4,500,000 kWh: Manufacturing or Industrial	1%	1%	14%	0%	0%	11%	0%	16%
>4,500,000 kWh: Office	2%	2%	16%	0%	0%	7%	0%	13%
>4,500,000 kWh: Other	0%	0%	1%	0%	0%	1%	0%	0%
>4,500,000 kWh: Public Assembly	0%	1%	4%	0%	0%	1%	0%	0%
>4,500,000 kWh: Retail	1%	1%	5%	0%	0%	3%	0%	0%
>4,500,000 kWh: Unknown	0%	0%	2%	0%	0%	1%	0%	0%
>4,500,000 kWh: Warehouse	0%	0%	0%	0%	0%	2%	0%	0%

[1]kWh in 1,000's.

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.