Results of the Massachusetts On-site Lighting Inventory 2014

FINAL

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Part of the Residential Evaluation Program Area

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Executive Summary

Overview

This report presents the findings of research related to the market for energy-efficient light bulbs in Massachusetts. As a member of the Residential Evaluation Team led by Cadmus, NMR Group, Inc. (NMR) served as the lead subcontractor for this research effort, working with Tetra Tech, Inc., and Navigant Consulting (hereafter collectively referred to as the Team).

The objective of the study is to track various lighting market indicators—many of which have been measured in Massachusetts for over a decade—and to explore the data for possible impacts (particularly stockpiling of incandescent bulbs) associated with the Energy Independence and Security Act of 2007 (EISA). This act increased minimal efficiency standards for general service light bulbs, effectively phasing out A-line incandescent bulbs in 2012 (100W phase-out), 2013 (75W phase-out), and 2014 (40W and 60W phase-out).

Specifically, this report presents an analysis of over four hundred residential lighting on-site inventories collected in Massachusetts, Georgia, and Kansas in 2014. Georgia and Kansas were chosen as comparison areas for this study because of the lack of long-standing residential lighting programs in the two states. Kansas does not have a lighting program. The program in Georgia has historically focused mostly on consumer education and limited bulb giveaways, but recent program activity has been more substantial, with Georgia Power supporting about one compact fluorescent lamp (CFL) per household (two million bulbs) in 2013—but no light-emitting diodes (LEDs).

This report also compares findings from 2014 to those from previous on-site studies conducted in Massachusetts in 2009, 2010, 2012, and 2013 and in Kansas and Georgia in 2009.

Altogether, the team visited 406 homes:

- 150 first-time (new) visits in Massachusetts
- 111 revisits (panel) in Massachusetts; homes previously visited as part of the 2013 Massachusetts On-site Study[1]
- 78 new visits in Georgia
- 67 new visits in Kansas

[1] NMR, *Results of the Massachusetts On-site Lighting Inventory 2013*, Delivered to the Massachusetts Program Administrators on June 7, 2013.

Main Conclusions

The 2014 Massachusetts on-site inventories revealed an increase in CFL saturation (i.e., percent of total sockets containing a CFL) from 28% (2013) to 33% (2014).[2] This is an important finding, given the relative lack of growth in saturation between 2009 and 2013 (2% absolute increase [Figure 1, top left graph]).[3] Adding LEDs to the calculation increases the overall efficient bulb saturation to 36%; also including fluorescent bulbs (tubes of any size, circline, etc.) boosts saturation to 45%. CFL saturation in low-income households (defined based on eligibility for the Low Income Heating Energy Assistance Program [LIHEAP] in 2013/2014) in Massachusetts increased even more, from 27% to 39% between 2013 and 2014; LED saturation increased from below 1% to 3% in the same households.

Direct-install programs in Massachusetts have contributed—but do not fully explain—the increased CFL and LED saturation rates. If we remove homes that had direct-install audits, the saturation rate decreases to 31% for CFLs and 2% for LEDs, or 33% overall—just three percentage points lower than when these homes are included. One must recognize, however, that direct-install programs certainly have an impact on the homes they visit; of the 27 homes that went through such a program, the saturation rate for CFLs was 44% and for LEDs was 5%. In summary, such programs clearly helped to boost saturation between 2013 and 2014, but they were not the sole driver of the increase.

In Massachusetts, incandescent and halogen bulbs comprise more than three-fifths of all bulbs with less than a 750-lumen output and one-half of all bulbs in the 750-1049 lumen range (see Table 42 for more details).[4] Together, these lumen ranges account for 71% of all bulbs currently installed (27% <750, 44% 750-1049), making these important targets for future program efforts. In addition, at the upper end of the lumen range, inefficient bulbs account for nearly one-half of all bulbs in the 1,490 to 2,600 lumen range. However, this range accounts for fewer than 10% of all bulbs. Note that the lumen outputs generally subject to EISA range between 310 lumens and 2,600 lumens.[5]

Overall, between 2009 and 2014, we observed a 7% increase in CFL saturation in Massachusetts. It is worth noting that the majority of the increase came in the last year. This is significantly higher growth than that observed in Georgia over the same period (3%), but slightly lower compared to the increase observed in Kansas (8%) (Figure 1, top left graph).

Thus, it is logical that the increase in efficient bulb saturation in Massachusetts has been counterbalanced by a decrease in incandescent bulb saturation. Furthermore, the 2014 on-site visits revealed for the first time that incandescent bulbs accounted for less than one-half of all sockets in Massachusetts (45%); incandescent and halogen bulbs combined accounted for 51% of all installed

[2] Throughout this report, unless otherwise specified, socket saturations are presented as a percent of total sockets regardless of base type.

[3] The Team focuses on absolute percentage point changes in this report rather than relative changes or rates of change, unless otherwise noted.

[4] For reference, the common 60W incandescent bulb typically emitted 750 to 850 lumens

[5] Lighting Fact. *The Energy Independence and Security Act of 2007.* http://www.lightingfacts.com/Library/Content/EISA

bulbs. In addition, 2014 was the first time the Team encountered homes with only energy-efficient bulbs installed—2% of homes had no incandescent or halogen bulbs installed. In Georgia and Kansas, incandescent remained the predominant bulb type (65% Georgia, 51% Kansas), although, in Kansas, incandescent bulbs accounted for just over one-half of all sockets.

CFL saturation rates in low-income households increased by 12% between 2013 (27%) and 2014 (39%), while they only increased by 3% in non-low-income households (28% in 2013 to 31% in 2014). Likewise, incandescent saturation decreased in low-income households by 16% (56% in 2013 to 40% in 2014), while the decrease in non-low-income households was 8% (55% in 2013 to 47% in 2014).

Findings regarding bulb replacement behavior from the 2014 Massachusetts panel visits help to explain the increase in efficient bulb saturation. As shown in Figure 1 in the bottom right graph, between 2013 and 2014, panelists replaced 13% of the bulbs in their homes. Among these sockets, 70% contained inefficient bulbs (incandescent 68%, halogen 2%) in 2013 and only 25% contained inefficient bulbs in 2014; in contrast, 69% contained efficient bulbs (58% CFLs, 11% LEDs; 6% were empty sockets).

While LEDs comprised 11% of replaced bulbs, total LED saturation remained lower, at 3% of total sockets in Massachusetts in 2014. However, penetration of LEDs (i.e., households using at least one LED) more than tripled since 2012, when Massachusetts first began tracking it (7% in 2009, 12% in 2013, and 23% in 2014; Figure 1). When examining the market for CFLs and LEDs, it is important to remember that we are observing two products on opposite ends of the market adoption curve. At this stage of market adoption, penetration is likely a better gauge of LED program success than is total saturation. As more households purchase LEDs and penetration rises, saturation rates will follow. Similarly, specialty CFL penetration has increased from being present in one-quarter (25%) of all homes in 2009 to being present in nearly two-thirds (65%) of all homes in Massachusetts in 2014.

As mentioned above, one driver of increased saturation was the greater number of bulbs reported as being installed by energy efficiency programs in 2014 compared to previous years. As discussed in greater detail in the main body of the report, those in the on-site sample reported receiving a large number of CFLs (35% of all obtained in the last year) and LEDs (30% of all obtained in the last year) through various direct-install programs in Massachusetts over the past year. Yet, overall, on-site households still obtained the majority of bulbs through retail stores.

According to the 2014 on-site visits, excluding bulbs obtained through direct-install energy efficiency programs, Massachusetts on-site participants purchased an average of 0.6 LEDs per household in the past year, up from an average of 0.2 purchased in the twelve months preceding the 2013 visits.[6] The current Massachusetts LED purchase rate is also 50% greater than the average (0.4 LEDs) in both Georgia and Kansas. For CFLs, again excluding direct-install bulbs, Massachusetts on-site participants purchased an average of 3.0 CFLs in the year preceding the 2014 visits, up from an average of 2.9 preceding the 2013 visits. For the comparison areas, CFL purchases in Georgia (2.7, excluding the few

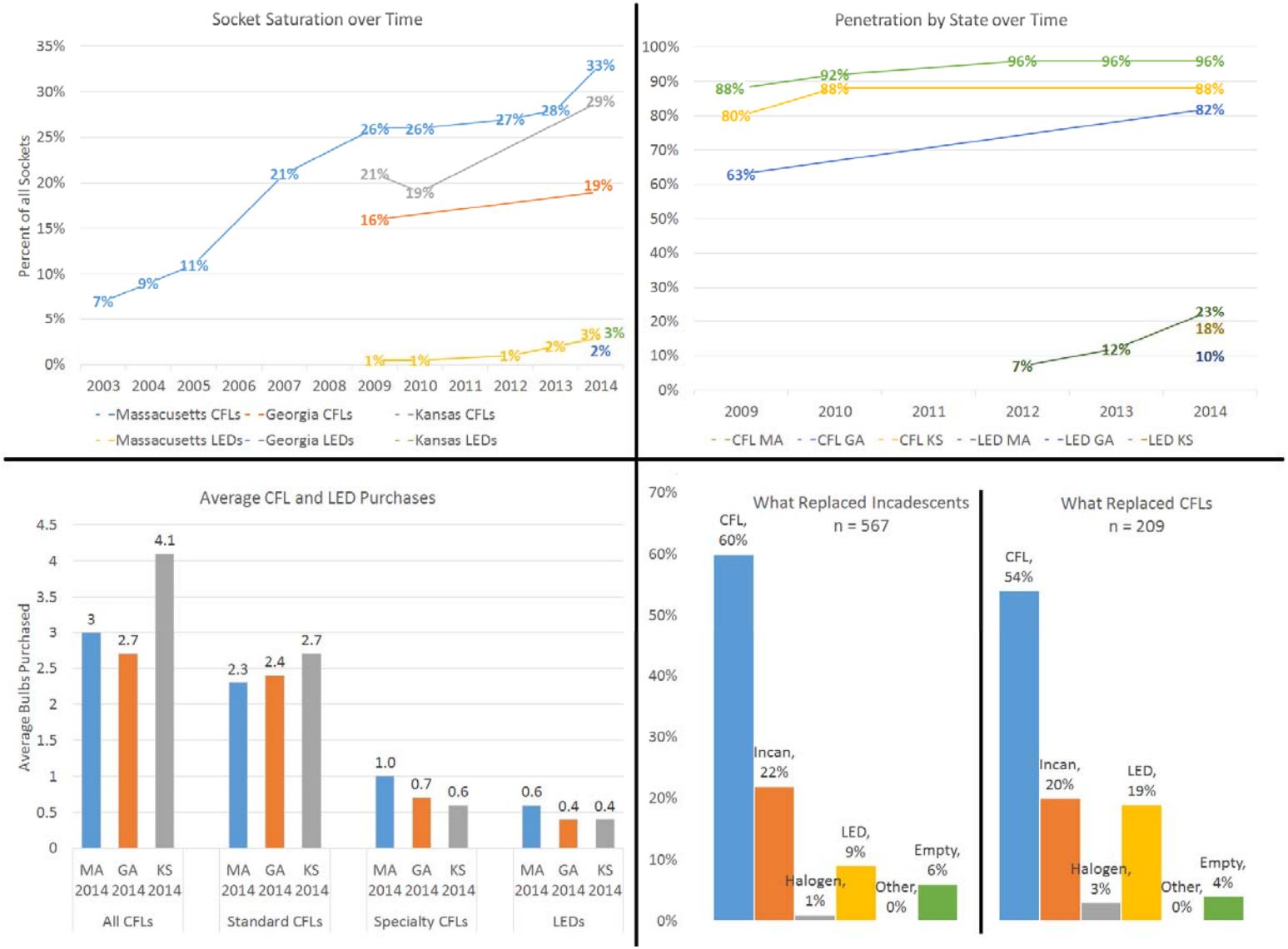
[6] The Team determined purchases by asking respondents whether they had obtained each CFL and LED found installed or in storage within the past year or more than a year ago.

bulbs obtained through direct-install programs in that state); in Kansas, CFLs purchases were relatively higher (4.1) when compared to Massachusetts. Among Massachusetts households, more than four out of ten CFLs purchased were specialty bulbs. In contrast, the proportion of specialty bulbs purchased in both Georgia (25%) and Kansas (14%) were significantly lower (Figure 1). Excluding direct-install bulbs, purchase rates for CFLs and LEDs among low-income households in Massachusetts were higher than for other households in the state; over the past year, low-income households purchased an average of 3.5 CFLs and 0.1 LEDs, while other households purchased an average 2.8 CFLs and 0.7 LEDs.

Perhaps owing in part to increases in CFL purchases among Massachusetts households, the number of CFLs in storage increased significantly from an average of 2.1 in 2013 to 3.9 in 2014. In addition, the percentage of homes storing CFLs increased substantially from 35% in 2013 to 56% in 2014. Results of the panel visits in Massachusetts confirm the increase in storage; among panelists, we observed a 38% increase in the number of CFLs found in storage. It is important to note that the 2014 on-site technicians found numerous errors in the 2013 data, which make storage data from the previous study suspect. More information on these errors and how they were corrected can be found in Table 82 in Appendix D: Panel Study Methods and Additional Results. Comparison-area households were found to store significantly fewer CFLs compared to Massachusetts. On average, Georgia households had 1.7 CFLs in storage, and Kansas households had 0.9 CFLs in storage. Just over one-third of homes in both Georgia (36%) and Kansas (34%) were storing CFLs.

Bulbs in storage also offer an opportunity to explore possible effects of EISA on customer purchasing behavior. As in past evaluations, during the 2014 on-site visits, the Team took an inventory of all stored bulbs, keeping an eye out for incandescent bulbs and asking follow-up questions to explore stockpiling behavior. Upon close examination, increases in storage of 40- to 100-Watt incandescent bulbs were primarily driven by a few homes that had a large number of incandescent bulbs in storage. Indeed, In Massachusetts, 4% of households said they were stockpiling 60-Watt incandescent bulbs, while 2% said they were stockpiling 75- or 100-Watt bulbs. A smaller percentage confirmed stockpiling practices in Georgia and Kansas, with 3% of homes stockpiling 60-Watt bulbs in Georgia, and only 2% in Kansas. Of the 17 households found to be stockpiling bulbs (two in Georgia, two in Kansas, and 13 in Massachusetts), all but two (both in Massachusetts) said they were aware of EISA.

Figure 1. Selection of Key Figures



Recommendations and Considerations

Based on these key findings, the Team offers the following recommendations and considerations, which we expand upon in the main body of the report.

Recommendation 1: Continue pursuit of panel study, adding in 2014 saturation study participants. The panel study results helped to answer questions regarding drivers of saturation changes and bulb replacement behavior that have been valuable in assessing the ever-changing residential lighting market. Repeating this study and expanding on the panel size will reveal whether the results observed this year represent a pattern of behavior or whether they were limited to a particular group at a specific time.

Consideration 1: Revise retail program to include an inefficient bulb buy-back program. A bulb buy-back program could convince people to change out inefficient bulbs before they burn out and fill them with a CFL or LED (as evidenced by the high rate of incandescent-to-CFL and -LED conversion found in the panel study). Previous evaluations have suggested a bulb buy-back program,[7] but the Team is not certain whether the Program Administrators (PAs) have incorporated such a design into the program. We repeat this suggestion as a consideration because of evidence presented at the Northeast Energy Efficiency Partnership's Lighting Summit in October 2014. There, implementers discussed the success of a similar program in Connecticut. The PAs and EEAC consultants may want to consider pursuing a buy-back here in Massachusetts.

Consideration 2: Consider program designs that address less efficient linear fluorescent tubes including T12s. Given that linear fluorescent bulbs are commonplace among residential homes, the PAs should consider investigating whether or not program elements that directly address the efficiency of these bulb types would be cost effective. Careful consideration should be given to how to target inefficient T12s, perhaps through a buy-back program or direct install program. Since replacing T12s with linear LEDs, T8s, or T5s may require replacing entire fixtures or magnetic ballasts, the program design may not be best suited to an upstream program.

Consideration 3: Inefficient bulbs still dominate lower lumen ranges. Given that inefficient bulb types comprise the majority of installed bulbs below 1049 lumens, the PAs may consider more focused efforts on this lumen range when selecting and determining incentive levels for LEDs and CFLs to offer through upstream programs.

Consideration 4: Consider revisions to program design to encourage the purchase of multiple LEDs in one shopping trip. Penetration of LEDs has been increasing rapidly, more than tripling since 2012, and saturation has doubled since 2014. LEDs, unlike CFLs, are predominantly sold in single-bulb packages. While there is certainly a role for single-bulb incentives, multi-bulb incentives may leverage increases in penetration by pushing consumers toward buying multiple LEDs in one trip.

[7] See NMR Group, Inc. *Results of the Massachusetts Onsite Compact Fluorescent Lamp Surveys.* Final report delivered to the PAs and EEAC Consultants on October 23, 2012.

Consideration 5: Consider directly studying use and purchase behavior among hard-to-reach (HTR) households, which would then inform whether the current upstream model or program additions/revisions would best serve to achieve remaining potential in such households and increase their adoption of LEDs. If the PAs and EEAC consultants desire more information on the use and purchase rates—including use and purchase of LEDs—of a wider range of households considered HTR (e.g., those that primarily speak a language other than English, recent immigrants, people with disabilities), they should work with evaluators—whether the Residential Team or one in another subject area—to design a study specifically to capture underrepresented households. While the Team oversamples multifamily households and recruits low-income ones, the current evaluation approach focuses on describing the residential lighting market. This yields information on only a small number of HTR households due to their limited representation in the population and the characteristics that make them "hard to reach." Without performing scoping research, the Team cannot say exactly what such a study would involve, but our professional experience suggests that the model will draw more from community organizing, community health programs, and similar efforts that perform direct outreach with the diverse HTR population. We suspect the study would work with Community Action Programs and contractors already involved with low-income programs in Massachusetts but would also expand to other community groups and recognized community leaders to spark interest and gain trust in the study. The Team warns that such a study could be difficult and costly to implement, but it would be better able to describe the HTR population and identify remaining potential for such households.

Introduction

This report presents the findings of research conducted to understand the market for energy-efficient light bulbs in Massachusetts. As a member of the Residential Evaluation Team led by Cadmus, NMR Group, Inc. (NMR) served as the lead subcontractor for this research effort, working with Tetra Tech, Inc., and Navigant Consulting (hereafter collectively referred to as the Team). Cadmus performed quality control for the reporting effort. The research presented here includes the results of on-site lighting socket inventories performed from May through August of 2014. Comparisons with similar on-site inventories (conducted in 2009, 2010, 2012, and 2013) are provided where appropriate.

Background

The Massachusetts Program Administrators (PAs) and the Energy Efficiency Advisory Council (EEAC) consultants have a long history of supporting on-site saturation research, with the first saturation studies dating back to the early 2000s. Since 2009, the PAs and EEAC consultants have engaged in nearly annual on-site efforts to monitor residential lighting inventories, conducting such studies in 2009, 2010, 2012, and 2013. This report presents the results of the fifth wave of on-site inventories (2014). In addition to monitoring inventories in Massachusetts, as part of the 2014 evaluation the PAs funded on-site lighting inventories in Georgia and Kansas to be used as comparison areas. The comparison-area results are also included in this report.

The time series of data available in Massachusetts helps the PAs and EEAC consultants to understand changes in residential lighting use and purchase behavior. It also helps them to characterize lighting conditions resulting from both the implementation of new lighting efficiency standards stemming from the Energy Independence and Security Act (EISA) of 2007 and the introduction, increased availability of, and lower pricing for light-emitting diodes (LEDs) and EISA-compliant halogen bulbs. By comparing the current results with those of previous lighting inventories,[8] the Team searched for any changes in residential lighting that could indicate impacts of these new standards and bulb types.

Methodology

For this evaluation, the Team collected data through 406 on-site lighting inventories conducted with homes located in Massachusetts (261), Georgia (78), and Kansas (67). The Team conducted the visits between May and August of 2014. The 261 Massachusetts households represent 150 visited for the first time in 2014 and 111 that had previously taken part in the 2013 saturation study. Table 1 provides an overview of the number of households included in each area as well as the dates when visits were conducted.

[8] NMR, "Results of the Massachusetts and Pennington County, South Dakota, Telephone and Onsite Compact Fluorescent Lamp Survey," in *Massachusetts ENERGY STAR Lighting Program 2010 Annual Report,* delivered to the Massachusetts Program Administrators on June 13, 2011. NMR, "Results of the Massachusetts Onsite Compact Fluorescent Lamp Surveys," delivered to the Massachusetts Program Administrators on October 23, 2012. NMR, "Results of the Massachusetts Onsite Lighting Inventory 2013," delivered to the Massachusetts Program Administrators on June 7, 2013.

Table 1. 2014 On-site Visits

Area	Sites Visited	Dates
Massachusetts 2014	261	May – June 2014
New Visits	*150*	*May – June 2014*
Panel Visits[1]	*111*	*May – June 2014*
Georgia 2014	78	June – August 2014
Kansas 2014	67	June – August 2014

[1] The panelists had previously taken part in the 2013 saturation study completed between December 2012 and March 2013.

The Team identified new households for inclusion in the on-site lighting inventories through the Lighting Consumer Surveys performed between March and August of 2014.[9] Panelists represent the subset of 2013 participants able and willing to let us visit their homes again in 2014.[10] Upon careful examination of the demographic and lighting-related characteristics of the panel and new visit data, the Team determined that households from both groups were similar enough to justify merging the two data sets. This decision mirrors one that we made when we previously performed panel visits in 2010.[11] Additional details on the minor differences between the panel and new visit data can be found in Appendix E and the first section of Appendix D.

Weighting

The Team weighted the on-site data to reflect the population proportions for home ownership (tenure) and education in Massachusetts based on the American Community Survey (ACS) 5-Year Estimates. The guiding principles behind the schemes are:

- To maintain comparability with previous schemes dating back to 2008; this is very important for tracking changes in saturation, use, purchase, and storage behavior
- To reflect the population of Massachusetts, including by weighing the data for Kansas and Georgia to the demographic characteristics of Massachusetts
- To make certain that the panel data are treated properly—i.e., that the panel data correctly represent the population and what we want to compare over time

While the Team developed various weights to explore the preliminary data, a simple tenure and education weight was chosen for the final scheme. The distribution of households in 2014 across tenure and education categories was similar to 2012 and 2013 on-site households with one exception—home ownership in 2012 on-site households was significantly higher than in 2014. This is likely related to a

9 Additional details for the forthcoming report Cadmus, NMR, "Spring 2014 Massachusetts Consumer Survey Results: Draft Report."

10 Some 2013 respondents had moved or had their phone numbers disconnected. Others declined to participate in the panel.

11 NMR, "Results of the Massachusetts and Pennington County, South Dakota, Telephone and Onsite Compact Fluorescent Lamp Survey," in *Massachusetts ENERGY STAR Lighting Program 2010 Annual Report.* Delivered to the Massachusetts Program Administrators on June 13, 2011.

shift in 2013 and 2014 to focus on recruiting and sampling 50% multifamily and 50% single-family homes (Appendix F: Demographics). For Massachusetts, the Team created a weighting scheme that combined the panel and new visits as well as a standalone panel visit weight scheme for use when we analyzed data available only for this subsample (*e.g.*, change in bulb type between 2013 and 2014). For Georgia and Kansas, the Team developed individual weighting schemes based on the population tenure (ownership versus renter status) and education proportions of Massachusetts; in this way, the two comparisons areas were weighted to resemble the Massachusetts populations and not to represent their own states. The weighting schemes are presented in Table 2.

Table 2. On-site Visits Weighting Scheme

Year	Tenure and Home Type	Households	Sample Size	Proportionate Weight
2014 Massachusetts On-site Visits (New and Panel Combined	*Total*	*2,525,694*	*261*	*n/a*
	Owner-Occupied			
	High School or Less	449,748	18	2.58
	Some College or Associate's Degree	399,899	44	0.94
	Bachelor's Degree or Higher*	746,312	111	0.69
	Renter-Occupied			
	High School or Less	400,349	13	3.18
	Some College or Associate's Degree**	246,900	20	1.28
	Bachelor's Degree or Higher	282,486	55	0.53
2014 Panel Visits	*Total*	*2,512,552*		
	Owner-Occupied			
	High School or Less	474,060	8	2.62
	Some College or Associate's Degree	397,959	27	0.65
	Bachelor's Degree or Higher	736,455	45	0.72
	Renter-Occupied			
	High School or Less	407,684	6	3.00
	Some College or Associate's Degree	226,427	5	2.00
	Bachelor's Degree or Higher	269,967	20	0.60
2014 Georgia Visits	*Total*	*2,525,694*	*78*	
	Owner-Occupied			
	High School or Less	449,748	14	0.99
	Some College or more	1,146,211	45	0.79
	Renter-Occupied			
	High School or Less	400,349	10	1.24
	Some College or more	529,386	9	1.82
2014 Kansas Visits	*Total*	*2,525,694*	*67*	
	Owner-Occupied			
	High School or Less	449,748	4	2.98
	Some College or more	1,146,211	41	0.74
	Renter-Occupied			
	High School or Less	400,349	10	1.06
	Some College or more	529,386	12	1.17

* Includes two education indicated as "Don't know/Refused" and one tenure and education both indicated as "Don't know/refused."

** Includes one "Occupied without payment or rent."

Sample Error

Table 3 provides an overview of the targeted number of completes, actual completes, and sample error at the 90% confidence level for the on-site visits included in this study. Maps providing an overview of the samples for each state along with population densities are provided in Appendix E (see Figure 12, Figure 13, and Figure 14).

In Massachusetts, the Team successfully completed the desired 150 on-site visits, but fell short of the targeted 125 panel visits, achieving a total of 111 visits. As mentioned above, the comparability of the new and panel visits allowed us to combine them to create a final Massachusetts dataset with 261 total households.

In Georgia and Kansas, the team had an initial target of completing 100 visits in each state, but due to difficulty in recruiting households through the consumer survey, we were only able to complete visits with 78 households in Georgia and 67 households in Kansas. It is important to note that, in order to maximize evaluation resources, the Team restricted visits in Kansas to the eastern portion of the state, roughly a 60-mile radius around Wichita, Topeka, and Kansas City. These areas represent over 84% of the population of Kansas.

Table 3. Sample Error

Area	Target Completes	Actual Completes	Sample Error at 90% Confidence Level
Massachusetts	275	261	5%
New Visits	150	150	7%
Panel Visits[*]	125	111	8%
Georgia	100	78	9%
Kansas	100	67	10%

Response Rates

Table 4 summarizes the response rates for the Consumer Surveys, the take rate (those who agreed to be contacted about the on-site visits), and the final on-site completion rate (those who completed an on-site visit / total who agreed). As the table shows, response rates in Georgia and Kansas were significantly lower compared to Massachusetts. In addition, while quotas were set in Massachusetts to achieve a 50/50 split between multifamily and single-family households, no quotas were set in Georgia or Kansas. The Team offered incentives and set aggressive goals to convert those who agreed to on-site visits in order to reduce potential non-response bias. However, the potential for non-response bias is unavoidable and, as with all survey efforts, the results of this study are subject to non-response bias. Given the relatively low response rates in Georgia and Kansas as compared to Massachusetts, it is more likely that those two areas could exhibit non-response bias or a higher level of bias. As described in detail in Appendix E, specifically the section on Exploring Non-response Bias, the Team found that the on-site samples in Kansas and Massachusetts were skewed toward households that reported higher levels of familiarity with CFLs. This may indicate a bias toward homes with a greater interest in the subject of the study, which the Team has observed before in Massachusetts (and which is embedded in all previous Massachusetts saturation estimates). To account for non-response bias, the Team explored various weights that accounted for familiarity with CFLs, but ultimately was unable to adjust for the bias.

The Team focused on weights that included tenure and education to preserve comparability with past Massachusetts on-site work; in Kansas, these weight schemes increase saturation.

Table 4. On-site Sample Response Rates

Area	Consumer Survey Response Rate (Count)	On-site Recruit Take Rate	Final On-site Complete Rate
Massachusetts			
New Visits	20% (940)	50% (446)	34% (150)
Panel Visits[*]	n/a	n/a	74% (111)
Georgia	5% (525)	27% (143)	55% (78)
Kansas	7% (557)	22% (120)	56% (67)

[*] The panel visits were initially recruited as part of the 2013 evaluation. For 2014, the Team contacted the 150 previous participants.

Changes in Socket Saturation over Time

In this section, we present an overview of findings regarding socket saturation (i.e., the percentage of sockets filled with a particular bulb type) data from the on-sites. Appendix A explores CFL and LED use and saturation in more depth.[12]

After several years of stagnated growth, the 2014 Massachusetts on-site data show a substantial increase (saturation gain of 5 percentage points) in CFL saturation from 28% in 2013 to 33% in 2014 (Figure 2 on the next page). For LEDs, saturation growth is more substantial relative to prior LED saturation, but still a smaller number in terms of growth of bulbs used. LED saturation increased from 2% in 2013 to 3% in 2014 (a one percentage point saturation gain but an increase in LED saturation of 50%).[13,14,15] Looking at total efficient socket saturation, we observe a saturation gain of six percentage points from 39% in 2013 to 45% in 2014.

Turning to the comparison areas, we observed only a moderate increase in CFL saturation in Georgia (3% between 2009 and 2013), whereas in Kansas we observed an increase in saturation of 8% (from 21% in 2009 to 29% in 2014)—a slightly higher increase than that observed in Massachusetts over the same period (7% increase; Figure 3 on the next page).

In 2014, it was the first time the Team had found households in Massachusetts with zero inefficient bulbs installed—2% of households had no incandescent or halogen bulbs currently installed. In addition, incandescent saturation fell below 50% for the first time (55% in 2013, 45% in 2014). In both Georgia and Kansas, incandescent saturation remained above 50% (65% in Georgia, 51% in Kansas). Incandescent and halogen bulbs combined account for just 51% of all bulbs currently installed in Massachusetts, whereas the rates were 71% and 57% for Georgia and Kansas, respectively.

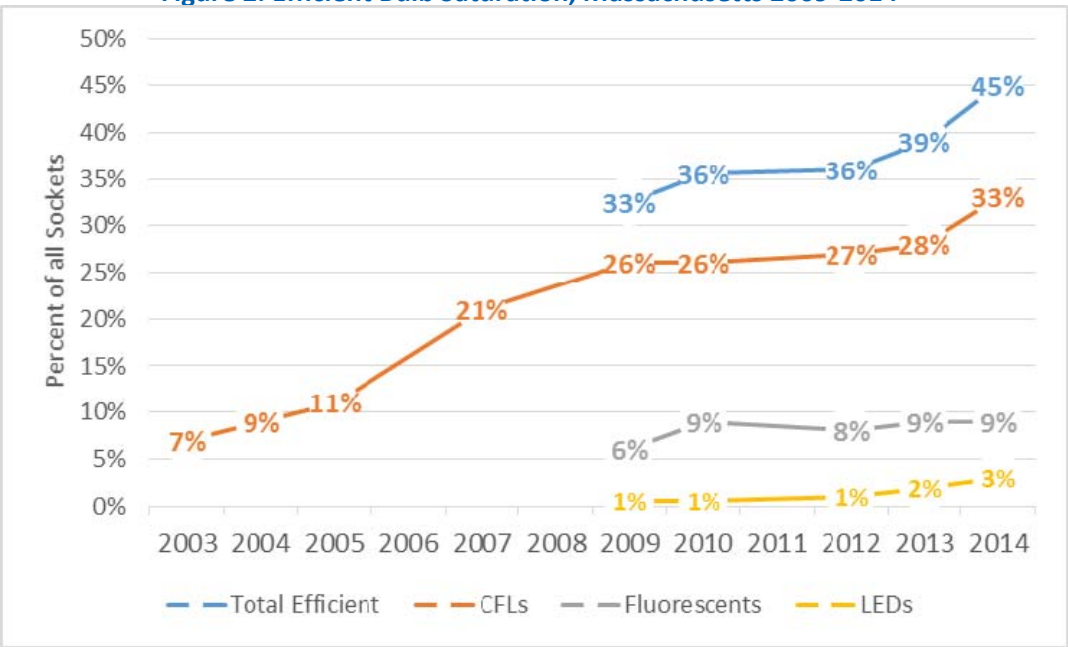
[12] We based socket saturation on all base types and sockets, including empty sockets.

[13] For ease of reading, the Team generally refers to changes in percent instead of the more literal changes in percentage points, unless otherwise noted. Most of these changes are absolute differences rather than relative ones, again unless otherwise noted.

[14] These three bulb types are the most efficient bulbs that are readily available to residential consumers at this time. As efficient standards change or as new technologies enter the market, the list of efficient bulbs could change over time.

[15] Saturation rates did not differ between new visit and panel visit homes, indicating that the panel does not appear to have altered its bulb installation behavior due to being included in the 2013 study.

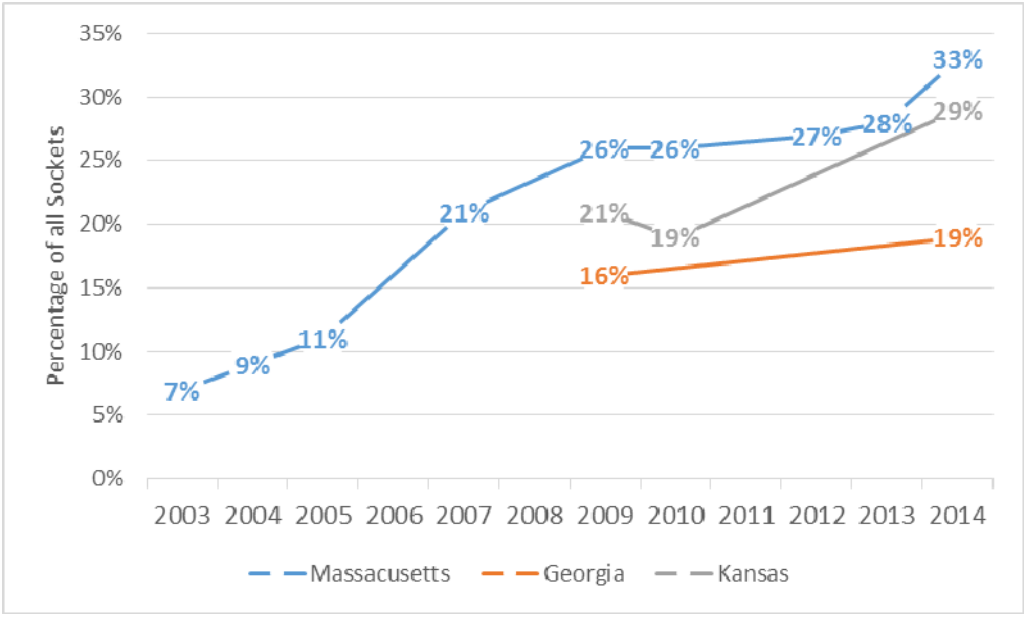
Figure 2. Efficient Bulb Saturation, Massachusetts 2009-2014*



* ODC collected data in 2003; RLW in 2004 and 2007; KEMA in 2009 and 2010; DNV KEMA in 2012; and NMR in 2014. Saturation data were not collected in 2006, 2008, and 2011.

** Total Efficient includes CFLs, Fluorescents (primarily linear tube), and LEDs. Fluorescents include all types of linear fluorescent tubes including T-12s.

Figure 3. CFL Saturation, Massachusetts, Georgia, & Kansas 2009-2014*



* Saturation data were not collected in 2006, 2008, or 2011 in Massachusetts. Saturation data were collected in Georgia in 2009 and 2014. Saturation data were collected in 2009, 2010, and 2014 in Kansas. Missing data shown as straight line interpolation. Note that for Kansas, Cadmus performed the site visits in 2009 and KEMA performed the site visits in 2010. In addition, because of small sample sizes, differences reported are not significant.

While incandescent bulbs were the most prevalent bulb type in Massachusetts households for the past six years, incandescent socket saturation has decreased dramatically, from filling nearly two-thirds (62%) of all sockets in 2009 to filling less than one-half (45%) of all sockets in 2014. This decrease in incandescent socket saturation has been counterbalanced by an increase in CFL socket saturation from 26% in 2009 to 33% in 2014 and an increase in LED saturation from less than 1% in 2009 to 3% in 2014. Notably, halogen saturation has largely remained steady over the same period.[16] While future saturation studies will be needed to confirm whether the boost in energy-efficient bulb saturation in 2014 reflects a single event or the start of a new trend, it is worth noting that if socket saturation continues to change at these rates, CFLs will surpass incandescent bulbs by the year 2016. When looking at CFL, fluorescent, and LED saturation together, energy-efficient bulbs may surpass non-energy-efficient bulbs (incandescent and halogen bulbs) sometime in 2015 (Table 5).[17]

Table 5. Comparison of Saturation Rates, 2009-2014

Sockets Containing	Massachusetts					Georgia	Kansas
	2009	2010	2012	2013	2014	2014	2014
Sample Size	*100*	*150*	*151*	*150*	*261*	*78*	*67*
Total Sockets	**3,709**	**6,741**	**6,565**	**6,341**	**13,550**	**4,052**	**3,963**
Incandescent	62%	57%	53%	55%	45%	65%$^{\delta}$	51%$^{\delta}$
CFLs	26%	26%	27%	28%	33%	19%$^{\delta}$	29%$^{\delta}$
Fluorescent	6%	9%	8%	9%	9%	7%$^{\delta}$	6%$^{\delta}$
Halogen	5%	7%	11%	5%	6%	6%	6%
LEDs*	<1%	<1%	1%	2%	3%	2%$^{\delta}$	3%
Other**	<1%	1%	-	2%	4%	2%$^{\delta}$	5%$^{\delta}$
Any specialty bulb	30%	31%	48%	38%	40%	39%	27%$^{\delta}$
Any specialty CFL	4%	7%	8%	8%	11%	4%$^{\delta}$	3%$^{\delta}$
Any specialty CFL (not including A-line CFLs)	-	-	7%	6%	9%	3%$^{\delta}$	3%$^{\delta}$

* The LED category includes both LED bulbs and integrated LED fixtures. Of the 421 LEDs in Massachusetts, 82% were screw-base; of the 69 LEDs in Georgia, 60% were screw-base; Of the 145 LEDs in Kansas, 67% were screw-base.

** Other includes xenon bulbs, empty sockets, and unknown bulb types.

$^{\delta}$ Significantly different from Massachusetts 2014 at the 90% confidence level.

As discussed later in the Recent Purchases section, 27 of the 261 homes took part in one of the Massachusetts direct-install programs "within the past twelve months," and most of these households had received CFLs and/or LEDs through the programs. Although the majority of these households also

16 Note that halogen bulbs are very similar in appearance and are in actuality a subtype of incandescent light bulbs. While technicians are thoroughly trained to distinguish halogen bulbs, it is still likely that some halogen bulbs are misidentified as standard incandescent light bulbs. For this reason, it may be best to look at halogens and incandescent bulbs as one category.

17 Although the next round of site visits in December 2014 and January 2015 will likely happen too soon (just six to seven months) after the last site visits for this trend to manifest, assuming it is actually a trend.

had CFLs installed that *did not* originate from the program, their participation is associated with higher saturation rates compared to other homes in the sample, 44% versus 31%. Much of the increase reflects the fact that the single-family Home Energy Assessment program gave contractors permission to install as many CFLs as possible in participating homes.[18] Saturation of LEDs is also higher in homes that took part in direct-install programs, standing at 5% versus 2% for homes that did not go through such programs.[19] In short, the direct-install program certainly contributed to—but in no way fully explains—the increased CFL and LED saturation between 2013 and 2014.

In order to assess the possible impact of program activity on hard-to-reach (HTR) households, the Team examined socket saturation for low-income households as designated by their eligibility for each state's Low Income Heating Energy Assistance Program (LIHEAP). The Team chose to focus on income status since we did not have any primarily non-English speaking households in the on-site sample and did not collect information on race or ethnicity.

Table 6 shows some indication that efforts to increase CFL adoption in so-called HTR households through the Residential Lighting upstream program and through low-income direct-install programs (single-family and multifamily) have been successful. More specifically, CFL saturation rates in low-income households increased by 12% between 2013 (27%) and 2014 (39%), while they only increased by 3% in non-low-income households (28% in 2013 to 31% in 2014). Likewise, incandescent saturation decreased in low-income households by 16% (56% in 2013 to 40% in 2014), while the decrease in non-low-income households was 8% (55% in 2013 to 47% in 2014). Saturation of LEDs increased from less than 1% to 3% in low-income households over the past year. Together, saturation of all energy-efficient bulb types in low-income homes was 51% compared to 43% for non-low-income households. Importantly, halogen saturation remained stable in low-income households, suggesting that such households are not defaulting to halogen bulbs simply because they are less expensive. Finally, low-income CFL saturation rates are much higher in Massachusetts than in Georgia (23%) or Kansas (24%).

[18] Of the 22 participants who specifically said they took part in MassSAVE, six of them received over 20 CFLs, accounting for 65% of the 312 bulbs obtained through the program.

[19] Of the same 22 participants who said they took part in MassSAVE, two of them accounted for 75% of the 52 LEDs obtained through the program.

Table 6. Comparison of Saturation Rates, 2013 & 2014

	Massachusetts				Georgia		Kansas	
	2013		2014*		2014		2014	
Sockets Containing	LI	NLI	LI	NLI	LI	NLI	LI	NLI
Sample Size	*47*	*103*	*82*	*166*	*32*	*46*	*20*	*47*
Total Sockets	**1,568**	**5,014**	**2,900**	**9,137**	**1,358**	**2,694**	**822**	**3,141**
Incandescent	56%	55%	40%	47%**	62%	67%**	53%	50%
CFLs	27%	28%	39%	31%**	23%	17%**	24%	31%**
Fluorescent	12%	8%**	9%	9%	6%	7%	12%	5%**
Halogen	3%	5%**	3%	8%**	5%	6%	2%	7%**
LEDs	<1%	2%**	3%	3%	2%	2%	2%	3%**
Other	2%	2%	6%	3%	3%	2%**	7%	5%**
Any specialty bulb	32%	41%**	36%	43%**	35%	41%**	20%	31%**
Any specialty CFL	5%	9%**	13%	11%**	4%	3%	3%	3%
Any specialty CFL (not including A-line CFLs)	4%	7%**	11%	9%**	1%	3%**	3%	3%

*13 DK/Refused income responses removed

**Significantly different from Low Income at the 90% confidence level.

Exploring Reasons for Differences in Saturation across Areas

The saturation rates in Massachusetts, Kansas, and Georgia are difficult to interpret, and it is worth noting that this may be an area of the analysis affected by non-response bias.[20] While CFL saturation in Massachusetts exceeds that in both Georgia and Kansas, the growth in CFL saturation between 2009 and 2013 in Kansas slightly exceeds that observed in Massachusetts over the same period, despite the fact that Kansas lacks any comprehensive lighting incentive program. In contrast, Georgia's saturation rate remained relatively stable between 2009 and 2013, even though Georgia has a program. The program in Georgia has historically focused mostly on consumer education and limited bulb giveaways, but recent program activity has been more substantial, with Georgia Power supporting about one bulb per household (two million bulbs) in 2013.[21] What, then, explains the different saturation rates and trends in those rates across these three states?

The team examined multiple possibilities, including the following:

- Size of homes
- Number of sockets in homes
- Familiarity with bulbs

[20] See Exploring Non-response Bias in Appendix E for additional details regarding non-response bias.

[21] Personal correspondence with Apex Analytics, currently involved in program evaluation for Georgia Power.

- Systematic differences in saturation rates between Kansas counties included in earlier studies and those included in the 2014 study[22]
- Variations in electricity rates[23]
- Potential impact of natural disasters such as floods or tornadoes[24]
- Concentration of home improvement and mass merchandise stores across the three areas

Only the last element revealed a specific pattern that helps to—but does not fully—explain the divergent saturation trends. We suspect that the higher concentration of mass merchandise stores, specifically Walmart, may be a contributing factor to saturation increases in Kansas. As Table 7 shows, of the three states, Kansas has the highest square footage per capita of Walmarts, and Massachusetts has the lowest (4.5 for Kansas, 3.0 for Georgia, and 1.1 for Massachusetts). In addition, the average distance from the on-site visits in each state to the nearest Walmart is the lowest in Kansas. The table also presents the square footage per capita of Home Depots as well as the distance to Home Depot, on average, for the sites visited in each state, revealing that the square footage differs less across the three areas but the distance to a store varies more.[25]

Table 7. Distance to Stores from On-site Visits

Area	Walmart		Home Depot	
	Miles	Sq. Ft. per Capita	Miles	Sq. Ft. per Capita
Massachusetts	6.7	1.1	5.0	0.7
Georgia	6.0	3.0	11.2	0.8
Kansas	3.4	4.5	8.7	0.5

Since the above data suggest the possibility that the concentration of Walmarts may be a part of the explanation, the Team further explored this relationship between specific stores and saturation by examining at which stores households reported purchasing bulbs in the 12 months preceding the on-site visits.[26] Based on this purchase data, we found the following results for Walmart by state, which again

[22] The saturation rate for all of Kansas was 19% in 2009, and it was also 19% for the subset of Kansas counties included both in 2009 and 2013.

[23] Massachusetts has the highest rate (at 15.9 cents per kWh in August 2013), but Georgia has the second highest rate (12.3 kWh), and Kansas the lowest (12.1 kWh). Moreover, higher rates do not necessarily translate into higher bills because the nature of the home—its appliances and equipment, insulation level, and other factors—affect bills as well.

[24] Flooding, blizzards, and tornadoes certainly plagued parts of Kansas between 2009 and 2013. In particular, Wichita, Sedgewick County, had extensive flooding in the summer of 2013. For a natural disaster to explain the increase in saturation, the increase would need to be localized to the area affected. However, the saturation increases in Kansas were fairly widespread. In fact, Sedgewick County's saturation rate increased from 25% to 33% (eight percentage points), compared to 19% to 29% (10 percentage points) for all of Kansas.

[25] Ironically, although Home Depot is headquartered in Atlanta, Georgians in our sample travel the farthest to get to a Home Depot.

[26] These estimates—and all purchase data reported here—are based on respondent self-reports, which may reflect some recollection error.

point to a strong influence of Walmart in Kansas, although the purchases at Walmart are also high in the lowest saturation state, Georgia:

- Kansas: 49% of all CFLs and LEDs purchased at Walmart
- Georgia: 30% of all CFLs and LEDs purchased at Walmart
- Massachusetts: 10% of all CFLs and LEDs purchased at Walmart

In one final exploration, using only the saturation data, we examined household saturation by purchases at the top three stores reported in the on-site data. As Table 8 shows, in both Georgia and Kansas the non-significant data nevertheless are indicative of a relationship between purchase behavior and saturation in that the highest saturation households bought bulbs at Walmart or Home Depot. This relationship seems to be more pronounced in Kansas where homes that had purchased CFLs or LEDs from Walmart or Home Depot had average saturation levels of 39% and 32% respectively, while homes that had purchased CFLs or LEDs from Lowe's or other stores had lower saturation rates of around 20%. In contrast, saturation in Massachusetts is fairly consistent by store/type of purchase. However, it is important to note that the sample sizes in Georgia and Kansas are relatively small because only a subset of on-site respondents reported purchasing CFLs in the 12 months preceding the visits. Future research based on larger sample sizes would be needed to draw more definitive conclusions.

Table 8. Saturation by Recent Purchases by Store*

Where Purchased CFLs/LEDs	GA Saturation	KS Saturation	MA Saturation
# of HH that purchased CFLs/LEDs in the past year	*31*	*34*	*167*
Walmart	24% (11)**	39% (15)	36% (21)
Lowe's	16% (10)	19% (6)	33% (65)
Home Depot	23% (3)	32% (8)	38% (19)
All other stores except WM/HD/Lowes	22% (12)	21% (8)	36% (112)

*Multiple response.

**Numbers in parentheses are number of households.

Based on these analyses, the Team believes that mass merchandise stores such as Walmart may play a critical role in affecting CFL saturation. Yet, the data are not entirely conclusive—the distance to and concentration of Walmarts in Georgia are between those of Massachusetts and Kansas, yet its saturation rate is lowest, even with a substantial CFL program sponsored by Georgia Power available to many households in 2013. Lacking shelf-stocking data for Kansas or Georgia, the Team is unable to draw any firm conclusions at this time about the availability and pricing of CFLs compared to other bulb types at Walmart or other stores in these states. However, the Residential Point-of-Sale modeling analysis being undertaken as part of the Saturation Stagnation and Multistage Net-to-Gross studies in Massachusetts may allow the Team to explore these issues further, although in a more general way, as discussion of specific retailers in that analysis will not be possible due to contractual agreements.

Penetration and Use of CFLs and LEDs over Time

Comparing Massachusetts CFL and LED penetration rates (i.e., the percentage of homes using the particular bulb type), we observe two lighting products on opposite ends of the market adoption curve. Whereas CFLs are almost ubiquitous in Massachusetts households, LEDs are currently found in fewer than one out of four homes. However, while CFL penetration has held steady at 96% since 2012, LED penetration has more than tripled since 2012 (7%) and nearly doubled between 2013 (12%) and 2014 (23%). In 2014, one out of every five homes had at least one LED bulb installed—this figure is nearly the same when integrated fixtures are removed and only medium-screw base LEDs are considered (22%).[27]

Turning to the comparison areas, penetration of both CFLs and LEDs in the comparison areas lag behind that in Massachusetts, with penetration of CFLs reaching 82% in Georgia and 88% in Kansas in 2014. Penetration for specialty CFLs alone in comparison areas (27% in Georgia, 35% in Kansas) was significantly lower than in Massachusetts (65%), and more in line with Massachusetts 2009 specialty CFL penetration (25%). It is worth mentioning that penetration of LEDs was similarly lower in both Georgia (10%) and Kansas (18%); though both areas have lower penetration, they are in the same ballpark as Massachusetts in 2013 (for Georgia) and 2014 (for Kansas), even though neither state currently provides incentives for LEDs.

Table 9 shows the percentage of homes that had at least one CFL or LED installed over the past five years. Since 2009, CFL penetration has increased by nearly 10% in Massachusetts, increasing from 88% in 2009 to 97% in 2014. When looking only at specialty CFLs, penetration has increased from being present in one-quarter (25%) of all homes in 2009 to being present in nearly two-thirds (65%) of all homes in Massachusetts in 2014. Interestingly, starting in 2012, we began to see some homes with no incandescent bulbs installed. In addition, in 2014, the Team encountered the first homes with only energy-efficient bulbs installed—2% of homes had no incandescent or halogen bulbs currently installed.

Table 9. Bulb Penetration, 2009-2014

	Massachusetts					Georgia	Kansas
Sockets Containing	**2009**	**2010**	**2012**	**2013**	**2014**	**2014**	**2014**
Sample Size	*100*	*150*	*151*	*150*	*261*	*78*	*67*
CFLs	88%	92%	96%	96%	96%	82%$^{\delta}$	88%$^{\delta}$
Specialty CFLs	25%	57%	58%	62%	65%	27%$^{\delta}$	35%$^{\delta}$
Any LEDs*	-	-	7%	12%	23%	10%$^{\delta}$	18%
Medium-Screw Base LEDs	-	-	7%	11%	22%	8%$^{\delta}$	17%
Incandescents	100%	-	99%	96%	97%	100%	99%

* Includes both LED bulbs and integrated LED fixtures.

$^{\delta}$ Significantly different from Massachusetts 2014 at the 90% confidence level

[27] As with saturation, penetration of energy-efficient bulbs did not differ between new visit and panel visit homes, indicating that the panel does not appear to have led these homes to alter their behavior due to being included in the 2013 study.

The consumer survey asked respondents if they currently had any CFLs or LEDs installed. Based on prior experience, the Team suspected that at least some people incorrectly surmised whether they did or did not have a particular bulb type installed. Moreover, some households who said they were not aware of or not very familiar with CFLs or LEDs may nevertheless have had them installed because they misunderstood our bulb descriptions or did not realize they had these bulbs types.[28] The results presented in Table 10 bear out this expectation; in summary, whether or not they realize it, most households in all three areas use CFLs. In contrast, many households that reported using LED bulbs do not actually have any LEDs installed.

More specifically, nearly all households across the three states who said they use CFLs actually do use them (93% in Georgia to 99% in Massachusetts), but so do the majority of households that said they were not aware of or not very familiar with CFLs (78% in Kansas to 92% in Massachusetts). In fact, one-half (in Georgia) or more (67% in Kansas and 89% in Massachusetts) of households that said they did not use CFLs actually do use them. In contrast, of the households in Massachusetts that said they used LEDs, only 45% actually did; this percentage was 22% in Georgia and 32% in Kansas. Likewise, 8% to 23% of households that did not think they used LEDs and 2% to 18% of households that were not very familiar with them actually used LEDs. This analysis points to the continued need to educate consumers about the diversity of lighting options. Consumers may have preconceived notions about bulb types based on media reports and not even realize that they have been using these bulbs for some time with no complaints or problems. Education could help to increase satisfaction with the products, which may in turn lead to greater adoption and even higher saturation rates in the future.

Table 10. Self-Reported CFLs / LEDs Currently Installed vs. Actually Installed

Self-Reported	Massachusetts (n=261)		Georgia (n=78)		Kansas (n=67)	
	% Actually Use CFLs	% Actually Use LEDs	% Actually Use CFLs	% Actually Use LEDs	% Actually Use CFLs	% Actually Use LEDs
Currently use	99% (n=176)	45% (n=70)	93% (n=44)	22% (n=21)	96% (n=48)	32% (n=20)
Don't Use	89% (n=9)	23% (n=137)	50% (n=11)	8% (n=36)	67% (n=11)	13% (n=30)
Not Aware	92% (n=76)	2% (n=54)	79% (n=23)	5% (n=21)	78% (n=8)	18% (n=17)

Base: All on-site respondents

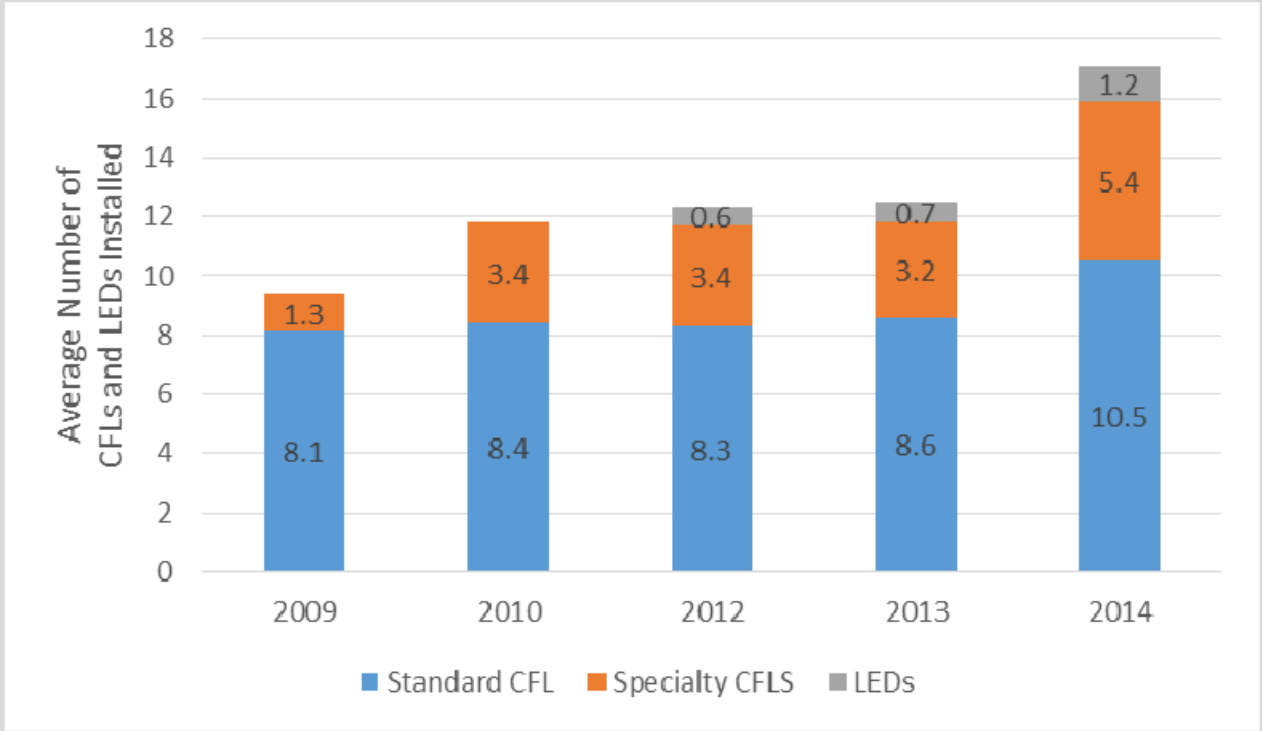
Turning to the number of CFLs and LEDS in use overall, as Figure 4 shows, the average number of CFLs installed in Massachusetts increased from 9.4 per household to 15.9 per household over that period (Table 11).[29] Looking more closely, CFL use experienced a substantial increase between 2009 and 2010 (9.4 to 11.7) and then again between 2013 and 2014 (11.8 to 15.9). In Georgia, there are currently fewer CFLs (9.0) in use on average than in Massachusetts. However, in Kansas, the average number of CFLs in

[28] Respondents were not asked if they had any CFLs or LEDs installed if, in a prior question, they said they were not aware or not very familiar with these types of bulbs.

[29] The team does not report CFL use for low-income versus other households because different home sizes—and therefore socket counts—limit the usefulness of this analysis.

use (16.1) is nearly identical to that in Massachusetts. The number of LEDs in use in homes remains considerably lower than that of CFLs, but it is increasing. In 2012 and 2013, the average number of LEDs installed per household was fewer than one, but this increased to 1.2 in 2014. Georgia still had fewer than one LED installed per household, but Kansas had the same number as Massachusetts (1.2).[30]

Figure 4: CFL and LED Use over Time - Massachusetts



[30] **Error! Reference source not found.** and Table 37 in Appendix A present more detail on these trends, including separate estimates for specialty and standard CFLs.

Table 11. Current Total and Average Use of CFLs and LEDs

	Massachusetts					Georgia	Kansas
	2009	2010	2012	2013	2014	2014	2014
Sample Size	*100*	*150*	*151*	*150*	*261*	*78*	*67*
All CFLs							
Total CFLs in use	*953*	*1,765*	*1,754*	*1,766*	*4,559*	*701*	*1,077*
Mean # of CFLs in use	9.4	11.7	11.6	11.8	15.9	9.0	16.1
Median # of CFLs in use*	n/a	7	9	9	12	4	10
All LEDs							
Total LEDs in use	*n/a*	*n/a*	*92*	*127*	*352*	*47*	*103*
Mean # of LEDs in use**			0.6	0.7	1.2	0.5	1.2

Base: All on-site respondents

*Median not reported in 2009

**Median for LEDs is zero for all states, meaning that most homes still do not have LEDs installed.

The Team also performed an analysis of the accuracy of consumer survey estimates of self-reported CFLs installed and on-site-verified installed CFLs. The consumer survey asked all respondents who said they use CFLs if they used four or fewer, or five or more of the bulbs. Table 12 presents the *actual* number of CFLs installed by the response to this survey question, including the consumer survey respondents—among those self-reporting four or fewer CFLs installed—who were "not aware" of CFLs and those who said they did not currently use them. The results suggest that households tend to know that they use either "some" or "a whole bunch of" CFLs, at least relatively. Specifically, households that self-reported using a greater number of CFLs actually use at least twice as many CFLs as those who said they were not aware of CFLs or used few of them. Moreover, as the penetration analysis above demonstrates, a good deal of the error in self-reported use stems from the "not aware" households, who use CFLs despite claiming their lack of awareness.

Table 12. Self-Reported vs. Installed CFLs

	Massachusetts*		Georgia**		Kansas*	
	Self-reported ≤ 4 CFLs installed or not aware of CFLs	Self-reported 5+ CFLs installed	Self-reported ≤ 4 CFLs installed or not aware of CFLs	Self-reported 5+ CFLs installed	Self-reported ≤ 4 CFLs installed or not aware of CFLs	Self-reported 5+ CFLs installed
Sample size	*142*	*118*	*42*	*31*	*29*	*37*
Installed	**Actual Mean**	**Actual Mean**	**Actual Mean**	**Actual Mean**	**Actual Mean**	**Actual Mean**
Four or fewer***	3	3	1	2	1	3
Five or more	15	23	14	19	20	24
Overall	10	23	4	16	8	23

Base: All on-site respondents

*One respondent reported not knowing how many CFLs were installed

**Five respondents reported not knowing how many CFLs were installed

***Including no CFLs

Panel Visits – Changes in Bulb Types

During the panel visits, technicians compared each bulb found during the 2014 lighting inventories to data listed for the 2013 lighting inventories.[31] Based on the comparison of available bulb details (type, shape, base type, wattage, as well as manufacturer and model number for CFL and LED bulbs) and questioning the customer, the technician designated each bulb as New (for bulbs that have been installed since the last on-site visit), Same (for bulbs that were included in the 2013 on-site data and are the same in 2014), Corrected (for bulbs that were included in the 2013 on-site data but were labeled incorrectly), or Missed (for bulbs that the homeowner says were installed at the time of the 2013 visit but were not included in the 2013 data. The technician also designated fixtures in the same manner. If a technician designated a *bulb* as New and installed in a *fixture* that was marked as Same, Corrected, or Missed (indicating a replacement bulb in a fixture that was present in the home in 2013), the data collection program would prompt the technician to enter into the 2014 form the bulb type present in 2013 for that socket and also to ask the customer the reasons for changing bulb types, if the types were different. By asking the customer about each bulb replacement, technicians were able to provide correct information about bulb type changes, even if the recorded data for the 2013 bulb had errors or omissions. Appendix D includes additional details on bulb replacements (including Replaced Bulbs by Wattage).

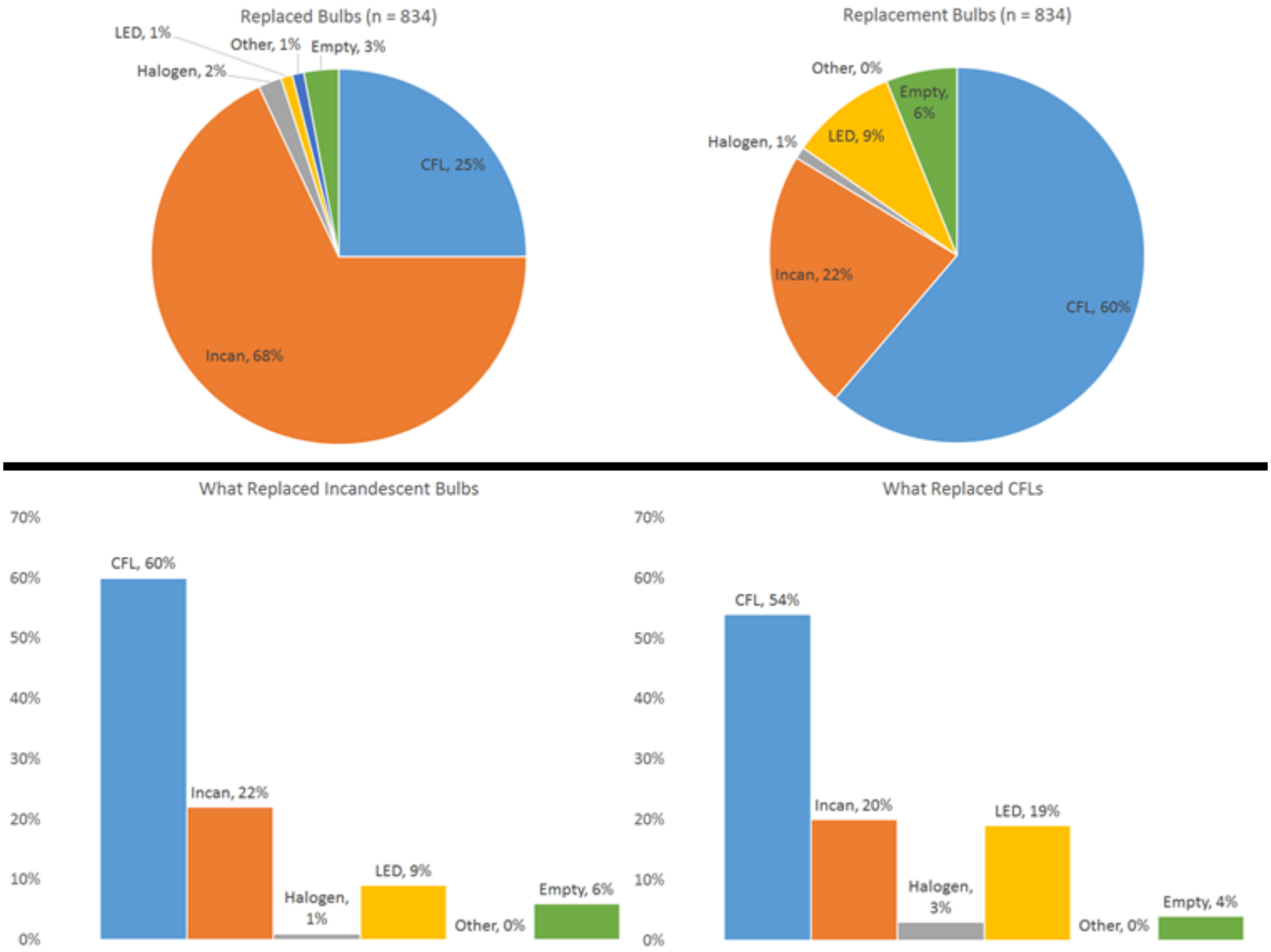
Sockets with Bulb Replacements 2013-2014

Sockets where the customer had replaced the bulb (or installed a bulb in an empty socket) since the previous visit were of special interest in the panel visit homes in order to document what happens when a bulb burns out or gets removed. This interest stems largely from the desire to understand possible impacts of EISA on replacing incandescent bulbs and which bulbs respondents use to replace CFLs that burn out. During the panel visits, we found 834 sockets with a bulb replaced between 2013 and 2014. This represents 13% of the total observed sockets (6,200). The results show a large increase in the share of efficient bulbs for these sockets.

Figure 5 provides a graphic overview of the bulb changes between 2013 and 2014 overall as well as breakdowns of what type of bulbs were used to replace incandescent bulbs and CFLs. The distribution of bulbs before replacement (replaced bulbs) is shown on the top left; this shows what bulbs were installed in these sockets during the 2013 visits. The pie chart on the top right shows the distribution of bulbs in the same 834 sockets at the time of the 2014 visits (replacement bulbs). The column charts below provide an overview of the types of bulbs that replaced 2013 incandescent and 2013 CFLs. Additional details and analyses are included in the next section.

[31] Technicians observed some errors made in the original visits to panel households. Appendix D describes the steps taken to correct for these errors.

Figure 5: Bulb Replacements 2013-2014



Replaced Bulbs: Type

Table 13 shows the bulb type for all sockets where bulbs were replaced in 2013 and in 2014. Households were nearly three times as likely to choose a CFL instead of an incandescent to replace an incandescent bulb. This set of sockets went from holding approximately one-quarter efficient bulb types in 2013 to nearly three-quarters in 2014.

- Among replaced sockets, **incandescent bulbs** were present in 68% of the sockets in 2013 and only 23% in 2014. Of the sockets that held incandescent bulbs in 2013, 60% had been switched to CFLs and 9% to LEDs. Households replaced 22% of these with new incandescent bulbs.
- The share of **CFLs** in replaced sockets overall increased from 25% in 2013 to 58% in 2014. Of the replaced sockets that held CFLs in 2013, households replaced 54% with new CFLs, 19% with LEDs, and 20% with incandescents.
- Two percent of replaced sockets held **halogen** bulbs in both 2013 and 2014. By 2014, households had replaced 20% of these with new halogen bulbs, 47% with CFL bulbs, 27% with LEDs, and 7% with incandescents. Note that only 5% of sockets held halogen bulbs in 2013, which explains why failed halogens accounted for only 2% of replaced sockets.
- **LED** bulbs occupied only 1% of the replaced sockets in 2013, but this increased to 11% in 2014. There were only five LED medium-screw base bulbs that were replaced between 2013 and 2014. Of these five 2013 LED bulbs, three were replaced by CFLs, one was replaced by a halogen bulb, and one was removed and not replaced (empty socket). The percentages in the table below are presented weighted and therefore do not match up exactly with these counts.
- Three percent of these sockets were empty in 2013 vs. six percent in 2014**.** Households installed CFLs in 62% of the **empty sockets**, LEDs in 10%, and incandescents in 29%.

Table 13. Sockets with Bulb Replacements 2013-2014 (weighted, 111 households, 834 sockets)

			2014 Bulb Type (count = 834)						
			Incand	CFL	Fluor	Halo	LED	Other	Empty
		% (count)	*% (count)*	*% (count)*	*% (count)*	*% (count)*	*% (count)*	*% (count)*	*% (count)*
	All Bulbs	*100% (834)*	*22% (183)*	*57% (478)*	*0.3% (3)*	*2% (18)*	*12% (97)*	*0.1% (1)*	*7 (56)*
2013 Bulb Type	Incand	71% (590)	22% (131)	60% (351)	0% (0)	1% (8)	9% (56)	0% (0)	8% (44)
	CFL	22% (183)	20% (36)	54% (99)	0% (0)	3% (5)	19% (35)	0% (0)	4% (8)
	Fluorescent	0.3% (3)	0% (0)	0% (0)	100% (3)	0% (0)	0% (0)	0% (0)	0% (0)
	Halogen	2% (17)	7% (1)	47% (8)	0% (0)	20% (3)	27% (4)	0% (0)	0% (0)
	LED	1% (7)	0% (0)	33% (2)	0% (0)	17% (1)	0% (0)	0% (0)	50% (3)
	Other	2% (13)	64% (8)	27% (3)	0% (0)	0% (0)	0% (0)	9% (1)	0% (0)
	Empty	3% (23)	29% (7)	62% (14)	0% (0)	0% (0)	10% (2)	0% (0)	0% (0)

When a technician identified a socket where the bulb type had changed from 2013 to 2014, he/she asked for the reasons why households chose the new bulb type. Table 14 shows the results for CFLs or LEDs that replaced incandescent bulbs. Fifty-four percent said that they were intentionally replacing incandescents with efficient bulb types as the incandescents burn out. More than one-quarter (26%) stated that MassSave or other energy efficiency programs (e.g., Next Step Living or a program identified only as a utility or energy efficiency program) had replaced the incandescent with a CFL (suggesting they had had an energy assessment on their home).[32] Three percent said that they had chosen an incandescent because it was the only type they had in storage.

[32] As the purchase section below explains, 27 of the 261 homes in the 2014 study said that they had received bulbs in the past year from MassSAVE or other energy efficiency programs (often stated generically). Thirteen (11%), or about one-half of these homes, were members of the panel study, and 14 (9%) were visited for the first time that year. Given the small sample sizes and minimal differences in participation rates, the replacement sample did not take part in such programs at a statistically higher rate. Members of both samples received substantial numbers of CFLs from these programs, again as discussed later.

Table 14. Reasons CFLs or LEDs Replaced Incandescents (multiple response possible, count=390)

Reason	Percent
Replacing incandescent bulbs with efficient bulbs as they burn out	54%
MassSave installed the bulb	26%
Don't know	16%
That was the only type we had in storage	3%
Other	2%

Table 15 shows the reasons households cited for replacing a CFL or LED with an incandescent bulb, yielding a total of 44 individual responses. The most popular response (38%) was that the incandescent was the only type available in storage. One-third (33%) said that they wanted a brighter or dimmer bulb in the fixture. Eighteen percent said that they had installed an incandescent in place of a CFL because they do not like CFLs in general. Five percent said that incandescents were the only type available when they had purchased the replacement bulb. A further 4% said that the CFL had not worked in that particular application.

Table 15. Reasons Incandescents Replaced CFLs or LEDs (multiple response possible, count=44)

Reason	Percent
That was the only type we had in storage	38%
I wanted a brighter or dimmer bulb in this fixture	33%
I do not like CFLs in general	18%
What was available when purchasing	5%
CFLs did not work in this application	4%
Don't know	21%

Comparison to Intention for Stored Bulbs

Interestingly, the findings from the panel study regarding bulb replacement are counter to the self-reported data that consumers provided us about intentions for stored bulbs. On-site respondents were asked what type of bulb their stored bulbs would replace. Based on the differences and the higher level of rigor inherent in the panel visit data, we present the intention responses only as an aside (Table 16).

- Across all bulbs in storage (4,205), the majority (60%) would be used to replace incandescent bulbs; more than one-fifth (22%) would be used based on need to replace whichever bulb type burned out first (CFL or incandescent); and one out of ten (12%) would specifically replace CFLs.
- Looking only at CFLs in storage (1,215), most would be used in one of three ways: to replace other CFLs (37%), to replace whichever bulb type needed replacing first (31%), or to replace incandescent bulbs (29%).
- For incandescents found in storage (2,660), three-quarters (76%) would replace other incandescents, one out of five would replace whichever type of currently installed bulb burned out first (31%), and only 1% would be used to replace CFLs.

Table 16. Type of Bulb Stored Bulb will Replace

Type of Bulb to be Replaced	Massachusetts 2014			
	All Stored Bulbs	Stored CFLs	Stored Incandescents	Stored Other*
Number of bulbs	*4,205*	*1,215*	*2,660*	*330*
CFL	12%	37%	1%	8%
Don't know	<1%	1%	<1%	0%
Empty Socket/New Fixture	1%	1%	<1%	5%
Incandescent	60%	29%	76%	18%
Other bulb type	5%	1%	1%	63%
Whichever needs replacing first	22%	31%	20%	7%

Base: Stored bulbs respondents planned to use in the future

* "Other" bulb type includes all stored halogen, fluorescent and LED bulbs.

Replaced Bulbs: Shape

The Team also assessed whether households were switching between specialty and standard bulb shapes when replacing incandescent bulbs with new incandescent bulbs. Since EISA regulations do not apply to specialty bulb shapes, shape changes in incandescent-to-incandescent replacements may indicate that households are choosing specialty shapes to continue using a wattage value no longer available in an A-line shape. In 2014, we observed a shift in bulb shapes among sockets where incandescent bulbs replaced incandescents (Table 17). Seventy percent of these sockets had traditional A-line incandescents in 2013, but only 53% did in 2014. Nearly all of the changes were to spot/reflector/flood bulbs, which went from 7% in these sockets in 2013 to 24% in 2014. These bulb shapes are also subject to their own set of EISA regulations, so the Team is uncertain about what may reflect the shift in bulb shape. In future panel visits, this behavior could be explored further by asking customers if they chose a different shape specifically to maintain the wattage value and bulb type.

Table 17. Shape Changes in Incandescent-to-Incandescent Replaced Bulbs 2013-2014 (weighted, n=111)

			2014 Bulb Shape (count = 133)*			
			A-line	Candle	Globe	Flood
		% (count)	*% (count)*	*% (count)*	*% (count)*	*% (count)*
	All bulbs	*100% (133)*	*53% (70)*	*14% (19)*	*8% (11)*	*24% (32)*
2013 Bulb Shape	A-line	70% (93)	69% (64)	-	1% (1)	30% (28)
	Candle	15% (20)	6% (1)	94% (19)	-	-
	Globe	8% (11)	10% (1)	-	90% (10)	-
	Flood**	7% (9)	50% (4)	-	-	50% (4)

*Includes sockets with bulbs replaced 2013-2014 that were not empty sockets in 2013 or 2014

**Includes flood, spot, and reflector bulb shapes.

To determine if there were any differences in replacement practices between specialty incandescent bulbs and standard (A-line) incandescent bulbs, the Team examined what type of bulbs replaced incandescent bulbs by shape. As Table 18 shows, except in the case of candelabra bulbs, panelists were significantly more likely to replace an incandescent bulb with a CFL or an LED regardless of specialty bulb shape. This is not surprising, given the high percentage of all incandescent bulbs that were replaced with efficient bulb types. As for candelabra bulbs, consumers may find it difficult to locate comparable CFL and LED bulbs at a price point they are willing to pay.

Table 18. Bulb Shape of Replaced Incandescents by Replacement Bulb Type 2013-2014 (weighted, n=111)

			2014 Bulb Type (count = 590)		
			Incandescent or Halogen	*CFL or LED*	*Empty Socket*
	Incandescents	*590 % (count)*	*% (count)*	*% (count)*	*% (count)*
2013 Bulb Shape	A-line	70% (413)	24% (99)	70% (287)$^{\delta}$	7% (28)$^{\delta}$
	Bullet/Torpedo	0.2% (1)	--	--	100% (1)
	Candle	8% (48)	42% (20)	47% (22)	12% (6)
	Globe	8% (47)	21% (10)	69% (32)$^{\delta}$	10% (4)
	Flood**	13% (74)	13% (10)	79% (59)$^{\delta}$	8% (6)
	Tube	0.2% (1)	--	100% (1)	--
	Don't know	1% (6)	--	83% (5)$^{\delta}$	17% (1)

$^{\delta}$ Significantly different from incandescent or halogen

**Includes flood, spot, and reflector bulb shapes.

The Team also explored changes in bulb types for bulbs installed in fixtures with dimmable and three-way capabilities. As Table 19 shows, as with general bulbs, there was a significant shift away from inefficient bulbs toward CFLs and LEDs in 2014, even among dimmable and three-way fixtures. Among bulbs installed in fixtures with dimmable and three-way capabilities between 2013 and 2014, over four-fifths (81%) were incandescent or halogen bulbs in 2013 and under two-fifths (35%) were in 2014. CFLs and LEDs split the growth of efficient saturation in this area, with each increasing by 24% between 2013 and 2014 among replaced bulbs.

Table 19. Dimmable or Three-way Replaced Bulbs 2013-2014 (weighted, n=111)

	Bulb Type				
	Incandescent	*CFL*	*Halogen*	*LED*	*DK*
Year	*% (count)*	*% (count)*	*% (count)*	*% (count)*	*% (count)*
2013 Bulb Types	78% (79)	18% (18)	3% (3)	0% (0)	1% (1)
2014 Bulb Types	32% (32)	42% (42)	3% (3)	24% (24)	0% (0)

Recent Purchases

In order to ascertain lighting purchase behavior, technicians asked 2014 on-site respondents when they had obtained any of the CFLs and LEDs found installed or stored in their homes. Periods included "within the past twelve months" and "prior to the past twelve months." The Team also includes an assessment of bulbs obtained through direct-install programs.[33] Finally, we compare the results presented here to those from the previous inventories, when appropriate.

LED Purchases

According to the 2014 on-site visits, in the twelve months prior to the 2014 visits, on-site participants purchased or obtained (e.g., through a direct-install program, landlord installation, or as a gift) an average of 0.8 LEDs per household, up from an average of just 0.2 purchased per household according to 2013 on-site visits but similar to the 0.6 found in 2012. Note that the Team cannot say whether LED purchases were *really* lower in 2013 than in 2012, only that self-reported purchases (anchored by the number of LEDs in the home) were lower. It is likely that sales of LEDs will continue to increase over the coming years if the price continues to decrease and they resolve some of the persistent concerns with CFLs such as mercury, light quality, slowness to brighten, and dimmability. In each comparison state, 28 LEDs were purchased within the past year. The average of 0.4 LEDs purchased per household in both Georgia and Kansas is one-half the average of bulbs per household purchased in Massachusetts within the past year (0.8) (Figure 6).

The 27 Massachusetts households that took part in direct-install programs received an average of 2.4 LEDs (66 in total) from these programs in the past year, accounting for 30% of all the LEDs obtained during the same period (Table 20). The households also purchased another 11 LEDs on their own, although we cannot say for certain if these represent spillover bulbs because the Team did not ask whether they had bought those bulbs before or after their participation in a direct-install program.

Table 20. Recent LED Purchases, 2014

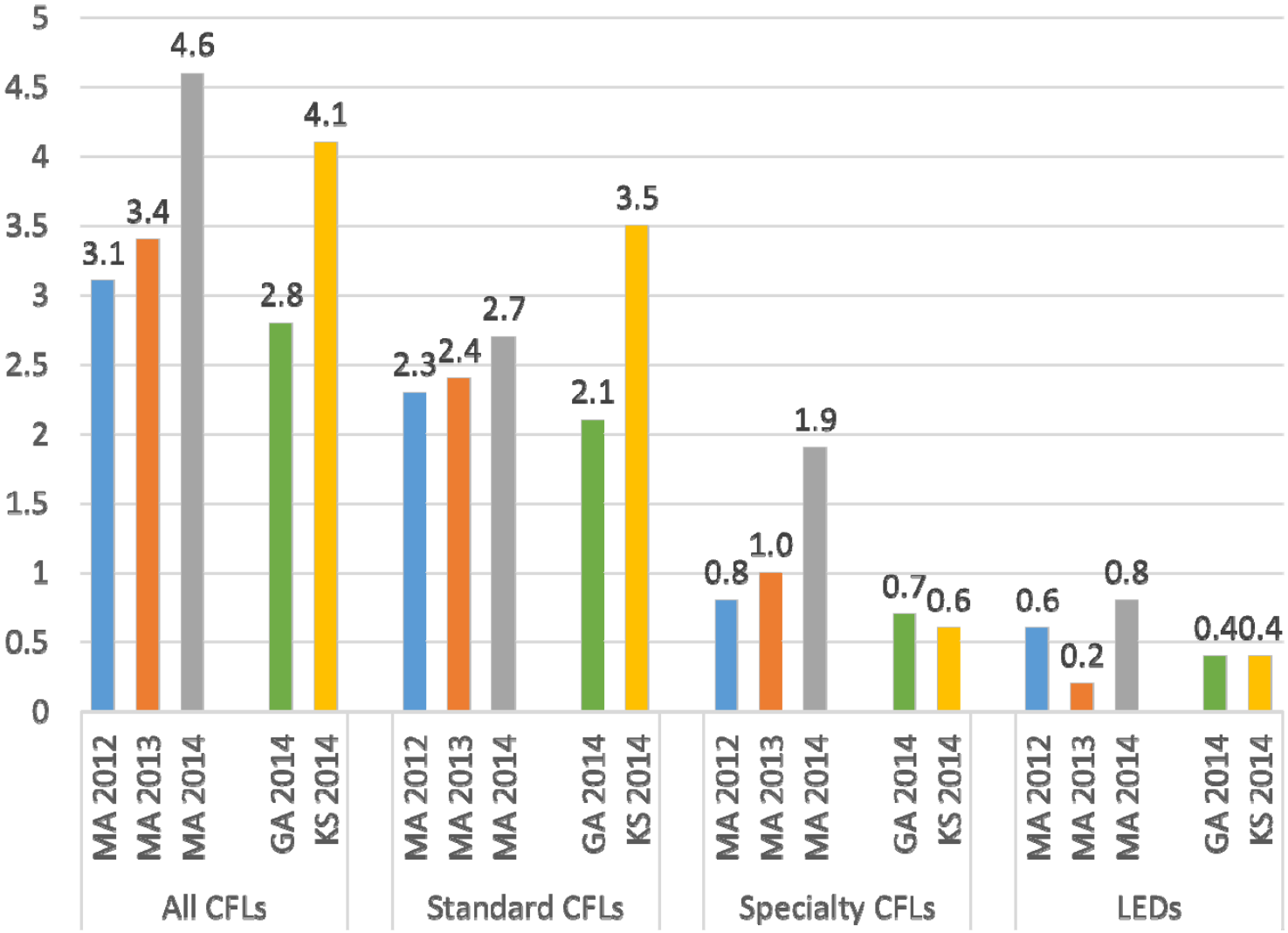
	Massachusetts	Georgia	Kansas
Sample Size	*261*	*78*	*67*
LED Bulbs (including direct-install bulbs)	219	28	28
LED Bulbs (excluding direct-install bulbs)	153	28	28
LED Bulbs (from direct-install programs)	66	0	0

[33] Twenty-seven of the 261 households obtained CFLs and LEDs through MassSAVE. The team noticed a substantial uptick in bulbs obtained from MassSAVE, which we believe is due to recent program changes to allow the installation of energy-efficient bulbs in all sockets in participating homes as opposed to limiting the number installed. In 2013, we observed approximately 12% of CFLs obtained from MassSAVE or other energy efficiency programs, and that percentage was 39% in 2014.

CFL Purchases

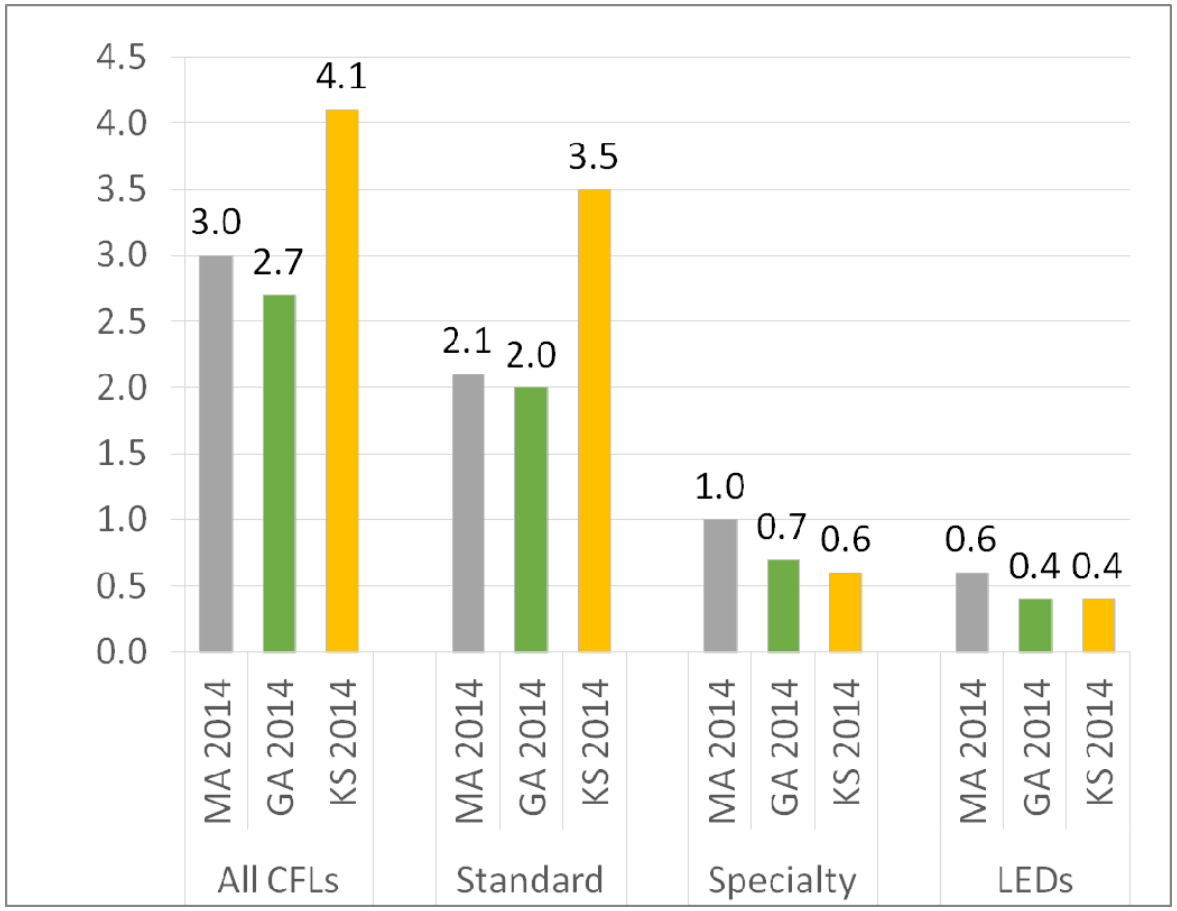
Massachusetts on-site respondents purchased or obtained an average of 4.6 CFLs in the twelve months prior to the 2014 inventory, up from 3.4 CFLs in 2013 (Figure 6). Georgia households purchased an average of 2.8 CFLs and Kansas households an average of 4.1 CFLs. Removing direct-install bulbs from these counts reduces the estimated number of CFLs obtained in the past year to 3.0 in Massachusetts and 2.7 in Georgia; Kansas did not have a direct-install program (Figure 7). Notably, more than four out of ten (42%) CFLs purchased by Massachusetts households in the past year were specialty CFLs, up from three out of ten (29%) in 2013. In contrast, the proportion of specialty CFL purchases among comparison-area households was significantly lower (25% in Georgia and 14% in Kansas).

Figure 6. Average Number of CFL and LED Purchases in Previous Year*



*Inclusive of bulbs obtained through direct-install programs and given to the respondent by a landlord or as a gift

Figure 7. Average Number of CFL and LED Purchases in Previous Year without Direct-Install Bulbs



Similar to LEDs, households taking part in Massachusetts direct-install programs obtained numerous CFLs through the program. These 27 households received an average of 15 CFLs (418 in total) from direct-install programs in the past year, accounting for 35% of all CFLs obtained by on-site households during this period. The percentages were even higher for specialty bulbs—direct-install programs accounted for about 53% of A-line bulbs and 49% of all other specialty bulbs.[34]

Table 21. CFLs Purchased or Obtained, 2014

	Massachusetts	Georgia	Kansas
Sample Size	*261*	*78*	*67*
CFL Bulbs (including direct-install bulbs)	1,209	222	273
CFL Bulbs (excluding direct-install bulbs)	791	212	273
CFL Bulbs (from direct-install programs)	418	10	0

In order to extrapolate these purchases to all households in Massachusetts, the Team weighted the purchases of CFLs to the population of all households in the state. Georgia and Kansas were also weighted based on the population tenure and education proportions of Massachusetts so as to resemble the Massachusetts populations and not to represent their own states.[35] This extrapolation suggests that on-site households purchased or obtained approximately 11.7 million CFLs in the twelve months prior to the 2014 on-site study. In the 2013 Massachusetts On-site Lighting Socket Inventory Report, the Team concluded that the small estimated increase in CFLs purchased in 2012 over what we observed for 2011 suggests that the first year of EISA implementation did not greatly increase CFL purchases.[36] Although the estimate of 2013 purchases made by the 2014 sample appears to indicate that the second year of EISA implementation boosted CFL purchases, the inclusion of far more direct-install bulbs than in previous years and the improvement in on-site protocols that led to the identification of a greater number of bulbs overall, particularly those in storage (see below), limits the conclusions we can draw from these estimates (Table 22). Without direct-install bulbs, the extrapolation suggests that on-site households purchased or obtained approximately 7.7 million CFLs in the twelve months prior to the 2014 on-site study (Table 23).

[34] The direct-install households reported receiving about four A-line CFLs, seven standard CFLs, and seven specialty bulbs (all dimmables [despite shape], 2-way, 3-way, and non-A-line shaped bulbs).

[35] This analysis includes bulbs that customers self-reported as obtained through direct-install programs in Massachusetts and the two million standard CFLs supported by Georgia Power in Georgia. This is to preserve comparability with previous years and across space, as 2011 and 2012 estimates for Massachusetts included direct-install bulbs, upstream bulbs, and non-program purchases. The forthcoming net-to-gross analysis will adjust for direct-install bulbs in Massachusetts and Georgia and upstream bulbs in Georgia.

[36] The increased purchases and saturation rates discussed here may reflect PA program intervention, EISA and/or recession recovery—and probably some mixture of these three factors. The on-site saturation study was not able to test the relative impact of these three factors on increased CFL and LED purchases or saturation.

Table 22. Estimates of all CFLs Purchased or Obtained in Massachusetts, Georgia and Kansas (Including Direct-Install bulbs)

Products	Massachusetts 2011 (by 2012 sample)	Massachusetts 2012 (by 2013 sample)	Massachusetts 2013 (by 2014 sample)	Georgia 2013 (by 2014 sample)	Kansas 2014 (by 2014 sample)
Total CFLs Purchased	7,957,295	8,445,249	11,704,374	7,182,786	10,274,021
Standard CFLs					
Total CFLs Purchased	5,779,861	5,954,987	6,785,812	5,396,391	8,809,858
% of All CFLs Purchased	73%	71%	58%	75%	86%
Specialty CFLs					
Total CFLs Purchased	2,177,435	2,490,262	4,918,562	1,786,395	1,464,163
% of All CFLs Purchased	27%	29%	42%	25%	14%

Base: All on-site respondents

Table 23. Estimates of all CFLs Purchased in Massachusetts, Georgia and Kansas (without Direct-Install bulbs included)

Products	Massachusetts 2013 (by 2014 sample)	Georgia 2013 (by 2014 sample)	Kansas 2014 (by 2014 sample)
Total CFLs Purchased	7,653,050	6,862,229	10,274,021
Standard CFLs			
Total CFLs Purchased	5,200,441	5,075,834	8,809,858
% of All CFLs Purchased	70%	74%	86%
Specialty CFLs			
Total CFLs Purchased	2,452,609	1,786,395	1,464,163
% of All CFLs Purchased	32%	26%	14%

Bulbs Obtained by Low-Income Households

Given the fact that low-income households (defined by eligibility for the LIHEAP program) tend to live in smaller homes, it is surprising to find that the average low-income household in Massachusetts purchased more CFLs and LEDs in both 2013 and 2014 than did the average non-low-income household (Table 24). The opposite, and more expected, finding is true for low-income homes in Georgia and Kansas. The average number of CFLs and LEDs purchased did not increase statistically for low-income households in Massachusetts between 2013 and 2014, despite large increases in the socket saturation of these bulb types. Two factors may explain this seeming contradiction. First, CFLs and LEDs have relatively long measure lives, so the bulbs purchased in one year may still be present even as new bulbs get installed in the next year. Second, low-income households tend to live in smaller homes with fewer sockets, so they achieve higher rates of saturation with fewer numbers of energy-efficient bulbs installed. Finally, the average number of purchases of CFLs and LEDs in Massachusetts for low-income households did exceed those for similar households in Georgia and Kansas.

Table 24. Number of CFLs and LEDs Obtained within the past Year by Income (Excluding Direct-Install Bulbs)

Sockets Containing	Massachusetts 2013 LI	Massachusetts 2013 NLI	Massachusetts 2014* LI	Massachusetts 2014* NLI	Georgia 2014 LI	Georgia 2014 NLI	Kansas 2014 LI	Kansas 2014 NLI
Means by Total Sample Size								
Sample Size	*47*	*103*	*82*	*166*	*32*	*46*	*20*	*47*
Total Bulbs Purchased	**3.4**	**3.0**	**3.7**	**3.5**	**2.0**	**3.8**	**2.9**	**5.2**
CFLs	3.3	2.8	3.5	2.8**	2.0	3.2	2.8	4.6
LEDs	0.1	0.3	0.1	0.7	0.0	0.6	0.0	0.6
Means by Sample Size that Purchased CFLs or LEDs in Past Year								
Sample Size that purchased bulbs in past year	*18*	*39*	*38*	*107*	*9*	*19*	*11*	*23*
Total Bulbs Purchased	**8.1**	**8.1**	**7.9**	**5.4****	**7.2**	**9.2**	**5.2**	**10.5**
CFLs	7.9	7.3	7.6	4.3**	7.2	7.8	5.2	9.4
LEDs	0.3	0.8	0.3	1.2**	0.0	1.5	0.1	1.2**

*In 2014, 10 DK/Refused income purchased 63 CFLs and 25 LEDs for a total of 88 bulbs in the past year (unweighted).

**Significantly different from Low Income at the 90% confidence level.

Nine of the 27 households taking part in a direct-install program met our definition of low-income. On average, they had obtained 14 CFLs through the direct-install program in the past year, accounting for 31% of CFLs obtained by low-income households in the past year. This is actually a smaller percentage than for non-low-income homes, which obtained 36% of their CFLs (an average of 16 per home) through direct-install programs during the same period. Direct-install programs also served as the source of one-fourth of LEDs obtained by low-income households and 30% of LEDs obtained by other households. The small sample sizes prevent the Team from drawing too many conclusions from these results, but they do make clear that at least some low-income houses are obtaining energy-efficient bulbs through retail locations, many of which likely partner with the upstream program.

Types of Stores where Respondents Shop for Light Bulbs

The discussion above makes clear that households in the on-site sample reported receiving a large number of CFLs (35% of all obtained) and LEDs (30% of all obtained) through various direct-install programs in Massachusetts over the past year. Yet, households obtained the majority of bulbs through retail stores. This section focuses on learning more about the purchasing behavior of those households that bought CFLs and LEDs in the past year.[37]

The on-site respondents were asked the date and location that they had purchased the CFLs and LEDs installed and stored in their homes. Figure 8 shows the proportion of bulbs purchased by type of store.[38] Since 2011, the proportion of bulbs purchased from home improvement stores has been declining, but still represents the number one source for purchased bulbs. The next most common source of CFLs purchased in the twelve months prior to the 2014 study was other stores,[39] followed by mass merchandise and discount stores. Another major source of CFL purchases in this period were hardware stores and warehouse type stores. The observed changes in the types of stores where households buy CFLs most likely reflects, at least in part, the efforts of the PAs to expand the channels included in the program to increase purchases among hard-to-reach households.

[37] Some direct-install households also bought CFLs and LEDs through retailers, and this analysis includes these purchases. The Team did not ask about the timing of audits versus the purchase of bulbs, so we cannot assess whether the bulb purchases represent spillover from the direct-install efforts.

[38] See Appendix B for comparisons of manufacturer by store type.

[39] Other stores includes: bargain, online, drugstore, landlord/building management, specialty lighting, charity, home furnishing, grocery/supermarket, other (unspecified), and don't know.

Figure 8. Types of Stores where CFLs Were Purchased, Massachusetts

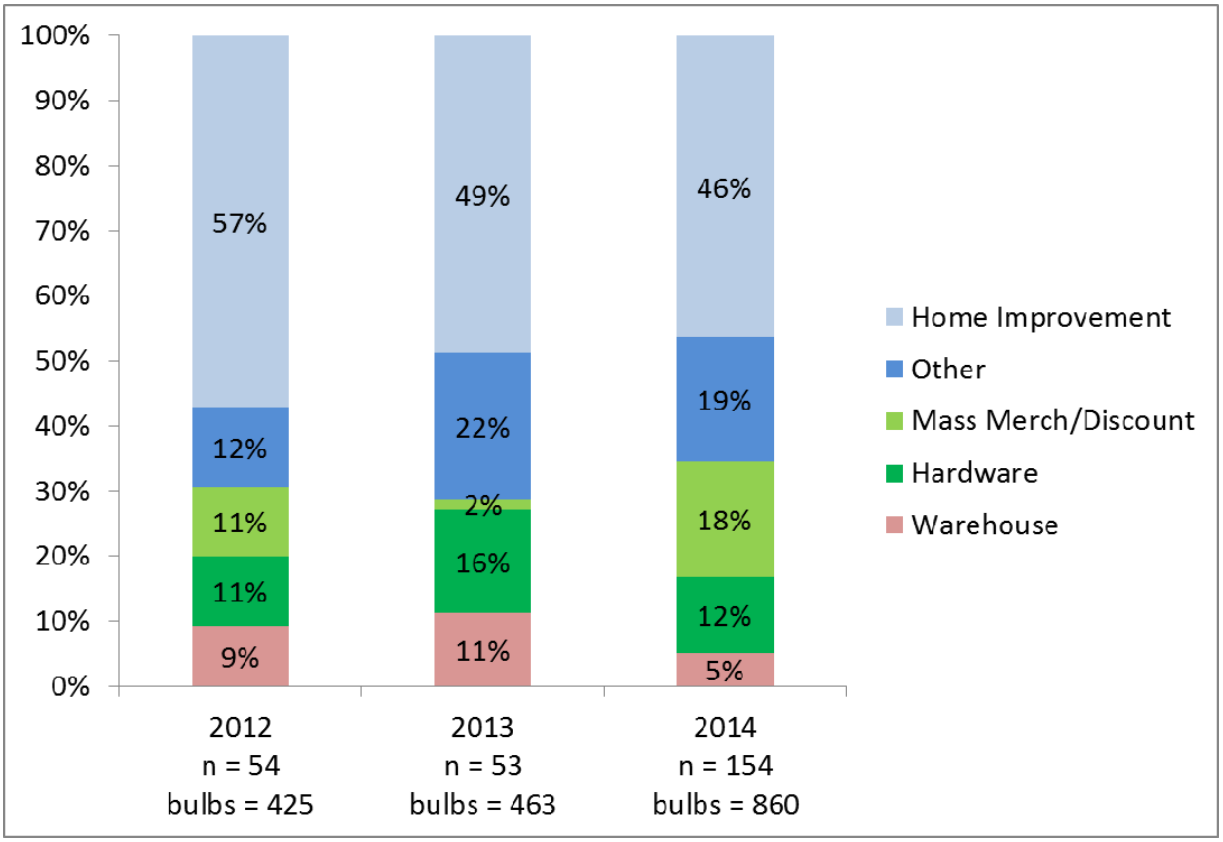
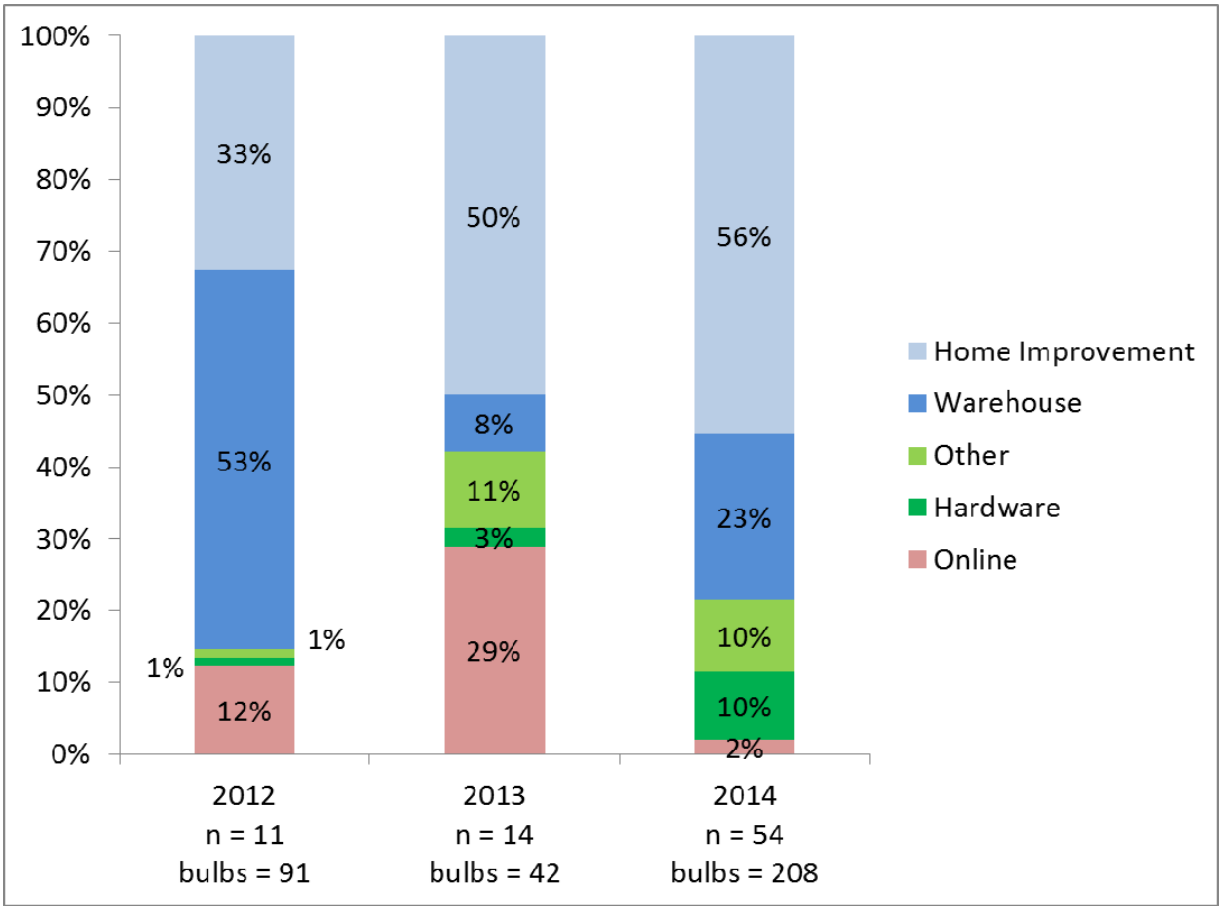


Figure 9 summarizes the store types where on-site households had purchased LEDs in the twelve months preceding the on-site visits in 2011, 2013, and 2014. As the figure shows, unlike CFLs, the sources for purchasing LEDs appear to follow a trend of becoming more concentrated among fewer store types. The proportion of LEDs purchased at home improvement stores has increased since 2011, as has the proportion purchased from hardware stores. However, prior to 2014, the number of LEDs reported purchased was fairly low. It is important to note that relatively few households purchased any LEDs in 2012 and 2013 (11 and 14, respectively).

Figure 9. Types of Stores where LEDs Were Purchased, Massachusetts



CFL purchasers in Massachusetts—both low-income (30%) and non-low-income (39%)—most frequently reported buying CFLs from Home Depot in the past year (Table 25). Among low-income participants, Walmart was the next most common location for purchasing bulbs; 23% of CFLs purchased in the past year among low-income participants were purchased at Walmart compared to only 6% among non-low-income homes. What is perhaps less expected is the small differences in purchase rates in the types of stores typically considered to cater to HTR households, namely bargain stores like Ocean State Job Lot and even, to some extent, various charity stores or sources (although low-income households did buy from these stores slightly more frequently than non-low-income households). Low-income households reported purchasing only 17 LEDs in the past year, the majority of which were purchased at home improvement stores. Many HTR bulbs were sold through grocery stores typically associated with Asian and Latino populations, and such households chose not to take part in the on-sites.[40]

Table 25. Where CFLs were Purchased (Mass Save bulbs included), Unweighted

Where Purchased	LI		NLI		Total	
	Count	%	Count	%	Count	%
Total	*260*		*543*		*803*	
Home Depot	77	30%	211	39%	288	36%
Walmart	61	23%	32	6%	93	12%
Lowe's	12	5%	71	13%	83	10%
Ocean State Job Lot	7	3%	19	3%	26	3%
BJ's	3	1%	22	4%	25	3%
Local Hardware Store	0	0%	24	4%	24	3%
Stop & Shop	8	3%	16	3%	24	3%
True Value	12	5%	11	2%	23	3%
Target	0	0%	21	4%	21	3%
Aubuchon Hardware	10	4%	10	2%	20	2%
Charities	13	5%	5	1%	18	2%
Other	41	16%	89	16%	130	16%
Don’t know	16	6%	12	2%	28	3%

*In 2014, 8 DK/Refused income purchased 63 in the past year (unweighted).

[40] The consumer survey did include some Spanish-speaking respondents, but they were not included in the on-site sample. The PAs, EEAC consultants, and Team have previously determined that it is not cost-effective to field the surveys in languages other than English and Spanish. If the PAs and EEAC Consultants want to learn more about the non-English speaking portion of the HTR population, the Team will need to consider how to design a study that captures such households in a way that makes efficient use of evaluation resources.

Similarly, when looking at CFLs purchased in the past year by store type, the most common location where both low-income (34%) and non-low-income (52%) on-site participants reported acquiring CFLs in the past year were home improvement stores (Table 26). Low-income households also bought many bulbs at mass merchandise /discount stores (27%).

Table 26. Type of Store where Purchased CFLs (Mass Save bulbs included), Unweighted

	LI		NLI		Total	
Where Purchased	**Count**	**%**	**Count**	**%**	**Count**	**%**
Total	*260*		*543*		*803*	
Home Improvement	89	34%	282	52%	371	46%
Mass Merch/Discount	69	27%	72	13%	141	18%
Hardware	25	10%	70	13%	95	12%
Warehouse	3	1%	41	8%	44	5%
Grocery/Supermarket	13	5%	21	4%	34	4%
Home Furnish	3	1%	16	3%	19	2%
Charity	13	5%	5	1%	18	2%
Specialty Lighting	14	5%	0	0%	14	2%
Landlord/Building management	2	1%	9	2%	11	1%
Drugstore	7	3%	3	1%	10	1%
Online	2	1%	3	1%	5	1%
Bargain	3	1%	0	0%	3	0%
Other/Don't know	17	7%	21	4%	38	5%

*In 2014, 8 DK/Refused income purchased 63 in the past year (unweighted).

Stored Bulbs

Current Bulb Storage for the Entire Sample

During the on-site visits, technicians also counted the CFLs found in storage. In Massachusetts in 2014, incandescent bulbs again accounted for the majority (68%) of stored bulbs (Table 27). CFLs accounted for one-fourth (25%) of all stored bulbs, down from 31% in 2013. In the comparison areas, the proportion of incandescent stored bulbs was similar to that in Massachusetts. While in Georgia, storage of CFLs was similar to Massachusetts, CFLs comprised a significantly lower proportion of bulbs in storage in Kansas. Importantly, LED storage increased in Massachusetts from less than 1% to 2%, the same rate as in Georgia and Kansas. Households in Georgia and Kansas stored more halogen bulbs than did Massachusetts households. It is important to note that, during the 2014 panel visits, the Team identified numerous errors of omission in recording bulbs in storage in 2013. During the panel visits, it was apparent that technicians from the previous year[41] had overlooked bulbs in storage—recording zero bulbs in storage for some homes that, according to participants, had had many bulbs in storage the year before. Because of these errors of omission, the counts for bulbs in storage for 2012 and 2013 are suspect, and the PAs and EEAC consultants should expect that the time series from 2014 onward will differ from those of previous years.

Table 27. Stored Bulbs

	Massachusetts			Georgia	Kansas
	2012	2013	2014	2014	2014
Number of households	*151*	*150*	*261*	*78*	*67*
Avg # of Stored Bulbs per Home**	**6.7**	**7.1**	**15.8**	**8.2**$^{\delta}$	**6.4**$^{\delta}$
Incandescent	66%	66%	68%	69%	72%
CFL	24%	31%	25%	21%	15%
Fluorescent	1%	1%	2%	2%	2%
Halogen	8%	3%	4%	6%	10%
LED	<1%	<1%	2%	2%	2%
Other*	0%	0%	0%	<1%	0%

Base: All on-site respondents

* Other includes high pressure sodium bulbs and mercury vapor bulbs.

** In 2014, technicians found more bulbs in storage than had been found in previous years due to new quality control and data collection protocols.

$^{\delta}$ Significantly different from Massachusetts 2014 at the 90% confidence level

Looking more carefully at CFLs in storage, the percentage of Massachusetts homes storing CFLs follows the same pattern as installed CFLs—an increase from 2009 to 2010, followed by several years of no

[41] DNV performed data collection in 2012 and 2013. In 2014, NMR performed data collection. In 2014, NMR implemented rigorous quality control and assurance protocols to prevent further errors in data collection. The same protocols were implemented in the comparison areas.

change and a significant increase from 2013 to 2014. One-third (34%) of homes stored just one to five CFLs, and more than one-fifth (22%) of homes stored six or more CFLs, up from just 14% in 2013. The mean number of CFLs in storage jumped from 2.1 in 2013 to 3.9 in 2014. Comparison-area households were found to be storing significantly fewer CFLs compared to Massachusetts. About two-thirds of homes in both Georgia (64%) and Kansas (66%) were storing no CFLs. On average, Georgia households had 1.7 CFLs in storage, and Kansas households had 0.9 CFLs in storage (Table 28).

Table 28. Current Storage of CFLs by Households

All CFLs	Massachusetts					Georgia	Kansas
	2009	2010	2012	2013	2014	2014	2014
Sample Size	*100*	*150*	*151*	*150*	*261*	*78*	*67*
Zero	72%	63%	62%[†]	65%	44%[†β§‡]	64%	66%
One to five	18%	24%	25%	21%	34%[†β§‡]	28%	29%
Six to fifteen	9%	9%	12%	13%	17%[†β]	6%	5%
Sixteen or more	2%	4%	1%[β]	1%[β]	5%[§‡]	2%	0%
CFL Storage							
Total # of households	100	150	151	150	261	78	67
Total CFLs in storage	139	380	247	310	1,028	134	63
Mean # of CFLs in storage	1.4	2.5	1.6	2.1	3.9	1.7	0.9

Base: All on-site respondents

[†] Significantly different from 2009 at the 90% confidence level

[β] Significantly different from 2010 at the 90% confidence level

[§] Significantly different from 2012 at the 90% confidence level

[‡] Significantly different from 2013 at the 90% confidence level

Table 29 shows fluctuation in the percentage of stored CFLs found in Massachusetts homes that store these bulbs. The 2014 data show a more even spread of storage than observed in other years. In 2009, 2012, and 2013, the majority of stored CFLs were found in homes that stored six to fifteen CFLs, while in 2010 the majority were in homes that stored sixteen or more CFLs. Households in Georgia and Kansas that were storing CFLs were more likely to be storing one to five CFLs compared to Massachusetts households.

Table 29. Current Storage of CFLs by Percentage of CFLs in Storage

All CFLs	Massachusetts					Georgia	Kansas
	2009	2010	2012	2013	2014	2014	2014
Sample Size	*100*	*150*	*151*	*150*	*261*	*78*	*67*
# of CFLs in storage	**139**	**380**	**247**	**310**	**1,028**	**134**	**63**
One to five	28%	21%	36%$^{\beta}$	28%	23%§	43%	55%
Six to fifteen	50%	28%†	55%$^{\beta}$	59%$^{\beta}$	41%$^{\beta\S\ddagger}$	26%	45%
Sixteen or more	22%	51%†	9%$^{\dagger\beta}$	13%$^{\dagger\beta}$	36%$^{\dagger\beta\S\ddagger}$	31%	0%

Base: All on-site respondents

† Significantly different from 2009 at the 90% confidence level

$^{\beta}$ Significantly different from 2010 at the 90% confidence level

§ Significantly different from 2012 at the 90% confidence level

‡ Significantly different from 2013 at the 90% confidence level

Panel Stored Bulb Changes

Working from corrected data[42] for 2013 stored bulb counts, we see a 32% increase in the number of stored bulbs at the panel visit sites, but a very similar distribution of bulb types (Table 30). In both years, incandescent bulbs comprise nearly three-quarters of the stock of stored bulbs, with CFLs making up most of the balance.

[42] The Team found numerous errors and omissions in the 2013 data. Fortunately, the panel visits allowed for the Team to correct such errors. The detailed methods for corrections are presented in Corrections to 2013 Data for Panel Visits in Appendix D.

Table 30: Stored Bulb Type Changes 2013-2014 (weighted, n=111)

	2013	2014
All bulbs	*1,555* *% (count)*	*2,151* *% (count)*
Incandescent	72% (1,124)	71% (1,536)
CFL	22% (342)	23% (491)
Fluorescent	2% (23)	1% (30)
Halogen	4% (55)	3% (60)
LED Bulb	0% (7)	1% (20)
LED Fixture	0% (0)	1% (13)
Other	0% (4)	0% (1)

EISA and Possible Stockpiling

As mentioned earlier, EISA included new efficiency standards for lighting products. The legislation's first phase went into effect in January 2012, when 100-Watt incandescent light bulbs could no longer be manufactured or imported into the United States; January 2013 ushered in the phase-out of 75-Watt incandescent bulbs, followed by the phase-out of 60- and 40-Watt bulbs in January 2014. EISA has naturally raised some concerns that consumers would stockpile incandescent bulbs to avoid switching to other bulb types. The forthcoming consumer survey results suggest that at least some respondents would stockpile incandescent bulbs. However, because actual stockpiling behavior may differ from self-reported behavior, the Team believes that on-site verified evidence of stockpiling is a more valid indicator of this behavior.

During the on-site visits, the Team took an inventory of all stored bulbs, keeping an eye out for incandescent bulbs and asking follow up questions to explore stockpiling behavior. The average number of 40- to 100-Watt incandescent bulbs in storage jumped from approximately four bulbs in 2013 to approximately ten bulbs in 2014 (Table 31). Of the 23 households who reported during the consumer survey that they were "very likely" to stockpile, one home accounted for nearly 40% of all stored bulbs and three homes had no 40- to 100-Watt incandescent bulbs stored. Those consumer survey respondents who reported being "somewhat unlikely" to stockpile actually had more 40- to 100-Watt incandescent bulbs in storage, on average (15.6), than those who indicated being "very likely" to stockpile (10.5). Upon closer examination, these results are largely influenced by a small number of respondents who reported being "somewhat unlikely" to stockpile, but who actually had a large number of incandescents in storage. Two households accounted for nearly one-half of all 40- to 100-Watt incandescent bulbs in storage in "somewhat-unlikely"-to-stockpile households; removing these two homes reduces the average to 10.1.

Table 31. Self-Reported Likelihood of Buying and Saving Extra 40- to 100-Watt Incandescent Bulbs after Phase-out, Massachusetts 2014

Self-Reported Likelihood	% of Respondents (sample size unweighted)	Ave. 40- to 100-Watt Stored	Count All Incand. Stored (weighted)
Overall	*232*[*]	*10.2*	*2,618*
Very likely	9% (23)	10.5	10% (257)
Somewhat likely	14% (32)	7.4	10% (263)
Somewhat unlikely	11% (26)	15.6	14% (362)
Very unlikely	61% (141)	10.4	64% (1,681)
Don't know	5% (11)	5.6	2%(55)

Base: All on-site respondents

[*]In 2014, respondents who reported that they did not currently use any incandescent light bulbs of any wattage in their home were not asked this question.

During the 2014 on-site visits, for each 60-, 75-, and 100-Watt incandescent bulb found in storage, the technician asked the homeowner if he or she was stockpiling that specific bulb because that type of bulb was no longer manufactured. In Massachusetts, 4% of households said they were stockpiling 60-Watt incandescent bulbs, while 2% said they were stockpiling 75- or 100-Watt bulbs. A smaller percentage confirmed stockpiling practices in Georgia and Kansas, with 3% of homes stockpiling 60-Watt bulbs in Georgia, and only 2% in Kansas. Of the 17 households identified as stockpiling bulbs (two in Georgia, two in Kansas, and 13 in Massachusetts), only two participants from Massachusetts said they were not aware of EISA.

For each stored bulb, technicians asked why the homeowner was storing that bulb. When looking only at 60-, 75-, and 100-Watt incandescent bulbs, almost all were being stored for future use (Table 32). A very small number of respondents did not plan to use the stored bulbs or planned to throw them out or recycle them; these responses were less common in comparison areas.

Table 32. Stockpiling and Reasons Respondents Store 60-, 75-, and 100-Watt Incandescents, 2014

Reason	Massachusetts			Georgia			Kansas		
	100-Watt Bulbs	75-Watt Bulbs	60-Watt Bulbs	100-Watt Bulbs	75-Watt Bulbs	60-Watt Bulbs	100-Watt Bulbs	75-Watt Bulbs	60-Watt Bulbs
Sample Size	*261*	*261*	*261*	*78*	*78*	*78*	*67*	*67*	*67*
% of HH Stockpiling Bulb	2% (5)	2% (5)	4% (11)	0%	0%	3% (2)	0%	1% (1)	1% (1)
Reasons for Storing Bulb									
Total # of bulbs	*56*	*57*	*143*	*12*	*5*	*26*	*7*	*8*	*23*
For future use	42	49	119	11	5	26	6	8	22
Do not plan to use	7	6	11	2	0	1	2	0	2
Plan to throw out/Recycle	7	2	11	0	0	1	0	0	0
Other	1	2	5	0	0	0	0	0	0
Don't know/Refused	6	3	13	0	0	0	0	0	0

Base: Respondents with 60-, 75-, or 100-Watt Incandescents in Storage

Tracking CFLs over Time[43]

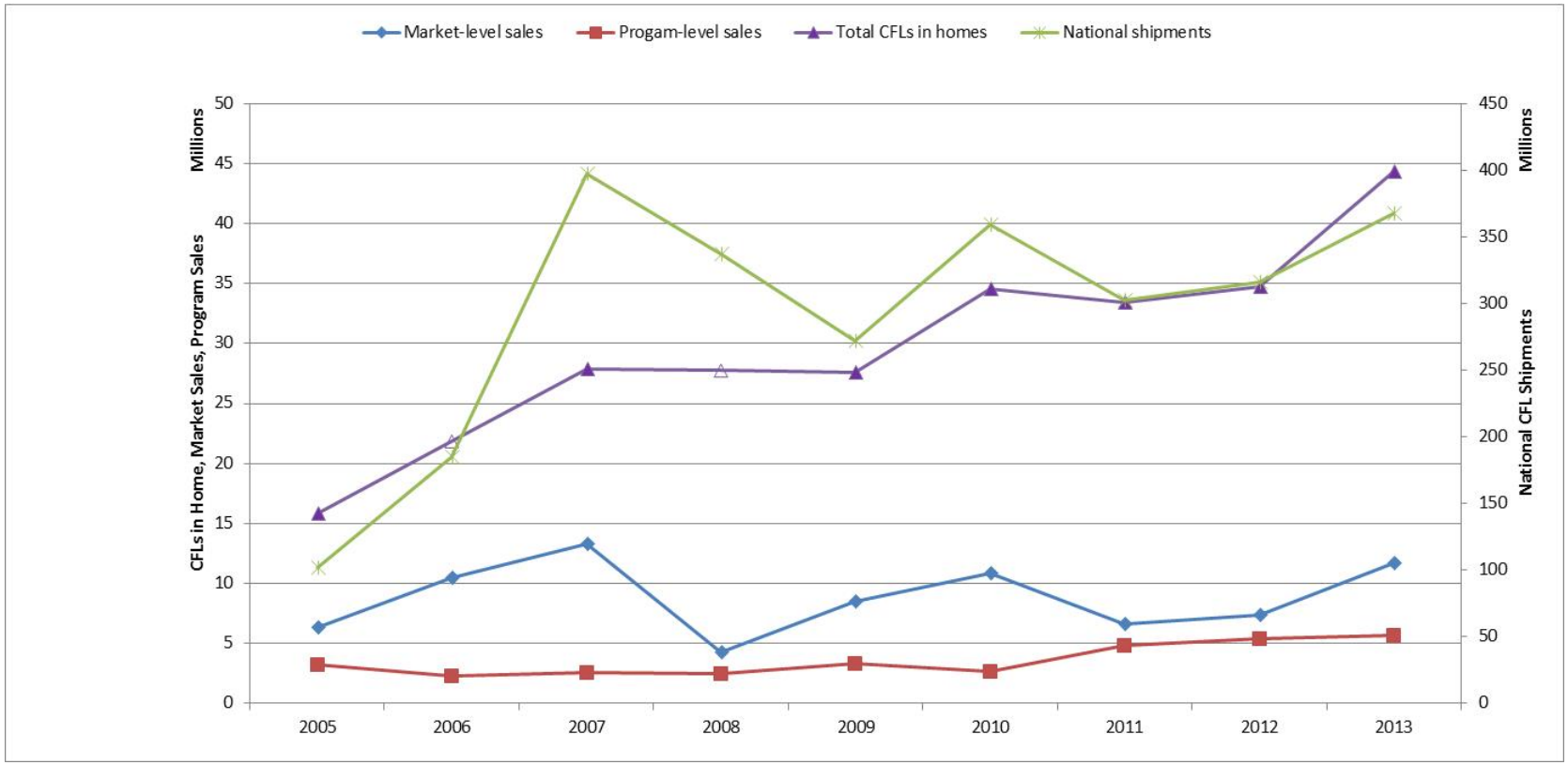
Massachusetts has been tracking the CFL market for numerous years, and in the two most recent on-site saturation reports, the Team began to report trends in CFL use, storage, purchases, and shipments as well as estimate the number of CFLs that may have burned out or been removed over the past year. [44] This section updates this analysis based on the 2014 on-site saturation data. Even with the caveat that some of the changes may be exaggerated due to the new on-site protocols, the Team believes that continued tracking and presentation of the trends helps the PAs and EEAC consultants understand the CFL market and where it may be going in the near future. The forthcoming Market Adoption Model will provide an explicit tool to help the PAs and EEAC consultants assess the future of the lighting market and their possible role in influencing program sales as EISA progresses.

Figure 10 demonstrates the continued mirroring of three of the four trends shown: 1) national shipments, 2) market-level sales, and 3) total CFLs in homes. Only program-supported bulbs follow its own trend, which is driven by program design, objectives, and the nature of agreements between the PAs and the program partners.

[43] Because we lack a long time series for LEDs, the Team presents these results only for CFLs. However, future survey reports could begin to track similar information for LEDs to the extent they are available.

[44] NMR, "Results of the Massachusetts Onsite Compact Fluorescent Lamp Surveys," delivered to the Massachusetts Program Administrators on October 23. NMR, "Results of the Massachusetts Onsite Lighting Inventory 2013," delivered to the Massachusetts Program Administrators on June 7, 2013.

Figure 10. CFL Use, Sales, and Shipment Estimates, 2005 to 2013



Sources: Total CFLs in homes, market-level sales, and program-level sales for 2005 to 2010 as compiled for the 2010 Delphi Panel.[45] Total CFLs in homes and market-level sales for 2011 through 2013 from the on-site visits discussed in this report. Program-level sales in 2011 through 2013 provided by the PAs or their data tracking vendors. National shipment data as compiled from the Department of Commerce.

[45] NMR, "Estimating the Net-to-Gross Ratio for the 2009-2010 Massachusetts ENERGY STAR Lighting Program: Delphi Panelist Response Summary," Appendix G in *Massachusetts ENERGY STAR Lighting Program 2010 Annual Report*, Delivered June 16, 2011.

Beginning with the 2012 on-site report, the Team also began tracking the possible number of CFLs purchased in a given year that could be replacing CFLs that had recently burned out. Table 33 summarizes this approach for possible CFL failures in 2013. It considers the installation rates and the failure rates of CFLs as estimated in the 2008 *Residential Lighting Measure Life Study*, covering the first six years of a CFL's life and extrapolating failure rates for the seventh through sixteenth years based on the previous rates of failure (cells with empirically observed or derived data are shown in white, and cells with extrapolated data are shaded gray).[46] Moreover, this approach takes into account the history of market-level CFL purchases in Massachusetts between 1998 and 2013. Applying the failure rates to installations allows us to estimate the burnouts per year. This approach estimates 2013 CFL burnouts to be about 6.3 million. Moreover, this method suggests that a total of 38 million CFLs have burned out since the start of the PAs' lighting programs in 1998.

The panel study described above in Sockets with Bulb Replacements allows us to estimate how many of the 6.3 million CFLs that burned out this year may have been replaced with other CFLs (54%) or with LEDs (19%). Specifically, 3.4 million of the burned out CFLs were likely replaced with other CFLs, and another 1.2 million were likely replaced with LEDs. The team will continue to track these estimates with the next panel study, to be completed in early 2015 with households that originally took part in on-site visits in 2013 and 2014.

[46] NMR and RLW. *Residential Lighting Measure Life Study*. Delivered to the New England Residential Lighting Program Sponsors, June 10, 2008.

Table 33. Estimating CFLs Replacing Other CFLs

Year after Purchase	Failure Rate*	Year	Market-Level Purchases	Newly Installed in Given Year**	Burned out in a Given Year***
First	4%	1998	305,216	235,016	9,039
Second	9%	1999	554,077	457,161	38,674
Third	8%	2000	530,006	494,034	79,202
Fourth	15%	2001	979,811	862,863	149,326
Fifth	10%	2002	892,859	838,483	241,637
Sixth	8%	2003	3,565,495	2,932,698	397,649
Seventh	10%	2004	4,565,862	3,961,549	715,159
Eight	5%	2005	6,308,402	5,670,605	1,110,896
Ninth	5%	2006	10,426,466	9,115,805	1,842,610
Tenth	4%	2007	13,330,771	11,938,180	2,815,756
Eleventh	3%	2008	4,248,761	5,647,270	3,675,034
Twelfth	3%	2009	8,447,382	8,262,437	4,385,247
Thirteenth	2%	2010	10,870,314	9,639,756	5,292,905
Fourteenth	2%	2011	6,611,870	7,022,909	5,483,572
Fifteenth	2%	2012	7,370,732	7,423,682	5,827,452
Sixteenth	2%	2013	11,697,650	10,405,451	**6,347,726**
Cumulative			90,705,674	84,907,900	38,011,673

* Derived from NMR and RLW, *Residential Lighting Measure Life Study*, 2008. This column does not correlate with the columns to the right of the table, but factors into the burn-out rate for each year; we show the failure rates in this table in order to have all the components of the calculations in one place.

** Sum of 77% of the current year market-level purchases and 10% of each of the two previous years' market-level purchases.

*** Sum of the burnouts occurring in that year based on all installations occurring prior to that year. To use a simple example, the number of burned out CFLs in 2000 includes 4% of the CFLs obtained in 2000 plus 9% of the CFLs obtained in 1999 and 8% of the CFLs obtained in 1998.

Conclusions and Recommendations

In this section, the Team presents the key conclusions and takeaways from the 2014 evaluation, followed by recommendations. Thanks to a rich dataset with saturation studies dating back to the early 2000s, the PAs and EEAC consultants are uniquely positioned to understand changes in residential lighting use and purchase behavior and to characterize lighting conditions resulting from the implementation of new lighting efficiency standards stemming from the Energy Independence and Security Act (EISA) of 2007 as well as the introduction of, increased availability of, and lower pricing for light-emitting diodes (LEDs) and EISA-compliant halogen bulbs. In addition, the inclusion of on-site lighting inventories in Georgia and Kansas offers the chance to compare progress made in Massachusetts to that in other areas of the country. Finally, the inclusion of a set of panel visits in Massachusetts in 2014 provides the opportunity for deeper understanding regarding what bulb types consumers choose to replace existing bulbs and why.

Saturation

Perhaps most importantly, after four years of flat growth (2009-2013), the 2014 Massachusetts visits reveal a substantial increase in saturation between 2013 (28%) and 2014 (33%).

Key Takeaways

- After hovering between 26% and 28% from 2009 to 2013, CFL saturation rates increased to 33% in 2014. Adding LEDs to the calculation increases the overall efficient bulb saturation to 36%; also including fluorescent bulbs (tubes of any size, circline, etc.) boosts saturation to 45%. All other bulb types (incandescents, halogens, and miscellaneous types), as well as empty sockets, account for the other 65% of sockets.[47] Saturation in low-income households (as defined by their eligibility for LIHEAP) increased even more, from 27% to 39% for CFLs and from below 1% to 3% for LEDs.

- An increase in CFL saturation in Massachusetts was mirrored by an increase in Kansas. Between 2009 and 2014, CFL saturation increased 7% in Massachusetts and 8% in Kansas, despite the lack of program activity in Kansas during this period. In contrast, saturation in Georgia increased only 3% between 2009 and 2014, despite Georgia having a substantial program in 2013.

- The higher concentration of mass merchandise, specifically Walmart, may be a contributing factor to saturation increases, especially in Kansas. Of the three states, Kansas not only has the highest square footage per capita of Walmarts but also the lowest average distance from the on-site visits to the nearest Walmart. In both Georgia and Kansas there appears to be a

[47] In keeping with Massachusetts practice, “sockets” includes all socket types—medium screw base, small screw base, pin-based, and GU bases, among any others we may find in the homes.

relationship between purchase behavior and saturation in that the highest saturation households bought bulbs at Walmart or Home Depot.

- For the first time since Massachusetts has tracked socket saturation (2003), incandescent bulbs comprised fewer than 50% of bulbs installed in homes in the state, with a saturation of 45%, equal to that of the combined saturation of energy-efficient bulbs. Incandescent and halogen bulbs combined accounted for just 51% of all installed bulbs. In Georgia and Kansas, incandescent remained the predominant bulb type (65% Georgia, 51% Kansas), although, in Kansas, incandescent bulbs accounted for just over one-half of all sockets.

- Although still a small portion of sockets (3%), LED saturation has been increasing steadily by about 1% per year for the past three years.

- Inefficient bulbs dominate lower lumen ranges. Incandescent and halogen bulbs account for more than three-fifths of all bulbs with less than 750 lumens in output (see Table 42). This lumen range represents 71% of total sockets in Massachusetts households. This may present a role for LEDs that CFLs were previously unable to fill.

Penetration

While total LED saturation (percent of sockets filled with the bulb type) remained low at 3% of total sockets in Massachusetts in 2014, penetration (percent of homes using the bulb type) of LEDs has more than tripled since 2012, when Massachusetts first began tracking it (7% in 2009, 12% in 2013, and 23% in 2014). Penetration is particularly important for LEDs because, at this stage of market adoption, penetration is likely a better gauge of LED program success than is total saturation.

Key Takeaways

- In Massachusetts, penetration of CFLs has held steady at 96% since 2012. Coinciding with a shift in program focus towards specialty CFLs, the penetration of specialty CFLs has increased substantially from 25% in 2009 to 65% in 2014. Penetration of LEDs has more than tripled since 2012, increasing from 7% in 2012 to 23% in 2014.

- In Georgia and Kansas, penetration rates of both CFLs and LEDs lag behind those in Massachusetts, with penetration of CFLs reaching 82% in Georgia and 88% in Kansas. While significantly lower compared to Massachusetts, penetration rates of LEDs in Georgia (10%) and Kansas (18%) appear to be relatively high for areas with no existing LED programs.

Replacement

Findings regarding bulb replacement behavior from the 2014 Massachusetts panel visits help to explain the increase in efficient bulb saturation. Examining the bulbs replaced among panel homes between 2013 and 2014, we find a dramatic shift from inefficient bulbs to efficient bulbs. Between 2013 and 2014, panelists replaced 13% of the bulbs in their homes. Among these sockets, 70% contained

inefficient bulbs in 2013 and only 25% contained inefficient bulbs in 2014. Furthermore, when panelists were asked why they replaced an incandescent bulb with a CFL or LED, over one-half (54%) of respondents said they were replacing incandescent bulbs with efficient bulbs as they burned out.

Key Takeaways

- Based on the results of the Massachusetts panel visits, households were nearly three times as likely to choose a CFL instead of an incandescent to replace an incandescent bulb. Among replaced bulbs, the proportion of incandescent bulbs decreased dramatically from 68% to 23% between the 2013 and 2014 visits. At the same time, the proportion of CFLs increased from 25% to 58%.

- Based on the results of the panel visits and on an updated assessment of the number of likely CFLs to burn out in 2013, the Team estimates that about 6.3 million CFLs burned out in 2013. Of these, 3.4 million were likely replaced with another CFL and 1.2 million were likely replaced with an LED.

- In contrast to the finding above, when panelists were asked why they had replaced a CFL or LED with an incandescent bulb, the most popular response (38%) was that the incandescent bulb was the only type in storage. One-third of the panelists indicated that they wanted a brighter or dimmer bulb, and nearly one-fifth (18%) said they had replaced the CFL because they do not like CFLs in general.

- Among 2014 panelists, we observed a shift in bulb shapes among sockets where incandescent bulbs replaced incandescents. Seventy percent of these sockets had traditional A-line incandescents in 2013, but only 53% did in 2014. Nearly all of the changes were toward spot/reflector/flood bulbs, which went from 7% in these sockets in 2013 to 24% in 2014. These bulb shapes are also subject to their own set of EISA regulations, so the Team is uncertain of what may reflect the shift in bulb shape.

Purchases

According to the 2014 on-site visits, Massachusetts households purchased or obtained more CFLs, on average (4.6), than in 2012 (3.1) or 2013 (3.4). Average CFL purchases in Georgia (2.8) and Kansas (4.1) were relatively lower than those in Massachusetts. In Massachusetts, there was a large increase in the average number of specialty CFLs purchased (1.9), nearly doubling compared to 2013 (1.0). Similarly, average LED purchases in Massachusetts increased from 0.2 in 2013 to 1.0 in 2014.

Key Takeaways

- Massachusetts households reported purchasing an average of 0.6 LEDs per household in the year preceding the 2014 on-site visits compared to just 0.2 reported by households in 2013; Georgia and Kansas households reported purchasing relatively fewer LEDs, an average of 0.4

LEDs per household in the year preceding the on-site visits. These estimates exclude bulbs obtained through direct-install programs.

- Excluding bulbs obtained through direct-install programs, Massachusetts households purchased an average of 3.0 CFLs in the year preceding the 2014 study, compared to 2.9 reported by households in 2013. Georgia households purchased an average of 2.7 CFLs and Kansas households an average of 4.1 CFLs.

- Low-income households purchased about 3.5 CFLs and 0.1 LEDs in the past year. These purchases typically came from the same stores at which non-low income households reported buying CFLs and LEDs, although low-income households were more likely to buy bulbs at Walmart. Very few low-income households self-reported buying bulbs at the types of stores that sold *only* bulbs targeted at HTR households (i.e., bargain, dollar, and "ethnic" grocery stores), but this may reflect the characteristics of households agreeing to the on-site visits (especially the lack of households that do not primarily speak English) and not a short-coming of the HTR component of the Residential Lighting Program.

- More than four out of ten (42%) CFLs purchased by Massachusetts households in the year preceding the 2014 study were specialty CFLs—compared to about three out of ten (29%) reported in 2013. In contrast, the proportions of specialty CFL purchases among households in Georgia (25%) and Kansas (14%) were significantly lower.

Storage

In Massachusetts, storage of CFLs seemingly followed the same trend as CFL purchases. CFLs in storage increased significantly, from an average of 2.1 in 2013 to 3.9 in 2014. In addition, the percentage of homes storing CFLs increased substantially, from 35% in 2013 to 56% in 2014. Note, however, that this increase may be due in part to the implementation of additional quality control procedures to ensure that bulbs in storage were properly accounted for during the on-site visits. Results of the panel visits in Massachusetts confirm the increase in storage. Among panelists, we observed a 38% increase in the number of CFLs found in storage. Comparison-area households were found to be storing significantly fewer CFLs compared to those in Massachusetts. On average, Georgia households had 1.7 CFLs in storage and Kansas households had 0.9 CFLs in storage. Just over one-third of homes in both Georgia (36%) and Kansas (34%) were storing CFLs.

Key Takeaways

- More than one-half of Massachusetts households were storing at least one CFL at the time of the 2014 on-site visits—significantly more compared to both Georgia (36%) and Kansas (34%). In Massachusetts, the average number of CFLs in storage increased from 2.1 in 2013 to 3.9 in 2014. Comparison-area households were found to be storing significantly fewer CFLs (1.7 in Georgia, 0.9 in Kansas).

- Panel data support the increases found in Massachusetts, showing a 32% increase in the number of stored bulbs at the panel sites. While more bulbs were found in storage, the composition of those bulbs held steady, with CFLs comprising just under one-quarter of bulbs (22% in 2013, 23% in2014) and incandescent bulbs accounting for nearly three-quarters of all stored bulbs (72% in 2013, 71% in 2014).

- Coinciding with increases in storage, the average number of 40- to 100-Watt incandescent bulbs in storage increased from approximately four bulbs in 2013 to eight bulbs in 2014. This could be an indication of possible EISA-related storage of bulbs. Comparison-area households were found to be storing fewer 40- to 100-Watt incandescent bulbs, on average (5.1 in Georgia, 3.8 in Kansas).

- Based on examination of storage data and key questions from the consumer survey, the Team has identified 17 households stockpiling incandescent bulbs (13 in Massachusetts and two each in Georgia and Kansas). These households account for a large proportion of the 40- to 100-Watt incandescent bulbs in storage. Fifteen of the 17 households said they were familiar with EISA—the two who said they were not familiar are both in Massachusetts.

Recommendations and Considerations

The Team offers the following recommendation and considerations.

Recommendation 1: Continue pursuit of panel study, adding in 2014 saturation study participants. The panel study results helped to answer questions regarding drivers of saturation changes and bulb replacement behavior that have been valuable in assessing the ever-changing residential lighting market. Repeating this study and expanding on the panel size will reveal whether the results observed this year represent a pattern of behavior or whether they were limited to a particular group at a specific time.

Consideration 1: Revise retail program to include an inefficient bulb buy-back program. A bulb buy-back program could convince people to change out inefficient bulbs before they burn out and fill them with a CFL or LED (as evidenced by the high rate of incandescent-to-CFL and -LED conversion found in the panel study). Previous evaluations have suggested a bulb buy-back program,[48] but the Team is not certain whether the Program Administrators (PAs) have incorporated such a design into the program. We repeat this suggestion as a consideration because of evidence presented at the Northeast Energy Efficiency Partnership's Lighting Summit in October 2014. There, implementers discussed the success of a similar program in Connecticut. The PAs and EEAC consultants may want to consider pursuing a buy-back program here in Massachusetts.

[48] See NMR Group, Inc. *Results of the Massachusetts Onsite Compact Fluorescent Lamp Surveys.* Final report delivered to the PAs and EEAC Consultants on October 23, 2012.

Consideration 2: Consider program designs that address less efficient linear fluorescent tubes including T12s. Given that linear fluorescent bulbs are commonplace among residential homes, the PAs should consider investigating whether or not program elements that directly address the efficiency of these bulb types would be cost effective. Careful consideration should be given to how to target inefficient T12s, perhaps through a buy-back program or direct install program. Since replacing T12s with linear LEDs, T8s, or T5s may require replacing entire fixtures or magnetic ballasts, the program design may not be best suited to an upstream program.

Consideration 3: Inefficient bulbs still dominate lower lumen ranges. Given that inefficient bulb types comprise the majority of installed bulbs below 1049 lumens, the PAs may consider more focused efforts on this lumen range when selecting and determining incentive levels for LEDs and CFLs to offer through upstream programs.

Consideration 4: Consider revisions to program design to encourage the purchase of multiple LEDs in one shopping trip. Penetration of LEDs has been increasing rapidly, more than tripling since 2012, and saturation has doubled since 2014. LEDs, unlike CFLs, are predominantly sold in single-bulb packages. While there is certainly a role for single-bulb incentives, multi-bulb incentives may leverage increases in penetration by pushing consumers toward buying multiple LEDs in one trip.

Consideration 5: Consider directly studying use and purchase behavior among hard-to-reach (HTR) households, which would then inform whether the current upstream model or program additions/revisions would best serve to achieve remaining potential in such households and increase their adoption of LEDs. If the PAs and EEAC consultants desire more information on the use and purchase rates—including the use and purchase rate of LEDs—of a wider range of households considered HTR (e.g., those that primarily speak a language other than English, recent immigrants, people with disabilities), they should work with evaluators—whether it be the Residential Team or one in another subject area—to design a study specifically to capture underrepresented households. While the Team oversamples multifamily households and recruits low-income ones, the current evaluation approach focuses on describing the residential lighting market. This yields information on only a small number of HTR households due to their limited representation in the population and the characteristics that make them "hard to reach." Without performing scoping research, the Team cannot say exactly what such a study would involve, but our professional experience suggests that the model will draw more from community organizing, community health programs, and similar efforts that perform direct outreach with the diverse HTR population. We suspect that the study would work with Community Action Programs and contractors already involved with low-income programs in Massachusetts, but would also expand to other community groups and recognized community leaders to spark interest and gain trust in the study. The Team warns that such a study could be difficult and costly to implement, but it would be better able to describe the HTR population and identify remaining potential for such households.

Appendix A: Use and Saturation

The Team estimated CFL use and saturation (both interior and exterior sockets) primarily through the on-site saturation survey, although we occasionally supplement these data with pertinent information from the consumer survey. We note the source of the data for all tables.

Use of CFLs and LEDs

Each year, consumer survey respondents are asked if they have ever had CFLs installed in their homes. In the most recent consumer survey, 62% of respondents reported having had a CFL installed at some point, while 67% of the on-site subset of respondents said they had used a CFL (Table 34). Additionally, nearly one-fifth (18%) of all consumer survey respondents were not aware of or familiar with CFLs; this was statistically different from the 2014 new visit on-site sample. Thus, analysis comparing on-site households to consumer survey responses suggests that there is some evidence that on-site households are more familiar with and open to using CFLs than the entire sample survey.

Table 34. CFLs Ever Installed in Home

Have Ever Used a CFL	Winter 2011 Consumer Survey	2012 On-site Sample	Winter 2012 Consumer Survey	2013 On-site Sample	2014 Consumer Survey	2014 On-site Sample (New Visits Only)
Sample size	*582*	*151*	*600*	*150*	*940*	*150*
Yes	61%	68%	64%	67%	62%$^{\Psi}$	67%
No	20%	16%	16%	19%	16%$^{\Psi}$	13%$^{\Psi}$
Don't know/ Refused	6%	4%	3%	4%	3%$^{\Psi}$	5%
Not aware of/ familiar with CFLs	13%	12%	18%	11%§§	18%$^{\Psi\S\ddagger}$	13%$^{\alpha}$

Base: All consumer and on-site respondents, reflecting their consumer survey response

$^{\Psi}$ Significantly different from 2011 consumer survey at the 90% confidence level.

§ Significantly different from 2012 at the 90% confidence level

§§ Significantly different from the Winter 2012 consumer survey at the 90% confidence level

‡ Significantly different from 2013 at the 90% confidence level

$^{\alpha}$ Significantly different from 2014 consumer survey at the 90% confidence level

CFL penetration, or the percentage of households using at least one CFL, increased significantly from 88% in 2009 to 92% in 2010, but has held steady at 96% since 2012. LED penetration, however, has more than tripled since 2012; while approximately one out of ten homes had at least one LED bulb installed in 2012 and 2013 (7% and 12%, respectively), nearly one out of every four homes (23%) had at least one LED bulb installed in 2014. CFL and LED penetration rates in both Georgia (82% and 10%, respectively) and Kansas (88% and 10%, respectively) have lagged behind those in Massachusetts, though LED penetration in both comparison areas appears to be high, considering the complete lack of LED programs in both states (Table 35).

Table 35. CFL and LED Penetration

	Massachusetts					Georgia		Kansas		
	CFLs					CFLs		CFLs		
Base Type	2009	2010	2012	2013	2014	2009[49]	2014	2009*	2010[50]	2014
Sample Size	*100*	*150*	*151*	*150*	*261*	*63*	*78*	*70*	*95*	*67*
CFLs – Any base type	88%	92%	96%†	96%†	96%†	63%	82%	83%	88%	88%
CFLs – Screw base only	87%*	n/a	95%	95%	92%	n/a	82%	n/a	n/a	88%
LEDs – Any base type	2%*	n/a	7%	12%	23%§‡	n/a	10%	n/a	n/a	18%
LEDs – Screw base only	0%*	n/a	7%	11%	22%	n/a	8%	n/a	n/a	17%

Base: All on-site respondents

* Unweighted

† Significantly different from 2009 at the 90% confidence level

§ Significantly different from 2012 at the 90% confidence level

‡ Significantly different from 2013 at the 90% confidence level

[49] Source for Georgia and Kansas 2009 data: Cadmus, "Compact Fluorescent Lamps Market Effects, Fall Interim Report. Appendix A," delivered to the California Public Utilities Commission Energy Division on May 15, 2009.

[50] Source for Kansas 2010 data: NMR, "Results of the Multistate CFL Modeling Effort," delivered to NYSERDA on September 23, 2011.

The percentage of households using six or more CFLs has steadily increased over the past few years, from 53% of households in 2009 to 78% of households in 2014. Notably, in 2014, the percentage of households with six to fifteen CFLs installed actually decreased compared to 2013 (from 48% to 40%), while households with sixteen or more CFLs installed jumped significantly, from 28% in 2013 to 38% in 2014. The use of specialty CFLs in households increased significantly from 2009 to 2010, corresponding to the shift in Program focus to specialty CFLs; while adoption appeared to have slowed after 2010, in 2014, households with sixteen or more specialty CFLs increased significantly, from 4% in 2012 and 2013 to 10% in 2014 (Table 36).

Table 36. Current Use of CFLs by Type and Households

Number of CFLs	Massachusetts					Georgia	Kansas
	2009	2010	2012	2013	2014	2014	2014
Sample Size	*100*	*150*	*151*	*150*	*261*	*78*	*67*
All CFLs							
Zero	12%	8%	4%[†]	4%[†]	4%[†]	18%	12%
1 to 5	35%	31%	32%	23%[†]	19%[†β§]	36%	21%
6 to 15	34%	35%	40%	48%[†β]	40%	23%	26%
16 or more	19%	26%	25%	28%[†]	38%[†β§‡]	23%	42%
Standard CFLs							
Zero	14%	12%	7%[†]	9%	10%	24%	13%
1 to 5	37%	39%	46%	29%[β]	27%[†β§]	34%	24%
6 to 15	36%	32%	32%	41%[§]	41%[β§]	30%	24%
16 or more	13%	18%	16%	20%	23%[†§]	12%	40%
Specialty CFLs							
Zero	75%	43%[†]	42%[†]	38%[†]	31%[†β§]	68%	60%
1 to 5	16%	39%[†]	37%[†]	39%[†]	39%[†]	27%	28%
6 to 15	9%	14%	18%[†]	19%[†]	20%[†]	3%	13%
16 or more	1%	5%[†]	4%	4%[†]	10%[†β§‡]	2%	0%

Base: All on-site respondents

[†] Significantly different from 2009 at the 90% confidence level

[β] Significantly different from 2010 at the 90% confidence level

[§] Significantly different from 2012 at the 90% confidence level

[‡] Significantly different from 2013 at the 90% confidence level

Table 37 shows the same trend seen in Table 36, with the average number of installed CFLs increasing a great deal between 2009 and 2010, followed by a period of idle growth and another large increase in use between 2013 and 2014; the average household used 11.8 CFLs in 2013 compared to 15.9 CFLs in 2014. In Georgia there are significantly fewer CFLs in use (9.0), on average, than in Massachusetts. However, in Kansas, the average number of CFLs in use (16.1) is nearly identical to that in Massachusetts. In Massachusetts in 2014, there was a noteworthy shift in specialty CFL use from representing just over one-quarter (27%) of CFLs installed in 2013 to more than one-third (34%) in 2014. In the comparison areas, specialty CFLs comprise a significantly lower proportion of total CFLs compared to Massachusetts (20% Georgia, 11% Kansas).

Table 37. Current Use of CFLs

	Massachusetts					Georgia	Kansas
	2009	2010	2012	2013	2014	2014	2014
Sample Size	*100*	*150*	*151*	*150*	*261*	*78*	*67*
All CFLs							
Total CFLs in use	*953*	*1,765*	*1,754*	*1,766*	*4,559*	*701*	*1,077*
Mean # of CFLs in use	9.4	11.7	11.6	11.8	15.9	9.0	16.1
Median # of CFLs in use*	n/a	7	9	9	12	4	10
% of all CFLs in use	100%	100%	100%	100%	100%	100%	100%
Standard CFLs							
Total CFLs in use	*820*	*1,259*	*1,247*	*1,288*	*2,936*	*562*	*959*
Mean # of CFLs in use	8.1	8.4	8.3	8.6	10.5	7.2	14.3
Median # of CFLs in use*	n/a	5	5	7	9	3	10
% of all CFLs in use	86%	71%	71%	73%	66%	80%	89%
Specialty CFLs							
Total CFLs in use	*133*	*506*	*507*	*478*	*1,620*	*139*	*118*
Mean # of CFLs in use	1.3	3.4	3.4	3.2	5.4	1.8	1.8
Median # of CFLs in use*	n/a	1	1	1	2	0	0
% of all CFLs in use	14%	29%	29%	27%	34%	20%	11%

Base: All on-site respondents

* Median not reported in 2009

In Massachusetts in 2014, seven out of ten CFLs (70%) in use in 2014 were concentrated in homes with sixteen or more CFLs installed compared to 63% in Georgia and 81% in Kansas. In Massachusetts in 2014, households using sixteen or more standard CFLs accounted for more than one-half (54%) of all standard CFLs, compared to 42% in Georgia and 78% in Kansas. Finally, among Massachusetts households using sixteen or more specialty CFLs, these CFLs accounted for 44% of all CFLs, compared to 38% in Georgia and zero in Kansas. This is further evidence that CFL use is increasing and becoming more commonplace in Massachusetts homes. We may also observe that specialty CFLs in Georgia and Kansas are not as heavily adopted by households as in Massachusetts (Table 38).

Table 38. Current Use of CFLs by Percentage of CFLs Installed

Number of CFLs	Massachusetts					Georgia	Kansas
	2009	2010	2012	2013	2014	2014	2014
Sample Size	*953*	*1,765*	*1,754*	*1,766*	*4,559*	*701*	*1,077*
All CFLs							
1 to 5	10%	8%	8%	7%	4%	10%	3%
6 to 15	38%	27%	38%	42%	26%	27%	15%
16 or more	52%	66%	55%	51%	70%	63%	81%
Standard CFLs							
Sample Size	*820*	*1,259*	*1,247*	*1,288*	*2,936*	*562*	*959*
1 to 5	13%	11%	16%	11%	8%	11%	5%
6 to 15	47%	36%	39%	46%	38%	47%	17%
16 or more	40%	53%	45%	43%	54%	42%	78%
Specialty CFLs							
Sample Size	*133*	*506*	*507*	*478*	*1,620*	*139*	*118*
1 to 5	24%	27%	28%	24%	18%	45%	36%
6 to 15	55%	32%	47%	50%	37%	17%	64%
16 or more	21%	40%	25%	26%	44%	38%	0%

Base: All installed CFLs

Though the number of LEDs in use in homes was considerably lower than that of CFLs, the percentage of homes with at least one LED installed increased significantly, from 12% in 2013 to 22% in 2014. In 2012, a small number of households accounted for the majority of LED use, with two households accounting for 85 of the 127 LEDs (67%).[51] In 2014, though one home accounted for 41 of the 352 LEDs (12%) in use, the remaining LEDs were spread more evenly across the on-site sample. While LED penetration rates in Georgia (10%) and Kansas (18%) lag behind that in Massachusetts, penetration levels in both states, especially Kansas, are high considering the complete lack of LED programs in those states.

[51] 68 of the 85 LEDs were under-cabinet lights all in one household.

Table 39. Current Use of LEDs

LEDs	Massachusetts On-site Sample 2012		Massachusetts On-site Sample 2013		Massachusetts On-site Sample 2014		Georgia On-site Sample 2014		Kansas On-site Sample 2014	
Sample Size		*151*		*150*		*261*		*78*		*67*
Number of Bulbs		**92**		**127**		**352**		**47**		**103**
Zero	% of HHs	93%	% of HHs	88%	% of HHs	77%§‡	% of HHs	90%	% of HHs	82%
	% of LEDs	0%	% of LEDs	0%	% of LEDs	0%	% of LEDs	0%	% of LEDs	0%
One to five	% of HHs	5%	% of HHs	10% §	% of HHs	17%§‡	% of HHs	7%	% of HHs	12%
	% of LEDs	13%	% of LEDs	30%	% of LEDs	34%	% of LEDs	44%	% of LEDs	22%
Six to fifteen	% of HHs	1%	% of HHs	1%	% of HHs	3%	% of HHs	3%	% of HHs	5%
	% of LEDs	12%	% of LEDs	5%	% of LEDs	19%	% of LEDs	56%	% of LEDs	40%
Sixteen or more	% of HHs	1%	% of HHs	1%	% of HHs	2%	% of HHs	0%	% of HHs	2%
	% of LEDs	75%	% of LEDs	64%	% of LEDs	48%	% of LEDs	0%	% of LEDs	37%
Mean # of LEDs		0.6		0.7		1.2		0.5		1.2
Median # of LEDs		1		<1		<1		0		0

Base: All on-site respondents and installed LEDs

§ Significantly different from 2012 at the 90% confidence level

‡ Significantly different from 2013 at the 90% confidence level

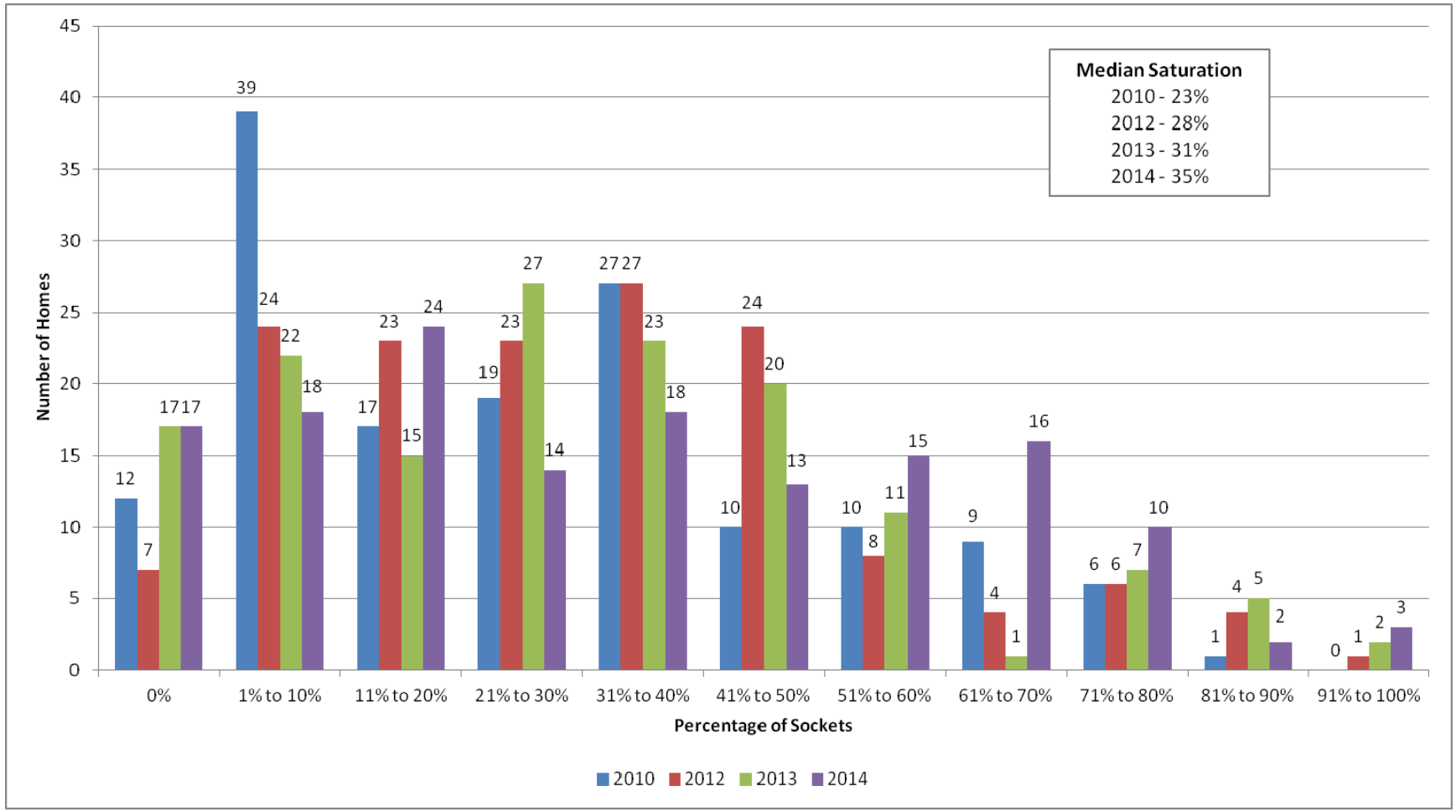
Socket Saturation and Remaining Potential

In addition to the Changes in Socket Saturation section in the main body of the report, the team performed substantial analyses to examine the socket saturations and remaining potential in more detail.

Figure 11 displays the 2010 to 2014 distributions of CFL saturation across homes—that is, the saturation *for each individual on-site home* rather than across all sockets in the state, as reported in Table 5. The data continues to reflect an increase in CFL use in Massachusetts homes. The data from 2010 to 2013 point to a right-skewed distribution, with the mass of the distribution concentrated on the left of the figure; in 2014, however, the skew has shifted noticeably, with the mass of the distribution concentrated more toward the center.[52] Saturation in individual homes is increasing, and the overall saturation across all homes has also increased. In addition, the median saturation—the midpoint—has consistently increased, from 31% in 2013 to 36% in 2014, providing another indication that a greater number of households are installing CFLs in an increasing percentage of sockets.

[52] The reason for the difference between the data in Figure 11 and those reported earlier for overall saturation reflects the method of calculation. In Figure 11, we find the saturation for each home and then average the results; the overall saturation rate looks across all sockets and across all homes. For example, a small home with 25 sockets and 10 CFLs has a saturation of 40%; a large home with 100 sockets and 20 CFLs has a saturation of 20%. The average of these two individual saturation rates is 30%, but the saturation rate calculated across all sockets is 24%.

Figure 11. CFL Saturation per Household



Base: All on-site households, 2010 to 2013; new visits only in 2014; data are unweighted

Socket Saturation by Lumen Ranges

To examine saturation by lumen output, the Team first transformed wattages into lumen ranges based on estimated efficacy information from ENERGY STAR.[53] Table 40 shows the wattage ranges and estimated lumen ranges assumed for this analysis, and Table 41 presents the maximum allowable wattage by lumen range according to EISA requirements by year. It is important to note that, for the purposes of analyzing bulbs by lumen categories, the team assumed that the majority of halogen bulbs installed in homes were *pre-EISA compliant*, so the lumen ranges listed below for halogens are accurate for the vast majority of these bulbs found in homes, but are not accurate for the very few EISA-compliant halogens found in homes and on retailers' shelves.

Table 40. Lumens per Watt by Bulb Type

Lumen Range	Watt Equivalents				
	CFLs	Fluorescent	Halogen	Incandescent	LEDs
<310	<4	<4	<24	<20	<4
310-749	5-12	5-9	25-60	21-50	5-10
750-1,049	13-16	10-13	61-84	51-70	11-14
1,050-1,489	17-23	14-19	85-119	71-99	15-19
1,490-2,600	24-40	20-33	120-208	100-173	20-33
2,600+	41+	34+	209+	174+	34+

Table 41. Lumen Range by EISA Requirements

Lumen Range	EISA Requirements (Maximum Watts)			
	2011	2012	2013	2014
310-749	40	40	40	29
750-1,049	60	60	60	43
1,050-1,489	75	75	53	53
1,490-2,600	100	72	72	72
2,600+	n/a	n/a	n/a	n/a

Table 42, Table 43, and Table 44 provide details on bulb saturation by lumen ranges and lumen saturation by bulb type. The first half of each table provides an overview of what type of bulbs are installed at each lumen range—for example, in Massachusetts, 65% of bulbs with <310 lumens of output are incandescent bulbs. The second half of each table provides the proportions of bulb types at various lumen levels—for example, in Massachusetts, 50% of incandescent bulbs are in the 750-1049 lumen range.

53 http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact%20Sheet_Lighting%20Technologies.pdf?a2d6-8832

In 2014, bulbs with a lumen range between 750 and 1049 were the most commonly found bulbs in all homes regardless of bulb type (Table 42). This corresponds with 60-Watt incandescent bulbs and 13- to 16-Watt CFLs. Among standard bulbs, the 750- to 1,049-lumen range is also the most common lumen range (49% of standard bulbs), while among specialty bulbs 310 to 749 was the most common lumen range (38% of specialty bulbs). This corresponds with 40-Watt incandescent bulbs and 5- to 12-Watt CFLs.

CFLs. The majority of CFLs (82%) fell within two lumen ranges. CFLs in the 750- to 1049-lumen range were the most common (63%), followed by the 310- to 749-lumen range (23%). A closer look at lumen range by bulb type shows that CFLs made up more than one-half (53%) of all bulbs in the 1050-1489 lumen range and nearly one-half (48%) of all bulbs in the 750-1049 lumen range.

Fluorescents. Fluorescent bulbs fell within higher lumen ranges compared to CFLs, halogens, and incandescent bulbs, making up 91% of the bulbs found in the 2,600+ lumen range. When looking at lumen ranges among fluorescent bulbs only, bulbs in the 2,600+ range were the most common (56%), followed by 1,490 to 2,600 (28%), and 1,050 to 1,489 (11%).

Halogens. Keeping in mind that halogen bulbs found on-site were assumed to be almost exclusively pre-EISA compliant, the halogens observed typically fell in the 310 to 749 range (40%), followed by the <310 range (20%), and the 1050 to 1489 range (17%). Additionally, halogen bulbs made up one-third (34%) of all bulbs found in the <310 lumen range.

Incandescents. Incandescent bulbs made up the majority of nearly all lumen ranges, with the exception of the 1050-1489 range, which was dominated by CFLs, and the 750-1049 range, which was split almost evenly between incandescents and CFLs. Looking at incandescent bulbs only, those in the 750- to 1,049-lumen range were the most common (45%), followed by the 310- to 749-lumen range (33%).

LEDs. More than one out of ten (11%) bulbs found in the <310 lumen range were LEDs. LEDs were also the most common bulb type where wattage was unknown, making up nearly one-half (48%) of this category. Examining LEDs alone, more than one-quarter (28%) of LEDs had an unknown wattage; many LED bulbs do not have the wattage written on them, making it difficult to obtain without the original packaging. For LEDs where the wattage was known, most fell within the 310 to 749 range (27%) followed by the 750 to 1049 range (23%).

Table 42. Saturation by Lumens, Massachusetts 2014

Lumen Range	All Types	CFLs	Fluorescent	Halogen	Incandescent	LEDs
Sample Size	*261*	*261*	*261*	*261*	*261*	*261*
All Bulbs	**13,083**	**4,560**	**1,147**	**927**	**6,028**	**421**
Bulb Saturation by Lumen Range (Rows sum to 100%)						
<310	4%	3%	<1%	34%	52%	11%
310-749	23%	15%	1%	11%	69%	4%
750-1049	44%	48%	<1%	2%	48%	2%
1050-1489	13%	53%	8%	8%	29%	2%
1490-2600	9%	22%	28%	3%	46%	1%
2,600+	6%	2%	91%	4%	4%	0%
Don't Know	2%	13%	6%	19%	14%	48%
Lumen Saturation by Bulb Type (Columns sum to 100%)						
<310	4%	<1%	<1%	20%	4%	12%
310-749	23%	9%	3%	40%	33%	27%
750-1049	44%	63%	1%	10%	45%	23%
1050-1489	13%	20%	11%	17%	8%	9%
1490-2600	9%	6%	28%	4%	9%	2%
2,600+	6%	<1%	56%	4%	<1%	0%
Don't Know	2%	1%	1%	6%	1%	28%

Base: All on-site respondents

Table 43. Saturation by Lumens, Georgia 2014

Lumen Range	All Types	CFLs	Fluorescent	Halogen	Incandescent	LEDs
Sample Size	*78*	*78*	*78*	*78*	*78*	*78*
All Bulbs	**3,941**	**763**	**280**	**227**	**2,624**	**47**
Bulb Saturation by Lumen Range (Rows sum to 100%)						
<310	2%	0%	0%	38%	40%	22%
310-749	27%	4%	<1%	4%	90%	2%
750-1049	49%	23%	<1%	4%	72%	<1%
1050-1489	7%	52%	2%	12%	33%	<1%
1490-2600	7%	17%	51%	4%	28%	0%
2,600+	2%	11%	78%	3%	8%	0%
Don't Know	6%	32%	22%	10%	37%	0%
Lumen Saturation by Bulb Type (Columns sum to 100%)						
<310	2%	0%	0%	14%	1%	42%
310-749	27%	5%	2%	20%	36%	54%
750-1049	49%	59%	2%	34%	53%	2%
1050-1489	7%	18%	2%	14%	3%	2%
1490-2600	7%	6%	51%	5%	3%	0%
2,600+	2%	1%	23%	1%	<1%	0%
Don't Know	6%	10%	20%	11%	3%	0%

Base: All on-site respondents

Table 44. Saturation by Lumens, Kansas 2014

Lumen Range	All Types	CFLs	Fluorescent	Halogen	Incandescent	LEDs
Sample Size	*67*	*67*	*67*	*67*	*67*	*67*
All Bulbs	**3,743**	**1,056**	**269**	**209**	**2,106**	**103**
Bulb Saturation by Lumen Range (rows sum to 100%)						
<310	2%	0%	0%	21%	65%	15%
310-749	24%	12%	0%	14%	71%	3%
750-1049	48%	39%	<1%	3%	57%	2%
1050-1489	12%	65%	1%	2%	29%	4%
1490-2600	8%	24%	21%	2%	53%	2%
2,600+	5%	2%	94%	0%	4%	0%
Don't Know	1%	7%	14%	35%	45%	0%
Lumen Saturation by Bulb Type (Columns sum to 100%)						
<310	2%	0%	0%	9%	3%	15%
310-749	24%	9%	0%	58%	32%	27%
750-1049	48%	60%	1%	23%	50%	30%
1050-1489	12%	28%	1%	4%	6%	23%
1490-2600	8%	6%	26%	2%	8%	5%
2,600+	5%	<1%	71%	0%	<1%	0%
Don't Know	1%	<1%	2%	5%	1%	0%

Base: All on-site respondents

CFL Saturation by Bulb and Fixture Characteristics

Table 45 shows CFL saturation by room type over time. Note that these saturation figures can be used to update residential lighting hours of use (HOU) in conjunction with the findings of the Northeast Residential Lighting HOU study.[54] Across most room types, CFL saturation remained consistent or showed only slight variation in Massachusetts from 2009 to 2013, followed by an increase from 2013 to 2014. Offices and hallways had the highest CFL saturation (42%), followed by living spaces (39%) and bedrooms (38%). Both utility/laundry rooms and garages showed a decrease in CFL saturation after a jump in 2013. Kitchen CFL saturation shows only a slight variation from 2009 to 2014. Comparing room-by-room saturation levels in Massachusetts to those in Georgia and Kansas, we found that saturation in Georgia and Kansas appears to be more concentrated in relatively few rooms rather than spread throughout households, as in Massachusetts.

[54] NMR, Northeast Residential Lighting Hours-of-Use Study, 2014.

Table 45. CFL Socket Saturation by Room Type

Room Type	Massachusetts					Georgia 2014	Kansas 2014	Average Total Sockets				
								Massachusetts			Georgia 2014	Kansas 2014
	2009	2010	2012	2013	2014			2012*	2013*	2014*		
Sample Size	*100*	*150*	*151*	*150*	*261*	*78*	*67*	*151*	*150*	*261*	*78*	*67*
Hall	28%	28%	31%	30%	42%	18%	33%	2.7	2.7	3.0	2.1	2.6
Office	23%	24%	31%	34%	42%	19%	27%	1.1	0.9	1.2	1.5	1.5
Living Room	33%	35%	32%	34%	39%	27%	36%	5.3	5.5	6.4	7.3	8.9
Bedroom	26%	28%	31%	30%	38%	26%	32%	8.1	8.2	8.0	9.2	9.8
Bathroom	18%	27%	23%	24%	33%	15%	33%	5.4	6.0	6.7	8.3	8.9
Basement	34%	26%	23%	26%	32%	21%	15%	3.8	2.8	3.5	0.7	1.3
Kitchen	30%	28%	35%	33%	32%	19%	20%	5.4	6.2	6.3	6.3	5.5
Foyer	16%	21%	21%	15%	29%	2%	20%	1.1	0.6	1.2	1.7	1.5
Exterior	19%	27%	18%	22%	25%	18%	28%	2.6	2.4	3.7	3.5	3.5
Dining Room	20%	10%	17%	20%	22%	9%	13%	3.3	3.3	3.4	3.0	3.1
Utility/Laundry	0%	19%	10%	33%	19%	27%	31%	0.7	0.4	0.7	1.0	1.1
Garage	38%	12%	13%	21%	17%	9%	16%	0.6	1.0	1.6	0.9	2.6
Den***	-	-	-	23%	-	-	-	-	0.3	-	-	-
Family Room**	15%	25%	27%	-	-	-	-	1.6	-	-	-	-
Other	0%	14%	21%	25%	32%	21%	41%	1.8	1.9	1.3	1.1	1.8

Base: All on-site respondents

* Average number of sockets across all rooms of this type in all homes in the study. Note that some homes do not have all room types, hence averages that fall below one.

** In 2013 and 2014, "Family Room" was grouped with "Living Room" into one category.

***In 2013 "Den" was an additional room category not listed in other years.

In each of the Massachusetts samples from 2009 to 2014, CFLs were most commonly found in portable fixtures such as floor lamps and table lamps. CFL use in most other fixture types showed gains since 2013, with the exception of track lighting, other fixtures types, and night lights. Notably, CFL saturation in pendant fixtures increased from 14% to 19% after several years of decline (Table 46).

Table 46. CFL Socket Saturation by Fixture Type

Room Type	Massachusetts					Georgia 2014	Kansas 2014	Average Total Sockets				
								Massachusetts			Georgia 2014	Kansas 2014
	2009	2010	2012	2013	2014			2012*	2013*	2014*		
Sample Size	*100*	*150*	*151*	*150*	*261*	*78*	*67*	*151*	*150*	*261*	*78*	*67*
Floor Lamp	38%	35%	44%	48%	48%	36%	41%	2.1	2.5	2.7	1.6	1.8
Table Lamp	35%	41%	37%	37%	41%	26%	34%	5.1	5.6	5.7	4.8	3.3
Ceiling Fan	28%	30%	33%	26%	38%	29%	31%	2.5	3.8	3.5	8.7	5.7
Flush Mount	29%	24%	32%	31%	37%	15%	32%	11.7	10.1	13.1	12.3	11.6
Recessed	17%	23%	23%	30%	36%	24%	29%	7.2	5.0	5.8	2.7	7.8
Wall Mount	21%	27%	20%	22%	27%	15%	34%	7.1	6.8	9.6	8.8	7.9
Track	8%	9%	8%	28%	22%	13%	8%	1.1	0.8	0.9	0.3	0.8
Pendant	16%	18%	15%	14%	19%	11%	18%	5.4	4.0	4.2	7.0	6.0
Night Light	0%	<1%	0%	0%	5%	0%	0%	0	0.1	0.3	0.2	0.3
Under Cabinet	0%	3%	3%	6%	3%	0%	21%	0.5	1.2	1.2	0.4	0.6
Other**	0%	10%	22%	23%	19%	8%	19%	0.3	2.3	1.9	1.0	1.0

Base: All on-site respondents

* Average number of sockets across all fixtures of a given type in all homes in the study. Note that some homes do not have all fixture types, hence averages that fall below one.

**Other includes: Clip Light, Garage Door Light, In Cabinet/Display, Porch, Post Mount, String/Rope Lights, Walkway, and Other fixture types.

While the table above displayed CFL saturation for all fixtures of a given type, Table 47 presents data only on fixtures with CFLs installed in them and shows the frequency of CFL installations within those fixtures. Three out of ten (31%) CFLs in 2014 were installed in ceiling flush mount fixtures, with wall mount and table lamp fixtures following at 16% and 15%, respectively. Track and under-cabinet lighting represents the lowest percentage of total CFL fixture types installed. The pattern of installation in 2014 is very similar to that of 2012 and 2013.

Table 47. CFL Fixture Type Saturation by CFL Total Fixtures

Fixture Type	Massachusetts			Georgia	Kansas
	2012	2013	2014	2014	2014
Sample Size	*151*	*150*	*261*	*78*	*67*
Number of CFLs	**1,754**	**1,766**	**4,559**	**763**	**1,056**
Ceiling Flush Mount	32%	26%	31%	21%	27%
Wall Mount	12%	13%	16%	14%	20%
Table Lamp	18%	18%	15%	14%	8%
Recessed	14%	13%	13%	7%	16%
Ceiling Fan	7%	8%	8%	28%	13%
Floor Lamp	8%	11%	8%	6%	6%
Pendant	7%	5%	5%	8%	8%
Track	1%	2%	1%	<1%	1%
Under Cabinet	0%	1%	<1%	0%	1%
Other	1%	5%	2%	1%	1%

Base: All on-site respondents

After remaining relatively stable from 2009 to 2012, screw base socket saturation rose in 2013 to 32% and continued to rise in 2014 to 36% (Table 48). In 2014, the percentage of CFLs filling pin base sockets fell from 6% in 2013 to 3% in 2014; this is likely due to the traditional pin base fluorescent lighting that we commonly find in homes (Table 48).

Table 48. CFL Socket Saturation by Socket Base Type

Socket	Massachusetts					Georgia	Kansas
	2009	2010	2012	2013	2014	2014	2014
Sample Size	*100*	*150*	*151*	*150*	*261*	*78*	*67*
Screw base*	28%	28%	29%	32%	36%	21%	34%
Pin base	11%	7%	15%	6%	3%	1%	4%
GU Base	0%	100%	100%	93%	61%	7%	33%
Other/Unknown	0%	<1%	100%	0%	0%	0%	0%

Base: All on-site respondents

* Screw base includes small, intermediate, and medium screw base bulbs; large screw base bulbs are included in "other" base type.

Looking only at sockets with CFLs, 94% of CFLs were installed in screw-base socket types, similar to the 96% in 2013. The remaining CFLs were either GU base (5%) or pin base (1%) (Table 49).

Table 49. CFL Socket Base Saturation by Total CFL Socket Base

Socket Base Type	Massachusetts			Georgia	Kansas
	2009	2010	2012	2014	2014
Sample Size	*151*	*150*	*261*	*78*	*67*
Number of CFL Sockets	**1,754**	**1,766**	**4,559**	**763**	**1,056**
Screw base*	91%	96%	94%	99%	99%
Pin base	8%	3%	1%	<1%	1%
GU Base	<1%	1%	5%	<1%	<1%
Other/Unknown	<1%	0%	0%	0%	0%

Base: All on-site respondents

* Screw base includes small, intermediate, and medium screw base bulbs; large screw base bulbs are included in "other" base type.

Table 50 provides a detailed look at installed LEDs by base type. While more than three-quarters (76%) of all installed LEDs were screw base (medium or small screw-base), nearly one out of five (17%) LEDs were integrated LED fixtures.

Table 50. LEDs by Base Type

Base Type	MA 2014	GA 2014	KS 2014
Sample Size	*261*	*78*	*67*
Total # of bulbs	**421**	**69**	**145**
Screw Base	76%	61%	66%
Integrated LED Fixture	17%	31%	31%
GU Base	2%	0%	0%
Pin Base	1%	8%	1%
String/Rope Lights	<1%	0%	0%
Strip	<1%	0%	0%
Other/Don't know	5%	0%	3%

Table 51 shows CFL socket saturation by bulb shape and selected specialty features.[55] Looking first at shape, one-quarter of flood or spot lamps were CFLs, more than one-fifth (21%) of globe lamps were CFLs, and nearly one-fifth (17%) of tube-shaped bulbs were CFLs, all of which are increases from 2013. Only 6% of A-line bulbs—the most common bulb shape found in homes—were CFLs, largely reflecting the fact that the spiral CFL is meant to replace an A-line incandescent bulb. Looking at specialty controls, two out of every five (40%) three-way bulbs were CFLs, and 14% of all dimmable bulbs were CFLs in 2014.[56]

[55] We have not shown all bulb types here, as some are found in fewer than 5% of homes, and small variations in use by just one or two households can greatly alter the reported percentages.

[56] In addition to small sample sizes for some bulb types, the Team also believes that mislabeling of lighting technologies in a given year or by particular technicians may account for some of the larger variations in socket saturation over time. While our training efforts and quality control procedures limit the frequency of such misidentification, even minor errors will have a large impact on annual estimates for the less common bulb features, fixture types, and control type due to small sample sizes.

Table 51. CFL Socket Saturation by Bulb Features

Bulb Feature	Massachusetts					Georgia	Kansas
	2009	2010	2012	2013	2014	2014	2014
Sample Size	*100*	*150*	*151*	*150*	*261*	*78*	*67*
Flood/Spot	10%	17%	13%	22%	25%	16%	7%
Globe**	11%	40%	8%	14%	21%	2%	9%
Tube	14%	14%	21%	9%	17%	1%	1%
Circline**	44%	2%	5%	0%	7%	0%	0%
A-line*	3%	2%	3%	4%	6%	3%	1%
Candelabra	1%	1%	8%	4%	5%	<1%	2%
Dimmable***	9%	19%	6%	11%	14%	6%	17%
Three-way***	17%	27%	23%	19%	40%	23%	35%

Base: All on-site respondents

* A-line bulbs are the typical shape for standard incandescent bulbs. A-line CFLs are made to look and feel like traditional incandescent bulbs.

** Differences in the pictures provided to identify CFLs may have influenced whether technicians classified these products as CFLs or other types of lighting. Moreover, sample sizes for circline bulbs are small.

*** Dimmable and three-way bulbs also fall within shape categories and therefore are not additive.

The spiral-shaped CFL bulb—the standard bulb—represents the largest number of CFLs installed (71%), a decrease from the 75% of CFLs installed in 2013. Flood/spot, tube, and A-line CFLs have notable levels of saturation at 11%, 6%, and 5%, respectively (Table 52).

Table 52. CFL Feature Saturation by Total CFL Feature Sockets

Bulb Feature	Massachusetts			Georgia	Kansas
	2012	2013	2014	2014	2014
Sample Size	*151*	*150*	*261*	*78*	*67*
Number of CFL Sockets	**1,754**	**1,766**	**4,559**	**763**	**1,056**
Spiral	71%	75%	71%	85%	94%
Flood/Spot	9%	11%	11%	6%	2%
Tube	10%	4%	6%	<1%	<1%
A-line	3%	5%	5%	7%	1%
Globe	2%	3%	4%	1%	1%
Bullet/Torpedo	0%	1%	2%	0%	1%
Candelabra	4%	1%	1%	<1%	1%
Bug Light	0%	<1%	<1%	<1%	0%
Circline	0%	0%	<1%	0%	0%
Other	0%	<1%	<1%	0%	0%
Dimmable	2%	4%	4%	1%	3%
Three-way	2%	1%	4%	4%	2%

Base: All on-site respondents

Table 53 looks at bulb shape by specialty CFLs only. In Massachusetts and Georgia, nearly one-third (32%) of all specialty CFLs are flood/spot-shaped bulbs. In Kansas, the majority of specialty CFLs are spiral-shaped.

Table 53. Specialty CFL Socket Saturation by Bulb Shape

Bulb Shape	MA 2014	GA 2012	KS 2014
Sample Size	*261*	*78*	*67*
Total # of Bulbs	**1,613**	**155**	**110**
Flood/Spot	32%	31%	22%
Tube	18%	2%	3%
A-Line*	15%	34%	7%
Spiral*	15%	25%	43%
Globe	11%	6%	12%
Bullet/Torpedo	5%	0%	8%
Candle	4%	1%	5%
Bug Light	<1%	1%	0%
Circline	<1%	0%	0%
Other	<1%	0%	0%

*Spiral and A-line CFLs are included only if they have dimmable or three-way bulb features.

CFL Saturation by Home Size and Types

Previous studies performed by the Team suggest that socket saturation varies by home size, with smaller homes often having higher saturation rates—although fewer sockets overall—than larger homes. This analysis also helps to determine if the sizes of homes in the study were skewed toward larger homes, thereby artificially lowering socket saturation. To examine this possibility, we examined the current data by number of rooms and compared them to the ACS 5-Year Estimates.

Table 54 compares the number of bulbs installed and CFL saturation for on-site homes visited in 2012, 2013, and 2014. For each year, the "MA Census" column shows the distribution of homes by the number of rooms in the home, while the "Massachusetts On-site Visits" column shows the same for the on-site participants. The third column shows the average number of sockets found in homes of that size, while the final column shows the average, unweighted saturation. These data show that, in each year, the on-site samples were slightly biased toward larger homes, but the 2013 and 2014 samples were more similar to the distribution of home sizes found in the state than was the 2012 sample. This is largely due to the strategy of recruiting and sampling 50% multifamily and 50% single-family homes. In the 2012 effort, NMR noted the possibility that saturation could have been slightly higher than 27% due to the inclusion of more large homes in that sample. In contrast, the distributions of homes in the 2013 and 2014 samples are more similar to the state and less biased toward larger homes. In 2014, the Census estimates that 49% of homes contain five or fewer rooms, and the on-site sample also indicates 49%.

Table 55 compares the number of bulbs installed and CFL saturation for on-site homes visited in Georgia and Kansas in 2014 by number of total rooms in the home as compared to the Census values. As the table shows, the Georgia on-site visits are somewhat biased toward larger homes—32% of the on-site visits were conducted in homes with five or fewer rooms compared to 44% from the Census. The Kansas data is similarly biased, with 36% of homes visited having five or fewer rooms compared to 44% from the Census. It is important to note that the Georgia and Kansas samples had no quotas set for multifamily or single-family homes as the Massachusetts sample did.

Table 54. Analysis of Saturation by Home Size, 2012 to 2014

	2012				2013				2014			
Total Rooms	MA Census	MA On-site Visits	Average # of Bulbs Installed	CFL Saturation	MA Census	MA On-site Visits	Average # of Bulbs Installed	CFL Saturation	MA 2012 ACS 5-Year Est.	MA On-site Visits	Average # of Bulbs Installed	CFL Saturation
Sample size	*2,520,419*[*]	*151*	*151*	*151*	*2,799,357*[*]	*150*	*150*	*150*	*2,804,206*	*261*	*261*	*261*
1	2%	2% (3)	21	20%	2%	1% (1)	12	33%	2%	1% (2)	10	24%
2	3%	1% (2)	10	45%	3%	1% (2)	14	57%	3%	3% (9)	14	56%
3	10%	6% (9)	30	32%	10%	11% (17)	17	38%	10%	7% (18)	21	47%
4	15%	9% (14)	29	43%	16%	15% (23)	28	23%	16%	21%(54)[§]	29	32%
5	18%	10% (15)	35	27%	19%	15% (23)	32	32%	18%	17%(45)[§]	39	39%
6	18%	22% (33)	40	33%	18%	16% (24)	46	26%	18%	18% (46)	50	35%
7	13%	10% (15)	58	26%	12%	17% (25)[§]	55	27%	12%	14% (36)	68	31%
8	10%	17% (24)	58	25%	9%	8% (12)[§]	58	38%	9%	6% (16)[§]	69	35%
9	12%[**]	8% (12)	70	26%	11%	6% (9)	76	18%	12%	5% (14)	95	32%
10 or more		13% (19)	84	18%		9% (13)	69	30%		8% (20)	105	29%
Don't know/ Refused	-	2% (3)	118	24%	-	1% (1)	31	7%	-	<1% (1)	21	68%

Base: All on-site respondents; data are unweighted

[*] Total occupied housing units

[**] MA Census only reports homes with 9 rooms or more

[§] Significantly different from 2012 at the 90% confidence level

Table 55. Analysis of Saturation by Home Size: Georgia and Kansas

	Georgia				Kansas			
Total Rooms	GA Census	GA On-site Visits	Average # of Bulbs Installed	CFL Saturation	KS 2012 ACS 5-Year Est.	KS On-site Visits	Average # of Bulbs Installed	CFL Saturation
Sample size	*3,508,477*	*78*	*78*	*78*	*1,109,391*	*67*	*67*	*67*
1	1%	0%	-	-	2%	0%	-	-
2	1%	0%	-	-	2%	2% (1)	23	78%
3	6%	3% (2)	18	8%	7%	10% (7)	29	21%
4	15%	8% (6)	23	11%	14%	9% (6)	23	37%
5	21%	21% (16)	24	19%	19%	15% (10)	33	17%
6	20%	18% (14)	41	25%	18%	16% (11)	42	36%
7	13%	21% (16)	53	19%	13%	15% (10)	63	31%
8	10%	19% (15)	72	20%	11%	18% (12)	64	23%
9	13%	4% (3)	52	19%	15%	5% (3)	97	34%
10 or more		8% (6)	101	12%		10% (7)	137	23%
Don't know/Refused	-	0%	-	-	-	0%	-	-

Base: All on-site respondents; data are unweighted

* Total occupied housing units

** MA Census only reports homes with 9 rooms or more

§ Significantly different from 2012 at the 90% confidence level

As we did in 2013, the Team continues to monitor the effects of study design changes requiring a larger proportion of multifamily households than samples prior to 2013. To explore possible effects created by oversampling multifamily homes, we examined saturation data, both weighted and unweighted, by home type, and the total number of sockets, again both weighted and unweighted. These analyses also provide additional insight into the patterns governing socket saturation.

Table 56 shows the total number of sockets, average number of sockets, saturation of energy-efficient bulbs, and potential for CFLs or LEDs by home type, both weighted and unweighted, for 2012, 2013, and 2014. Single-family and multifamily households, both weighted and unweighted, show an increase in energy-efficient bulb saturation between 2013 and 2014. Among 2014 households, while multifamily saturation estimates are relatively higher compared to single-family estimates (48% vs. 45%), the differences are minor.

Finally, examining the influence of multifamily homes on the overall saturation levels, multifamily homes accounted for approximately 16% of total weighted sockets in 2012, nearly 37% of total sockets in 2013, and 22% of sockets in 2014.[57] Given the relatively higher saturation levels among multifamily households, they have the general effect of increasing saturation estimates, albeit slightly.

[57] According to the Census, multifamily housing accounts for 41% of the housing stock in Massachusetts. See **Error! Reference source not found.**.

Table 56. Analysis of Saturation by Home Type

	Weighted			Unweighted		
Single-Family Only	**2012**	**2013**	**2014**	**2012**	**2013**	**2014**
Sample Size	*118*	*69*	*161*	*118*	*69*	*164*
Total Sockets	5,525	3,995	9,836	6,913	4,131	10,572
Average # of Sockets	47	58	61	59	60	64
EE Bulb Saturation	35%	37%	45%	35%	40%	45%
Potential for CFLs or LEDs	65%	62%	51%	65%	59%	52%
Don't Know/Empty sockets	-	1%	3%	-	1%	3%
Multifamily Only	**2012**	**2013**	**2014**	**2012**	**2013**	**2014**
Sample Size	*32*	*81*	*100*	*32*	*81*	*97*
Total Sockets	1,040	2,346	2,954	751	2,451	2,978
Average # of Sockets	33	29	30	24	30	31
EE Bulb Saturation	41%	41%	44%	45%	41%	47%
Potential for CFLs or LEDs	59%	57%	51%	55%	56%	48%
Don't Know/Empty sockets	-	2%	5%	-	3%	4%
All Homes	**2012**	**2013**	**2014**	**2012**	**2013**	**2014**
Sample Size	*150*	*150*	*261*	*150*	*150*	*261*
Total Sockets	6,565	6,341	12,790	7,664	6,582	13,550
Average # of Sockets	44	42	49	51	44	52
EE Bulb Saturation	36%	39%	45%	36%	40%	45%
Potential for CFLs or LEDs	64%	60%	51%	64%	58%	51%
Don't Know/Empty sockets	-	2%	4%	-	2%	3%

Base: All on-site respondents

* EE Bulb Saturation is the percentage of all bulbs that are considered energy-efficient. This includes CFLs, LEDs, and Fluorescent bulbs.

** Potential for all CFLs and LEDs is the percentage of all bulbs that are halogen or incandescent bulbs.

Table 57 summarizes the distribution of households by total number of sockets from the Massachusetts on-sites. Relatively few significant differences exist between the on-site samples from 2012 to 2014. However, the mean number of sockets in 2014 was relatively higher compared to both 2012 and 2013. Table 58 presents a comparable analysis for Georgia and Kansas. Compared to the 2014 Massachusetts on-site visits (49), Georgia households have similar numbers of sockets, on average (48), and Kansas households have relatively more sockets (55).

Table 57. Analysis of Total Sockets, 2012 to 2014

Total Sockets	Weighted			Unweighted		
	2012	2013	2014	2012	2013	2014
Sample size	*150*	*150*	*261*	*150*	*150*	*261*
24 or less	33% (49)	31% (47)	28% (73)	19% (28)	29% (44)§	26% (68)§
25 to 49	43% (64)	36% (54)	31% (82)§	41% (62)	33% (50)	31% (80)§
50 to 74	10% (15)	22% (33)§	22% (59)§	23% (35)	25% (37)	20% (53)
75 to 99	7% (10)	7% (10)	10% (26)	9% (14)	11% (16)	12% (30)
100 to 124	4% (6)	1% (1)§	6% (16)‡	2% (3)	2% (3)	8% (22)§‡
125 or more	4% (6)	3% (5)	2% (6)	5% (8)	-§	3% (8)‡
Mean	**44**	**42**	**49**	**51**	**44**	**52**
Median	**32**	**38**	**43**	**44**	**39**	**44**
Standard Deviation	**38**	**30**	**31**	**34**	**25**	**34**

Base: All on-site respondents

§ Significantly different from 2012 at the 90% confidence level

‡ Significantly different from 2013 at the 90% confidence level

Table 58. Analysis of Total Sockets: Georgia and Kansas, 2014

Total Sockets	Georgia 2014		Kansas 2014	
	Weighted	Unweighted	Weighted	Unweighted
Sample size	*78*	*78*	*67*	*67*
24 or less	26% (20)	21% (16)	26% (17)	24% (16)
25 to 49	38% (30)	37% (29)	36% (24)	31% (21)
50 to 74	21% (16)	23% (18)	12% (8)	16% (11)
75 to 99	8% (6)	10% (8)	12% (8)	13% (9)
100 to 124	4% (3)	5% (4)	8% (5)	6% (4)
125 or more	3% (2)	4% (3)	7% (5)	9% (6)
Mean	**48**	**52**	**55**	**59**
Median	**32**	**43**	**39**	**44**
Standard Deviation	**34**	**35**	**43**	**45**

Base: All on-site respondents

Remaining Saturation Potential for Energy-Efficient Bulbs

If each incandescent and halogen bulb were converted to an energy-efficient bulb, approximately 51% of sockets in the 2014 sample could still be filled with a CFL or LED (Table 59). While standard bulbs represented the majority of potential sockets in the home in 2013 (57%), %), specialty sockets (based on non-A-line bulb shape as well as fixture controls) account for the majority (65%) of all potential sockets in the home in 2014.

Table 59. Percentage of Sockets Filled with Standard or Specialty Bulbs, 2013 and 2014

Bulb Type	Massachusetts						Georgia 2014			Kansas 2014		
	2013			2014								
	All Bulbs	Standard Bulbs	Specialty Bulbs	All Bulbs	Standard Bulbs	Specialty Bulbs	All Bulbs	Standard Bulbs	Specialty Bulbs	All Bulbs	Standard Bulbs	Specialty Bulbs
Sample size	*150*	*150*	*150*	*261*	*261*	*261*	*78*	*78*	*78*	*67*	*67*	*67*
All Bulb Types	**6,342**	**4,236**	**2,106**	**13,550**	**7,787**	**5,763**	**4,052**	**2,476**	**1,576**	**3,963**	**2,789**	**1,174**
Incandescent	3,501	50%	65%	6,028	42%	51%	2,624	57%	78%	2,106	45%	66%
CFLs	1,766	33%	18%	4,560	36%	27%	763	25%	10%	1,056	37%	11%
Fluorescent	568	12%	3%	1,147	14%	2%	284	11%	<1%	275	8%	<1%
Halogen	290	1%	12%	927	<1%	14%	227	2%	11%	206	2%	15%
LEDs	104	2%	1%	421	2%	6%	69	2%	<1%	145	2%	7%
Other	0	0%	0%	50	1%	<1%	0	0%	0%	2	<1%	0%
DK/Empty Sockets	113	3%	<1%	417	6%	<1%	85	3%	<1%	170	6%	1%
CFL or LED Pot.	**3,791**	**57%***	**43%****	**6,955**	**42%***	**65%****	**2,851**	**59%**	**89%**	**2,312**	**47%**	**81%**

Base: All on-site respondents

* Potential for all CFLs and LEDs is the percentage of all bulbs that are halogen or incandescent bulbs.

** Potential for specialty CFLs and LEDs is the percentage of all halogen and incandescent bulbs that are specialty; this includes halogens that are pin base, although to replace these bulbs with CFLs or LEDs, the entire fixture would have to be replaced to accommodate a screw base bulb.

Table 60 examines potential for subsets of households. Differences in saturation potential based on demographic characteristics are minor; however, given the relative number of total fixtures, the majority of potential exists among owners and non-low-income households.

Table 60. Overall Saturation Potential by Demographic Characteristics

	Massachusetts 2014				Georgia 2014				Kansas 2014			
Demographic Characteristic	n	Sat Pot	Avg Sockets/ Home	Avg Sat Pot Sockets	n	Sat Pot	Avg Sockets/ Home	Avg Sat Pot Sockets	n	Sat Pot	Avg Sockets/ Home	Avg Sat Pot Sockets
Ownership status												
Own or buying	174	53%	62	33	59	69%	59	41	45	60%	74	45
Rent or lease	87	44%	25	11	19	74%	30	23	22	48%	28	13
Type of home												
Single-family	164	51%	61	31	73	70%	54	38	57	60%	64	38
Multifamily	97	51%	30	15	5	79%	22	17	10	40%	33	13
Income status*												
Low income	82	44%	34	15	32	66%	42	29	20	55%	41	23
Non-low income	166	55%	59	32	46	73%	59	43	47	59%	67	40

Base: All 2014 on-site respondents

* Does not include 13 respondents with Don't know/Refused responses for income level.

Similarly, saturation potential by room type suggests that substantial saturation potential (greater than 40%, with the exception of basements [27%] and utility/laundry rooms [37%]) for CFLs and LEDs exists across all room types. However, as in 2013, the vast majority of saturation potential exists among the top four rooms with the greatest number of total sockets: bedrooms, bathrooms, living spaces, and kitchens (Table 61).

Table 61. Overall Saturation Potential by Room Type

Room Type	Total Sockets	Saturation Potential for CFLs or LEDs	Saturation Potential Sockets
Sample Size	*261*	*261*	*261*
Total Sockets	**123,771,899**	**63,530,963**	**63,530,963**
Bedroom	20,278,613	52%	10,449,568
Bathroom	16,974,915	58%	9,765,559
Living Space	16,134,621	51%	8,296,255
Kitchen	15,923,821	44%	6,952,824
Exterior	9,467,847	67%	6,355,861
Basement	8,959,813	27%	2,426,125
Dining Room	8,551,483	69%	5,897,950
Hall	7,675,365	52%	3,971,717
Closet	4,770,365	40%	1,905,909
Garage	3,978,823	43%	1,702,087
Other	3,358,359	59%	1,961,631
Foyer	3,054,931	61%	1,855,794
Office	2,931,431	47%	1,371,787
Utility or Laundry Room	1,711,511	37%	607,806
Average Sockets per Household	49.0	25.2	25.2

Base: All 2014 on-site respondents

While saturation potential varied greatly among specialty sockets in 2013, saturation potential for CFLs and LEDs among standard and specialty bulbs does not differ greatly in 2014 (Table 63).

Table 62. Saturation Potential for CFLs and LEDs by Standard or Specialty Bulbs

	Massachusetts						Georgia 2014			Kansas 2014		
	2013			2014								
	Sat Pot	Avg Sockets/ Home	Avg Sat Pot Sockets	Sat Pot	Avg Sockets/ Home	Avg Sat Pot Sockets	Sat Pot	Avg Sockets / Home	Avg Sat Pot Sockets	Sat Pot	Avg Sockets / Home	Avg Sat Pot Sockets
Sample Size	*150*	*150*	*150*	*261*	*261*	*261*	*78*	*78*	*78*	*67*	*67*	*67*
All bulbs	60%	42	25	51%	49	25	71%	48	34	57%	55	31
Standard Bulbs	51%	28	14	49%	29	12	51%	29	17	59%	39	18
Specialty Bulbs	77%	14	11	52%	20	13	49%	18	17	41%	16	13

Base: All 2014 on-site respondents

Socket Saturations and Remaining Potential by Selected Characteristics

The tables in this section provide detail on saturation for all bulb types and estimate the remaining potential for CFLs and LEDs.[58]

As illustrated in Table 63, households had an average of 49.0 sockets across the entire sample, which were most often filled with incandescent bulbs (22.2 on average) and CFLs (15.9 on average). Just as in 2013, in the 2014 sample, bedrooms had the largest number of bulbs of all types installed. CFLs and incandescent bulbs accounted for 86% of installed bulbs in bedrooms and 87% of all bulbs in bathrooms. Halogens were mostly installed in exterior spaces and kitchens; fluorescent bulbs represented a large percentage of bulbs installed in utility/laundry rooms, garages, closets, and basements. LEDs are gaining adoption in kitchens (6% of bulbs) as well as in bedrooms and bathrooms (4% of bulbs in each). The remaining potential for CFLs or LEDs was highest in dining rooms (69%) and exterior spaces (67%).[59]

[58] The stated potential serves as a best case scenario. Actual saturation potential will be lower due to limitations in fixture shape, lighting application, and the preferences of the homeowner.

[59] Remaining saturation potential is calculated as the number of incandescent and halogen bulbs that can be replaced with CFLs or LEDs.

Table 63. Socket Saturation – Room Types by Percent of Sockets, Massachusetts 2014

Room Type	All Sockets	CFL	Fluorescent	Halogen	Incandescent	LED	Potential for CFLs or LEDs
Sample Size	*261*	*261*	*261*	*261*	*261*	*261*	*261*
Total Sockets	**123,771,899**	**40,201,791**	**11,018,041**	**7,566,913**	**55,964,052**	**4,000,519**	**63,530,965**
Bedroom	16%	38%	1%	3%	48%	4%	52%
Bathroom	14%	33%	3%	4%	54%	4%	57%
Kitchen	13%	32%	12%	13%	31%	6%	44%
Living Space	13%	39%	4%	6%	46%	3%	51%
Exterior	8%	25%	1%	23%	44%	2%	67%
Basement	7%	32%	34%	4%	23%	2%	27%
Dining Room	7%	22%	2%	1%	68%	3%	69%
Hallway	6%	42%	1%	3%	49%	1%	52%
Closet	4%	22%	36%	1%	39%	<1%	40%
Garage	3%	17%	37%	1%	42%	2%	43%
Foyer	2%	29%	2%	2%	59%	3%	61%
Office	2%	42%	5%	8%	39%	3%	47%
Utility	1%	19%	43%	5%	31%	2%	36%
Other	3%	32%	6%	2%	56%	1%	58%
Sockets per Household	**49.0**	**15.9**	**4.4**	**3.0**	**22.2**	**1.6**	**25.2**

Base: All 2014 on-site respondents, weighted to the population of households in the state

Flush mount, wall mount, recessed, and table lamp fixtures were the most prevalent fixture type found in the 2014 sample of on-site homes (27%, 20%, 12%, and 12%, respectively). Overall, portable fixtures (table and floor lamps, and nightlights) accounted for nearly one-fifth of all sockets (18%), with permanent fixtures making up the remaining 82%. Night lights, pendants, and other fixture types tended to be primarily filled with incandescent bulbs. More than one-quarter of under-cabinet-type fixtures (26%) were filled with fluorescents, while halogen bulbs filled one-half of all track lighting sockets and more than one-third (35%) of all under-cabinet sockets. More than one-fifth of all night lights (22%) were LEDs. The saturation potential to replace incandescent and halogen bulbs with CFLs or LEDs was greatest in track lighting (74%), night lights (72%), other fixture types (69%), and pendants (67%) (Table 64).

Notably, CFLs filled one out of every two (48%) floor lamp sockets, while incandescent bulbs filled two out of every five (39%) floor lamp sockets. Additionally, CFLs and incandescent bulbs filled almost the same percentage of flush mount sockets (37% and 38%, respectively) in 2014.

Table 64. Socket Saturation – Fixture Types by Number of Sockets, Massachusetts 2014

Fixture Type	All Sockets	CFL	Fluorescent	Halogen	Incandescent	LED	Potential for CFLs or LEDs
Sample Size	*261*	*261*	*261*	*261*	*261*	*261*	*261*
Total Sockets	**123,771,899**	**40,201,791**	**11,018,041**	**7,566,913**	**55,964,052**	**4,000,519**	**63,530,965**
Flush Mount	27%	37%	16%	2%	38%	2%	40%
Wall Mount	20%	27%	11%	10%	46%	3%	56%
Recessed	12%	35%	4%	7%	46%	6%	52%
Table Lamp	12%	41%	1%	2%	50%	3%	52%
Pendant	9%	19%	10%	2%	65%	2%	67%
Ceiling Fan	7%	38%	<1%	2%	49%	6%	51%
Floor Lamp	5%	48%	2%	3%	39%	2%	43%
Under Cabinet	3%	3%	26%	35%	13%	2%	48%
Track	2%	21%	0%	50%	24%	1%	74%
Night Light	1%	5%	0%	0%	72%	22%	72%
Other	4%	19%	3%	11%	58%	6%	69%
Sockets per Household	**49.0**	**15.9**	**4.4**	**3.0**	**22.2**	**1.6**	**25.2**

Base: All 2014 on-site respondents, weighted to the population of households in the state

As illustrated in Table 65, the socket saturation of screw base-type sockets in 2014 was 84%, which is the same as it was in 2013. Sixty-one percent of GU base sockets were CFLs, down from 93% in 2013. Nearly all incandescent bulbs were screw base types. Nearly three-quarters of the pin base-type sockets were fluorescent bulbs (71%), while halogen bulbs represented another 20%. Since the majority of socket types were screw base, the greatest saturation potential for CFLs and LEDs was with these types of sockets, at 68%.

Table 65. Socket Saturation – Socket Types by Percent of Sockets, Massachusetts 2014

Socket Type	All Sockets	CFL	Fluorescent	Halogen	Incandescent	LED	Potential for CFLs or LEDs
Sample Size	*261*	*261*	*261*	*261*	*261*	*261*	*261*
Total Sockets	**123,771,899**	**40,201,791**	**11,018,041**	**7,566,913**	**55,964,052**	**4,000,519**	**63,530,965**
Screw base*	84%	36%	<1%	4%	53%	3%	57%
Pin base	12%	3%	71%	20%	3%	<1%	24%
GU base	3%	61%	10%	23%	0%	2%	23%
Other / Unknown	1%	<1%	2%	28%	11%	66%	40%
Sockets per Household	**49.0**	**15.9**	**4.4**	**3.0**	**22.2**	**1.6**	**25.2**

Base: All 2014 on-site respondents, weighted to the population of households in the state

* Screw base includes small, intermediate, and medium screw base bulbs; large screw base bulbs are included in "other" base type.

The most prevalent bulb shape for all sockets observed in the 2014 on-site survey was the A-line bulb (29%), followed by twist/spiral-shaped bulbs (23%) and flood/spot-shaped bulbs (14%). The majority of A-line and candelabra bulbs were incandescent (90% and 91%, respectively), with the remainder split between CFLs (6% and 5%, respectively) and LEDs (4% and 3%, respectively); not surprisingly, these bulb types also hold the most potential for CFLs or LEDs. High saturation potential remains in globe-shaped bulbs (75%) as well as bullet/torpedo (75%) and spot/flood bulbs (66%). Bulbs installed on dimmable circuits tended to be primarily incandescent (66%), but CFLs also accounted for 14% of dimmable circuits (up from 11% in 2013 and 6% in 2012) and LEDs accounted for 7% (up from 4% in 2013). More than one-half of all three-way bulbs were incandescent (54%), though 40% were CFLs, more than double the 19% of three-way bulbs that were CFLs in 2013 (Table 66).

Table 66. Socket Saturation – Bulb Features by Percent of Sockets, Massachusetts 2014

Bulb Shape	All Sockets	CFL	Fluorescent	Halogen	Incandescent	LED	Potential for CFLs or LEDs
Sample Size	*261*	*261*	*261*	*261*	*261*	*261*	*261*
Total Sockets	**123,771,899**	**40,201,791**	**11,018,041**	**7,566,913**	**55,964,052**	**4,000,519**	**63,530,965**
A-Line	29%	6%	0%	1%	90%	4%	91%
Twist/Spiral	23%	100%	0%	0%	0%	0%	0%
Spot/Reflector/Flood	14%	25%	0%	24%	41%	8%	66%
Tube	11%	17%	73%	8%	2%	<1%	9%
Candelabra	8%	5%	0%	3%	89%	3%	92%
Globe	6%	20%	0%	<1%	77%	2%	77%
Bullet/Torpedo	3%	19%	0%	42%	34%	<1%	75%
Circline	1%	7%	92%	0%	0%	0%	0%
Bug Light	<1%	25%	0%	0%	75%	0%	75%
Other	1%	1%	1%	1%	18%	45%	18%
Three-way**	3%	40%	0%	1%	54%	1%	55%
Dimmable**	10%	14%	0%	11%	66%	7%	77%
Sockets per Household	**49.0**	**15.9**	**4.4**	**3.0**	**22.2**	**1.6**	**25.2**

Base: All 2014 on-site respondents, weighted to the population of households in the state

*A-line bulbs are the typical shape for standard incandescent bulbs. A-line CFLs are made to look and feel like traditional incandescent bulbs.

**Dimmable and three-way bulbs also fall within shape categories and therefore are not additive; for non-CFL bulbs types, dimmability was determined by the control type, not the bulb type.

In Massachusetts, the number of sockets per fixture stood at about 1.5 overall as well as for incandescents and CFLs; fluorescents and halogens had slightly higher averages, at 1.7 and 1.8 sockets per fixture, respectively (Table 67). Track lighting, ceiling fans, and pendant fixtures (including chandeliers) tended to have the largest number of sockets per fixture overall and for CFLs, incandescents, and LEDs.

Table 67. Average Number of Sockets by Predominant Bulb Type by Fixture Type, Massachusetts 2014

Fixture Type	All Fixtures	CFL Fixtures	Fluorescent Fixtures	Halogen Fixtures	Incandescent Only Fixtures	LED Fixtures	Unknown/ Other Bulb Type	Empty Fixtures
Sample Size	*261*	*261*	*261*	*261*	*261*	*261*	*261*	*261*
Total Fixtures	**81,509,302**	**29,156,563**	**6,745,785**	**4,397,693**	**36,627,380**	**2,779,361**	**285,925**	**1,516,594**
Track (n=86)	3.21	3.39	-	3.30	3.12	2.00	1.00	-
Ceiling Fan (n=315)	2.77	3.09	2.00	1.38	2.62	3.77	1.00	1.86
Pendant (n=496)	2.57	2.19	2.06	1.87	2.93	1.87	-	1.00
Under Cabinet (n=190)	1.87	1.09	1.20	2.63	1.28	1.11	5.88	1.00
Wall Mount (n=1,579)	1.67	1.80	1.34	1.72	1.67	2.21	1.69	1.15
Floor (n=474)	1.58	1.66	1.15	1.34	1.58	1.20	-	1.00
Flush Mount (n=2,414)	1.50	1.45	1.84	1.73	1.45	1.39	1.48	1.23
Recessed (n=1,454)	1.13	1.11	2.56	1.18	1.08	1.10	1.00	1.23
Table (n=1,519)	1.06	1.06	1.16	1.03	1.06	1.05	-	1.05
Night Light (n=77)	1.00	1.00	-	-	1.00	1.00	1.00	-
Other (n=383)	1.39	1.27	1.86	1.76	1.42	1.15	1.00	1.00
All Fix Types (n=8,987)	1.52	1.48	1.65	1.76	1.51	1.44	3.01	1.15

Base: All 2014 on-site respondents, weighted to the population of households in the state

Appendix B: Purchases of Lighting Products

Number and Type of CFLs and LEDs Purchased

Table 68 summarizes the number of CFLs that 2012, 2013, and 2014 on-site households recalled purchasing in the year prior to the inventory.[60] In 2014, more than one-half (55%) of all households had purchased at least one CFL in the past year, which was significantly more than in 2013 (36%). Most of the CFLs purchased by 2014 on-site respondents were standard CFLs, though significantly more households had purchased specialty CFLs in 2014 than in 2013 (33% vs. 16%).

Table 68. CFLs Purchased in Previous Year by Household and Type

	Massachusetts On-site			Georgia	Kansas
	2012	2013	2014	On-site 2014	On-site 2014
Sample Size	*151*	*150*	*261*	*78*	*67*
All CFLs					
Zero	62%	64%	45%§‡	62%δ	54%
One to five	16%	17%	31%§‡	16%δ	26%
Six to fifteen	16%	14%	17%	15%	12%
Sixteen or more	4%	5%	7%	6%	8%
Standard CFLs					
Zero	65%	70%	55%§‡	66%δ	54%
One to five	22%	14%§	28%‡	14%δ	27%
Six to fifteen	10%	12%	14%§	19%	12%
Sixteen or more	2%	4%	3%	1%	7%
Specialty CFLs					
Zero	80%	84%	68%§‡	87%δ	59%
One to five	16%	10%	24%§‡	11%δ	8%δ
Six to fifteen	2%	5%	5%§	1%δ	6%
Sixteen or more	1%	1%	4%§‡	1%δ	0%δ

Base: All on-site respondents

§ Significantly different from 2012 at the 90% confidence level

‡ Significantly different from 2013 at the 90% confidence level

δ Significantly different from Massachusetts 2014 at the 90% confidence level

[60] While self-reported, on-site households recalled when they bought these CFLs while looking at the specific bulb with the on-site technician. Although still subject to self-reporting error, the Team has found this approach to provide more reliable estimates of the number of CFLs purchased during a period than asking about number of bulbs purchased during a consumer survey.

Manufacturers of CFLs and LEDs Obtained in the Past Year

Table 69 lists the number of standard CFLs, specialty CFLs, and LEDs purchased for each manufacturer based on the top ten manufacturers found in the 2014 on-site inventory. We report the unweighted number of bulbs purchased because of the relatively small sample sizes of purchases for each manufacturer. TCP (99 standard CFLs and 199 specialty CFLs) accounted for the largest number of CFLs that respondents reported purchasing in the year prior to the 2014 study, followed by GE (128 standard CFLs and 154 specialty CFLs). Home Depot accounted for the largest number of standard CFLs (151) and was the third most common manufacturer for all CFLs. When reviewing the purchase of LEDs in 2013, Philips was the leading manufacturer (87 LEDs) just as in 2012, followed by Feit Electric (78 LEDs).[61]

[61] It is important to note that the *self-reported* date of purchase is subject to respondent error, and the date of actual purchase may differ. However, the on-site technician determines manufacturer by looking at the actual bulb; therefore, the manufacturer data are more reliable than the date of purchase data.

Table 69. Total Purchases by Manufacturer

Manufacturer	Total Number of Bulbs											
	2011 (by 2012 sample)				2012 (by 2013 sample)				2013 (by 2014 sample)			
	Stand CFLs	Spec CFLs	LEDs	Total	Stand CFLs	Spec CFLs	LEDs	Total	Stand CFLs	Spec CFLs	LEDs	Total
TCP	0	34	0	34	19	40	1	60	99	199	0	298
GE	7	72	1	80	19	32	1	52	128	154	11	293
Home Depot	0	91	1	92	46	68	0	114	151	49	0	200
Feit Electric	1	25	29	55	19	29	2	50	48	30	78	156
Philips	1	42	1	44	11	3	11	25	7	38	87	132
Greenlite	0	2	0	2	12	20	0	32	50	34	11	95
Osram Sylvania	0	25	8	33	21	48	5	74	64	13	17	94
Maxlite	0	9	0	9	10	9	0	19	27	36	0	63
Litetronics	12	15	0	27	8	35	0	43	37	20	0	57
Lowe's	0	7	0	7	8	12	1	21	42	6	5	53
Walmart	0	0	0	0	3	0	0	3	35	2	0	37
Other	0	21	43	65	15	18	15	48	64	60	61	185

Base: All CFLs and LEDs purchased within the past year; data are unweighted.

Table 70. Total Purchases by Manufacturer, Comparison Areas 2014

Manufacturer	Georgia 2013 (by 2014 sample)				Kansas 2013 (by 2014 sample)			
	Stand CFLs	Spec CFLs	LEDs	Total	Stand CFLs	Spec CFLs	LEDs	Total
Feit Electric	1	1	1	3	7	0	3	10
GE	30	5	0	35	100	25	8	133
Greenlite	0	0	0	0	1	0	0	1
Home Depot	27	27	0	54	17	6	0	23
Litetronics	0	0	0	0	1	0	0	1
Lowe's	6	0	0	6	29	4	0	33
Maxlite	5	5	0	10	0	0	0	0
Osram Sylvania	0	0	0	0	21	0	0	21
Philips	12	3	1	16	1	1	20	22
TCP	5	5	0	10	7	0	0	7
Walmart	35	0	0	35	28	2	0	30
Other	37	12	29	78	24	1	6	31

Base: All CFLs and LEDs purchased within the past year; data are unweighted.

Bulb Manufacturer by Source of Bulb

The tables below provide details on bulb manufacturers by store type for Massachusetts and the comparison areas.

Table 71. Types of Stores where Bulbs Were Purchased by Manufacturer, Massachusetts 2014

	EE Program	Home Improve-ment	Mass Merch/ Discount	Hard-ware	Ware-house	Grocery /Super-market	Home Furnish	Charity	Landlord	Drug-store	Spec. Lighting	Online	Bargain	Other	Don't Know
# of CFLs purchased	**596**	**512**	**157**	**119**	**90**	**42**	**26**	**19**	**11**	**11**	**14**	**9**	**3**	**25**	**33**
Feit Electric	24	49	0	5	60	0	0	0	0	0	12	0	0	0	6
GE	121	55	65	22	4	7	0	0	0	9	0	0	0	2	8
Greenlite	15	18	23	33	0	1	0	0	0	0	0	0	2	2	1
Home Depot	12	148	6	24	3	3	0	0	0	0	0	0	0	0	4
Litetronics	28	19	5	1	0	1	0	0	1	0	0	0	0	2	0
Lowe's	0	40	9	2	0	0	1	0	0	0	0	0	0	1	0
Maxlite	27	16	0	5	0	0	1	1	0	0	0	0	0	13	0
Osram Sylvania	15	43	2	4	7	20	0	0	0	0	2	0	0	0	1
Other	32	72	37	17	2	9	24	14	1	2	0	4	1	2	9
Philips	80	34	5	2	0	0	0	0	0	0	0	4	0	3	4
TCP	242	18	5	4	14	1	0	4	9	0	0	1	0	0	0

Table 72. Types of Stores where Bulbs Were Purchased by Manufacturer, Georgia 2014

	EE Program	Home Improve-ment	Mass Merch/ Discount	Hard-ware	Ware-house	Grocery /Super-market	Home Furnish	Charity	Landlord	Drug-store	Spec. Lighting	Online	Bargain	Other	Don't Know
# of CFLs purchased	**10**	**65**	**78**	**0**	**2**	**27**	**0**	**0**	**0**	**0**	**4**	**6**	**31**	**8**	**16**
Feit Electric	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0
GE	0	9	14	0	1	9	0	0	0	0	0	0	0	0	2
Greenlite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Home Depot	0	17	0	0	1	3	0	0	0	0	0	0	24	0	9
Litetronics	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lowe's	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0
Maxlite	0	0	8	0	0	0	0	0	0	0	0	0	0	2	0
Osram Sylvania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philips	7	1	6	0	0	0	0	0	0	0	0	0	0	0	2
TCP	1	2	3	0	0	0	0	0	0	0	0	0	1	3	0
Walmart	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0
Other	2	31	10	0	0	15	0	0	0	0	3	6	5	3	3

Table 73. Types of Stores where Bulbs Were Purchased by Manufacturer, Kansas 2014

	EE Program	Home Improve-ment	Mass Merch/ Discount	Hard-ware	Ware-house	Grocery /Super-market	Home Furnish	Charity	Landlord	Drug-store	Spec. Lighting	Online	Bargain	Other	Don't Know
# of CFLs purchased	**0**	**151**	**141**	**5**	**10**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**2**
Feit Electric	0	3	7	0	0	0	0	0	0	0	0	0	0	0	0
GE	0	60	60	1	9	1	0	0	0	0	0	0	1	0	1
Greenlite	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Home Depot	0	10	11	2	0	0	0	0	0	0	0	0	0	0	0
Litetronics	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Lowe's	0	17	15	0	0	0	0	0	0	0	0	0	0	0	1
Maxlite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Osram Sylvania	0	9	11	1	0	0	0	0	0	0	0	0	0	0	0
Other	0	21	8	1	0	0	0	0	0	0	0	0	1	0	0
Philips	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0
TCP	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0
Walmart	0	8	22	0	0	0	0	0	0	0	0	0	0	0	0

Appendix C: High CFL Users vs. Low CFL Users

The 2013 report explored interesting differences between households that were not aware of CFLs or self-reported current household use of four or fewer CFLs ("low CFL users") and those households that reported current household use of five or more CFLs ("high CFL users").[62] This section looks at these two categories of households for the 2014 on-site visits.

In Massachusetts, nearly all (98%) of the on-site respondents who had indicated that they had five or more CFLs installed actually had that many CFLs installed (Table 74). Conversely, nearly two-thirds (65%) of those who reported having four or fewer CFLs installed actually had five or more CFLs installed in their homes. The error in self-reporting among this group is partly explained by respondents who said they were not aware of CFLs actually having CFLs installed—in fact, on average, unaware respondents who took part in the on-site had an average of 12 CFLs in the home.

In contrast, in Georgia, both self-reported low CFL users were more accurate, with three-quarters (75%) correctly identifying themselves as low CFL users (four or fewer CFLs). As was the case in Massachusetts, a large proportion of self-reported high CFL users (86%) in Georgia actually had five or more CFLs installed in their homes.

In Kansas, just over two-fifths of self-identified low CFL users (41%) incorrectly reported their CFL counts. As was the case in Massachusetts, the vast majority of self-reported high CFL users (94%) correctly identified themselves as having five or more CFLs installed (Table 75).

[62] In the Massachusetts Onsite Lighting Socket Inventory Report from June 2013, these homes were referred to as CFL Novices (self-reported not aware of CFLs or four or fewer installed) and CFL Experts (self-reported five or more installed).

Table 74. Self-Reported vs. Installed CFLs

	Massachusetts				Georgia				Kansas			
	Households that self-reported not aware of CFLs or ≤4 installed		Households that self-reported five or more CFLs installed		Households that self-reported not aware of CFLs or ≤4 installed		Households that self-reported five or more CFLs installed		Households that self-reported not aware of CFLs or ≤4 installed		Households that self-reported five or more CFLs installed	
Sample size[*]	*75*		*135*		*42*		*31*		*27*		*37*	
	Actual % with self-reported # of CFLs installed	Actual Mean	Actual % with self-reported # of CFLs installed	Actual Mean	Actual % with self-reported # of CFLs installed	Actual Mean	Actual % with self-reported # of CFLs installed	Actual Mean	Actual % with self-reported # of CFLs installed	Actual Mean	Actual % with self-reported # of CFLs installed	Actual Mean
Four or fewer[**]	35%	2	2%	3	75%	1	14%	2	57%	1	6%	3
Five or more	65%	13	98%	23	25%	15	86%	19	41%	14	94%	24
Overall	-	9	-	23	-	5	-	16	-	6	-	23

Base: All on-site respondents

[*] One respondent reported not knowing how many CFLs were installed.

[**] Including no CFLs.

Table 75. Self-Reported vs. Installed CFLs for Households Reporting Four or Fewer CFLs

	MA Households Not Aware of CFLs (n=8)		GA Households Not Aware of CFLs (n=15)		KS Households Not Aware of CFLs (n=4)	
	Actual count with self-reported # of CFLs installed	Actual Mean	Actual count with self-reported # of CFLs installed	Actual Mean	Actual count with self-reported # of CFLs installed	Actual Mean
Four or fewer[*]	2	4	13	1	2	1
Five or more	6	15	2	21	2	15
Overall	8	12	15	4	4	8

Base: On-site respondents who were not aware of CFLs aided or unaided; unweighted

[*] Including no CFLs.

Not surprisingly, CFL socket saturation was higher among Massachusetts, Georgia, and Kansas households that self-reported having five or more CFLs than households that were unaware of CFLs or that self-reported having four or fewer CFLs. In Massachusetts and Kansas, LED socket saturation was also relatively higher among households that self-reported having five or more CFLs compared to households that reported having four or fewer CFLs. In Georgia, LED socket saturation was the same in both cases. As the Team concluded in the 2013 study, this finding refutes the hypothesis that LEDs will more readily be adopted by households that dislike CFLs and instead supports the hypothesis that households that already embrace CFLs will also be more likely to give LEDs a try (Table 76).

Table 76. Socket Saturation by CFL Experience

	Massachusetts			Georgia			Kansas		
	Overall	Households with ≤4 CFLs	Households with 5 or More CFLs	Overall	Households with ≤4 CFLs	Households with 5 or More CFLs	Overall	Households with ≤4 CFLs	Households with 5 or More CFLs
Sample Size	*210*[*]	*75*	*135*	*73*	*42*	*31*	*64*	*27*	*37*
CFL Saturation	32%	20%	41%	19%	13%	27%	29%	22%	31%
LED Saturation	2%	1%	3%	1%	1%	1%	2%	<1%	3%

Base: All on-site respondents

[*]One panel visit respondent reported not knowing how many CFLs were installed; 50 new visit respondents were not asked these questions.

Appendix D: Panel Study Methods and Additional Results

Comparison of Panel and New Visit On-site Samples

This section compares the panel and new visit on-site samples on such factors as CFL awareness, familiarity, use, and purchases as well as demographic characteristics. The purpose of this comparison is to identify any systematic differences between the two on-site samples in order to assess whether they should be treated as two separate groups or combined into one sample.

The on-site survey data were weighted to reflect the population proportions for home ownership and education in Massachusetts based on the American Community Survey (ACS). This is described in more detail below in Appendix E, which also describes the development of the three weights we used to analyze the data. In short, the weights represented 2014 new visits only, the combined panel and new visit samples, and panel visits only.

Standard panel study procedure includes surveying the same individuals more than once, but also collecting data from a new group—the replacement sample—and comparing the results to make sure they do not differ in undesirable ways. As expected, the two on-site samples in this study exhibited similar levels of CFL awareness and familiarity, as measured in the 2013 RDD survey for the revisit sample and the 2014 on-site survey for the new sample (Table 77). Likewise, current CFL penetration (i.e., the percentage of households using at least one CFL), saturation (i.e., the percentage of sockets filled with CFLs), and use (i.e., the number of CFLs in use), as verified in the 2014 on-site survey, were also similar for the two on-site samples. CFLs and LEDs purchased over the past year were also similar across visit types.

Table 77. Comparison of CFL-Related Factors for Revisit and New Visit On-site Samples

(Base: All on-site respondents by visit type)

Factor	2014 Panel Visits (Weight P)	2014 New Visits (Weight N)	2014 Panel and New Visits (Weight C)
Sample Size	*111*	*150*	*261*
Aware of CFLs	89%	90%	90%
Somewhat or very familiar with CFLs	73%	76%	75%
CFL penetration	96%	97%	96%
CFL saturation	31%	33%	33%
Mean number of CFLs in use	16	16	16
Mean number of CFLs purchased within the past year	4	5	5
Mean number of LEDs purchased within the past year	1	1	1

As Table 78 shows, an examination of the demographic data indicates that the panel homes are demographically similar to the new visits. However, the weight 111 provides a closer match with the

new visits. When weighted, the panel visits and new visits combined are nearly identical to the weighted new visits alone.

Table 78. Comparison of Demographic Factors for Revisit and New Visit On-site Samples

(Base: All on-site respondents by visit type)

Factor	2014 Panel Visits (Weight P)	2014 New Visits (Weight N)	2014 Panel and New Visits (Weight C)
Sample Size	*111*	*150*	*261*
Rent home	36%	36%	36%
Single-family detached home	43%	41%	41%
Apartment with two or more units	51%	45%	48%
Less than a college degree	60%	59%	59%
Low Income	37%	45%	42%

Finally, we examined bulb saturation based on the three weights. As Table 79 shows, when comparing across visit types, CFL saturation was similar, with approximately one-third of all sockets filled with CFL bulbs (31% in panel visit homes and 33% in new visit homes). Nearly one-half (47%) of all sockets in panel visit homes were filled with incandescent bulbs, while only 43% of all new visit home sockets were filled with incandescents.

Table 79. Comparison of Saturation Rates, Panel vs. Saturation Homes

Sockets Containing	2014 Panel Visits (Weight P)	2014 New Visits (Weight N)	2014 Panel and New Visits (Weight C)
Sample Size	*111*	*150*	*261*
Total Sockets	**6,200**	**7,350**	**13,550**
Incandescents	47%	43%	45%
CFLs	31%	33%	33%
Fluorescents	9%	9%	9%
Halogens	6%	7%	6%
LEDs	3%	3%	3%
Other	4%	4%	4%

Based on the comparison of panel households and new households, the Team concluded that it was reasonable to combine the panelists and new visits when presenting 2014 data. Therefore, in this report, we present 2014 as the combination of new and panel visits.

Corrections to 2013 Data for Panel Visits

The panel visits allowed the Team to correct errors and omissions in the 2013 data. Technicians making panel visits had all of the data collected in 2013 for each site, including sketches and data on rooms, fixtures, installed bulbs, and stored bulbs. They would ask the customers early in the visit to point out any bulbs that had been changed since the previous visit. They would then proceed through each room

and attempt to match the 2013 data to what was present in 2014. In cases when they believed there to be errors in the 2013 data, they would ask the customers for assistance. Based on the information available through observation and customer inquiries, technicians could copy 2013 records for rooms, fixtures, installed bulbs, and stored bulbs as 2014 data. If they found a direct match to a 2013 record, they would designate the 2014 record as "Same." If they found a close match, but believed the 2013 data to have errors, they could copy the 2013 record to 2014, correct the information, and mark it as "Corrected." Rooms, fixtures, and bulbs found in 2014 with no match in the 2013 data would be marked as "New" or "Missed" (present in the home in 2013 but not in the 2013 data) based on information provided by the customer. The data collection form also allowed technicians to indicate 2013 fixtures that had been removed or moved to a different room, and indicate when the customer had changed the use of a particular room (e.g., a bedroom converted to an office). Technicians were encouraged to enter notes and take photographs to clarify any confusing or ambiguous situations.

Table 80: Corrections to 2013 Fixtures

Count of 2013 Fixtures	Fixture Status in 2014			
	Same	Corrected	Missed	Moved
4,116	62%	18%	19%	1%

Table 81: Corrections to 2013 Installed Bulbs

Bulb Type	Count of 2013 Bulbs	Bulb Status in 2014		
		Same	Corrected	Missed
All Bulbs	*5,232*	*54%*	*24%*	*22%*
Incandescent	2,557	58%	22%	20%
CFL	1,536	56%	26%	18%
Fluorescent	504	59%	17%	24%
Halogen	399	28%	38%	34%
LED Bulb	54	46%	28%	26%
LED Fixture*	18	0%	39%	61%
Other	6	0%	83%	17%
Empty Socket	155	21%	17%	61%
Don't know	3	0%	67%	33%

* LED Fixtures with integrated bulbs had been categorized as LEDs in 2013, so Corrected records generally were just to clarify the category under the 2014 LED Bulb/LED Fixture distinction.

Table 82: Corrections to 2013 Stored Bulbs

Bulb Type	Count of 2013 Bulbs		Bulb Status in 2014					
		Same	Corrected	Missed	Installed in fixture	Thrown out/Recycled	Don't know	Error in 2013
All Bulbs	*2,052*	*23%*	*6%*	*53%*	*6%*	*4%*	*7%*	*1%*
Incandescent	1,476	22%	6%	54%	5%	5%	7%	1%
CFL	455	28%	7%	45%	12%	1%	8%	0%
Fluorescent	32	16%	0%	81%	0%	3%	0%	0%
Halogen	73	14%	11%	60%	7%	1%	7%	0%
LED Bulb	10	20%	0%	70%	10%	0%	0%	0%
Other	6	0%	0%	100%	0%	0%	0%	0%

Replaced Bulbs by Wattage

Table 83 indicates the wattages of incandescent bulbs that households replaced with CFLs or LEDs between 2013 and 2014. The largest share of replaced incandescents was 60-Watt bulbs (45%), the most popular wattage of incandescent. Eighteen percent (18%) had been 40-Watt bulbs. Nine percent of the bulbs had been 65-Watt bulbs, a common wattage for reflective/spot-style incandescents. Another 18% of replaced incandescents had wattages greater than 65, and 4% had wattages less than 40.

Table 83. Wattage of Incandescents Replaced by CFLs or LEDs
(CFLs or LEDs purchased within the last 12 months, weighted, count=291)

Wattage	Percent
>100	0.4%
100	8%
90	0.2%
75	9%
66-74	1%
65	9%
60	45%
41-59	2%
40	18%
<40	4%
Don't know	4%

Replaced Bulbs: Demographic Differences

Housing Type

Single-family households were much more likely to replace a CFL with an LED bulb than multifamily households (Table 84). Multifamily households chose LED bulbs to replace CFLs 7% of the time compared to 23% in single-family homes.

Table 84. Type Changes in Bulb Replacements by Housing Type (unweighted, n=111)

		Count	CFL	Incandescent	LED Bulb	Halogen	Empty Socket
Multifamily	CFL	*57*	58%	28%	7%	0%	7%
	Incandescent	*211*	59%	23%	8%	2%	8%
Single-family	CFL	*150*	51%	19%	23%	3%	5%
	Incandescent	*354*	61%	24%	9%	1%	5%

Tenure

There was a relatively small number of CFLs replaced in rented households, but renters tended to replace CFLs with incandescent bulbs at a higher rate than homeowners (44% vs. 19%, Table 85). Homeowners replaced incandescents with incandescents more often than renters (25% vs. 16%).

Table 85. Type Changes in Bulb Replacements by Tenure (unweighted, n=111)

		Count	CFL	Incandescent	LED Bulb	Halogen	Empty Socket
Own/Buying	CFL	*189*	54%	19%	20%	2%	5%
	Incandescent	*484*	60%	25%	9%	1%	5%
Rent/Lease	CFL	*18*	44%	44%	6%	0%	6%
	Incandescent	*81*	63%	16%	5%	4%	12%

Income

Low-income households were less likely than non-low-income households to choose a CFL when replacing a CFL (50% vs. 67%) or when replacing an incandescent bulb (56% vs. 72%, Table 86). Low-income households were more likely, however, to choose an LED bulb to replace a CFL (22% vs 3%) or an incandescent (11% vs. 2%).

Table 86. Type Changes in Bulb Replacements by Income (unweighted, n=111)

		Count	CFL	Incandescent	LED Bulb	Halogen	Empty Socket
Low Income	CFL	*36*	50%	24%	22%	2%	2%
	Incandescent	*155*	56%	25%	11%	2%	6%
Non-Low Income	CFL	*171*	67%	8%	3%	0%	22%
	Incandescent	*410*	72%	19%	2%	1%	7%

Education

Households with higher educational attainment were more likely to replace CFLs with LED bulbs (24% vs. 7%) and more likely to replace an incandescent with a CFL (64% vs. 56%, Table 87).

Table 87. Type Changes in Bulb Replacements by Educational Attainment (unweighted, n=111)

		Count	CFL	Incandescent	LED Bulb	Halogen	Empty Socket
Bachelor's Degree or Better	CFL	*135*	51%	22%	24%	0%	3%
	Incandescent	*340*	64%	21%	9%	2%	5%
Less Than Bachelor's Degree	CFL	*72*	57%	21%	7%	6%	10%
	Incandescent	*225*	56%	27%	8%	1%	8%

Bin Jumping in Replaced Bulbs

"Bin jumping" is when someone switches a bulb with a particular lumen value for a bulb with a substantially higher or lower value. Table 88 presents typical lumen ranges by bulb type. Each of these ranges represents a bin in this analysis. For example, switching a 60-Watt incandescent bulb (750-1,049 lumen bin) for a 23-Watt CFL (1,050-1,489 lumen bin) would be a jump of one bin. Frequent bin jumping to higher lumen values would be of special concern for incandescent bulbs if people began to replace EISA-covered incandescent bulbs with non-EISA high-wattage bulbs as the 100-, 75-, and 60-Watt incandescents become unavailable.

Table 88: Typical Lumen Ranges by Bulb Type

Lumen Range	Watt Equivalents				
	CFL	Fluorescent	Halogen	Incandescent	LED
<310	<4	<4	<24	<20	<4
310-749	5-12	5-9	25-60	21-50	5-10
750-1,049	13-16	10-13	61-84	51-70	11-14
1,050-1,489	17-23	14-19	85-119	71-99	15-19
1,490-2,600	24-40	20-33	120-208	100-173	20-33
2,600+	41+	34+	209+	174+	34+

Table 89 and Table 90 present bin jumping behavior in the panel visit homes. The bin jumping data include all sockets with bulbs replaced by the customer from 2013 to 2014, except sockets that were empty in 2013 or 2014. Bin jumping was limited for bulbs of all types; 51% of replaced bulbs had the same lumen range as the original bulb. Another 39% were one lumen range bin higher or lower than the original bulb.

Table 89: Bin Jumping: All Replaced Bulbs 2013-2014 (weighted, n=111)

Bins Jumped	Percent of Bulbs
Total	*763*
-4	0%
-3	1%
-2	6%
-1	19%
0	51%
1	20%
2	3%
3	0%

Results are similar if we limit the results to just incandescent bulbs replaced by other incandescent bulbs (Table 90). Customers chose a bulb in the same lumen bin in 45% of cases, and a jump of one bin up or down in another 39%. For this subset, there is a greater percentage of bin jumps of two or more in the brighter/greater wattage direction: 9% for the incandescent-to-incandescent replacements versus 3% for bulbs overall. This statistic should be monitored to see if this behavior is more common as supplies of EISA-covered incandescents are consumed.

Table 90: Bin Jumping: Incandescents Replaced by Incandescents 2013-2014 (weighted, n=111)

Bins Jumped	Percent of Bulbs
Total	133
-3	2%
-2	4%
-1	27%
0	45%
1	12%
2	8%
3	1%

Appendix E: Methodology

On-site Visits

After completing the consumer survey, each survey respondent was offered an incentive to participate in an on-site visit to his or her home. The Team randomly selected among all survey respondents voicing interest and called to set up an on-site visit. The visits were conducted between May and August of 2014. DNV GL (KEMA) complete on-site studies in Massachusetts in 2009, 2010, 2012, and 2013, while NMR completed an on-site study in the state in 2014. NMR also completed the on-site study in Georgia in 2014, while Navigant completed the on-site study in Kansas in 2014.

During the on-site visits, a trained technician gathered detailed information on each socket in the home. This information included:

- Bulb type
- Bulb shape
- Wattage
- Fixture type
- Socket type
- Room location
- Specialty features
- Date and store type where compact fluorescent lamps (CFLs) and light-emitting diodes (LEDs) were purchased
- Manufacturer and model number of each CFL and LED, when these could be determined

The Team also collected data on *all* bulbs found in storage.[63]

A typical on-site visit proceeded as follows: A trained technician arrived at the home at a pre-scheduled time, introduced him- or herself, and asked for the contact person who had been identified when scheduling the visit. To ensure uniformity in data collection and to facilitate quality control checks,[64] the technician walked around the outside of the home in a clockwise direction, recording all information on exterior lighting sockets. Next, the technician proceeded through the inside of the home in a clockwise direction, beginning with the foyer (entryway) and going through each room and part of the home systematically. If the product was a CFL or LED, the technician noted its manufacturer and model number and any specialty features. The technician also asked the respondent to estimate when he or she had purchased that particular CFL. The technician and householder also examined all light bulbs in storage, again noting similar detailed information on stored LEDs and CFLs and asking the householder the specific reason why he or she had bought the stored bulbs. Lastly, if the home was also selected for the HOU study, the technician installed lighting loggers on fixtures in targeted room types using a

[63] Prior to the 2012 on-site inventory, on-site inventories only collected data on CFLs found in storage.
[64] The Team completed quality control revisits on 5% of the sample homes to ensure the reliability and validity of all procedures and data collection.

predetermined random selection methodology. The lighting inventory portion of the visits averaged just under two hours.

On-site Visit Maps

The following figures provide an overview of the sample included in each state along with population densities.

Figure 12. Massachusetts On-Site Visits

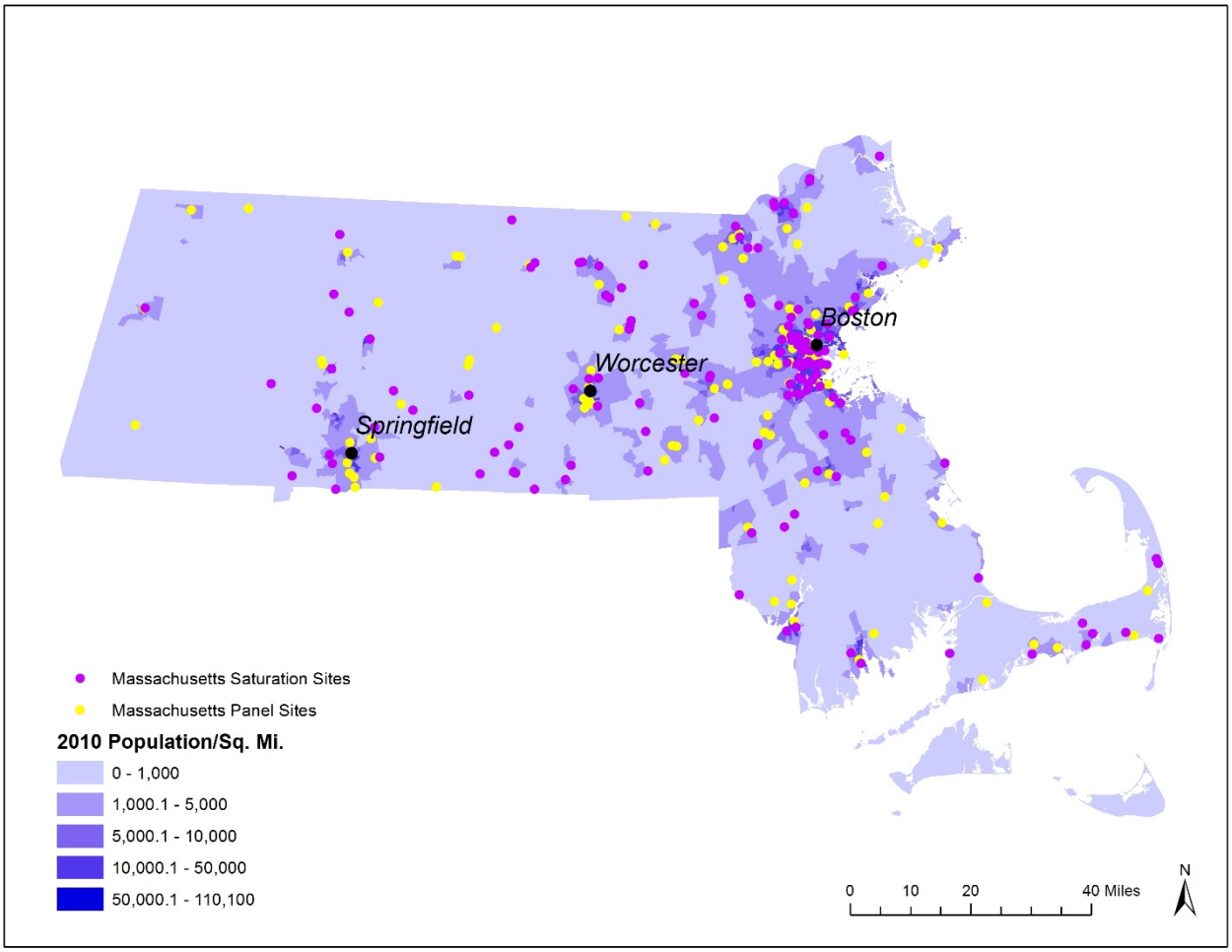


Figure 13. Georgia On-Site Visits

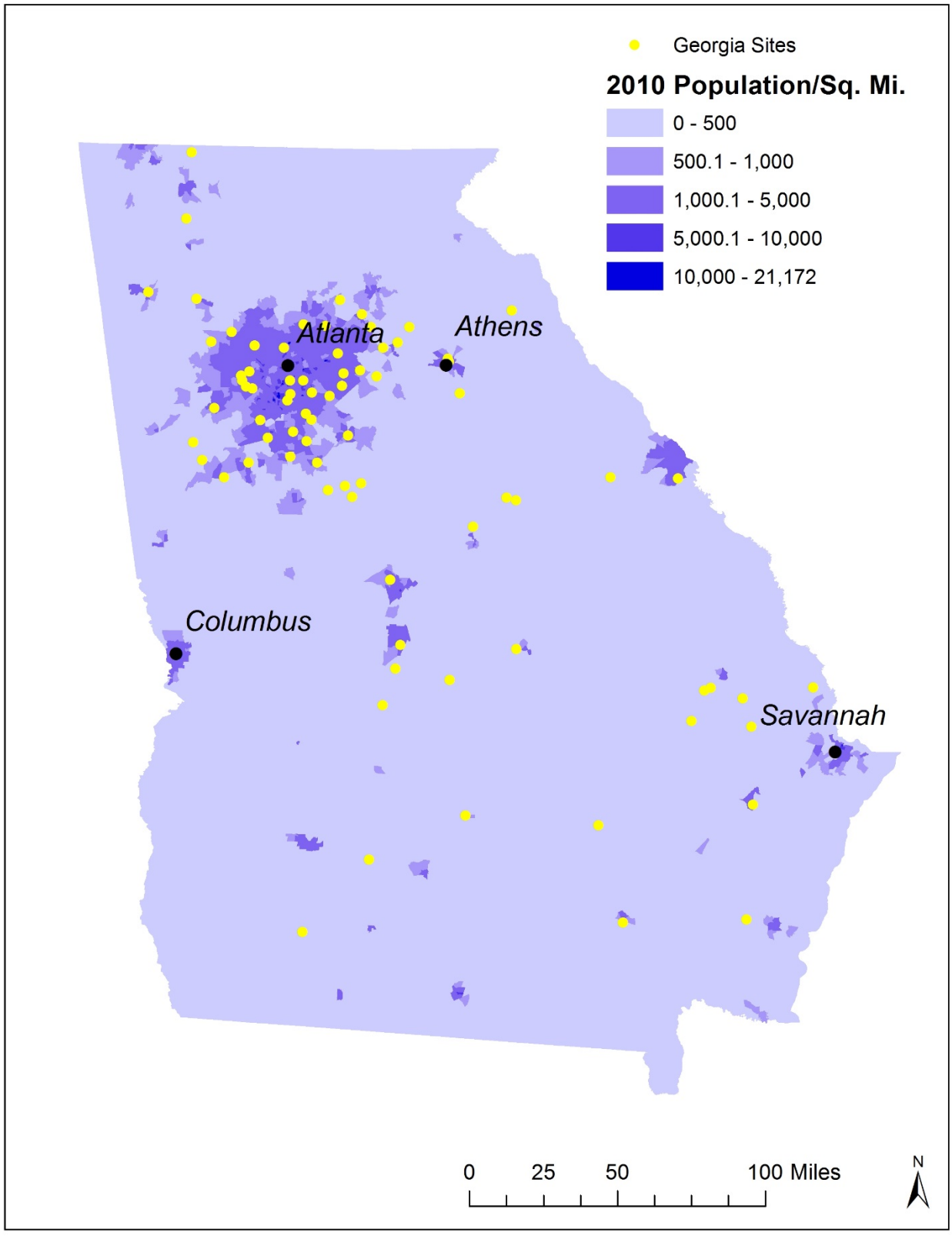
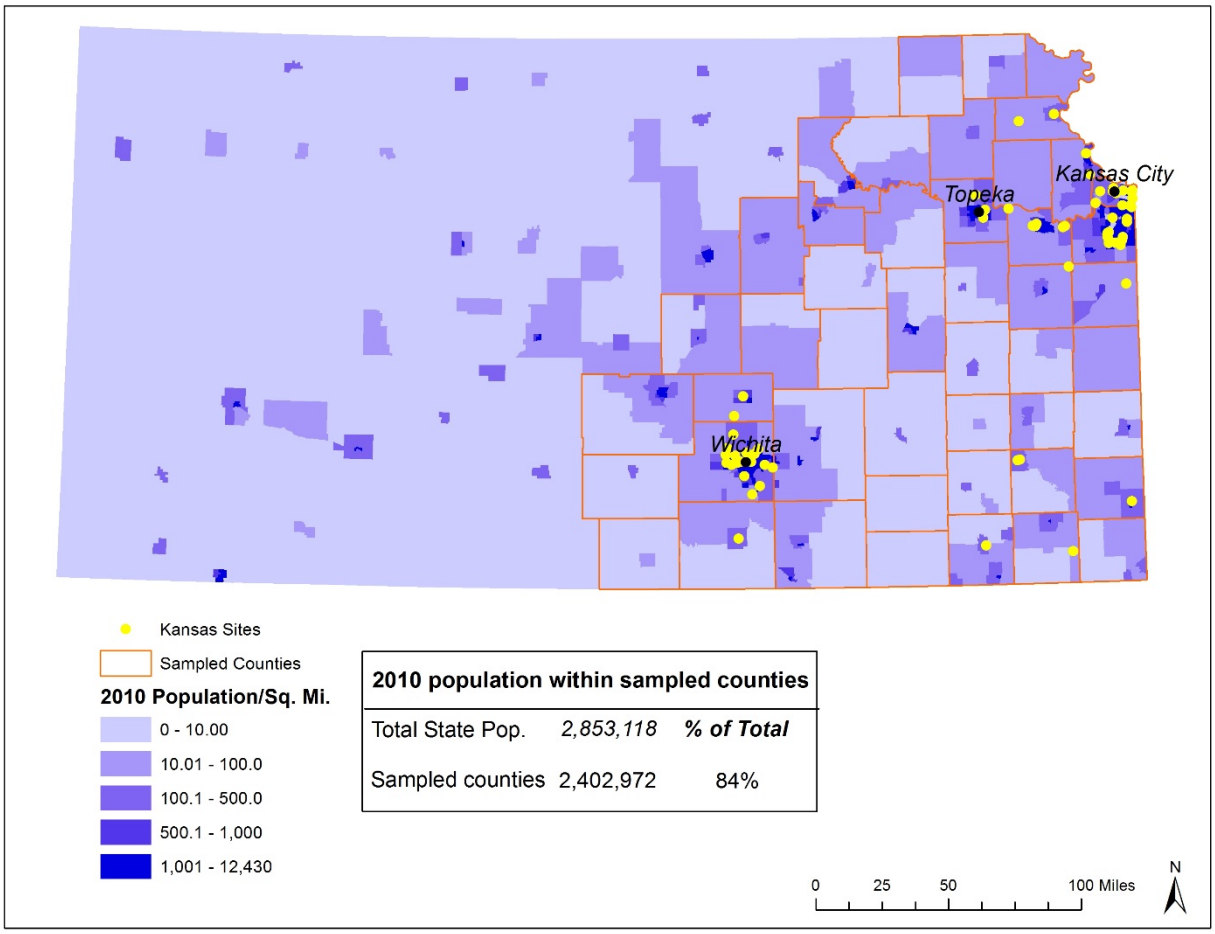


Figure 14. Kansas On-Site Visits



Panel Visits

As stated earlier, in 2014, the Massachusetts on-site visits included 111 panel visits conducted with households that had previously been visited in 2013. The panel visits are an important addition to the annual residential lighting on-site research, as they provide the ability to help answer questions about the types of bulbs customers use to replace others that have burned out or been removed for other reasons.

For the panel visits, in addition to collecting all of the information detailed above, the technicians were able to compare lighting inventory data from 2013 to what they found on-site in 2014. Based on the comparison of available bulb details (type, shape, base type, wattage, as well as manufacturer and model number for CFL and LED bulbs) and questioning the customer, the technician could designate a bulb as *New*, *Same*, *Corrected*, or *Missed*. If a technician designated a bulb as *New* and installed in a fixture that was marked as *Same*, *Corrected*, or *Missed* (indicating a replacement bulb in a fixture that was present in the home in 2013), the data collection form would prompt the technician to enter the bulb type present in 2013 for that socket and also to ask the customer his or her reason for changing

bulb types, if the types were different. By asking customers about each bulb replacement, technicians were able to provide correct information about bulb type changes even if the recorded data for the 2013 bulb had errors.

The 2013 data were not without errors; in total, the Team made corrections to 18% of all installed bulb data. In addition, the Team encountered numerous instances where bulbs had been missed in 2013 and needed to be added.

Weighting Scheme

The on-site survey data were weighted to reflect the population proportions for home ownership and education in Massachusetts based on the American Community Survey (ACS). The guiding principles behind the schemes are as follows:

- To maintain comparability with previous schemes dating back to 2008; this is very important for tracking changes in saturation, use, purchase, and storage behavior
- To reflect the population of Massachusetts
- To make certain that the panel data are treated properly—i.e., that they correctly represent the population and what we want to compare over time

To this end, we developed three separate weights to explore preliminary data. Table 91 shows the weights developed for this study:

1. 2014 New Visits Weights (Weight N) – Sample of all 150 households first visited in 2014, weighted to the most recent American Community Survey (ACS) data available; we primarily used this scheme when analyzing data solely for the 2014 new visits, mostly when comparing the panel to the new visits.
2. Combo Weights (Weight C) – Sample of all 261 households visited in 2014, comprising both the 150 new visits and 111 panel visits, weighted to the most recent ACS data available. This is the predominant weight we use for describing overall current residential lighting in Massachusetts.
3. Panel Weights 150 (Weight P) – Sample of 111 panel homes, weighted to the 2013 ACS data used in last year's study but reweighted to reflect the sample size of 111 versus the weights from last year, which were based on 150 homes.

Table 91. On-site Visits Weighting Scheme

Year	Tenure and Home Type	Households	Sample Size	Proportionate Weight
2014 New Visits (Weight N)	*Total*	*2,525,694*	*150*	*n/a*
	Owner-Occupied			
	High School or Less	449,748	10	2.67
	Some College or Associate's Degree	399,899	17	1.40
	Bachelor's Degree or Higher†	746,312	66	0.67
	Renter-Occupied			
	High School or Less	400,349	7	3.40
	Some College or Associate's Degree§	246,900	15	0.98
	Bachelor's Degree or Higher	282,486	35	0.48
2014 Panel Visits (Weight P)	*Total*	*2,512,552*		
	Owner-Occupied			
	High School or Less	474,060	8	2.62
	Some College or Associate's Degree	397,959	27	0.65
	Bachelor's Degree or Higher	736,455	45	0.72
	Renter-Occupied			
	High School or Less	407,684	6	3.00
	Some College or Associate's Degree	226,427	5	2.00
	Bachelor's Degree or Higher	269,967	20	0.60
2014 New & Panel Visits (Weight C)	*Total*	*2,525,694*	*261*	*n/a*
	Owner-Occupied			
	High School or Less	449,748	18	2.58
	Some College or Associate's Degree	399,899	44	0.94
	Bachelor's Degree or Higher†	746,312	111	0.69
	Renter-Occupied			
	High School or Less	400,349	13	3.18
	Some College or Associate's Degree§	246,900	20	1.28
	Bachelor's Degree or Higher	282,486	55	0.53

§ Includes one "Occupied without payment or rent."

† Includes two education indicated as "Don't know/Refused" and one tenure and education both indicated as "Don't know/refused."

Exploring Non-response Bias

To explore the possible effects of non-response bias in the on-site sample, the Team compared the responses to key questions in the consumer survey to the on-site sample to determine whether the on-site sample was biased compared to the full sample of consumer survey respondents. In Kansas and Massachusetts, it appears that this is the case. Table 92 shows the responses to questions about familiarity with CFLs from the full survey and the sample of on-site visits. The results are shown unweighted, weighted by tenure and education, and weighted by tenure and education + familiarity. As the table shows, levels of familiarity in on-site homes in Georgia are fairly similar between the full survey

and the on-site visits, while Massachusetts and Kansas show more variation, with Kansas being the most skewed toward those who are more familiar with CFLs. This may indicate a bias toward homes with a greater interest in the subject of the study, which the Team has observed before in Massachusetts (and which is embedded in all previous estimates of saturation).

Table 92. Comparison of Level of Familiarity with CFLs

Level of Familiarity	Georgia		Kansas		Massachusetts	
	Consumer Survey	On-sites Only	Consumer Survey	On-sites Only	Consumer Survey	On-sites Only
Sample Size	*525*	*78*	*552*	*67*	*1,530*	*261*
Very familiar	23%	21%	26%	37%	31%	39%
Somewhat familiar	41%	47%	40%	39%	39%	40%
All familiar (very + somewhat)	64%	68%	66%	76%	70%	79%
Difference very familiar	-2%		11%		8%	
Difference familiar	4%		10%		9%	

In an attempt to account for this bias, the Team explored various weights that accounted for familiarity with CFLs. The weights and their effect on familiarity and saturation are shown in Table 93. In Kansas, the tenure and education weighting scheme increases saturation, while it lowers saturation slightly in Massachusetts and has no impact on saturation in Georgia. The Team focused on weights that included tenure and education to preserve comparability with past Massachusetts on-site work.

Table 93. CFL Saturation by Level of Familiarity with CFLs, Various Weighting Schemes

Bulb Type	Georgia				Kansas				Massachusetts			
	Un-weight	Ten by Edu	Level of CFL Famil-iarity	Ten by Edu* CFL Famil-iarity	Un-weight	Ten by Edu	Level of CFL Famil-iarity	Ten by Edu* CFL v	Un-weight	Ten by Edu	Level of CFL Famil-iarity	Ten by Edu* CFL Famil-iarity
Sample Size	78	78	78	78	67	67	67	67	261	261	261	261
Very familiar	21%	19%	23%	21%	37%	42%	26%	29%	39%	35%	31%	28%
Somewhat familiar	47%	47%	41%	41%	39%	34%	40%	36%	40%	40%	39%	39%
Not too familiar	6%	6%	13%	12%	13%	14%	19%	20%	12%	11%	16%	15%
Not at all familiar/ Not aware of CFLs	27%	28%	24%	26%	10%	10%	15%	15%	10%	14%	14%	18%
CFL Saturation	**19%**	**19%**	**19%**	**18%**	**27%**	**29%**	**26%**	**29%**	**34%**	**32%**	**33%**	**32%**

Appendix F: Demographics

More than six out of ten (61%) of 2014 Massachusetts on-site participants owned their homes. This is similar to the 2013 onsite sample (65%), but significantly lower the 2012 onsite sample (81%) (Table 94).

Table 94. Tenure

Factor	Massachusetts						Georgia On-site 2014	Kansas On-site 2014
	Winter 2011 Consumer Survey	2012 On-site Sample	Winter 2012 Consumer Survey	2013 On-site Sample	2014 Consumer Survey	2014 New Visits		
Sample Size	*582*	*150*	*600*	*150*	*940*	*150*	*78*	*67*
Own or Buying	78%$^{\delta}$	81%$^{\delta}$	62%	65%	64%	61%	76%$^{\delta}$	67%
Rent or Lease	21%$^{\delta}$	19%$^{\delta}$	38%	35%	35%	37%	24%$^{\delta}$	33%
Occupied w/o payment or rent	0%	0%	0%	0%	1%	1%	0%	0%
Don't know/Refused/Other	1%	1%	<1%$^{\delta}$	0%	1%	1%	0%	0%

$^{\delta}$ Significantly different from Massachusetts 2014 at the 90% confidence level

The most common level of education achieved among participants all three states in 2014 was a bachelor's degree or higher, though this was significantly higher for the Massachusetts participants (63% in Massachusetts vs. 40% in Georgia and 45% in Kansas) (Table 95).

Table 95. Highest Level of Education

Factor	Massachusetts						Georgia On-site 2014	Kansas On-site 2014
	Winter 2011 Consumer Survey	2012 On-site Sample	Winter 2012 Consumer Survey	2013 On-site Sample	2014 Consumer Survey	2014 New Visits		
Sample Size	*582*	*150*	*600*	*150*	*940*	*150*	*78*	*67*
Less than high school graduate	2%	3%	4%$^{\delta}$	2%	3%$^{\delta}$	1%	3%	3%
High school graduate (Included GED)	15%	9%	17%$^{\delta}$	13%	15%	11%	28%$^{\delta}$	16%
Some college or associates degree	21%	23%	25%	27%	22%	25%	30%	34%
Bachelor's degree or higher	61%	65%	53%$^{\delta}$	58%	57%	63%	40%$^{\delta}$	45%$^{\delta}$
Don't know/Refused	2%	1%	2%	0%	7%$^{\delta}$	1%	0%	2%

$^{\delta}$ Significantly different from Massachusetts 2014 at the 90% confidence level

As in the 2013 on-site visits, approximately one half (48%) of 2014 on-site participants resided in single-family detached or single-family attached homes, which is significantly different from the 2012 on-site sample (67%) (Table 96). As mentioned earlier in the report, this is largely due to the strategy of recruiting and sampling 50% multifamily and 50% single-family homes in 2013 and 2014. In the comparison areas, approximately eight out of every ten homes that took part in the on-site study were single-family detached or single-family attached homes (80% in Georgia and 76% in Kansas).

Table 96. Home Type

Factor	Massachusetts						Georgia On-site 2014	Kansas On-site 2014
	Winter 2011 Consumer Survey	2012 On-site Sample	Winter 2012 Consumer Survey	2013 On-site Sample	2014 Consumer Survey	2014 New Visits		
Sample Size	*582*	*150*	*600*	*150*	*940*	*150*	*78*	*67*
One-family house, detached	54%$^{\delta}$	55%$^{\delta}$	40%	41%	44%	39%	77%$^{\delta}$	71%$^{\delta}$
One-family house, attached	16%$^{\delta}$	12%	10%	9%	9%	9%	3%$^{\delta}$	5%
In a building with 2-4 apts	13%$^{\delta}$	19%	49%	51%	19%	21%	7%$^{\delta}$	4%$^{\delta}$
In a building with 5+ apts	14%$^{\delta}$	13%$^{\delta}$			22%	26%	8%$^{\delta}$	18%
Mobile home or trailer	<1%	0%	1%$^{\delta}$	0%	<1%$^{\delta}$	0%	6%$^{\delta}$	1%
Something else	1%$^{\delta}$	2%	1%$^{\delta}$	0%$^{\delta}$	5%	5%	0%$^{\delta}$	0%$^{\delta}$
Don't know/Refused	<1%	0%	0%	0%	<1%$^{\delta}$	0%	0%	0%

$^{\delta}$ Significantly different from Massachusetts 2014 at the 90% confidence level

In Massachusetts in 2014, six out of ten on-site participants (60%) reported that their homes were smaller than 2,000 square feet. Similarly, in Georgia and Kansas, nearly seven out of ten on-site participations reported that their homes were smaller than 2,000 square feet (67% and 70% respectively). (Table 97)

Table 97. Size of Home

Factor	Massachusetts						Georgia On-site 2014	Kansas On-site 2014
	Winter 2011 Consumer Survey	2012 On-site Sample	Winter 2012 Consumer Survey	2013 On-site Sample	2014 Consumer Survey	2014 New Visits		
Sample Size	*582*	*150*	*517*	*150*	*940*	*150*	*78*	*67*
Less than 1,400 ft^2	36%	40%	32%	32%	32%	37%	29%	37%
1,400 ft^2 to < 2,000 ft^2	32%$^{\delta}$	24%	36%$^{\delta}$	41%$^{\delta}$	20%	23%	38%$^{\delta}$	33%
2,000 ft^2 to < 2,500 ft^2	15%$^{\delta}$	17%$^{\delta}$	15%$^{\delta}$	18%$^{\delta}$	12%	10%	17%	12%
2,500 ft^2 to < 3,500 ft^2	11%	8%	13%	7%	7%	9%	10%	13%
3,500 ft^2 to < 4,000 ft^2	3%$^{\delta}$	5%$^{\delta}$	2%$^{\delta}$	1%	1%$^{\delta}$	0%	6%$^{\delta}$	2%
4,000 ft^2 to < 5,000 ft^2	1%	1%	1%	1%	2%	1%	1%	2%
5,000 ft^2 or more	2%$^{\delta}$	4%$^{\delta}$	2%$^{\delta}$	0%	1%$^{\delta}$	0%	0%	1%
Don't know	-	-	-	-	25%$^{\delta}$	19%	0%$^{\delta}$	0%$^{\delta}$

$^{\delta}$ Significantly different from Massachusetts 2014 at the 90% confidence level

The most common household size among respondents in all three states was two (Table 98).

Table 98. Number of People Living in the Home

Factor	Massachusetts						Georgia On-Sites 2014	Kansas On-Sites 2014
	Winter 2011 Consumer Survey	2012 On-site Sample	Winter 2012 Consumer Survey	2013 On-site Sample	2014 Consumer Survey	2014 New Visits		
Sample Size	*582*	*150*	*600*	*150*	*940*	*150*	*78*	*67*
1 person	17%	18%	26%	26%	26%	22%	15%	19%
2 people	35%$^{\delta}$	31%$^{\delta}$	37%	38%	40%	43%	37%	30%$^{\delta}$
3 people	20%$^{\delta}$	24%$^{\delta}$	15%	16%	13%	13%	19%	15%
4 people	16%	17%	15%	16%	12%	14%	14%	18%
5 people	7%	6%	5%	2%	4%	5%	6%	7%
6 or more people	4%	3%	2%	1%	4%	3%	9%$^{\delta}$	10%$^{\delta}$
DK/Refused	<1%	1%	1%	0%	2%	1%	0%	2%

$^{\delta}$ Significantly different from Massachusetts 2014 at the 90% confidence level