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Report

California Commercial Market Share Tracking Study

Prepared for
California Public Utilities Commission

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Legal Notice

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Executive Summary

ES.1 Introduction

The Commercial Market Share Tracking Study (CMST) describes the non-residential recent purchase market for Linear Fluorescents, Televisions, and small packaged HVAC units in California. The market for these high priority measures is analyzed using recent purchase information collected from both end users and supply-side actors. The information from supply-side actors provides a broad picture of the current market for Linear Fluorescent lighting and packaged HVAC systems.[1] The Commercial Saturation Survey (CSS) and CMST telephone survey were used to collect self-reported information from end users and to recruit for the CMST on-site survey. The CMST on-site data collection effort led to the development of information on the efficiency level of recent purchases by non-residential customers by IOU, business size, and energy efficiency program participation.[2] The CMST Study provides the CPUC with a database containing on-site and contractor information on recent purchases of these three high priority measures. The data collected and analyzed by the CMST study will provide the CPUC, IOUs, and the evaluation community with a baseline estimate of the quantity of these technologies purchased and information on the efficiency distribution of recent purchases. Combining the on-site end user information with IOU energy efficiency (EE) program tracking data enables the analysis to determine if the efficiency distribution of these measures differs if the business participated in IOU EE programs.

The study collected information on current purchases using three overlapping data collection efforts:

- A joint CSS/CMST telephone survey collected information from 7,890 businesses.
- A CMST on-site data collection effort collected data on purchases of high priority equipment from 2009-2012.[3]
  - On-site data was collected at over 500 businesses installing new Linear Fluorescents.
  - On-site data was collected at over 400 businesses installing new Televisions.

[1] There is no supply side actor survey for televisions because there are no easily identifiable contractors installing televisions.

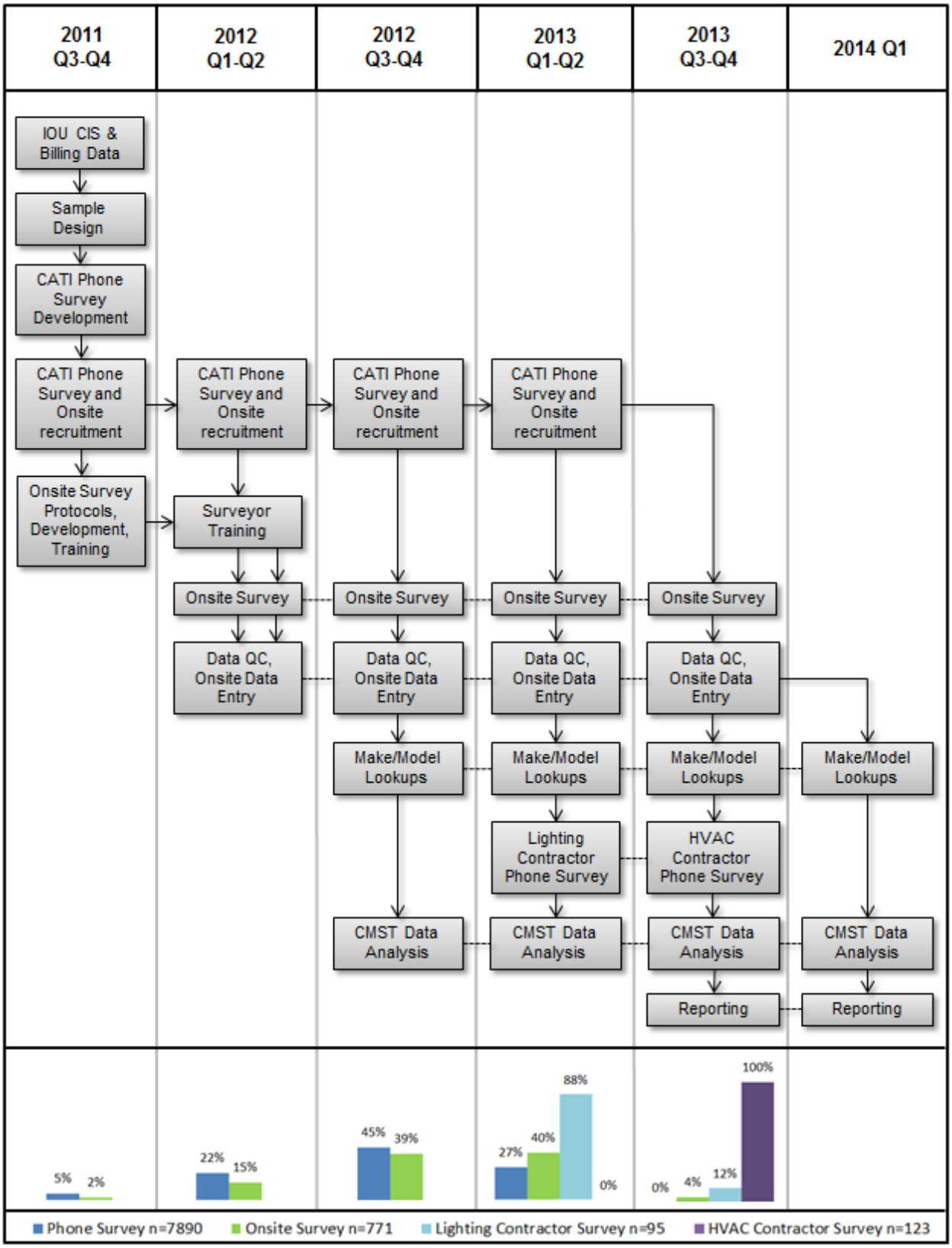
[2] The CMST on-site data collection effort overlapped with the CSS on-site data collection effort. The majority of the CMST on-site end user sites are also CSS sites. The CMST end user sites may have participated in multiple end use data collection efforts.

[3] Given that the on-site data collection effort began in late 2011 and was completed in May 2013 a limited number of measures incorporated into the analysis were purchased in 2013. These measures are classified with the 2012 purchases.

  - On-site data was collected at nearly 200 businesses installing new HVAC systems.
- A CMST contractor telephone survey collected information on the efficiency of sales from 2011 to 2012.
  - Self-report data was collected from 95 contractors who install Linear Fluorescents.
  - Self-report data was collected from 123 contractors who install commercial HVAC systems.

The CMST end user telephone and on-site data collection spanned the period from November 2011 to May 2013. The CMST lighting contractor telephone survey occurred in the second and third quarter of 2013 and the HVAC contractor telephone survey was fielded in the fourth quarter of 2013. Subsequent to the finalization of the CMST research plan, the various CMST data collection devices and test survey findings were reviewed by the CPUC and comments received were incorporated into the final version of the multiple data collection devices. The careful development of the research and the data collection devices led to a more efficient collection of the desired information and the study progressed with a clear vision of study objectives. Figure ES-1 provides a description of the activities that were undertaken during this study timeframe.

Figure ES-1: CMST Study Timeline



The CMST and the CSS research projects were designed to be a coordinated effort to collect the data necessary to describe current baseline purchases of select high priority equipment and the current baseline saturation of measures in businesses in the commercial population. The CMST Study provides information on the baseline of recent purchases of select technologies, while the efficiency distribution within the CSS provides information on a broader stock of technology within businesses, regardless of when they were purchased. Having the ability to analyze these data sets, which were collected over the same time period, provides multiple sources of baseline data and a unique and informative source of information for program planners, evaluators, and future potential studies.

This report represents one of three reports developed from the CSS/CMST study focusing on the data collected during the CMST on-site surveys. Additional reports include the Commercial Saturation and Commercial Market Share Tracking Study Telephone Survey Findings (Oct, 2013)[4] and the California Commercial Saturation Survey (June, 2014). The Study will also provide the CPUC and IOUs with searchable databases enabling additional analyses.

Non-Residential Frame and Telephone Survey Overview

The research team worked with the CPUC and the California IOUs to develop the necessary databases. The sample of sites needed for this study is reliant on the population of electric customers in the Non-Residential Frames (NRF) of Pacific Gas and Electric (PG&E), Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E) (collectively referred to as the IOUs). The IOU data used for the study included the Non-Residential Customer Information System Data (CIS), the Non-Residential Billing data, and the Energy Efficiency (EE) Program Tracking Data. The program participation data were used to characterize the efficiency distribution of recent purchases of high priority measures by program participation.[5]

The telephone survey's primary objective is to help develop an on-site sample for estimating a wide range of commercial customer characteristics. Given that the primary purpose of the telephone survey was to recruit a representative sample for the CSS and CMST on-site surveys, planned phone survey sample sizes were exceeded for some strata where the phone survey was achieving responses but a sufficient number of sites could not be recruited for on-site visits to achieve the CSS on-site sample design objectives.

[4] The telephone survey report included limited information comparing the customers' telephone survey responses to data collected during on-site visits.

[5] Information on the distribution of sites in the non-residential frame is available in Chapter 3 of the CSS/CMST telephone survey report.

The telephone survey sample design incorporates 14 business types, three IOUs and five usage strata (Very Small, Small, Medium, Large, and Unknown)[6] to produce 210 unique strata. The telephone survey asks respondents about recent purchases of Linear lighting technologies, Televisions, and packaged HVAC units. Sites that had recently purchased Linear technologies, TVs, or HVAC units were eligible to participate in the CMST on-site survey. These sites were recruited to participate in the CMST on-site study at the end of the telephone survey. Sites not purchasing new high priority measures were recruited to participate in the CSS on-site study. CMST eligible equipment was often found during CSS on-site data collection. These sites and their new equipment were incorporated into the CMST study.

CMST On-Site Survey

CMST on-site surveys collected data on recent purchases of both Base and High efficiency Linear lighting technologies, Televisions, and small packaged Air Conditioning units. The CMST on-site data came from a combination of businesses identified from the phone survey as CMST sites and CSS sites. The CMST sites were those that claimed during the telephone survey to have purchased and installed new qualified equipment at their facility. The CSS sites are businesses that claimed to have not purchased or installed any new CMST-eligible equipment at their facility, but during the CSS-onsite visit, new CMST-eligible measures were found to have been installed.

The data collected during the on-site at CMST eligible sites included the number of high priority measures purchased, the self-reported year of purchase, and make and model numbers from recently purchased equipment. Make and model lookups served to verify manufacturer names, model numbers, system types, and efficiency ratings. The measure level efficiency information enabled the development of efficiency distributions for the high priority measures. The data on recent purchases and efficiency levels were analyzed in conjunction with site level data (IOU, size, and business type) and information from IOU energy efficiency program tracking databases to help determine the share of High Efficiency purchases reported by these characteristics.

CMST Contractor Surveys

The Joint Lighting Contractor Survey and the Joint HVAC Contractor Survey included survey batteries questioning contractors about the efficiency distribution of their recent sales and installations of CMST Linear lighting technologies and small packaged HVAC units. Efficiency distribution information collected from contractors provides a broad picture of the distribution of measures installed in the non-residential sector in California. The information collected in the

[6] The Unknown usage category represents accounts found in the CIS that do not have a matching record in the billing data.

Lighting and HVAC Contractor Surveys are triangulated with the end user market share data collected during the CMST on-site surveys.

ES.2 CMST Lighting

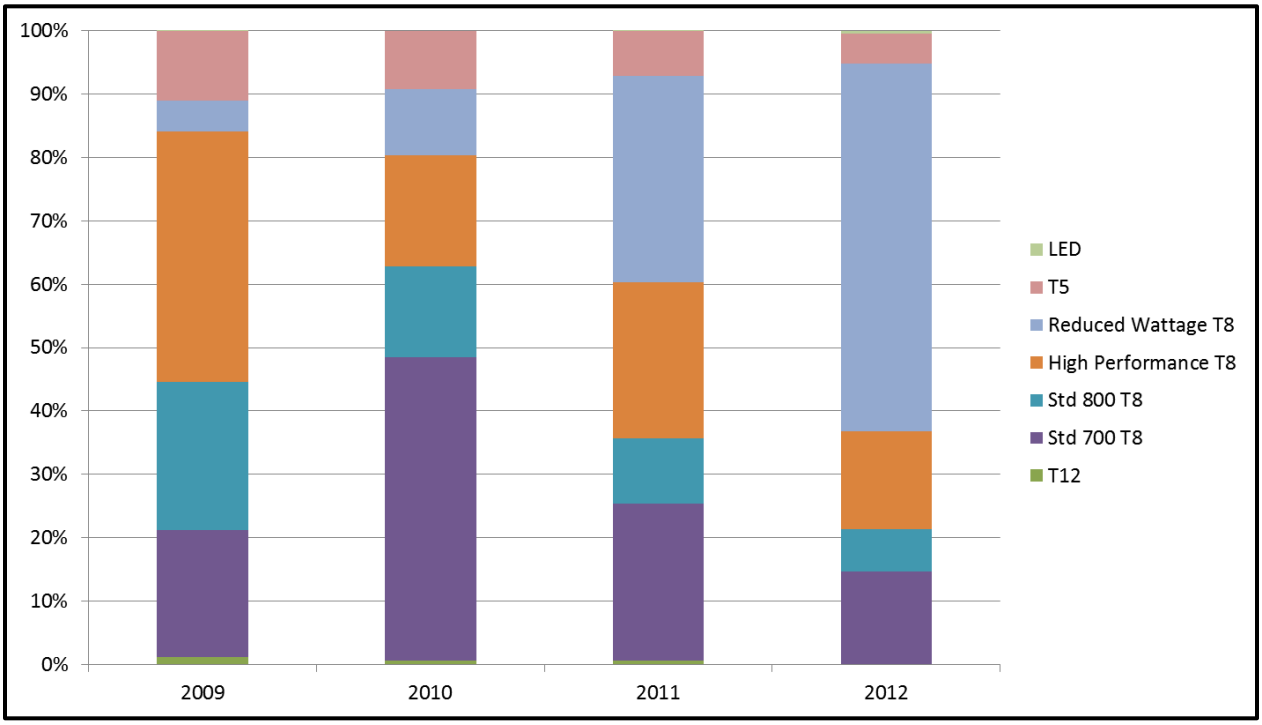
Linear Fluorescent lighting technology was chosen for the CMST analysis due to their prominence in non-residential lighting, their dominance in non-residential EE programs, and recent and on-going changes in Linear lighting standards. The CMST lighting analysis incorporated data collected during 568 non-residential on-site surveys and 95 telephone surveys with lighting contractors. The on-site make and model number information were analyzed to develop a detailed picture of the efficiency of recent purchases. The lighting contractor analysis used self-reported data from contractors to develop a detailed understanding of the efficiency of recent purchases.

CMST End User Lighting

Through the collection of telephone and on-site inventory information describing recent purchases of Linear Fluorescents, this study documents the purchasing behavior of California businesses during 2009-2012. The CMST analysis examines the purchasing behavior by IOU, business size, EE program participation, and year. These variables help to illustrate the Linear Fluorescent market in ways that are of interest to program planners and regulators; how does the energy efficiency classification of Linear Fluorescent purchases differ for energy efficiency program participants and non-participants?

The make and model lookups completed for the CMST enabled a disaggregated look at the efficiency distribution of recently purchased Linear technologies. Figure ES-2 illustrates the efficiency distribution of recently purchased Linear technologies by self-reported year of purchase.

Figure ES-2: CMST Linear Fluorescent Efficiency Distribution by Year, Fixture Count Shares*



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

The efficiency data that was collected and analyzed as part of the CMST-Linear end user analysis leads to the following conclusions:

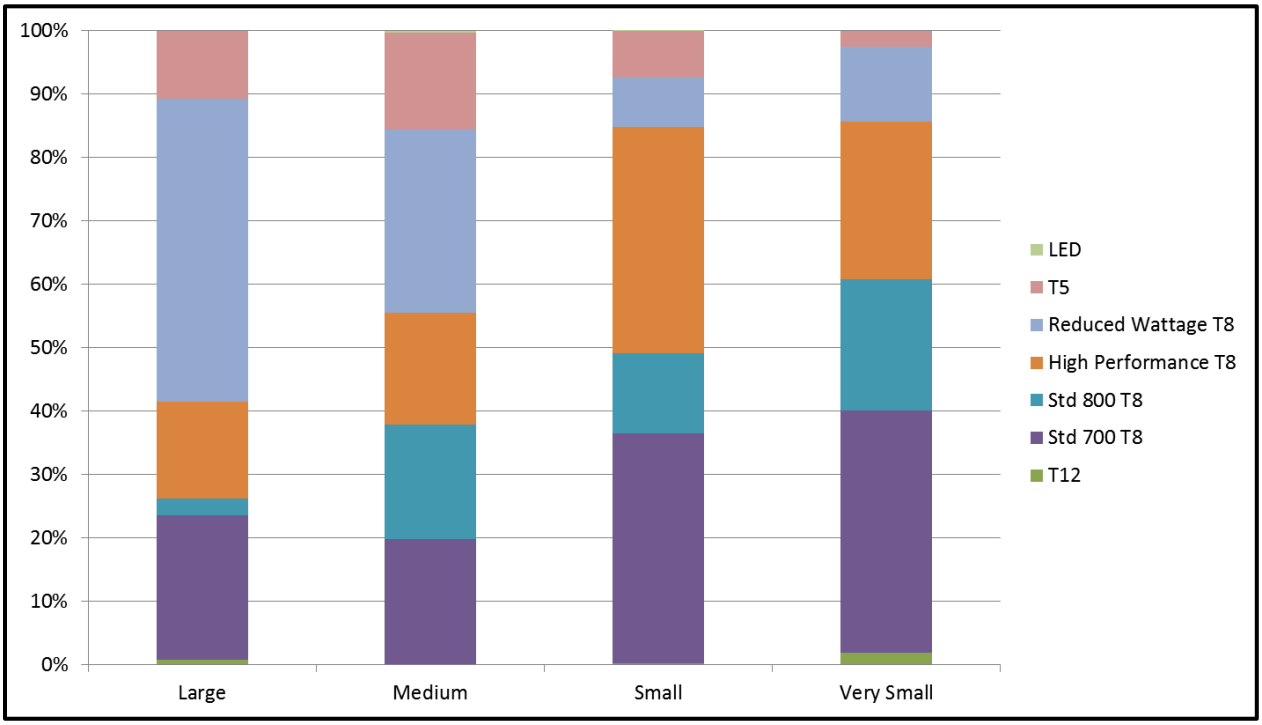
- Slightly more than half of Linear fixtures purchased from 2009 to 2012 by non-residential customers in California are High Efficiency units. High efficiency technologies include High Performance T8, Reduced Wattage T8, T5, and Linear LEDs. Base Efficiency technologies include T12, Standard 700-Series T8, and Standard 800-Series T8.
  - The CMST end user data analysis estimates that 46% of recently purchased Linear lighting fixtures are Base Efficiency and 54% are High Efficiency.[7]
  - The CMST data indicates that Reduced Wattage T8s have experienced a significant increase in installations in California businesses from 2009-2012 (see Figure ES-2).
  - A higher share of Linear Fluorescent purchases in 2011 and 2012 were High Efficiency than those purchased from 2009-2010 (see Figure ES-2).

[7] The reported efficiency share only includes information for lighting measures whose make and model number were collected and these data led to the development of efficiency information.

- Linear lighting purchasers that have participated in Linear Fluorescent EE programs during the time period 2009-2012 have a higher share of High Efficiency purchases than non-participants.
  - Approximately 77% of the Linear lighting fixtures purchased by Linear EE program participants are High Efficiency equipment while 44% of purchases at businesses that have not participated in Linear Fluorescent EE programs are High Efficiency Linear technologies.[8]
    - The substantial share of High Efficiency purchases by businesses that have not participated in Linear EE programs indicates that additional research is needed to better understand non-participant spillover. The CPUC will be researching spillover during the 2013-2014 evaluation cycle.
    - The substantial share of High Efficiency purchases by businesses that have not participated in Linear EE programs may also indicate that EE programs for Linear lighting measures are not pushing the market forward for some non-residential segments.
- Figure ES-3 illustrates that 74% of the Linear technologies installed in Large businesses were High Efficiency lighting while only 39% of Linear technologies installed in Very Small businesses were High Efficiency.
  - The small share of High Efficiency Linear installations in Very Small businesses may indicate that additional programs are needed to facilitate the installation of High Efficiency technologies in this hard-to-reach segment.

[8] Program participation for Linear Technologies was determined by the Linear Fluorescent High Impact Measure designation (LF HIM). Custom projects that do not list installed technologies, may have installed Linear Technologies but not have a LF HIM designation. Custom projects are more common in larger sized sites. The share of Reduced Wattage and High Performance T8s in non-participant sites, however, is not higher for Large sites than for Small and Very Small sites. While it is possible that the high share of high efficiency technologies in non-participant sites is impacted by Linear Technologies installed through custom projects, the evidence is not substantial.

Figure ES-3: CMST Linear Fluorescent Efficiency Distribution by Size, Fixture Count Shares*



* **The results presented above have been weighted by site weight.** Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh.

- The CMST end user on-site data for 2009-2012 found that businesses in California were more likely to install High Efficiency Linear technologies when the installations were not associated with new construction or a major remodel (62% of businesses installed High Efficiency) than when Linear technologies were installed as part of new construction or a major remodel (41% of businesses installed High Efficiency).
  - Disaggregating these data into installations in 2009-2010 and 2011-2012 shows that the low High Efficiency share (41%) for new construction/remodel is largely due to a very low High Efficiency share (28%) during the 2009-2010 time period. During 2011 and 2012 the efficiency distribution of these two groups are similar.
  - Developing a better understanding of the observed relationship is important for future program development. Future lighting contractor surveys should attempt to collect information to better understand the new construction and retrofit lighting markets.

CMST Lighting Contractor Survey

The CMST lighting contractor survey is part of the Joint Lighting Contractor Survey. The objective of the CMST lighting contractors' survey was to determine the efficiency and distribution of Linear installations that were sold and installed during the period 2011-2012. The CMST battery questioned lighting contractors about the share of their sales and installations associated with T12, Standard 700-Series T8, Standard 800-Series T8, High Performance T8, Reduced Wattage T8, T5 and Linear LED installation and sales. Since the survey gathered market share information from 2011-2012 and the survey was administered in 2013, contractors were also asked if sales and installation of lighting equipment had changed throughout that period. These questions aim to uncover potential changes in the market share of Linear technologies since the implementation of the Department of Energy's General Service Lighting legislation banning the production of T12s.[9]

The CMST survey questions are designed to shed light on the market share of Linear lighting technologies from the perspective of the contractor. Contractors were asked a series of questions to determine the relative efficiency of Linear lighting equipment installed and sold in California during 2011-2012 and the market share of those technologies.

The CMST contractor Linear lighting efficiency data that was collected and analyzed leads to the following conclusions:

- As expected, only a small share of contractors (20%) report installing T12 systems during 2011 and 2012.
- Over 80% of lighting contractors reported installing Standard 800-Series T8 and T5.
- Using information on the contractors' efficiency share of sales and installations during 2011 and 2012, the study estimates that 38% of sales and installations of Linear technologies are Base Efficiency. Base efficiency technologies include T12 and Standard 700- and 800-Series T8.
- Disaggregating contractors by their number of employees, the efficiency distribution of Linear technologies installed by larger contractors display a higher share of Base Efficiency equipment than for smaller contractors.

ES.3 CMST Televisions

TVs were chosen for the CMST analysis due to recent advances in TV technology that have led to three updates to the ENERGY STAR rating for TVs during the 2009-2012 time period,

[9] The Energy Independence and Security Act of 2007 banned the production of T12s for commercial purposes starting in July of 2012.

anecdotal evidence that the number of TVs and the share of businesses with TVs has risen over time, and a high degree of uncertainty surrounding TVs in the non-residential sector. The analysis examines the non-residential TV purchasing behavior by IOU, year, and business size. This analysis helps to illustrate the TV market in ways that are of interest to program planners and regulators, showing how the energy efficiency share of TV purchases is evolving.

The CMST-TV study collected make and model number information during the on-site survey. The make and model number information that was collected was looked up using make and model number to efficiency tables provided by ENERGY STAR. The analysis effort classified the recently purchased TVs as not ENERGY STAR eligible or ENERGY STAR Version 3.0, 4.1, or 5.3. For the ENERGY STAR eligible units, higher version numbers represent more efficient units.

The efficiency data that was collected and analyzed as part of the CMST-TV end user analysis leads to the following conclusions:

- Approximately 25% of non-residential businesses self-reported purchasing a TV from 2009-2012.
- Sixty percent of TVs purchased by the non-residential sector from 2009-2012 were High Efficiency. For the CMST study, the definition of High Efficiency was based on ENERGY STAR Version 3.0, 4.1, or 5.3 and these definitions were time dependent. TVs that were Version 3.0 and 4.1 were only counted as High Efficiency options if the TV was purchased during the qualifying ENERGY STAR time period.
- The share of High Efficiency purchases fell in 2012 relative to 2009-2011. The declining efficiency share, however, is likely due to increases in ENERGY STAR standards that eliminated Version 3.0 and 4.1 as a High Efficiency options by the end of 2011.[10]
- TV purchasers in the Small and Very Small business size category purchased a higher share of High Efficiency measures than Large and Medium-sized businesses.

ES.4 CMST HVAC

Small packaged and split system HVAC units (under 65,000 Btuh) were chosen for the CMST analysis due to the importance of HVAC measures in the California Strategic Plan and the prevalence of these units in commercial businesses. Collecting information on the current efficiency distribution of small commercial HVAC purchases will help the CPUC and IOUs better understand the current baseline and standard purchase practices and to develop HVAC

[10] While TVs with ENERGY STAR Version 4.1 were still available for purchase in 2012, changes in ENERGY STAR standards in 2011 imply that Version 4.1 was Base Efficiency technology in 2012.

energy efficiency programs needed to help meet the Strategic Plan goals. The CMST HVAC analysis incorporated data collected during 197 non-residential on-site surveys and 123 telephone surveys with HVAC contractors. The on-site make and model number information were analyzed to develop a detailed picture of the efficiency of recent purchases. The HVAC contractor analysis used self-reported data from contractors to develop a detailed understanding of the efficiency of recent purchases.

CMST End User HVAC

Through the collection of telephone and on-site inventory information describing recent purchases of small split and packaged HVAC units, this study documents the purchasing behavior of California businesses during 2009-2012. The CMST end user analysis examines the purchasing behavior by IOU, business size, EE program participation, and year. These variables help to illustrate the commercial small HVAC market in ways that are of interest to program planners and regulators.

The CMST-HVAC analyses collected make and model number information during the on-site data collection effort. Table ES-1 illustrates the efficiency distribution derived from make and model lookups of recently purchased small packaged HVAC units. These data indicate that the majority of HVAC units purchased from 2009 to 2012 by CMST businesses are Base Efficiency (SEER 13).

Table ES-1: CMST HVAC Estimated Efficiency Distribution

	HVAC Units		Businesses	
Efficiency Level	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**
Base Efficiency	72%	10%	89%	7%
High Efficiency	28%	27%	23%	46%
High Efficiency Tiers Distribution				
14-14.99 SEER	6%		7%	
15-15.99 SEER	10%		5%	
16-16.99 SEER	10%		8%	
> 17 SEER	2%		3%	
n	**879**		**192**	

*** The results presented above have been weighted by site weight.** Each level reported represents the different Tiers. The percent of businesses sums to more than 100% because a site can install both Base and High Efficiency units.

The efficiency data that was collected and analyzed leads to the following conclusions:

- The CMST end user data analysis estimates that 72% of purchased units are Base Efficiency. HVAC purchasers that have participated in energy efficiency programs

during the time period 2009-2012 are more likely to purchase High Efficiency units than those who are not EE program participants.

- Forty-seven percent of HVAC units purchased by EE participants are High Efficiency equipment while only 26% of units purchased by customers who have not participated in EE programs are estimated to be High Efficiency systems.[11]

CMST HVAC Contractor Survey

The CMST HVAC contractor survey is part of the Joint HVAC Contractor Survey. The objective of the CMST HVAC contractors' survey was to determine the efficiency and distribution of small packaged and split system air conditioning units (less than 65,000 Btuh) sold and installed during the period 2011-2012. The CMST battery questioned HVAC contractors about the share of their sales and installations associated with Base Efficiency and High Efficiency units. For this analysis High Efficiency units were broken down into those whose SEER rating were 14-14.99 SEER, 15-15.99, and 16 SEER and higher.

The CMST survey questions are designed to shed light on the market share of small packaged air conditioning systems from the perspective of the contractor. Contractors were asked a series of questions to determine the relative efficiency of air conditioning equipment installed and sold in California during 2011-2012 and the market share of those technologies.

The CMST contractor HVAC efficiency data that was collected and analyzed leads to the following conclusions:

- Using information on the contractors' efficiency share of sales and installations during 2011 and 2012, the study estimates that 78% of sales and installations of small packaged air conditioning units are Base Efficiency or have a SEER rating less than 14.
- Disaggregating HVAC contractors by their number of employees, the efficiency distribution of small packaged air conditioning units installed by larger contractors display a higher share of Base Efficiency equipment than for smaller contractors.

ES.5 CMST Conclusions and Recommendations

Lighting

The end user on-site data collection effort indicates that substantial improvement was made in the lighting efficiency of Linear technologies installed in California businesses from 2009 to

[11] The high share of base efficiency HVAC purchases by HVAC EE program participants is due in part to the fact that the HVAC EE programs rebate many HVAC measures and services other than packaged HVAC units. Most of the HVAC EE program participants were not purchasing packaged HVAC units under the program.

2012. During this time period there was a substantial increase in the share of Linear technologies being installed that were Reduced Wattage T8s and a decline in the share of installations that were Standard 700-Series T8s.

The CMST study found that Liner Fluorescent participants in the IOU EE programs installed a larger share of High Efficiency Linear technologies than non-participants. The High Efficiency share of Linear technologies installed by non-participants during 2011 and 2012, however, exceeded 50% of their installations during this time period. These findings have implications for the establishment of baselines for measure savings and should be reviewed by program planners, DEER, and evaluators.

The CMST end user analysis found that Small and Very Small businesses were installing a smaller share of High Efficiency lighting than Large businesses. These findings are consistent with results from the CSS/CMST end user telephone survey analysis that showed that a significantly smaller share of Small and Very Small businesses had participated in IOU EE programs and that smaller businesses were less aware of energy efficiency programs than larger sized businesses. These findings may indicate that the CPUC and IOUs should consider reinstating a hard to reach goal for smaller businesses.

The high level efficiency distributions from the End User and the Lighting Contractor Surveys were similar. Both types of surveys have provided interested parties with valuable information. The speed of change within the lighting market necessitates frequent data collection efforts to help maintain an up to date understanding of current market trends. Lighting contractor surveys represent a cost effective way to frequently collect information on the commercial lighting market. Energy Division staff acknowledge that lighting contractor surveys may provide substantial information to the IOUs, CPUC, and the evaluation community if they reoccur every one to three years. The CMST End User survey represents an approach to collect a unique set of information on the current distribution of recent installations within the non-residential sector by multiple domains of interest. Energy Division staff acknowledge that continuing to implement the CMST on-site lighting survey with large population surveys like the CSS may provide the CPUC, IOUs, and evaluation community with unique information on recent linear lighting purchases.

HVAC

The CMST end user and contractor surveys found that approximately 75% of small packaged HVAC units installed in commercial businesses in California from 2009 to 2012 were Base Efficiency units. These findings indicate that there is substantial unrealized potential for improvements in the efficiency of HVAC units installed in businesses in California. Developing a more complete understanding of the market for small HVAC units within the commercial

sector will help in the creation of programs designed to effectively achieve this unrealized energy efficiency potential.

Additional research should be undertaken to determine if the installation of High Efficiency small packaged HVAC units is cost effective for businesses in California. The high base efficiency share of small HVAC units within the commercial sector may be due in part to existing perceptions of the cost effectiveness of these units. If the units are cost effective, additional marketing may be needed to help encourage the installation of high efficiency units within the commercial sector.

The HVAC Contractor Survey undertaken for this study included batteries collecting information on incremental labor costs, labor training practices, HVAC maintenance practices, and the distribution of sales by efficiency levels. These different batteries of questions provided information on the HVAC market. Future surveys of HVAC contractors, however, should include a battery of questions inquiring about the contractor's knowledge of high efficiency HVAC systems, their marketing of these systems to their clients, their knowledge of available IOU rebate programs, and their perception of their clients' willingness and barriers to adopting high efficiency HVAC systems.

With additional information on the cost effectiveness of small packaged HVAC units and a better understanding of the willingness and barriers as perceived by customers adopting these systems, the CPUC and IOUs should review their existing commercial HVAC programs, working to determine how these programs can be modified to encourage more businesses to install High Efficiency HVAC units.

The high level efficiency distributions from the End User and the HVAC Contractor Surveys were similar. The importance of the commercial HVAC market necessitates frequent data collection efforts while the slow speed of change within the market points to the need to provide time for change between data collection efforts. HVAC contractor surveys represent a cost effective way to frequently collect information on the commercial HVAC market. Energy Division staff acknowledge that HVAC contractor surveys may provide substantial information to the IOUs CPUC, and the evaluation community if they reoccur every two to four years. The CMST End User survey collected a unique set of information on the current distribution of recent installations within the non-residential sector by multiple domains of interest. Energy Division staff acknowledge that continuing to implement the CMST on-site HVAC survey with large population surveys like the CSS may provide the CPUC, IOUs, and evaluation community with unique information on recent HVAC purchases.

Additional Research Opportunities Building on Data Collected

The CSS/CMST on-site survey collected extensive information on the make and model numbers of equipment found on-site. For Linear technologies, HVAC systems, and TVs the make and model numbers were look up to determine the efficiency distribution of recent purchases (CMST) and of existing equipment (CSS). The make and model numbers and the efficiency information were combined with IOU program participation data to determine the EE participation status of businesses that participated in the CSS/CMST. Using the extensive information collected on-site and the program participation information, it is possible to distinguish businesses that purchased their high efficiency Linear technologies and their HVAC technologies inside and outside the IOU EE programs. This set of information has extra value in the evaluation of spillover because it is verifiable information on the efficiency level of recently purchased equipment. These data can be used to further analyze both participant and non-participant spillover. For participants, the information on Linear and HVAC installations can be further analyzed to determine if the business installed additional high efficiency lighting and HVAC measure outside the program – a potential indication of participant "like measure" spillover. For non-participants we know the verified efficiency level of their installations of Linear and HVAC technologies – a potential pool of businesses to survey concerning non-participant spillover. For participants and non-participants additional make and model look ups could be undertaken on refrigeration equipment and additional HVAC equipment to determine if sites installing high efficiency Linear and HVAC technologies also installed other high efficiency equipment outside the IOU EE programs. The CSS/CMST data will be further analyzed as part of the 2013-2014 non-residential spillover evaluation.

The CSS/CMST on-site survey data provides for additional comparisons between the new and existing equipment that was not highlighted in the series of reports. Additional analyses of the existing equipment present in businesses that have recently installed equipment will provide insight into the equipment stocks of businesses that have demonstrated that they have recently updated some equipment. This analysis could include a comparison of existing Linear and HVAC technologies to newly purchased technologies for CMST sites. Additionally, analyses could compare the existing equipment at CMST sites with the equipment distribution for non-CMST sites. These analyses would provide the CPUC, IOUs, and evaluation community with a better understanding of where remaining potential exists and present information on the distribution of equipment at sites that have not recently purchased equipment. This information may help to better define businesses with remaining energy efficiency potential.

1

Introduction

The Commercial Market Share Tracking Study (CMST) describes the non-residential recent purchase market for Linear Fluorescents, Televisions, and small packaged HVAC units in California. The market for these high priority measures is analyzed using recent purchase information collected from both end-users and supply-side actors. The information from supply-side actors provides a broad picture of the current market for Linear Fluorescent lighting and packaged HVAC systems.[1] The Commercial Saturation Survey and CMST telephone survey was used to collect self-reported information from end users and to recruit for the on-site survey. The CMST on-site data collection effort led to the development of precise information on the efficiency level of recent purchases.[2] The information collected and analyzed by the CMST study will provide the CPUC, IOUs, and the evaluation community with a baseline estimate of the quantity of these technologies purchased and information on the efficiency distribution of recent purchases. Combining the on-site end user information with IOU energy efficiency (EE) program tracking data enables the analysis to determine if the efficiency distribution of these measures differs if the business participated in IOU energy efficiency programs.

The CMST study collected information on current purchases using three data collection efforts:

- The joint CSS/CMST telephone survey collected information from 7,890 businesses. The CMST results from the telephone survey are available in a companion report, The Commercial Saturation Survey and Market Share Tracking Phone Survey Findings.
- The CMST on-site end user data collection effort collected data on recent purchases.
  - Data was collected at over 500 businesses installing new Linear technologies.
  - Data was collected at over 400 businesses installing new Televisions.
  - Data was collected at over 200 businesses installing new smaller (less than 65 kBtuh) HVAC systems.
- The CMST contractor survey collected information on the efficiency of recent sales of Linear technology and HVAC systems.

[1] There is no supply side actor survey for televisions because there are no easily identifiable contractors installing televisions.

[2] The telephone and on-site CMST data collection efforts from end-users are coordinated with the Commercial Saturation Study (CSS). The combination of the CSS and CMST telephone and on-site surveys works to increase efficiencies and the number of sites available for each study.

- Data was collected from 95 contractors who install Linear Fluorescents.
- Data was collected from 123 HVAC contractors. Information was collected on the installation of small HVAC systems.

The CSS/CMST telephone survey questioned businesses on recent purchases of linear technologies, TVs, and HVAC equipment and recruited sites purchasing this equipment to participate in on-site surveys. CMST on-site surveys collected data on recent purchases of both standard and high efficiency high priority measures. The data collected on-site included make and model numbers from recently purchased equipment, enabling the development of efficiency look up tables for high priority measures. The data on recent purchases and efficiency levels have been analyzed in conjunction with information from IOU energy efficiency program tracking databases to help determine the share of high efficiency purchases reported to be receiving IOU rebates. The findings from these analyses will help to determine the efficiency distribution of recent purchases of high priority measures and if the efficiency distribution differs by year of purchase (2009-2012), IOU, customer size, and EE participation.

The CMST contractor telephone surveys collected market level information on the installation of linear fluorescents and packaged HVAC systems. These data provide a high level overview of the standard and high efficiency share of these systems currently installed in non-residential businesses in California. This report also carefully compares the CMST on-site end user and contractor data to provide a fuller picture of recent purchases of these two high priority end uses.

The sections of the CMST report include the following:

- A description of the objectives of the CMST surveys.
- A description of the telephone survey CMST completes and on-site recruitment.
- A description of the CMST on-site weighting.
- Presentation of the CMST lighting on-site results.
- Presentation of the CMST lighting contractor telephone survey design and results.
- Presentation of the CMST HVAC on-site and contractor results.
- Presentation of the CMST HVAC contractor telephone survey design and results.
- Presentation of the CMST TV results.

2

Commercial Market Share Tracking Objectives

The Commercial Saturation Survey and the Commercial Market Share Tracking Survey are designed to answer an extensive list of baseline research objectives. The research objectives for the studies differ and overlap for the three components of the study: the CSS/CMST telephone survey, the CMST on-site data collection, and the CSS on-site data collection. The following sections highlight the different and overlapping surveys of the multiple data gathering efforts while focusing on the research objectives of the CMST study.

2.1 Telephone Survey Research Objectives

The telephone survey interviewed approximately 8,000 non-residential customers in the three California electric IOU service territories, providing the evaluation team with the unique opportunity to collect baseline information on a large number of customers. The team collected information on firm demographics, the customer's environmental consciousness, their awareness of DSM programs, and their current participation in these programs. The survey also collected information on the types of technologies currently used in the customer's building and whether the customer had purchased high priority new technologies since 2009. The CSS/CMST telephone survey also recruited for both the CSS and CMST end user on-site data collection effort.

2.2 Commercial Market Share Tracking Research Objectives

Commercial market share tracking information was collected using three approaches during this study: Telephone and on-site surveys with end users and telephone surveys with contractors. Information on recent purchases of Linear Fluorescents, Televisions, and small HVAC systems was collected from non-residential customers during the telephone survey. The on-site data collection efforts verified recent purchases identified during the telephone survey, collected information on additional recent purchases of these technologies that were not identified during the telephone survey, and collected make and model number information that is used to develop detailed descriptions of the efficiency of recent purchases. Telephone surveys of lighting and HVAC contractors are used to develop a high level understanding of the efficiency distribution of recent sales and installations by contractors in non-residential sites in California.

The information collected as part of the CMST telephone survey questions is presented in detail in the Commercial Saturation Survey and Market Share Tracking Telephone Survey Report. The CMST report provides limited information on the telephone survey including a brief description of the telephone survey sample design as it relates to the customers included in the CMST on-site survey and a brief accounting of the CMST phone survey findings. The CMST report, however, focuses on the analysis of data collected during the CMST on-site and contractor surveys.

The specific research objectives of the CMST study are listed below.[1]

1) Develop an estimate of the number of sites purchasing linear technologies during 2009 to 2012. Develop an estimate of the number of bulbs or fixtures recently purchased. Using the EE program tracking data, determine the share of sites and fixtures purchased by customers participating in the IOU EE programs and the share purchased by non-participants. These estimates are used to develop a high level understanding of the market for linear technologies in California and to determine the share of the market participating in IOU programs.
2) Use the make and model number information collected on-site to determine the distribution of linear fluorescents purchases by T12, generation of T8, and T5s for lighting purchased by non-residential businesses since 2009. This information illustrates the efficiency share of the market.
3) Determine the efficiency distribution of technologies installed in sites that participated in EE programs for linear technologies and the efficiency distribution of technologies at sites not participating in IOU EE programs. This analysis facilitates the comparison of linear technologies installed inside and outside EE programs, helping to illustrate the impact of programs and to provide information on standard practices outside the program.
4) Disaggregation of the participant and non-participant efficiency distributions by self-reported year of purchase provides information on how the efficiency of linear fluorescent purchases has changed over this four year time period and how this change may have been influenced by program participation.
5) Disaggregation of the participant and non-participant efficiency distributions of linear technologies by customer size and business type provides information on technologies installed in different segments and on the influence of the IOU EE programs within different segments. This information can help with future program planning.
6) Using the lighting contractor telephone survey information, the study develops an estimate of the efficiency distribution of linear technologies installed by lighting

[1] The CMST study includes end-user on-site surveys in nearly all nonresidential segments, excluding only transportation, communications, and utilities (TCU), agriculture, mining, and street lighting. See Section 4 for a more detailed description.

contractors. The lighting contractor findings are compared to the results from the end users data collection efforts.

7) Develop an estimate of the number of sites purchasing TVs during 2009 to 2012. Develop an estimate of the number of TVs recently purchased. This information will help the CPUC, IOUs, and evaluators better understand the recent TV purchase behavior of non-residential customers, helping to better describe this rapidly changing technology.
8) Collect information on the number of televisions purchased by the sample of non-residential businesses, determine the Base and High Efficiency share of recent television purchases, and determine the share of recent television purchases that represent television replacements and those that reflect new load growth.
9) Develop an estimate of the number of non-residential customers purchasing small air conditioning units during 2009 to 2012. Develop an estimate of the number of small air conditioning units recently purchased.
10) Determine the share of Base and High Efficiency packaged air conditioning units purchased by non-residential customers and determine if efficiency distribution differs for sites participating in the IOU EE programs.
11) Using the HVAC contractor telephone survey information, develop an estimate of the efficiency distribution of small air conditioning units installed by contractors. Compare these findings to those from the end users data collection efforts. The HVAC contractor data will also provide information in the efficiency distribution of larger sized air conditioning units.

Using the data collected from the CMST on-site surveys and the lighting and HVAC contractor surveys, the CMST study has developed a baseline of recent purchases of Linear technologies, TVs, and small packaged HVAC units. The recent purchase baselines provide important information on the marketplace, contributes to our understanding of standard practices, provides information on the effectiveness of current IOU EE programs, and provides insights for the program planning process.

2.3 Commercial Saturation Survey

The research objectives of the CSS study center around determining the current baseline of equipment in commercial businesses.

- The CSS collects information on the lighting employed in commercial businesses through a full inventory of commercial lighting and use analyses approaches similar to those used in the CMST study to determine the efficiency share of linear fluorescents and ballasts to describe the current baseline for these lighting systems.

- Determine the number and type of office equipment, including computers and printers, currently used in commercial buildings.
- Determine the number and types of televisions currently used in commercial buildings.
- Collect information on the HVAC equipment currently used in commercial buildings. The data collection will focus on packaged units while also collecting information on larger, more diverse systems. For smaller air conditioning units, the CSS will use analyses approaches similar to those used in the CMST study to determine the efficiency distribution of existing units. These data will illustrate the current baseline of HVAC equipment and help to describe the potential of HVAC retrofits and quality maintenance services.
- Determine the current baseline for commercial refrigeration equipment.
- Collect information on the building square footage that will be combined with the building energy usage to calculate whole-building energy intensities.

2.4 Comparison of the CSS and the CMST

Table 2-1 presents a high level comparison of the CSS and CMST studies. The CMST and CSS have unique objectives, though the study implementation used a joint telephone survey and overlapping on-sites. The business types included in the two studies were identical for the joint telephone survey, but the types of businesses included in the CSS on-site data collection was more limited than for the CMST on-site data collection effort. The CSS on-site data collection and analysis, however, incorporated more technologies than the CMST study. The technologies with efficiency look ups in the CSS mirror the technologies analyzed in the CMST. The CMST Study provides information on the baseline of current purchases of Linear technologies, small packaged HVAC, and TVs while the efficiency look ups within the CSS provide information on the baseline of these current technology distributions within businesses. Having the ability to analyze both of these data sets, which were collected over the same time period, provides a description of where the market is currently heading (CMST) and what the efficiency of equipment in businesses currently is (CSS). The combination of these two sources of baseline data provides a unique and informative source of information for program planners, evaluators, and future potential studies.

Table 2-1: CSS and CMST Comparison

CSS Study	CMST Study
Joint Phone Survey	Joint Phone Survey
On-sites Implemented in Select Commercial Business Types	On-sites Implemented in Select Non-Residential Business Types
	Contractor Telephone Survey
Analyzed Existing Baselines for Lighting, HVAC, Refrigeration, TV, Office Equipment, EMS, and DG	Analyzed Recent Purchases for Linear Lighting, TV, and Select HVAC
Analyzed Efficiency Distribution of Equipment for Lighting, TV, and Select HVAC	Analyzed Efficiency Distribution of Equipment for Linear Lighting, TV, and Select HVAC
Disaggregated the analysis by IOU EE Participation, Customer Size, IOU, and Building Type	Disaggregated the analysis by IOU EE Participation, Customer Size, IOU, and Building Type

3

CMST Approach and Samples

The CSS/CMST telephone surveys gathered self-reported customer information regarding commercial building type, installed measures, and utility program participation decisions and experience, where relevant.[1] One of the phone survey's primary purposes, however, was to recruit for the CSS and CMST on-site surveys and to inform the on-site verification effort. The telephone surveys helped to refine the sample design for on-site data collection by gathering better information on building types. They also identified those businesses that qualify for CMST on-site data collection due to their self-reported purchase of new Linear Fluorescents, Televisions, and/or air conditioning systems. The telephone survey enabled the surveyor to approach each on-site survey equipped with better information about the establishment's size, measure specifications, baseline information, and dates of installation.

This section briefly discusses the on-site sample design for CSS and the recruitment for CMST. The CSS on-site sample design is discussed in more detail in the CSS on-site report. The CSS phone survey sample design is discussed in more detail in the CSS on-site report.

3.1 Sample Design

The development of the CSS on-site sample design followed an approach similar to the telephone survey sample design. Specifically, the design was based equally on the number of sites and the usage of sites. The sample design for the CMST on-site survey was dependent on the telephone survey sites that reported purchasing high priority measures.

3.1.1 CSS/CMST Telephone Survey Sample Design

The goal of the telephone survey sample design was to develop a representative sample of the non-residential population. The primary objective of the telephone survey was to help develop an on-site sample that provides the desired level of statistical precision for estimating a wide range of commercial customer characteristics. Given that the primary purpose of the telephone

[1] The sample design and findings for the CSS/CMST telephone survey are available in the telephone survey report, Commercial Saturation and Commercial Market Share Tracking Study Telephone Survey Findings, Sept. 2013.

survey is to recruit for the on-site surveys, the final telephone survey sample design was adjusted during the survey process to successfully fulfill this objective.

The telephone survey sample design incorporates 14 business types: colleges and universities, food and liquor stores, non-hospital health care, hospitals, hotels and motels, industrial, miscellaneous, offices, property managers, restaurants, retail, K-12 schools, warehouses, and unclassified and undefined.[2] The business type strata were further disaggregated by the three electric IOUs and five usage strata (very small, small, medium, large, and unknown)[3] to produce 210 unique strata. The telephone survey quota was originally developed based equally upon the usage and number of unique sites. In other words, two separate quotas were calculated by strata based first, on kWh, and then by counts. These two quotas were then averaged for each stratum. The sample design was also dependent upon ensuring that there were an adequate number of sites, but not too many, for each IOU/business type combination and the design allocated a target number of sites by IOU. Over time, some strata were oversampled in order to achieve sufficient survey recruits for the on-site survey in those strata. As additional sites were needed to ensure adequate on-site strata, the quota for the telephone survey was simply increased. The CMST/CSS telephone survey resulted in 7,890 completed surveys in CMST eligible businesses.

3.1.2 CMST On-Site Sample Design

The CMST research plan called for on-site data collection at 300 sites that have recently purchased Linear Fluorescents, 300 sites that have recently purchased TVs, and 200 sites that have recently purchased small HVAC systems. The number of on-site data collection points was chosen based on the number of sites needed for 90/10 within a random sample (270 sample points) and the likely ability to collect data on recent purchases. Given that the turnover of HVAC measures is significantly lower than TVs and Linear technologies, the data collection plan called for fewer sites that had recently purchased HVAC units. Given the dependence on self-reports for these new equipment purchases, there was no specific sample design based on building type, IOU, or customer size.

The CMST study completed 568 Linear Fluorescent sites, 485 TV sites, and 197 HVAC sites. The number of Linear and TV sites exceeded the quota, while the HVAC sites are only slightly short of the quota. The CMST completes are a combination of non-residential customers who accurately self-reported that they had purchased new Linear technologies, TVs, or small packaged HVAC and customers who were found during the CSS on-sites to have purchased high priority equipment from since January 2009. The study was able to efficiently exceeds the

[2] Unclassified and undefined buildings represent records in the CIS that the IOUs have classified using an unclassified or undefined building type or records with no NAICS code.

[3] The unknown usage category represents accounts found in the CIS that do not have a matching record in the billing data.

desired data collection for Linear Fluorescents and TVs due to the joint implementation of the CSS and CMST studies.

3.1.3 CMST Lighting and HVAC Contractor Sample Design

The CMST study included telephone surveys with lighting and HVAC contractors. The research team attempt to achieve 125 completed surveys from both lighting and HVAC contractors, distributed by contractor size and the geographic location of the contractor. The CMST study completed 95 surveys with lighting contractors and 123 surveys with HVAC contractors. The contractors were questioned about the efficiency distribution of their sales and installations of linear technologies and small packaged air conditioning units during the time period 2011-2012.

Discussions of the contractor sample frame, design, and completed survey distribution are available in the lighting and HVAC contractor sections.

3.1.4 CSS Sample Design

The sample design for the CSS on-site survey effort was developed from the telephone survey completes using the following methodology:

- The number of telephone survey completes by strata,
- The annual usage of those telephone survey completes,
- A desired number of completes per utility, and
- A minimum and maximum number of completes per utility and business type combination.

The methodology was very similar to the approach used as part of the telephone survey sample design. This process worked to ensure that each stratum was represented by a minimum number of on-site surveys and that the more populous strata did not overwhelm the smaller strata. The CSS on-site sample design and completes are presented in more detail in the Commercial Saturation Survey report.

3.2 CMST Telephone Survey

The telephone survey included questions asking businesses if they had recently purchased new linear fluorescents, new televisions, and/or new small HVAC units. The respondents self-reported their recent purchases (since 2009) to the best of their ability. Table 3-1 lists the number and share of telephone survey respondents that self-reported purchasing a CMST measure from 2009 to 2012. Sites that reported a recent purchase were recruited for the on-site data collection effort.

Table 3-1: CMST Telephone Survey Shares by Business Type and Measure[4]

Business Type	Phone Survey	CMST Phone Survey	Share of Phone CMST	CMST Phone Linears	CMST Phone TVs	CMST Phone HVAC
College	29	20	69%	9	9	9
Food/Liquor	486	164	34%	64	82	46
Health/ Medical - Clinic	633	285	45%	99	195	81
Health/ Medical - Hospital	59	37	63%	17	34	13
Hotel	199	144	72%	36	131	25
Industrial	695	327	47%	194	126	114
Miscellaneous	1,637	651	40%	257	387	222
Office	1,314	510	39%	220	262	204
Restaurant	595	254	43%	66	181	52
Retail	1,019	347	34%	149	200	99
School	479	258	54%	134	112	118
Warehouse	745	293	39%	154	147	82
Total	**7,890**	**3,290**	**42%**	**1,399**	**1,866**	**1,065**

The data in Table 3-1 indicate that 3,290 or 42% of telephone survey completes self-reported purchasing at least one of the three CMST measures. Hotels, Colleges, and Hospitals, were the business types more likely to self-report new purchases at 72%, 69%, and 63%, respectively. Only 34% of food and liquor and retail stores self-reported a new purchase of Linear technologies, Televisions, or HVAC. Of the 3,290 sites that self-reported a new purchase, 43% of sites purchased new linear technologies, 57% purchased new televisions, and 32% new HVAC units.[5] Many of the sites that self-report purchasing a high priority measure report purchasing more than one type of high priority measure. Of the 3,290 sites that self-reported a new purchase, 14% reported purchasing both TVs and Linear technologies, 12% reported new purchases of TVs and HVAC equipment, 10% stated that they had recently purchased Linear and HVAC equipment, and 4% of purchasers reported purchasing all three technologies during 2009-2012. The CMST telephone survey data is analyzed in more detail in the end use specific sections of the report.[6]

[4] These data are not weighted. They represent the count of sites responding to the telephone survey as CMST eligible by business type.

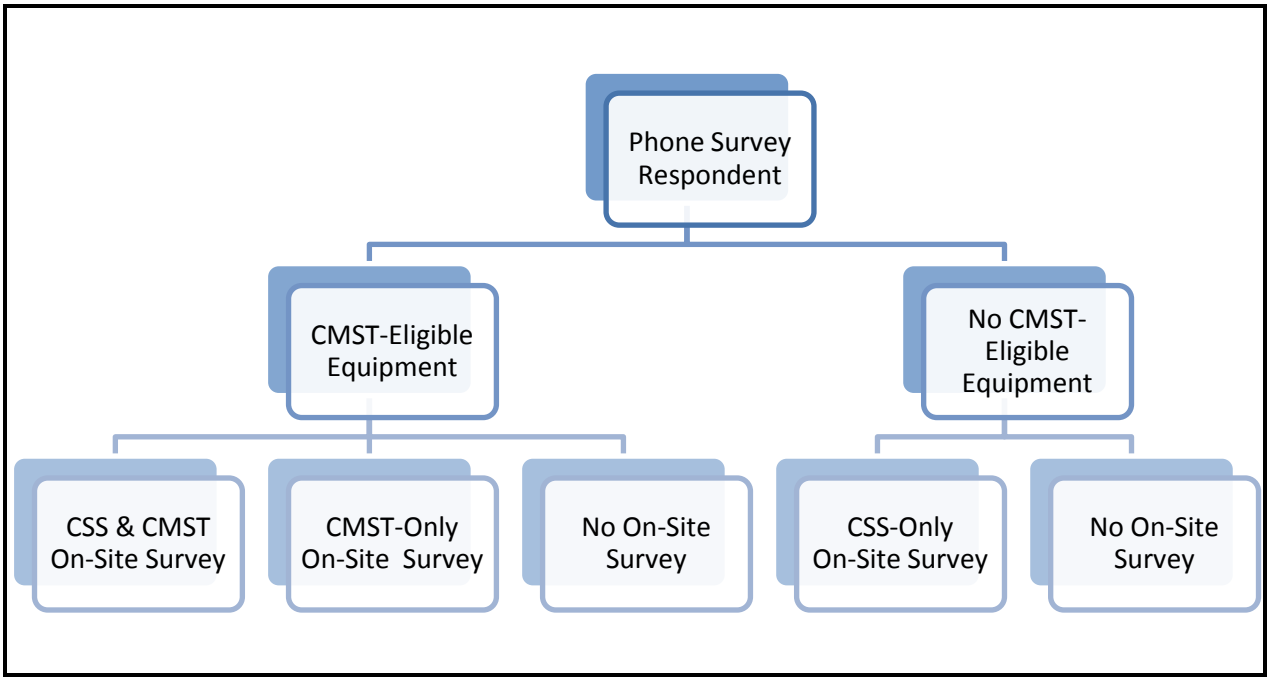
[5] The share of sites self-reporting the purchase of new HVAC equipment is substantially higher than what was found on-site due to the very specific specifications of the HVAC equipment analyzed for the CMST study.

[6] The end use specific sections will discuss that many of the self-reported recent purchases were found to be incorrect during the on-site verification and that many sites that self-reported not purchasing new equipment were found to have made recent qualifying purchases.

3.3 On-Site Recruitment

The last set of questions in the phone survey involved the on-site recruitment battery. The respondent confirmed that he or she is the one most knowledgeable about the energy usage at their facility and the battery helped determine whether or not CMST-eligible equipment had been purchased and installed at the facility. The respondent was first asked if they were willing to participate in a full CSS on-site survey regardless of whether they had installed CMST-eligible equipment or not.[7] The CSS survey collected information on both CMST-eligible and non-CMST-eligible equipment. If the respondent refused and they continued to decline an on-site despite being offered a small incentive gift card, they were then asked to participate in the CMST on-site data collection effort (as long as they confirmed that they had recently installed CSMT-eligible equipment). If the site identified itself as a Hospital, College or University, Hotel, or Industrial site during the telephone survey, they were not eligible for the CSS survey. If the respondent stated that they had recently purchased Linear Fluorescents, TVs, or small packaged HVAC units, they were recruited to participate in the CMST on-site. Figure 3-1 shows a visual representation of the phone survey recruitment options for respondents.

Figure 3-1: Phone Survey Recruitment Options



[7] Hospitals, Colleges and Universities, Hotels, and Industrial sites were not recruited for the CSS survey. These types of sites were not eligible for the CSS survey and were skipped directly to the CMST recruit script if they had self-reported during the telephone survey that they recently purchased one of the three types of measures in the CMST analysis.

Figure 3-2 shows the total number of on-site survey recruits, along with the type of each recruit. The figure below illustrates that the study recruited a total of 2,648 sites for on-site data collection. Of these 2,648 sites, 2,456 sites agreed to participate in a CSS on-site survey and 1,234 sites self-reported a recent purchase of a high priority measure and agreed to participate in a CMST on-site survey. Of the 2,456 sites recruited for the CSS data collection study, 1,042 sites agreed to both the CSS and the CMST data collection, while 1,414 sites self-reported that they had not purchased any of the three high priority measures and would only participate in the CSS on-site survey.[8]

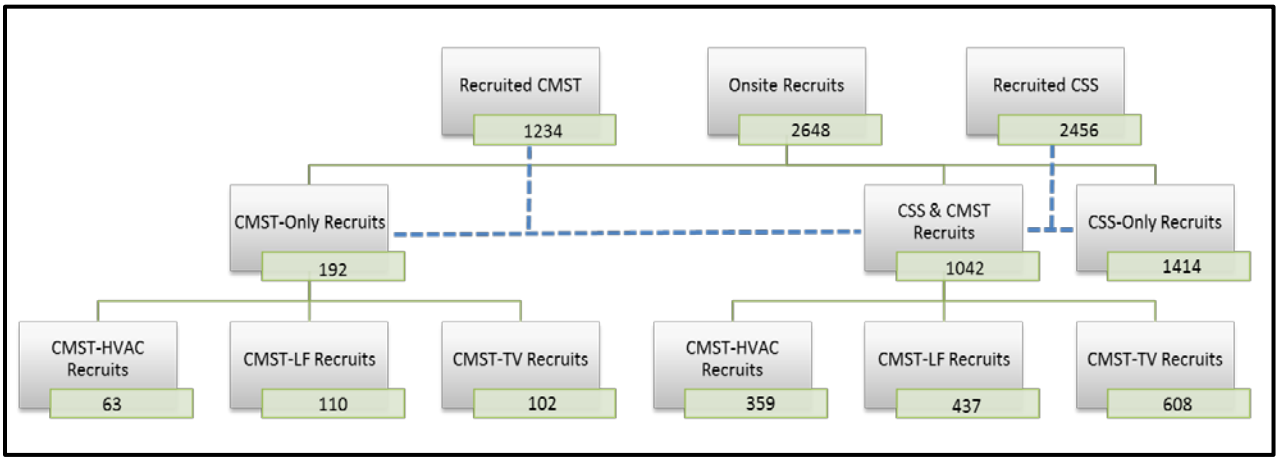
Of the 1,234 CMST on-site recruits, 1,042 sites agreed to participate in both the CSS and the CMST data collection effort, while 192 agreed to only the CMST on-site verification.[9] The 1,234 recruited CMST on-site businesses often stated that they had installed more than one CMST measure. For the 192 sites agreeing to a CMST on-site verification, 33% report installing new air conditioning, 57% self-reported installing linear technologies, and 53% reported new televisions. For the 1,042 sites recruited for both the CSS and CMST on-site data collection effort 34% self-reported installing new air conditioners, 42% stated that they installed linear technologies and 58% reported purchasing new televisions since January 2009[10]. The verification of these technologies and the collection of information necessary to determine the efficiency of recent purchases is the objective of the CMST on-site data collection effort. The strata specific distribution of CMST recruited sites, on-site CMST surveys, and sites where CMST verified measures were found is presented in Appendix E.

[8] Sites that participated in the CSS data collection effort were questioned about recent purchases while the surveyor was on-site. If the site contact stated that they had recently purchased a high priority measure during the on-site interview, the CMST data was collected while on-site.

[9] The 192 sites that agreed to a CMST only on-site survey are a combination of sites that were not eligible for the CSS on-site surveys (business types = Hospital, College or University, Hotel, or Industrial) and sites that had opted to only participate in the shorter CMST on-site survey.

[10] CMST recruits often reported installing more than one type of CMST-eligible measure.

Figure 3-2: Recruited CSS and CMST Sites



3.4 Site Characteristics and Business Hours

Site characteristics collected during the telephone survey were used for planning purposes by the on-site surveyors. This information included size of the site (square footage and number of buildings), electrical usage, hours of operation, on-site contact information and any notes or directions needed for the site. In the event of a site having multiple meters, the address associated with the meter was also listed. This information helped the surveyor determine whether the site consisted of multiple addresses (or suites) or was located at a single address. This information was crucial to review beforehand because it helped to estimate schedules and how long a site would take to survey. It also provided the surveyor with an opportunity to gather extra information from the site contact prior to the on-site.

3.5 On-Site Measure Specifications

The information collected on-site contributed to two different, but overlapping research efforts: the CSS and CMST studies. The CMST survey collected information on recent purchases of Linear technologies, TVs, and small HVAC systems within the non-residential sector. The data collected for the CMST has been used by the CSS, except in situations where the CMST participant did not agree to the longer CSS survey or if the site was not in a business type included in the CSS study.[11] The CSS survey collected more extensive site and measure information not included in the CMST.

[11] The CMST is a survey of the non-residential sector. It includes all non-residential segments other than TCU, agriculture, mining, and street lighting. The business types included in the CSS are more restrictive than the CMST. The CSS also does not include colleges and universities, hotels, hospitals, and industrial sites due to budget limitations and the belief that these business types may be more efficiently and effectively surveyed with a more focused effort.

3.5.1 CMST Equipment

When identifying the measures to incorporate into the CMST study, Itron reached out to other evaluation leads from the 2010-2012 Evaluation Studies – the CPUC, DEER Team, and IOUs. The study team requested that these groups provide a prioritized list of their information needs to help the study team choose the measures to be included in the CMST. The criteria for inclusion were measures with significant program activity or recent code changes, those whose sales are sufficient to justify a market share study, those associated with the Strategic Plan or Market Transformation Indices, and measures whose sales distribution were important, but uncertain. The information needs process helped to determine that the highest priority CMST needs include the following:

1) The distribution of Linear Fluorescents purchased;
2) The total number of TVs purchased by commercial businesses, the base and high efficiency share, and additional TV options; and
3) The share of base and high efficiency small commercial packaged air conditioning units purchased.

Linear Fluorescent technologies were chosen because these technologies have been the focus of the IOU commercial rebate programs for an extended period and these measures are being impacted by federal lighting standard updates. In addition, the indoor lighting end use is the largest consumer of energy within the commercial sector, consuming 30% of the sector's electricity usage.[12]

TVs were included in the CMST due to the uncertainty surrounding this measure. Anecdotal evidence indicates that the saturation of TVs in the non-residential sector is growing, but there have been few studies to quantify the saturation of TVs. There is also no current understanding of the efficiency level of TVs purchased for the commercial sector. The CMST provides information on the growth of TVs in the commercial sector and on the efficiency distribution of recently purchased TVs.

HVAC technologies were included in the CMST to provide more information on a measure that plays an important role in the Energy Efficiency Strategic Plan. The cooling end use is the second largest consumer of energy within the commercial sector, consuming 15% of the sector's electricity usage.[13] More importantly, cooling equipment is a major contributor to the

[12] The lighting share of total annual consumption is from the California Commercial End Use Study (CA CEUS, 2006). The CA CEUS Project Final Report was completed on behalf of the California Energy Commission. Report # CEC-400-2006-005. CA CEUS is also available at: http://capabilities.itron.com/CACEUSWeb/Default.aspx

[13] The HVAC share of total annual consumption is from the CA CEUS, 2006.

commercial sector's peak demand. The CMST provides information on the current purchasing distribution for this important end use.

Linear Fluorescents

Many advances in Linear Fluorescent lighting technology have taken place over the last 10-15 years. Technology advances have been paired with policy changes limiting older, inefficient technologies from being manufactured. The data collected during the CMST survey is used to estimate the number and efficiency distribution of Linear Fluorescent purchases from 2009 to 2012. These data are also used to describe any differences in the efficiency distribution for sites participating in IOU Linear Fluorescent rebate programs and non-participating sites.

CMST Linear Fluorescent sites were recruited to participate in the on-site survey during the telephone survey. During the on-site data collection, some of the self-reported recent purchasers were found to have not purchased new Linear Fluorescents since January 2009.[14] In addition, some of the CSS sites claimed to have not purchased Linear Fluorescents during the telephone survey, but new Linear Fluorescents were discovered during the on-site survey. Of the 547 CMST Linear sites recruited for on-site surveys, 345 were visited. During the on-site surveys, 266 sites had new Linear Fluorescents and 79 were in-eligible for the Linear CMST study. During the CSS on-site data collection efforts, 302 sites that did not self-report purchasing new Linear Fluorescents during the telephone survey were found to have CMST-eligible linear fluorescents on-site. Of the 568 CMST-Linear on-site surveys completed, 266 sites self-reported purchasing CMST Linear measures during the telephone survey and 302 sites did not self-report purchasing new Linear Fluorescents during the telephone survey. Appendix E provides information on the distribution of CMST Linear sites by the CSS on-site strata. See Section 4 for a full description of the CMST end user Linear on-site sample and findings. Section 5 describes the findings from the contractor survey and Section 6 compares and contrasts the end users and contractor findings.

Televisions

New advances in TV technology have boosted their efficiency. During the same period, anecdotal evidence indicates that the number of TVs in the non-residential sector may have risen dramatically. Data collected for CMST TVs will show trends in the number and efficiency distribution of recently purchased TVs. The data will also be used to estimate the share of recent purchases that are replacing old TVs and those that represent additional loads.

[14] The majority of the on-site CMST equipment was purchased from 2009-2012. Limited surveys were also undertaken in 2013 leading to a few sites with new purchases from 2013. The 2013 recent purchases are characterized with the 2012 purchases.

CMST TV sites were recruited to participate in the on-site survey based upon their self-reported recent purchase of a TV during the telephone survey. During the on-site data collection, some of the self-reported recent purchasers were found to have not purchased new TVs and in some cases, the opposite was true. Of the 710 CMST TV sites recruited for on-site surveys, 419 were visited. During the on-site surveys, 344 sites had new TVs and 75 were found ineligible for the CMST TV study. During the CSS on-site data collection efforts, 141 sites that did not self-report purchasing new TVs during the telephone survey were found to have CMST -TVs during the on-site visit. Of the 485 CMST-TV on-site surveys completed, 344 sites self-reported purchasing CMST TV measures during the telephone survey and 141 sites did not self-report purchasing new TVs during the telephone survey. Appendix E provides information on the distribution of CMST TV sites by the CSS on-site strata. See Section 7 for a full description of the CMST TV on-site sample and findings.

HVAC

The CMST HVAC on-site survey collected information on the efficiency distribution of small single zoned HVAC systems. The HVAC systems that are CMST-eligible include the following:

- Split- and packaged-single zone HVAC systems with DX cooling, less than or equal to 65,000 Btuh, and
- Packaged-single zone systems with evaporative cooling, less than or equal to 65,000 Btuh.

Using the data collected on-site, the study developed an estimate of the number of small packaged HVAC units installed from 2009 to 2012 and the efficiency distribution of these recent purchases. The CMST HVAC study also determined if the efficiency distribution of recent IOU HVAC program participants differed from the efficiency distribution of non-participants.

CMST HVAC sites were recruited to participate in the on-site survey based upon their self-reported recent purchase of a HVAC unit during the telephone survey. Given the very specific requirements for participation in a CMST HVAC on-site survey, many of the telephone survey self-reported recent purchasers did not qualify for the CMST HVAC study. In addition, some CSS sites claimed to have not recently purchased HVAC units during the phone survey, but new units were found during the on-site visit. Of the 422 CMST HVAC sites recruited for on-site surveys, 243 were visited. During the on-site surveys, new HVAC systems were found at 119 sites and 124 sites were found to be in-eligible for the CMST HVAC study. During the CSS on-site data collection efforts, 78 sites that did not self-report purchasing new HVACs during the telephone survey were found to have CMST-eligible HVAC systems on-site. Of the 197 CMST-HVAC on-site surveys completed, 119 sites self-reported purchasing CMST HVAC measures during the telephone survey and 78 sites did not self-report purchasing new HVACs during the telephone survey. Appendix E provides information on the distribution of CMST HVAC sites

by the CSS on-site strata. See Section 8 for a full description of the CMST HVAC end user on-site sample and findings. Section 9 describes the findings from the contractor survey and Section 10 compares and contrasts the end users and contractor findings.

3.5.2 Non-CMST Equipment

The CMST-only on-site data collection was predominantly associated with the three high priority measures. However, basic information regarding building shell, insulation and building vintage were also collected. All lighting technologies were surveyed in order to estimate lighting power densities. HVAC, Linear Fluorescent, and TV information were collected for both CMST-eligible and non-CMST-eligible equipment. Equipment densities were created for each site and meter information was collected to ensure the site has been aggregated correctly.[15]

3.6 On-Site Weighting Methodology

This section describes the development of weights that were applied to each sample point from the CMST on-site surveys. The on-site survey findings presented in this report were aggregated to the frame using site weights though kWh weights were also developed.[16] The weights were developed to be CMST measure specific and were designed to weight up sites to the number of sites purchasing measures in the frame. A given CMST participant may have purchased more than one type of CMST eligible measure. Sites have a unique CMST site and kWh weight for each measure type that was purchased.

This section discusses how on-site observations were weighted in the CMST end user analysis to develop population estimates for various findings in this report. Separate analysis weights are developed for each type of high priority measure being reported (e.g., Linear Fluorescents, TVs, and HVAC). The on-site sample was drawn from the telephone survey sample. Phone survey respondents were classified at the highest level as reporting to have either installed a given piece of equipment or not. For example, if we are estimating the share of High Efficiency Linear Fluorescents, phone respondents were initially categorized as having recently installed Linear Fluorescents or not, based on their phone survey response. The on-site sample was pulled such that phone respondents were oversampled if they responded positively about installing a relevant piece of equipment. Therefore, the analysis needed to weight the on-site sample according to weather or not they reported positively or not about installing a particular high priority measure

[15] Meter number information was not collected for CMST-only sites.

[16] Data provided to the CPUC and the IOUs will include the kWh weights. The CSS/CMST web site provides information on both site and kWh weighted distributions.

(i.e., responded yes or no to recently installing linear fluorescents, when the share of high efficiency linear fluorescents was being estimated).[17]

The on-site sample was also stratified and weighted in a way to most accurately represent the population in order to reduce any potential response bias. Key parameters that are known for the population, that are believed to potentially have some correlation to the values being measured, are IOU, building type, and customer size. In addition, the sample was also stratified by whether or not a customer had recently participated in an energy efficiency program (EE participants). Clearly, someone that had recently participated in a program would have a significantly greater likelihood of installing higher efficiency equipment (particularly, linear fluorescents since many of customers installed linear fluorescents under the program). Although the sample was selected randomly within the yes/no installation category discussed above, and within IOU, building type and size, we found that past EE participants were much more likely to be willing to respond to the phone survey and willing to have an on-site visit. Therefore, it was very important to stratify the sample by EE participation to make sure that EE participants were not over-represented in the final results.

To summarize, the on-site sample was stratified by the yes/no measure installation classification (where the yes/no measure installation corresponded to the phone survey responses to the particular type of high priority measure being estimated), IOU, building type, size and EE participation. Using a combination of CIS data (for IOU, building type and size), program tracking data (EE participation) and the phone survey (yes/no classification), population values were estimated for the number of sites and the amount of annual kWh consumption in every segment. Furthermore, every on-site participant was also classified into one of these various segments. By doing so, weights were developed so that the on-site sample represented the population with respect to both the number of sites and annual kWh consumption.

The site weight for an individual 'j' in yes/no classification 'C,' IOU 'I,' building type 'B,' size 'S,' and EE participation 'E' is:

$$\text{Onsite\_SiteWeight}_{C,I,B,S,E,j} = \frac{numSitePop_{C,I,B,S,E}}{numSiteOS_{C,I,B,S,E}} \quad (1)$$

Where:

$numSitePop_{C,I,B,S,E}$ is the total number of sites in the population that fall into yes/no classification 'C,' IOU 'I,' building type 'B,' size 'S,' and EE participation 'E;'

[17] A business can report installing multiple types of high priority measures. The yes/no stratification by measure installation are measure type specific. If a business installed multiple types of measures, their weights will be measure type specific.

$numSiteOS_{C,I,B,S,E}$ is the total number of on-sites conducted that fall into yes/no classification 'C,' IOU 'I,' building type 'B,' size 'S,' and EE participation 'E.'

Note that every on-site within a stratum gets the same site weight. However, the kWh weights differ within a segment and are proportional to the customer's annual kWh consumption. The kWh weight for an individual 'j' in yes/no classification 'C,' IOU 'I,' building type 'B,' size 'S,' and EE participation 'E' is:

$$\text{Onsite\_kWhWeight}_{C,I,B,S,E,j} = \frac{kWh_j \times kWhPop_{C,I,B,S,E}}{kWhOS_{C,I,B,S,E}} \quad (2)$$

Where:

kWh_j is the total annual kWh for on-site customer 'j;'

$kWhPop_{C,I,B,S,E}$ is the total annual kWh for all sites in the population that fall into yes/no classification 'C,' IOU 'I,' building type 'B,' size 'S,' and EE participation 'E;'

$kWhOS_{C,I,B,S,E}$ is the total annual kWh for all on-sites conducted that fall into yes/no classification 'C,' IOU 'I,' building type 'B,' size 'S,' and EE participation 'E.'

As mentioned above, the number of sites and annual kWh for a given segment are determined using a variety of data source including CIS data (for IOU, building type and size), program tracking data (EE participation) and the phone survey (yes/no classification). The number of sites and kWh consumption can be directly calculated for the population for IOU, building type, size, and EE participation as these values are known for the entire population. However, the yes/no classification are only known for the phone survey population. Therefore, to estimate the number of sites or kWh consumption at the IOU, building type, size, EE participation and yes/no classification level, we first needed to calculate the population value for sites or kWh consumption at the IOU, building type, size, and EE participation level and then allocate this to the yes/no classification level based on the proportion found from the phone survey.

More specifically, the number of sites in the population that fall into yes/no classification 'C,' IOU 'I,' building type 'B,' size 'S,' and EE participation 'E' is:

$$numSitePop_{C,I,B,S,E} = SitePCT_{C,I,B,S,E} \times numSitePop_{I,B,S,E} \quad (3)$$

Where:

$numSitePop_{I,B,S,E}$ is the total number of sites in the population that fall into IOU 'I,' building type 'B,' size 'S,' and EE participation 'E;'

$SitePCT_{C,I,B,S,E}$ is the percent of the phone survey respondents in segment IOU 'I,' building type 'B,' size 'S,' and EE participation 'E' that gave response 'C.'

Similarly, the total annual kWh consumption in the population that fall into yes/no classification 'C,' IOU 'I,' building type 'B,' size 'S,' and EE participation 'E' is:

$$kWhPop_{C,I,B,S,E} = kWhPCT_{C,I,B,S,E} \times kWhPop_{I,B,S,E} \quad (4)$$

Where:

$kWhPop_{I,B,S,E}$ is the total annual kWh consumption in the population that fall into IOU 'I,' building type 'B,' size 'S,' and EE participation 'E;'

$kWhPCT_{C,I,B,S,E}$ is the percent of annual kWh consumption for phone survey respondents within segment IOU 'I,' building type 'B,' size 'S,' and EE participation 'E' that gave response 'C.'

This weighting methodology accounts for any potential EE bias or the fact that energy efficiency participants are more likely to both respond to the telephone survey and allow for an on-site survey. The weighting also accounts for the over sampling of sites that self-report the recent purchase of high priority measures. The over sampling of these sites was necessary to achieve sufficient number of sites purchasing new equipment. The weighting also accounts for potential differences by IOU, building type and size.

4

CMST End User Linear Fluorescent Analysis

Linear Fluorescent lighting technology is one of the three measures chosen for the CMST analysis. Over the last several years there have been both improvements in efficiency in their design as well as changes in standards. Older magnetic ballasts and inefficient T12 technologies are being phased out and, shortly, the manufacturing of older Standard 700-Series T8 lamps will be phased out as well. Through the collection of telephone and on-site inventory information describing recent purchases of Linear Fluorescents, this study documents the purchasing behavior of California businesses during 2009-2012. The CMST analysis examines the purchasing behavior by year, IOU, business size, and business type. The results are also presented comparing energy efficiency program participants to non-participants, as well as how new construction or remodel installations compare with retrofits. These variables help to illustrate the Linear Fluorescent market in ways that are of interest to program planners and regulators; how is the energy efficiency classification of Linear Fluorescent purchases changing for energy efficiency program participants and non-participants as standards and energy efficiency programs are changing?

The CMST end users Linear Fluorescent analysis uses data from several data sources. The four primary sources of information are telephone surveys, on-site surveys, make and model lookups to determine efficiency levels, and energy efficiency participation information. The following sections describe and analyze the data that was collected as part of the CMST end users Linear Fluorescent analysis.[1]

4.1 Sources of Data

Information on recent purchases of Linear Fluorescents (2009-2013)[2] was collected during the telephone and on-site surveys. During the telephone survey, sites were asked if they have purchased any new lighting since January 2009. If the site purchased lighting, they were asked

[1] The data presented below is for 4-ft Linear Fluorescents. Installations of 4-ft Linear Fluorescents represent over 90% of the newly installed Linear technologies observed during the on-site verifications.

[2] A limited number of the on-site surveys occurred during 2013. Some installations of Linear technologies during 2013 were recorded during these surveys. Due to the small number of sites reporting the installation of new Linear measures during 2013, these installations have been included in the 2012 numbers. These data can be separated upon request, but the small number of sites surveyed in 2013 implies that the 2013 installations are not representative of installations for the entire 2013 period.

to list the types of lighting purchased. Using these data, sites purchasing Linear Fluorescents were identified and the self-reported type of Linear Fluorescent was used to determine the efficiency distribution of Linear purchases reported during the telephone survey. Those sites that self-reported that they had purchased new Linear Fluorescents were recruited to participate in on-sites surveys to collect additional verification information.

The CMST-Linear Fluorescent on-site visits targeted facilities that claimed during the telephone survey to have purchased and installed new Linear Fluorescent measures since 2009. During the on-site survey, data were collected on the year the technologies were purchased, the number of new Linear Fluorescents at the site, and the make and model number of these new technologies. Looking up the make and model number information, the research team determined the type and efficiency level of the technology.

Additional CMST-Linear Fluorescent sites were also developed from the CSS on-site surveys. While on site at a CSS site, a full inventory of all Linear Fluorescent fixtures was performed, including the collection of make and model number information. Site contacts were also questioned about the vintage of the technologies. If a surveyor found Linear Fluorescent technologies at a CSS site that met the criteria for CMST (installed since 2009), these technologies were CMST eligible and the site became a CSS-CMST site.

Following the collection of on-site information, the make and model numbers were researched to determine the efficiency of the new Linear Fluorescents. The telephone survey and on-site data were also merged with the energy efficiency program tracking data to determine the distribution of purchases for energy efficiency program participants and non-participants.

4.1.1 Phone Survey

A total of 7,890 phone surveys with CMST-eligible businesses were completed from November 17, 2011 to May 9, 2013. The phone surveys questioned the respondent to determine if the facility had purchased and installed Linear Fluorescent lighting since 2009 and, if they had, what type of equipment was installed and the type of equipment replaced. If the contact was not able to provide information regarding the kind of lighting installed, they were asked to describe it (i.e., skinny/thin tubes, fat/thick tubes). Of the 7,890 telephone survey respondents, 1,399 reported purchasing new Linear Fluorescents, or approximately 18% of telephone survey respondents. The 1,399 sites that reported purchasing Linear Fluorescents were asked to participate in the on-site data collection effort; 547 or 39% of these sites agreed to participate. Table 4-1 provides the distribution by business type of the telephone survey sites reporting new Linear purchases.

Table 4-1: CMST Telephone Survey Linear Fluorescent Distribution by Business Type

Business type	Phone Survey Completes	CMST Phone Survey Linear Sites	% Self-Reported (Overall)	Recruited CMST-Linear Sites	Share of CMST-Linear Recruits
College	29	9	69%	2	22%
Food/Liquor	486	64	34%	32	50%
Health/Medical - Clinic	633	99	45%	44	44%
Health/Medical - Hospital	59	17	63%	7	41%
Hotel	199	36	72%	7	19%
Industrial	695	194	47%	45	23%
Miscellaneous	1,637	257	40%	112	44%
Office	1,314	220	39%	84	38%
Restaurant	595	66	43%	37	56%
Retail	1,019	149	34%	51	34%
School	479	134	54%	72	54%
Warehouse	745	154	39%	54	35%
Total	**7,890**	**1,399**	**42%**	**547**	**39%**

4.1.2 On-Site Data

The on-site data are derived from a combination of businesses identified from the phone survey as CMST-only sites, CSS-CMST sites, and CSS-only sites. The CMST-only sites were those that claimed to have purchased and installed new Linear Fluorescent lighting throughout their facility, but were ineligible for the CSS survey or would not consent to having a full CSS on-site survey performed.[3] Similarly, CSS-CMST sites were those that claimed to have purchased and installed new Linear Fluorescent lighting throughout their facility, but would allow the full CSS on-site survey to be performed at their facility. The last set, CSS-only sites, are those that claimed to have not purchased or installed any new CMST-eligible Linear Fluorescents at their facility, but during the full CSS on-site visit, new CMST-eligible measures were found to have been installed.

During the telephone survey, 547 sites that were identified as CMST-eligible Linear Fluorescent sites agreed to participate in the on-site data collection effort. The survey team undertook 345 on-site surveys at these 547 sites, of which 266 or 77% were found to have new Linear Fluorescents (see Table 4-2). When visiting CSS sites that had stated during the telephone survey that they had not purchased new Linear Fluorescents, 302 sites were found to have

[3] Colleges, Universities, Hotels, Hospitals, and Industrial businesses were not eligible for the CSS survey. To try to ensure coverage and representativeness of the CMST results across the non-residential sector, these segments were included in the CMST on-site survey.

CMST-eligible Linear Fluorescents. On-site surveys, therefore, have been completed for 568 CMST-eligible Linear Fluorescent sites. See Appendix E for the distribution of CMST Linear recruit and on-site businesses by CSS strata.

Table 4-2: CMST-Linear Fluorescent On-Site Distribution by Business Type

Business type	Recruited CMST-Linear Sites	PS CMST-Linear On-Sites Completed	PS CMST-Linear Recruits & OS Linears Found	Share of PS CMST-Linear Sites Found Linears OS	Sites with New Linears (Linears not ID'd on PS)	Total Sites with New Linears
College	2	1	1	100%	0	1
Food/Liquor	32	23	19	83%	28	47
Health/Medical - Clinic	44	29	19	66%	22	41
Health/Medical - Hospital	7	3	3	100%	0	3
Hotel	7	2	2	100%	0	2
Industrial	45	25	24	96%	0	24
Miscellaneous	112	68	48	71%	53	101
Office	84	50	39	78%	50	89
Restaurant	37	21	17	81%	32	49
Retail	51	34	26	76%	56	82
School	72	48	39	81%	31	70
Warehouse	54	41	29	71%	30	59
Total	**547**	**345**	**266**	**77%**	**302**	**568**

4.1.3 Make and Model Lookups

Make and model lookups develop crucial secondary information needed to classify the efficiency level of Linear Fluorescent measures.[4] The on-site form allows for the collection of make, model, size specifications, and wattage information from the bulbs and ballasts. Additional information needed for a thorough analysis includes lumens, rated life, and light color. However, these are details that cannot be collected on site. Lookup tables were developed using the data collected on-site to determine the efficiency level of the new Linear Fluorescents. The lookups also provided information on lumens, rated life, and light color.

Linear Fluorescent data were collected for 98% of sites. Information was recorded for approximately 94% of the fixtures during the onsite visits. The final step of the make and model lookups is allocating the Linear Fluorescents to one of seven performance groups in order of

[4] 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.

highest to lowest efficiency. These technologies were also classified as being either High or Base Efficiency.

- 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, these lamps were found to have a wattage range of 28 to 54 watts. More than 90% of the T5s were 54 watt lamps.
  - Reduced Wattage T8: Reduced wattage T8s as classified by the Consortium for Energy Efficiency (CEE). Using the CEE information to classify the newly purchased lamps found on-site, Reduced Wattage T8s were found based on make and model lookups to have a wattage range from 25-28 watts, with a median of 28, and a mean lumens range of 2,255 to 2,645 with a median of 2,560.[5]
  - High Performance T8: High performance T8s as classified by the CEE. These are the third generation of T8 bulbs, with an extended life of 4,000 hours over that of the Standard 700- and 800-Series bulbs with CRI (Color Rendering Index) in the 80s. This category of lamps was found to almost always be 32 watt T8s. The lookups also determined the mean lumen range for lamps found on-site to be 2,660 to 3,050 with the median value at 2,935.
- Base Efficiency technologies:
  - Std 800 T8: These are Standard 800-Series T8 bulbs, the second generation of T8 bulbs. These have a CRI in the 80s. Using the make and model lookups to classify the newly purchased lamps found on-site, 800 series T8s were found to largely use 32 watts, have a median mean lumen value of 2,800, and are rated between 87-92 lumens per watt.
  - Std 700 T8: These are Standard 700-Series T8 bulbs, the first generation of T8 bulbs. These bulbs were typically found to be 32W, T8s, with a median mean lumen value of 2,520.
  - T12: These are T12 bulbs, which were phased out of production as of July 2012. According to the make and model lookups, the T12 lamps found on-site have a wattage range of 34 watts to 40 watts.

[5] The make and model look ups produce an initial and mean lumens value for each lamp. The lumens values used in this report represent the mean lumens values.

The CEE-qualified equipment was determined by matching the on-site lighting inventory with the May 2013 Commercial Lighting Qualifying Products Lists from the CEE.[6] The remaining groups were assigned using on-site and lookup data.

4.1.4 IOU Energy Efficiency Program Tracking Data

The IOU energy efficiency program tracking data from 2009-2012 were merged with the non-residential frame. These data were merged by account number to develop a data set with program participation flags that are designed to be specific to the business at a given location.[7] Using these data, it is possible to determine if the site participated in energy efficiency programs and if the sites installed lighting measures that qualify for the Linear Fluorescent high impact measure (HIM)[8] as part of their program participation.[9]

4.2 CMST Telephone Survey

Telephone survey respondents were asked if they installed new lighting measures since 2009. For sites installing new measures, they were asked to describe the type of measures installed and the year of installation. Approximately 18% of the unweighted telephone survey sites reported installing a Linear Fluorescent measure since 2009. Given that the on-site survey found a substantial number of sites that did not report in the telephone survey that they had purchased new Linear Fluorescents, but new Linear Fluorescents were observed on site, it is possible that the share of purchasing businesses in California exceeds 18%.

The in-depth results of the telephone survey analysis have been described separately in the Commercial Saturation and Commercial Market Share Tracking Study Telephone Survey Findings report. The data collected as part of the telephone survey represent the site contact's best understanding of the lighting equipment their business purchased between 2009 and 2012. Attempting to understand the energy efficiency distribution of lighting purchases using self-

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6 http://library.cee1.org/content/commercial-lighting-qualifying-products-lists

7 If the tracking data does not merge by account number to any accounts in the CIS, the tracking data is merged by business name and address and/or address and customer name. Combining the CIS and IOU tracking data is designed to identify the business and location of program participants. If a business with multiple locations participates in an IOU program tracked under one location but installs the measures at multiple locations, the data development undertaken for this Study will not identify the program participation at the location not tracked by the participation data.

8 High Impact Measures are defined as those with over 1% of the claimed savings for the program cycle.

9 The ability to determine that the site installed a high efficiency Linear Fluorescent measure is dependent on the tracking data reporting that a Linear measure was installed. Some, but not all, custom projects may be missed by this approach to identifying Linear Fluorescent participants. Some custom projects simply list the lighting end use in the tracking data and do not list the specific type of lighting measure installed. Analysis of the non-participant data by customer size and lighting but not HIM_LF leads to the belief that the on-site data are not substantially impacted by custom lighting participants that do not identify the type of measure installed.

reported data, however, is hampered by the purchaser's understanding and ability to remember the technologies installed at their business. The following section describes the energy efficiency distribution of Linear Fluorescent technologies found during the on-site data collection effort. The on-site data rely on the site contact's ability to recall the year of installation of the lighting technology. The efficiency distribution, however, is dependent on the make and model lookups of efficiency information, leading to a more accurate picture of the efficiency distribution during this time period.

4.3 CMST On-Site Survey

During the telephone survey, the contact was asked for as much detail as possible about the new fixtures, including a description of the pre-retrofit lamp. However, as seen in Figure 4-1, purchases self-reported during the telephone survey often differed from what the surveyors found on-site. As part of the 7,890 telephone surveys, site contacts were questioned about recent purchases of Linear Fluorescents. From the 7,890 telephone surveys, 1,399 sites reported installing new Linear Fluorescents, while the remaining 82% of sites stated that they had not installed new Linear Fluorescents. Sites were recruited for the CMST-Linear Fluorescent on-site surveys from the group of telephone survey sites stating that they had installed new Linear Fluorescents. As part of the CSS study, CMST-eligible Linear Fluorescents could be found and recorded at sites that stated on the telephone survey that they did not install new Linear Fluorescents.

Table 4-1 and Table 4-2 at the beginning of this section list the distribution of telephone survey sites reporting new Linear Fluorescents, CMST-Linear Fluorescent on-site recruits, the number of sites where Linear Fluorescents were found on site, and the distribution of these sites between CMST telephone survey-identified sites and those found at previously unidentified CSS sites.

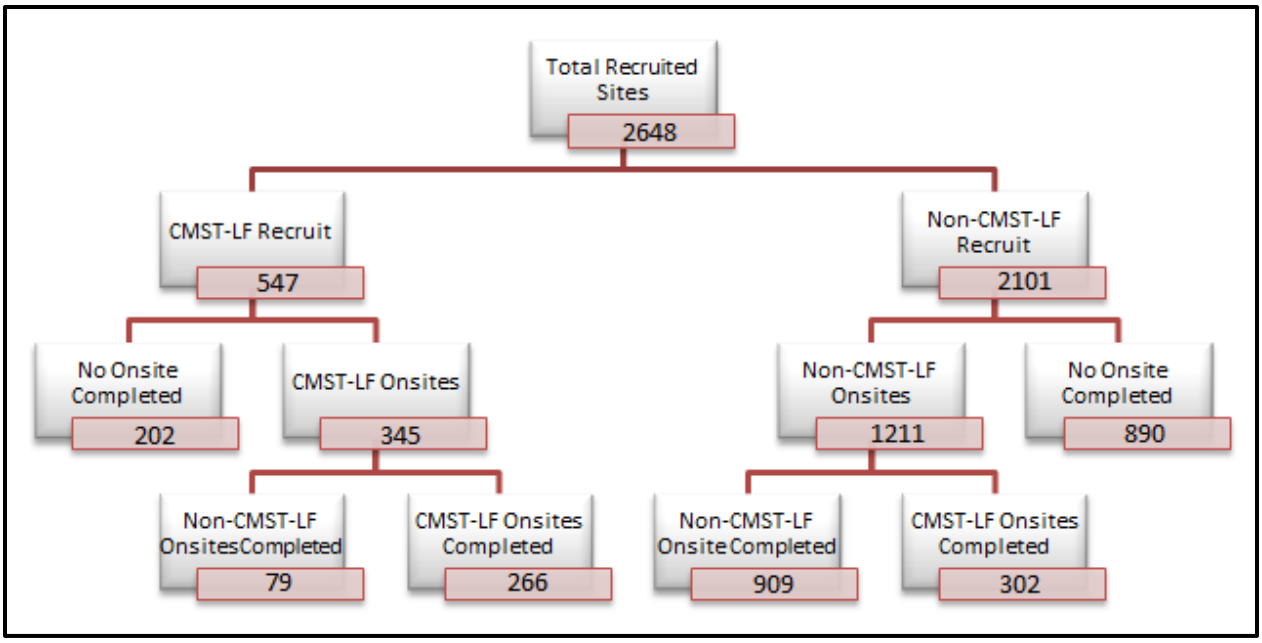
Figure 4-1 maps the count of sites with CMST-eligible linear fluorescent technology as derived from the telephone and on-site surveys. During the telephone survey, 2,648 sites were recruited for on-site visits. Out of the 2,648 recruited sites, 547 were recruited as CMST-Linear Fluorescent sites,[10] while 2,101 were recruited as non-CMST-Linear Fluorescent sites.[11] The non-CMST-Linear Fluorescent recruits were split into two groups—1,211 CSS and non-CMST-Linear Fluorescent on-site surveys and 890 sites where no on-site surveys were completed. Similarly, the CMST-Linear Fluorescent recruits were split into two groups—345 CMST-Linear Fluorescent on-site surveys and 202 where no on-site surveys were completed. Finally, each of

[10] These CMST-Linear Fluorescent sites may also have been recruited for CMST HVAC, CMST Television, and CSS on-site surveys, but for the purposes of the Linear Fluorescent analysis, the team is not concerned with other CMST-eligible equipment types or their participation in the larger CSS study.

[11] A non-CMST-Linear Fluorescent recruit could include CSS-only recruits and/or CSS and CMST HVAC and/or CSS and CMST Television recruits.

these two groups, where on-sites were performed, were once again each split into two groups—those where CMST-Linear Fluorescent measures were found on site, and those where no CMST-Linear Fluorescent measures were found on site.

Figure 4-1: Sites with CMST-Eligible Linear Fluorescent Technology



4.3.1 Linear Fluorescent Purchasing Sites

CMST-Linear Fluorescent data were collected at 568 sites. These data were analyzed and weighted to represent the number of businesses purchasing Linear Fluorescents in the population of CMST-eligible sites. Using these data, the research team developed a better understanding of the share of businesses purchasing Linear Fluorescents, the share of Linear Fluorescent purchasers participating in IOU Linear Fluorescent rebate programs, and the average number of fixtures installed at participant and non-participant businesses.

The data in Table 4-3 present an estimate of the share of non-residential businesses installing new Linear Fluorescent technologies during the period 2009-2012. An estimated 16% of PG&E's non-residential businesses installed new Linear Fluorescent technologies during the period 2009-2012. In SCE's territory, an estimated 33% of non-residential businesses installed new Linear lighting, and about 35% of non-residential businesses in SDG&E's territory installed new Linear lighting.

Table 4-3: Share of Businesses Installing Linear Fluorescents Relative to Number of Sites in Frame*

Utility	Utility Sites in Frame	Estimated Share of Linear Fluorescent Businesses
PG&E	392,294	16%
SCE	462,944	33%
SDG&E	99,495	35%

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

4.3.2 Linear Fluorescent Fixture Purchases

Using the data collected at CMST-Linear Fluorescent sites with the site weights developed for this analysis, Table 4-4 provides an estimate of the number of two-lamp-equivalent fixtures installed by businesses from 2009-2012.[12, 13] The data in Table 4-4 indicate that businesses in SCE's territory installed more fixtures than businesses in PG&E's territory.[14] Using the data in Table 4-4 and the estimate of the number of businesses installing new Linear technologies, it is possible to calculate an estimate of the average number of fixtures installed at businesses installing Linear Fluorescents from 2009-2012. The site-weighted CMST data imply that the average PG&E business installed substantially more fixtures than businesses in SDG&E or SCE. On average, businesses installing Linear Fluorescents in PG&E installed 106 fixtures each, while SCE and SDG&E averaged 61 and 45 fixtures per business, respectively. These data indicate that a smaller share of businesses in PG&E's service territory installed Linear technologies from 2009-2012 than in the other IOU service territories but businesses in PG&E's territory installed a high number of lamps per installing business.

[12] Two-lamp-equivalent fixtures were developed to count fixtures at sites. If a fixture contained three lamps, it counted as 1.5 fixtures, whereas a one-lamp fixture counted as 0.5 fixtures.

[13] The estimated number of Linear Fluorescent fixtures installed has been rounded. Given the sampling and weighting process, these numbers are estimated with error, and providing the exact numerical estimate may lead readers to assume a level of precision that is not intended. These numbers should be taken as approximate estimates.

[14] A 2008 PG&E study estimates sales of 5.1 million commercial Linear fixtures in 2005 in California (Analysis of Standards Options for Linear Fluorescent Fixtures. Preliminary CASE Report, 2008 Pacific Gas and Electric Company. http://www.energy.ca.gov/appliances/2008rulemaking/documents/2008-02-01_documents/CASE_studies/Analysis_of_Standards_Options_for_Linear_Fluorescent_Fixtures.pdf). The study uses national data from the 2005 U.S. Census ballast shipments data. The estimate of yearly sales from the CMST analysis across the 2009-2012 period is approximately 4.5 million fixtures per year.

Table 4-4: Number of CMST Fixtures Installed and Average per Business Installing*

Utility	Estimated New Linear Fluorescent Fixtures	Estimated Average Fixtures per Business
PG&E	6,606,000	106
SCE	9,267,000	61
SDG&E	1,572,000	45

*** The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures.

4.3.3 Efficiency Analysis

The CMST-Linear Fluorescent analysis collected make and model number information during the on-site data collection effort. For 2% of the sites and 6% of the fixtures, it was not possible to collect make and model information. For sites where make and model numbers were not collected, it is often the case that the fixtures were inaccessible, the customers did not want the surveyor to use a ladder, or the make and model numbers were not visible. The make and model number information that was collected was researched as part of the analysis effort to classify the lighting as T12, Standard 700-Series T8, Standard 800-Series T8, Reduced Wattage T8, High Performance T8, T5, and LED Linear fixtures. Occasionally the make and model number collected during the on-site data collection effort could not be found during the look up effort.[15] For 96% of the sites and 93% of all fixtures, the efficiency analysis was able to classify the Linear Fluorescent efficiency level.

Efficiency Distribution

Table 4-5 lists the efficiency distribution for recent purchases of Linear Fluorescents. The data are presented for businesses purchasing Linear technologies and for the fixtures themselves using site count weights developed for the CMST analysis. The site weighted estimates indicate that 54% of businesses installed Base Efficiency Linear technologies and that 46% of fixtures installed were Base Efficiency.[16] Figure 4-2 shows that the percentage of High Efficiency technologies installed exceeds Base Efficiency technologies installed for fixtures, but the percentage of businesses with High Efficiency technologies installed is roughly the same as the percentage of businesses with Base Efficiency technologies.

The High and Base Efficiency technologies can be disaggregated into specific measures. Base Efficiency Linear technologies include T12, Standard 700-Series T8, and Standard 800-Series T8. High Efficiency Linear technologies include High Performance T8, Reduced Wattage T8,

[15] Inability to identify the make and model numbers during the lookup process is often due to inaccurate transcription by the surveyor.

[16] The site level efficiency distributions add up to more than 100% because a site can install multiple efficiency levels of technology.

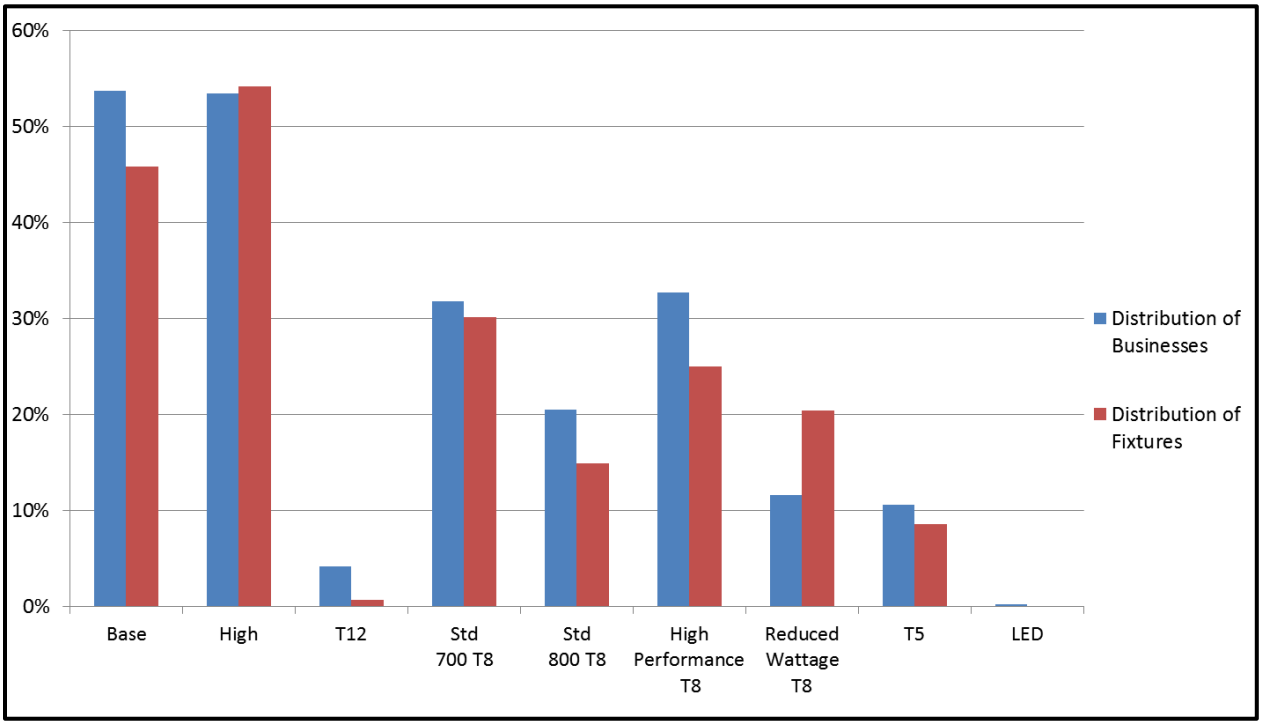
T5, and LED Linear technologies. The site-weighted business share estimates show that High Performance T8s were the most common fixture installed by the non-residential sector during the 2009-2012 periods. High performance T8s accounted for 33% of businesses installations but only 25% of fixture installations. The site-weighted fixture count share estimates were dominated by Standard 700-Series T8s, making up 30% of measure installations. For conciseness, the remaining figures will focus on the efficiency distribution of fixtures.

Table 4-5: CMST-Linear Fluorescent Efficiency Distribution, Business Count and Fixture Count Shares*

	Business Count Shares		Fixture Count Shares	
Efficiency Level	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**
Base Efficiency	54%	12%	46%	11%
High Efficiency	53%	12%	54%	9%
Base Efficiency Tiers Distribution				
T12	4%		1%	
Std 700 T8	32%		30%	
Std 800 T8	21%		15%	
High Efficiency Tiers Distribution				
High Performance T8	33%		25%	
Reduced Wattage T8	12%		20%	
T5	11%		9%	
LED	<1%		<1%	
n	**546**		**156,771**	

*** The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures. The percent of businesses sums to more than 100% because a site can install both Base and High Efficiency units.

Figure 4-2: CMST-Linear Fluorescent Efficiency Distribution, Business Count and Fixture Count Shares*



* **The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures.

Efficiency by Year

As part of the CMST-Linear Fluorescent on-site data collection, the site contact was asked to self-report the year the new Linear Fluorescents were installed. Table 4-6 lists the Linear Fluorescent efficiency distribution by year of installation for fixture count shares. Figure 4-3 illustrates the Linear Fluorescent efficiency distribution by year of installation for fixture count shares. The data in Table 4-6 and Figure 4-3 are site-weighted fixture count shares. These data indicate that the share of High Efficiency Linear measures was 55% in 2009, 37% in 2010, 64% in 2011, and 79% in 2012. Other than a fall in the High Efficiency share in 2010, the share of High Efficiency Linear technologies has risen over this time period. Analyzing the technology disaggregated information, High Performance T8s were the most common measure in 2009 at 39%, then Standard 700-Series T8s in 2010 at 48%, and then Reduced Wattage T8s in both 2011 and 2012 at 33% and 58%, respectively. The relatively high share of Standard 700-Series T8s in 2010 is consistent with the fall in the High Efficiency share in 2010. The growth in the Reduced Wattage T8 share over the four year time period—increasing from 5% in 2009, 10% in 2010, 33% in 2011, and 58% in 2012—illustrates a remarkable increase in the importance of this lighting technology.

Table 4-6: CMST-Linear Fluorescent Efficiency Distribution by Year, Fixture Count Shares*

Efficiency Level	2009		2010		2011		2012	
	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision
Base Efficiency	45%	29%	63%	10%	36%	15%	21%	26%
High Efficiency	55%	24%	37%	16%	64%	8%	79%	7%
Base Efficiency Tiers Distribution								
T12	1%		1%		1%		<1%	
Std 700 T8	20%		48%		25%		15%	
Std 800 T8	23%		14%		10%		7%	
High Efficiency Tiers Distribution								
High Performance T8	39%		18%		25%		15%	
Reduced Wattage T8	5%		10%		33%		58%	
T5	11%		9%		7%		5%	
LED	<1%		0%		<1%		1%	
n	**34,713**		**45,294**		**42,495**		**34,269**	

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

Significance testing was conducted to determine if the results across consecutive years listed in Table 4-6 were statistically significant. For this analysis, the Research Team developed t-tests comparing the distributions of Linear Fluorescents across years by technology.[17] As shown in Table 4-7, the distribution of technologies differed significantly across all year pairs for the aggregated technology groupings. The share of High Efficiency purchases in 2009 was significantly larger than in 2010, the share of High Efficiency purchases in 2011 was significantly larger than in 2010, and the share of High Efficiency Linear purchases was significantly larger in 2012 than in 2011. For the disaggregated Linear Fluorescent technologies, the distributions were not significantly different for T12s or T5s for any two consecutive years. The Standard 800-Series T8 share is 23% in 2009 and 14% in 2010. The p-values presented in Table 4-7 show that these numbers are significantly different at the 5% level. The Standard 800-Series T8 shares for 2010 and 2011, however, are not found to be significantly different. The results presented in Table 4-7 show that the yearly pairwise differences in Reduced Wattage T8s

[17] P-values less than 0.1 imply that the difference between the two observed means would be found in less than 10% of all cases if the null hypothesis of no difference were correct. P-values less than 0.10, 0.05, or 0.01 indicate an increasing level of significance that is used to reject the null hypothesis that there is no difference between the observed means.

shown in Table 4-6 were statistically significant for all pairwise analyses. Yearly pairwise differences in High Performance T8s were statistically significant for 2009-2010 and 2011-2012.

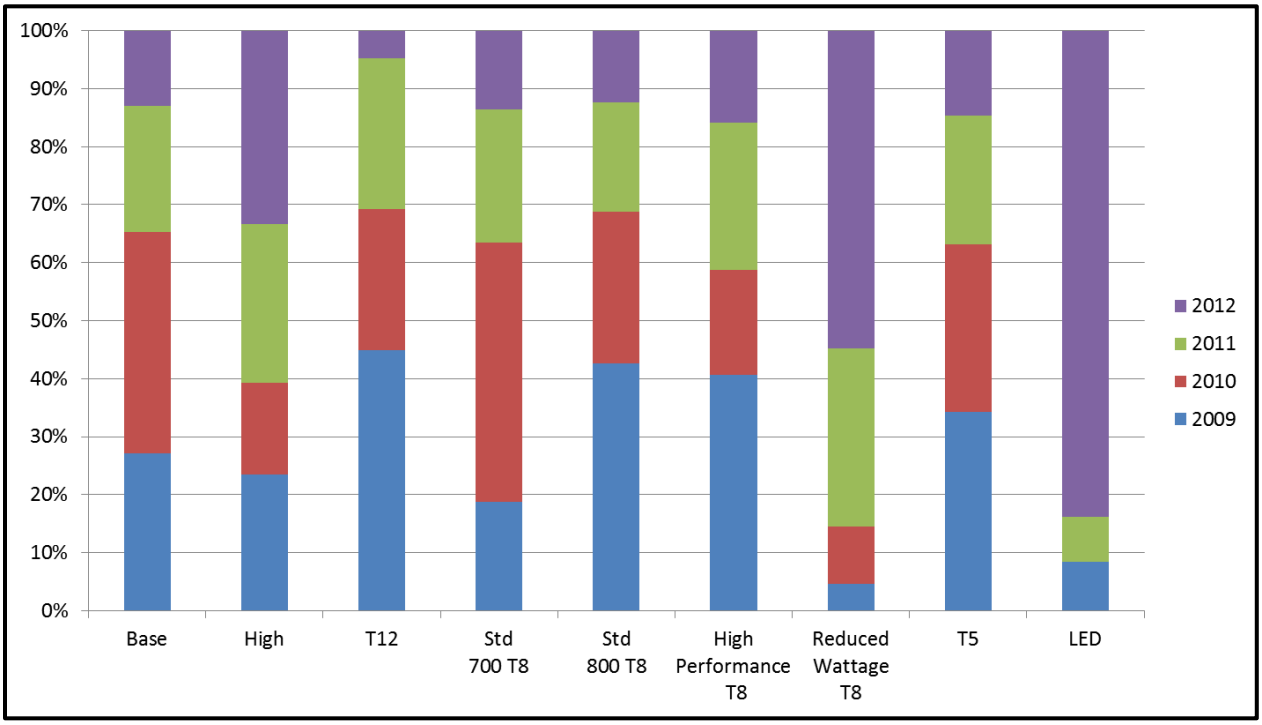
Table 4-7: T-Test P-Values Comparing CMST-Linear Fluorescent Efficiency Distribution by Year, Fixture Count Shares*

Efficiency Level	2009-2010	2010-2011	2011-2012
Base Efficiency	0.027**	0.000***	0.003***
High Efficiency	0.027**	0.000***	0.003***
Base Efficiency Tiers Distribution			
T12	0.523	0.925	0.375
Std 700 T8	0.000***	0.000***	0.023**
Std 800 T8	0.047**	0.266	0.085*
High Efficiency Tiers Distribution			
High Performance T8	0.014**	0.104	0.033**
Reduced Wattage T8	0.045**	0.000***	0.000***
T5	0.689	0.491	0.318
LED	0.181	0.132	0.090*

* **The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the participant column.

Figure 4-3 illustrates the installation year shares of Linear Fluorescents by performance group. The figure is a stacked bar graph summing to 100% for each technology. The graph illustrates the share of a given technology that was installed in each year. For example, LED technologies have a near zero share of all Linear lighting installed in 2009, 2010, and 2011 and only a 1% share in 2012. Given that 2012 has the dominate share of the installations at 1% of all installations, the LED bar is largely colored purple to represent the high share of the technology that was installed in 2012. The graph also illustrates the steady growth in the installation of Reduced Wattage T8s over the time period and the falling share of T12 installations.

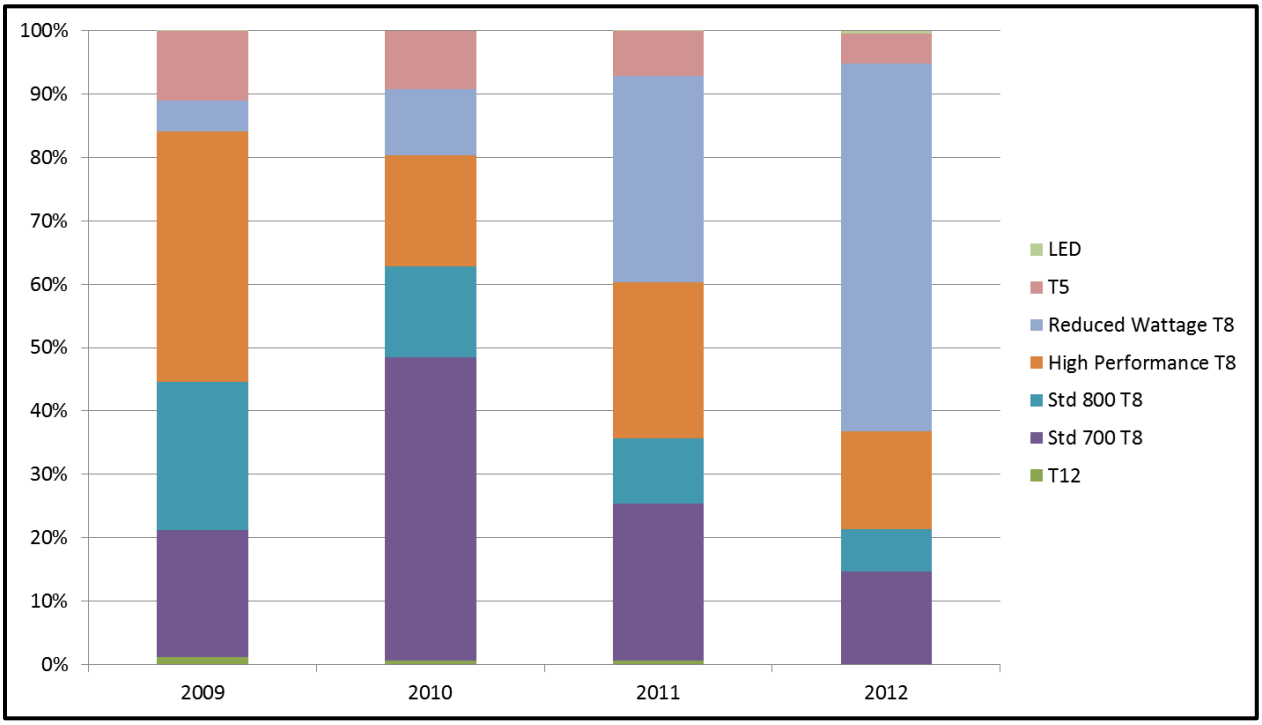
Figure 4-3: CMST-Linear Fluorescent Year Distribution by Performance Group, Fixture Count Shares*



* **The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures. Instances where the lamp model is missing or not found on-site have been excluded from this figure.

Figure 4-4 illustrates the Linear Fluorescent efficiency distribution in a stacked bar chart by year of installation. This figure illustrates the data presented in Table 4-6. The data sum to 100% representing the share of each technology installed in a given year. This illustration clearly shows that the share of Linear installations captured by Standard 700-Series T8s has fallen significantly since 2010, while the share of Reduced Wattage T8s has risen.

Figure 4-4: CMST-Linear Fluorescent Efficiency Distribution by Year, Fixture Count Shares*



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

Efficiency by IOU

Table 4-8 and Figure 4-5 present the CMST-Linear Fluorescent efficiency distribution by IOU using site weights. Table 4-9 presents p-values for t-tests to determine if the Linear Fluorescent efficiency distribution is significantly different by IOU. The tests were undertaken in a pair-wise fashion, comparing the measure level shares for PG&E and SCE, PG&E and SDG&E, and SCE and SDG&E. All three utilities have an efficiency distribution of Linear technologies that favors High Efficiency installations over Base Efficiency. When looking at the distribution of Base and High Efficiency across IOUs, no statistically significant differences are found.

The disaggregated technology measure level data imply that Standard 700-Series T8s are the most common lighting type installed in PG&E and SCE at 32% and 30% respectively. The most commonly installed Linear fixtures in SDG&E are Reduced Wattage T8s (26%), followed by High Performance T8s (22%). SDG&E has a statistically significantly higher share of T12s than PG&E and SCE (see Table 4-9). SCE has a statistically significantly higher share of Standard 700-Series T8s than SDG&E. The results presented in Table 4-8 and Table 4-9 indicate that few of the differences in Linear efficiency distributions by IOU are statistically significant. The type of Linear technology installed by business does not generally differ by IOU.

Table 4-8: CMST-Linear Fluorescent Efficiency Distribution by IOU, Fixture Count Shares*

	PG&E		SCE		SDG&E	
Efficiency Level	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**
Base Efficiency	48%	23%	45%	11%	44%	19%
High Efficiency	52%	21%	55%	9%	56%	15%
Base Efficiency Tiers Distribution						
T12	<1%		<1%		5%	
Std 700 T8	32%		30%		20%	
Std 800 T8	15%		14%		19%	
High Efficiency Tiers Distribution						
High Performance T8	28%		24%		22%	
Reduced Wattage T8	17%		22%		26%	
T5	8%		10%		7%	
LED	<1%		<1%		<1%	
n	**64,937**		**75,174**		**16,660**	

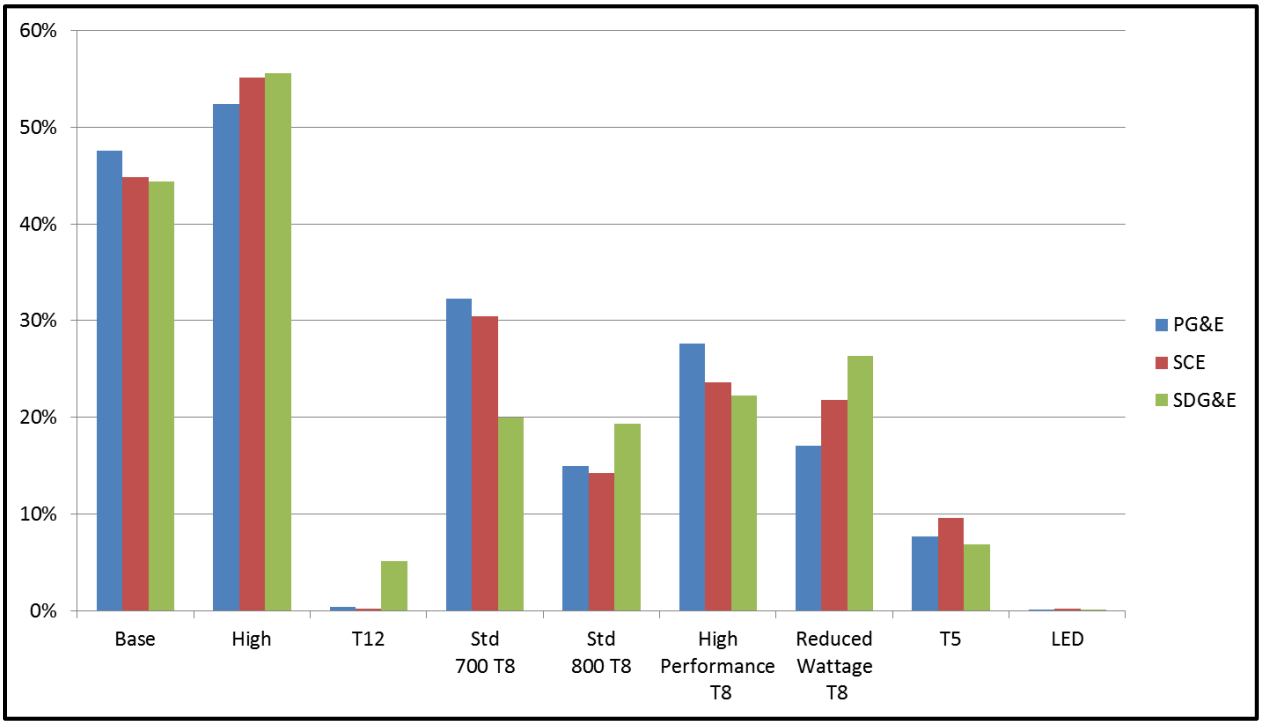
*** The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures.

Table 4-9: T-Test P-Values Comparing CMST-Linear Fluorescent Efficiency Distribution by IOU, Fixture Count Shares*

Efficiency Level	**PG&E-SCE**	**PG&E-SDG&E**	**SCE-SDG&E**
Base Efficiency	0.725	0.756	0.876
High Efficiency	0.725	0.756	0.876
Base Efficiency Tiers Distribution			
T12	0.396	0.017**	0.002***
Std 700 T8	0.769	0.173	0.095*
Std 800 T8	0.909	0.403	0.295
High Efficiency Tiers Distribution			
High Performance T8	0.578	0.701	0.823
Reduced Wattage T8	0.223	0.101	0.324
T5	0.486	0.841	0.475
LED	0.185	0.280	0.572

* **The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the participant column.

Figure 4-5: CMST-Linear Fluorescent Efficiency Distribution by IOU, Fixture Count Shares*



* **The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures. Instances where the lamp model is missing or not found on-site have been excluded from this figure.

Efficiency by Business Size

Table 4-10 and Table 4-12 present the CMST-Linear Fluorescent efficiency distribution by business size using site weights for fixture count and business count shares, respectively. Table 4-11 and Table 4-13 present p-values for t-tests to determine if the Linear Fluorescent efficiency distribution and the distribution of businesses installing these technologies differ by Business Size. Once again, the t-tests were undertaken in a pair-wise fashion, comparing the measure level shares for Large and Medium, Medium and Small, and Small and Very Small businesses.

For fixture count shares, the data presented in Table 4-10 shows that Large businesses are more likely to install High Efficiency technologies than Small and Very Small businesses. Large businesses are also found to have a statistically significantly higher share of High Efficiency installations compared to Medium businesses. The data indicate that 74% of Linear technologies installed in Large businesses are High Efficiency, 62% for Medium businesses, 51% for Small, and 39% for Very Small businesses. When looking at the distribution of Base and High Efficiency across Small and Very Small business sizes, no statistically significant differences are found.

For disaggregated fixture technologies, the 48% share of Reduced Wattage T8s in Large businesses was found to be statistically significantly higher than the 29% share in Medium businesses. Similarly, the 29% share for Reduced Wattage T8s in Medium businesses is significantly larger than the 8% share for Reduced Wattage T8s in Small businesses. The 18% share of High Performance T8s for Medium businesses, however, was found to be statistically significantly lower than its share in Small businesses (36%). Very Small and Small businesses installing High Efficiency Linear technologies appear to predominantly install High Performance T8s, while Medium and Large businesses are more likely to install Reduced Wattage T8s. The high share of 38% for Standard 700-Series T8s in Very Small businesses is consistent with Very Small businesses having a relatively low High Efficiency share.

Table 4-10: CMST-Linear Fluorescent Efficiency Distribution by Business Size, Fixture Count Shares*

Efficiency Level	Large		Medium		Small		Very Small	
	Percent	**Relative Precision**	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**
Base Efficiency	26%	29%	38%	12%	49%	27%	61%	11%
High Efficiency	74%	10%	62%	7%	51%	26%	39%	18%
Base Efficiency Tiers Distribution								
T12	1%		<1%		<1%		2%	
Std 700 T8	23%		20%		36%		38%	
Std 800 T8	3%		18%		13%		21%	
High Efficiency Tiers Distribution								
High Performance T8	15%		18%		36%		25%	
Reduced Wattage T8	48%		29%		8%		12%	
T5	11%		15%		7%		2%	
LED	0%		<1%		<1%		0%	
n	**43,468**		**90,005**		**18,728**		**4,476**	

*** The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures. Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh.

Table 4-11: T-Test P-Values Comparing CMST-Linear Fluorescent Efficiency Distribution by Business Size, Fixture Count Shares*

Efficiency Level	Large-Medium	Medium-Small	Small-Very Small
Base Efficiency	0.048**	0.114	0.258
High Efficiency	0.048**	0.114	0.258
Base Efficiency Tiers Distribution			
T12	0.098*	0.320	0.033**
Std 700 T8	0.577	0.004***	0.754
Std 800 T8	0.000***	0.118	0.102
High Efficiency Tiers Distribution			
High Performance T8	0.645	0.008***	0.383
Reduced Wattage T8	0.004***	0.000***	0.183
T5	0.479	0.116	0.104
LED	0.392	0.369	0.362

* **The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the participant column.

Looking at business count shares in Table 4-12, the High and Base Efficiency shares are close to 50% for all business sizes, and no statistically significant differences are found between the size pairings (see Table 4-13). The business count shares add up to more than 100% because a single site can install both Base and High Efficiency technologies. Medium businesses show a slightly higher share of High Efficiency installations, at 62%, relative to other business sizes. Using business shares, Large businesses have the highest proportion of T5s compared to other business sizes (28%) and Very Small businesses have the highest proportion of High Performance T8s (34%). The differences between the business count and fixture count shares and the fact that the business count shares sum to more than 100% indicate that many businesses are installing Linear technologies of multiple efficiency levels over the four year time period.

Table 4-12: CMST-Linear Fluorescent Efficiency Distribution by Business Size, Business Count Shares*

Efficiency Level	Large		Medium		Small		Very Small	
	Percent	**Relative Precision**	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**
Base Efficiency	53%	26%	49%	16%	56%	15%	55%	16%
High Efficiency	56%	25%	62%	12%	51%	17%	53%	17%
Base Efficiency Tiers Distribution								
T12	4%		2%		6%		4%	
Std 700 T8	32%		29%		35%		32%	
Std 800 T8	20%		26%		21%		20%	
High Efficiency Tiers Distribution								
High Performance T8	17%		18%		32%		34%	
Reduced Wattage T8	24%		20%		10%		10%	
T5	28%		25%		13%		9%	
LED	0%		4%		<1%		0%	
n	**42**		**178**		**174**		**148**	

*** The results presented above have been weighted by site weight.** The percent of businesses sums to more than 100% because a site can install both Base and High Efficiency units. Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh.

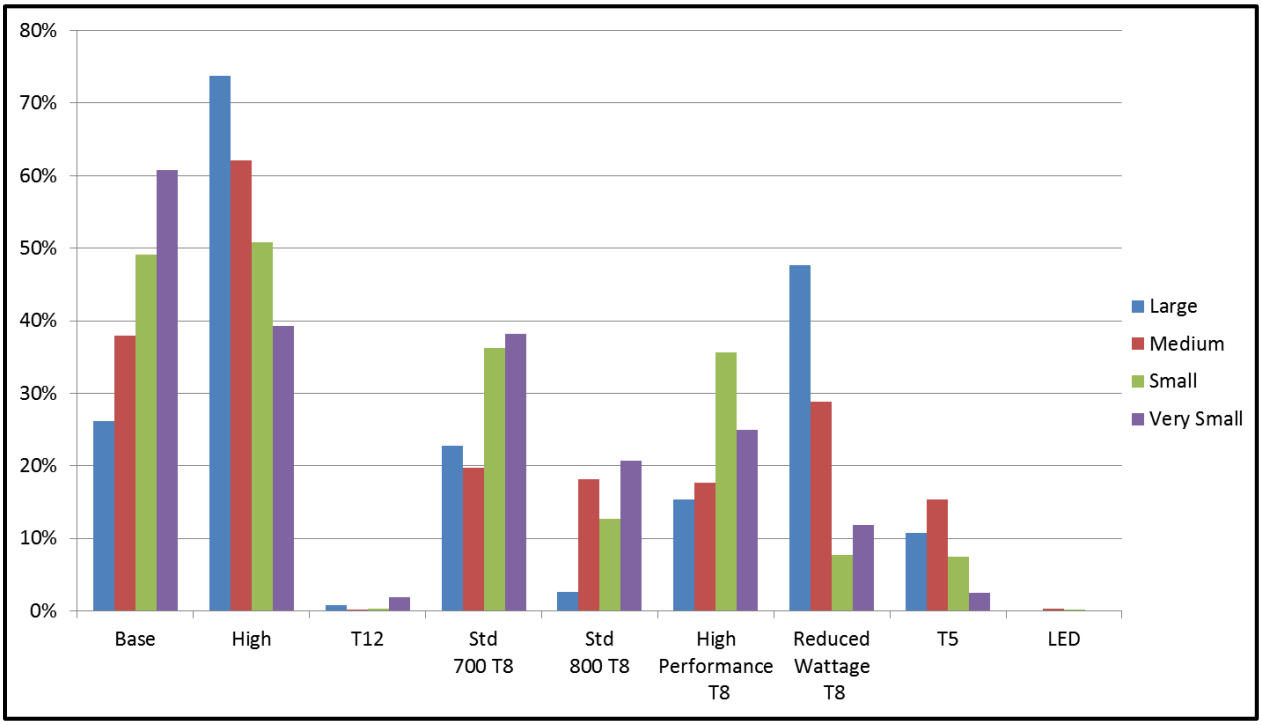
Table 4-13: T-Test P-Values Comparing CMST-Linear Fluorescent Efficiency Distribution by Business Size, Business Count Shares*

Efficiency Level	Large-Medium	Medium-Small	Small-Very Small
Base Efficiency	0.602	0.291	0.980
High Efficiency	0.602	0.291	0.980
Base Efficiency Tiers Distribution			
T12	0.605	0.282	0.563
Std 700 T8	0.639	0.453	0.932
Std 800 T8	0.509	0.442	0.895
High Efficiency Tiers Distribution			
High Performance T8	0.848	0.024**	0.781
Reduced Wattage T8	0.675	0.013**	0.922
T5	0.768	0.016**	0.383
LED	0.189	0.013**	0.359

* **The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the participant column.

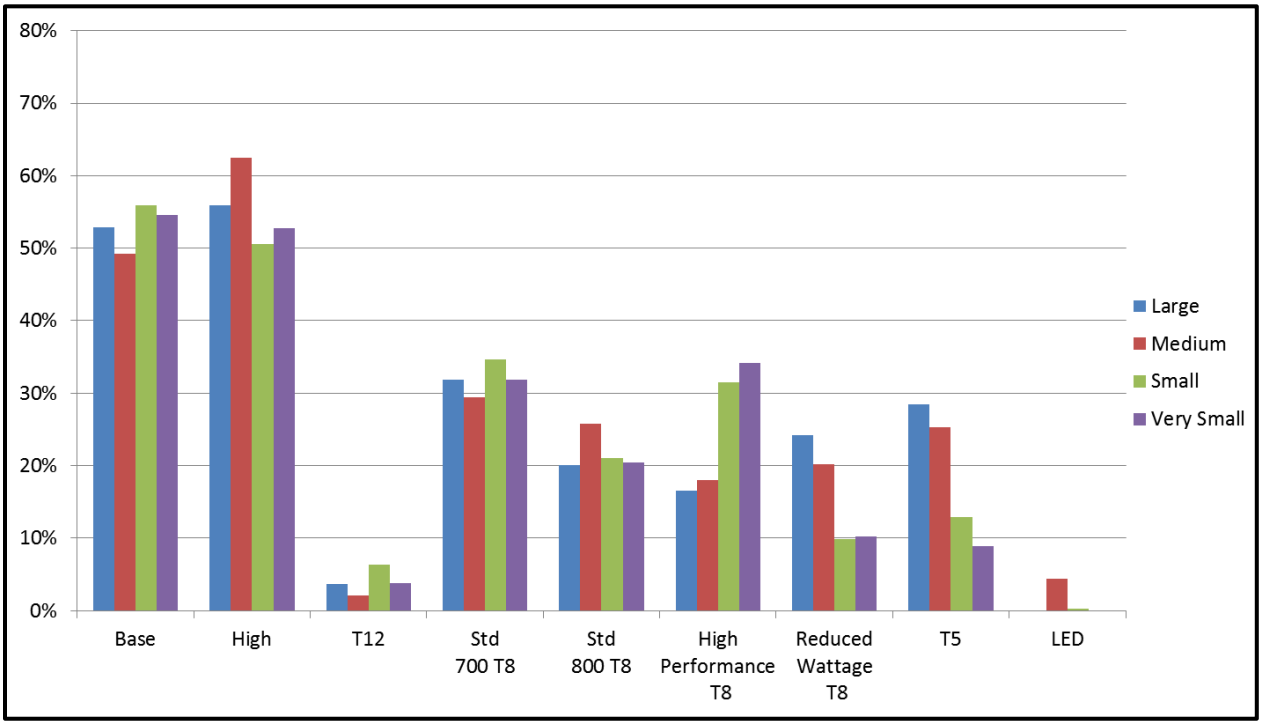
Figure 4-6 and Figure 4-7 present the CMST-Linear Fluorescent efficiency distribution by business size using site weights for fixture count shares and business count shares, respectively. Looking at business count shares for the disaggregated technologies, statistically significant differences are found between Medium and Small businesses for each of the High Efficiency technologies.

Figure 4-6: CMST-Linear Fluorescent Efficiency Distribution by Business Size, Fixture Count Shares*



* **The results presented above have been weighted by site weight.** Instances where the lamp model is missing or not found on-site have been excluded from this figure. Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh.

Figure 4-7: CMST-Linear Fluorescent Efficiency Distribution by Business Size, Business Count Shares*



* **The results presented above have been weighted by site weight.** Instances where the lamp model is missing or not found on-site have been excluded from this figure. Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh.

Efficiency by Program Participation

Table 4-14 and Figure 4-8 present the efficiency distribution of CMST-Linear Fluorescents by site-level participation in the Linear Fluorescent HIM. Significance testing was conducted to determine if the results of the analysis by energy efficiency program participation differ statistically. Table 4-15 presents p-values for t-tests for both the Linear Fluorescent efficiency distribution and the distribution of businesses for program participants and non-participants. With the exception of fixture count shares for Standard 800-Series T8s, fixture count shares for High Performance T8s, and business count and fixture count shares for T5s, the differences in the efficiency distributions were found to be statistically significant for all High and Base Efficiency technologies and disaggregated performance groups.

These distributions illustrate that non-participants have a higher share of fixtures and businesses installing Base Efficiency measures (56% of fixtures and 63% of businesses) compared to High Efficiency measures, while participants have a higher share of fixtures and businesses installing High Efficiency measures (77% of fixtures and 86% of businesses). For both fixture count and business count shares, the businesses participating in the IOU Linear Fluorescent HIM are

installing higher shares of High Efficiency measures than non-participant businesses. The measure with the highest fixture count share for participant businesses is Reduced Wattage T8 (37%), while the measure with the highest fixture count share for non-participant businesses is Standard 700-Series T8 (38%).

Table 4-14: CMST-Linear Fluorescent Efficiency Distribution by Participation in the LF HIM, Fixture Count and Business Count Shares*

	Fixture Count Shares				Business Count Shares			
	Participants		Non-Participants		Participants		Non-Participants	
Efficiency Level	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**
Base Efficiency	23%	14%	56%	13%	22%	29%	63%	13%
High Efficiency	77%	4%	44%	17%	86%	7%	44%	19%
Base Efficiency Tiers Distribution								
T12	<1%		1%		2%		5%	
Std 700 T8	11%		38%		14%		37%	
Std 800 T8	12%		16%		11%		23%	
High Efficiency Tiers Distribution								
High Performance T8	29%		23%		60%		24%	
Reduced Wattage T8	37%		13%		22%		8%	
T5	11%		8%		10%		11%	
LED	<1%		<1%		<1%		<1%	
n	**83,709**		**73,062**		**246**		**300**	

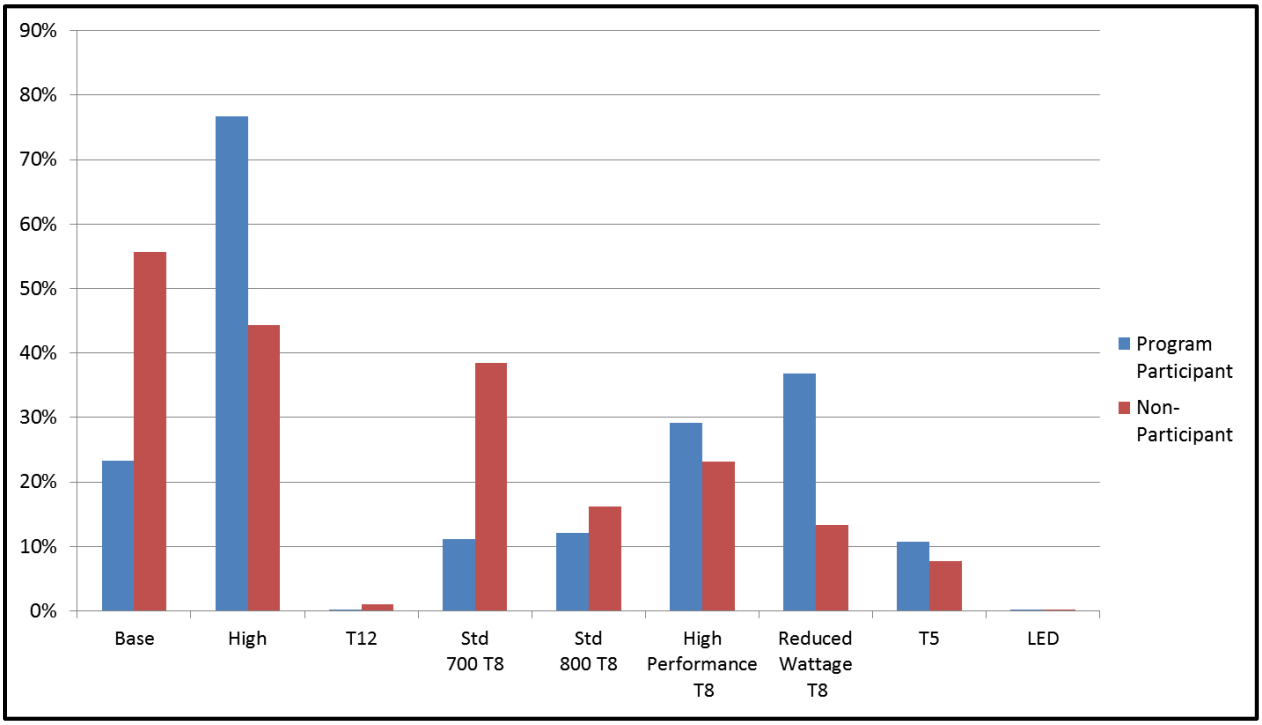
*** The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures. RP is the relative precision for participants and non-participants.

Table 4-15: T-Test P-Values Comparing CMST-Linear Fluorescent Efficiency Distribution by Participation in the LF HIM, Fixture Count and Business Count Shares*

Efficiency Level	Participant – Non-Participant	
	Fixture Count Shares	**Business Count Shares**
Base Efficiency	0.000***	0.000***
High Efficiency	0.000***	0.000***
Base Efficiency Tiers Distribution		
T12	0.036**	0.007***
Std 700 T8	0.000***	0.000***
Std 800 T8	0.102	0.002***
High Efficiency Tiers Distribution		
High Performance T8	0.276	0.000***
Reduced Wattage T8	0.000***	0.000***
T5	0.303	0.289
LED	0.044**	0.002***

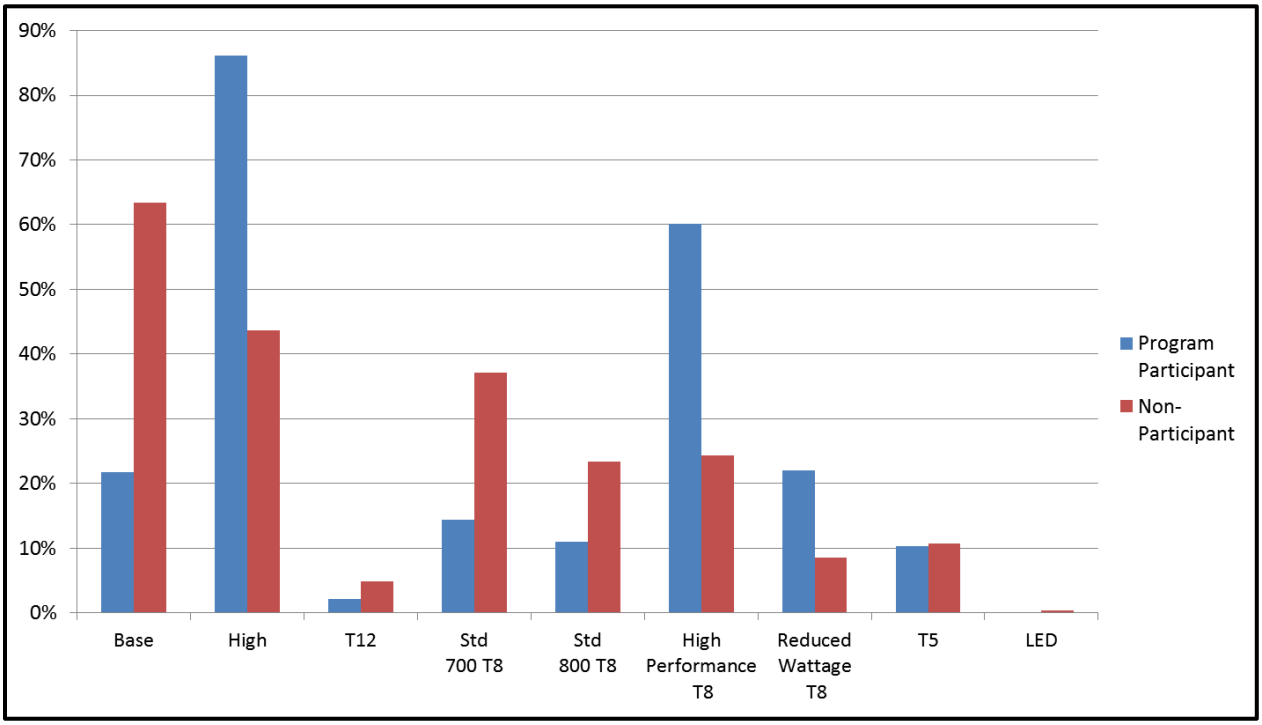
* **The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the participant column.

Figure 4-8: CMST-Linear Fluorescent Efficiency Distribution by Participation in the LF HIM, Fixture Count Shares*



* **The results have been weighted by site weight.** The fixture counts represent two light equivalent fixtures. Instances where the lamp model is missing or not found on-site have been excluded from this figure.

Figure 4-9: CMST-Linear Fluorescent Efficiency Distribution by Participation in the LF HIM, Business Count Shares*



* **The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures. Instances where the lamp model is missing or not found on-site have been excluded from this figure.

Efficiency by Program Participation and Year

The efficiency distribution of Linear technologies is presented by participation in the Linear Fluorescent HIM and year of installation in Table 4-16 and Figure 4-10. Linear Fluorescent HIM participants' High Efficiency shares are between 73% and 83% for each year from 2009 to 2012. In comparison, the High Efficiency fixture count shares for businesses that have not participated in the Linear Fluorescent HIM are 54% in 2009, 24% in 2010, 54% in 2011, and 74% in 2012. The participant and non-participant shares of High and Base Efficiency measures are statistically different in 2010 and 2011 (see Table 4-17).

Looking at measure level distributions for program participants, Reduced Wattage T8s have the highest share of installed lighting in 2009 (33%), 2011 (35%), and 2012 (54%). In 2010, High Performance T8s surpassed Reduced Wattage T8s, with a share of 35% of installed Linear fixtures among program participants. For non-participants, the dominant technology installed changes over the time period. In 2009, High Performance T8s had the highest share of non-participant installations at 41%. In 2010, the non-participant technology with the highest share was Standard 700-Series T8s at 61%. In 2011, Standard 700-Series T8s had the highest share of non-participant installations at 39%, and in 2012, Reduced Wattage T8s had the highest share at

62%. Note that the dominant technology installed among non-participants was a High Efficiency technology in 2009 and 2012. In addition, the High Efficiency share increased substantially for non-participants in 2012 relative to the previous 3 years.

Significance testing was conducted to determine if the results indicating that participant and non-participant efficiency shares that appear to be different (results listed in Table 4-16) are statistically significant. For this analysis, the Research Team developed t-tests comparing the participant and non-participant shares within a year. The t-tests were developed by year and technology.

Turning first to 2009, the observed lower share of Base Efficiency lighting for participants (23% versus 46% for non-participants) is not statistically different from the non-participant share of Base Efficiency lighting. For 2009, t-tests were able to determine that a statistically significant higher share of Reduced Wattage T8s was installed by participants than by non-participants. In 2010, non-participants installed significantly more Standard 700-Series T8s than participants, while participants installed significantly more High Performance and Reduced Wattage T8s than non-participants. In 2011, non-participants installed a statistically significantly higher share of Standard 700-Series T8s and Linear LEDs than participants. In 2012, non-participants installed a significantly higher share of Standard 700-Series T8s and Linear LEDs, while participants installed a significantly higher share of High Performance T8s.

The significance testing supports the general conclusion that non-participants are installing a statistically significant higher share of Base Efficiency Linear technologies, largely Standard 700-Series T8s, than participants. Depending upon the specific year, businesses that have participated in the IOU Linear Fluorescent programs were found to be installing a statistically significant higher share of High Performance T8s, Reduced Wattage T8s, and Linear LEDs than non-participants.

Table 4-16: CMST-Linear Fluorescent Efficiency Distribution by Participation in the LF HIM, Fixture Count Shares*

Efficiency Level	2009				2010				2011				2012			
	Participants		Non-Participants		Participants		Non-Participants		Participants		Non-Participants		Participants		Non-Participants	
	Per-cent	Relative Precision	Per-cent	Relative Precision	Per-cent	Relative Precision	Per-cent	Relative Precision	Per-cent	Relative Precision	Per-cent	Relative Precision	Per-cent	Relative Precision	Per-cent	Relative Precision
Base Efficiency	23%	47%	46%	32%	24%	25%	76%	8%	27%	20%	46%	21%	17%	32%	26%	38%
High Efficiency	77%	14%	54%	27%	76%	8%	24%	26%	73%	8%	54%	18%	83%	6%	74%	13%
Base Efficiency Tiers Distribution																
T12	0%		1%		<1%		<1%		<1%		1%		0%		<1%	
Std 700 T8	13%		21%		11%		61%		14%		39%		7%		22%	
Std 800 T8	10%		25%		13%		15%		13%		7%		9%		4%	
High Efficiency Tiers Distribution																
High Performance T8	21%		41%		35%		12%		28%		20%		25%		6%	
Reduced Wattage T8	33%		2%		25%		5%		35%		29%		54%		62%	
T5	23%		10%		16%		7%		9%		5%		4%		5%	
LED	<1%		<1%		0%		0%		0%		<1%		0%		1%	
n	**6,207**		**28,506**		**19,802**		**25,492**		**32,868**		**9,627**		**24,832**		**9,437**	

*** The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures.

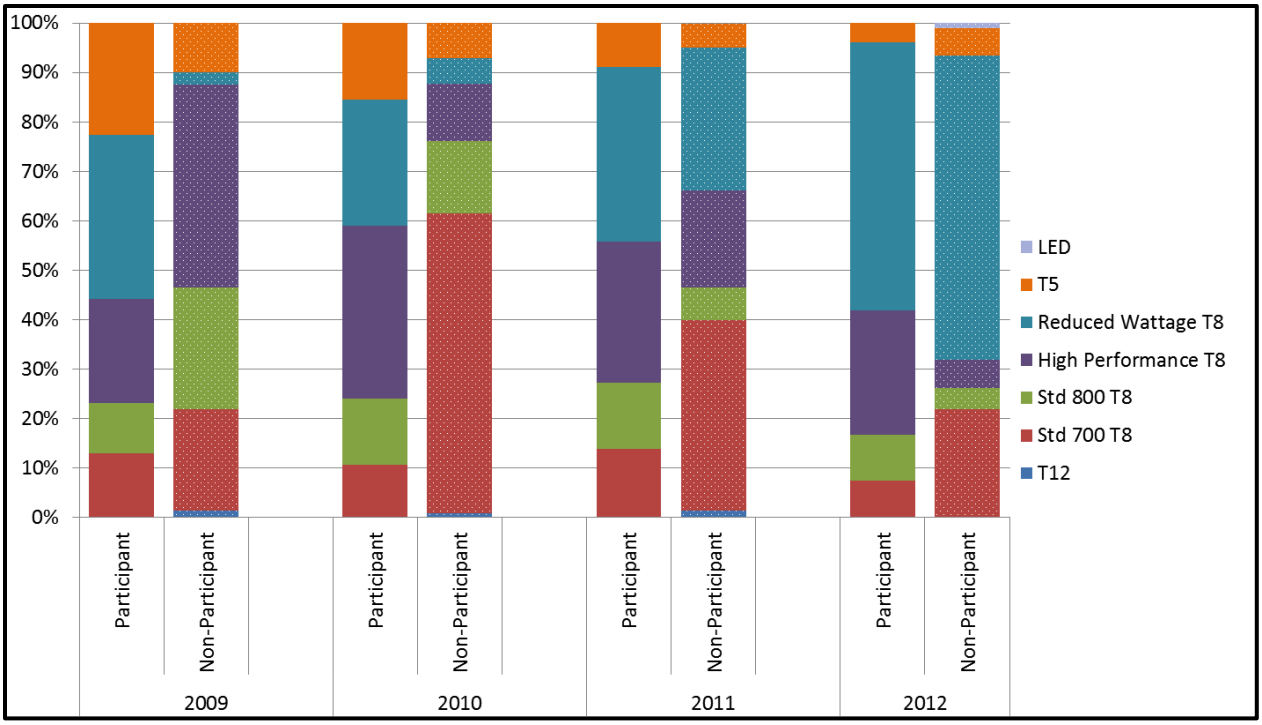
Table 4-17: T-Test P-Values Comparing CMST-Linear Fluorescent Efficiency Distribution by Participation in the LF HIM, Fixture Count Shares*

	Participant – Non-Participant			
Efficiency Level	**2009**	**2010**	**2011**	**2012**
Base Efficiency	0.276	0.000***	0.003***	0.114
High Efficiency	0.276	0.000***	0.003***	0.114
Base Efficiency Tiers Distribution				
T12	0.587	0.115	0.151	0.156
Std 700 T8	0.511	0.000***	0.000***	0.009***
Std 800 T8	0.292	0.948	0.113	0.152
High Efficiency Tiers Distribution				
High Performance T8	0.457	0.000***	0.166	0.000***
Reduced Wattage T8	0.000***	0.000***	0.499	0.389
T5	0.193	0.167	0.486	0.467
LED	0.887	–	0.010***	0.033**

* **The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the participant column.

Figure 4-10 illustrates the efficiency distribution by year and program participation. This graph clearly illustrates the falling share of Standard 700-Series T8s between 2010 and 2012 and the increasing share of Reduced Wattage T8s between 2009 and 2012 for non-participants. These data indicate that businesses that are not participating in the IOU Linear Fluorescent programs are dramatically changing their purchasing behavior over this time period.

Figure 4-10: CMST-Linear Fluorescent Efficiency Distribution by Year and Participation in the LF HIM, Fixture Count Shares



* **The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures. Instances where the lamp model is missing or not found on-site have been excluded from this figure.

Efficiency by Business Type

Table 4-18 shows the distribution of Linear Fluorescent efficiency by business type for fixture count and business count shares, respectively. The following business types were included only in the CMST on-site survey and were not included in the CSS study: College, Hospital, Hotel, and Industrial. Because these business types had fewer on-sites than the other business types,[18] they were grouped into a category called "CMST-Only" in order to present a more meaningful level of aggregation. Looking at fixture count shares, CMST-Only businesses, Offices, Retail

[18] The business types that were in the CSS on-site data collection effort have the opportunity to say during the telephone survey that they have not installed new lighting equipment and agree to a CSS on-site. For these sites, it is possible for the on-site surveyor to discover CMST-eligible equipment. This opportunity is not available to the CMST-Only business types that were not incorporated into the CSS study.

stores, Schools, and Warehouses have a higher percentage of High Efficiency fixtures being installed than Base Efficiency fixtures. For business count shares, Health/Medical Clinics, Miscellaneous business types, Offices, and Retail stores have a higher percentage of businesses with High Efficiency installations.

Table 4-18: CMST-Linear Fluorescent Efficiency Distribution by Business Type, Fixture Count and Business Count Shares*

Building Type	Efficiency Level	Fixture Count Shares			Business Count Shares		
		Percent	Relative Precision	*n*	Percent	Relative Precision	*n*
CMST-Only	Base Efficiency	40%	-1%	**8,190**	58%	-100%	**37**
	High Efficiency	60%	-1%		49%	-100%	
Food/Liquor	Base Efficiency	66%	120%	**6,800**	61%	28%	**43**
	High Efficiency	34%	141%		40%	44%	
Health/Medical - Clinic	Base Efficiency	55%	114%	**4,107**	48%	43%	**39**
	High Efficiency	45%	117%		52%	40%	
Misc.	Base Efficiency	61%	115%	**17,734**	50%	29%	**92**
	High Efficiency	37%	124%		53%	27%	
Office	Base Efficiency	48%	115%	**20,755**	52%	34%	**78**
	High Efficiency	52%	114%		58%	30%	
Restaurant	Base Efficiency	74%	113%	**897**	79%	14%	**47**
	High Efficiency	26%	137%		32%	49%	
Retail	Base Efficiency	38%	125%	**18,413**	37%	40%	**84**
	High Efficiency	62%	116%		68%	22%	
School	Base Efficiency	41%	114%	**65,307**	63%	26%	**71**
	High Efficiency	59%	109%		50%	39%	
Warehouse	Base Efficiency	24%	160%	**14,568**	64%	29%	**55**
	High Efficiency	76%	118%		57%	39%	

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

Efficiency by New Construction / Remodel

As part of the phone survey, respondents were asked what year their facility was built and/or remodeled. If the site was constructed or remodeled between 2009 and the present, it was considered a recent new construction/remodel site. Table 4-19 and Figure 4-10 present the CMST-Linear Fluorescent efficiency distribution for businesses that have recently undergone new construction or remodeling versus those businesses that replaced equipment outside of new construction or new remodel, i.e. the installation was part of a retrofit. These data indicate that the High Efficiency share of Linear measures installed during new construction/remodel (41%) is

substantially lower than the High Efficiency share of Linear technologies installed during a retrofit (62%).

The disaggregated measure shares illustrate that retrofit installations have higher shares of High Efficiency technologies than new construction/remodel installations. For lighting installed outside of new construction or a remodel, 29% of newly installed Linear technologies were found to be High Performance T8. For lighting installed as part of new construction or a remodel, the Linear technology with the largest efficiency share was Standard 700-Series T8 at 40% of all new construction/remodel installations.

The last column in Table 4-19 presents p-values for t-tests to determine if the Linear Fluorescent efficiency distributions differ between new construction/remodels and non-new construction/remodel installations. As seen, the distributions for the two categories were found to be statistically significantly different for both the aggregated Base and High Efficiency technology categories. Standard 700- and 800-Series T8s have statistically higher shares for new construction/remodel projects (40% and 19%, respectively) compared to no new construction/remodel (24% and 12%, respectively). Conversely, Reduced Wattage T8s have a statistically lower share for new construction/remodel projects (14%) compared to no new construction/remodel (24%).

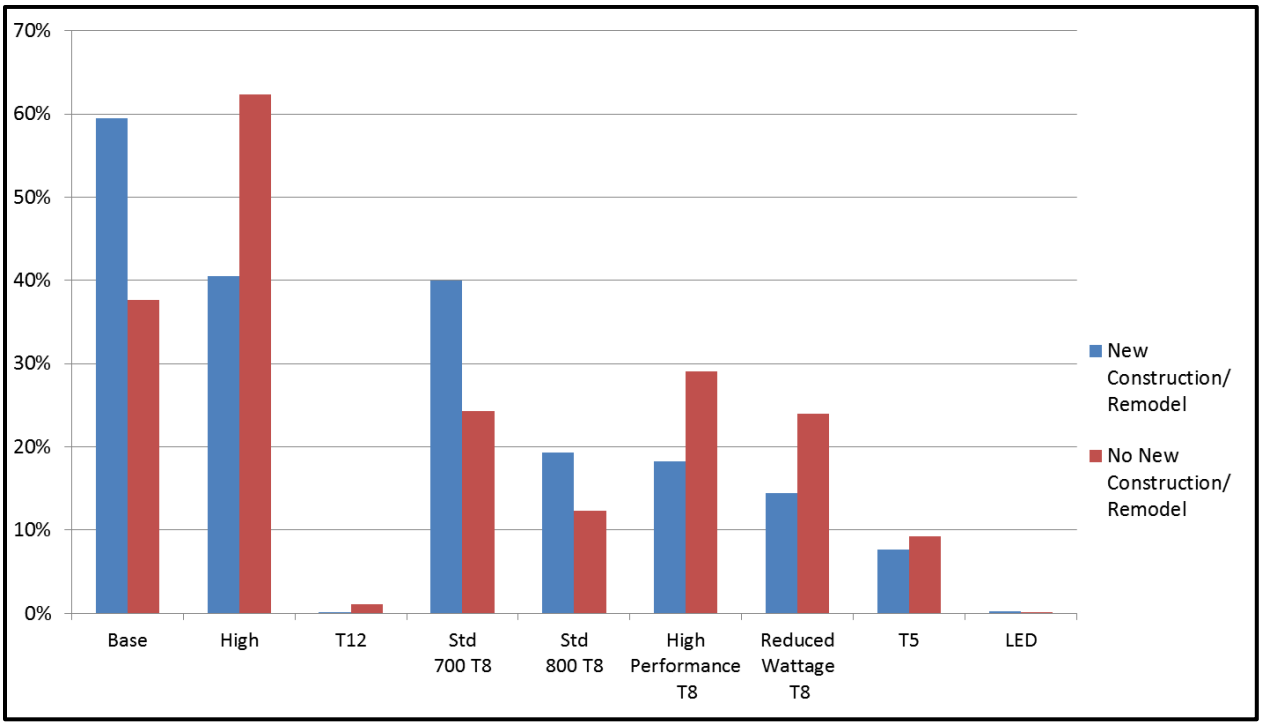
The results presented in Table 4-19 led to a question concerning the yearly distribution of new construction/remodel versus non-new construction/remodel installations. To determine if these findings were consistent over the four year time period, these data were analyzed for installations in 2009-2010 and for installations in 2011-2012.

Table 4-19: CMST-Linear Fluorescent Efficiency Distribution by New Construction/Remodel, Fixture Count Shares*

Efficiency Level	New Construction/Remodel		No New Construction/Remodel		T-Test P-Values Comparing NC/Rem to No NC/Rem
	Percent	Relative Precision	Percent	Relative Precision	
Base Efficiency	59%	10%	38%	16%	0.000***
High Efficiency	41%	14%	62%	10%	0.000***
Base Efficiency Tiers Distribution					
T12	<1%		1%		0.160
Std 700 T8	40%		24%		0.002***
Std 800 T8	19%		12%		0.018**
High Efficiency Tiers Distribution					
High Performance T8	18%		29%		0.118
Reduced Wattage T8	14%		24%		0.022**
T5	8%		9%		0.577
LED	<1%		<1%		0.144
n	**53,373**		**103,398**		

***** **The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures. P-values are presented in the last column above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the participant column.

Figure 4-11: CMST-Linear Fluorescent Efficiency Distribution by New Construction/Remodel, Fixture Count Shares*



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

Efficiency by New Construction / Remodel and Year Group

Table 4-20 builds on the analysis provided in Table 4-19. It presents the CMST-Linear Fluorescent efficiency distribution for businesses that are new construction/remodel versus those businesses that replaced equipment outside of new construction or remodel, separating them into two year groups: 2009-2010 and 2011-2012. For both year groups, the share of High Efficiency equipment found in new construction/remodel facilities was lower than in no new construction/remodel facilities. However, in 2011-2012, the distributions for these two types of installations were similar, with the new construction/remodel facilities having a 68% penetration of High Efficiency equipment, and no new construction/remodel facilities having a 72% share.

The disaggregated measure shares illustrate that there was a shift to High Efficiency technologies in 2011-2012 from previous years in both new construction/remodel and no new construction/remodel facilities. Reduced Wattage T8s have the highest penetration in 2011-2012 for both facility types. This is a change from the Standard 700-Series fixtures that dominated the 2009-2010 new construction/remodel facilities, and the High Performance T8 fixtures that dominated the 2009-2010 no new construction/remodel facilities.

Table 4-20: CMST-Linear Fluorescent Efficiency Distribution by New Construction/Remodel and Year Group, Fixture Count Shares*

	New Construction/Remodel				No New Construction/Remodel			
	2009-2010		2011-2012		2009-2010		2011-2012	
Efficiency Level	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision
Base Efficiency	72%	9%	32%	22%	43%	23%	28%	17%
High Efficiency	28%	22%	68%	10%	57%	18%	72%	7%
Base Efficiency Tiers Distribution								
T12	<1%		<1%		1%		<1%	
Std 700 T8	47%		24%		28%		19%	
Std 800 T8	25%		8%		14%		9%	
High Efficiency Tiers Distribution								
High Performance T8	14%		27%		36%		17%	
Reduced Wattage T8	5%		35%		10%		47%	
T5	9%		5%		11%		7%	
LED	0%		<1%		<1%		<1%	
n	**28,687**		**24,686**		**51,320**		**52,078**	

*** The results presented above have been weighted by site weight.** The fixture counts represent two light equivalent fixtures.

5

CMST Lighting Contractor Analysis

The CMST lighting contractor survey is part of the Joint Lighting Contractor Survey. The CMST survey questions are designed to shed light on the market share of Linear lighting technologies from the perspective of the contractor. The findings from the lighting contractor survey are also triangulated with the Linear lighting market share data collected from commercial sites that reported purchasing Linear lighting from 2009 to 2012.

This section of the report describes the non-CMST data collection efforts, the CMST lighting contractor research questions, the methods used to develop the lighting contractor frame and the distribution of completed surveys, the weighting methodology, and lighting contractors. Further, this section analyzes the commercial Linear Fluorescent market share from the contractor perspective.

5.1 Joint Lighting Contractor Survey

The Joint Lighting Contractor data collection effort includes survey batteries for the Measure Cost Study (WO017), the Nonresidential Lighting Evaluation (WO029), the LED Market Effects Study (WO054) and the Commercial Market Share Tracking Study (WO024). While the data requirements for each work order are different, combining the data collection efforts for all four studies limited respondent fatigue associated with over surveying and ensured that contractors were not asked general firm description information on multiple surveys.

5.1.1 Measure Cost Study Survey Questions

For the Measure Cost Study the Joint Lighting Contractor Survey (JLCS) collected information on the number of man hours required to install different types of Linear technologies and configurations within different workplace settings. The findings from this survey will be used by the measure cost team, the DEER team and other evaluators to determine the labor costs associated with installing occupancy sensors, installing T5s and T8s, replacing T8 lamps, retrofitting ballasts, delamping and removing fixtures. (See the Measure Cost Study report for more information on these series of questions.)

5.1.2 Nonresidential Lighting Evaluation Survey Questions

The Nonresidential Lighting Evaluation questioned lighting contractors on the impact that IOU rebate programs and federal lighting regulations have had on their customer's lighting decisions. Contractors were asked to report on what share of their commercial and industrial lighting projects received an IOU lighting rebate and what share were eligible for a rebate but did not receive a rebate. The survey also questioned lighting contractors on the impact that the Department of Energy's General Service Lamp phase-out of T12 lamps has had on their customers' lighting decisions. (See the Nonresidential Lighting Evaluation for results pertaining to the lighting phase-out and IOU influence questions.)

5.1.3 LED Market Effects Survey Questions

The LED Market Effects survey was designed to collect information from contractors regarding their sales and installation of LED products in the nonresidential sector and how LEDs are perceived by their customers in California. The survey asked contractors general LED installation questions as well as questions regarding why they believe their customers are either interested or hesitant to install LEDs and what the contractor believes are the advantages of LED lighting. The survey also asked contractors about which market segments they believe are most likely to be early adopters of LEDs, their customers' satisfaction with LEDs and if the contractor has installed LEDs in applications that have received IOU rebates. (See the LED Market Effects report for results pertaining to the LED Joint Lighting Survey questions.)

5.2 CMST Lighting Contractor Survey Research Objectives

The objective of the CMST lighting contractors' survey was to determine the efficiency and distribution of Linear installations that were sold and installed during the period 2011-2012. The CMST battery questioned lighting contractors about the share of their sales and installations associated with T12, Standard 700-Series T8, Standard 800-Series T8, High Performance T8, Reduced Wattage T8, T5 and Linear LED installation and sales. Since the survey gathered market share information from 2011-2012 and the survey was administered in 2013, contractors were also asked if sales and installation of lighting equipment had changed throughout that period. These questions aim to uncover potential changes in the market share of Linear technologies since the implementation of the Department of Energy's General Service Lighting legislation banning the production of T12s.

The market share tracking findings from the lighting contractor survey are triangulated with the market share findings found in the end-users on-site survey. The lighting contractors' survey provides a broad picture of the market share for Linear technologies. The end-users on-site survey and make and model lookup provides a specific description of the market share for Linear technologies found on-site for customers that installed new Linear technologies from 2009 to

2012. Both types of surveys look at market share, but they provide different perspectives. The triangulation of these two market share approaches for the same technologies and geographic regions will provide additional insight into the current nonresidential market for Linear lighting in California.

5.3 Development of the Lighting Contractor Frame

To our knowledge there is no list of lighting contractors approved to work in California from which the survey team could directly develop a lighting contractor frame. In years past the California IOUs had developed a list of lighting contractors for customers to contact for IOU rebated lighting installations. The utilities, however, have not maintained the lighting contractor list and restricting the Joint Lighting Contractor Survey to a list of contractors maintained by the IOUs could bias the study findings. To avoid the potential for bias associated with using the out of date IOU lighting contractor list, the research team chose to develop a lighting contractor frame from a list of electrical contractors in California.

Information from a Dunn and Bradstreet extraction of electrical contractors was used to develop a lighting contractor frame representing the population of lighting contractors in California. The North American Industry Classification System or NAICS code for electrical contractor is 238210. The electrical contractor NAICS code was used to pull an electrical contractor frame within California. Table 5-1 lists the number of electrical contractors in the frame by their region and the number of employees at the location.[1]

Using the electrical contractor frame and quota of 125 completed lighting contractor surveys, the team developed a quota for the lighting contractor surveys based on the contractor's geographical location (north/south) and the number of employees associated with the contractor. Table 5-1 presents the lighting contractor quota and the number of survey completes achieved.

Distinguishing lighting contractors from electrical contractors is the first set of screening questions in the survey. Survey respondents are asked the following three questions to determine if they are lighting contractors eligible for the lighting survey:

[1] Using the electrical contractor NAICS to develop the lighting contractor frame may results in the study missing some groups of lighting contractors. For example, lighting contractors listed under general contractor NAICS codes. This approach may also exclude lighting contractors that work as employees for large institutions such as hospitals or school districts. If lighting contractors listed as general contractors or lighting contractors working for large employees are systematically different in the types of lighting they install, the frame development methodology may lead to biases in our findings. There is no a-priori reason to believe that the potential lighting contractors left out of the frame development were systematically different in their installations from those included in the analysis. Attempts to include these types of contractors, however, would be difficult. Including general contractors would lead to a significant increase in the number of calls needed to contact a lighting contractor, increasing the cost of the survey. It is not clear how contact information for in-house lighting contractors could be developed.

- Do you perform installations of lighting equipment for commercial and industrial customers in California?
- Do you sell lighting equipment to commercial and industrial customers, including multifamily residential facilities in California?
- Do you sell lighting to other contractors for installation in commercial and industrial facilities?

To continue with the lighting survey, the contractor had to respond affirmatively to at least one of the questions above. The survey tracked both the number of electrical contractors passing and not passing the lighting contractor screening questions by strata. This information is used to develop an estimate of the size of the lighting contractor population by strata. The size of the lighting contractor population is used to develop contractor weights.

Table 5-1: Electrical Contractor Frame and Lighting Contractor Quota and Survey Completes

Region	Number of Employees	Number of Electrical Contractors	Lighting Contractor Survey Quota	Lighting Contractor Surveys
North	1 to 2	1,111	0	0
South	1 to 2	1,417	0	0
North	3 to 4	2,078	6	8
South	3 to 4	3,001	8	10
North	5 to 9	707	10	11
South	5 to 9	1,008	11	11
North	10 to 19	318	8	8
South	10 to 19	490	12	12
North	20 to 49	201	11	9
South	20 to 49	219	14	13
North	50 to 99	67	10	4
South	50 to 99	85	10	5
North	100 to 249	18	6	2
South	100 to 249	28	8	1
North	250 to 499	10	6	0
South	250 to 499	3	2	0
North	1,000 to 4,999	1	1	1
South	1,000 to 4,999	2	2	0
Total		**10,764**	**125**	**95**

5.4 Weighting

The weighting methodology was developed using revenue data from the electrical contractors in the population and information on the share of electrical contractor revenue derived from the sales or installation of lighting that was collected as part of the Joint Lighting Contractor Telephone Survey. To develop an estimate of the revenue for the population of lighting contractors, the following steps were undertaken:

- By stratum, the electrical contractors' revenues were summed to develop an estimate of revenue for the electrical contractor population in California.
- To develop an estimate of lighting contractor revenue by stratum, for the electrical contractors that participated in the survey it was necessary to determine the share of the electrical contractor revenues that were derived from the sales and installation of lighting measures.
  - Determine if the electrical contractor installed or sold lighting measures. If the contractor did not install or sell lighting measures, attribute none of the contractor's revenue to lighting contractors.
  - If the electrical contractor installed or sold lighting measures, determine the share of their total revenue generated from lighting sales and installations in California.
  - Sum all of the revenues associated with electrical contractors we spoke with as part of the phone survey. These revenues include the electrical contractor revenues for contractors that state that they do not sell or install lighting.
  - Sum all of the revenues associated with lighting sales and installations from the electrical contractors we spoke with as part of the phone surveys.
  - Divide the lighting revenues by the revenue associated with electrical contractors to develop a ratio or share of the electrical contractor revenues that are derived from lighting sales and installations.
  - Multiply the lighting revenue share and the revenue from the population of electrical contractors to develop the revenue for the population of lighting contractors.

Using the information on the revenue for the population of lighting contractors and information on each of the sampled site's lighting revenues, the weight for a given contractor is developed using the following formula:

$$W_{ij} = \frac{Pop\ LT\ Rev_j * LT\ Rev_i}{\sum LT\ Rev_j} \quad (1)$$

Where:

W_{ij} is the weight for lighting contractor 'i' in strata 'j,'

$Pop\ LT\ Rev_j$ is the revenue for the population of lighting contractors in stratum 'j,'

$LT\ Rev_i$ is the lighting revenue for contractor 'i' in stratum 'j,' and

$\sum LT\ Rev_j$ is the lighting revenue for lighting contractors interviewed as part of stratum 'j.'

This methodology weights up an individual contractor's lighting revenue to our best understanding of their share of the lighting contractors' revenue in California.

5.5 Lighting Contractors Survey Findings

While the main objective of the CMST lighting contractors' survey is to estimate the distribution and efficiency of Linear lighting technologies sold and installed throughout California during 2011-2012, the survey also captures certain business characteristics of the contractors selling and installing those technologies.

5.5.1 Lighting Contractors Business Characteristics

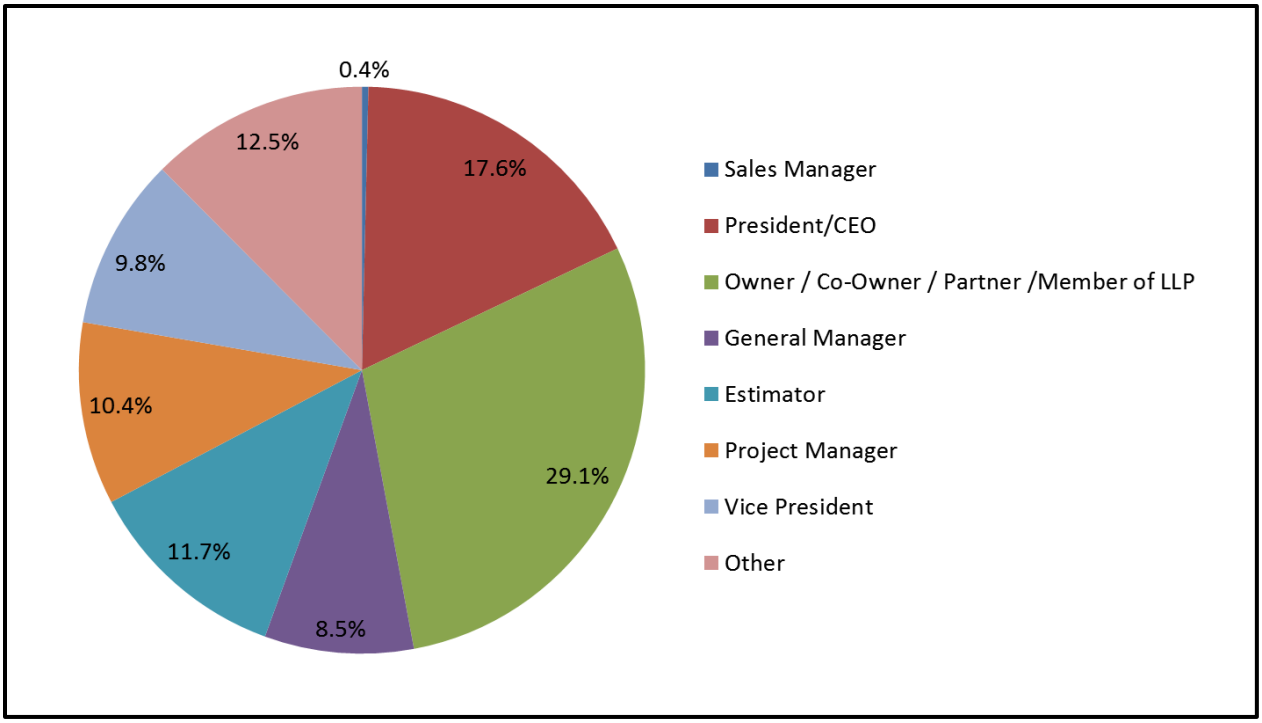
The lighting contractors that were surveyed represent a cross section of vendors in California – in size, geographic location and sales volume. As stated earlier, the strata were developed based on the contractors' geographic location (north/south) and by their number of employees. Ultimately, 95 contractors took part in the lighting contractor survey; 43 of the 95 contractors (45%) were located in the north and 52 of the 95 (55%) were located in the south. As described in Table 5-2, the vast majority of the contractors (86%) that were surveyed employed less than 50 individuals at their business location in 2011-2012.

Table 5-2: Distribution of Contractor Size Based on Number of Employees

Number of Employees	Survey Count	Distribution
3 to 4	18	19%
5 to 9	22	23%
10 to 19	20	21%
20 to 49	22	23%
50 to 99	9	9%
100 to 249	3	3%
>1000	1	1%

The contractors were asked personnel questions regarding lighting revenues, number of lighting projects completed and types of projects completed throughout 2011-2012. The relevance of these personnel questions is predicated on the individuals answering them and their knowledge of the organization's financials and operations. Figure 5-1 provides a snapshot of the job titles for the individuals who responded to the survey. A variety of decision makers were interviewed with a significant majority holding high level positions within their organization.[2]

Figure 5-1: Job Titles of Survey Respondents

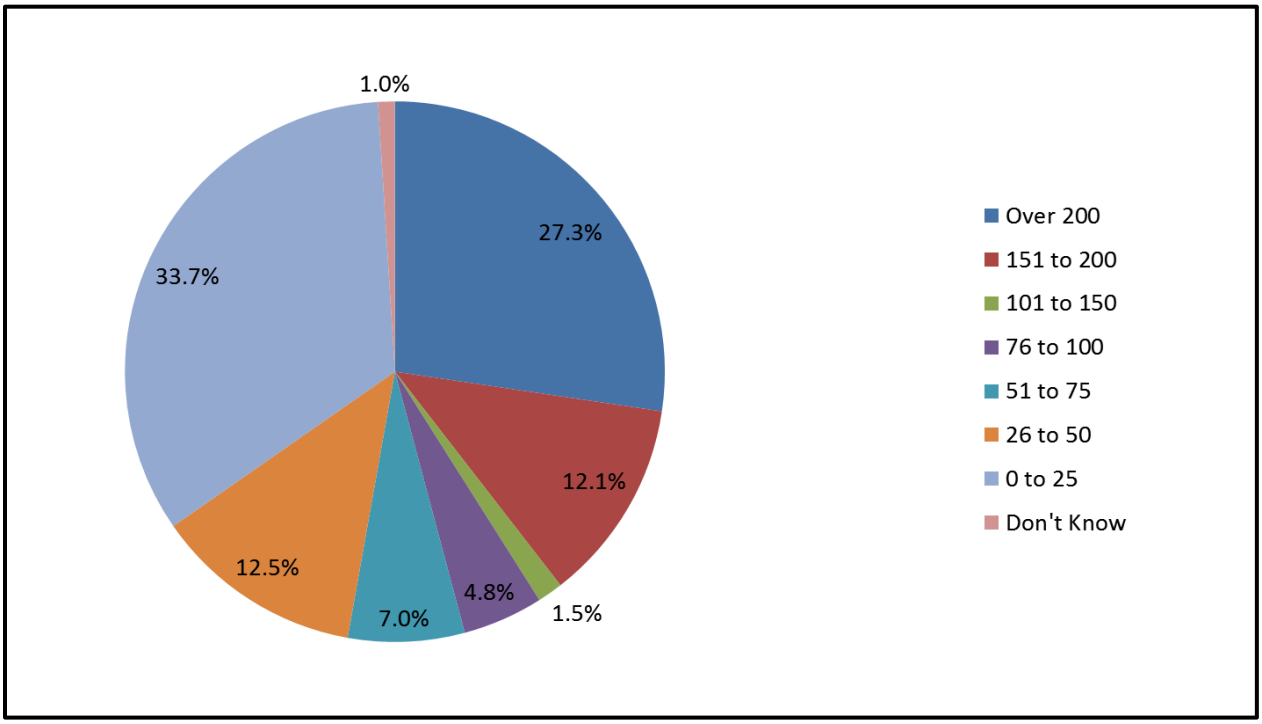


An important caveat to the methodology of the Linear lighting battery was that financial, organizational, and operational questions were specific to the respondent's business location. Since several contractors noted that their business operates from more than one location throughout California, tailoring responses to a specific business location provides a more consistent representation of contractors.

Figure 5-2 provides estimates of the number of lighting installation projects that contractors had completed in 2011-2012. Roughly 34% had completed no more than 25 projects in that period, 27% had completed over 200 and the remaining distribution of projects in between those two ranges were fairly normal. These results indicate that approximately 1/3 of the surveyed contractors completed few job (less than 25), the second third completed 25-200 jobs, and almost one third completed over 200 lighting jobs.

[2] The telephone survey asks to speak with the individual in the organization that is most familiar with the business's involvement in the commercial and industrial lighting business.

Figure 5-2: Number of Lighting Projects Completed in 2011-2012



In addition to the number of projects completed from 2011-2012, the survey asked questions regarding revenues generated from lighting sales and installations to commercial and industrial customers in California. Roughly 99% of lighting contractors surveyed performed lighting installations for commercial and industrial customers throughout the state and 54% sold lighting equipment. The contractors were asked to estimate what percentage of their total revenue was generated from lighting sales and installations (see Table 5-3). These revenue shares represent the contractors that were surveyed and are not weighted. The data show that 68% of contractors reported that lighting sales and installation represented 21-60% of their total revenue, Thirteen percent of contractors claimed that 60% or more of their total revenue was attributed to lighting and 19% of contractors claimed that 20% or less of their overall revenue was generated from lighting sales and installations.[3]

[3] The self-reported share of revenue attributable to lighting sales and installations contributes to the development of weights discussed above.

Table 5-3: Percent of Contractor Revenue from Lighting Sales and Installations

Percent of Lighting Revenue to Total Revenue	Percentage of Contractors
81 to 100	2.8%
61 to 80	10.2%
41 to 60	21.1%
21 to 40	46.6%
11 to 20	15.8%
0 to 10	3.5%

Since one of the key research objectives of CMST is to track recent purchases of Linear lighting systems by nonresidential customers and to estimate the market share of those technologies in California, it is important to have an understanding of where contractors are installing lighting in order to triangulate the data collected by the contractor and end users surveys. The contractors were asked to estimate the percentage of their California lighting revenue that was generated from commercial lighting. Table 5-4 provides a breakdown of the percentage of weighted revenue generated from commercial lighting sales and installations in California in 2011-2012.[4].

Table 5-4: Residential and Commercial Lighting Sales and Installations in CA (2011-2012)

Project Type	% of Sales and Installs
Small Commercial	52.0%
Large Commercial	28.5%
Total Commercial	**80.5%**

The survey also collected data on the share of lighting contractors' commercial and industrial lighting sales and installations that were generated from new construction and from retrofit/remodel projects. This question sheds light on the types of projects being undertaken in California and provides information to compare the efficiency distribution of installed lighting by a contractor's new versus retrofit lighting share. According to the survey results (Table 5-5), 42% of contractors claim that more than 75% of their C&I business was generated from retrofit/remodel projects while 21% of contractors claim that new construction projects represented greater than 75% of their commercial and industrial work. Seventeen percent of contractors reported that they did not engage in any new construction projects and 5% did not engage in retrofit/remodel work. These data suggest that contractors were engaging in retrofit/remodel projects more often than in new construction projects from 2011-2012.

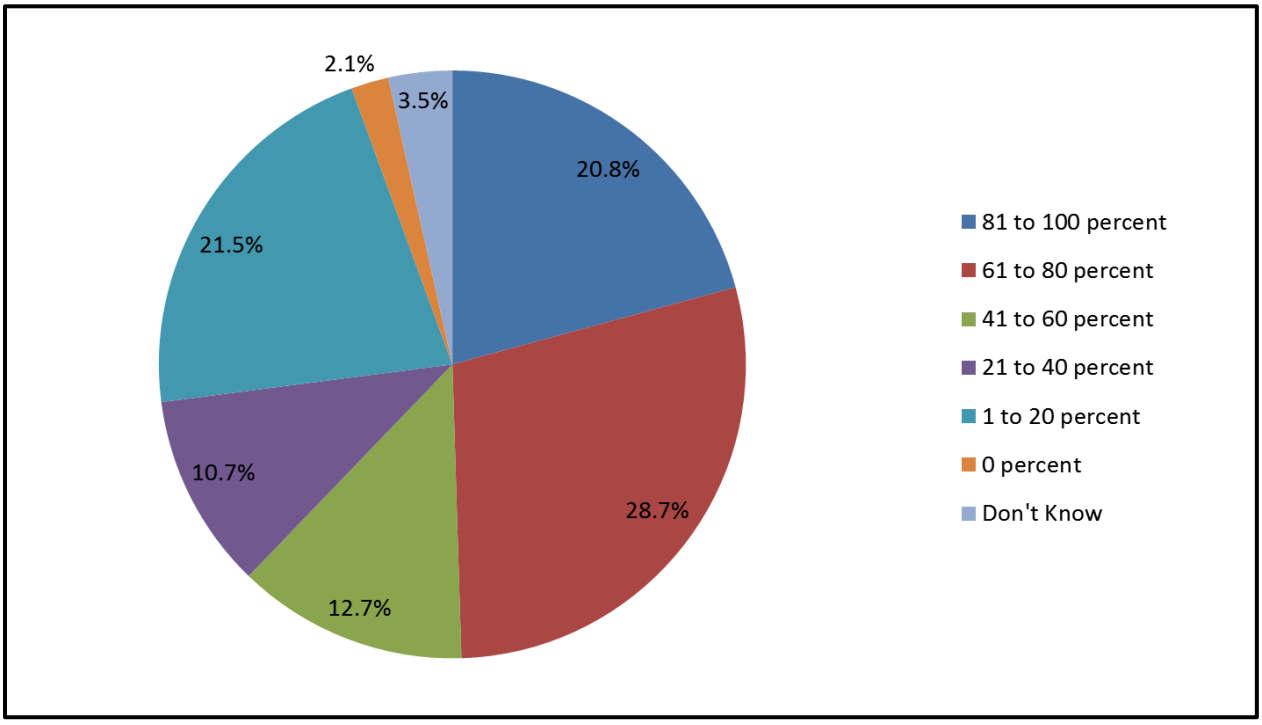
[4] To be included in the JCLS all contractors had to respond that they had sales and installations of lighting in the commercial and industrial sector. This requirement likely increased the share of revenue from the commercial and industrial sector relative to all lighting contractors.

Table 5-5: Percentage of C&I Lighting Contractor Business in New Construction vs. Retrofit/Remodel

Percent of C&I Lighting	New Construction	Retrofit/Remodel
76 to 100	21%	42%
51 and 75	17%	12%
26 and 50	14%	20%
1 and 25	32%	21%
0	17%	5%

Contractors were also asked to quantify the percentage of their total commercial and industrial lighting business that was associated with Linear applications. The range in sales and installations of Linear applications is presented in Figure 5-3. Almost 50% of respondents reported that 60% or more of their C&I lighting sales and installation came from the Linear lighting market. These results illustrate the importance of the Linear technology market for lighting contractors in California.

Figure 5-3: Linear Lighting Business as a Percent of C&I Lighting

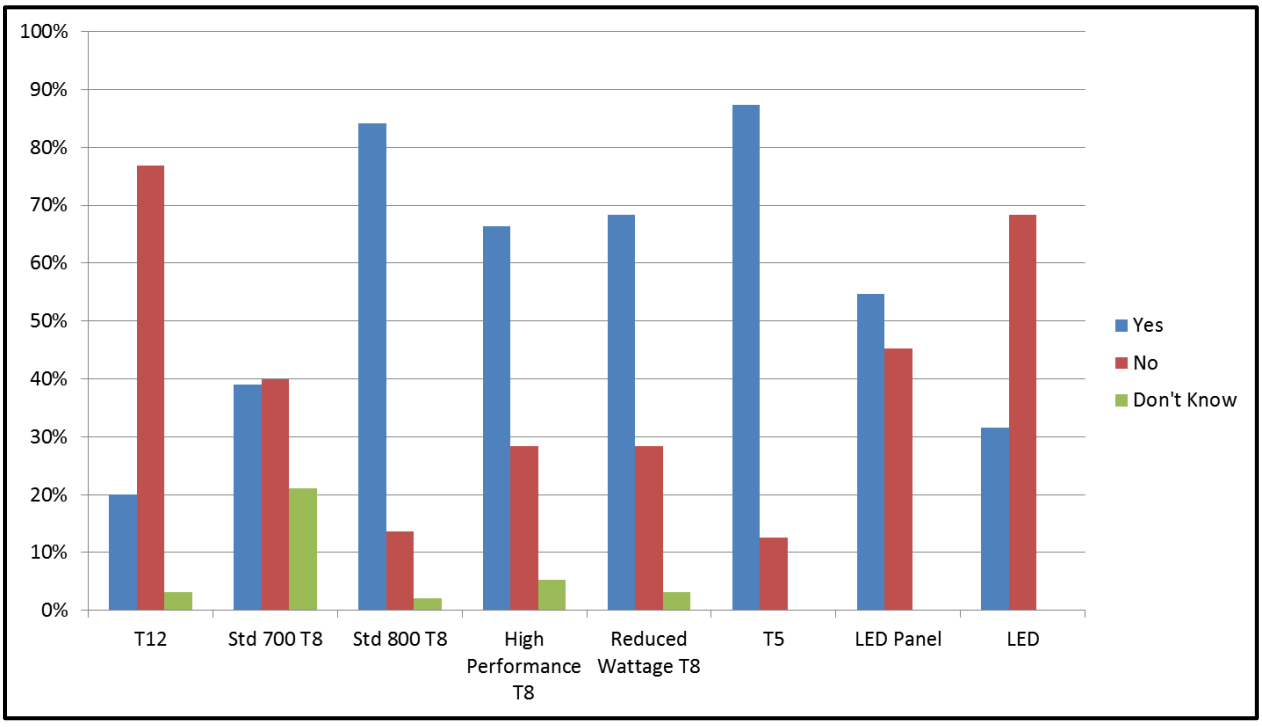


5.5.2 Linear Fluorescent Market Share

Contractors were asked a series of questions to determine the relative efficiency of Linear lighting equipment installed and sold in California during 2011-2012 and the market share of those technologies. Contractors were initially asked whether or not they sold or installed six

different Linear lighting systems (and two LED technologies). Figure 5-4 conveys the results from this series of questions. A significant majority of contractors self-reported that they sold and/or installed Standard 800-Series T8s, High Performance T8s, Reduced Wattage T8s, and T5 technologies. The Standard 700-Series T8 systems, the least efficient of the T8s, were installed by roughly 40% of contractors and only 20% reported installing T12 systems during 2011-2012.

Figure 5-4: Technologies Installed by Contractors in 2011-2012



Contractors were asked to estimate the percentage of their location's total California lighting revenue that was generated from commercial and industrial sales and installations. The contractors were also asked to estimate what percentage each of the lighting technologies made up of all their Linear fixture sales and installations from this location. The self-reported Linear technology shares have been applied to the firm's lighting revenue to determine the efficiency distribution of fixtures sold and installed in 2011-2012.

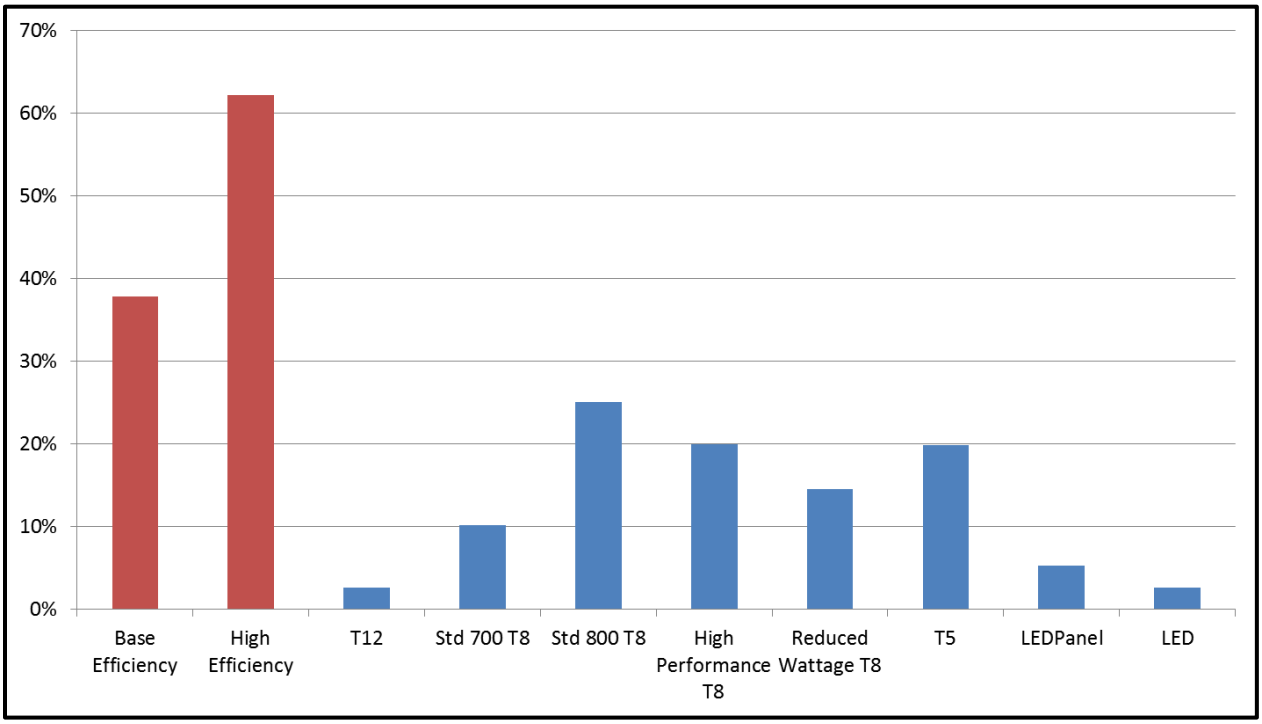
Table 5-6 and Figure 5-5 convey the distribution of Linear lighting sold and installed by Base Efficiency and High Efficiency technologies. Base equipment includes T12, Standard 700-Series T8 and Standard 800-Series T8. The High Efficiency lighting includes High Performance T8, Reduced Wattage T8, T5, and the two LED systems. These data suggest that the majority of lighting being installed by contractors is High Efficiency lighting. Base efficiency lighting represents 38% of Linear lighting sold and installed.

The Base and High Efficiency distributions can also be disaggregated into their individual lighting components. The most frequently installed Base Efficiency equipment was Standard 800-Series T8 with an estimate of 25% of lighting sales and installations or 66% of Base Efficiency sales and installations. The contractor self-reported sales and installation of High Efficiency equipment is approximately evenly distributed between High Performance T8 (20%), Reduced Wattage T8 (15%) and T5 (20%).

Table 5-6: Linear Lighting Market Share by Base and High Efficiency (2011-2012)

Technology	Market Share	Relative Precision
Base Efficiency	38%	13%
High Efficiency	62%	8%
Base Efficiency Technology Distribution		
T12	3%	
Std 700 T8	10%	
Std 800 T8	25%	
High Efficiency Technology Distribution		
High Performance T8	20%	
Reduced Wattage T8	15%	
T5	20%	
LED Panel	5%	
LED	3%	

Figure 5-5: Linear Lighting Market Share by Base and High Efficiency (2011-2012)



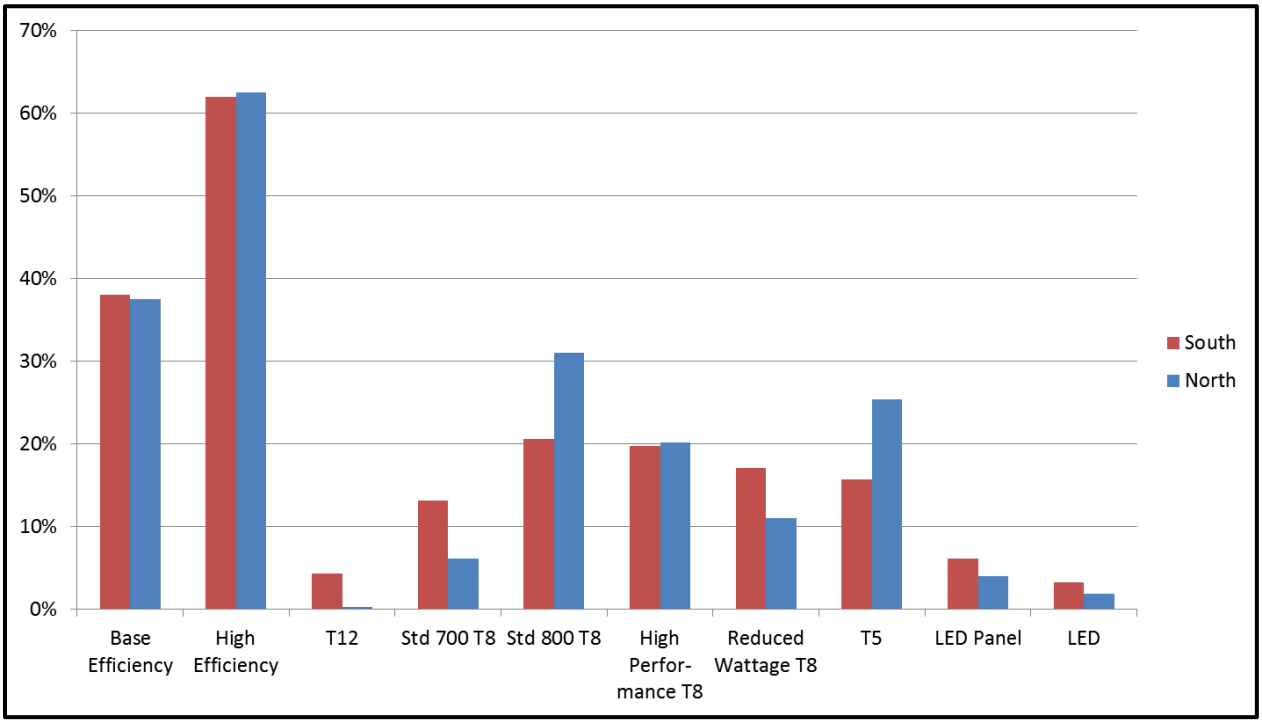
Linear Technology Efficiency Distribution by Geographic Region

The market share and efficiency of Linear lighting technologies sold in California throughout 2011-2012 can also be disaggregated further based on the contractors' geographic location – northern California or southern California. Table 5-7 and Figure 5-6 convey those distributions. Overall, Base Efficiency equipment represents 37.5% of Linear lighting sold and installed in northern California and 38% in southern California. While the overall market shares of Base and High Efficiency equipment for each geographic region are very similar, the market shares are different when examined by technology distribution. T12 and Standard 700-Series T8 account for 17% of all lighting sold and installed in southern California while those technologies represent 6% in northern California. The vast majority of Base Efficiency equipment being installed in northern California was Standard 800-Series T8 (83% of all Base Efficiency equipment). The distribution of High Efficiency equipment is similar for both regions with the exception of Reduced Wattage T8 and T5. Reduced Wattage T8s account for 17% of sales and installations for southern contractors and 11% for northern contractors and T5 accounts for 25% of the market share in northern California relative to 16% in southern California.

Table 5-7: Distribution of Linear Technologies by Geographic Region (2011-2012)

Technology	North	South
Base Efficiency	37.5%	38.0%
High Efficiency	62.5%	62.0%
Base Efficiency Technology Distribution		
T12	0%	4%
Std 700 T8	6%	13%
Std 800 T8	31%	21%
High Efficiency Technology Distribution		
High Performance T8	20%	20%
Reduced Wattage T8	11%	17%
T5	25%	16%
LED Panel	4%	6%
LED	2%	3%

Figure 5-6: Distribution of Linear Technologies by Geographic Region (2011-2012)



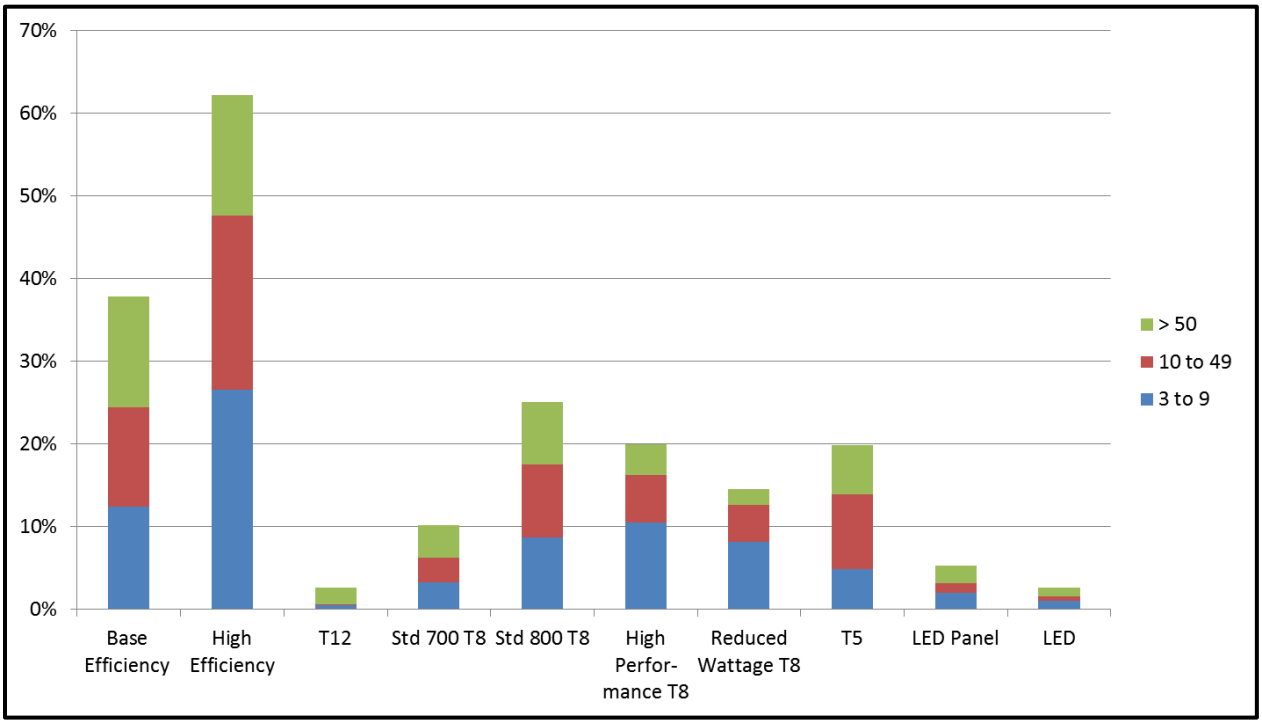
Linear Technology Efficiency Distribution by Contractor Size

The Linear technology efficiency share data can be disaggregated by the size of contractor, represented by their number of employees. Roughly 42% of contractors employed 3 to 9 individuals, 42% employed 10 to 49 individuals and 13% employed greater than 50 individuals. In terms of revenue, contractors that employed 3 to 9 individuals accounted for roughly 39% of

all commercial and industrial Linear lighting sales and installations followed by the 10 to 49 group (33%) and the greater than 50 group (28%).

The data in Figure 5-7 represent the share of each Linear technology to the total market share of Linear lighting by size of contractor. These data indicate that 62% of Linear lighting installed is High Efficiency and that contractors that employed 3 to 9 individuals accounted for 43% of the High Efficiency sales and installations, contractors with 10 to 49 employees installed 34% of the High Efficiency lighting, and 23% were installed by contractors with greater than 50 employees. Looking at High Efficiency technologies, roughly 52% of all High Performance T8 lighting and 57% of Reduced Wattage T8 were installed by contractors that employed 3 to 9 individuals. Forty six percent of T5 lighting was installed by contractors that employ 10 to 49 individuals. In contrast, contractors employing great than 50 individuals installed approximately 75% of the T12 and 40% of the Standard 700-Series T8 lighting. Turning to LED, these self-reported data indicate that contractors employing 3 to 9 and greater than 50 individuals installed the majority of LED technologies (80% total).

Figure 5-7: Distribution of Linear Technologies by Contractor Size (2011-2012)



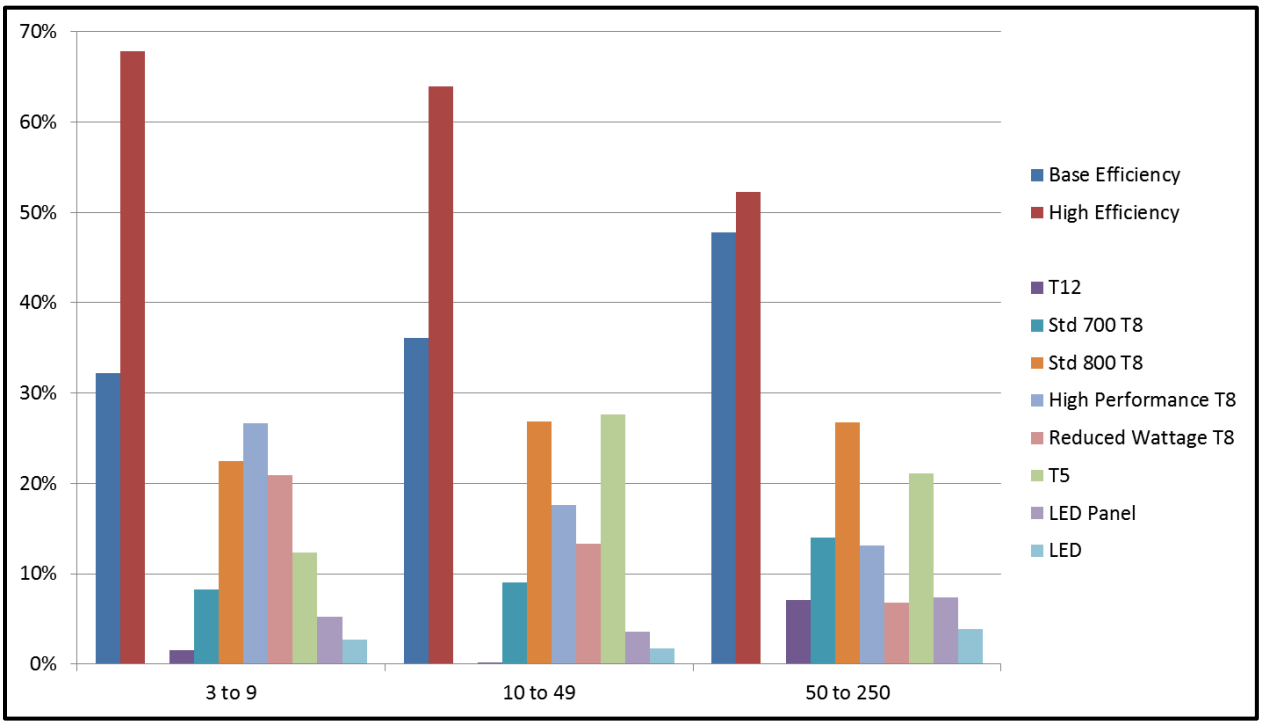
Alternatively, the data can be viewed by the distribution of efficiency and market share of Linear lighting for each size group of contractors (see Figure 5-8). As evidenced in the self-reported data, the smaller sized contractors report that a higher share of their sales and installations are High Efficiency lighting than larger contractors. Efficient lighting represents roughly 68% of all

sales and installations for contractors employing 3 to 9 individuals, 64% for those with 10 to 49 employees, and only 52% of sales and installations for those with more than 50 employees.

High Performance T8 represents the greatest share of Linear lighting (27%) installed by contractors with 3 to 9 employees followed by Standard 800-Series T8 (22%) and Reduced Wattage T8 (21%). Standard 800-Series T8 (27%), T5 (27%) and High Performance T8 (18%) represent the vast majority of sales and installations for contractors with 20 to 49 individuals. T5 lighting represents 21% of sales and installations for large contractors while their Base Efficiency technologies represent roughly 48% of their total. Analyzing the contractor data using pairwise t-tests that compare the efficiency distributions observed for Large contractors with Medium and Medium with Small contractors, the observed efficiency differences are not statistically significant.

The data on the relationship between contractor size and the efficiency distribution of lighting installed provides some evidence that smaller sized contractors are slightly more likely to install High Efficiency lighting than larger contractors. These findings may indicate that utility education programs need to ensure that larger contractors are well informed about High Efficiency lighting and the IOU energy efficiency programs that work to encourage the installations of these technologies.

Figure 5-8: Distribution of Lighting Efficiency Sales and Installations by Contractor Size



5.5.3 Contractor Knowledge and Behavior Due to T12 Phase-Out

Despite not having longitudinal data to compare against, the low market share of T12 and 700-Series T8s suggest, in part, that the 2009 General Service Lamp legislation, which called for the phasing out of T12 lamp production in July 2012 and 700-Series T8s in July 2013, is having an effect. It is also likely that long-standing utility programs and rebates have encouraged the installation of more efficiency technologies. These data are also consistent with shipment information compiled in a news report released by NEMA in March 2013.[5] According to their sales index, T5 sales have increased by roughly 57% since base year 2006 with a major uptick from late 2009 through 2011. T12 sales have decreased by roughly 75% and T8 sales have increased by 3% throughout the fourth quarter of 2012. While these are national sales figures, the measured increase in T5 sales provides support to the self-reported estimates made by California contractors. It is difficult to discern trends in the T8 market since the NEMA shipment data for T8 technologies is not disaggregated by technology.

The decrease in national sales of T12 lighting from 2006-2012 and the low market share uncovered in the lighting contractor survey may be explained by several factors. The 2009 General Service Lamp legislation, which called for the phasing out of T12 lamp production in July 2012 and 700-Series T8s in July 2013, has certainly affected the supply of these technologies on the market. Supply limitations brought on by phase-outs may explain some of this, but behavioral and economic effects may play a role as well. Increased public awareness regarding the real and/or perceived market availability of these technologies has, perhaps, prompted a behavioral shift in the contractors selling and installing the equipment and their customers as well. In an effort to capture these potential behavioral shifts, the survey asked contractors a series of questions regarding their knowledge of the T12 phase-out and if they communicate that knowledge to their customers. Table 5-8 provides those results. It is clear that a vast majority of contractors are aware of the T12 phase-out (86%) and most of them communicate that information to their customers before selling them or installing Linear lighting equipment. Likewise, a majority of contractors (63%) believe that the phase-out has influenced their customers' decisions to retrofit their existing T12 systems earlier than they would have absent the phase-out.

[5] http://www.nema.org/News/Pages/Linear-Fluorescent-Lamp-Shipments-Wane-During-2012.aspx

Table 5-8: Contractors Knowledge of T12 Phase-Out and Influence on Customers' Retrofit Decisions

Survey Questions	Yes	No	Don't Know
Are you aware of the new law that came into effect in July of 2012 that has phased out the production of most T12 Linear Fluorescent lamps?	85.6%	14.4%	0.0%
Do you inform your customers of the T12 Linear Fluorescent lamp phase-out?	81.9%	16.5%	1.7%
Do you think the T12 phase-out has had an influence on your customers' decisions to retrofit their existing T12 systems earlier than they otherwise would have?	62.6%	30.7%	6.7%

As stated earlier, while the contractors were questioned about their sales and installations of Linear lighting from 2011-2012, the survey was administered in 2013. The survey battery included a series of questions that aimed to qualify whether or not the contractors had shifted their sales and installations of Linear lighting technologies throughout that time period. If a contractor had claimed to have sold T12 lighting in 2011-2012, for example, they were also asked if the share of those sales and installations had increased, decreased or remained the same since July 2012. Table 5-9 conveys self-reported information on the change in sales and installations of Linear technologies since July 2012. Of the 19 contractors that claimed to have installed T12 lighting in 2011-2012, 26% reported a decrease in sales and installations while 74% claimed that their T12 business has remained the same. The contractors that were installing LED lighting in 2011-2012 experienced the greatest increase in sales and installations, followed by High Performance T8.

While no quantitative results can be elicited from these data, it does lend support to the shipment data supplied by NEMA. The 3% increase in T8 shipments from base year 2006 through the fourth quarter of 2012 suggest that, perhaps, the overall sales and installations of T8 lighting has not changed substantially, but the share of technologies within the many different efficiency levels of T8s being sold and installed has shifted from Base Efficiency Standard 700- and 800-Series T8s to High Efficiency High Performance and Reduced Wattage T8 measures.

Table 5-9: Contractor Self-Reported Change in Linear Sales and Installations from July 2012 through 2013

Technology	Increase	Decrease	Same	*n*
T12	0%	26%	74%	**19**
Std 700 T8	3%	22%	75%	**37**
Std 800 T8	11%	21%	68%	**80**
High Performance T8	40%	10%	50%	**63**
Reduced Wattage T8	27%	14%	59%	**65**
T5	27%	15%	58%	**83**
LED Panel	52%	15%	32%	**52**
LED	75%	0%	25%	**30**

6

CMST Linear Fluorescent Contractor and End User Comparison

This section provides a comparison of the findings of the CMST-Linear contractor and end user findings. The CMST-Linear contractor findings are derived from self-report information on Linear technology sales and installations in the non-residential sector in California during 2011 and 2012. The CMST-Linear end user findings are derived from on-site data collection for Linear Fluorescents where the site contact self-reported that the Linear technology was purchased after January 2009. The CMST end user efficiency distributions are present for Linear technologies installed from 2009-2012 and from 2011-2012.

6.1 Sources of Data

The comparison gathers data from:

- Lighting Contractor Survey,
- CMST/CSS Phone Survey,
- CMST On-site Survey, and
- Make and Model lookups.

Each data source listed above provided specific information that was used in this analysis. The information from the Joint Lighting Contractor Survey (JLCS) provided specific organizational and operational details of lighting contractors in California. In the JLCS the lighting contractors were asked to self-report the share of their sales and installations of Linear lighting technologies during 2011 and 2012. The CMST/CSS phone survey was used to identify recent purchasers of Linear measures and to recruit for on-site data collection. The CMST On-site Survey was used, along with the make and model lookups, to capture the efficiency distribution of new Linear Fluorescent lighting installed on-site from 2000-2012.

6.2 Results Comparison

The Joint Lighting Contractor Survey and the CMST On-site end user survey both provide information on the distribution of Linear Fluorescent technology installed in non-residential

facilities in California from 2011 to 2012. The self-reported lighting contractor data and the on-site end user data are presented in Table 6-1. The estimated distributions of Base and High Efficiency lighting installed from both the contractor and end user surveys are very similar. The contractor survey estimated that 38% of non-residential Linear lighting sold and installed in California (2011-2012) was Base Efficiency, while the end user survey estimated that 30% of Linear technologies installed from 2011-2012 were Base Efficiency This share is 46% if the time period is extended to 2009-2012. The lighting contractor and end user estimates of the share of Base Efficiency installations are similar, lending support to the likelihood that the Base Efficiency share is between 30% and 38% for the time period 2011-2012.[1]

Table 6-1: Contractor and End User Distribution of Linear Lighting Technologies

Technology	Contractor Market Share 2011-2012	End User Installations 2011-2012	End User Installations 2009-2012
Base Efficiency	38%	30%	46%
High Efficiency	62%	70%	54%

* **The end-user results presented above have been weighted by site weight.**

The Base and High Efficiency groups can be disaggregated into specific Linear technologies. The Base Efficiency group includes T12, Standard 700-Series T8, and Standard 800-Series T8. The High Efficiency group is disaggregated into High Performance T8, Reduced Wattage T8, T5, and Linear LED. Table 6-2 lists the estimated efficiency share distribution of newly installed Linear technologies for specific measures from the contractor survey (2011-2012) and the end user survey for installations from 2011-2012 and from 2009-2012. The data presented in Table 6-2 show that there are considerable differences between the estimated efficiency shares for these two surveys when the Base and High Efficiency shares are disaggregated into measures.

The self-reported contractor efficiency estimates indicate that Standard 700-Series T8 measures accounted for 10% of sales and installations, while Standard 800-Series T8 measures represent 25%. Turning to the end user survey, the on-site data for installations in 2011 and 2012 indicate that Standard 700-Series T8 measures accounted for 20% of new installations, while Standard 800-Series T8 measures represent 9%. While these distributions are not starkly different, they are also not highly similar. Summing the distributions for these two Standard Series T8 measures, lighting contractors estimate that these lamps represent 35% of installations, while end user data supports 29%.

Turning to the High Efficiency Linear measures, the lighting contractor and the end user results are similar for the share of High Performance T8 but are dissimilar for the remaining High

[1] The end user Base Efficiency share of 30% is not statistically significantly different from the Contractor share of 38% using standard t-test values.

Efficiency technologies. The end user survey leads to a Reduced Wattage T8 efficiency share estimate of 43% for the 2011-2012 period, while the contractor survey leads to an estimate of 15% for the same technology.[2] The T5 estimates are also very different, with lighting contractor data supporting a 20% efficiency share and end user data indicating a 6-9% share.[3] For T5s, the lighting contractor share and the end user share are statistically significantly different using accepted t-test values.

Table 6-2: Contractor and End User Distribution of Linear Lighting Technologies for Specific Linear Measures

Technology	Contractor Market Share 2011-2012	End User Installations 2011-2012	End User Installations 2009-2012
Base Efficiency			
T12	3%	<1%	<1%
Std 700 T8	10%	20%	30%
Std 800 T8	25%	9%	15%
High Efficiency			
High Performance T8	20%	21%	25%
Reduced Wattage T8	15%	43%	20%
T5	20%	6%	9%
LED Panel	5%		
LED	3%	<1%	<1%

* **The end-user results presented above have been weighted by site weight.**

Differences in results from the end user and contractor surveys could be attributed in part to sampling differences between the two analyses. Contractors who participated in this study could have a larger interest in specific business types, or a focus on specific technologies which would affect the overall distribution of Linear measure installations reported by them. Given the development of the lighting contractor sample frame, the lighting contractor survey does not account for installations made directly by business owners or facility managers.

When reviewing the reliability of these data, both data sources also likely include self-report error. Contractors are asked to self-report their distribution of sales and installations for eight different Linear lighting measures over the previous two years. While it is reasonable to assume

[2] Using standard t-test significance values, the contractor and end-user 11-12 Reduced Wattage share are statistically significantly different.

[3] The share of T5 installations is likely to be very sensitive to the contractors and the businesses included in the surveys. T5 applications are very specific, largely representing Linear lighting in high bay applications. If the contractors that we spoke with tend to install lighting in these applications, this may help to explain the higher contractor share. The lower end user share for T5 lighting may also be explained by a lower share of industrial businesses within the CMST end user survey as this business type was not included in the CSS survey.

that contractors estimate these shares to their best ability, it is unlikely that they examined their actual sales data during the telephone survey. Asking contractors to disaggregate their sales into eight different Linear lighting technologies may lead to increased error, leading to reliable Base and High Efficiency estimates but less reliable measure specific shares. End users are asked to report the purchase of new lighting measures and the year of the purchase. It is clear that end users self-reported purchases that didn't occur and forgot to report actual purchases.[4] The make and model look ups implemented for the on-site data, however, support the conclusion that the distribution of new Linear technologies found on-site is accurately classified into specific measures.

In conclusion, as seen in this and other research efforts, self-reported data can provide an accurate depiction of high level information (Base versus High Efficiency), but detailed sales or on-site information is needed to better estimate measure specific efficiency distributions. Both of these sources of information, the self-reported contractor sales distributions and the on-site information are valuable, providing a unique set of information.

6.2.1 Conclusions and Recommendations

Overall, the CMST lighting contractors' survey and the Commercial Market Share Tracking end users on-site data provide complementary results regarding the efficiency and market share of linear lighting systems in California. The results are produced using very different methodologies. The CMST onsite efforts covered a 4 year period (2009-2012) while the lighting contractor survey was designed to cover sales and installations for a 2 year period (2011-2012). The vendor survey included high level questions regarding the percentage of sales and installations for each linear technology while the CMST study took a much more granular approach to determine the market share and efficiency of linear lighting in California – an extensive onsite data collection effort and make and model lookup. However, comparing the results from the supply side perspective with those of the end user provides an additional metric in determining the efficiency and market share of linear lighting systems installed in commercial settings in California.

The data from the contractor survey provides additional data on the relationship between contractor size and efficiency sales and installations that are not available from the end users survey. These data indicate that smaller sized contractors have a higher share of their sales and installations in High Efficiency linear technologies than larger sized contractors. These findings may have implications for future IOU education efforts.

[4] Data in the CMST End Users Linear Fluorescent Analysis section show that 345 telephone survey respondents indicated that they installed Linear technologies, agreed to an on-site and an on-site was undertaken. For 79 of the 345 sites, however, no new Linear technologies were found on-site. These data clearly support the conclusion that end users self-report purchases with error.

The lighting contractor survey provides a relatively cost-effective approach to collecting information on recent sales to non-residential customers. Linear lighting has been the focus of recent and on-going standards updates and has been a prime component of non-residential energy efficiency programs therefore, it is reasonable to assume that the non-residential lighting market will continue to go through significant change in the short term. The speed of change within this market necessitates frequent data collection efforts to help maintain an up to date understanding of the current market trends. Energy Division staff acknowledge that lighting contractor surveys may provide substantial information to the IOUs, CPUC, and evaluation community if they reoccur every one to three years and will consider this matter in the future.

The end user on-site CMST lighting survey provides a unique set of information on the current distribution of recent installations within the non-residential market by customer size, business type, and program participation. The ability to disaggregate the efficiency distribution by these characteristics provides the interested parties with information that impact our understanding of baselines, standard practices, provides information on potential spillover, and will help the IOUs update future non-residential lighting programs. Combining the CMST data collection effort with the CSS on-site data collection activities led to economies of scale for both projects. Energy Division staff acknowledge that continuing to implement the CMST on-site lighting survey with large population surveys like the Commercial Saturation Survey may provide the CPUC, IOUs, and evaluation community with a unique time series of information on recent linear lighting purchases that can be disaggregated by domains of substantial interest. This issue will be considered in the future.

7

CMST TV Analysis

TVs are one of the three high priority measures chosen for the CMST analysis. Advances in TV technology have created a push toward increased energy efficiency. The ENERGY STAR rating for TVs has been updated three times during the 2009-2012 time period. Anecdotal evidence also indicates that the number of TVs and the share of businesses with TVs are rising over time. Through the process of telephone and on-site surveys, the end user CMST-TV study documents the current purchasing behavior of California businesses.[1] This analysis describes the purchasing behavior of non-residential customers for TVs during this period of technology advancement. The analysis examines the purchasing behavior by year, IOU, customer size, business type, and new construction/remodel versus direct TV purchases. These characteristics of the purchasers or the time of purchase help to illustrate the TV market in ways that are of interest to program planners and regulators, showing how the energy efficiency share of TV purchases is evolving.

The end user CMST-TV data is derived from several sources: telephone surveys, on-site surveys, and make and model lookups to determine the TV efficiency levels. Unlike CMST-Linear measures, there are no site specific energy efficiency programs geared towards the purchase of energy efficient TVs. The following sections describe and analyze the data that was collected as part of the end user CMST-TV analysis.

7.1 Sources of Data

Information on recent purchases of TVs (2009-2013)[2] was collected during the telephone and on-site survey. During the telephone survey, sites were asked if they have purchased any new TVs since January 2009. If the site purchased TVs, they were asked to list the types of TVs and the number of TVs purchased. Those sites that self-reported that they had purchased TVs were recruited to participate in on-sites surveys to collect additional verification information.

[1] The CMST analysis for TVs relies solely on the on-site end user analysis. This analysis differs from those for Linear technologies and small packaged air conditioning units in that there is no contractor survey for TVs.

[2] There was very little opportunity for end users to purchase TVs in 2013 and be observed for this analysis. Very few surveys were completed in 2013. Due to the lack of a full year's-worth of 2013 purchase data, the 2013 purchasers have been included with the 2012 purchasers. These data can be separated upon request, but the small number of sites surveyed in 2013 implies that the 2013 installations are not representative of installations for the entire 2013 period.

The CMST-TV on-site visits target facilities which claimed during the telephone survey to have purchased and installed new TV measures since 2009. During the on-site survey, data was collected on the year the technologies were purchased, the number of new TVs purchased for the facility, and the make and model number of these new technologies.

Additional CMST-TV sites were also developed from the CSS on-site surveys. While at a CSS site, the surveyor performs an entire inventory of all TVs at a facility, including the collection of make and model number information. Site contacts were also questioned about the vintage of the televisions. If a surveyor found TVs at a CSS site that met the criteria for CMST (installed since 2009), these technologies were CMST-eligible and the site became a dual CSS-CMST site.

Using the make and model number information collected during the on-sites, the research team determined the type and efficiency level of the televisions. As part of the make and model number lookup, the CSS/CMST research team requested and received make and model number tables from ENERGY STAR. These tables identify TVs that qualify for all ENERGY STAR efficiency levels since 2009. These data, combined with web-based make and model lookups were used to identify if the new TV was an ENERGY STAR TV and if so, the corresponding ENERGY STAR efficiency version.

Performance groups for TVs were established by matching the on-site data with quarterly ENERGY STAR Qualifying Products Lists from 2009-2013, corresponding with ENERGY STAR ratings of 3.0, 4.1, and 5.3.[3] Table 7-1 lists the ENERGY STAR version numbers and their applicable time period. The end user purchase information collected as part of the on-site survey only indicates the year of purchase. Given the data collected on-site, all Version 3.0 televisions are considered High Efficiency measures for 2009 and 2010 even though they are no longer considered High Efficiency by ENERGY STAR after April 2010. Similarly, Version 4.1 is considered High Efficiency for the years 2009, 2010, and 2011 even though they are only ENERGY STAR High Efficiency through September 2011. For TVs not found on the ENERGY STAR list, they were put into groups based on ENERGY STAR standards comparing the relationship between TV screen area and on-mode power consumption. Screen areas were calculated for the on-site TV inventory using Pythagorean relationships between diagonal screen size and aspect ratio.

[3] The official ENERGY STAR Product List was provided to Itron by ICF International with the permission of ENERGY STAR. The list included qualified products for 2009, 2010, 2011, 2012, and the first quarter of 2013.

Table 7-1: Energy Star Version Number and Eligibility Dates

ENERGY STAR	Start Date	End Date	High Efficiency Years for Study
Version 3.0	October 2008	April 2010	2009, 2010
Version 4.1	April 2010	September 2011	2009, 2010,2011
Version 5.3	September 2011	June 2013	2009, 2010, 2011, 2012

For the TV make and model lookups, if the TV was not in the ENERGY STAR efficiency lists, it was often difficult to collect efficiency data from the web-based lookups. Given that the research team has the ENERGY STAR make and model catalog for all measures with an ENERGY STAR rating for 2009-2012, it is likely that most of the TVs whose efficiency level is officially not classified are, in fact, non-ENERGY STAR units.

A total of 7,890 telephone surveys with CMST-eligible businesses were completed from November 17, 2011 to May 9, 2013. The phone surveys questioned the respondent to determine if the facility had purchased a TV since 2009. Of the 7,890 telephone survey respondents, 1,866 reported purchasing TVs, or approximately 24% of telephone survey respondents. The 1,866 sites that reported purchasing TVs were asked to participate in the on-site data collection effort; 710 or 38% of these sites agreed to participate. See Table 7-2 for a distribution by business type of the telephone survey sites reporting new TV purchases.

Table 7-2: CMST TV Telephone Distribution by Business Type

Business Type	Phone Survey Completes	CMST Phone Survey TV Sites	% Self-Reported (Overall)	Recruited CMST-TV Sites	Share of CMST-TV Recruits
College	29	9	31%	3	33%
Food/Liquor	486	82	17%	37	45%
Health/Medical Clinic	633	195	31%	77	39%
Health/Medical - Hospital	59	34	68%	9	26%
Hotel	199	131	66%	26	20%
Industrial	695	126	18%	19	15%
Misc.	1,637	387	24%	169	44%
Office	1,314	262	20%	107	41%
Restaurant	595	181	30%	87	48%
Retail	1,019	200	20%	67	34%
School	479	112	23%	58	52%
Warehouse	745	147	20%	51	35%
Total	**7,890**	**1,866**	**24%**	**710**	**38%**

During the telephone survey, 710 sites that were identified as CMST-eligible TV sites agreed to participate in the on-site data collection effort. The survey team undertook 419 on-sites for these 710 sites, of which 344 or 82% were found to have new TVs on site (see Table 7-3). When visiting CSS sites that had stated during the telephone survey that they had not purchased new TVs, 141 sites were found to have CMST-eligible TVs. On-site surveys, therefore, have been completed for 485 CMST-eligible TV sites.

Table 7-3: CMST TV On-site Distribution by Business Type

Business Type	Recruited CMST-TV Sites	PS CMST-TV On-Sites Completed	PS CMST-TV Recruits & OS TVs Found	Share of PS CMST-TV Sites Found TVs OS	Sites with New TVs (TVs not ID'd on PS)	Total Sites with New TVs
College	3	1	1	100%	0	1
Food/Liquor	37	23	21	91%	16	37
Health/Medical Clinic	77	51	45	88%	17	62
Health/Medical - Hospital	9	3	3	100%	0	3
Hotel	26	15	15	100%	0	15
Industrial	19	12	11	92%	1	12
Miscellaneous	169	84	72	86%	25	97
Office	107	62	51	82%	22	73
Restaurant	87	54	45	83%	16	61
Retail	67	52	44	85%	18	62
School	58	36	15	42%	11	26
Warehouse	51	26	21	81%	15	36
Total	**710**	**419**	**344**	**82%**	**141**	**485**

7.2 CMST Telephone Survey

Every facility that participated in an on-site visit first participated in a phone survey. A total of 7,890 phone surveys were completed. The phone surveys attempted to find out whether or not the facility had purchased and installed TVs since 2009, and if they had, what type and size TV was installed. Large and Medium sites were more likely to self-report having purchased new TVs since 2009 than Small and Very Small sites.

The telephone survey asked respondents about the type and size of TV they purchased. The results from the telephone survey show that LCD TVs were the most common type of TVs purchased. The most common size of TV was 42-60 inches. The findings from the telephone survey indicate that TVs at business locations were most commonly purchased at Costco and Best Buy. The in-depth results of the telephone survey analysis have been described separately

in the Commercial Saturation and Commercial Market Share Tracking Study Telephone Survey Findings report.

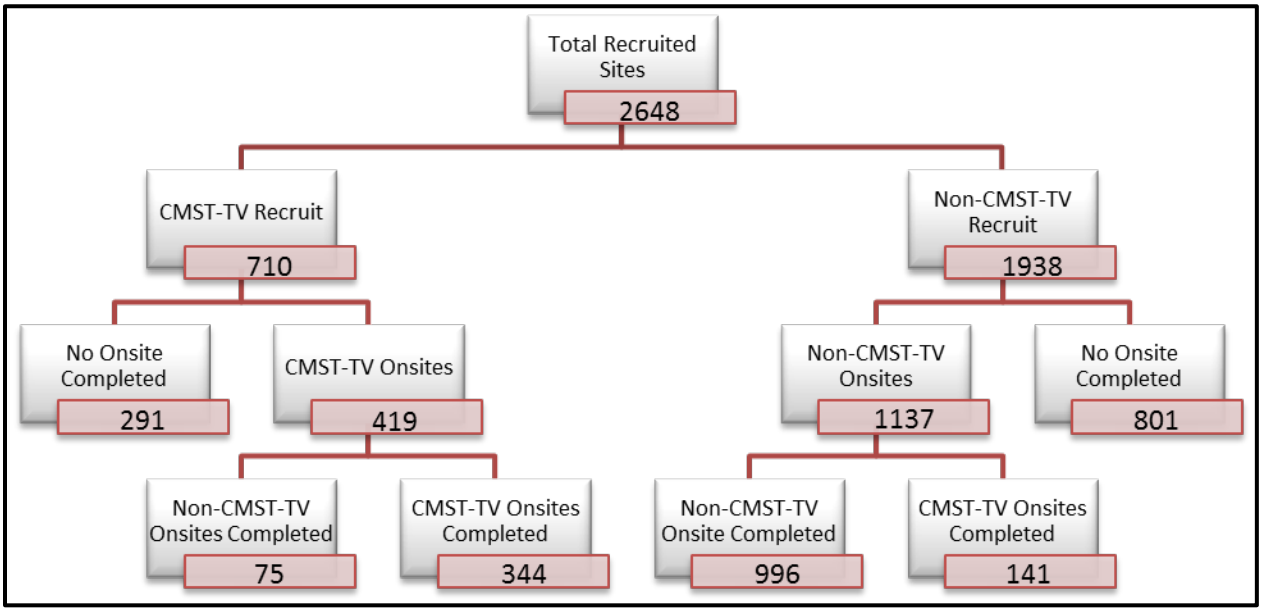
Recent purchasers of TVs were recruited to participate in the CSS and CMST on-site survey. As part of the on-site survey, make and model numbers were collected from TVs. This information has been analyzed to determine the efficiency level of recent TV purchases.

7.3 CMST-TV On-Site Survey

Every on-site survey that was recruited first underwent a rigorous phone survey battery where information on the business, building type, business hours, and equipment on-site was collected. Finally, these phone survey participants were asked whether or not they were interested in participating in an on-site survey also. On-site surveys are the most accurate way to collect baseline data on measure efficiency.

The data collected through the 7,890 phone surveys and an additional 1,556 on-site visits gathered data on the quantity of new TVs purchased since 2009. During the phone survey, the contact was asked for details on the type and size of new TVs purchased.

Figure 7-1: Sites with CMST-Eligible TVs



Overall 2,648 sites were recruited during the telephone survey for on-site visits as displayed in Figure 7-1. Out of the recruited sites, 710 were recruited as CMST-TV[4] sites, while 1,938 were

[4] These CMST-TV sites may have been also recruited for CMST-HVAC or CMST-Linear sites, but for the purposes of the TV analysis we are not concerned with the other CMST-eligible equipment types.

recruited as Non-CMST-TV Recruits.[5] The Non-CMST-TV Recruits were split into two groups; 1,137 CSS & Non-CMST-TV on-sites and 801 where no on-sites were completed. Similarly, the CMST-TV recruits were split into 419 CMST-TV on-sites and 291 where no on-sites were completed. Finally, each of these two groups, where on-sites were performed, were once again each split into two groups; those where CMST-TV measures were found on-site, and those where no CMST-TV measures were found on-site.

On-site surveys have been completed for 485 CMST-TV eligible sites. Of these, CMST-eligible TVs were found at 141 sites not determined to be CMST sites during the phone survey process. The remaining 344 CMST-TV sites are sites that self-reported installing new TVs during the telephone survey. Of the 419 sites visited as self-reporting CMST-TV sites, 75 sites were visited where the contact claimed to have installed CMST-eligible TVs over the phone, but when the surveyor arrived on-site, no CMST-eligible TVs were found.

7.3.1 Sites Purchasing TVs

CMST-TV data has been collected at 485 sites. These data have been analyzed and weighted. Using these data, the research team developed an estimate of the number of sites purchasing TVs in the CMST-eligible frame and the average number of TVs purchased by all CMST-eligible sites. Table 7-4 lists the site-weighted estimate of the share of businesses purchasing TVs within the CMST non-residential frame. The CMST-TV data collected as part of the on-sites indicate that over a quarter of PG&E's non-residential businesses purchased new TVs from 2009 to 2012 while 25% of SCE and 22% of SDG&E's non-residential businesses are estimated to have purchased new TVs during this time period.

Table 7-4: CMST Sites Installing TVs*

Utility	Sites in Frame	Share of Sites Purchasing TVs
PG&E	392,294	26%
SCE	462,944	25%
SDG&E	99,495	22%

*** The results presented above have been weighted by site weight**

During the development of the CMST on-site survey effort, many concerned parties expressed interest in knowing if recent purchases of TVs represent TVs replacing existing older units or if recent purchases are adding to the stock of TVs in the non-residential sector. Surveyors questioned the site contact to determine if the newly purchased TV was replacing an older TV or if the unit was increasing the number of TVs at the site. The responses from site contacts indicate that approximately 60% of recent TV purchases were adding to the stock of non-

[5] A Non-CMST-TV recruit could include CSS-Only recruits and/or CSS & CMST-HVAC and/or CSS & CMST-Linear recruits.

residential TVs, 20% of recent purchases were replacing older units, and 20% of site contacts either didn't know or they declined to answer the question.

7.3.2 TV Purchases

Using the data collected as part of the CMST-TV on-sites, Table 7-5 lists an estimate of the number of TVs purchased by the non-residential CMST-eligible businesses during 2009-2012.[6] Dividing the estimated number of TVs purchased by the number of businesses purchasing TVs leads to an estimate of the average number of TVs purchased per business. The data in Table 7-5 indicate that the average SDG&E business purchasing TVs during this period purchased four TVs while the average PG&E and SCE business purchased 2 to 3 TVs.

Table 7-5: Estimated Number of TVs Purchased 2009-2012 Non-Residential Businesses*

Utility	Estimated Number of TVs Purchased	Number of TVs Purchased per Businesses
PG&E	255,000	2.5
SCE	385,000	3.5
SDG&E	90,000	4

*** The results presented above have been weighted by site weight**

7.3.3 Efficiency Analysis

The CMST-TV study collected make and model number information during the on-site survey. For 10% of the TVs, it was not possible to collect these data.[7] The make and model number information that was collected was looked up as part of the analysis effort to classify the TVs as not ENERGY STAR-eligible or ENERGY STAR Version 3.0, 4.1, or 5.3. For the ENERGY STAR-eligible units, higher version numbers represent more efficient units. Table 7-1 presents the eligibility time frame for the ENERGY STAR versions.

Occasionally the make and model number collected during the on-site data collection effort could not be found during the look up effort. For 4% of the TVs, it was not possible to determine the ENERGY STAR classification from the make and model number collected on-site. Given that the make and model number lookup effort used the official ENERGY STAR classification lists, it is likely that nearly all of the 4% of unclassified TVs are not ENERGY

[6] The estimated number of TVs purchased has been rounded. Given the sampling and weighting process, these numbers are estimated with error and providing the exact numerical estimate may lead readers to assume a level of precision that is not intended. These numbers should be taken as approximate estimates.

[7] For most of the sites where it was not possible to collect make and model number information the televisions were mounted on the wall. For televisions mounted on the wall, the surveyors asked the site contact for the User's Guide but these were not always available. For some televisions, it is possible to determine the make and model number using the remote control, for others this feature is not available.

STAR-qualified.[8] For 86% or 4,627 out of 5,406 newly purchased TVs, the TV efficiency analysis was able to classify the ENERGY STAR efficiency level.

Efficiency Distribution

Table 7-6 lists the efficiency distribution for TVs purchased and the distribution of businesses purchasing TVs using site count weights, while Figure 7-2 illustrates the distribution. These data indicate that the majority of the TVs purchased were ENERGY STAR (60%).[9] These data also imply that 86% of the businesses purchasing TVs purchased at least one High Efficiency TV.[10] Combining the TV units and businesses purchasing TV information implies that businesses that were purchasing a higher number of TVs were more likely to purchase Base Efficiency TVs than businesses purchasing fewer TVs.

When classifying a TV as ENERGY STAR, two pieces of information were used: the TV's ENERGY STAR version number and the self-reported timing of the TV purchase. If a TV that is ENERGY STAR Version 3.0 qualified was self-reported to have been purchased in a year when Version 3.0 no longer qualified as ENERGY STAR eligible, the TV purchase was classified as a Base Efficiency TV. For example, if a Version 3.0-eligible TV was purchased in 2011, the TV was a Base Efficiency measure, but if the same TV were self-reported to have been purchased in 2010, it was recorded as a High Efficiency Version 3.0 purchase.[11] See Table 7-1 for the ENERGY STAR eligibility calendar.

The disaggregated measure level High Efficiency data in Table 7-6 indicate that the ENERGY STAR 3.0 TVs were the most common High Efficiency TV technology installed during the 2009-2012 period. Looking at the site level data, for businesses purchasing High Efficiency TVs, businesses most commonly purchased Version 4.1.

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8 The unclassified or "Model not found" group are made up of televisions not on the ENERGY STAR-qualified list. These measures were looked up on the internet but they were either not found or energy usage information was not available. For those measures found, but without energy usage information, it is likely that these measures are not ENERGY STAR-qualified, as the ENERGY STAR lists are assumed to include all ENERGY STAR-qualified units. For those measures not found on the internet, it is likely that the make and model number were recorded with error.

9 The 4% of recently purchased TVs where it was not possible to determine the efficiency, either because the make and model number was not recorded or the make and model numbers were not found in the efficiency lookup process, are not included in the following tables or analysis. These data are available upon request.

10 If a site purchased both an efficient TV and a Base Efficiency TV, it will be counted as both a High Efficiency and a Base Efficiency site. This results in total efficiency distributions by business that exceed 100%.

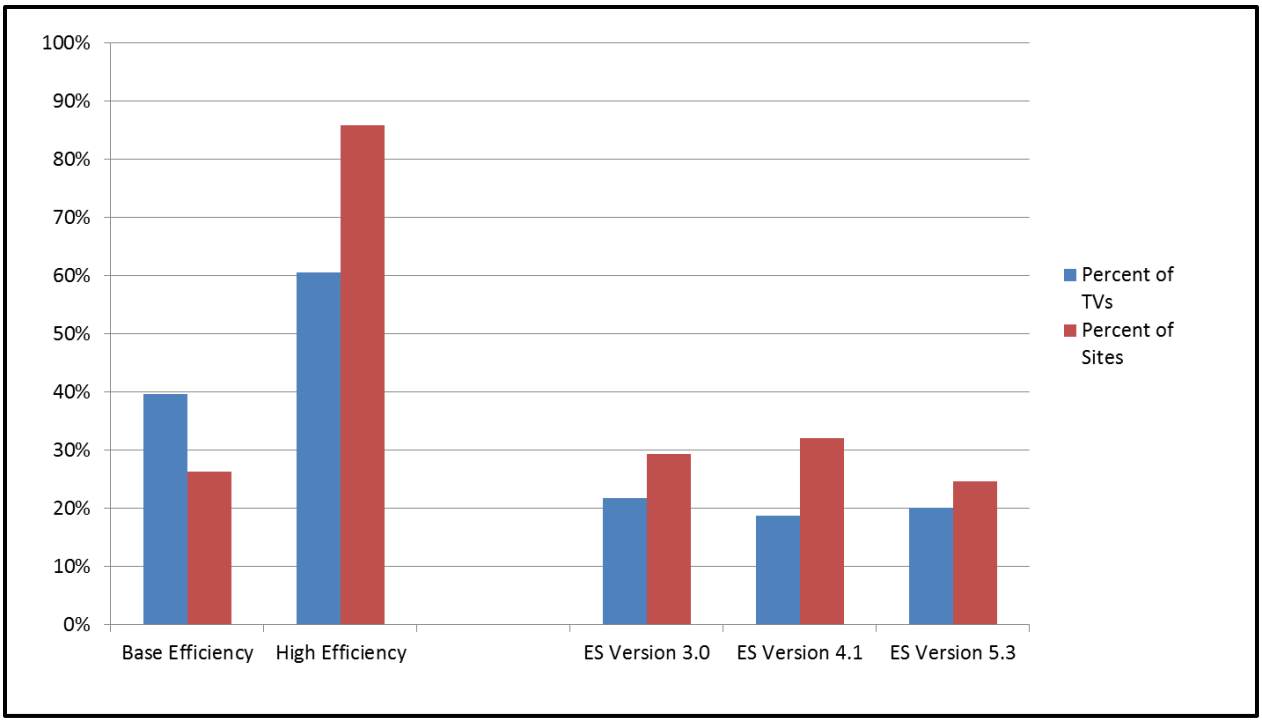
11 The ENERGY STAR eligibility timeline uses both months and years but the self-reported purchase data from the survey is a year of purchase. Therefore, all Version 3.0-eligible TVs purchased in 2010 are recorded as High Efficiency even though these models were only truly classified as High Efficiency until May 2010. This method allows for minor self-reporting error. This method may also slightly over-estimate the High Efficiency share. For a TV to be High Efficiency and Version 3.0, it must be purchased prior to 2011; for Version 4.1, the TV must be purchased prior to 2012.

Table 7-6: CMST TV Efficiency Distribution*

Efficiency Level	TVs		Businesses	
	Percent	**Relative Precision**	**Percent**	**Relative Precision**
Base Efficiency	40%	27%	26%	28%
High Efficiency	60%	18%	86%	7%
High Efficiency ENERGY STAR Distribution				
ES Version 3.0	22%		29%	
ES Version 4.1	19%		32%	
ES Version 5.3	20%		25%	
n	**4,627**		**362**	

* **The results presented above have been weighted by site weight.** The percent of businesses purchasing TVs can exceed 100% due to sites purchasing multiple types of TVs by efficiency classification.

Figure 7-2: CMST TV Efficiency Distribution*



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

Efficiency by Year

As part of the CMST-TV on-site data collection, the on-site surveyor collected self-reported information from the site contact regarding the year of installation of the TV. Table 7-7 lists the TV distribution by year of installation.

Figure 7-3 is site weighted and represents the distribution of TVs installed from 2009 to 2012. When reviewing the data in Table 7-7 and Figure 7-3 it is important to remember the ENERGY STAR eligibility timelines. An ENERGY STAR Version 3.0-qualified TV is designated as High Efficiency for this analysis for installation years 2009 and 2010, Version 4.1 is High Efficiency for 2009-2011, and Version 5.3 is High Efficiency for 2009-2012 (see Table 7-1 for the ENERGY STAR eligibility timeline). While Version 5.3-qualified TVs are designated as High Efficiency for the entire analysis time period, it is important to remember that few TVs would have been produced to these specifications in 2009, as this specification was not initiated until September of 2011. In addition, Version 3.0 TVs were produced, sold, and installed in 2011 and 2012, but they are not ENERGY STAR-eligible for the purposes of this analysis.

The eligibility timeline for ENERGY STAR materially impacts the yearly efficiency distribution for the installation of TVs. The estimates from this analysis indicate that in 2009, 54% of the TVs installed in the non-residential sector are High Efficiency (Version 3.0, 4.1 or 5.3); 90% of TVs installed in 2010 are estimated to be High Efficiency (Version 3.0, 4.1, or 5.3); 55% of TVs installed in 2011 are High Efficiency (Version 4.1 or 5.3); and only 33% of TVs installed in 2012 are High Efficiency (Version 5.3). In 2010, the year with the highest efficiency share, a substantial share of Version 3.0 and 4.1 TVs were purchased, and TVs with specifications qualifying them for the future 5.3 standard also have a 5% share of measures. It is likely that 2010 represents a year when the overlapping availability of many ENERGY STAR-qualified versions leads to a very large High Efficiency share. It should also be noted that the share of sub-Version 3.0 TVs is higher in 2011 and 2012 than 2010, which can also likely be linked to the implementation of new efficiency standards.[12]

Turning to the disaggregated High Efficiency shares, these data indicate that ENERGY STAR Version 3.0 was the most common High Efficiency TV purchased in 2009 and 2010, while Version 5.3 was the most common High Efficiency TV in 2011 and 2012. The progression of High Efficiency purchases from Version 3.0 in 2009 and 2010 to Version 5.3 in 2011 and 2012 is largely a function of the ENERGY STAR classification. Version 3.0 TVs were not ENERGY STAR-eligible in 2011 and 2012, and the specifications for Version 5.3 were not announced in 2009 so few TVs would have been built to these higher efficiency specifications.

Significance testing was conducted to determine if the results between adjacent years are statistically the same or if they statistically differed. For this analysis, the Research Team developed t-tests comparing the distributions of TV units across years by efficiency level[13]. The

[12] Examining the results without implementation of the version eligibility timeline shows that the distributions for Versions 3.0, 4.1, and 5.3 are 15%, 17%, and 38%, respectively, in 2011 and 9%, 31%, and 32%, respectively, in 2012. The shares of sub-Version 3.0 Base Efficiency TVs are 30% in 2011 and 28% in 2012.

[13] P-values less than 0.10 imply that there is less than a 10% chance of obtaining the two observed sample mean values when there is no actual difference between them in the population. P-values less than 0.10, 0.05, or 0.01

results of these tests, presented in Table 7-8, support the hypothesis that the changes in Base and High Efficiency levels of TVs are statistically significant between 2009 and 2010, and between 2010 and 2011. The changes within the High Efficiency share between 2009 and 2010 and between 2010 and 2011 for Versions 4.1 and 5.3 are also statistically significant.

Table 7-7: CMST TV Efficiency Distribution, by Year*

Efficiency Level	2009		2010		2011		2012	
	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision
Base Efficiency	46%	47%	10%	54%	45%	48%	67%	27%
High Efficiency	54%	40%	90%	6%	55%	39%	33%	55%
High Efficiency ENERGY STAR Distribution								
ES Version 3.0	43%		46%					
ES Version 4.1	10%		39%		17%			
ES Version 5.3	1%		5%		38%		33%	
n	**961**		**1,235**		**1,956**		**587**	

*** The results presented above have been weighted by site weight.** Television units that meet ENERGY STAR Version specifications are only counted as high efficiency for the years in which the Version was in effect. Please refer to Table 7-1 for more information on eligibility dates.

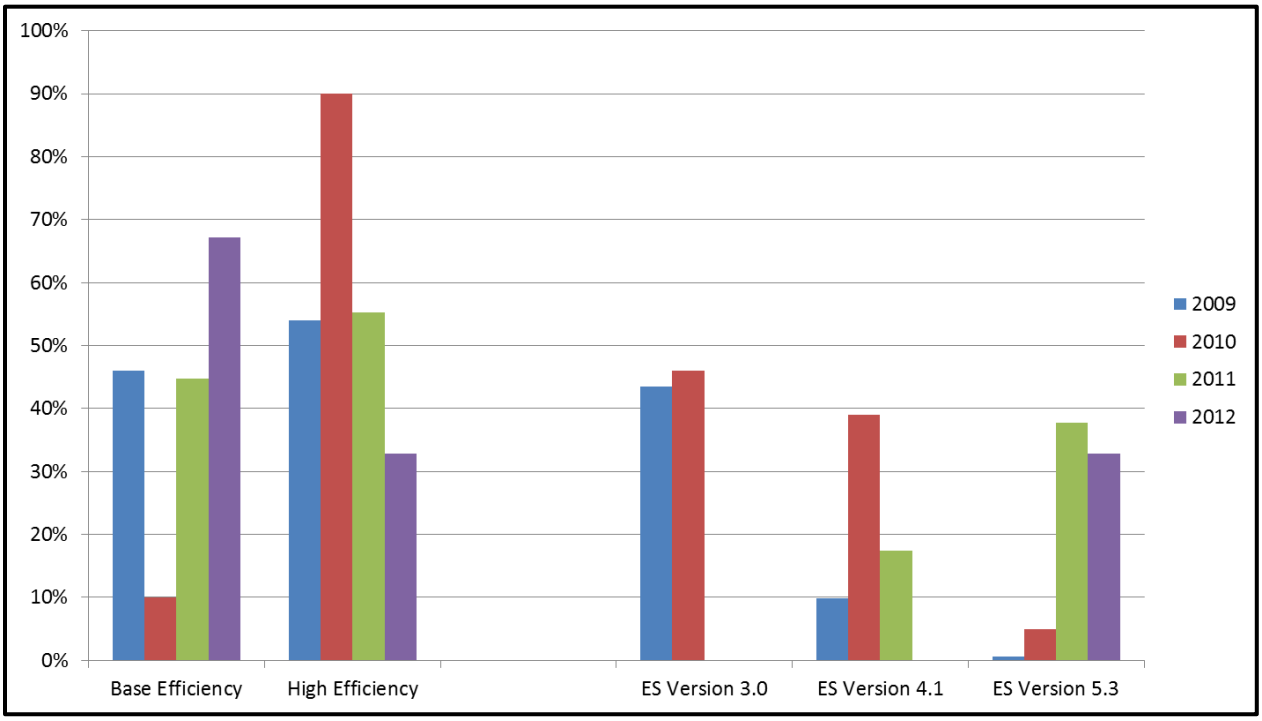
Table 7-8: T-Test Results Comparing CMST TV Efficiency Distribution, by Year *

Efficiency Level	2009-2010	2010-2011	2011-2012
Base Efficiency	0.004***	0.004***	0.201
High Efficiency	0.004***	0.004***	0.201
High Efficiency ENERGY STAR Distribution			
ES Version 3.0	0.998		
ES Version 4.1	0.006***	0.025**	
ES Version 5.3	0.063*	0.003***	0.748

*** The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the column.

indicate increasing levels of significance which are used to reject this null hypothesis that there is no difference between the observed means.

Figure 7-3: CMST TV Efficiency Distribution, by Year*



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

Efficiency by IOU

Table 7-9 and Figure 7-4 show that the differences in Base and High efficiency between PG&E and SCE are statistically significant. There is a relatively small sample size for SDG&E, which may contribute to their higher relative precision and decreased significance.

Table 7-9: CMST TV Efficiency Distribution, by IOU*

Efficiency Level	PG&E		SCE		SDG&E	
	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision
Base Efficiency	25%	45%	48%	33%	43%	67%
High Efficiency	75%	16%	52%	31%	57%	50%
High Efficiency ENERGY STAR Distribution						
ES Version 3.0	13%		28%		21%	
ES Version 4.1	22%		13%		34%	
ES Version 5.3	39%		11%		3%	
n	**1,299**		**2,569**		**870**	

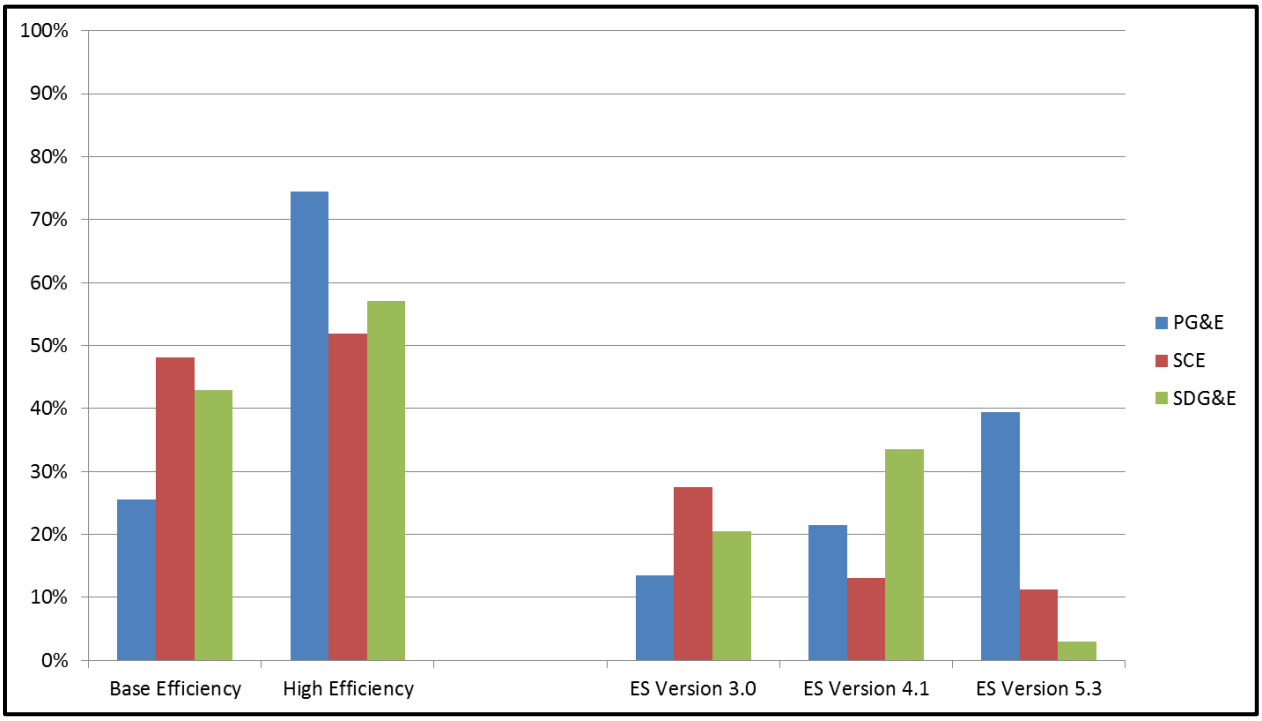
*** The results presented above have been weighted by site weight.**

Table 7-10: T-Test Results Comparing CMST TV Efficiency Distribution, by IOU*

Efficiency Level	PGE-SCE	PGE-SDG&E	SCE-SDG&E
Base Efficiency	0.062**	0.256	0.753
High Efficiency	0.062**	0.256	0.753
High Efficiency ENERGY STAR Distribution			
ES Version 3.0	0.194	0.514	0.603
ES Version 4.1	0.227	0.321	0.053*
ES Version 5.3	0.001***	0.007***	0.178

* **The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the column.

Figure 7-4: CMST TV Efficiency Distribution, by IOU*



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

Efficiency by Business Size

Table 7-11 and Table 7-13 present the CMST-TV efficiency distribution by business size using site weights for TV counts and businesses, respectively. When looking at the efficiency distribution by TV counts for Large- and Medium-sized businesses, a large share of TV purchases were found to be non-ENERGY STAR models. For Large businesses, 58% of TVs purchased appear to be non-ENERGY STAR, while 49% of TVs purchased by Medium-sized businesses were non-ENERGY STAR. In comparison, only 22% of the TVs purchased by Small-

sized businesses and 20% of those purchased by Very Small businesses are non-ENERGY STAR. There is an apparent difference in efficiency distribution between the Large/Medium businesses and the Small/Very Small businesses. This could be due to the need of larger sites to have more televisions, and consequently reducing costs by purchasing more Base Efficiency units. When looking at the business-based efficiency distributions in Table 7-13, 47% of Large businesses purchased Base Efficiency TVs and 88% of businesses purchased High Efficiency TVs. These numbers indicate that many Large businesses are purchasing both Base and High Efficiency TVs over this four year time period. In addition, the fact that 58% of the TVs purchased by Large businesses are Base Efficiency while only 47% of these businesses are purchasing Base Efficiency further supports the hypothesis that many of the high quantity purchases for these businesses were Base Efficiency purchases. Figure 7-5 and Figure 7-6 present the CMST-TV efficiency distribution by business size using site weights for TV shares and business shares, respectively. Large and Medium businesses purchased a larger number of non-ENERGY STAR TVs relative to smaller businesses, (Figure 7-5). Large businesses, however, also purchased a much larger number of ENERGY STAR 5.3 TVs. When looking at Figure 7-6, the data indicate that a larger share of businesses were likely to purchase ENERGY STAR TVs. Significance tests were conducted to compare the difference between adjacent business sizes for both business shares and TV unit shares. The results, shown in Table 7-12 and Table 7-14, both suggest that the differences in Base versus High Efficiency between Medium and Small businesses are statistically significant. These findings show that Small businesses had a significantly larger share of high efficiency TV installations than Medium businesses.

Table 7-11: CMST TV Efficiency Distribution, by Business Size, TV Count Shares*

Efficiency Level	Large		Medium		Small		Very Small	
	Percent	**Relative Precision**	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**	**Percent**	**Relative Precision**
Base Efficiency	58%	47%	56%	32%	18%	46%	20%	46%
High Efficiency	42%	64%	44%	41%	82%	10%	80%	11%
High Efficiency ENERGY STAR Distribution								
Version 3.0	14%		12%		33%		32%	
Version 4.1	1%		15%		35%		26%	
Version 5.3	27%		17%		15%		23%	
n	**1,965**		**2,335**		**340**		**97**	

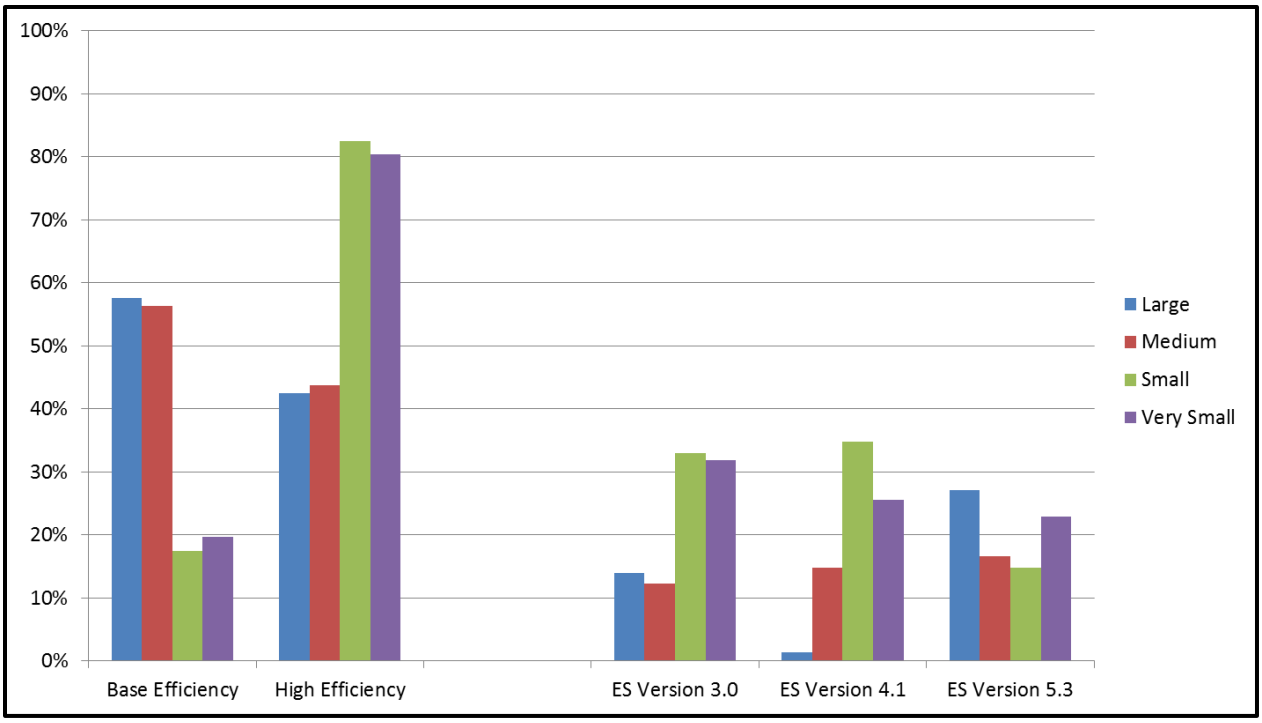
*** The results presented above have been weighted by site weight.** Large sites have annual usage over 1,750,000 kWh, medium have greater than 300,000 kWh and less than or equal to 1,750,000, small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, very small have annual usage less than or equal to 40,000 kWh.

Table 7-12: T-Test Results Comparing CMST TV Efficiency Distribution, by Business Size, TV Count Shares*

Efficiency Level	Large-Medium	Medium-Small	Small-Very Small
Base Efficiency	0.895	0.010***	0.879
High Efficiency	0.895	0.010***	0.879
High Efficiency ENERGY STAR Distribution			
ES Version 3.0	0.867	0.072*	0.996
ES Version 4.1	0.124	0.028**	0.508
ES Version 5.3	0.429	0.795	0.356

* **The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the column.

Figure 7-5: CMST TV Efficiency Distribution, by Business Size, TV Count Shares*



* **The results presented above have been weighted by site weight.** Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh.

Table 7-13: CMST TV Efficiency Distribution, by Business Size, Business Count Shares*

Efficiency Level	Large		Medium		Small		Very Small	
	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision
Base Efficiency	48%	30%	45%	18%	29%	38%	22%	49%
High Efficiency	88%	14%	74%	13%	90%	9%	86%	11%
High Efficiency ENERGY STAR Distribution								
Version 3.0	28%		25%		27%		31%	
Version 4.1	26%		28%		45%		27%	
Version 5.3	34%		21%		19%		28%	
n	**44**		**151**		**107**		**60**	

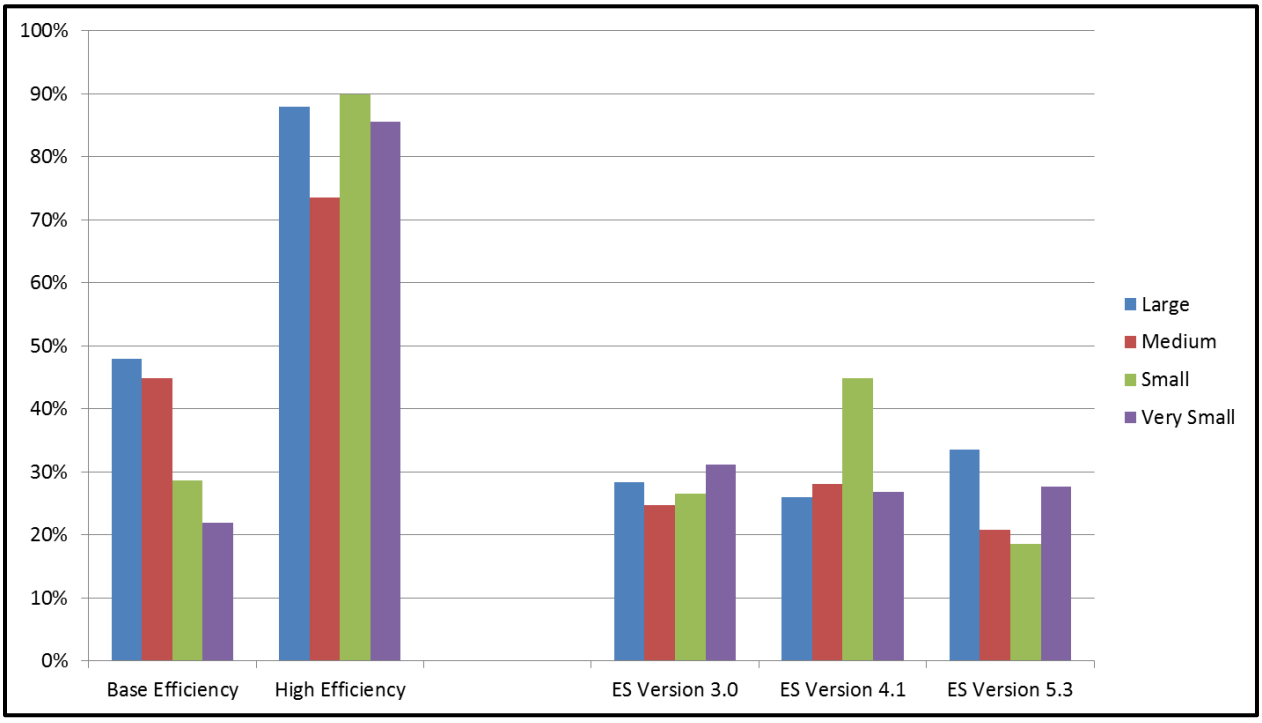
*** The results presented above have been weighted by site weight.** Large sites have annual usage over 1,750,000 kWh, medium have greater than 300,000 kWh and less than or equal to 1,750,000, small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, very small have annual usage less than or equal to 40,000 kWh.

Table 7-14: T-Test Results Comparing CMST TV Efficiency Distribution, by Business Size, Business Count Shares*

Efficiency Level	Large-Medium	Medium-Small	Small-Very Small
Base Efficiency	0.767	0.046**	0.513
High Efficiency	0.146	0.013**	0.898
High Efficiency ENERGY STAR Distribution			
ES Version 3.0	0.663	0.793	0.641
ES Version 4.1	0.824	0.037**	0.108
ES Version 5.3	0.153	0.719	0.264

*** The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the column.

Figure 7-6: CMST TV Efficiency Distribution, by Business Size, Business Count Shares*



* **The results presented above have been weighted by site weight.** Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, and Very Small have annual usage less than or equal to 40,000 kWh.

Efficiency by Business Type

Table 7-15 shows the distribution of TV efficiency by business type for business counts and TV unit counts, respectively, using site weights. Certain business types were unique to the CMST study: College, Hospital, Hotel, and Industrial. Because these business types had fewer actual on-sites than the others, they were grouped into a category called "CMST-Only" in order to present a more meaningful level of aggregation. Over 99% of Miscellaneous and Retail businesses and 88% of Offices purchased High Efficiency TVs, while only 52% of Warehouses and 52% of CMST-Only businesses purchased High Efficiency TVs.

Table 7-15: CMST TV Efficiency Distribution, by Business Type, Business and TV Count Shares*

Business Type	Efficiency Level	TVs			Businesses		
		Percent	Relative Precision	*n*	Percent	Relative Precision	*n*
CMST-Only	Base Efficiency	65%	27%	**2,931**	59%	51%	**35**
	High Efficiency	35%	50%		52%	65%	
Food/Liquor	Base Efficiency	28%	54%	**64**	32%	59%	**28**
	High Efficiency	72%	21%		72%	25%	
Health/Medical - Clinic	Base Efficiency	20%	69%	**503**	43%	58%	**44**
	High Efficiency	80%	18%		85%	22%	
Miscellaneous	Base Efficiency	10%	58%	**264**	5%	64%	**71**
	High Efficiency	90%	6%		99%	2%	
Office	Base Efficiency	18%	61%	**290**	40%	56%	**53**
	High Efficiency	82%	14%		88%	23%	
Restaurant	Base Efficiency	28%	49%	**110**	32%	59%	**41**
	High Efficiency	72%	19%		82%	12%	
Retail	Base Efficiency	6%	104%	**108**	10%	110%	**43**
	High Efficiency	94%	6%		100%	14%	
School	Base Efficiency	40%	84%	**408**	49%	60%	**19**
	High Efficiency	60%	56%		71%	49%	
Warehouse	Base Efficiency	35%	85%	**60**	52%	64%	**29**
	High Efficiency	65%	45%		52%	63%	

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

Efficiency by New Construction / Remodel

As part of the phone survey, respondents were asked what year their facility was built and/or remodeled. If the site was constructed or remodeled between 2009 and the present, it was considered a recent new construction/remodel site. Table 7-16 and Figure 7-7 present the CMST-TV efficiency distribution by this classification, using site weights. The results suggest that a slight majority of TVs installed at new construction businesses were non-ENERGY STAR TVs, while 73% of TVs at businesses that were not new construction or remodels were High Efficiency. This could possibly be attributed to the diminished importance or attention put on purchasing High Efficiency TVs during a new construction/remodeling effort, compared to the targeted purchase of TVs for a business. Given that the analysis indicates that newly purchased

TVs are installed during new construction/remodeling efforts in a significant number of cases, it is important to improve the efficiency distribution of these purchases.[14]

The t-test results presented in Table 7-16 indicate that the differences in TV unit efficiency distribution between businesses that either had or did not have a recent new construction/remodel effort are, for the most part, statistically significant.

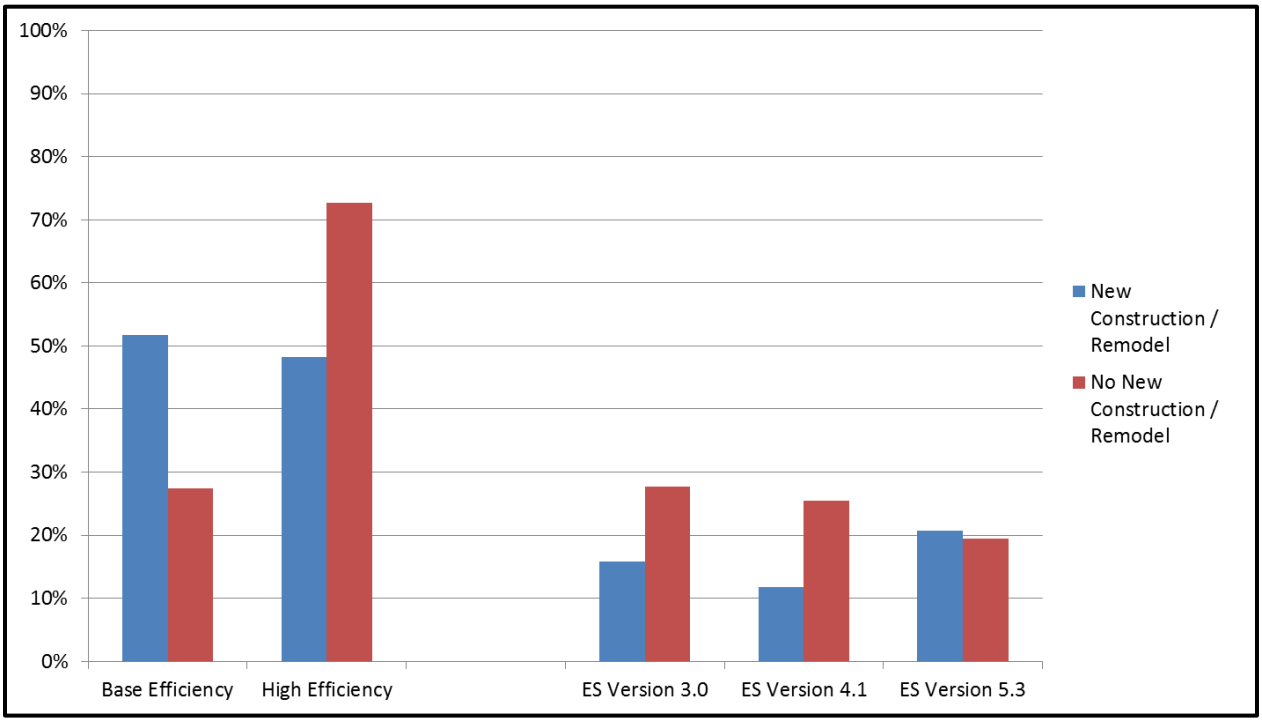
Table 7-16: CMST TV Efficiency Distribution, by New Construction/Remodel *

Efficiency Level	New Construction/Remodel		No New Construction/Remodel		T-Test P value Results Comparing NC/Rem to No NC/Rem
	Percent	Relative Precision	Percent	Relative Precision	
Base Efficiency	52%	33%	27%	31%	0.014**
High Efficiency	48%	35%	73%	12%	0014**
High Efficiency ENERGY STAR Distribution					
ES Version 3.0	16%		28%		0.157
ES Version 4.1	12%		25%		0.064*
ES Version 5.3	21%		20%		0.911
n	**2,893**		**1,845**		

*** The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the column.

[14] The size of the new construction/remodeling market for TVs as a share of all TVs purchased can be approximated by the number of TVs survived in this category relative to all TVs surveyed (2,884 new construction/remodel TVs versus 4,627 total TVs surveyed). Some new construction/remodel purchases are likely to represent very large purchases.

Figure 7-7: CMST TV Efficiency Distribution, by New Construction/Remodel *



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

8

CMST HVAC End User Analysis

HVAC systems are one of the three high priority measures in the CMST analysis. Small packaged HVAC units were chosen for this analysis due to the importance of HVAC measures in meeting the Strategic Plan goals and the prevalence of these units in commercial businesses. The Strategic Plan calls for 50% of all existing commercial buildings to be zero net energy by 2030 and to transform HVAC to ensure that its energy performance is optimal for California's climate. Collecting information on the current efficiency distribution of small commercial HVAC purchases will help the CPUC and IOUs develop HVAC energy efficiency programs to help meet these goals.

The types of HVAC systems eligible for CMST include:

- Split- and packaged-single zone HVAC systems with DX (direct expansion) cooling, less than or equal to 65,000 Btuh cooling capacity; and
- Packaged-single zone systems with evaporative cooling, less than or equal to 65,000 Btuh cooling capacity.

The analysis reported in this section uses the telephone and on-site end user data on recent purchases of small HVAC systems to estimate the number of units purchased from 2009 to 2012, the number of businesses purchasing systems, and the efficiency distribution of recent purchases. The analysis will also look at the efficiency distribution by year, IOU, business size, business type, and new construction/remodel versus direct HVAC purchases. With this information, it will be possible to determine if the efficiency distribution is changing over this time period and if different size businesses are purchasing systems with the same average efficiency.

8.1 Sources of Data

Information on recent purchases of HVAC systems (2009-2013)[1] was collected during the telephone and on-site survey. During the telephone survey, sites were asked if they have

[1] There was very little opportunity for end users to purchase HVAC units in 2013 and be observed for this analysis. Very few surveys were completed in 2013. Due to the lack of a full year's worth of 2013 purchase data, the 2013 purchasers have been included with the 2012 purchasers. These data can be separated upon

purchased any new HVAC systems since January 2009. If the site purchased an HVAC system, they were asked to list the types of HVAC systems, along with whether or not they would be considered High Efficiency or Base Efficiency.[2] They were also asked what the efficiency rating is, if known.[3] Using these data, sites purchasing HVAC systems were identified and the self-reported types of HVAC systems were used to determine the size distribution of HVAC system purchases reported during the telephone survey. Those sites that self-reported that they had purchased qualified HVAC systems were recruited to participate in on-site surveys to collect additional verification information.

The CMST-HVAC on-site visits targeted facilities which claimed during the telephone survey to have purchased and installed new qualified HVAC systems since 2009. During the on-site survey, data was collected on the year the technologies were purchased, the number of new qualified HVAC systems at the site, and the make and model number of these new technologies. Additionally, information on cooling and heating types, efficiencies, and fuel type were collected. Make and model lookups also allowed the team to collect information that wasn't available on-site.

Additional CMST-HVAC sites were also developed from the CSS on-site surveys. While on-site at a CSS site, an entire inventory of all HVAC systems at a facility was performed, including the collection of make and model number information. Site contacts were also questioned about the vintage of the technologies. If a surveyor found HVAC systems at a CSS site that met the criteria for CMST, these technologies were CMST-eligible and the site became a CSS-CMST site.

Following the collection of on-site information, the make and model numbers were looked up to determine the efficiency of the new HVAC systems. The telephone survey and on-site data were also merged with the energy efficiency program tracking data to determine the distribution of purchases for energy efficiency participants and non-participants.

A total of 7,890 phone surveys with CMST-eligible businesses were completed from November 17th, 2011 to May 9th, 2013. The phone surveys questioned the respondent to determine if the facility had purchased and installed an HVAC system since 2009, and if they had, what type of equipment was installed and what type of equipment was replaced. Of the 7,890 telephone survey respondents, 1,065 reported purchasing an HVAC system or approximately 13% of

request, but the small number of sites surveyed in 2013 implies that the 2013 installations are not representative of installations for the entire 2013 period.

[2] Given the specifications of the types of systems that are eligible for the CMST-HVAC study, it is unlikely that the telephone survey site contact will know if their new purchase is eligible for the CMST on-site.

[3] Few sites know the efficiency level of the systems that have been purchased. Information on the HVAC systems is difficult to collect with accuracy over the telephone due to the highly technical nature of the measures.

telephone survey respondents. The 1,065 sites that reported purchasing HVAC systems were asked to participate in the on-site data collection effort, and 422 or 40% of these sites agreed to participate. See Table 8-1 for a distribution by business type of the telephone survey sites reporting new HVAC systems.

Table 8-1: CMST HVAC Telephone Distribution by Business Type*

Business type	Phone Survey Completes	CMST Phone Survey HVAC Sites	% Self-Reported (Overall)	Recruited CMST HVAC Sites	Share of CMST HVAC Recruits
College	29	9	31%	2	22%
Food/Liquor	486	46	9%	26	57%
Health/Medical Clinic	633	81	13%	31	38%
Health/Medical - Hospital	59	13	22%	6	46%
Hotel	199	25	13%	8	32%
Industrial	695	114	16%	16	14%
Misc.	1,637	222	14%	96	43%
Office	1,314	204	16%	83	41%
Restaurant	595	52	9%	27	52%
Retail	1,019	99	10%	36	36%
School	479	118	25%	61	52%
Warehouse	745	82	11%	30	37%
Total	**7,890**	**1,065**	**13%**	**422**	**40%**

During the telephone survey, 422 sites that were identified as CMST-eligible HVAC sites agreed to participate in the on-site data collection effort. The survey team undertook 243 on-sites at these 422 sites, of which 119 or 49% were found to have CMST-eligible new HVAC systems on-site (see Table 8-2). The CMST-HVAC on-sites found that the phone survey-identified HVAC sites were not eligible for CMST more frequently than in the Linear or TV CMST analysis. The CMST-HVAC effort was focused on a specific set of technologies, and identifying these technologies during the telephone survey has been difficult. When visiting CSS-sites that had stated during the telephone survey that they had not purchased new HVAC systems, 78 sites were found to have CMST-eligible HVAC. On-site surveys, therefore, have been completed for 197 CMST-eligible HVAC sites.

Table 8-2: CMST HVAC On-site Distribution by Business Type*

Business type	Recruited CMST-HVAC Sites	PS CMST-HVAC On-Sites Completed	PS CMST-HVAC Recruits & OS HVAC Found	Share of PS CMST-HVAC Sites Found HVAC OS	Sites with New HVAC (HVAC not ID'd on PS)	Total Sites with New HVAC
College	2	0	0	0%	1	1
Food/Liquor	26	15	6	40%	7	13
Health/Medical Clinic	31	18	11	61%	10	21
Health/Medical - Hospital	6	1	1	100%	0	1
Hotel	8	5	3	60%	0	3
Industrial	16	8	4	50%	1	5
Miscellaneous	96	47	20	43%	12	32
Office	83	57	23	40%	11	34
Restaurant	27	14	8	57%	5	13
Retail	36	22	13	59%	12	25
School	61	37	21	57%	9	30
Warehouse	30	19	9	47%	10	19
Total	**422**	**243**	**119**	**49%**	**78**	**197**

8.1.1 Phone Survey

Every facility that participated in an on-site visit first participated in a phone survey. A total of 7,890 phone surveys were completed from November 17th, 2011 to May 9th, 2013. The phone surveys attempted to reach out to the contact and find out whether or not the facility had purchased and installed new qualified HVAC systems since 2009, and if they had, what type and efficiency HVAC system was installed. If the contact was not able to provide what kind of HVAC system was installed, they were asked to describe it. The phone survey also asked about HVAC controls.

8.1.2 On-Site Data

The data collected on-site came from a combination of businesses identified from the phone survey as CMST-only sites, CSS-CMST sites, and CSS-only sites. The CMST-only sites were those that claimed to have purchased and installed new qualified HVAC systems throughout their facility, but were ineligible for the CSS survey or would not consent to having a full CSS

on-site survey performed.[4] Similarly, CSS-CMST sites were those that claimed to have purchased and installed new qualified HVAC systems throughout their facility and would allow the full CSS on-site to be performed at their facility. The last set, CSS-sites, are those that claimed to have not purchased or installed any new CMST-eligible HVAC systems at their facility, but during the full CSS on-site visit, new CMST-eligible measures were found to have been installed.

8.1.3 Make and Model Lookups

Make and model lookups are crucial as secondary information to on-site data. 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. Therefore, HVAC nameplate photos taken on-site have proven invaluable to this effort as the slightest mix-up in the model numbers can completely change the model information collected during the lookups.

The on-site form allowed for the collection of make, model, heating and cooling type, heating fuel and refrigerant type, size specifications, and efficiency levels. However, these data are not always available on-site, so make and model lookups are sometimes necessary to capture all possible information about the system.

The list of HVAC units found on-site was merged with our HVAC make and model lookups in order to group them into performance tiers. The make and model lookups served to verify manufacturer names, model numbers, distribution system types, EER/SEER ratings, etc. Out of about 5,000 records in the on-site HVAC Inventory, there are about 362 CMST-qualified HVAC systems. About 97% or 349 HVAC units matched a make/model lookup. The following efficiency categories were developed for the efficiency classification:

- Base 10 - SEER < 11: All CMST-eligible equipment less than 11 SEER.
- Base Tier 11-12 SEER: All CMST-eligible equipment between 11 and 11.99 SEER.
- Base Tier 12-13 SEER: All CMST-eligible equipment between 12 and 12.99 SEER.
- Base Tier 13-14 SEER: All CMST-eligible equipment between 13 and 13.99 SEER.
- Tier 1 – Single Package: All air-cooled or evaporative cooled single packaged systems.

$$14 \leq SEER < 15 \text{ or } 11.6 \leq EER < 12$$

- Tier 1 – Split System: All air-cooled or evaporative cooled split systems.

[4] Colleges, Universities, Hotels, Hospitals, and Industrial businesses were not eligible for the CSS survey. To try to ensure coverage and representativeness of the CMST results across the non-residential sector, these segments were included in the CMST on-site survey.

$$14 \leq SEER < 15 \text{ or } 12 \leq EER < 12.5$$

- Tier 2 – Single Package: All air-cooled or evaporative cooled single packaged systems.

$$15 \leq SEER < 16 \text{ or } 12 \leq EER < 12.4$$

- Tier 2 – Split System: All air-cooled or evaporative cooled split systems.

$$15 \leq SEER < 16 \text{ or } 12.5 \leq EER < 13$$

- Tier 3 – Single Package: All air-cooled or evaporative cooled single packaged systems.

$$16 \leq SEER < 17 \text{ or } 12.4 \leq EER < 13$$

- Tier 3 – Split System: All air-cooled or evaporative cooled split systems.

$$16 \leq SEER < 17 \text{ or } 13 \leq EER < 13.5$$

- Tier 4 – Single Package: All air-cooled or evaporative cooled single packaged systems.

$$SEER \geq 17 \text{ or } EER \geq 13$$

- Tier 4 – Split System: All air-cooled or evaporative cooled split systems.

$$SEER \geq 17 \text{ or } EER \geq 13.5$$

Performance tiers were defined using the 2010-2012 SCE Qualifying Minimum Equipment Efficiencies & Incentive Levels for Commercial Air Conditioners.[5] There were four tiers in total for each of the HVAC system types (single package and split system). All classifications were made using the SCE standards and a combination of the on-site and lookup data.

8.1.4 IOU Energy Efficiency Program Tracking Data

The IOU energy efficiency program tracking data from 2009-2012 was merged with the non-residential frame. Using these data it was possible to determine if the site participated in energy efficiency programs and if the site installed HVAC measures as part of their program participation.

8.2 CMST Telephone Survey

A total of 7,890 sites participated in phone survey, while 2,648 of them were recruited for on-site surveys. Out of those, 1,556 participated in on-site surveys. The phone survey collected self-report data on the installation of CMST-eligible HVAC measures and collected baseline information for these measures. Fifteen percent of phone survey respondents claimed to have installed CMST-HVAC measures. The phone survey asked questions to determine if sites had

[5] Southern California Edison Commercial HVAC Distributor Incentive Program, 2010-2012 Qualifying Minimum Equipment Efficiencies & Incentive Levels for Commercial Air Conditioners and Heat Pumps. https://www.cainstantrebates.com/ca_media/er/img/SCE_HVAC_Incentive_Levels_2012.pdf

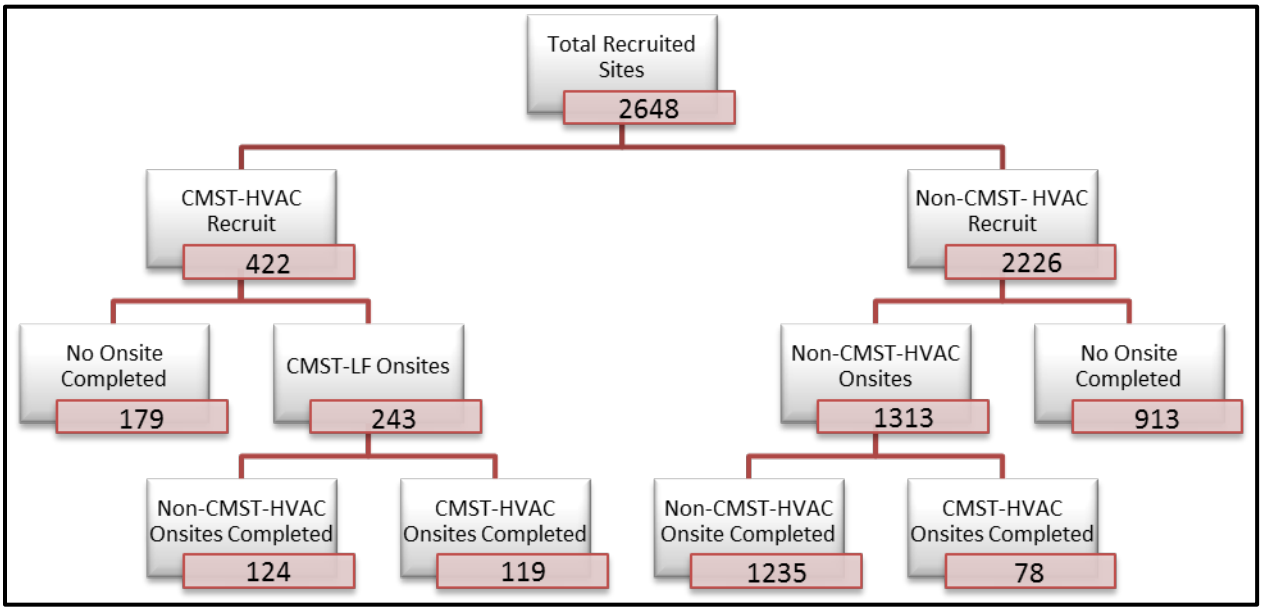
installed HVAC equipment between 2009 and 2012. Sites that had remodeled since 2009 were asked this question separately from sites that had retrofit equipment.

The data collected as part of the telephone survey represents the site contact's best understanding of the HVAC equipment their business purchased between 2009 and 2012. Attempting to understanding the energy efficiency distribution of HVAC purchases using self-reported data, however, is hampered by the purchaser's understanding and ability to remember the technologies installed at their business. Additionally, unlike the Linear Fluorescent and TV questions, CMST-eligible HVAC requires more criteria than simply year installed. Only specific technologies, under a specific size range qualify, which makes it more difficult to identify CMST-eligible equipment from the telephone survey. The following section describes the energy efficiency distribution of HVAC technologies found during the on-site data collection effort. The on-site data rely on the site contact's ability to recall the installation of the HVAC technology. The efficiency distribution, however, is dependent on the make and model lookups of efficiency information, leading to a more accurate picture of the efficiency distribution during this time period.

8.3 CMST On-Site HVAC Survey

The data collected through the phone surveys and on-site visits focused on the quantity of new HVAC systems purchased since 2009. Figure 8-1 shows the breakdown of recruits from the telephone and what was found for sites participating in an on-site. Comparing the phone survey to the on-site survey may result in slightly differing results for HVAC systems, as one of the requirements for CMST-HVAC systems is the system size and cooling equipment type, and these are not fields confirmed on the phone survey due the technical nature of these specifications.

Figure 8-1: Sites with CMST-Eligible HVAC Systems



There were 2,648 CSS/CMST sites that were recruited for on-site visits. Out of those, 422 were recruited as CMST-HVAC[6] sites while 2,226 were recruited as Non-CMST-HVAC recruits.[7] The Non-CMST-HVAC recruits were split into two groups; 1,313 CSS & Non-CMST-HVAC on-sites and 913 where no on-sites were completed. Similarly, the CMST-HVAC recruits were split into 243 CMST-HVAC on-sites and 179 where no on-sites were completed. Finally, each of these two groups, where on-sites were performed, were once again split into two groups; those where CMST-HVAC measures were found on-site and those where no CMST-HVAC measures were found on-site.

8.3.1 HVAC Purchasing Sites

CMST-HVAC data has been collected at 197 sites. These data have been analyzed and weighted to represent the number of businesses purchasing HVAC systems in the population of CMST-eligible businesses. Using these data, the research team developed an estimate of the number of businesses purchasing HVAC systems. Table 8-3 lists the study's estimate of the share of businesses purchasing CMST eligible HVAC units within the CMST non-residential frame. The site-weighted CMST HVAC data collected as part of the on-sites implies that just below 10% of SCE and SDG&E's non-residential businesses purchased new units from 2009 to 2012 while only 5% of PG&E's businesses installed new units.

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6 These CMST- HVAC sites may have been also recruited for CMST-TV or CMST-LF sites, but for the purposes of the HVAC analysis we are not concerned with the other CMST-eligible equipment types.

7 A Non-CMST-HVAC recruit could include CSS-Only recruits and/or CSS & CMST-TV and/or CSS & CMST-LF recruits.

Table 8-3: Estimated Share of Sites Installing HVAC Units*

Utility	Sites in Frame	Share of Sites Purchasing HVAC Units
PG&E	392,294	5%
SCE	462,944	9%
SDG&E	99,495	9%

*** The results presented above have been weighted by site count.**

8.3.2 HVAC Purchases

Using the data collected as part of the CMST HVAC on-sites, Table 8-4 lists the estimate of the number of HVAC units purchased by the non-residential CMST eligible businesses during 2009-2012.[8] HVAC shipment data from the Air Conditioning, Heating and Refrigeration Institute (AHRI) indicates roughly 20 million small HVAC units shipped between 2009 and 2012 in the United States.[9] These units were shipped to customers in all sectors. Assuming that 10% of these shipments went to California, and that 10% of those were to commercial businesses, results in an estimate of approximately 200,000 HVAC units across all California businesses, compared to the 175,000 estimate for the three major IOUs presented below.[10] Dividing the estimated number of HVAC units purchased by the number of businesses purchasing HVAC units leads to an estimate of the average number of HVAC units purchased per business. The data in Table 8-4 indicate that, on average, the businesses in PG&E's and SCE's territory installed just over two HVAC units per business, while those in SDG&E's territory installed approximately three units per business. HVAC units purchased in SCE and SDG&E's territory had an average tonnage of 10 tons per business purchasing new units, while units in PG&E had an average of 8. The average tonnage per unit purchased, however, was between 3.5 and 4 tons across all three utilities.

8 The estimated number of units and the tonnage purchased has been rounded. Both sampling and weighting error exist and rounding these numbers to indicate that the estimate of the number of units purchased is imprecise.

9 http://www.ari.org/monthly+shipping+releases.aspx

10 The difference between the 200,000 estimate and our estimate of approximately 180,000 units installed in businesses in the three IOUs may be associated with HVAC units installed in businesses in CA that are outside the IOU territories.

Table 8-4: Estimated Number of HVAC Units Purchased 2009-2012 Non-Residential Businesses*

Utility	Estimated HVAC Units Purchased	Average Number of HVAC Units Purchased	Average Tonnage Purchased Per Site	Average Tonnage Per Unit Purchased
PG&E	45,000	2	8	3.5
SCE	105,000	2.5	10	4
SDG&E	25,000	3	10	3.5

*** The results presented above have been weighted by site count.**

8.3.3 Efficiency Analysis

The CMST HVAC analysis collected make and model number information during the on-site data collection effort. For less than 1% of the sites installing HVAC units it was not possible to collect these data. The make and model number information that was collected was looked up as part of the analysis effort to classify the HVAC equipment into specific performance Tiers, based on their SEER and distribution system type. Occasionally the make and model number collected during the on-site data collection effort could not be found during the look up effort. For 1% of the sites it was not possible to determine the HVAC classification from the make and model number collected on-site. Given that the HVAC information was not collected at 1% of sites and the collected make and model information did not lead to a classification at 1% of the collected sites, for 98% of the sites the efficiency analysis was able to classify the HVAC efficiency level. Of the 197 HVAC CMST sites, we were able to develop HVAC efficiency information for 192 sites.

Efficiency Distribution

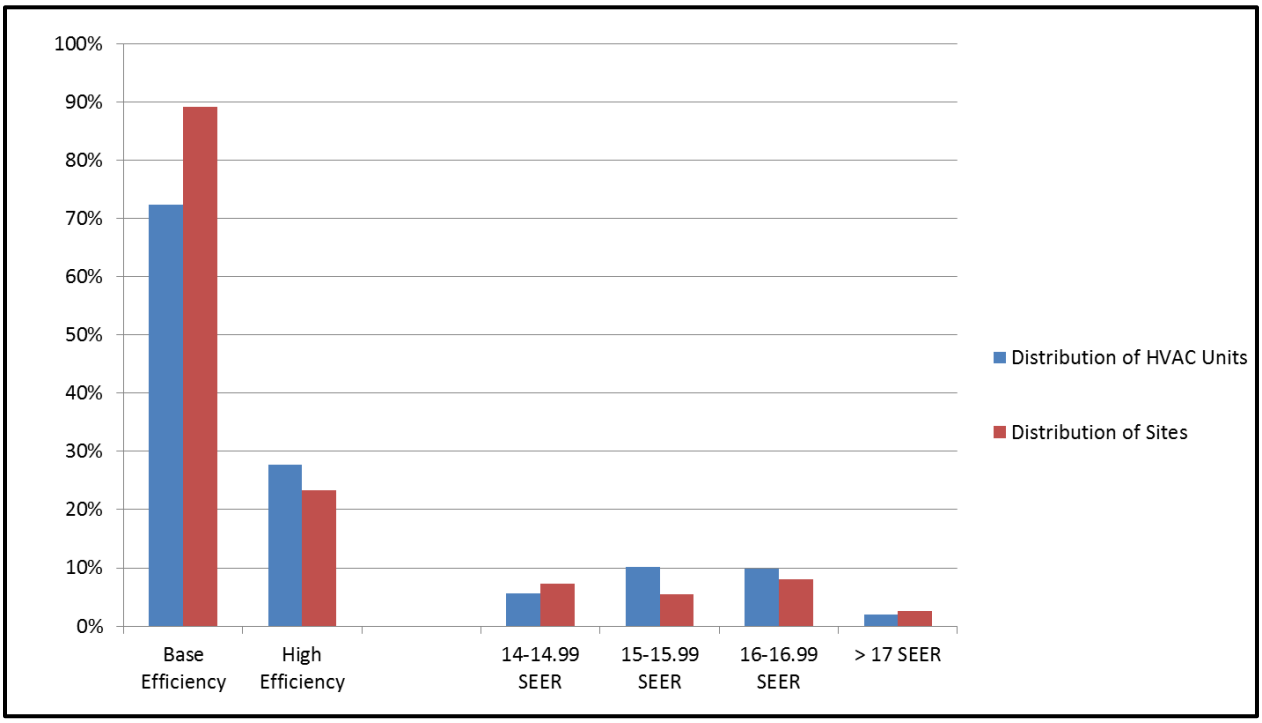
Table 8-5 lists the efficiency distribution for businesses and HVAC units using site count weights implied by the CMST on-site data collection effort. These data lead to an estimate that 72% of surveyed HVAC units and 89% of businesses installed Base Efficiency units (between 10 and 13.99 SEER) during the 2009-2012 period. Note that the distribution of Base and High HVAC Efficiency in businesses sums to more than 100% because a business can install both Base and High Efficiency units, leading to its classification in both groups. Figure 8-2 illustrates the results in Table 8-5. For conciseness, going forward the figures will focus on the efficiency distribution of installed measures.

Table 8-5: CMST HVAC Estimated Efficiency Distribution

Efficiency Level	HVAC Units		Businesses	
	Percent	**Relative Precision**	**Percent**	**Relative Precision**
Base Efficiency	72%	10%	89%	7%
High Efficiency	28%	27%	23%	46%
High Efficiency Tiers Distribution				
14-14.99 SEER	6%		7%	
15-15.99 SEER	10%		5%	
16-16.99 SEER	10%		8%	
> 17 SEER	2%		3%	
n	**879**		**192**	

*** The results presented above have been weighted by site count.** Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3. The percent of businesses sums to more than 100% because a business can install both Base and High Efficiency units.

Figure 8-2: CMST HVAC Efficiency Distribution*



*** The results presented above have been weighted by site count.** Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3.

Efficiency by Program Participation

The CMST HVAC sites were merged with the energy efficiency program tracking data to determine if a site participated in the HVAC HIM. To determine if HVAC EE program participants installed more High Efficiency HVAC units than non-participants, the HVAC efficiency distribution was disaggregated by HVAC EE participation.[11] Table 8-6 lists and Figure 8-3 illustrates the HVAC unit efficiency distribution by the HVAC EE program participation. Businesses participating in IOU HVAC EE programs appear to be less likely to install Base Efficiency air conditioners (53%) than non-participants (74%). Turning to the High Efficiency disaggregation, EE program participants also have a higher share of measures in the 16+ SEER units than non-participants.

Significance testing was conducted to determine if the efficiency distribution differences by HVAC program participation were statistically significant. For this analysis, the Research Team developed t-tests comparing the efficiency distributions of HVAC units by program participation. The results below show that, for the most part, the differences between the two groups are not statistically significant, though program participants have a statistically larger share of installations for units with 16 SEER and higher.[12]

[11] The disaggregation by HVAC EE program participation is not specific to having received a rebate for installing a new air conditioning unit. The majority of measures included in the HVAC HIM are not for the installation of an air conditioning unit, but rather include coil cleaning, system tune-ups, economizer repair, etc.

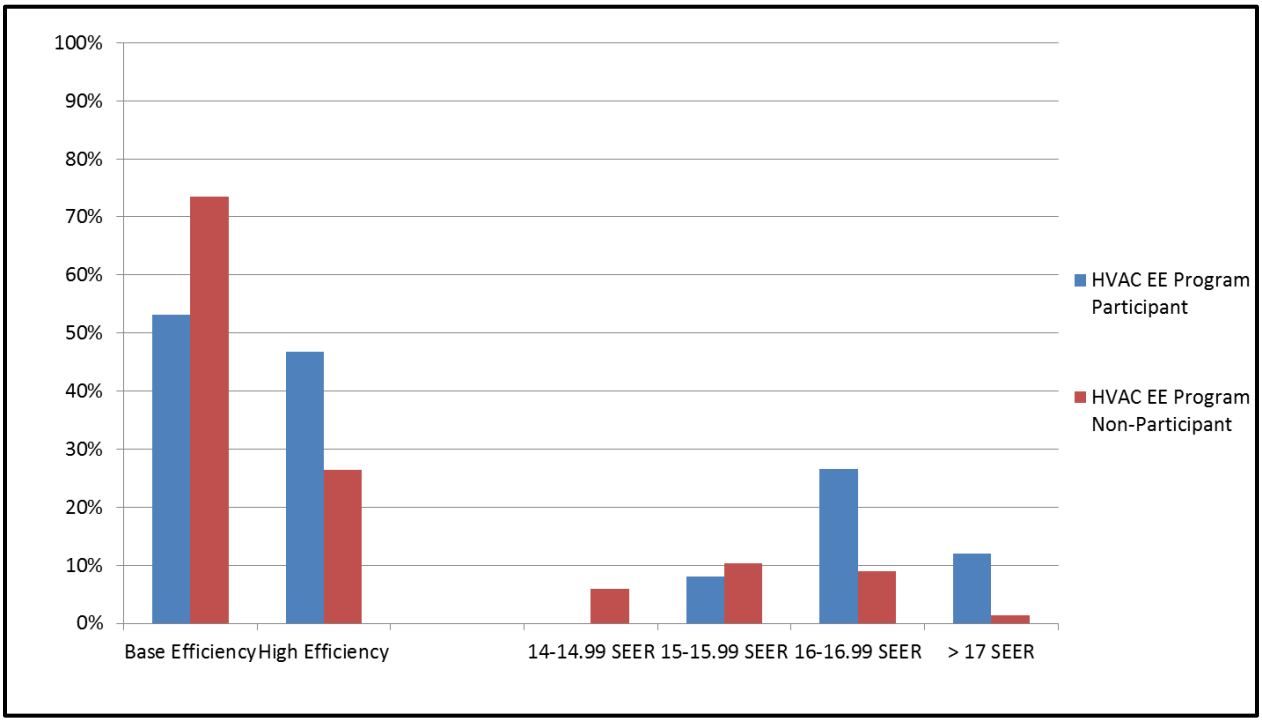
[12] P-values less than 0.10 imply that there is less than a 10% chance of obtaining the two observed sample mean values when there is no actual difference between them in the population. P-values less than 0.10, 0.05, or 0.01 indicate increasing levels of significance which are used to reject this null hypothesis that there is no difference between the observed means.

Table 8-6: CMST HVAC Efficiency Distribution by Program Participation by Equipment Count, Site Weighted*

Efficiency Level	HVAC EE Program Participant		HVAC EE Program Non-Participant		T-Test P-Values Comparing EE Participants to EE Non-Participants
	Percent	Relative Precision	Percent	Relative Precision	
Base Efficiency	53%	39%	74%	11%	0.147
High Efficiency	47%	44%	26%	29%	0.147
High Efficiency Tiers Distribution					
14-14.99 SEER	0%		6%		0.313
15-15.99 SEER	8%		10%		0.784
16-16.99 SEER	27%		9%		0.067*
> 17 SEER	12%		1%		0.021**
n	**111**		**768**		

* **The results presented above have been weighted by site count.** Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3. P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the column.

Figure 8-3: CMST HVAC Efficiency Distribution by Program Participation



*** The results presented above have been weighted by site count.** Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3.

Efficiency by Year

As part of the CMST-HVAC on-site data collection effort, the surveyor collects self-reported information on the year the new HVAC systems were installed. Table 8-7 lists the HVAC efficiency distribution by year of installation for newly installed HVAC units. From 2009 to 2011, Base Efficiency units dominated, with 2009, 2010, and 2011 seeing 77% to 78% of installed units having Base Efficiency. In 2012, there was a drop in the share of Base Efficiency measures installed relative to the 2009-2011 timeframe with 45% of installed unit Base Efficiency and 55% High Efficiency in 2012.[13] While the end-user Base Efficiency share was significantly lower in 2012, the Base Efficiency share from the HVAC contractor survey for 2011 and 2012 (see Section 9 of this report) is similar to the Base Efficiency share from the end-user on-sites for 2009 to 2011. Given the similarities between the 2009 to 2011 end user and the 2011 to 2012 HVAC contractor survey Base Efficiency shares, additional data from future years of end user or contractor surveys may be needed to demonstrate that the share of High Efficiency purchases is improving and being maintained. Table 8-8 presents the results of significance testing between adjacent years. These results show that between 2011 and 2012, the changes in distributions of Base versus High Efficiency are statistically significant, showing a significant increase in the High Efficiency share. Figure 8-4 illustrates the HVAC system efficiency distribution by year of installation.

[13] T-tests were used to determine if the Base Efficiency share for 2012 differed statistically from the Base Efficiency share for 2009, 2010, and 2011. The t-tests found that the Base Efficiency share in 2012 differed statistically from the share in earlier years. See Table 8-8 for p-values for the differences between adjacent years.

Table 8-7: CMST HVAC Efficiency Distribution by Year*

Efficiency Level	2009		2010		2011		2012	
	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision
Base Efficiency	78%	17%	77%	13%	78%	17%	45%	48%
High Efficiency	22%	59%	23%	45%	22%	63%	55%	39%
High Efficiency Tiers Distribution								
14-14.99 SEER	15%		4%		0%		1%	
15-15.99 SEER	6%		11%		7%		21%	
16-16.99 SEER	1%		8%		11%		26%	
> 17 SEER	0%		0%		3%		7%	
n	**189**		**267**		**257**		**166**	

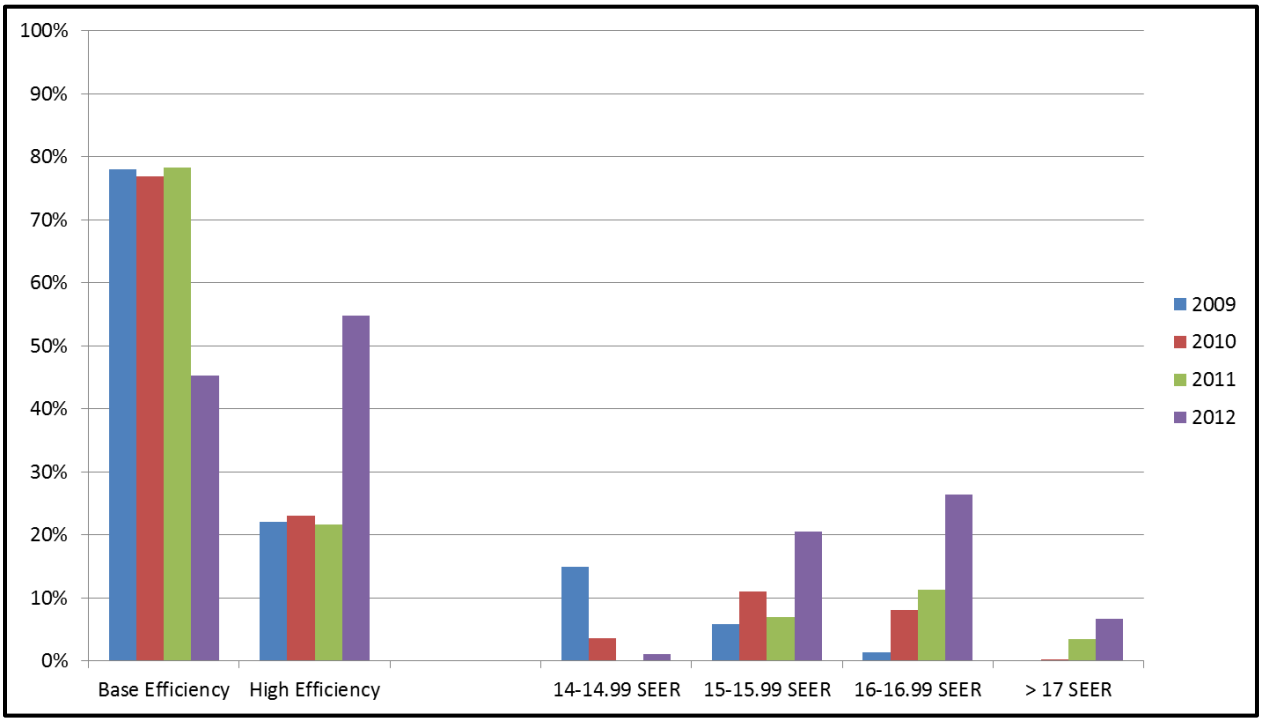
*** The results presented above have been weighted by site count.** Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3.

Table 8-8: T-Test Results Comparing CMST HVAC Efficiency Distribution, by Year*

Efficiency Level	2009-2010	2010-2011	2011-2012
Base Efficiency	0.894	0.746	0.025**
High Efficiency	0.894	0.746	0.025**
High Efficiency Tiers Distribution			
14-14.99 SEER	0.079*	0.081*	0.179
15-15.99 SEER	0.368	0.229	0.196
16-16.99 SEER	0.178	0.700	0.304
> 17 SEER	0.213	0.265	0.583

*** The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the column.

Figure 8-4: CMST HVAC Efficiency Distribution by Year*



* **The results presented above have been weighted by site count.** Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3.

Efficiency by IOU

Table 8-9 and Figure 8-5 present the CMST HVAC measure efficiency distribution by IOU. These data imply that across all utilities, Base Efficiency units account for the majority of purchases. PG&E and SCE have approximately 75% Base Efficiency units installed during this time period, while SDG&E has a relatively lower share of Base Efficiency units installed at 59%. The results of the significance testing in Table 8-10 suggest that the difference in distribution of HVAC efficiency levels between IOUs is generally not statistically significant.

Table 8-9: CMST HVAC Efficiency Distribution by IOU by Equipment Count, Site Weighted*

Efficiency Level	PG&E		SCE		SDG&E	
	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision
Base Efficiency	74%	17%	75%	14%	59%	28%
High Efficiency	26%	47%	25%	43%	41%	41%
High Efficiency Tiers Distribution						
14-14.99 SEER	10%		4%		5%	
15-15.99 SEER	11%		7%		19%	
16-16.99 SEER	2%		13%		13%	
> 17 SEER	4%		1%		4%	
n	**239**		**392**		**248**	

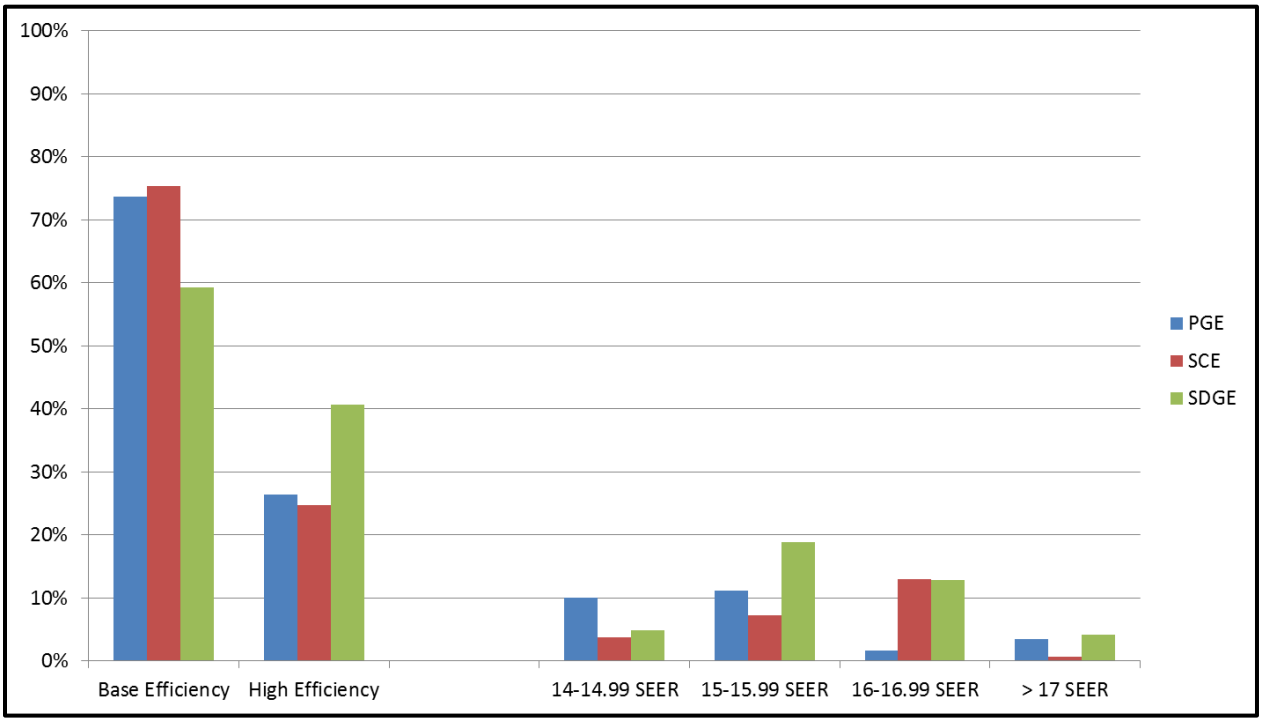
*** The results presented above have been weighted by site count.** Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3.

Table 8-10: T-Test Results Comparing CMST HVAC Efficiency Distribution, by IOU*

Efficiency Level	PGE-SCE	PGE-SDG&E	SCE-SDG&E
Base Efficiency	0.980	0.205	0.211
High Efficiency	0.980	0.205	0.211
High Efficiency Tiers Distribution			
14-14.99 SEER	0.244	0.499	0.781
15-15.99 SEER	0.784	0.271	0.210
16-16.99 SEER	0.071*	0.070*	0.956
> 17 SEER	0.212	0.906	0.201

*** The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the column.

Figure 8-5: CMST HVAC Efficiency Distribution by IOU*



* **The results presented above have been weighted by site count.** Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3.

Efficiency by Business Size

The distribution of HVAC performance groups by business size is shown in Table 8-11 and Table 8-13 by HVAC count shares and business count shares, respectively. Looking at the efficiency distribution of installed measures by business size, it appears that Large, Medium, and Small sized businesses were less likely to install Base Efficiency measures than Very Small businesses. Approximately 75% of small air conditioning units installed in Large and Medium sized businesses were Base Efficiency as were 58% of the units installed in Small sized businesses. Ninety-eight percent of small air conditioning units installed in Very Small sized businesses were Base Efficiency. Pairwise significance testing results in Table 8-12 show that the differences between Small and Very Small businesses in Base and High efficiencies is significant in looking at the HVAC unit shares, with Small businesses having a larger share of High efficiency installations than Very Small businesses.

Table 8-11: CMST HVAC Efficiency Distribution by Business Size, HVAC Count Shares*

Efficiency Level	Large		Medium		Small		Very Small	
	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision
Base Efficiency	77%	15%	73%	13%	60%	20%	87%	13%
High Efficiency	23%	53%	27%	36%	40%	31%	13%	89%
High Efficiency Tiers Distribution								
14-14.99 SEER	6%		4%		7%		5%	
15-15.99 SEER	8%		12%		18%		0%	
16-16.99 SEER	8%		10%		13%		6%	
> 17 SEER	1%		2%		2%		2%	
n	**141**		**493**		**202**		**43**	

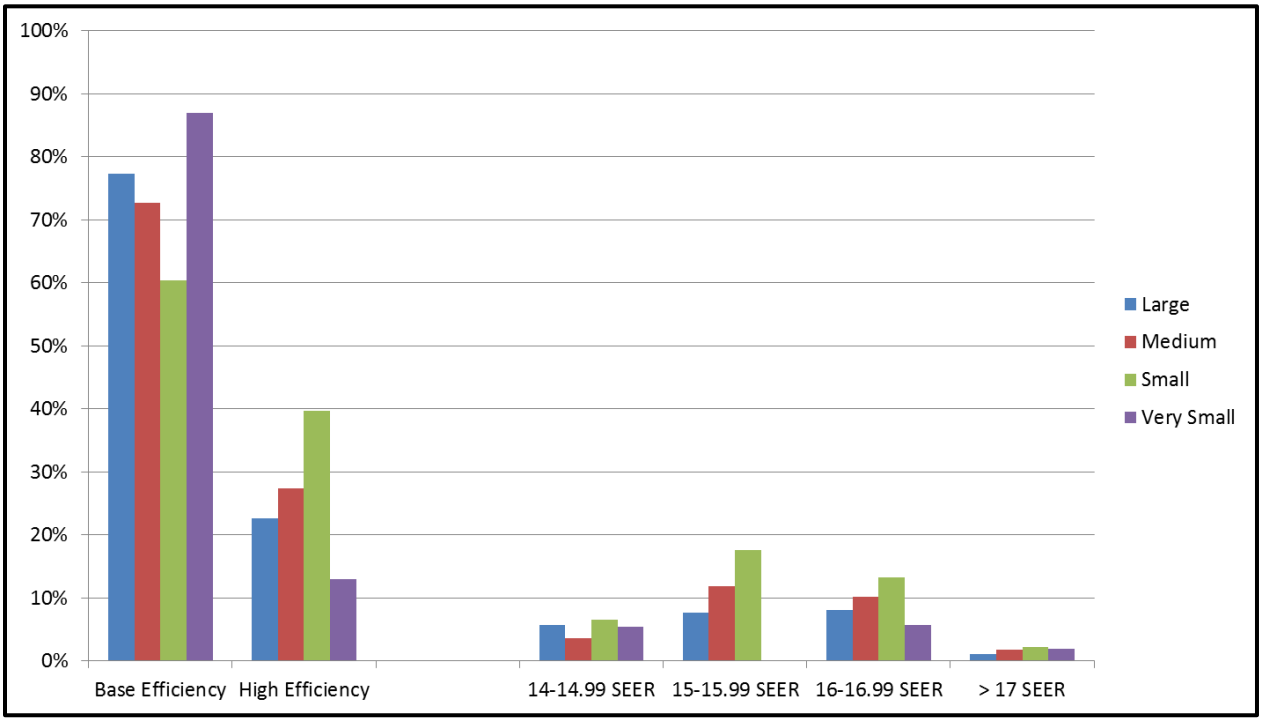
*** The results presented above have been weighted by site count.** Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, Very Small have annual usage less than or equal to 40,000 kWh. Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3.

Table 8-12: T-Test Results Comparing CMST HVAC Efficiency Distribution, by Business Size, HVAC Count Shares*

Efficiency Level	Large-Medium	Medium-Small	Small-Very Small
Base Efficiency	0.603	0.210	0.040**
High Efficiency	0.603	0.210	0.040**
High Efficiency Tiers Distribution			
14-14.99 SEER	0.797	0.416	0.833
15-15.99 SEER	0.595	0.517	0.129
16-16.99 SEER	0.813	0.600	0.389
> 17 SEER	0.758	0.792	0.871

*** The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the column.

Figure 8-6: CMST HVAC Efficiency Distribution by Business Size, HVAC Count Shares*



* **The results presented above have been weighted by site count.** Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, Very Small have annual usage less than or equal to 40,000 kWh. Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3.

Turning to the business-level HVAC efficiency distributions by business size, the data in Table 8-13 shows that 91% of Large businesses installed Base Efficiency equipment and 33% of the businesses installed High Efficiency equipment. Looking at Medium and Small sized businesses in Table 8-13, the Base and High Efficiency shares also sum to substantially more than 100%. These data indicate that many businesses were installing both Base and High Efficiency measures. Finding that a significant number of Large, Medium, and Small sized businesses were installing both Base and High Efficiency equipment indicates that those businesses installing High Efficiency equipment were not consistently making the efficient choice. Significance tests were conducted to compare the difference between adjacent business sizes. The results in Table 8-14 suggest that the differences in HVAC efficiency between business sizes are not statistically significant when looking at business count shares.

Table 8-13: CMST HVAC Efficiency Distribution by Business Size, Business Count Shares*

Efficiency Level	Large		Medium		Small		Very Small	
	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision	Percent	Relative Precision
Base Efficiency	92%	16%	80%	12%	87%	10%	92%	10%
High Efficiency	31%	110%	39%	35%	36%	66%	13%	88%
High Efficiency Tiers Distribution								
14-14.99 SEER	5%		10%		6%		8%	
15-15.99 SEER	5%		8%		14%		0%	
16-16.99 SEER	13%		13%		13%		4%	
> 17 SEER	8%		8%		3%		1%	
n	**15**		**90**		**59**		**28**	

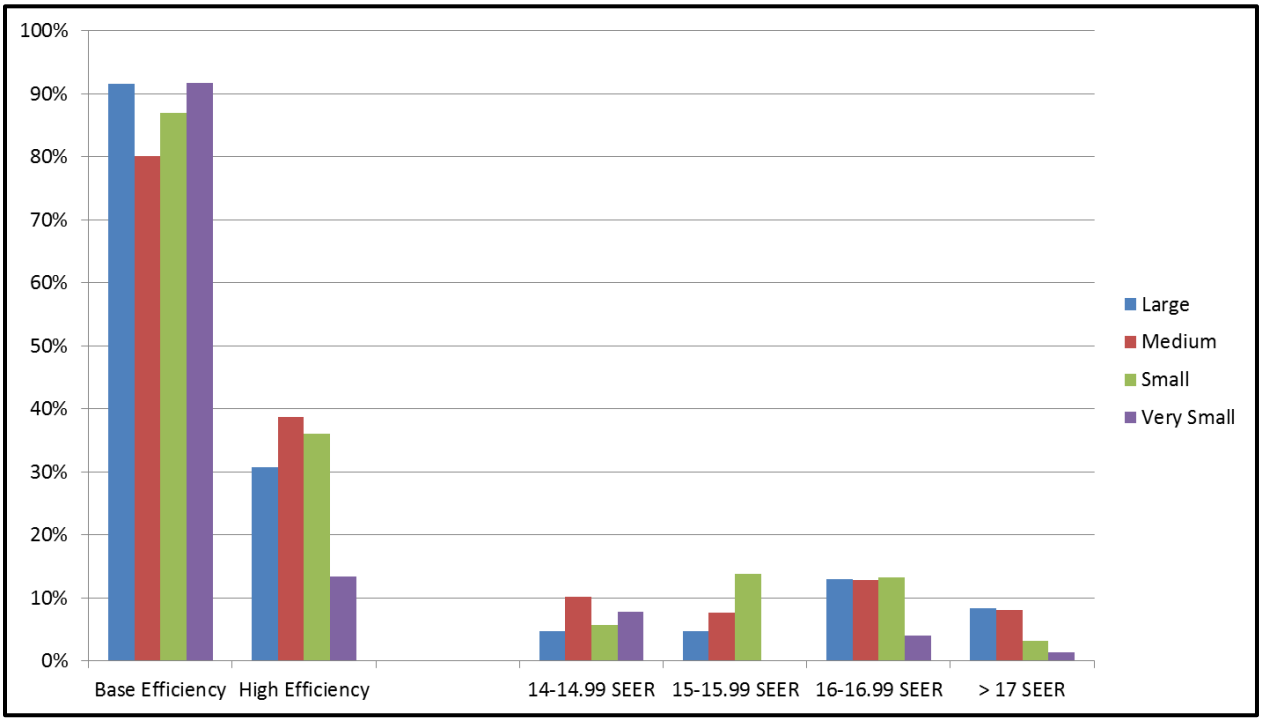
*** The results presented above have been weighted by site count.** Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, Very Small have annual usage less than or equal to 40,000 kWh. Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3. The business count shares sum to more than 100% because a site can install multiple efficiency levels of equipment.

Table 8-14: T-Test Results Comparing CMST HVAC Efficiency Distribution, by Business Size, Business Count Shares*

Efficiency Level	Large-Medium	Medium-Small	Small-Very Small
Base Efficiency	0.440	0.416	0.571
High Efficiency	0.400	0.284	0.478
High Efficiency Tiers Distribution			
14-14.99 SEER	0.745	0.621	0.762
15-15.99 SEER	0.695	0.355	0.183
16-16.99 SEER	0.982	0.943	0.382
> 17 SEER	0.978	0.426	0.618

*** The results presented above have been weighted by site weight.** P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the column.

Figure 8-7: CMST HVAC Efficiency Distribution by Business Size, Business Count Shares*



* **The results presented above have been weighted by site count.** Large sites have annual usage over 1,750,000 kWh, Medium have greater than 300,000 kWh and less than or equal to 1,750,000, Small have max annual usage greater than 40,000 kWh and less than or equal to 300,000, Very Small have annual usage less than or equal to 40,000 kWh.

Efficiency by Business Type

Table 8-15 shows the distribution of HVAC efficiency by business type for unit counts and business counts, respectively. Certain business types were not included in the CSS study - College, Hospital, Hotel, and Industrial. Because these business types had fewer on-sites than the other business types,[14] they were grouped into a category called "CMST-Only" in order to present a more meaningful level of aggregation. When analyzing the HVAC equipment installed at schools, 59% of equipment installed was Base Efficiency and 41% was High Efficiency. The share of High Efficiency equipment installed in Schools represents the highest share of High Efficiency equipment by business type, but the high level of businesses installing both Base and High Efficiency indicates that even Schools installing High Efficiency equipment do not make a consistent decision to always install High Efficiency HVAC equipment. For Schools, 91% installed new Base Efficiency equipment, while 35% installed High Efficiency equipment.

[14] The business types that were in the CSS on-site data collection effort have the opportunity to say that they have not installed new HVAC equipment on the telephone survey, agree to a CSS on-site, and discover CSMT eligible equipment. This opportunity is not available to the CMST only business types that were not incorporated into the CSS study.

These data indicate that the schools installing new HVAC equipment were very likely to install both Base and High Efficiency equipment.

Table 8-15: CMST HVAC Efficiency Distribution by Business Type, HVAC Count and Business Count Shares*

Building Type	Efficiency Level	HVAC Units			Businesses		
		Percent	Relative Precision	*n*	Percent	Relative Precision	*n*
CMST-Only	Base Efficiency	94%	7%	**109**	99%	3%	**12**
	High Efficiency	6%	149%		26%	137%	
Food/Liquor	Base Efficiency	100%	0%	**23**	100%	0%	**12**
	High Efficiency	0%	0%		0%	0%	
Health/Medical - Clinic	Base Efficiency	87%	15%	**64**	92%	13%	**22**
	High Efficiency	13%	116%		10%	126%	
Miscellaneous	Base Efficiency	59%	34%	**97**	89%	15%	**29**
	High Efficiency	41%	50%		41%	99%	
Office	Base Efficiency	64%	28%	**124**	91%	12%	**34**
	High Efficiency	36%	51%		21%	106%	
Restaurant	Base Efficiency	75%	34%	**27**	93%	12%	**13**
	High Efficiency	25%	118%		23%	126%	
Retail	Base Efficiency	88%	14%	**39**	82%	29%	**21**
	High Efficiency	12%	119%		18%	129%	
School	Base Efficiency	59%	23%	**353**	91%	11%	**28**
	High Efficiency	41%	34%		35%	105%	
Warehouse	Base Efficiency	89%	12%	**43**	87%	20%	**21**
	High Efficiency	11%	119%		15%	124%	

*** The results presented above have been weighted by site count.**

Efficiency by New Construction / Remodel

As part of the phone survey, respondents were asked what year their facility was built and/or remodeled. If the site was constructed or remodeled between 2009 and the present, it was considered a recent new construction/remodel site. Table 8-16 and Figure 8-8 present the CMST HVAC efficiency distribution for businesses that are new construction/remodel versus those businesses that replaced HVAC equipment outside of new construction or new remodel. These data indicate that the likelihood of installation of High Efficiency small air conditioning units is higher during a remodel/new construction (39%) than during a direct replacement of the unit (14%).

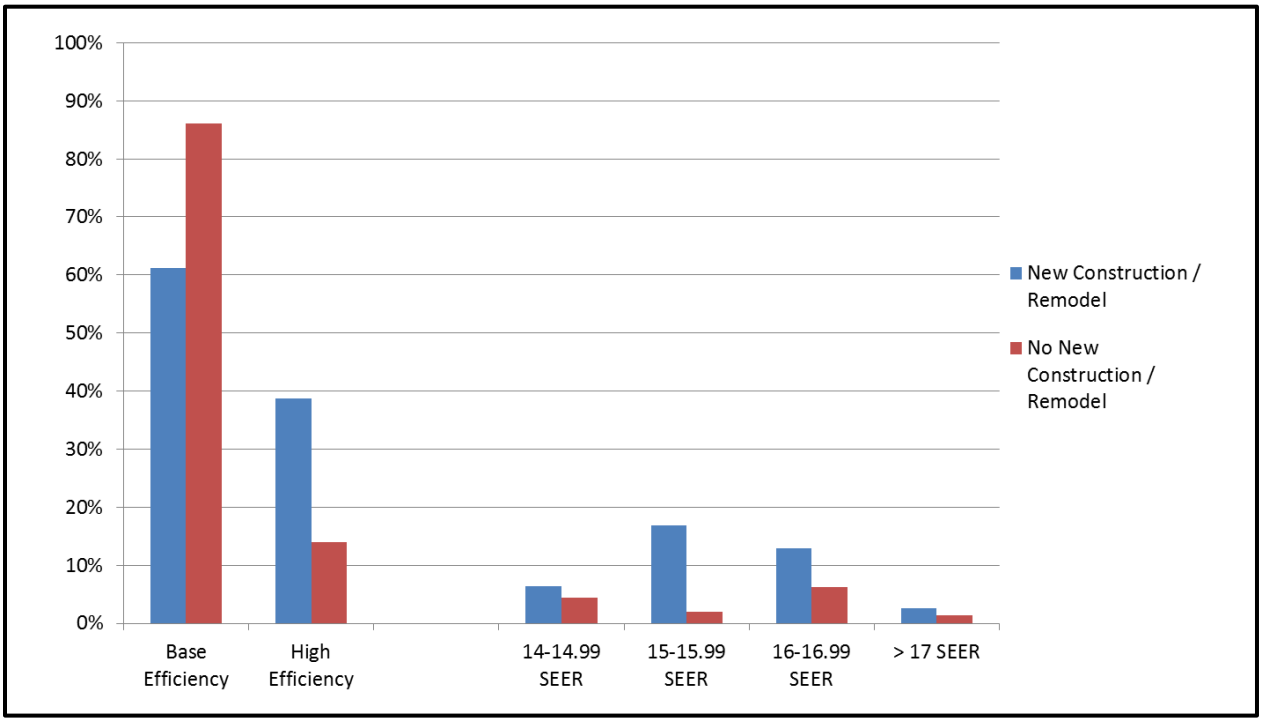
The t-test results in Table 8-16 suggest that the differences in HVAC unit efficiency distribution between businesses that either had or did not have a recent new construction/remodel effort are statistically significant overall, but not between efficiency tiers. HVAC units installed in New Construction or Remodel have a statistically significant larger high efficiency share than those units installed as a retrofit.

Table 8-16: CMST HVAC Efficiency Distribution by New Construction/Remodel*

Efficiency Level	New Construction / Remodel		No New Construction / Remodel		T-Test P-value Results NC/Rem to No NC/Rem
	Percent	Relative Precision	Percent	Relative Precision	
Base Efficiency	61%	19%	86%	8%	0.004***
High Efficiency	39%	31%	14%	47%	0.004***
High Efficiency Tiers Distribution					
14-14.99 SEER	6%		4%		0.669
15-15.99 SEER	17%		2%		0.011**
16-16.99 SEER	13%		6%		0.246
> 17 SEER	3%		1%		0.504
n	**474**		**405**		

*** The results presented above have been weighted by site count.** Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3. P-values are presented above. *** denotes that percentages are significantly different at a 1% significance level, ** denotes a 5% significance level, and * denotes a 10% significance level. The percentages do not differ significantly if there is no asterisk in the column.

Figure 8-8: CMST HVAC Efficiency Distribution by New Construction/Remodel*



* **The results presented above have been weighted by site count.** Each level reported represents the different Tiers. There are slight variations in EER between single packaged systems and split systems, which are explained above in Section 8.1.3.

9

CMST HVAC Contractor Analysis

The CMST HVAC contractor survey is part of the Joint HVAC Contractor Survey effort designed to address research needs for the Measure Cost Study, Quality Maintenance and Installations Survey, Workforce Education and Training Study, and the Commercial Market Share Tracking Study. The contractor survey is designed to collect HVAC information from contractors and vendors who sell and install HVAC units in California. The primary object of the CMST HVAC study is to determine the efficiency distribution of small packaged air conditioning units installed in nonresidential facilities in California. The contractor survey's efficiency distribution of small HVAC units will be triangulated with the efficiency distribution derived from the CMST on-site end users data collection for businesses purchasing small air conditioning units from 2009 to 2012.

9.1 Joint Survey Effort

The Joint HVAC Contractor data collection effort includes survey batteries for the Measure Cost Study, Quality Installation and Maintenance Study, the Workforce Experience and Training Study and the Commercial Market Share Tracking Study. While the data requirements for each work order are different, combining the data collection efforts for all three studies limited respondent fatigue associated with over surveying and ensured that contractors were not asked general firm description information on multiple surveys.

9.1.1 Measure Cost Study Survey Questions

The Measure Cost Study focuses on the cost of installation and maintenance of a HVAC unit. The questions are designed to take into account both the financial cost, and the time involved with retrofitting or maintaining HVAC equipment. The Measure Cost Study questions are broken down into three main areas: 1) retrofits of split or packaged units, 2) retrofits of PTAC units and 3) maintenance of packaged units. Small packed, split and PTAC unit questions target the cost and time associated with removing an old unit, installing a new unit and testing and commissioning the newly installed unit. The maintenance questions apply to performance maintenance for a 5 ton outdoor condenser unit or a 5 ton packaged unit in accordance with ASHRAE Standard 180 and are concerned with the time it takes to complete basic maintenance.

9.1.2 Quality Installation and Maintenance Survey Questions

As part of the Joint HVAC Contractor Survey the Quality Installations and Maintenance battery is designed to find out from HVAC contractors their installation documents and procedures. The survey asks contractors about the time required for basic installation and if the technician has any procedures to follow while installing the unit. Each contractor is asked what the typical installation consist of and if there are any written documents that they follow: such as an installation manual or the manufacturers' specifications. The final questions ask the contractor if they are aware of the California IOUs' Quality installation Program and if their technicians perform work through it.

9.1.3 Workforce Experience and Training Survey Questions

The purpose of the Workforce Experience and Training battery is to collect information on the level of training provided to field technicians installing HVAC units in California. There are a series of general questions about how much experience is required for all their newly hired field technicians. Specific questions are asked about required or emphasized certifications and trainings for technicians and whether or not the contractor pays for these. The final questions for the Workforce Experience and Training battery are about the money the company spends on training for its employees each year and the hourly wages of field technicians.

9.1.4 CMST HVAC Contractor Survey Research Objectives

The CMST HVAC Contractor Survey is designed to determine the efficiency distribution of recent air conditioning sales and installations by vendors and contractors to the non-residential sector. Of particular interest to this survey effort are small packaged and split-system single zone systems, including heat pumps. The survey attempts to learn the share of sales and installation associated with a 13, 14, 15, and 16+ SEER rating for air conditioning unit smaller than 65 kBtuh. The efficiency distribution derived from the contractor information on the sales and installation of units smaller than 65 kBtuh will be compared to the information collected as part of the CMST end-user on-site data collection effort.

9.2 Development of the HVAC Contractor Frame

The HVAC contractor frame was developed from contractors with current C20 Licenses. A C20 license from the California Contractor State License Board (CLSB) is a required state license for HVAC contractors that install, maintain, service, and repair HVAC systems in California. The C20 license list provided information on the names of licensed HVAC contractors or their business name and the contractors' (or businesses') telephone number and address.

While the C20 list provided a potential HVAC contractor frame, the information on the list does not include data on the size, sales, or revenue of the contractor that is necessary to develop weighting variables. To collect information that could be used for weighting, the research team matched the C20 contractor list with data from an InfoUSA extract. InfoUSA is a comprehensive database that includes information on business sizes and sales volumes for many business types. The data from InfoUSA was collected for businesses in California with specific NAICS codes: Altogether four NAICS codes were used: 28322 (Plumbing, Heating, and Air-Conditioning Contractors), 238990 (All Other Specialty Trade Contractors), 81131001 (Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance) and 81141227 (Appliance Repair and Maintenance).

Combining the InfoUSA data with the C20 contractor list, approximately 50% of the C20 contractors were matched to the data pulled from InfoUSA. The matching process was difficult because the contractors may have used their business or own name when applying for the C20 license and their business or own phone numbers. Slight differences in the name or phone number in either the C20 list or the InfoUSA data can hamper a match between these two different contractor data sources. To insure that the matched C20 and InfoUSA database are an unbiased representation of the C20 HVAC contractor frame the team compared the matched C20 contractors to the unmatched contractors. To check for potential bias the team compared the geographic location of the matched and unmatched contractors in the C20 list. The relative distribution of matched and unmatched firms by the geographic location in the backfilled C20 frame very closely mirrors those in the unmatched C20. The team also compared the number of employees and the revenue of the matched C20 contractors with those in NAICS 28322. The distribution of employees and revenue for these two groups of contractors was found to be similar. Given the similarities, the team has used the matched C20 frame as the HVAC contractor frame, working under the assumption that the matched C20 contractors represent an unbiased subset of the C20 frame.

The number of contractors and the distribution of HVAC contractors by geographic location and number of employees are listed in Table 9-1. Following the matching of the C20 and InfoUSA data the HVAC contractor frame included 5,054 contractors. The number of contractors in the south exceeds the number of HVAC contractors in the north. This distribution is likely due in part to the higher air conditioning needs of the southern part of the state.

Table 9-1: HVAC Contractor Frame, Survey Quota, and Survey Completes

Region	Number of Employees	Frame of HVAC Contractors	HVAC Contractor Survey Quota	HVAC Contractor Survey Completes
North	1 to 2	765	14	14
South	1 to 2	1044	19	20
North	3 to 4	537	13	13
South	3 to 4	719	18	18
North	5 to 9	443	11	12
South	5 to 9	541	13	14
North	10 to 19	227	6	6
South	10 to 19	260	6	6
North	20 to 49	142	4	4
South	20 to 49	229	6	6
North	50 to 99	41	3	3
South	50 to 99	53	3	3
North	100 to 249	24	3	3
South	100 to 249	21	3	1
North	250 to 499	4	1	0
South	250 to 499	3	1	0
North	500 to 999	1	1	0
South	500 to 999	0	0	0
Total		**5,054**	**125**	**123**

9.3 Weighting

The 5,054 HVAC contractors in the matched C20 HVAC frame are disaggregated into stratum defined by geographic location (North and South or based on electric utility to PG&E for Northern California and SCE and SDG&E for Southern) and number of employees. Using these two variables, 14 strata are defined (see Table 9-1). Using these strata and a quota of 125 surveys, the quota are distributed across stratum. Table 9-1 also lists the number of survey completes by stratum. The Joint HVAC Contractor Survey completed 123 surveys, slightly oversampling some of the stratum with more contractors and not meeting the quota for some of the stratum with fewer contractors.

The weighting methodology was developed using revenue data from the matched C20 HVAC contractors in the population and information on the share of HVAC contractors' revenue derived from the sales or installations of HVAC; which was collected as part of the Joint HVAC Contractor Telephone Survey.

Using the information on the revenue for the population of HVAC contractors and information on each of the sampled site's HVAC revenues, the weight for a given contractor is developed using the following formula:

$$W_{ij} = \frac{Pop\ HVAC\ Rev_j * HVAC\ Rev_i}{\sum HVAC\ Rev_j} \quad (1)$$

Where

W_{ij} is the weight for HVAC contractor i in strata j,

$Pop\ HVAC\ Rev_j$ is the revenue for the population of HVAC contractors in stratum j,

$HVAC\ Rev_i$ is the HVAC revenue for contractor i in stratum j, and

$\sum HVAC\ Rev_j$ is the HVAC revenue for HVAC contractors interviewed as part of stratum j.

The weighting methodology weighs up an individual contractor's HVAC revenue to our best understanding of their share to the HVAC contractors' revenue in California.

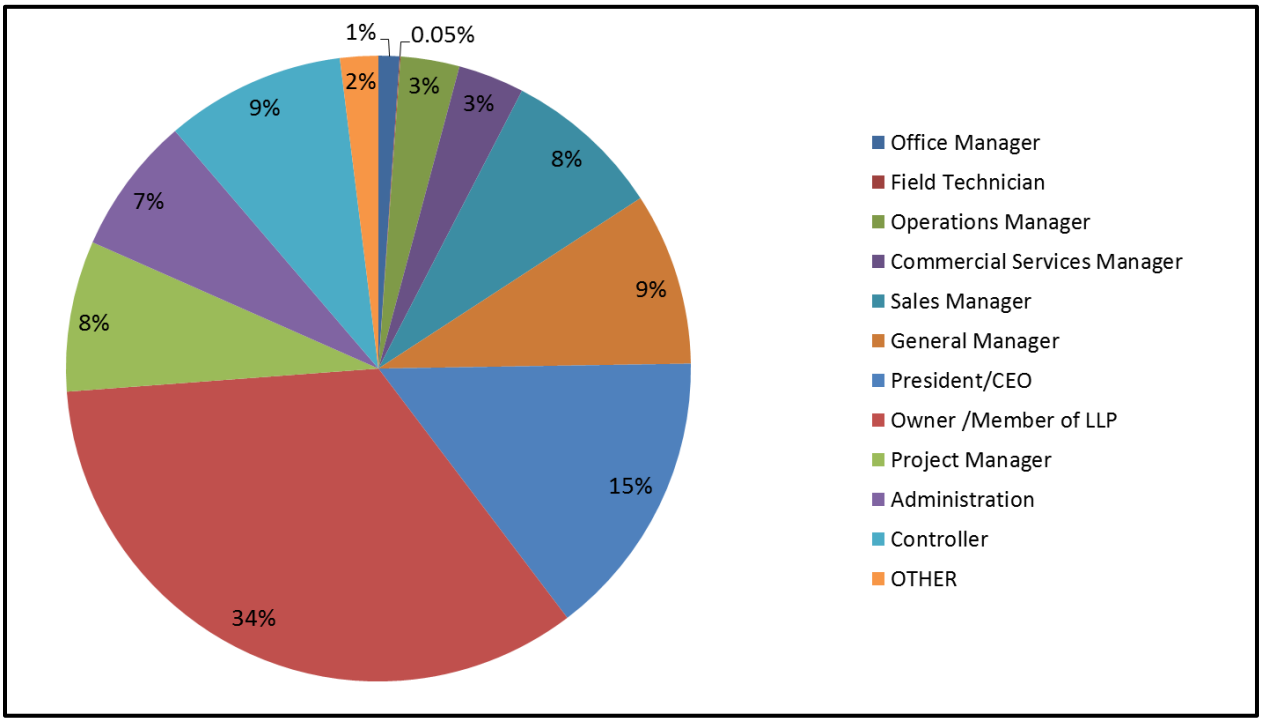
9.4 HVAC Contractor Survey Findings

The main objective of the CMST HVAC contractors' survey is to determine the distribution of HVAC systems sold and installed in California based on size and efficiency. Along with capturing this information the survey also provides business characteristics for the contractors selling and installing HVAC systems.

9.4.1 HVAC Contractor Business Characteristics

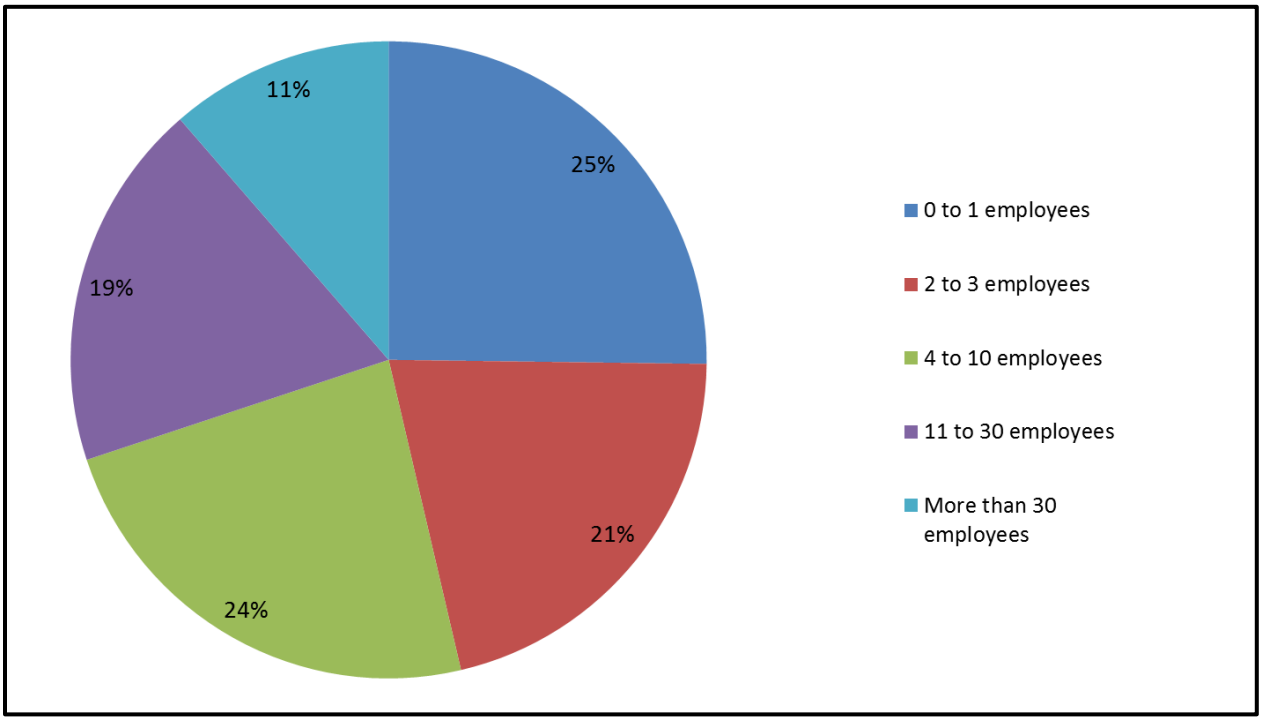
The HVAC Contractor survey covers a range of disciplines and therefore requires the interviewee to be knowledgeable in many areas of their business. A variety of decision makers were interviewed with a significant majority holding high level positions within their organization. Of the contractors interviewed 50% were either the president or owner of the company. Figure 9-1 shows a complete distribution of the decision makers that were interviews.

Figure 9-1: Job Title of HVAC Contractor Respondent



The HVAC contractors that were surveyed represent a cross section of HVAC contractors in California in terms of size and sales volume. Questions regarding number of employees, revenues, and location provide the contextual framework of contractors selling and installing HVAC units in California. In order to obtain clear and consistent results the contractors with multiple locations were given instructions to answer the questions for only their current location. Eighteen percent of sites responded saying that they have multiple locations, with 8% of the contractors reporting that they sold or installed HVAC units outside of California. Figure 9-2 shows how the survey participants break down by the number of employees. Of the sites that were contacted about 75% answered that they had 10 or fewer employees and 25% of the contractors answered that their business has only one employee.

Figure 9-2: Distribution of HVAC Contractor Size by Number of Employees



Each of the contractors was asked approximately how many new HVAC units they install per year. The data in Table 9-2 show that 29% of contractors responded that they annually install 25 units or less. The number of units installed annually can be supplemented by the revenue from maintenance and tune-ups of units and the replacement of parts.

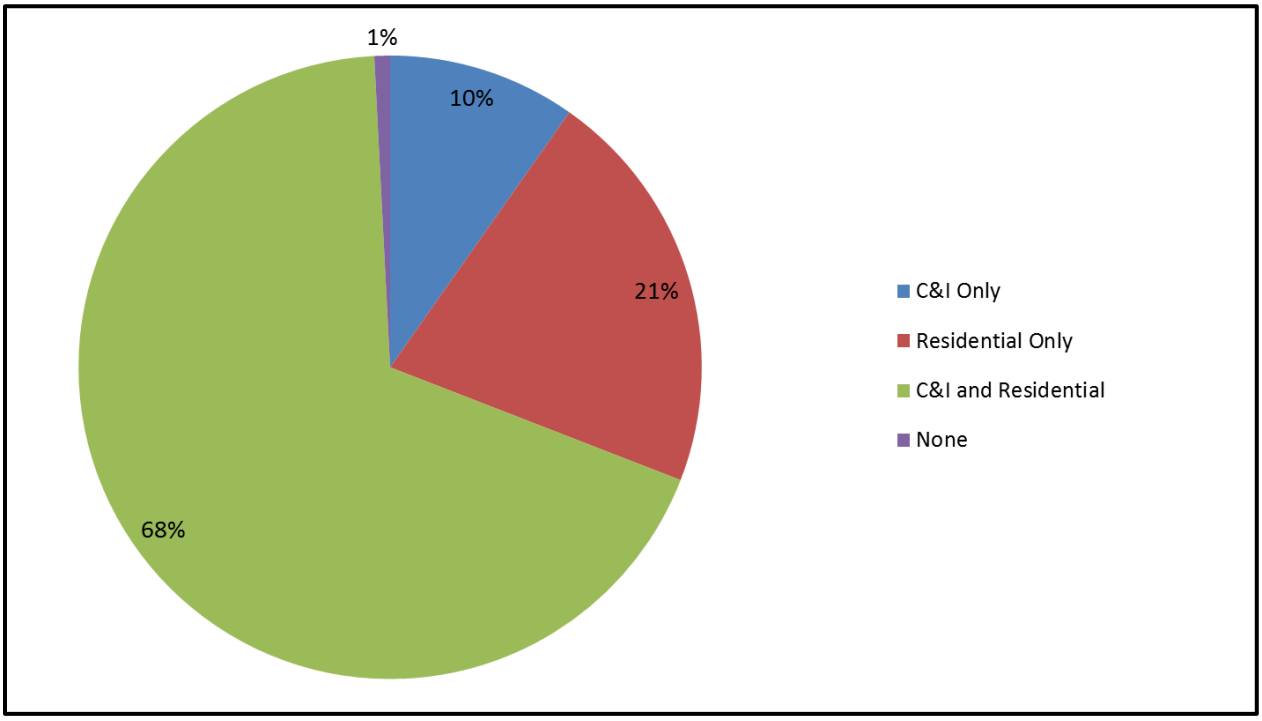
Table 9-2: Number of HVAC Installations Completed Annually

Number of units Installed Annually	Percent of Contractors
1 to 25 units	29%
26 to 50 units	8%
51 to 75 units	5%
76 to 100 units	26%
101 to 300 units	15%
More than 300 units	8%
Refused	0.5%
Don't know	8%
n	**123**

The Joint HVAC Contractor Since included questions for both residential and commercial HVAC contractors but the focus of the CMST study is on small commercial packaged HVAC

units. Therefore the survey included questions to disaggregate a contractor's sales and installation into their residential and commercial shares. Of the 123 contractors surveyed 84 preform installations in both the residential and C&I sectors. The remaining 39 surveys get broken down as 12 installing only in the commercial sector, 26 installing only in the residential sector and 1 vendor that self-reported that they did not perform any installations. The percent of contractors that install in the residential and C&I sectors can be found in Figure 9-3. From those 84 contractors who perform installations in both the residential and non-residential sectors, 29% of their revenue comes from commercial sales and installations.

Figure 9-3: Share of Installations in the Residential and C&I Business for HVAC Contractors[1]



The survey also asked HVAC contractors to report the percent of their business from new construction, retrofit/remodel, and maintenance and repair. This question allows for the revenue information to be broken down ever further. This question is important in that it allows for a more detailed picture of operations and business practices for HVAC contractors in California. It also may provide some information on the distribution of HVAC installations between new construction and retrofit/remodel and how the efficiency of installed units differs for these two types of customers. The survey findings, presented in Table 9-3, indicate that on average contractors self-report that 47% of business was in remodel/retrofit with 24% in New

[1] One contractor reported preforming maintenance of HVAC equipment only; therefore, he meets the requirements of having more than 10% of his revenue from HVAC sales and installations in California.

Construction and 29% maintenance. A majority of the revenue from HVAC contractors is derived from installing new HVAC units for retrofit and remodel applications.

Table 9-3: Distribution of HVAC Business to New Construction, Remodel/Retrofit, and Maintenance and Repairs

Business Activity	Percent of Revenue
New Construction	24.3%
Remodel/Retrofit	46.7%
Maintenance and repairs	29.0%
n	**123**

The HVAC installation market can be broken down into three categories: replacing a non-operational unit, replacing an operational unit, and installing for new construction. Breaking down the HVAC sales of contractors into these three groups allows for a deeper understanding of the HVAC installation work undertaken by contractors. The distribution of C&I new installations is represented in Table 9-4. Overall 53% of contractors' revenue from new installations comes from replacing units when they are no longer operational. This illustrates that contractors will typically replace a broken unit for every one unit from new construction or early retirement.

Table 9-4: Distribution of C&I New Installations[2]

HVAC Market	Percent of units installed
Replacing Operational Units	19.1%
Replacing Non-Operational units	52.7%
New Construction	28.2%
n	**118**

9.4.2 HVAC Contractor Market Share

The primary objective of the CMST HVAC study is to determine the efficiency distribution of small packaged HVAC units installed in nonresidential facilities in California. The CMST on-site study collected information from end users on the number of units installed and collected manufacturer and model number information that enabled the study to estimate the efficiency distribution of newly installed units in the non-residential sector. The contractor survey provides an alternative approach to develop an estimate of the efficiency distribution of recent HVAC sales and installations. The contractor survey goes directly to the people selling and installing

[2] Out of the 123 surveys completes, 5 of the contractors did not know the breakdown of new installations, and 1 contractor refused to answer the question.

the HVAC units, HVAC contractors. The efficiency information collected from the contractor provides a broader picture of the air conditioning market as these data represent a larger number of installation than the number of end user sites verified during the CMST on-sites. The CMST on-sites, however, allow for more detailed data collection from individual sites installing new equipment.

The CMST HVAC on-site survey focuses solely on the small split and packaged units that have either DX or evaporative cooling, where a small unit is any unit that has a cooling capacity of less than 65,000 Btuh or approximately 5.5 tons. This type of units was chosen as the focus of the CMST HVAC study because they represent the majority of the units in the commercial sector.

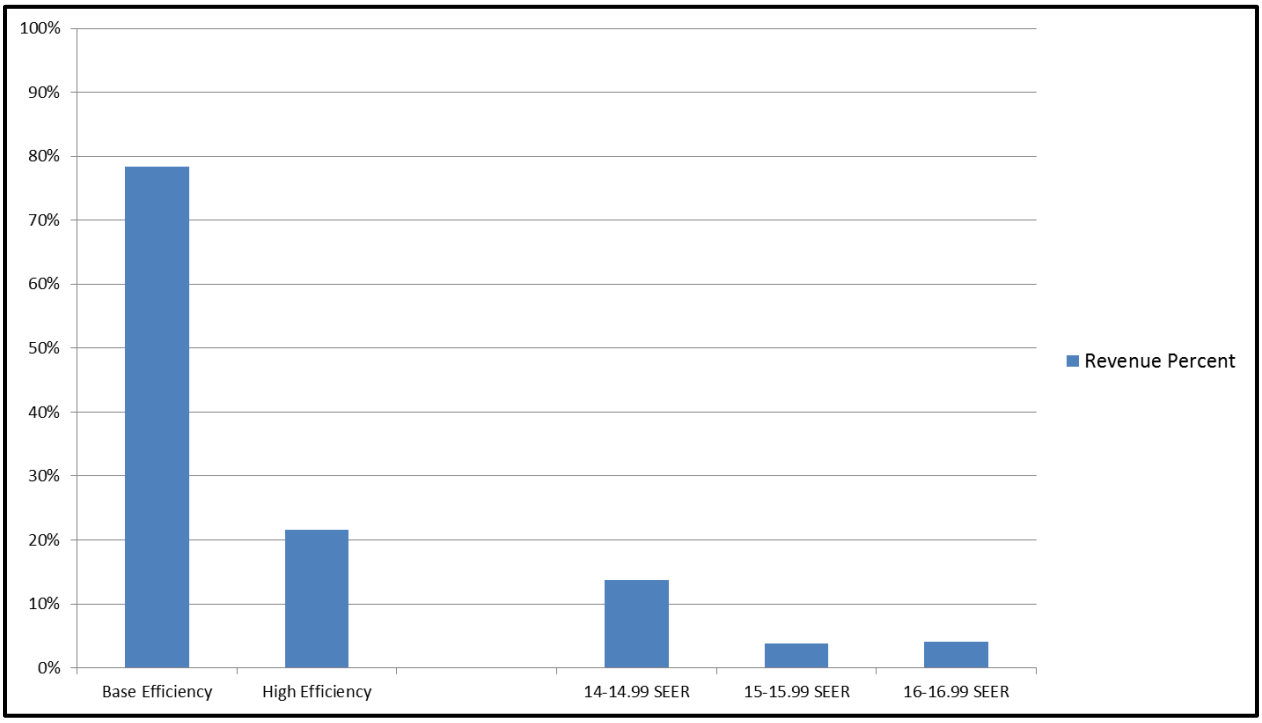
Small Package/Split AC/HP Systems

Small units are the focus of the CMST HVAC report because they represent the majority of units that are installed and being installed. Given their role as one of the primary sources of cooling in the commercial sector it is important to look at the efficiency distribution of newly installed units. Contractors were questioned on the efficiency share of their sales and installations of small HVAC units. Contractors were asked to allocate their sales and installations of units between base (13 SEER), 14-14.99 SEER, 15-15.99 SEER, and 16+ SEER. Using the contractors self-reported efficiency sales and installation distributions, it is clear that a majority of the sales and installations for these contractors come from installing base efficiency, 13 SEER or less, units. From Table 9-5 and Figure 9-4, 78% of the small units that are being installed are base efficiency units. Contractors are largely installation the least efficient HVAC units that are currently produced.

Table 9-5: Market Share of Small Units by Efficiency

Efficiency Level	Revenue Percent	Relative Precision
Base Efficiency	78%	30%
High Efficiency	22%	143%
High Efficiency Tiers Distribution		
14-14.99 SEER	14%	
15-15.99 SEER	4%	
16-16.99 SEER	4%	
n	**52**	

Figure 9-4: Market Share of Small Units by Efficiency

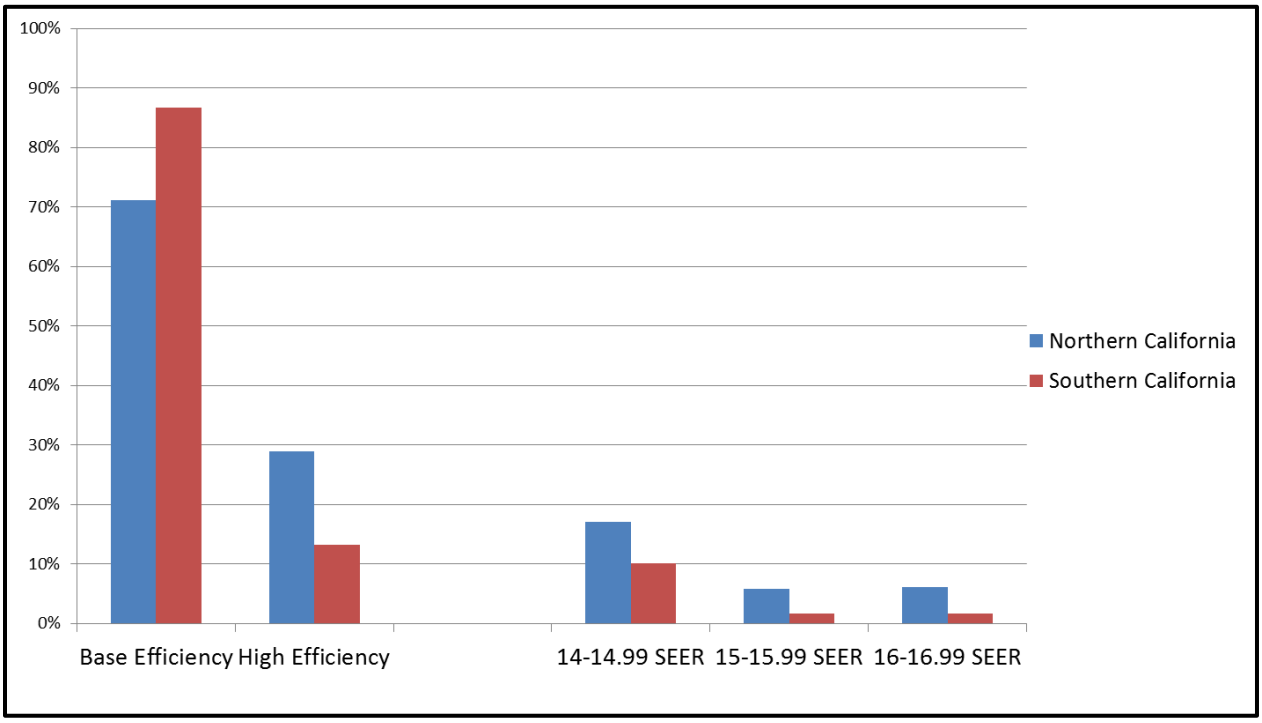


The market share of HVAC units sold and installed can also be disagregated by geographic location (Northern California and Southern California). When looking at the contractors in this way it is evident that the majority of units sold in either location are of base efficiency. Contractors in Northern California are selling and installing a slightly higher percentage of air conditioning units that are considered high efficiency. Table 9-6 and Figure 9-5 illustrate that 29% of revenue in Northern California comes from high efficiency units while high efficiency units only make up 13% of the market in Southern California.

Table 9-6: Distribution of Efficiency by Geographic Location

Efficiency Level	Northern California	Relative Precision	Southern California	Relative Precision
Base Efficiency	71%	40%	87%	30%
High Efficiency	29%	37%	13%	41%
High Efficiency Tiers Distribution				
14-14.99 SEER	17%		10%	
15-15.99 SEER	6%		2%	
16-16.99 SEER	6%		2%	
n	**21**		**31**	

Figure 9-5: Distribution of Efficiency by Geographic Location

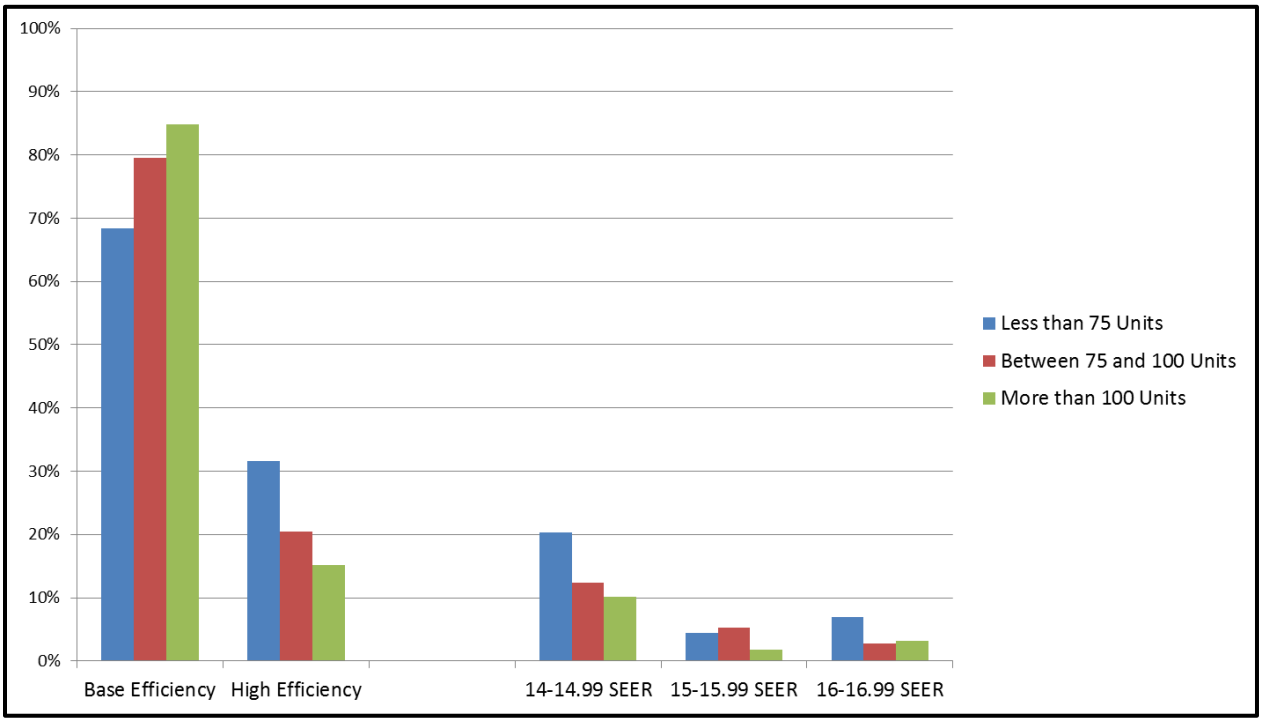


The sales and installations can also be broken down by the size of the contractor. Table 9-7 and Figure 9-6 show the breakdown HVAC efficiency by the number of HVAC units the contractor installs. Eighty five percent of the sales and installations for those contractors installing more than 100 units annually were from sales and installations of base efficiency units. The small contractors, less than 75 units installed annually, self-reported the highest share of high efficiency units at 32% of sales and installations.

Table 9-7: Distribution of HVAC Efficiency by Number of Jobs

Efficiency Level	Less than 75 Units	Relative Precision	Between 75 and 100 Units	Relative Precision	More than 100 Units	Relative Precision
Base Efficiency	68%	41%	80%	60%	85%	42%
High Efficiency	32%	69%	20%	48%	15%	53%
High Efficiency Tiers Distribution						
14-14.99 SEER	20%		12%		10%	
15-15.99 SEER	4%		5%		2%	
16-16.99 SEER	7%		3%		3%	
n	**30**		**9**		**11**	

Figure 9-6: Distribution of HVAC Installations by Number of Jobs

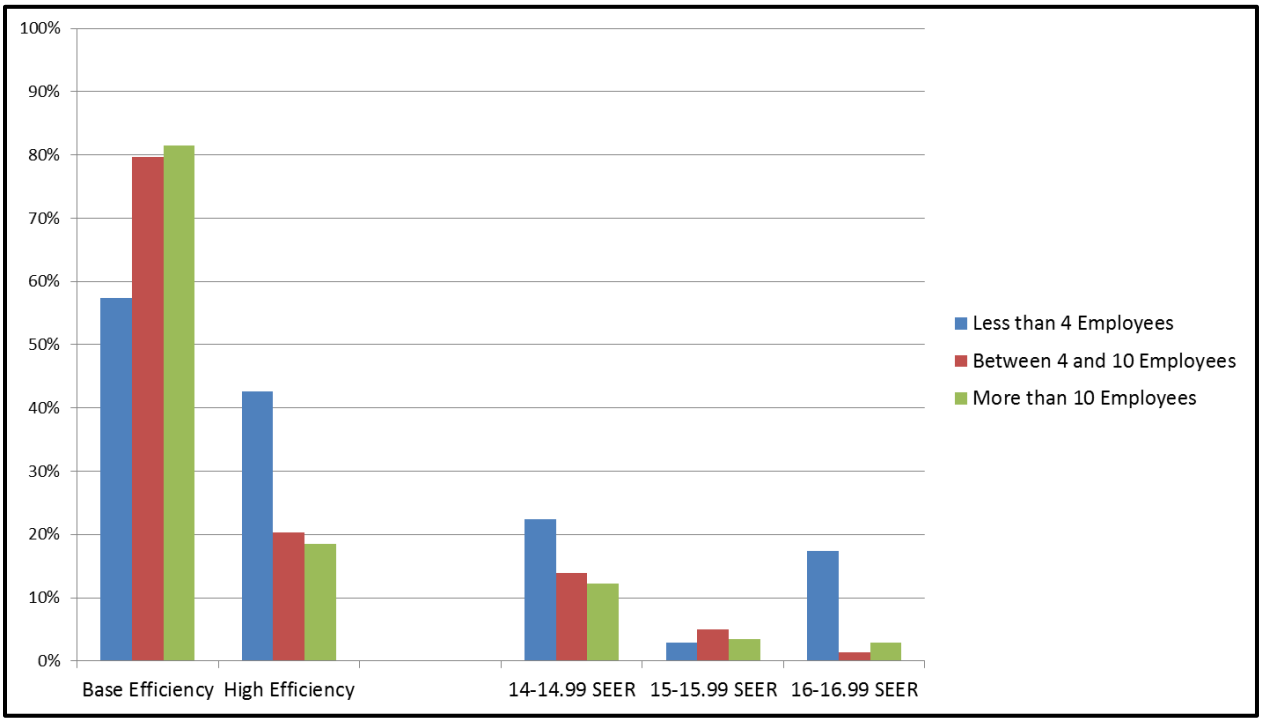


An alternative way to break up the contractors by size is to look at the number of employees. Table 9-8 and Figure 9-7 give a detailed distribution of HVAC efficiency distribution by the number of employees employed by a contractor. Once again, smaller contractors self-report installing a higher share of high efficiency units than larger contractors. While a majority of the units installed by small contractors are base efficiency units, nearly half or 43% of their installations are high efficiency units.

Table 9-8: Distribution of HVAC Efficiency by Number of Employees

Efficiency Level	Less than 4 Employees	Relative Precision	Between 4 and 10 Employees	Relative Precision	More than 10 Employees	Relative Precision
Base Efficiency	57%	59%	80%	62%	81%	24%
High Efficiency	43%	121%	20%	69%	19%	28%
High Efficiency Tiers Distribution						
14-14.99 SEER	22%		14%		12%	
15-15.99 SEER	3%		5%		4%	
16-16.99 SEER	17%		1%		3%	
n	**17**		**16**		**19**	

Figure 9-7: Distribution of Efficiency by Number of Employees



10

CMST HVAC Contractor and End User Comparison

This section provides a comparison of the findings of the CMST-HVAC contractor and end user findings. The CMST-HVAC contractors' findings are derived from self-report information on the sales and installations of small packaged air conditioning units (less than 65,000 Btuh) in the non-residential sector in California during 2011 and 2012. The CMST-HVAC end user findings are derived from on-site data collection for small packaged air conditioning units where the site contact self-reported that the HVAC units were purchased after January 2009. The CMST end user efficiency distributions are present for air conditioning units installed from 2009-2012 and from 2011-2012.

10.1 Sources of Data

The comparison gathers data from:

- HVAC Contractor Survey,
- CMST/CSS Phone Survey,
- CMST Onsite Survey, and
- Make and Model lookups.

Each data source listed above provided specific information that was used in this analysis. The information from the Joint HVAC Contractor Survey (JHCS) provided specific organizational and operational details of HVAC contractors in California. In the JHCS the HVAC contractors were asked to self-report the efficiency share of their sales and installations of small packaged air condition units during 2011 and 2012. The CMST/CSS phone survey was used to identify recent purchasers of HVAC measures and to recruit for on-site data collection. The CMST On-site Survey was used, along with the make and model lookups, to capture the efficiency distribution of new small packaged air conditioning units installed on-site from 2000-2012.

10.2 Results Comparison and Recommendations

The Joint HVAC Contractor Survey and the CMST-Onsite end user survey both provide information on the efficiency distribution of small packaged air conditioning units installed in non-residential facilities in California from 2011 to 2012. The distribution of base and high

efficiency units installed from both the contractor and the end user surveys is presented in Table 10-1. The estimated distributions of base and high efficiency air conditioning installed from both the contractor and end user surveys are very similar. The contractor survey estimated that 72% of non-residential small packaged air conditioning sold and installed in California (2011-2012) was base efficiency while the end user survey estimated that 65% of units installed from 2011-2012 were base efficiency increasing to 78% if the time period is extended to 2009-2012. These two estimates of the share of base efficiency installations are remarkably similar, lending support to the likelihood that the base efficiency share is between 65% and 78% for this time period.

Table 10-1: Contractor and End User Distribution of HVAC Efficiency

Efficiency Level	HVAC Contractor Survey 2011-12	CMST End User Survey 2011-12	CMST End User Survey 2009-12
Base Efficiency	78%	65%	72%
High Efficiency	22%	35%	28%

The high efficiency category can be disaggregated into 14-14.99 SEER, 15-15.99 SEER, 16-16.99 and 17 SEER. Table 10-2 shows the disaggregated distribution of HVAC units being installed by HVAC contractors (2011-2012) and by end users from 2011 to 2012 and from 2009 to 2012. Disaggregating the data into specific efficiency ranges shows a considerable difference between the on-site and contractor survey. The difference between the end users and contractor surveys is evident in the estimated efficiency shares of 14-14.99 SEER units. Contractors reported that 14% for their installations fell into this category while the on-site data resulted in 14 SEER units having only a 6% share for 2009-2012 and 0% from 2011-2012. This considerable difference can be seen throughout all of the high efficiency shares.

Table 10-2: Distribution of High Efficiency Installations

Efficiency Level	HVAC Contractor Survey 2011-12	CMST End User Survey 2011-12	CMST End User Survey 2009-12
14-14.99 SEER	14%	0%	6%
15-15.99 SEER	4%	13%	10%
16-16.99 SEER	4%	17%	10%
SEER 17	-	5%	2%

When reviewing the reliability of these data, both data sources (self-reported efficiency shares from contractors and self-report purchase data from end users) likely include self-report error. Contractors are asked to self-report their efficiency distribution of sales and installations for five different efficiency levels (base plus four high efficiency levels) over the previous two years. While it is reasonable to assume that contractors estimate these shares to their best ability, it is unlikely that they examined their actual sales data during the telephone survey. Asking

contractors to disaggregate their sales into five different efficiency levels may lead to increased error, leading to reliable base and high efficiency estimates but less reliable measure specific shares. End users are asked to report the purchase of new small packaged air conditioning units and the year of the purchase. It is clear that end users self-reported purchases that didn't occur and forgot to report actual purchases. The make and model look ups implemented for the on-site data, however, support the conclusion that the distribution of new air conditioning units found on-site is accurately classified into specific efficiency levels.

In conclusion, as seen in this and other research efforts, self-reported data can provide an accurate depiction of high level information (base versus high efficiency), but detailed sales or on-site information is needed to better estimate measure specific efficiency distributions.

10.2.1 Recommendations

The HVAC contractor survey provides a relatively cost-effective approach to collecting information on recent sales of HVAC equipment to non-residential customers. Packaged HVAC units within the non-residential sector are a high priority measure within the California Strategic Plan, necessitating the on-going effort to maintain a clear understanding of the market. The high share of base efficiency sales, however, does not indicate that the market for packaged HVAC units is currently experiencing rapid change in efficiency market share. While understanding the HVAC market is important to help design more effective programs and determine the influence of these programs, the persistently high base efficiency share of sales indicates that this market is not currently as dynamic as the non-residential linear lighting market. The relevance of the non-residential HVAC market may justify frequent HVAC contractor surveys while the persistently high level of base efficiency sales may indicate that frequent surveys are likely to provide little new information. Energy Division staff acknowledge that HVAC contractor surveys may provide informative information to the IOUs, CPUC, and evaluation community if they reoccur every two to four years and will consider this matter in the future.

The end user on-site CMST HVAC survey provides a unique set of information on the current distribution of recent installations within the non-residential market by customer size, business type, and program participation. The ability to disaggregate the efficiency distribution by these characteristics provides the interested parties with information that impact our understanding of baselines, standard practices, provides information on potential spillover, and will help the IOUs update future non-residential HVAC programs. Combining the CMST data collection effort with the CSS on-site data collection activities led to economies of scale for both projects. Energy Division staff acknowledge that continuing to implement the CMST on-site HVAC survey with large population surveys like the Commercial Saturation Survey may provide the CPUC, IOUs, and evaluation community with a unique time series of information on recent packaged HVAC purchases that can be disaggregated by domains of substantial interest. This issue will be considered in the future.