Keep Calm and Carry On: Why Upstream Lighting Programs Are Still Important

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ABSTRACT

Historically, residential lighting programs have accounted for the largest share of all residential energy savings. In recent years, the implementation of the Energy Independence and Security Act of 2007 (EISA) and the introduction of LEDs into the marketplace have drawn into question the longevity of program-induced savings from residential lighting programs. The data presented in this paper will help inform program administrators as they make crucial decisions on how to allocate limited program funds.

Data for this study is based on on-site lighting inventories conducted nearly annually in two states from 2013 through 2017. Data collection for the current wave of the study took place between October 2016 and January 2017. The sample also includes a panel of homes that have been visited multiple times over the course of several years in both states

The primary objective of this study is to track residential lighting market indicators and to examine them for emerging trends and issues brought about by technological change and increased efficiency standards. There is a special emphasis on the adoption of ENERGY STAR LEDs in program and non-program states.

The research suggests that the market is still undergoing rapid change and may not yet be transformed. Residential lighting program administrators need to carefully consider when and if to exit the lighting market to avoid consumer backsliding, undoing the progress and investments made in retail lighting programs.

Introduction

In this paper, we focus primarily on long-term trends observed in two Northeastern states—Massachusetts and New York (MA 2017). Both Massachusetts and New York have long 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 supported CFLs through the end of 2016 and continues to support LEDs. Given their 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 serve 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 or at some point thereafter.

Methodology

The data for this paper were derived from a series of longitudinal studies conducted on behalf of the Massachusetts Program Administrators that includes New York as a comparison area. (NMR 2017, NMR 2016, NMR 2015) Owing to the complexity and comprehensiveness of these studies, this paper is one of two being presented at IEPEC Baltimore 2017. This paper focuses on comparisons between Massachusetts and New York. The companion paper, *It's Déjà Vu All Over Again: More Revelations from a Lighting Panel Study,* von Trapp, et al, focuses on overall approaches, methodology, longitudinal results, and replacement behavior. Here we present an overview of methods for the study, additional details can be found in the more methods-heavy companion paper.

Data for this paper was collected through on-site lighting inventories conducted in both states, with on-site participants recruited via consumer surveys. The team randomly selected and called participants from among all survey respondents voicing interest in setting up on-site visits. From 2013 through 2017, the evaluation team completed more than 2,150 on-site visits—506 in New York and 1,650 in Massachusetts (Figure 1). There were two types of visits: new visits and panel visits.[1] 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.

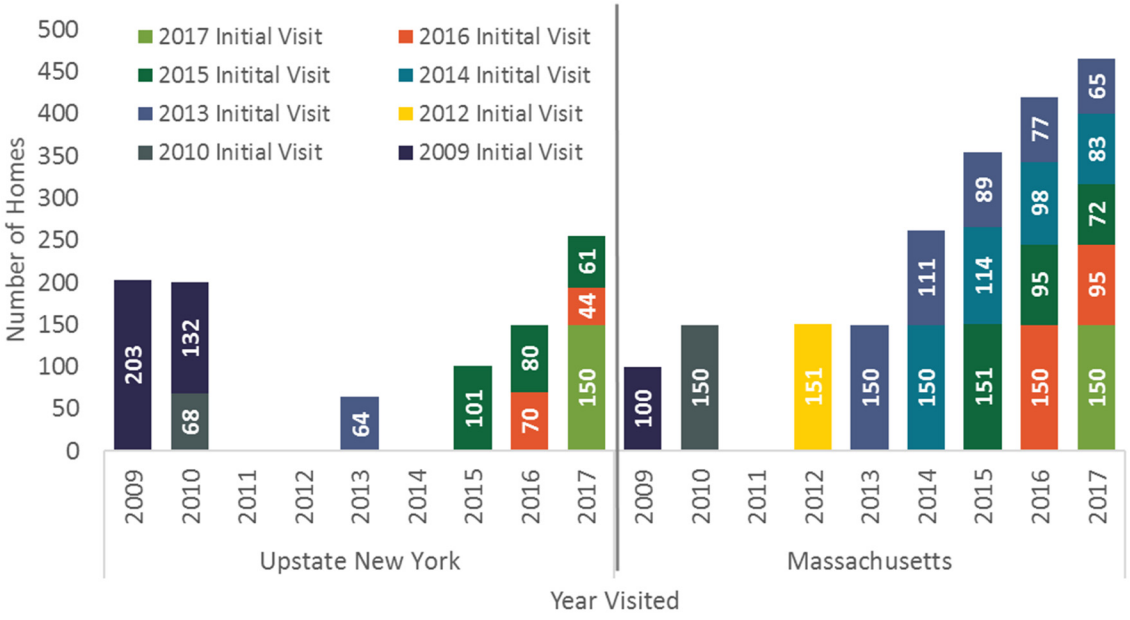


Figure 1. On-site lighting visits by year, state, and visit type

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.

It is important to note that the timing of on-site visits has varied somewhat across years. An overview of on-site visit timing is provided in Figure 2. 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, 2016, and 2017, the Massachusetts sponsors coordinated the timing of on-site visits in Massachusetts and New York so that they offered comparable snapshots.

[1] Additional details on panel methods can be found in the more methods-heavy companion paper also being presented at IEPEC 2017 (von Trapp, et al.)

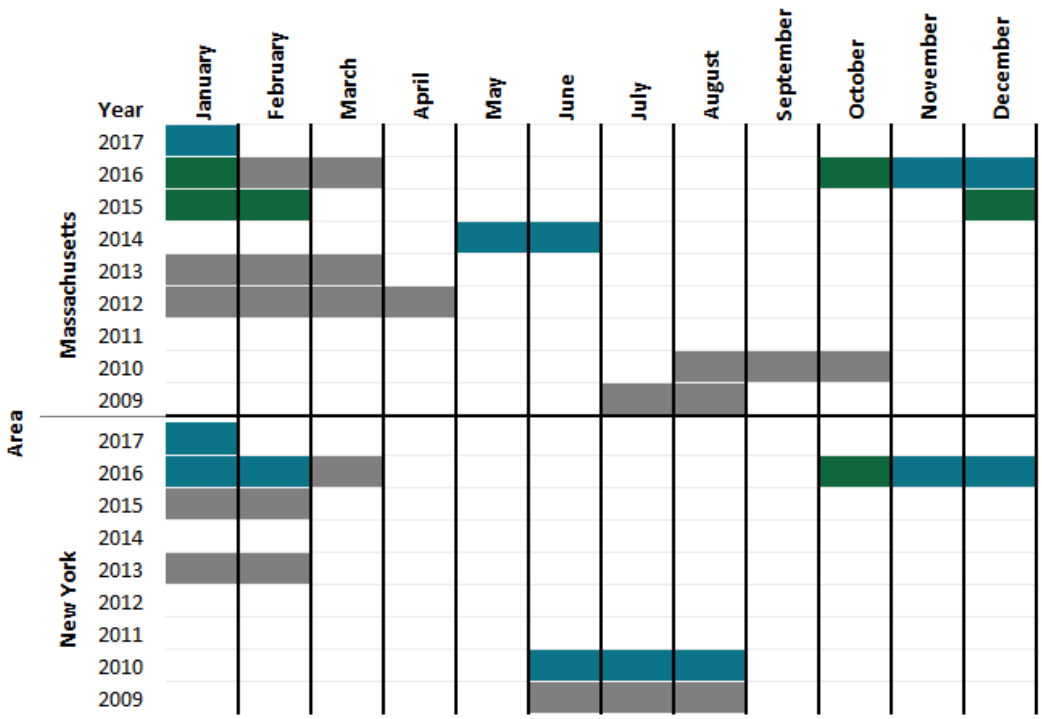


Figure 2. Timing of on-site lighting visits by year and state

As discussed in the 2015 IEPEC paper (Barclay et al. 2015), the authors compared key data for variables from Wave 1, Wave 2, Wave 3 and Wave 4 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 to assess whether any reactive or Hawthorne[2] 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.

For additional methodological details, please see the full 2016-17 Market Assessment report (NMR 2017) or the companion IEPEC paper (von Trapp, et al.).

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 2017 but also on trends that can be observed between 2009 and 2017.

Figure 3 provides time series data available for Massachusetts for six bulb categories: LEDs, CFLs, Linear Fluorescents, Incandescent and Halogens combined, LEDs and CFLs combined, and LEDs, CFLs and Linear Fluorescents combined.

The data in the figure show a steady increase in efficient bulb saturation (22 percentage points since 2009 or just under three percentage points per year, on average) and a corresponding decrease in inefficient bulb saturation (26 percentage points since 2009 or just over three percentage points 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. From 2015 to

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

2017, gains in energy efficient bulb saturation were mainly dominated by LED adoption as CFL saturation began to decrease and linear fluorescent saturation stayed the same.

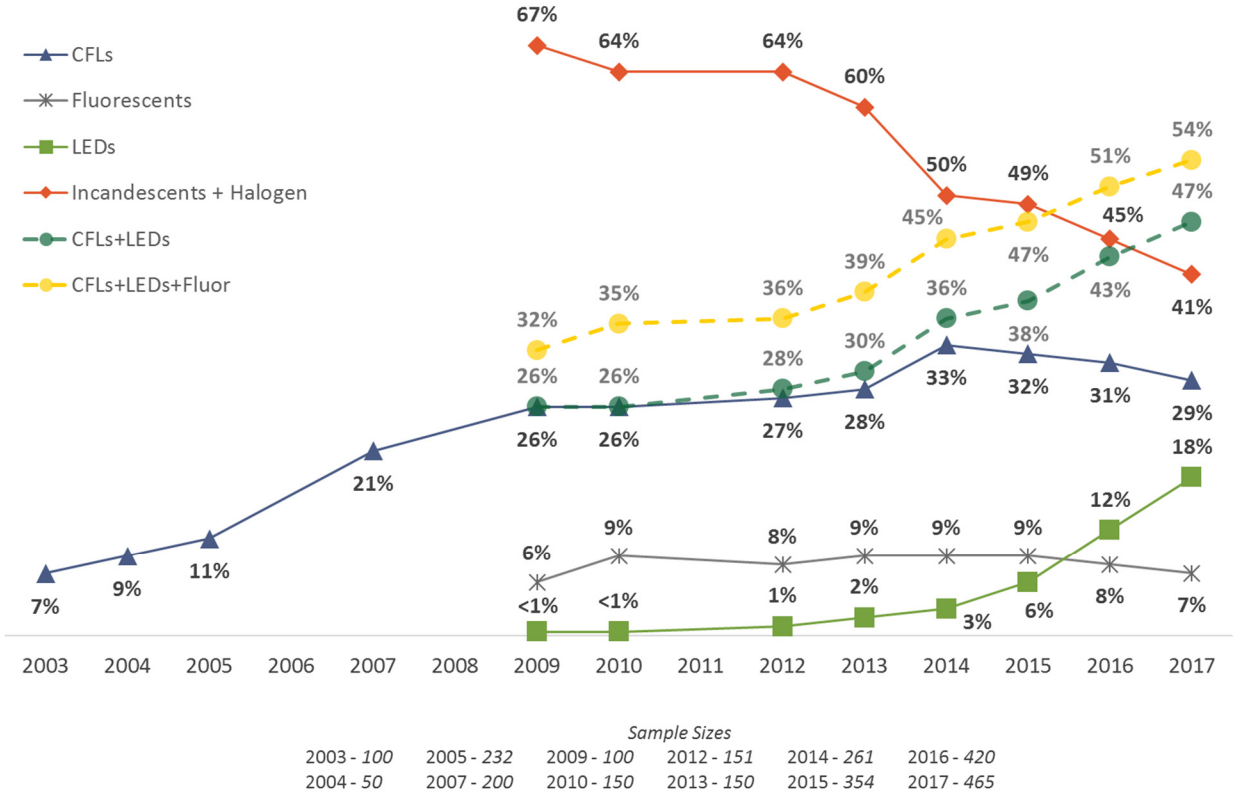


Figure 3. Massachusetts saturation over time

Figure 4 presents the combined saturation of CFLs and LEDs as well as inefficient (incandescent and halogen) bulbs found in households in New York (dotted lines) and Massachusetts (solid lines) between 2009 and 2017. In this figure, 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 2017.

As the figure shows, 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. Importantly, the divergence observed between the two states closely aligns with changes in program activity in New York.

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. Between 2013 and 2017, efficient saturation in Massachusetts increased steadily from 30% to 47% while efficient saturation in New York remained relatively flat moving only from 27% to 32%. The lack of growth in New York is in part explained by a backsliding in efficient saturation that occurred between 2013 and 2015 when efficiency saturation decreased relatively from 27% to 25% before beginning to show signs of growth in 2016 and 2017.

Between 2013 and 2017, the combined saturation of incandescent and halogen bulbs in Massachusetts decreased significantly by 19 percentage points (60% to 41%). In New York, combined incandescent and halogen saturation decreased marginally by four percentage points (57% to 53%) from 2013 to 2017.

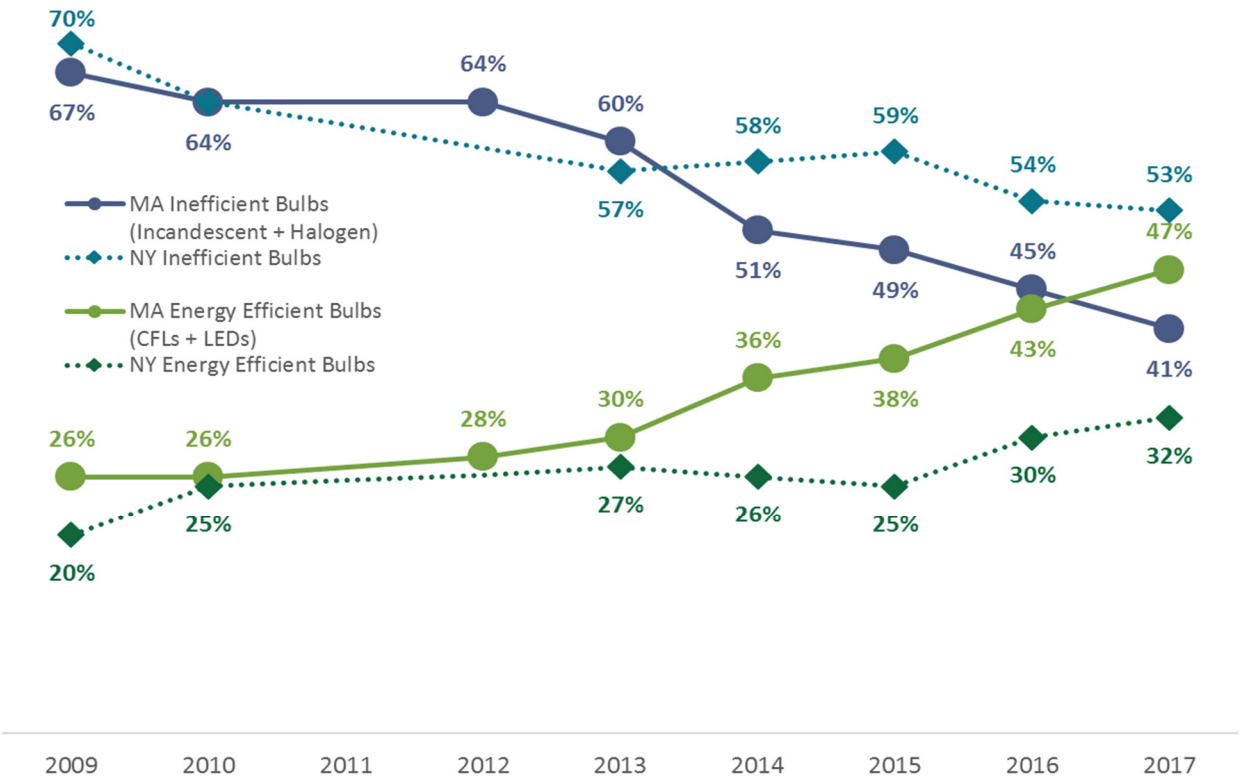


Figure 4. Inefficient and efficient saturation trends by state

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 2017. Figure 5 shows Massachusetts and New York bulb saturation for 2013, and 2015 through 2017, for incandescents, halogens, CFLs, and LEDs. When looking at efficient bulbs, CFLs show no growth in either state since 2013, while LEDs have increased significantly in both, albeit at a faster pace in Massachusetts. Both states show a decline in incandescent saturation since 2013, though incandescent saturation in New York in 2017 is significantly higher than in Massachusetts. Halogen saturation remained steady in both states with minor increases between 2013 and 2017.

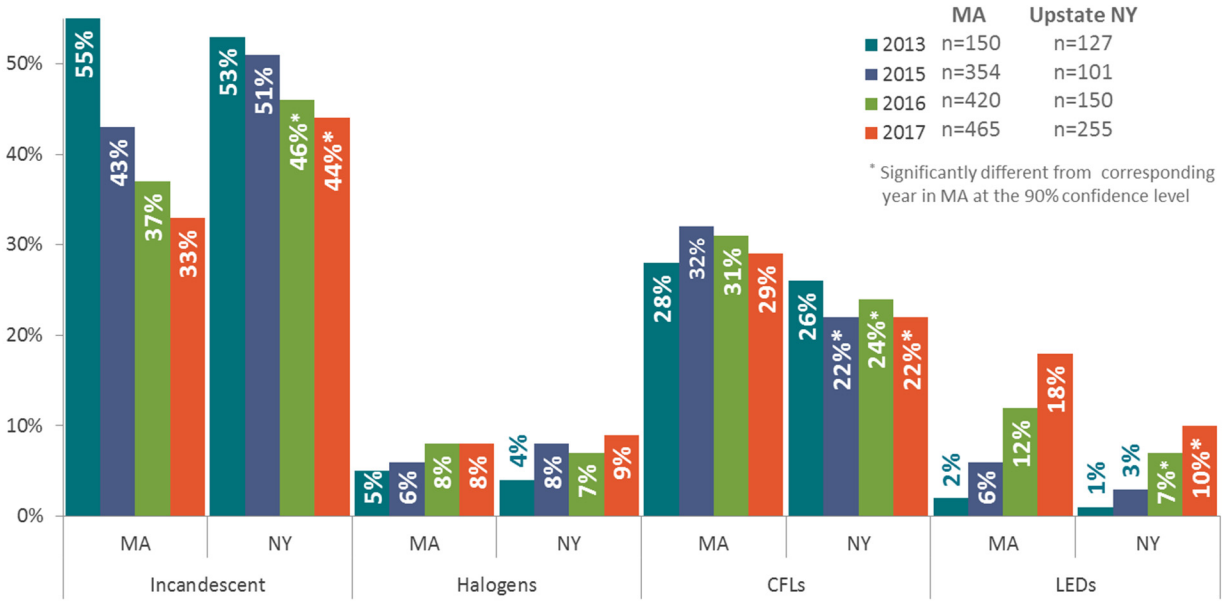
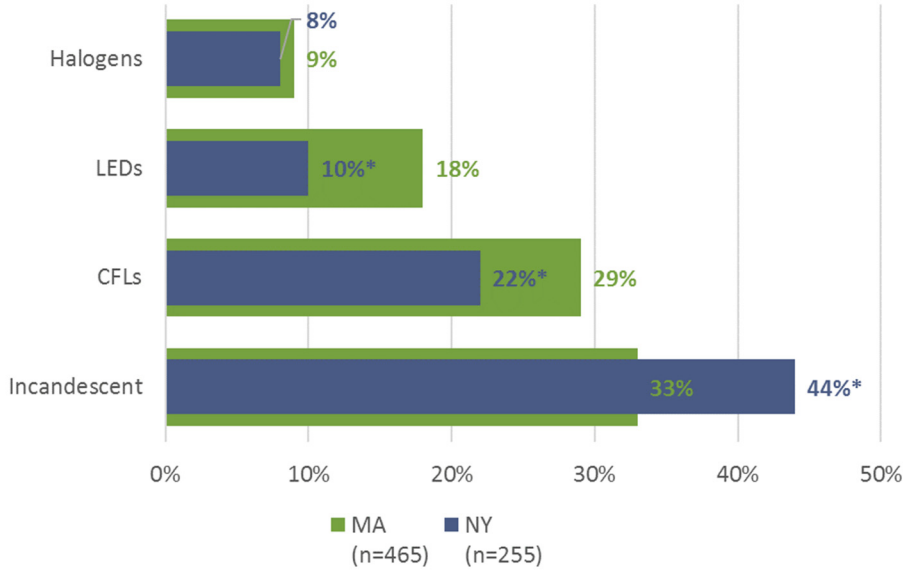


Figure 5. Massachusetts and New York saturation, 2013, 2015, 2016, 2017

Narrowing our focus to just 2017 (Figure 6), we observed significantly higher LED saturation in Massachusetts compared to New York (18% vs. 10%). Similarly, CFL saturation was significantly higher in Massachusetts compared to New York (29% vs. 22%). Following from this, incandescent saturation in Massachusetts was significantly lower compared to New York (33% vs. 44%).



Does not sum to 100% becuase linear fluorescents, "other" bulb types, and empty sockets were not included.
* Significantly different at the 90% confidence level.

Figure 6. Massachusetts and New York Saturation 2017

To further explore the difference in LED saturation between the two states, in 2016 and 2017, on-site technicians collected model numbers for all screw-base LED bulbs, which were then used to determine if an LED was ENERGY STAR qualified or not. The data reveal that ENERGY STAR LED saturation was more than three times as high in Massachusetts compared to New York (10% vs. 3%, a statistically significant difference; Figure 7), and that the increased saturation of ENERGY STAR LEDs accounted for almost the entire difference in LED saturation between the two states, with a one-percentage-point difference in LED fixture saturation accounting for the remaining difference.

Additionally, the percentage of ENERGY STAR LEDs obtained in the past year in Massachusetts (65%) is nearly double the percentage of ENERGY STAR LEDs obtained in New York (37%). This is strong evidence that program support in Massachusetts (which exclusively supports ENERGY STAR products, including LEDs) is driving increased adoption of LEDs in the state.

At the same time, increases in non-ENERGY STAR LED saturation in both states and in ENERGY STAR LED saturation in New York offer evidence of naturally occurring market adoption of LEDs.

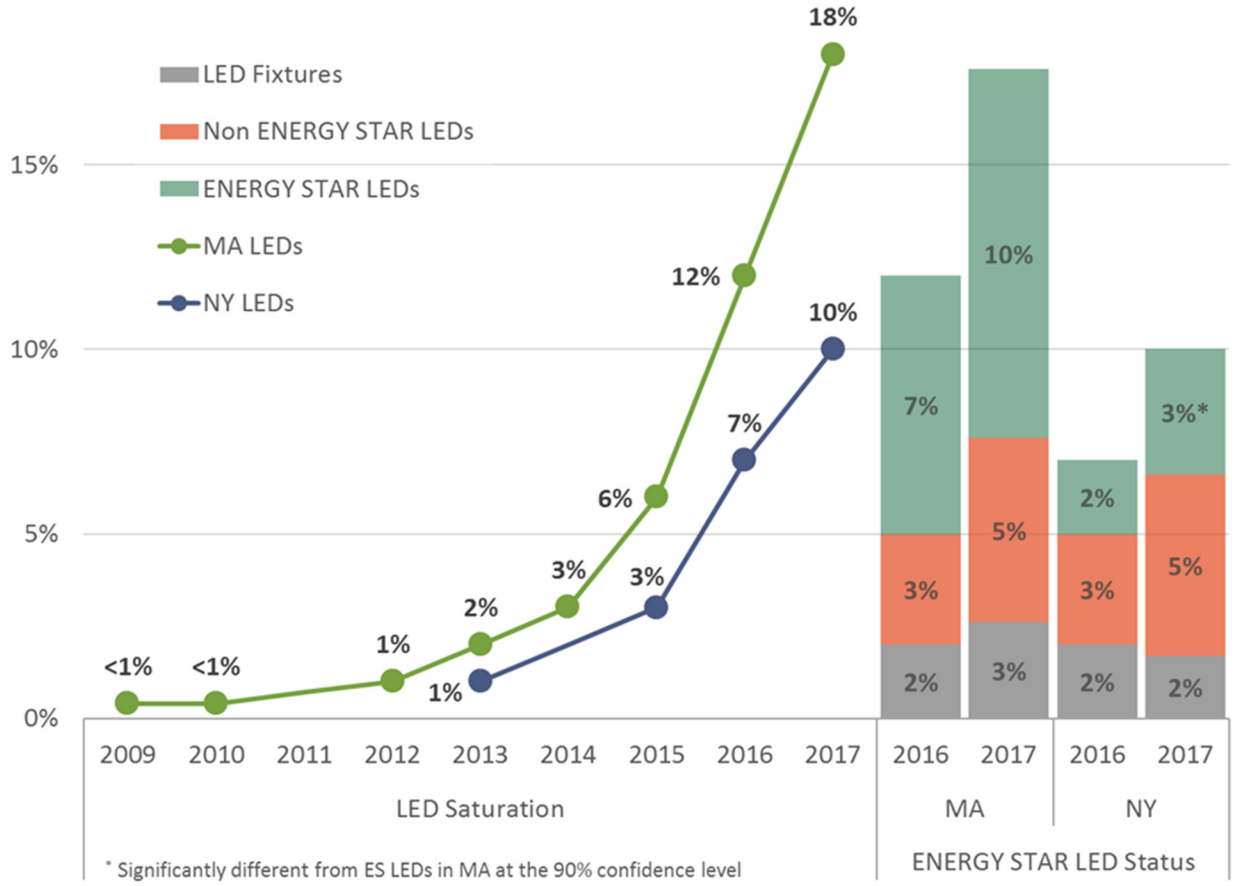


Figure 7. MA & NY LED Bulb Saturation 2009-2017 with ENERGY STAR LEDs in 2016 & 2017

Comparing both LED saturation and LED replacement trends (the percentage of LED bulbs that were installed to replace other bulbs in the past year) by income in both Massachusetts and New York, Figure 8 shows that while low-income households may lag behind their non-low-income counterparts in Massachusetts, they are adopting LEDs at a faster pace than low-income households in New York and at a rate comparable to non-low-income households in New York.

- Within Massachusetts, LED saturation among low-income households was significantly lower than non-low-income households (13% vs. 21%). However, saturation among low-income households in Massachusetts was higher than in low-income households in New York (13% vs. 4%) (left side of Figure 8).
- Low-income households in Massachusetts installed more than four times as many LEDs (40%) as low-income households in New York (8%) (right side of Figure 8)
- Both LED saturation *and* the rate at which LEDs were used as replacement bulbs in Massachusetts low-income households were comparable to the rates of non-low-income households in New York (13% vs. 11% [saturation] and 40% vs. 40% [rate that LEDs were used as a replacement bulb]; dotted orange lines in Figure 8).

This is strong evidence that the Massachusetts lighting programs are having a positive impact on efficient bulb adoption among low-income households. The findings point to similar trends when we compare lighting choices by educational attainment, home type, and tenure.

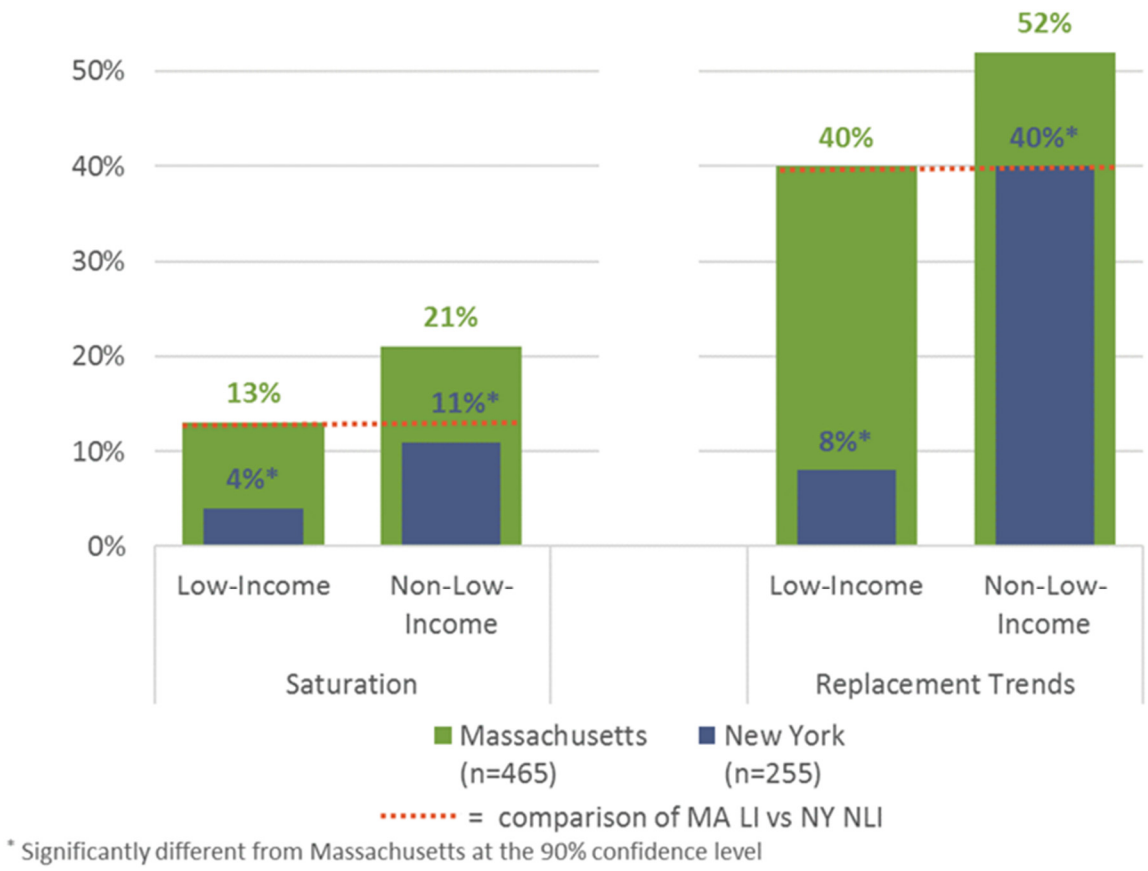
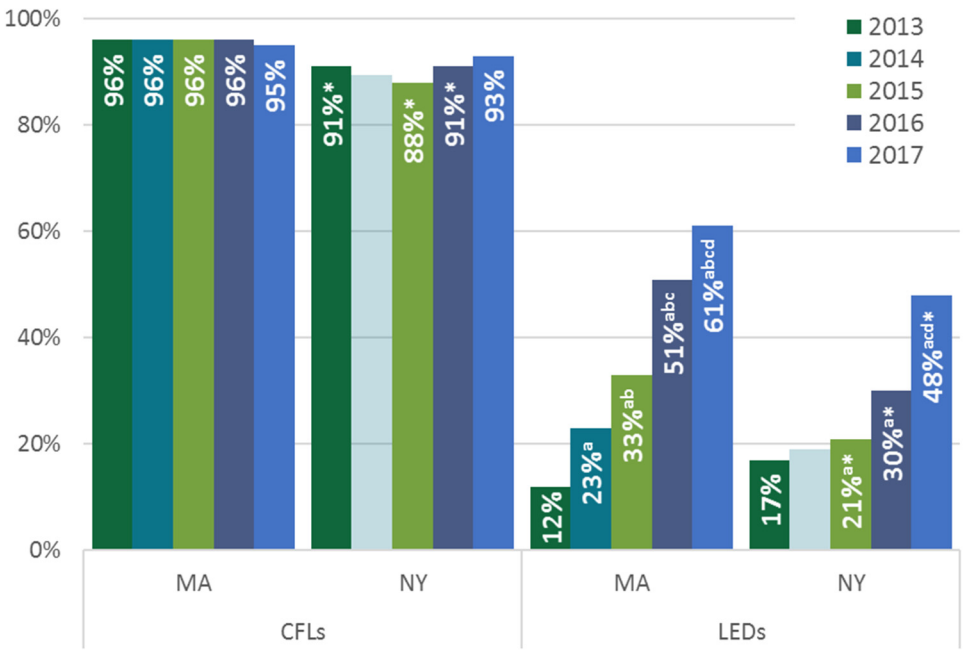


Figure 8. Massachusetts and New York LED Bulb Saturation 2009-2017 with ENERGY STAR LEDs in 2016 & 2017

Penetration Trends over Time

Figure 9 shows penetration by bulb type from 2013 to 2017; as there was no New York study in 2014, penetration for that year is estimated using straight-line interpolation and is shown as faded.

- **LED** penetration, not surprisingly, has increased the most out of all bulb types since 2013 in both states. In Massachusetts, LED penetration has increased significantly each year, with at least one LED present in more than six out of ten (61%) of all homes, up from 51% in 2016. LED penetration in New York also increased in 2017 (from 30% to 48%), but was still significantly lower than in Massachusetts. Even though penetration has increased rapidly, it is important to note that more than one-third of households in Massachusetts have yet to install an LED; therefore, the quality of LEDs is still important to avoid a negative first experience.
- **CFL** penetration decreased by one percentage point in Massachusetts in 2017 after having remained steady at 96% since 2013; CFL penetration in New York increased to 93% in 2017.



Significantly different from [a] 2013, [b] 2014, [c] 2015, [d] 2016, or * corresponding year in MA at the 90% confidence level.

Figure 9. Bulb penetration, 2013-2017

As Figure 10 shows, LED penetration in Massachusetts has increased in all room types since 2009; notably, penetration in all room types has at least doubled since the 2015 study. In 2017, bedrooms were the most common place to have at least one LED installed (47%), followed closely by living spaces (46%), bathrooms (46%), and kitchens (42%).

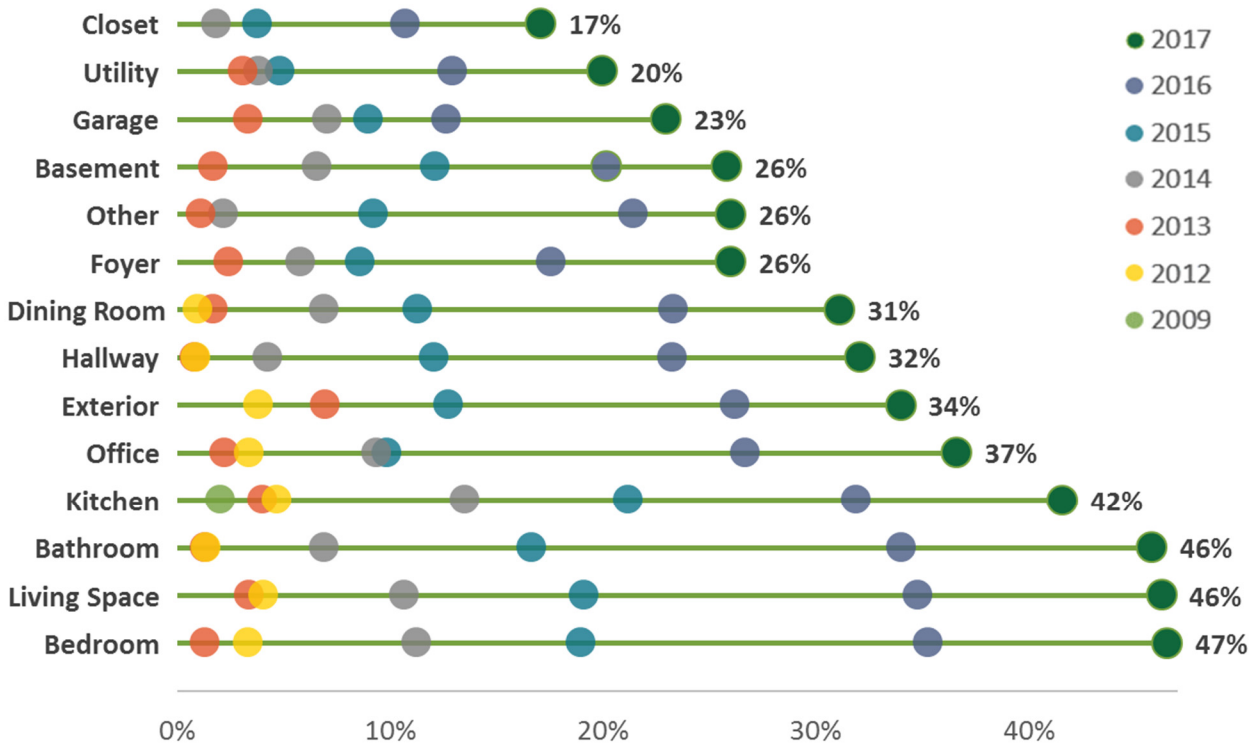


Figure 10. Massachusetts LED Bulb penetration by room type, 2009-2017

Conclusions

Evidence from this study suggests that the Massachusetts programs have had a strong impact on saturation and penetration of LEDs. While consumers in New York are adopting LEDs, LED saturation and penetration rates continue to lag the rates measured in Massachusetts.

The use of a comparison area design allowed us to assess trends in Massachusetts, a state that continues to support energy-efficient bulbs, to those of New York, a state that phased out its support of energy-efficient bulbs between 2012 and 2014. As Figure 4 shows, New York continues to lag Massachusetts in combined CFL and LED saturation (32% vs. 47%) and has higher combined inefficient saturation (53% vs. 41%).

As of 2017, LED saturation is 18% in Massachusetts and significantly lower (10%) in New York. Additionally, LED penetration is 61% in Massachusetts and significantly lower (48%) in New York. Further, ENERGY STAR® LEDs (the only type of LEDs supported by program efforts) accounted for the majority (seven of the eight-percentage-point) difference in LED saturation between the two states.

Examining trends in CFL saturation, in 2013, Massachusetts and New York began with similar CFL saturation (28% and 26%, respectively), but diverged between 2013 and 2017. In 2017, CFL saturation in Massachusetts was 25% higher than in New York (29% vs. 22%). This divergence aligned closely with New York's decision to cease spiral CFL incentives in 2012 and essentially all upstream lighting incentives in 2014—an action driven by the New York Department of Public Service's conclusion that the residential lighting market was or would become transformed without additional program intervention.

Over the past three years, we have observed a steady (though not statistically significant) decline in CFL saturation in Massachusetts, down from 33% in 2014 to 29% in 2017. Moving forward, we expect to see this trend accelerate for three key reasons:

- Recent changes to the ENERGY STAR specifications (ENERGY STAR 2.0) mean that most CFLs will no longer qualify for ENERGY STAR status and, as a result, Massachusetts ended program support for CFLs as of December 31, 2016

- Manufacturers and retailers are moving away from CFLs
- Consumers are rapidly adopting LEDs

Key Findings

- Examining data over time in Massachusetts, we observe a steady increase in combined efficient (CFL, LED, and fluorescent) saturation (from a low of 32% in 2009 to a high of 54% in 2017) and a corresponding decrease in combined inefficient bulb saturation (from a high of 67% to a low of 41% in 2017). In 2017, New York continues to lag significantly behind Massachusetts in combined efficient saturation (32% vs. 47%) and has significantly higher combined inefficient saturation (53% vs. 41%).
- In 2017, for the first time in Massachusetts, saturation of efficient (CFL and LED) bulbs (47%) has surpassed that of inefficient (incandescent and halogen) bulbs (41%). In contrast, efficient bulb saturation in New York continues to lag significantly behind Massachusetts and inefficient bulbs are still the most common bulb type installed.
- In Massachusetts, LED saturation has increased six-fold since 2014; in 2017, nearly one out of every five (18%) sockets was filled with an LED. New York also saw a significant increase in LED saturation (7% in 2016 to 10% in 2017), although not to the same pace as that observed in Massachusetts.
- CFL and LED saturation in Massachusetts increased significantly between 2013 and 2017, while New York experienced slower growth 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 2017, CFLs and LEDs combined accounted for 47% of all bulbs installed in sockets in Massachusetts (a statistically significant increase) and only 32% of bulbs installed in sockets in New York.
- LED penetration in Massachusetts increased significantly since 2016—from 51% to 61%; New York LED penetration lags Massachusetts significantly, and, at 48%, has not yet reached the Massachusetts 2016 penetration rate.
- While low-income households in both states have lower overall LED saturation, low-income households in Massachusetts are adopting LEDs at a faster pace than low-income households in New York and a comparable rate to non-low-income households in New York.

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