Back to the Future: Why Lighting Programs May Have Never Been More Important

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ABSTRACT

Historically, residential lighting programs have accounted for a majority of residential energy savings. In recent years, the implementation of EISA and the introduction of LEDs into the marketplace have drawn into question the effectiveness of program-induced savings from residential lighting programs. In the context of these changing market conditions, program administrators have had to carefully examine their programs.

Some regulators, stakeholders, and program administrators have concluded that the market is transformed or will be transformed in the near future, with or without their intervention. This conclusion has led several program administrators to end program support for upstream residential lighting. Others have scaled back efforts or switched their lighting programs' focus solely to LEDs, and a few have forged ahead with continued program support for both CFLs and LEDs.

This has created an opportunity for a unique natural experiment: examining markets in former program states and current program states. One recent market assessment study leveraged such a natural experiment to understand long-term trends in saturation as well as the impact of exiting the residential lighting market. As part of the study, evaluators compared the market in Massachusetts, which has continuing program support, with the market in New York, which has discontinued support. The results provide compelling evidence that, in the absence of programs, efficient bulb saturation may be backsliding and saturation of halogen bulbs increasing.

Introduction

In this paper, we focus primarily on long-term trends observed in two Northeastern states—Massachusetts and New York (MA 2015). In addition, we draw on corroborating evidence provided by a recent lighting saturation study completed in Connecticut (CT 2015) and a white paper prepared by the Northeast Energy Efficiency Partnerships (NEEP; Miziolek, Wallace, and Lis 2015). Both Massachusetts and New York have histories of upstream residential lighting program support and evaluation. In 2012, New York began to exit the residential upstream market with the cessation of standard spiral CFL incentives and essentially ceased all upstream incentives (for CFLs and LEDs) in 2014. In contrast, Massachusetts has continued to support both CFLs and LEDs, with an emphasis on LEDs in recent years. Given their close proximity as well as similar demographics and availability of detailed saturation data, the two states offered a unique opportunity to explore the effects of exiting the upstream lighting market.

On-site lighting saturation surveys in New York served as a proxy to help understand what may have happened in Massachusetts had the Massachusetts Program Administrators (PAs) similarly eliminated standard spiral CFL incentives in 2012 during the same period. It also provided some insights into what might happen if Massachusetts were to remove upstream incentives during the 2016 to 2018 program cycle, though it may be too early to judge what will happen with LEDs since the market is changing so rapidly. In addition, it is as of yet too early to judge what impact, if any, the ENERGY STAR® Lamps Specification 2.0 or the second stage of EISA—to be implemented in 2020—will have on the lighting market. Further, analyses from two recently completed studies show that the breadth of EISA coverage may not be as complete as initially considered.

Methodology

We derived our data from on-site visits in both states, with on-site participants recruited via consumer surveys. After completing the consumer survey, we offered each survey respondent an incentive to participate in an on-site visit to his or her home. The team randomly selected participants from among all survey respondents voicing interest and called to set up on-site visits. From 2013 through 2015, the evaluation team completed nearly 1,000 on-site visits—228 in New York and 765 in Massachusetts (Figure 1). There were two types of visits: new visits and panel visits.

New visits. During each on-site visit, a trained technician gathered detailed information on each socket in the home as well as all bulbs found in storage.

Panel visits. Panel visits were conducted with households that had previously been visited, gathering data similar to that gathered in the new visits and also recording which bulbs had been replaced and with what type of bulb.

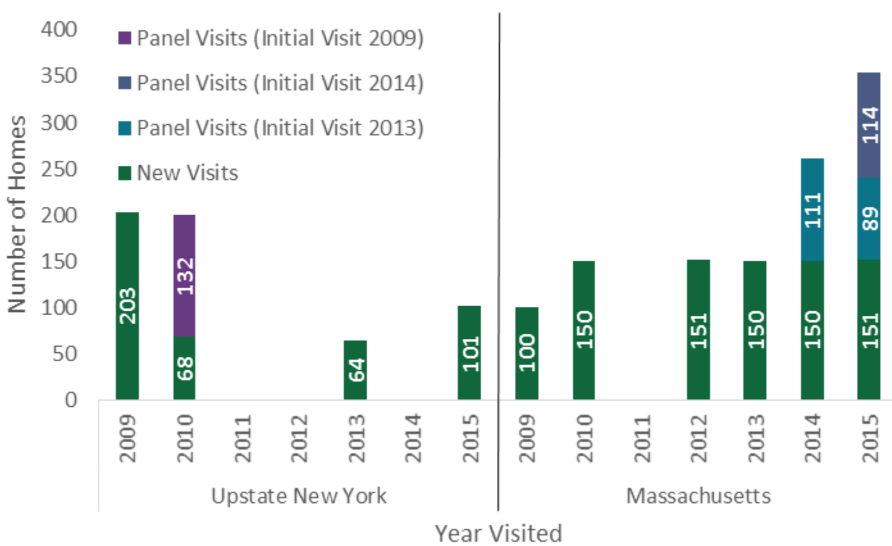

Figure 1. On-site lighting visits by year, state, and visit type.

Interpolation for missing years. While both Massachusetts and New York have conducted numerous socket saturation studies since 2009, the time series does have gaps. Saturation studies were not conducted in New York in 2011, 2012, or 2014, or in Massachusetts in 2011. To account for the gaps and provide a complete time series, we used straight-line interpolation to provide estimates for missing years.

Timing of on-site visits. It is important to note that the timing of on-site visits has varied somewhat across years. While evaluators have generally separated data collection by at least 12 months, in 2015 the Massachusetts on-site visits took place only five months after the 2014 visits. In 2013 and 2015, the Massachusetts sponsors coordinated the timing of on-site visits in Massachusetts and New York so that they offered comparable snapshots. An overview of on-site visit timing is provided in Figure 2.

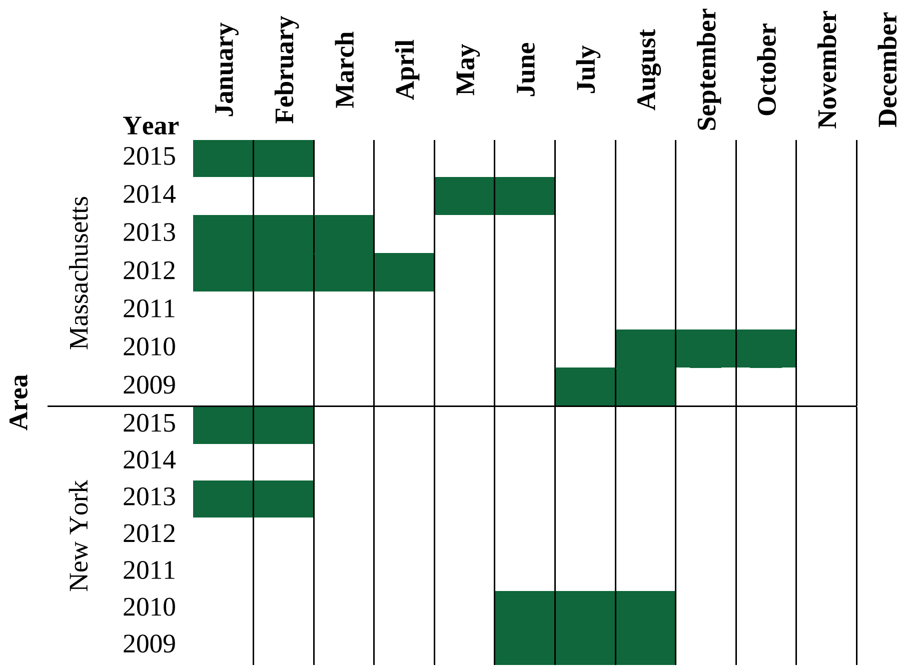

Figure 2. Timing of on-site lighting visits by year and state.

Examination of Potential Study Effects. As discussed in the 2015 IEPEC paper (Barclay et al. 2015), the authors compared key data for variables from Wave 1 and Wave 2 panelists to data from new visits in the same year. The purpose of this analysis was to identify any systematic differences between the two on-site samples in order to assess whether any reactive or Hawthorne[1] effects were occurring among panelists. The analysis found that the panel and new visits showed very similar or identical levels of penetration, saturation, and purchase behavior. The similarity of the data between the pool of potential panelists and the panelists in each wave suggests that there are few or no reactive effects or Hawthorne-type effects on panel saturation rates.

[1] The Hawthorne effect, also called reactive effects or observation bias, occurs when subjects of an experiment alter behavior due to observation.

Results and Analysis

Socket Saturation Trends over Time

In this section, we examine socket saturation data (i.e., the percentage of sockets filled with a particular bulb type) from the on-site visits. Since socket saturation has been tracked over time in both states, we are able to draw conclusions based not only on spot estimates for 2015 but also on trends that can be observed between 2009 and 2015.

Figure 3 provides time series data available for Massachusetts for five bulb categories: LEDs, CFLs, Linear Fluorescents, Combined Inefficient (incandescent and halogens), and Combined Efficient (LEDs and CFLs). Note that we combined halogens and incandescents in this figure due to the difficulty in distinguishing some halogen bulbs from standard incandescent bulbs.

The data in the figure clearly show a steady increase in efficient bulb saturation (15% since 2009 or 2.5% per year, on average) and a corresponding decrease in inefficient bulb saturation (18% since 2009 or 3% per year, on average). CFL adoption drove gains in efficient bulb saturation between 2003 and 2013, and increased LED adoption coupled with stable levels of CFL and linear fluorescent saturation explain gains between 2014 and 2015.

As mentioned previously, it is important to note that the 2015 on-site visits took place only five months after the 2014 visits. The 2015 on-site findings may at first appear to suggest that the Massachusetts lighting market showed limited directional change from 2014 and 2015. However, given the short time that elapsed between on-site visits, detecting changes at all is an indication of the rapid market changes taking place.

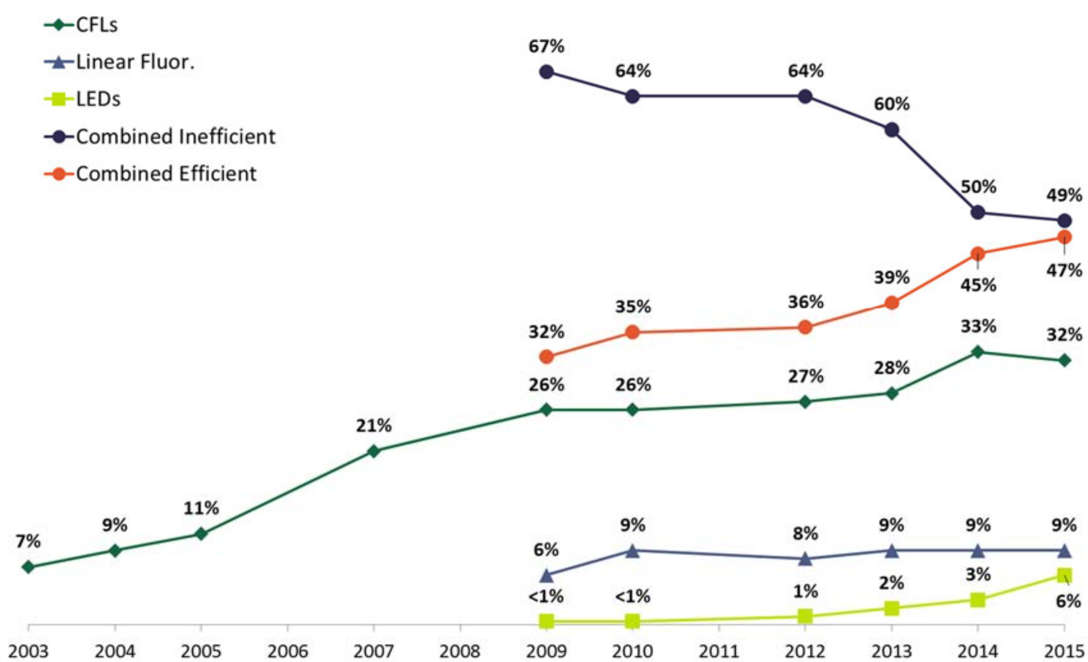

Figure 3. Massachusetts saturation over time.

Figure 4 presents the combined saturation of CFLs and LEDs as well as inefficient (incandescent and halogen) bulbs found in households in New York and Massachusetts between 2009 and 2015.[2] When we compare the two states, we see that, prior to 2013; the two states had similar levels of efficient and inefficient bulb saturation. However, between 2013 and 2015, saturation in the two states began to diverge.

In 2013, CFLs and LEDs combined accounted for 30% of all bulbs installed in sockets in Massachusetts and 27% of all sockets in New York. In 2015, CFLs and LEDs combined accounted for 38% of all bulbs installed in sockets in Massachusetts (a statistically significant increase) and only 25% of bulbs installed in sockets in New York (a relative decrease).

Between 2013 and 2015, the combined saturation of incandescent and halogen bulbs in Massachusetts decreased significantly by 11 percentage points (60% to 49%), while in New York it increased marginally by two percentage points (57% to 59%). The increase in New York is driven by halogens, as discussed below and shown in Figure 5.

Importantly, the divergence observed between the two states closely aligns with changes in program activity in New York. As mentioned previously, New York began to exit the residential upstream market with the cessation of standard spiral CFL incentives in 2012 and essentially ceased all upstream incentives (for CFLs and LEDs) by the end of 2014. In contrast, Massachusetts has continued to support both CFLs and LEDs, with an emphasis on LEDs in recent years.

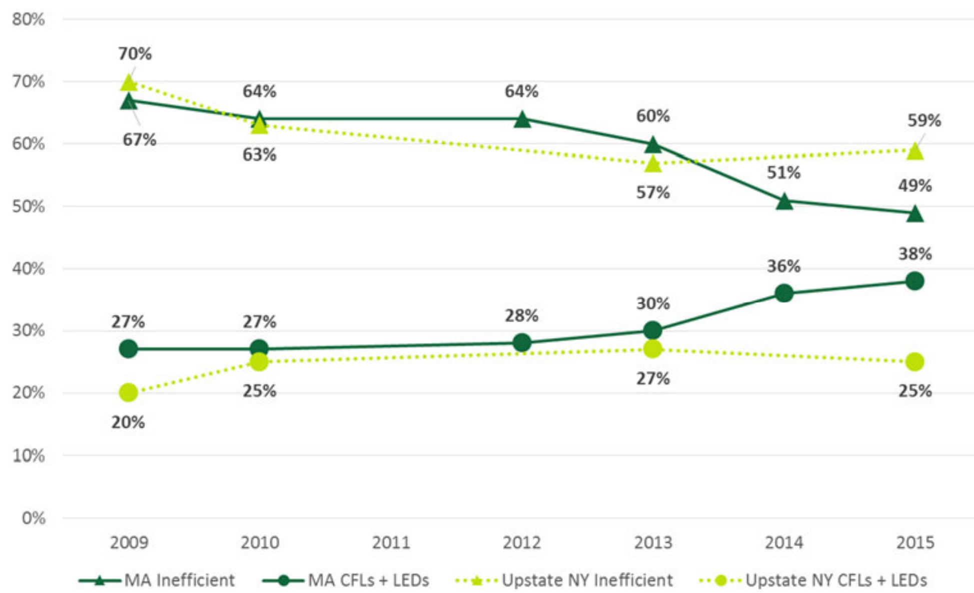

Figure 4. Inefficient and efficient saturation trends by state.

To aid in understanding the trends observed in Massachusetts and New York, we examined saturation for the four bulb types for which we saw changes between 2013 and 2015. As Figure 5 shows, CFL saturation decreased from 26% to 22% in New York, while halogen saturation doubled from 4% to 8% and LED saturation increased from 1% to 3%. Meanwhile, in Massachusetts, halogen saturation also increased, but only from 5% to 6% over the same period, and LED saturation increased from 2% to 6%.

[2] Here we exclude linear fluorescent bulbs and focus on LEDs and CFLs because linear fluorescent socket saturation is relatively unchanged in both states between 2009 and 2015.

The data suggest that, in the absence of standard CFL incentives, New York has been losing CFL saturation in favor of halogen and LED adoption, whereas Massachusetts has managed to maintain CFL saturation while increasing LED saturation and avoiding large gains in halogen saturation.

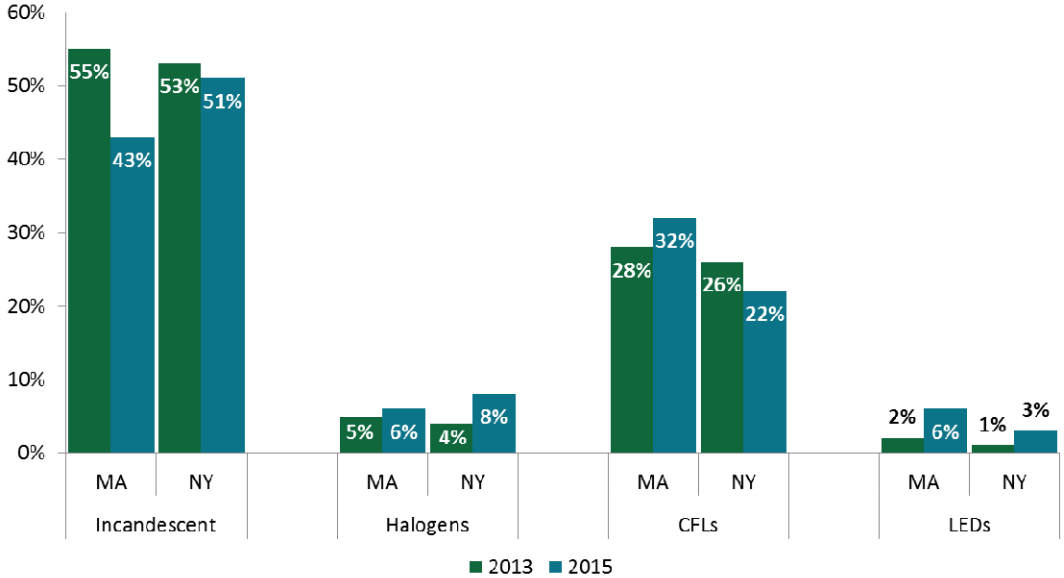

Figure 5. Massachusetts and New York saturation, 2013 and 2015.

Penetration Trends over Time

Adding further evidence to the conclusion that New York is experiencing backsliding, CFL penetration (the percentage of homes with at least one CFL installed) in New York decreased from 91% in 2013 to 88% in 2015 and is significantly lower compared to Massachusetts, which has held steady at 96% since 2013.

In Massachusetts, LED penetration (the percentage of homes with at least one LED installed) has increased significantly each year since 2013 while LED penetration in New York remained statistically unchanged between 2013 and 2015. Massachusetts LED penetration nearly doubled between 2013 (12%) and 2014 (23%) and reached 33% in 2015. Interestingly, despite the fact that both states had statistically similar levels of LED penetration in 2013 (12% in Massachusetts and 17% in New York), in 2015 Massachusetts LED penetration (33%) is significantly higher compared to New York (21%).

Table 1. Bulb penetration, 2009 – 2015

Sockets Containing	Massachusetts			New York	
	2013	2014	2015	2013	2015
Sample Size	150	261	354	127	101
CFLs	96%	96%	96%	91%	88%[c]
LEDs	12%	23%[a]	33%[ab]	17%	21%[c]

[a] Significantly different from MA 2013 at the 90% confidence level.
[b] Significantly different form MA 2014 at the 90% confidence level.
[c] Significantly different from MA 2015 at the 90% confidence level.

Awareness, Familiarity, and Bulb Preferences

To help understand how consumers choose what bulbs to purchase, the 2015 consumer surveys asked respondents about various factors that might inform their light bulb purchases and assessed their awareness and familiarity with energy-efficient light bulbs.

In the 2015 consumer surveys, we asked households in Massachusetts and New York to rate their familiarity with LEDs, CFLs, and halogens using the following options: very familiar, somewhat familiar, not too familiar, or not at all familiar. Households in both states reported similar levels of familiarity for CFLs and LEDs, and households in New York reported significantly higher levels of familiarity with halogen bulbs.

The findings related to halogen familiarity appear to align with higher levels of halogen saturation found in New York. However, despite similar levels of familiarity with LEDs and CFLs, New York households lag behind Massachusetts households in efficient saturation.

Table 2. Familiarity

	Massachusetts	New York
Sample Size	478	398
LED Familiarity	57%	57%
CFL Familiarity	78%	79%
Halogen Familiarity	57%	66%*

*Significantly different from MA at 90% confidence level

As a further assessment of energy-saving bulb awareness and familiarity, respondents who indicated that they were somewhat or very familiar with both CFLs and halogens were asked which bulb type used less energy to produce light. Among those who chose the correct answer, there were no significant differences between respondents in Massachusetts and New York (55% and 53%, respectively). This means that even though a large portion of New York respondents know that CFLs use less energy, they are still more likely than MA residents to choose halogens over CFLs.

It is worth noting that about one-third of respondents in both states (32% in MA and 33% in NY) were unable to answer the question correctly. Nearly equal proportions of respondents in both states thought CFLs and halogen bulbs used about the same energy (13% and 14%) or stated they did not know which of the two bulbs uses less energy (19% and 19%).

Table 3. Judgments about relative energy use

Which bulb uses less energy?	Massachusetts	New York
Sample Size	401	271
CFLs use less energy	55%	53%
Halogens use less energy	13%	14%
They use about the same	13%	14%
Don’t know	19%	19%

Bulb Replacements

Between 2013 and 2015, we conducted a total of 314 panel visits in Massachusetts (111 in 2014 and 203 in 2015). During these panel visits, technicians were able to observe actual bulb replacements—that is, the choices customers made when they removed a bulb from a socket and replaced it with a bulb from storage or another socket, or a bulb that was newly acquired. Because bulbs were marked during initial visits, technicians did not have to rely on self-reported behavior but instead were able to identify which bulbs were replaced.

Figure 6 provides the breakdown of replaced and replacement bulbs in Massachusetts panel homes between 2013 and 2015. These observed replacement findings provide additional context when interpreting the saturation trends observed in Massachusetts during the same period. As discussed at length in the 2015 IEPEC paper (Barclay et al. 2015), the data reveal that CFLs were most commonly chosen to replace other bulbs between 2013 and 2015 in Massachusetts. In fact, of the 1,522 bulbs replaced by panelists between 2013 and 2015, CFLs were chosen as replacements 49% of the time—nearly twice as frequently as the next most common choice (incandescents—25%). LEDs (17%) were the third most commonly chosen replacement, followed by empty sockets (6%), halogen bulbs (2%), and linear fluorescents (1%).[3]

While similar panel data does not exist for New York over this period, we can speculate from the saturation data collected that CFLs and LEDs were chosen less frequently as replacements in New York and that incandescent and halogen bulbs were chosen more frequently. This shortcoming in the data was identified by the Massachusetts PAs, and they have elected to begin a panel study in New York, the results of which will be available, along with additional panel results for Massachusetts, in June 2016. This new source of data will provide additional detail and will allow for apples-to-apples comparisons in the future.

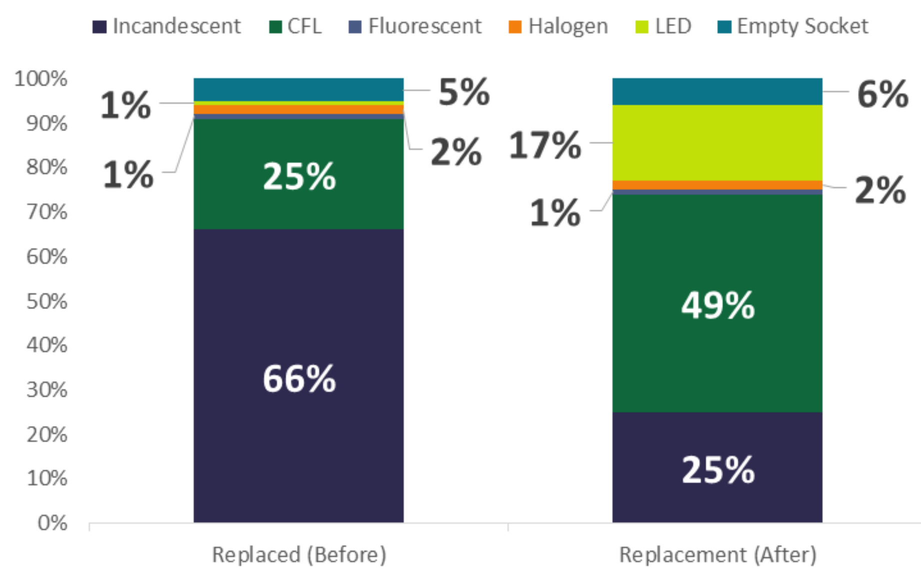

Figure 6. Observed bulb replacements in Massachusetts, 2013 to 2015 (n = 1,522).

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[3] Linear fluorescent tubes were only replaced by other linear fluorescent tubes—thus, the proportion is the same before and after.

Incandescents and CFLs comprise the majority of bulbs replaced between 2013 and 2015—93% of all bulbs replaced. When we examine what bulbs most commonly replaced incandescents and CFLs, the importance of CFLs in the marketplace in Massachusetts becomes readily apparent. Despite consumers' reported preferences for LEDs over CFLs, CFLs were the most commonly chosen bulb to replace any bulb type (including other CFLs). These data help lend support to the theory that by continuing to support CFLs while the LED market develops, the Massachusetts PAs have successfully avoided potential backsliding among customers who may otherwise have been unwilling to purchase more expensive LEDs or unsubsidized CFLs. It is this lack of CFL support that we believe has led to the signs of backsliding observed in New York during the same period. Coupled with lack of CFL support, the New York market must also deal with higher LED prices due to the lack of upstream LED programs.

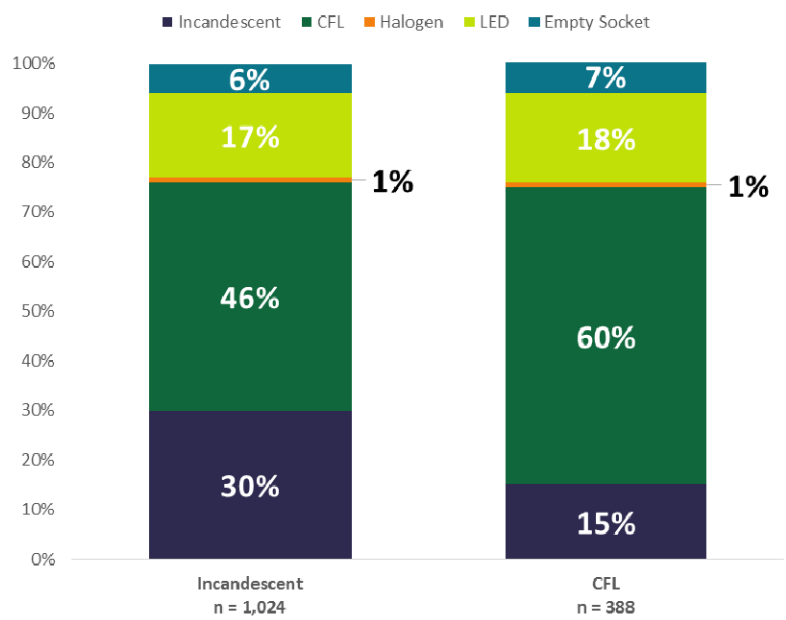

Figure 7. What replaced incandescents and CFLs in Massachusetts.

Impact of EISA

EISA 2007 set maximum wattage levels by lumen output for medium screw-base bulbs, ranging from 310 to 2,600 lumens, and operating at a range from 110 to 130 volts. The standards took effect through a phased process, beginning in 2012 (Stage 1). Table 4 shows the schedule for Stage 1. In Stage 2, slated to begin January 1, 2020, all general service bulbs must meet a much higher lumen-per-watt standard (85 to 100 lumens per watt).[4] This standard does not apply to 22 categories of "specialty" incandescent bulbs (such as three-way bulbs, outdoor bug lights, reflectors, and appliance lights).

Stage 1 of EISA 2007 prohibits the manufacture and import of non-compliant bulbs but does not affect the sale or use of such bulbs. For this reason, as observed in other studies, standard incandescent bulbs have remained available to consumers on retailers' shelves long after the implementation of EISA 2007 (NMR 2015). Stage 2 of EISA, as currently drafted,

[4] http://energy.gov/sites/prod/files/2016/02/f29/General%20Service%20Lamp%20NOPR_1.pdf

would prohibit not only the manufacture of non-compliant bulbs but also their sale. Prohibiting sales coupled with much higher lumen-per-watt standards means that EISA Stage 2 is likely to have a larger impact on the residential lighting market than Stage 1.

Table 4. EISA phase-in schedule

Rated Lumen Ranges	Typical Incandescent Lamp Wattage	Maximum Rate Wattage	Effective Date
1,490–2,600	100	72	1/1/12
1,050–1,489	75	53	1/1/13
750–1,049	60	43	1/1/14
310–749	40	29	1/1/14

Two recent studies, a NEEP white paper (Miziolek, Wallace, and Lis 2015) and a recent Connecticut Residential Market Assessment (NMR 2016) have tried to help place the impact of EISA on the market in context. For this analysis, the authors grouped installed bulbs into three categories: covered by EISA, exempt from EISA, and non-general service bulbs (outside the realm of EISA). As Figure 8 shows, while the two analyses do not agree on a single estimate, they both conclude that EISA applies only to a subset of the residential lighting market.

The Connecticut study found that nearly one-half (44%) of installed bubs in Connecticut were not covered by EISA and, the NEEP paper found that nearly two-thirds (64%) of bulbs currently being sold are not covered by EISA. This means that both studies found that a large proportion of bulbs are not directly covered by EISA. This led NEEP to conclude that great opportunities remain for efficiency programs to remain engaged with the residential lighting market.

The differences between the two studies' findings may be explained by differences in methodology. The analysis for the Connecticut study relied on on-site lighting inventory data (installed bulbs), whereas the NEEP estimates were developed based on secondary shelf-stocking data for the Northeast region (which were not sales-weighted).

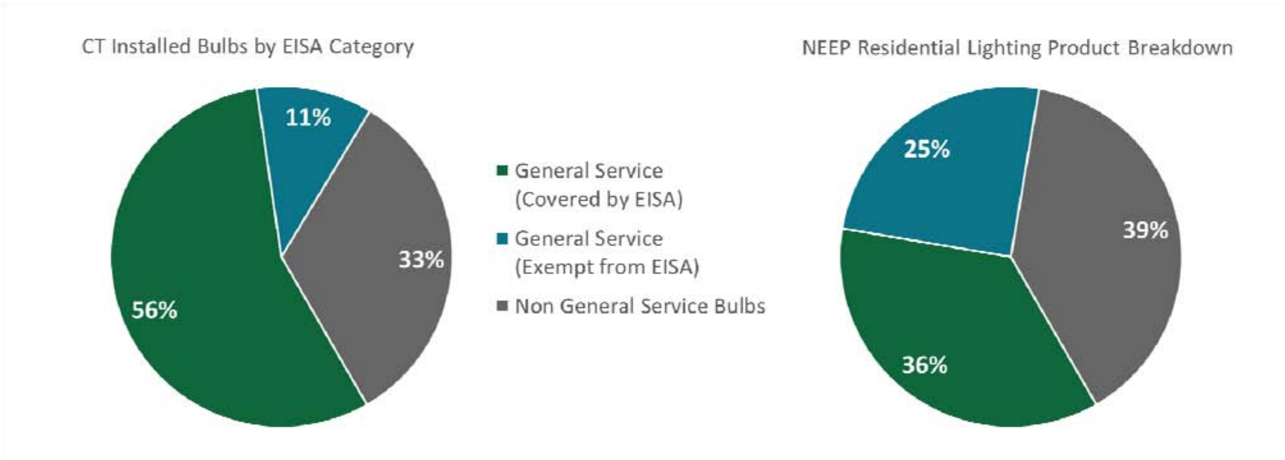

Figure 8. EISA coverage estimates.

Conclusions

Data from these recently completed market assessments in Massachusetts and New York, as well as 15 years of market indicator data, lead to the inescapable conclusion that the Massachusetts upstream lighting program has had a clear and dramatic impact on the residential lighting market in Massachusetts in favor of energy efficiency. In addition, two recent studies show that only a subset of bulbs installed in residential homes are covered by EISA, indicating that the impact of the first stage of EISA on the market may be more limited than expected by stakeholders who assumed EISA would effectively transform the market without the need for further upstream incentives. Finally, although the market is in an era of rapid change, the research suggests that it may not yet be transformed (meaning: able to sustain or increase levels of sales and market saturation in the absence of incentives), that removing program support may lead to backsliding, and that, ultimately, opportunities remain for further program efforts.

Key Findings

CFL and LED saturation in Massachusetts increased significantly between 2013 and 2015, while remaining statistically similar in New York during the same time period. In 2013, CFLs and LEDs combined accounted for 30% of all bulbs installed in sockets in Massachusetts and 27% of all sockets in New York. In 2015, CFLs and LEDs combined accounted for 38% of all bulbs installed in sockets in Massachusetts (a statistically significant increase) and only 25% of bulbs installed in sockets in New York (a relative decrease).

LED penetration in Massachusetts increased significantly between 2013 and 2015 while LED penetration observed in New York was statistically unchanged over the same period. In 2013, LED penetration was statistically similar in Massachusetts (12%) and New York (17%). Between 2013 and 2015, LED penetration increased significantly in Massachusetts (33%) while remaining statistically unchanged in New York (21%—a relative increase). This means that despite starting at similar levels of LED penetration in 2013, in 2015 LED penetration in Massachusetts is statistically higher compared to that in New York.

In the absence of standard CFL programs, New York has been losing CFL saturation in favor of halogen and LED adoption. Between 2013 and 2015, CFL saturation decreased from 26% to 22% in New York, while halogen saturation doubled from 4% to 8% and LED saturation increased from 1% to 3%. Meanwhile, in Massachusetts, halogen saturation also increased, but only from 5% to 6% over the same period, and LED saturation increased from 2% to 6%. While 2015 Massachusetts LED saturation (6%) is double that in New York (3%), the two estimates are statistically comparable.

The New York participants showed signs of backsliding, with increases in inefficient bulb saturation. Between 2013 and 2015, the combined saturation of incandescent and halogen bulbs in Massachusetts decreased by 11 percentage points (60% to 49%), while New York's increased by two percentage points (57% to 59%). The increase in New York is driven by halogens, as discussed above.

Efficient bulb saturation decreases in New York may be driven by reduced CFL purchases in the absence of program support. Given replacement trends observed in the Massachusetts panels, we can speculate that a main driving force behind backsliding in New York is a lack of new CFL purchases. As the panel visits show, incandescent and CFLs comprise the majority (93%) of bulbs being replaced between 2013 and 2015 in Massachusetts, where CFLs are by far the most common replacement choice. These data help lend support to the theory that by continuing to support CFLs while the LED market develops, the Massachusetts PAs have successfully avoided potential backsliding from customers who may otherwise have been unwilling to purchase more expensive LEDs or unsubsidized CFLs.

EISA 2007's impact on the residential lighting market may not be as far-reaching as initially theorized by some program administrators and regulators who assumed EISA would complete market transformation through mandate. A recent study in Connecticut found that just over one-half (56%) of installed bulbs are covered by EISA, and another suggests that when looking at bulbs available for purchase, fewer than two-fifths (36%) of bulbs on retailers' shelves are covered by EISA. This may mean that not even EISA Stage 2 will be able to transform the market on its own. However, the specifications for EISA Stage 2 are still subject to change, so it is too early to make an assessment of potential impact to the market.

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