Massachusetts Lighting Sales Data Analysis

FINAL

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SUBMITTED TO:
Massachusetts Electric Program Administrators
Massachusetts Energy Efficiency Advisory Council
Consultants

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Massachusetts Lighting Sales Data Analysis

Analyzing Market Trends for Light Bulbs

NMR conducted a study to examine light bulb market shares obtained from retail locations in Massachusetts. The study compares market share and bulb prices in Massachusetts, the United States, and various comparison areas with different levels of lighting program activity. The report explores 2018 market share by bulb type, shape, and ENERGY STAR® status, compares bulb prices, and considers trends in market share from 2009 to 2018. Although the sales data suggest that ENERGY STAR Lighting Programs in Massachusetts and across the nation still have a positive effect, the impact may be dwindling as market transformation of the LED market progresses across the nation.

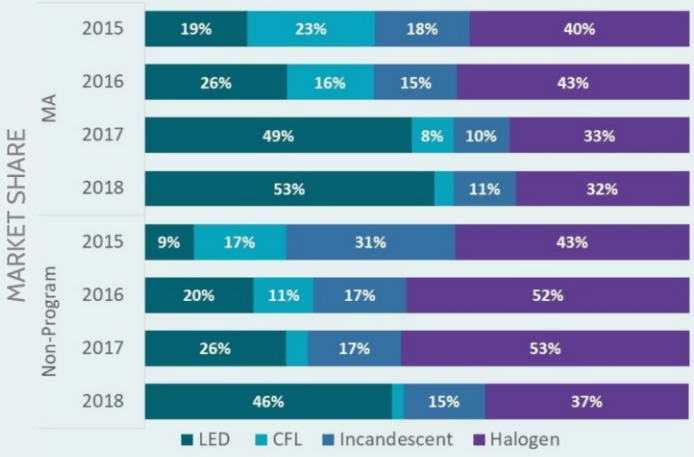
Key Findings

Massachusett's market share for efficient bulbs (LEDs + CFLs) stood at 57% in 2018, with LEDs alone accounting for 53% of all bulb sales.

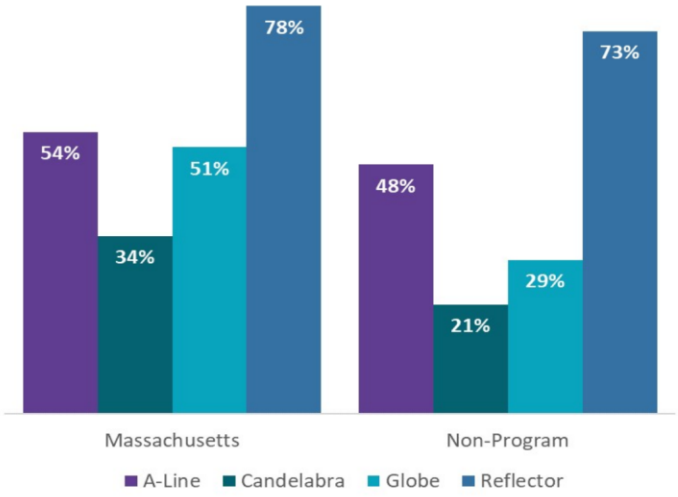
LED market share grew by 180% in Massachusetts and 400% in non-program areas between 2015 and 2018.

LED sales in Massachusetts are strongest in lumen bins (a measure of brightness) most closely associated with the 60 Watt and 40 Watt incandescent bulbs.

Massachusetts and Non-Program Market Share by Bulb Technology (All Channels)



LED Market Share by Bulb Shape (All Channels)



LED reflector sales were high in the areas examined, suggesting that the market is nearly transformed.

A-line sales were near or above 50% in all areas, pointing towards strong progress on transformation.

Globe market share was above 50% in Massachusetts, but less than 30% in non-program areas.

Candelabra market share was low across the board, suggesting that transformation is a long way off.

Data Sources

Consortium for Retail Energy Efficiency Data

NEMA shipment

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Executive Summary

This report describes recent screw-base light bulb market share, shipments, and prices in Massachusetts, the entire United States, and program and non-program states (defined below). The analyses draw on light bulb sales data compiled by the LightTracker Initiative of the Consortium for Residential Energy Efficiency Data (CREED) and shipment data reported by the National Electrical Manufacturers of America (NEMA).[1,2,3] The primary purpose of this study is to provide context for the lighting market.

Table 1 summarizes the topics explored in this report and their relevant data sources. LightTracker provided NMR with two different datasets:

- Full category lighting data (FCD): cover all retail channels (discount, dollar, drug, grocery, hardware, home improvement, mass merchandise, and membership stores)
- Point of sale (POS) data: only include a subset of channels (discount, dollar, drug, grocery, mass merchandise, and some membership stores), which covers approximately 31% of the retail lighting market in Massachusetts and 35% of the national market.

Although the POS data exclude the hardware, home improvement, and some membership channels, they allow for more detailed analyses of bulb shape, ENERGY STAR qualification, and lumens, and provide an additional six years of history (POS data have been available since 2009 compared to 2015 for the FCD).

For most topics, we compared Massachusetts to three areas: the entire United States, states with lighting programs, and states without lighting programs. We also explored NEMA shipment data from 2011 to 2019, including data collected prior to and after NEMA's recent methodological change in tracking A-line bulb shipments. As NEMA limits public shipment data to the national level, our review was similarly limited.

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[1] The information contained herein is based in part on data reported by IRI through its Advantage service, as interpreted solely by LightTracker, Inc. Any opinions expressed herein reflect the judgement of LightTracker, Inc., and are subject to change. IRI disclaims liability of any kind arising from the use of this information.

[2] Data presented include LightTracker calculations based in part on data reported by Nielsen through its Strategic Planner and Homescan Services for the lighting category for the 52-week period ending approximately on December 31, 2018, for the available state level markets and Expanded All Outlets Combined (xAOC) and Total Market Channels. Copyright © 2018, Nielsen.

[3] NEMA revised its calculation method to include newly available international shipment data for LEDs, as well as CFLs and halogens, and they also removed incandescents from the market share estimation. They provide data for 2017 using the prior and current calculation methods, but only share the current calculation method for 2018. See Section 1.2.2, Appendix A.2, and https://blog.nema.org/2018/12/11/nema-lamp-index-adjusts-to-newly-available-a-line-led-data/ for more details. NMR has been tracking NEMA shipment data over time and last pulled data using the prior calculation method on September 5, 2018, covering all of 2017. An overview of the current 2017 and 2018 data can be found at http://www.nema.org/Intelligence/Pages/Lamp-Indices.aspx, and NMR received detailed quarterly shipment shares directly from NEMA.

Table 1: Study Topics and Data Sources

Topic	Years	Data Source[1]
Current market share (sales) by bulb type and bulb shape	2018	LightTracker FCD
Market share (sales) over time	2009 to 2018	LightTracker POS (2009-2018) and FCD (2015-2019)
Market share (shipments) over time	2011 to Q1 2019	NEMA
Market share (sales) by lumen bins, ENERGY STAR qualifications	2018	LightTracker POS
Bulb price analysis	2018	LightTracker FCD

[1] FCD LightTracker data includes sales information for all retail channels and represents 100% of the lighting market. POS data include discount, dollar, drug, grocery, mass merchandise, and some membership stores, representing 31% of retail lighting sales in Massachusetts and 35% nationally. POS data exclude hardware, home improvement, and some membership stores.

OVERVIEW OF FINDINGS

The sales data analysis suggests that the Massachusetts Residential Lighting Core Initiative still matters and has positive impacts on the residential lighting market, but market transformation is progressing in Massachusetts and across the nation.

The sales data analysis suggests that the Massachusetts Residential Lighting Core Initiative (the Program) continued to increase the adoption of energy-efficient bulbs in 2018. LED market shares overall, for each bulb shape, and for ENERGY STAR qualified bulbs in Massachusetts were higher than in non-program states and similar to or higher than the nation and most other program states. Massachusetts paid an incentive of over $2.61 per LED – the second highest in the nation – which certainly contributed to it having the lowest LED price compared to the other areas considered. Massachusetts also had the lowest incremental cost difference between LEDs and halogens of the areas examined.

At the same time, the national market for LEDs showed substantial growth in 2018. Non-program states, as well as the nation and all program states, experienced a large increase in LED market share in 2018. LEDs accounted for about 50% or greater A-line market share and 70% or greater reflector market share in all areas considered. The recent Lighting Market Assessment Study in Massachusetts (RLPNC 18-10) provided similar evidence of expanded naturally occurring market adoption of LEDs: That study found that, although LED socket saturation remained much lower in the portions of New York lacking upstream lighting programs compared to Massachusetts (22% vs. 34%, respectively), New York experienced greater increases between 2018 and 2019 in the rate of adoption for LEDs overall and for all bulb shapes compared to Massachusetts.[4]

In both Massachusetts and all other areas considered, LED market share for candelabra bulbs and for A-line bulbs with very low and very high lumens remained dominated by inefficient bulb

[4] See pages 4 and 5 of NMR Group (2019). *RLPNC 18-10 Residential Lighting Market Assessment Study.* Delivered to the PAs and EEAC consultants March 29. Available at http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_1810_LtgMarketAssessment_FINAL_2019.03.29.pdf

sales. These types of bulbs are currently exempt from the Energy Independence and Security Act (EISA) and most likely will remain so regardless of the outcomes of future lawsuits.

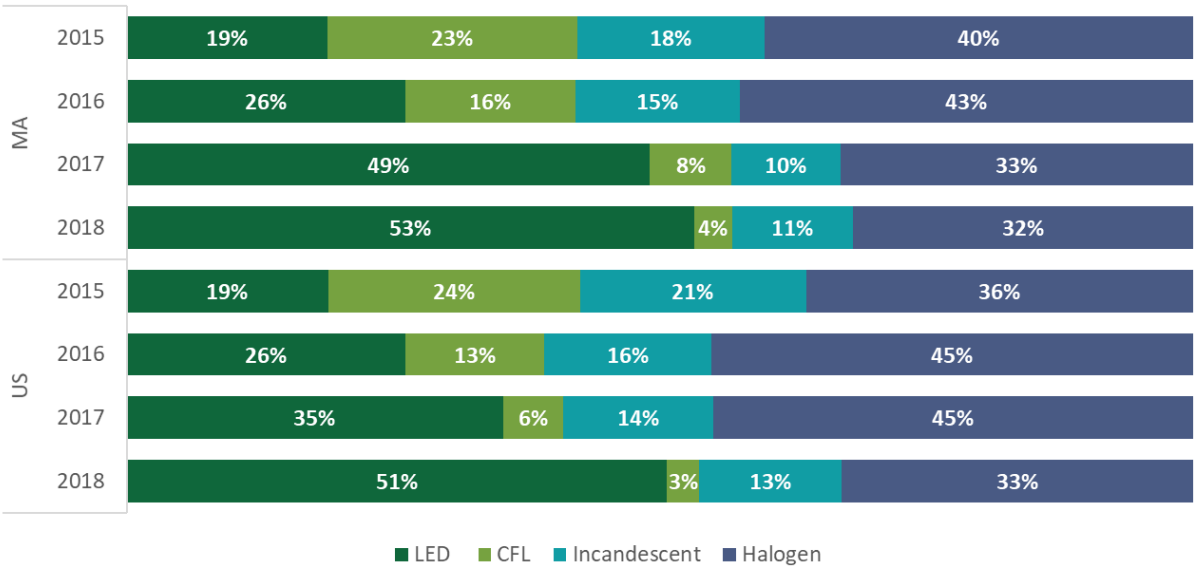
In summary, while the program still has some positive impacts, market transformation is progressing in Massachusetts and across the nation. The remaining inefficient sockets will likely be difficult to convert due to lingering consumer concerns about aesthetics, performance, and light quality as well as infrequent bulb use (as most consumers replace bulbs upon failure). The PAs may still have a role to play in the residential lighting market by increasing sales of ENERGY STAR qualified products and boosting the market share for certain specialty bulbs (including those A-lines with very low and very high lumens). However, the PAs can expect program impact on market share to dwindle, even as they help to convert those last difficult sockets to LEDs. Additional key findings are summarized below.

FINDINGS

Efficient lamp (LEDs and CFLs) market share in Massachusetts was slightly higher (57%) compared to the nation, but the same as in 2017. LED market share broke 50% in Massachusetts, the United States, and all program states.

Figure 1 shows that energy-efficient bulbs accounted for a larger share of the market in Massachusetts (57%) than in the US overall (54%), as well as in both program (54%) and non-program states (47%) (see Figure 7 and Figure 8 for program and non-program states). However, the rate of sales increases appeared to slow in Massachusetts compared to the other areas, although the CREED adjustment for program sales (Section 1.2.1) complicates the analysis and conclusions, as shown in Table 4 in the main body of the report.

Figure 1: Massachusetts and US Market Share by Bulb Technology 2015-2018[1,2]

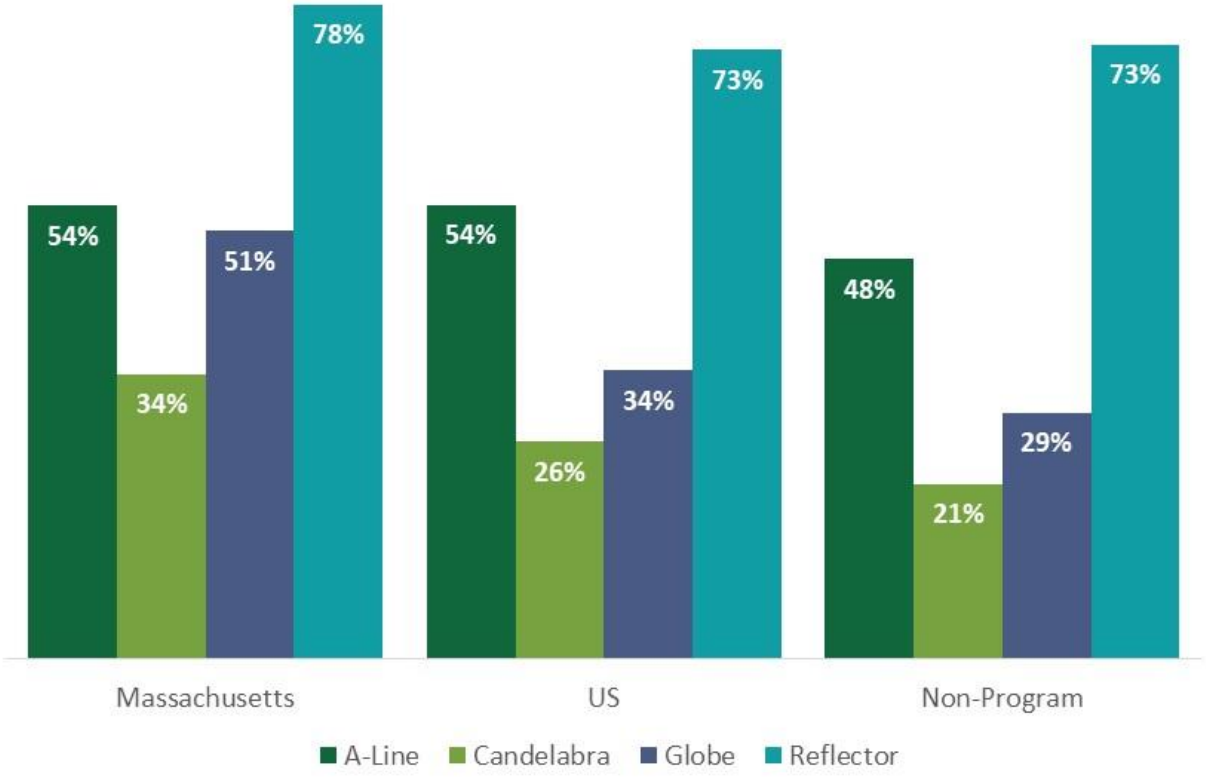


[1] All retail channels.
[2] In 2017 and 2018, CREED adjusted LED sales in some states (including Massachusetts) for better alignment with program sales data. Prior to the adjustment, 2017 LED market share in Massachusetts was 36% and 2018 was 50%. See Section 1.2.1 for more detail.

Massachusetts customers purchased a higher proportion of LEDs within each bulb shape compared to the nation and non-program areas, but reflector and A-line market shares across all areas considered showed strong progress towards transformation.

Massachusetts had higher market share in all bulb shape categories relative to the nation and non-program areas (Figure 2). Yet, reflector market share was above 70% and A-line market share near or above 50% in all areas considered, even non-program areas. Massachusetts still out-performed other areas in candelabra and globe LED market share, but candelabra bulb share continued to be dominated by inefficient bulb types in Massachusetts and all other areas.

Figure 2: 2018 LED Market Share by Bulb Shape in Massachusetts and Comparison Areas[1,2]

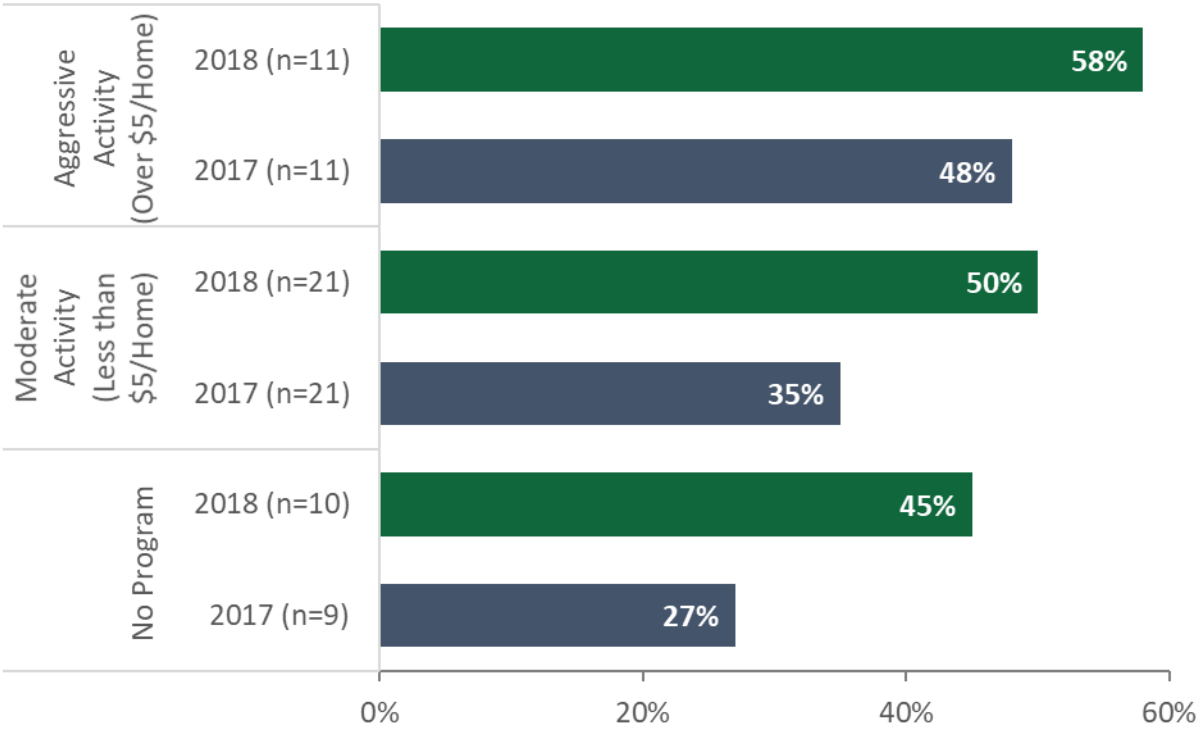


[1] All retail channels
[2] Market shares reflect LED adjustment for known program sales.

Residential lighting program spending is associated with higher LED market share, but natural market adoption of LEDs progressed the most in non-program areas between 2017 and 2018.

Figure 3 presents LED market share as a function of program spending (including incentives, marketing, and administration), and exhibits a clear increase in LED share as program spending increases. However, the rate of increase in market share between 2017 and 2018 was higher in non-program states than in all states with moderate or aggressive program activity. Massachusetts is an aggressive program state, with total program spending was over $5 per household in 2018. LED incentives were $2.61 per LED.[5]

Figure 3: 2017 & 2018 Program Spending and LED Market Share[1,2]



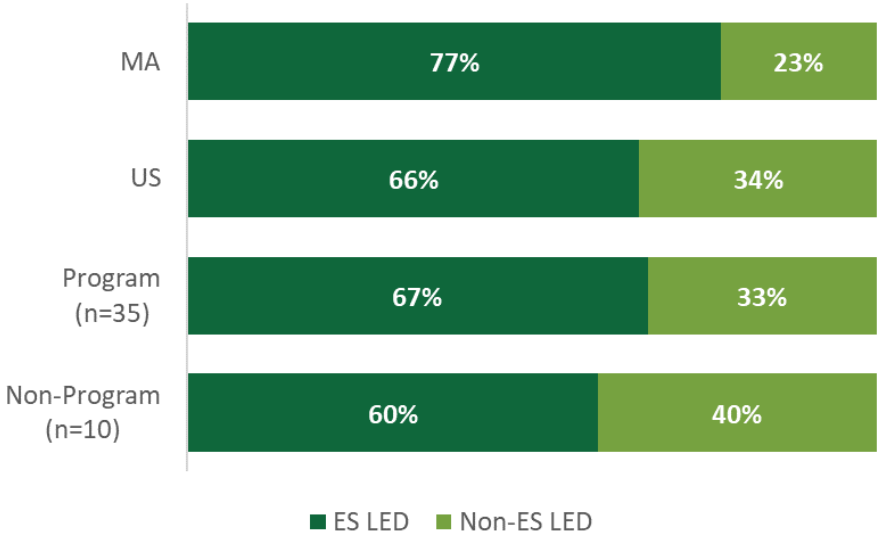
[1] All retail channels.

[5] As discussed in Section 2.1.3, Massachusetts had the second highest LED incentive among the 15 states for which CREED could separate LED incentive costs from other program expenses. This appears to be driven largely by the cost-of-living, which increases pre-incentive bulb prices.

A greater portion of LED bulbs sold in Massachusetts in 2018 were ENERGY STAR qualified compared to the comparison areas.

Over three-quarters of LEDs (77%) sold in Massachusetts in discount, dollar, drug, grocery, mass merchandise, and some membership stores qualified for the ENERGY STAR label (Figure 4). All other areas examined were at least ten-percentage points lower; non-program states were 17 percentage points lower, with an ENERGY STAR LED market share of 60%.

Figure 4: 2018 LED ENERGY STAR Status in Massachusetts and Comparison Areas[1]

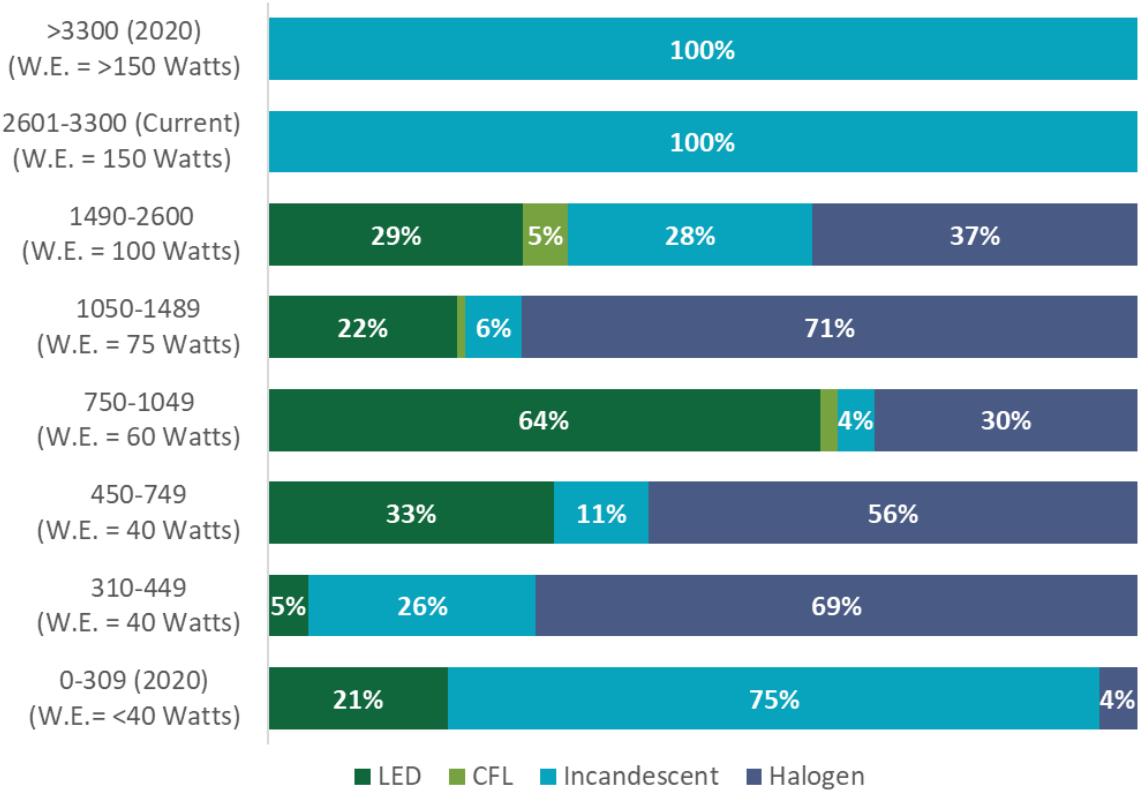


[1] Includes discount, dollar, drug, grocery, mass merchandise, and some membership stores. Represents approximately 31% of the Massachusetts market, 35% of the US, 34% of program states, and 41% of non-program states. Excludes hardware and home improvement stores.
[2] The ENERGY STAR sales percentages are not affected by CREED's adjustment for program sales, which only applies to the FCD.

LEDs garnered the majority of the A-line bulb market in the 60-watt equivalent range (750 to 1,049 lumens), while incandescents dominated lumen bins that are currently EISA exempt.

Figure 5 shows market share by technology type within each lumen bin in discount, dollar, drug, grocery, mass merchandise, and some membership stores, along with the equivalent incandescent wattage (W.E.). While LEDs were the majority (64%) in the 750 to 1,049 lumen bin (i.e., the bin that accounts for one-half of all A-line bulb sales and is most closely associated with the 60 Watt incandescent), LEDs still had significant growth potential in all other lumen bins. Halogens had the largest market share in four of the five lumen bins currently subject to EISA (310 to 2,600 lumens), while incandescents dominated all EISA-exempt lumen bins (below 310 and above 2,600).

Figure 5: 2018 Massachusetts A-line Market Share by Lumen Bin[1,2,3]

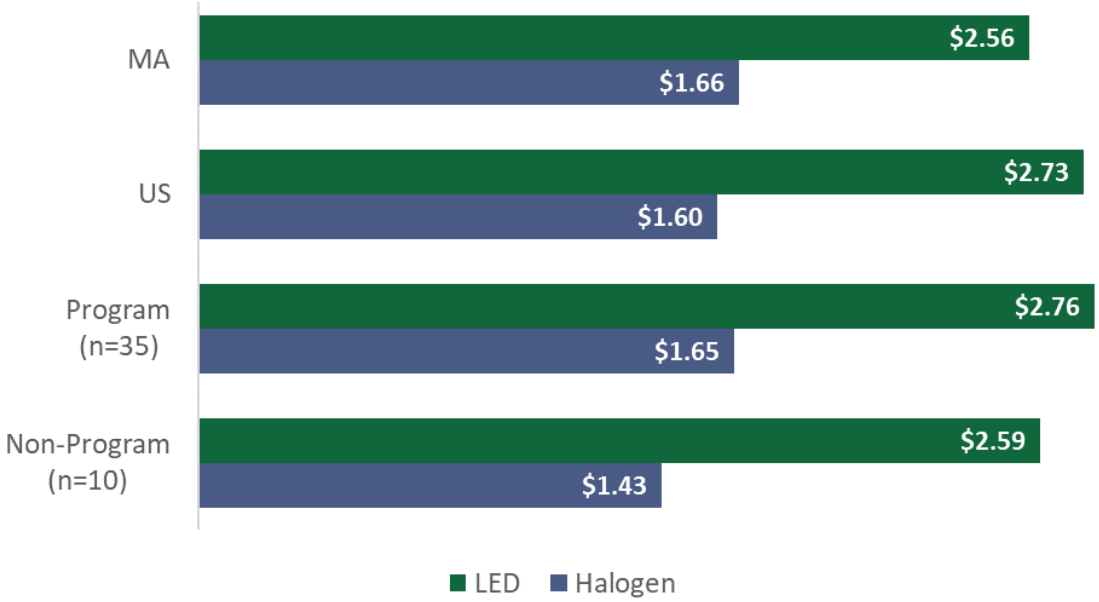


[1] Includes discount, dollar, drug, grocery, mass merchandise, and some membership stores, and represents approximately 31% of the Massachusetts market.
[2] Bins currently EISA Exempt: less than 310, above 2,600; bins exempt from EISA 2020 (if implemented): less than 310, above 3,300 (i.e., the 2,601 – 3,300 bin will become subject to EISA in 2020).
[3] Small sample sizes of lumen bins less than 310 and above 2,600, while still in the thousands, are much smaller than the hundreds of thousands of bulbs in the 450 to 2,600 lumen bins.

LED prices were about one dollar higher than halogens, but LED prices varied little across areas.

Figure 6 displays the shelf price for LEDs (including the application of program incentives) and halogens.[6] LEDs cost about 90 cents more than halogens in Massachusetts, compared to about $1.10 more in the other comparison areas. This implies that LEDs are more price competitive with halogens in Massachusetts, likely reflecting the $2.61 incentive in the state. The LED price in Massachusetts ($2.56) fell just below that of non-program areas ($2.59). The low price of LEDs in non-program states likely reflects a combination of cost-of-living and greater sales of non-ENERGY STAR LEDs.[7]

Figure 6: 2018 Average Shelf Price per Bulb[1,2]



[1] All retail channels.
[2] Does not include private label bulbs sold at specific retailers, so the prices reported here are likely somewhat higher than actual prices.

CONSIDERATIONS

Consideration 1: The PAs should carefully consider the future of the program and stay alert to any regulatory movement at the state or federal level that would call for withdrawing support for A-lines, reflectors, and specialty products within the 310 to 2,600 range.

Rationale: The PAs still have a role to play in the residential market as it currently stands. Their efforts have boosted adoption of ENERGY STAR LEDS and made LEDs more price competitive with halogens. Although A-line LEDs represent the majority of Massachusetts bulb sales in the lumen bin most closely associated with 60-Watt incandescents, inefficient

[6] The small sample sizes of CFLs and incandescents leads to large swings in pricing across areas.
[7] The CREED data contain indications that both incentive levels and unsupported bulb prices are higher in high cost-of-living states like Massachusetts. Also, retailers and manufacturers reported at the ENERGY STAR Partners meeting in September 2019 that they sell more non-ENERGY STAR LEDs in the absence of program incentives.

bulb types still garner more than 50% of sales in every other lumen bin. The remaining inefficient sockets may be difficult to convert to LEDS, and PA efforts to educate consumers and reduce LED prices may help to capture substantial savings before the market fully transforms.

Consideration 2: The PAs should carefully consider whether to continue support for reflectors bulbs.

Rationale: Market share for reflectors is high in all areas examined, including non-program areas. The long life and directional nature of LEDs makes them well suited to the most common reflector applications (recessed ceiling cans and exterior floods). This has likely enhanced their rate of naturally occurring market adoption in Massachusetts and across the nation. Traditional upstream program interventions alone may not be enough to create continued lift for reflectors.

Consideration 3: The PAs should consider continuing support for bulbs in the very low (below 310) and very high lumen ranges (above 3,300). Likewise, they should continue support for candelabra and globe bulbs, which show fewer signs of transformation in Massachusetts and across the nation.

Rationale: Incandescent bulbs account for nearly all A-line sales in the lumen bins that are currently exempt from EISA (below 310 and above 2,600) and those that will remain exempt if the next phase of EISA is eventually implemented (below 310 and above 3,300). While these represent less than 5% of A-line lighting sales in Massachusetts, it appears that these lumen bins remain largely untransformed. Likewise, candelabra bulbs generally and globes outside of Massachusetts have very small LED market shares, suggesting that program intervention still matters. Given that the September 5, 2019 final DOE Rule[8] prevents globes and candelabras from being defined as general service lamps, this intervention will likely remain important for at least a few more years (when either the outcomes of lawsuits or market transformation makes LEDs the dominant bulb type). While the small sales volumes and delta watts for these bins and bulb types will yield small achieved savings, support for them could help convert the remaining decorative, appliance bulbs, and high lumen (including indoor agriculture) bulbs that largely remain incandescent.

Consideration 4: The PAs and the implementation contractor should consider whether incentive levels should be adjusted downward.

Rationale: Massachusetts has one of the highest incentive levels in the nation. This likely reflects a combination of factors, including the cost-of-living and associated pre-incentive LED prices in the Northeast, the product mix offered, and program history. These deep incentives have helped Massachusetts and the Northeast achieve strong LED market share. Yet, as transformation progresses and LED prices remain low, it may be time to

[8] https://www.federalregister.gov/documents/2019/09/05/2019-18940/energy-conservation-program-definition-for-general-service-lamps

explore whether customers would continue to adopt LEDs at the same rate with a smaller incentive.

Section 1 Introduction

This report describes recent light bulb market share, sales, and shipment trends in Massachusetts, program states (defined below), non-program states (defined below), and the entire United States. This study is based on analyses of light bulb sales data compiled by the LightTracker Initiative of the Consortium for Residential Energy Efficiency Data (CREED).[9,10,11] This study also presents updated shipment data from the National Electrical Manufacturers Association (NEMA).[12] Finally, this study examines trends in light bulb shelf prices.

1.1 Study Objectives and Research Questions

The study objectives included the following:

- Examine current market share, bulb sales, and bulb shipments in Massachusetts, states with upstream programs, states without upstream lighting programs, and the entire nation.
- Provide breakdowns of market share by bulb type (i.e., light emitting diodes [LEDs], compact fluorescent lamps [CFLs], halogens, and incandescents), shape (A-line, reflector, globe, and candelabra), and ENERGY STAR® status, when data quality allow.
- Explore trends in bulb market share from 2009 to 2018 and NEMA reported quarterly bulb shipment share from 2011 to the most recent quarter available, including a comparison and assessment of NEMA's revised methodology.
- Compare average prices of LEDs to halogens in the bulb price analysis.
- Assess market share in very low (<310) and very high lumen bins (>3,300), which roughly coincide with ranges that will remain exempt if Phase II of the EISA goes into effect.

[9] CREED serves as a consortium of program administrators, retailers, and manufacturers working together to collect the necessary data to better plan and evaluate energy- efficiency programs. LightTracker, CREED's first initiative, is focused on acquiring full category lighting data, including incandescent, halogen, CFL, and LED bulb types for all distribution channels in the entire United States. As a consortium, CREED speaks as one voice for program administrators nationwide as they request, collect, and report on the sales data needed by the energy- efficiency community (https://www.creedlighttracker.com).

[10] The information contained herein is based in part on data reported by IRI through its Advantage service, as interpreted solely by LightTracker, Inc. Any opinions expressed herein reflect the judgement of LightTracker, Inc., and are subject to change. IRI disclaims liability of any kind arising from the use of this information.

[11] Data presented include LightTracker calculations based in part on data reported by Nielsen through its Strategic Planner and Homescan Services for the lighting category for the 52-week period ending approximately on December 31, 2018, for the available state level markets and Expanded All Outlets Combined (xAOC) and Total Market Channels. Copyright © 2018, Nielsen.

[12] NEMA "Lamp Indices." Accessed on October 2, 2019, at http://www.nema.org/Intelligence/Pages/Lamp-Indices.aspx.

The study achieved these objectives by exploring the following research questions:

- What are the short- and long-term trends in light bulb shipments, sales, and market share in Massachusetts?
- How do these trends in Massachusetts compare with other program states, non-program states, and the nation?
- What is the bulb price of LEDs compared to halogens in Massachusetts and other areas?
- Does the current LED share of bulbs in very high and very low lumen bins suggest any future program opportunities?
- What is the size of the total LED market and what portion of market-level LED sales receive direct PA support?

1.2 Data Sources

The Lighting Sales Data study draws on two data sources: LightTracker Initiative Sales Data and NEMA shipment data. Table 2 summarizes the topics examined and the sources of data. This section provides an overview of the data sources, while Appendix A provides a detailed discussion, including addressing variations in data provided by the LightTracker Initiative.

1.2.1 Lighting Sales Data

CREED generates the LightTracker dataset from two data sources: point of sale (POS) state sales data as scanned *at the register* and National Consumer Panel (NCP) state sales data. CREED purchases the data from third-party vendors and the LightTracker team cleans, processes, and calibrates the data for analysis. Both the POS and the NCP datasets provide national level estimates of bulb sales. They also provide state-level data for individual states with sufficient sales and/or panel participation. CREED combines these two datasets into a single dataset known as the full category data (FCD)

The POS dataset represents discount, dollar, drug, grocery, mass merchandise, and some membership stores. It accounts for about 31% of the retail lighting market share in Massachusetts and 35% nationally.[13] The NCP represents a panel of approximately 100,000 residential households that are provided a handheld scanner for their home and instructed to scan in every purchase they make that has a bar code. For Massachusetts, the NCP includes approximately 1,300 households. The use of a scanner avoids potential recall bias, which is prevalent in self-report methods that ask about lighting purchases. While the NCP dataset includes sales from all retail channels, to avoid double counting sales when combining the two data sources to create the FCD, CREED only uses sales from home improvement, hardware, online, and the remaining membership stores.

[13] Calculated as the number of bulb sales per area included in the POS dataset divided by the number of bulb sales per area in the FCD.

Each year, CREED improves its data cleaning and vetting procedures. Beginning with the 2017 dataset and continuing in 2018, they instituted two changes. First, the IRI and Nielsen data are unable to determine ENERGY STAR qualification for all LEDs. Therefore, CREED assigned ENERGY STAR LED qualification based on a combination of the status reported in the original IRI and Nielsen databases and the rated measure life of LEDs. For the latter, CREED assumed that all bulbs with 15,000 hours or more were ENERGY STAR qualified. Reviews of shelf stocking data from Massachusetts and Rhode Island provided to NMR by Lockheed Martin suggest that the 15,000 hours cut-off may overstate the number of ENERGY STAR qualified bulbs on store shelves. However, because CREED assigned ENERGY STAR status similarly in all states, the exaggeration would be more pronounced in states that have lower ENERGY STAR sales.

The second change that CREED introduced in 2017 involved instituting a process to align full category data total LED sales with known program-supported sales in the state. Prior to 2017, FCD total LED sales often seemed low compared to verified program sales. Starting in 2017 In states in which program-supported sales (which are almost universally ENERGY STAR-qualified across the nation) exceeded or rivaled LED sales (comprising both ENERGY STAR and non-ENERGY STAR sales), they adjusted LED sales as reported in the FCD (but not POS) upwards so that program-supported sales would not exceed 90% of ENERGY STAR sales. In 2017, CREED made this adjustment to five states, but in 2018 only Massachusetts required adjustment. Prior to this adjustment, 2017 LED market share in Massachusetts was 36%. With the adjustment, it was 49%.[14] The adjustment moved market share far less in 2018, from 50% to 53%, likely reflecting the reduced PA program sales in 2018 (which may itself reflect a leveling of market share due to high LED socket saturations; see Section 2.1.3 for more). In 2018, CREED made this adjustment to overall LED sales and to specialty sales, in both cases based on known program sales from Massachusetts.

Without the adjustment in this subset of states where program exceed LightTracker sales, it is almost certain that unadjusted LightTracker data under reports LED market. Yet, because the adjustment applies only to LEDs,[15] it increases LED market share, which may cause the adjusted LightTracker to overstate LED market share. For this reason, NMR generally presents in graphs or footnotes both adjusted and unadjusted market shares for Massachusetts.

The Massachusetts PAs and EEAC Consultants also desired longitudinal analyses of market and shipment share. Therefore, NMR supplemented the FCD for 2015 to 2018 with POS data from 2009 to 2018 (obtained from CREED).

[14] The final 2017 report listed incorrectly listed unadjusted market share as 44%, the result of a CREED analysis error. See NMR Group (2018). *RLPNC 18-11 Lighting Sales Data Analysis.* Delivered to the PAs and EEAC consultants November 26. Available at http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_1811_LtgSalesDataAnalysis_26NOV2018_final.pdf

[15] CREED concluded that adjusting all bulb types would lead to unreasonable estimates of total bulb sales per household. Moreover, although they had program sales data for LEDs, CREED had insufficient information to make informed adjustments to other bulb types.

The **key strengths and weaknesses** of the LightTracker dataset include the following:

- **Strengths**:
  - FCD sales reflect the entire market, comprising program and non-program sales, as well as all retail channels.
  - Comparable data are available for most states in the nation.
  - Characteristics such as lumens, bulb shape, and pricing are included.
- **Weaknesses**:
  - POS data, used for analyses by ENERGY STAR qualification and lumen bins as well as price, only cover a portion of the retail market (about 31%), notably missing the important hardware and home improvement channels (although the NCP data capture these channels based on a sample of households for most states).
  - The method used to assign ENERGY STAR status may overstate the percentage of ENERGY STAR qualified LEDs sold in all areas.
  - Raw sales data do not always align with program sales, leading CREED to make adjustments for some states (including Massachusetts) that may overstate the market share of LEDs.
  - Reliability is reduced with analyses of subsets of the market, such as those by bulb shape, lumen bins, and bulb prices.

Table 2: Study Topics and Data Sources

Topic	Years Analyzed	Areas Examined[1]	Data Source[2]	Market Coverage
Current market share (sales) by bulb type and bulb shape	2018	MA, US, program states, non-program states	LightTracker FCD	100% for all areas
Market share (sales) over time	2015 to 2018	MA, US, program states, non-program states	LightTracker FCD	100% for all areas
Market share (sales) over time	2009 to 2018	MA only	LightTracker POS	~31% of market[1]
Market share (shipments) over time	2011 to Q1 2019	Entire US only	NEMA	Unknown
Market share by lumen bins and ENERGY STAR qualifications	2018	MA, non-program states	LightTracker POS	~31% of market[1]
Relationship between program activity and market share	2017 to 2018	MA, program states, non-program states	LightTracker FCD and state program activity data	100% for all areas
Bulb Price Analysis	2018	MA, US, program states, non-program states	LightTracker FCD	100% for all areas

[1] In 2018, the POS data included mass merchandise, dollar, discount, grocery, drug, and some membership stores, representing 31% of retail lighting sales in Massachusetts and 35% nationally.

1.2.2 Shipment Data

We also examined quarterly NEMA A-line national shipment data for Q1 2011 to Q1 2019.[16] Prior to 2017, NEMA estimated shipment share from a survey of NEMA members, but in 2017, the federal government began to track international shipments into the US of LEDs and halogens meant for domestic consumption.[17] The new international shipment data indicated that NEMA reports had been underrepresenting LED shipments (although not halogens, as many are manufactured in the US). Accordingly, in 2017, NEMA began to augment the surveys with the international shipment data for CFLs, LEDs, and halogens.[18] NEMA also stopped tracking incandescent shipment share in 2017, arguing (and supported by the CREED data in Figure 17) that most A-line incandescent shipments fell into categories not considered general service lamps (e.g., low-lumen appliance bulbs or high-lumen grow lamps). NEMA says that low- and high-lumen LEDs, CFLs, and halogen bulbs were already excluded from shipment share estimates, so this step brought incandescents in alignment with the other bulb types.

The **key strengths and weaknesses** of the NEMA dataset include the following:

- **Strengths**:
  - Shipments representing the national A-line market, except incandescents
  - Improved accounting of international shipments, particularly for LEDs
- **Weaknesses**:
  - Revised 2018 method is only limited to EISA compliant A-lines (low/high lumen bins are excluded)
  - Non-reporting of incandescent shipment share under the current method.
  - Data not available for individual states
  - Break in the time series due to a revision in shipment share calculation approaches

1.3 PROGRAM ACTIVITY

Many of the analyses in this report assess market share and price by the presence and level of upstream lighting program activity. To determine program activity, the LightTracker team conducted a literature review of publicly available reports found on the internet or provided by PAs or their evaluators.[19] The team contacted local utilities in areas that did not have reports with the relevant information available. Additionally, the team accessed DSM Insights, an E Source product that provides a detailed breakdown of program-level spending, including incentives,

[16] NMR obtained the data from http://www.nema.org/Intelligence/Pages/Lamp-Indices.aspx, including direct correspondence with NEMA to get more precise shipment share estimates using the current calculation method. NEMA only releases national shipment share data and does not provide shipment counts or data for individual states.
[17] Prior to this time, the federal government only tracked CFLs. Data are available at http://dataweb.usitc.gov//
[18] Direct correspondence with NEMA.
[19] Specifically, the team began by searching the ENERGY STAR Summary of Lighting Programs website https://www.energystar.gov/ia/partners/downloads/2017%20ENERGY%20STAR%20Summary%20of%20Lighting%20Programs.pdf and referenced the Database of State Incentives for Renewables & Efficiency (www.dsireusa.org).

marketing, and delivery for over 100 PAs around the country.[20] All states with at least some program activity in 2018 were designated *program states;* the remaining states were designated *non-program states* (although Nevada was a program state until 2018).

1.4 APPROACHES

NMR and LightTracker Initiative analysts performed the following descriptive analyses of light bulb market share, sales, shipments, and prices:

- Compared 2018 market share by bulb type (Section 2.1.1) and bulb shape (Section 2.1.2) from the full LightTracker database for Massachusetts, states with lighting programs (program states), states without lighting programs (non-program states), and the US overall
- Described trends in market share in Massachusetts for 2009 to 2018, as reported in the POS data, and for 2015 to 2018, as reported in the FCD (Section 2.1.1)
- Examined 2011 to 2018 national NEMA shipment market share (Section 2.1.1)
- Explored general (not statistical) relationships between program spending and per-household bulb sales (Section 2.1.3)
- Examined the proportion of LED sales in Massachusetts, other program states, non-program states, and the nation that are ENERGY STAR qualified (Section 2.1.4)
- Analyzed market share by lumen bins for Massachusetts and non-program states to assess the distribution of bulb sales by current and future EISA exemption (Section 2.1.5)
- Reviewed prices for LEDs and halogens in Massachusetts other program states, non-program states, and the nation (Section 2.2)

[20] E Source. “DSM Insights.” April 2018.

Section 2 Data Examination

NMR examined trends in market share, ENERGY STAR market share for LEDs, and bulb prices using the LightTracker and NEMA shipment data. Table 2, above, summarizes the data sources and their coverage, and the bullets below serve as a reminder (we also footnote coverage in each figure):

- **FDC:** used for analysis of 2018 market share overall and by bulb shape as well as pricing data; represents all retail channels, including hardware and home improvement.
- **POS:** used for analysis of market share back to 2009 and market share by ENERGY STAR qualification for discount, dollar, drug, grocery, mass merchandise, and some membership club retail channels; data reflect 31% of the Massachusetts retail lighting market, 35% of the US, 34% of program states, and 41% of non-program states.
- **Shipments:** used for assessment of A-line shipment share back to 2011; market coverage is unknown.

The results generally describe market share and bulb prices in Massachusetts, program states, non-program states, and the nation. The NEMA shipment review in Section 2.1.1 covers national shipments only, while the program activity review in Section 2.1.3 considers all available states.

2.1 Market Share

NMR assessed market share in Massachusetts, program states, non-program states, and the nation in various ways, as summarized in Table 3. We note the percentage of the market covered under each figure in the discussion that follows.

Table 3: Summary of Market Share Analyses

Type of Analysis	Dataset	Year(s) Addressed	Retail Channels
Annual	LightTracker FCD	2018	All
Longitudinal	LightTracker FCD	2015 to 2018	All
Longitudinal by Lumen Bin by ENERGY STAR	LightTracker POS	2009 to 2018, 2017 to 2018	Discount, dollar, drug, grocery, mass merchandise, some membership clubs
Longitudinal	NEMA	2011 to Q1 2019[1]	All

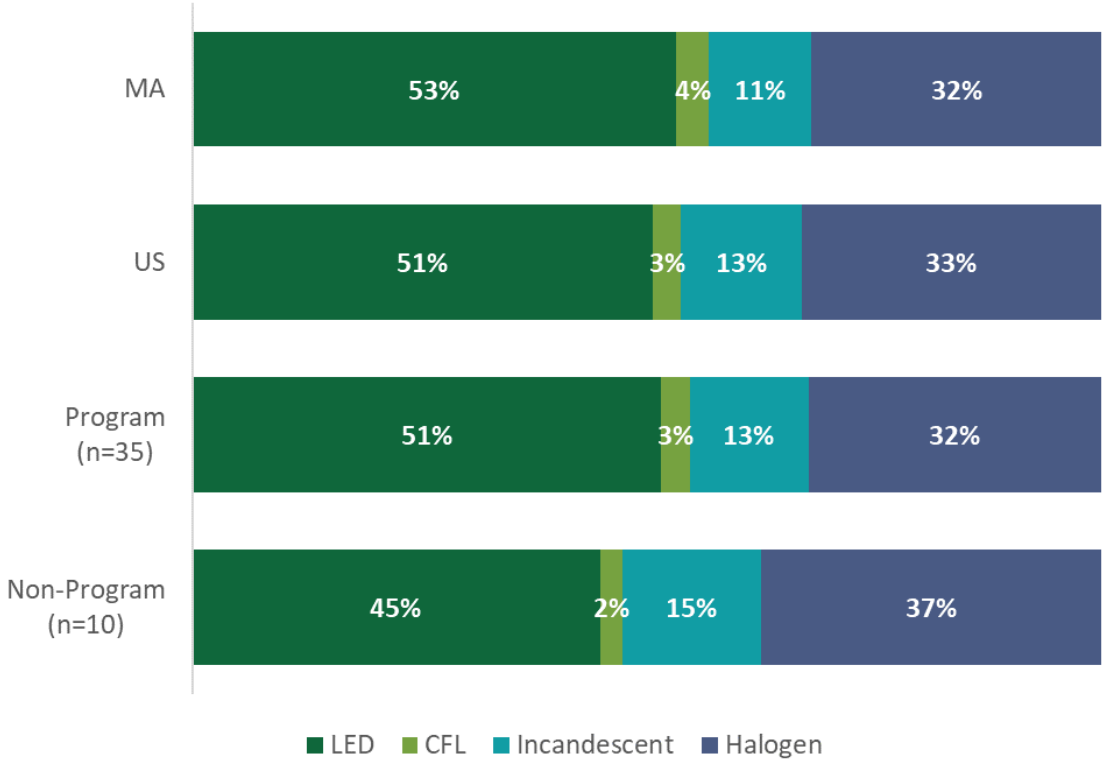
[1] Quarterly data from 2011 to Q4 2017 using old methodology. Quarterly data from 2017 to Q1 2019 using new methodology.

2.1.1 Market Share by Bulb Technology

Massachusetts had a slightly larger market share of efficient bulbs (LEDs and CFLs) in 2018 compared to the US average and the program states average, while market share was substantially higher than the non-program states average.

The market share of energy-efficient bulbs (LEDs and CFLs) was slightly higher in Massachusetts (about 57%) than for the US overall (about 54%) and program states (about 54%), and quite higher than non-program states (47%) in 2018 (Figure 7).

Figure 7: 2018 Market Share in Massachusetts and Comparison Areas[1,2]



[1] All retail channels.
[2] CREED adjusted LED sales in states (including Massachusetts) for better alignment with program sales data. Prior to the adjustment, 2018 LED market share in Massachusetts was 50%. See Section 1.2.1 for more detail.

The market share in Massachusetts for LEDs continued to grow between 2017 and 2018, but the entire nation – including non-program areas – saw strong increases in LED market share.

Figure 8 and Figure 9 display market share over time. Figure 8 reports 2015 to 2018 FCD market share for all channels, including hardware and home improvement, for Massachusetts (both adjusted and unadjusted for program sales) and the comparison areas. Figure 9 presents 2009 to 2018 market share for Massachusetts for a subset of channels: discount, drug, dollar, grocery, mass merchandise, and some membership stores.

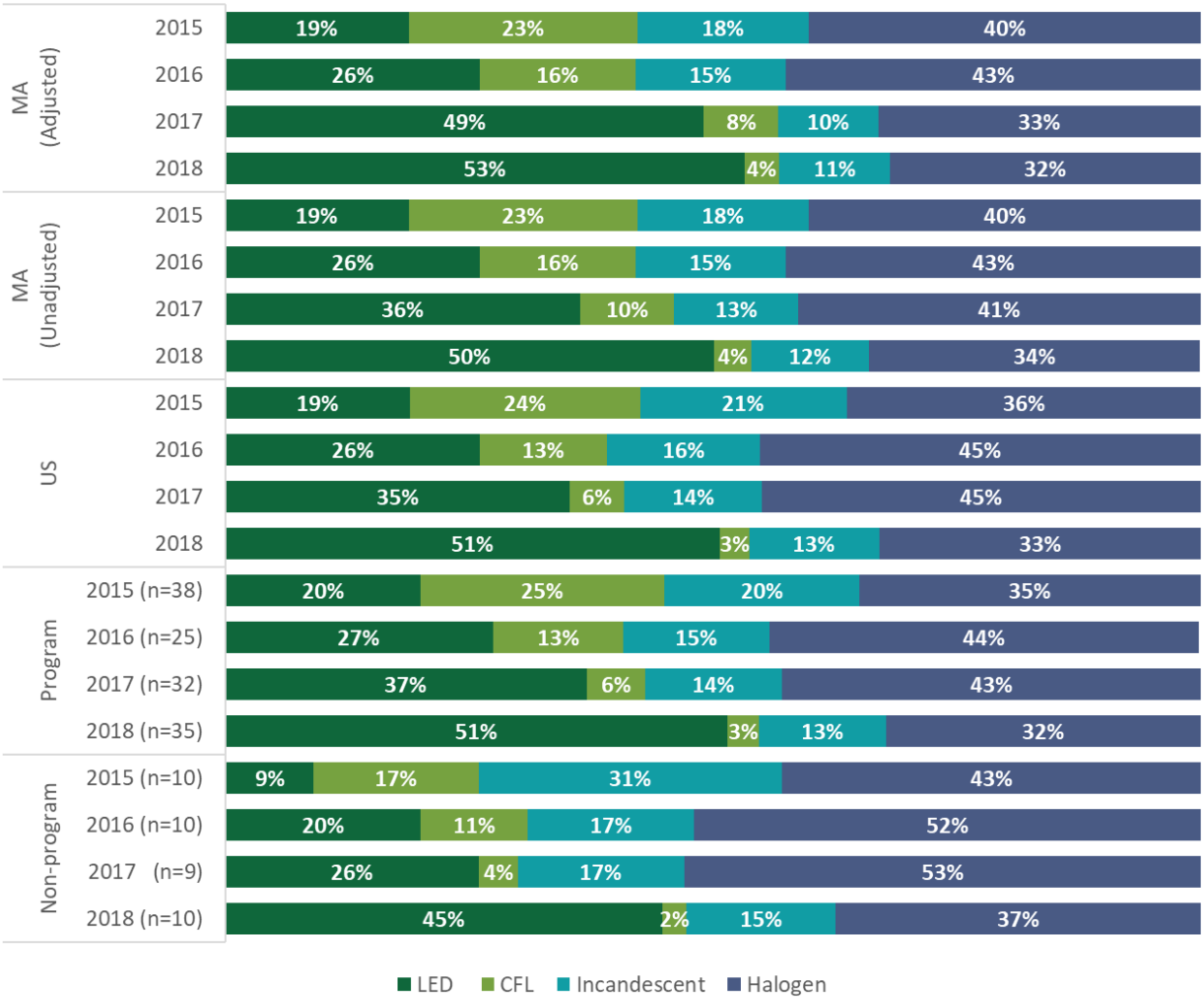
According to the *adjusted* FCD (Figure 8), LED market share in Massachusetts increased from 49% in 2017 to 53% in 2018; unadjusted it grew from 36% to 50%. Meanwhile, national LED market share increased from 35% in 2017 to 51% in 2018. Program state LED market share grew from 37% to 51%, while non-program states increased from 26% to 45%. Figure 9, based on POS data, suggests that LED market share was somewhat lower in the subset of channels than in all retail channels and that market shares rose from 15% in 2016 to 30% in 2017 and to 40% in 2018.

Non-program areas saw the greatest increase in the rate of market share adoption between 2017 and 2018 regardless of dataset (FCD or POS) or adjustments to align program and sales data counts.

Table 4 presents the rate of increase from 2016 to 2018 based on each approach to estimating LED market share over the past three years. NMR conducted this analysis because the program sales adjustment made to Massachusetts LED sales in 2017 and 2018 complicates comparisons of how quickly LED market share is increasing in Massachusetts compared to the nation and non-program areas.

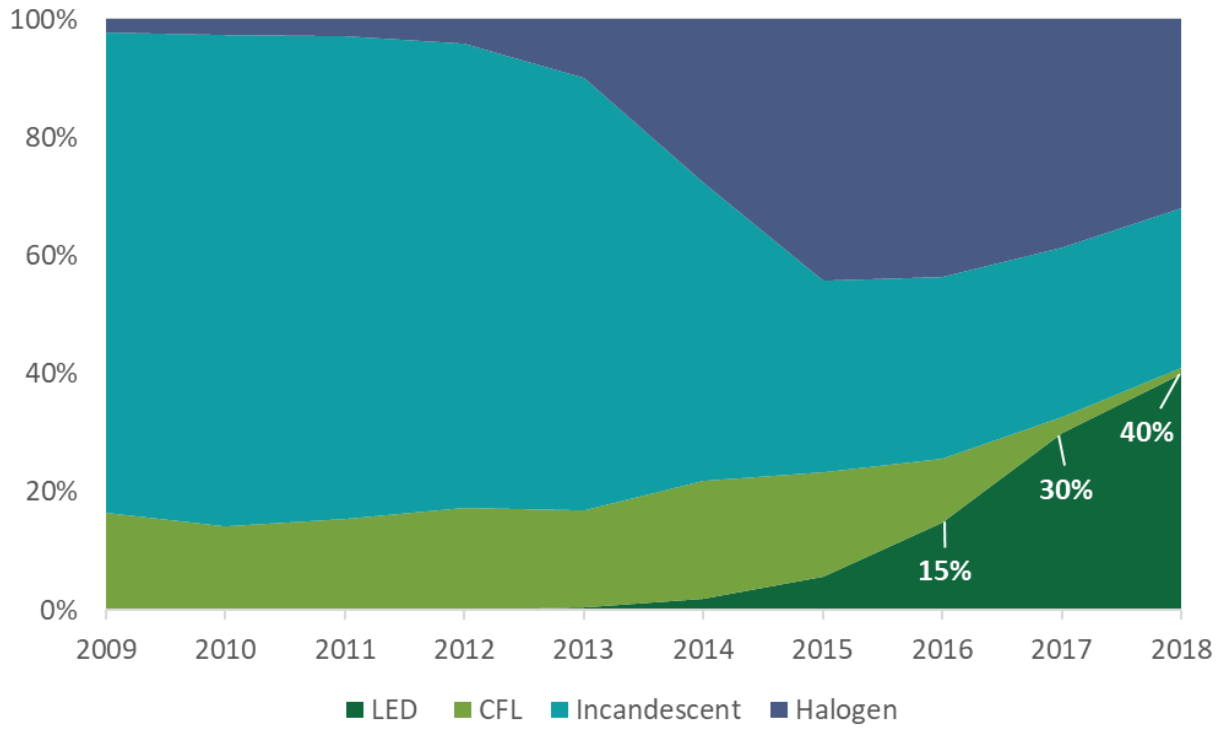
The adjusted FCD and the POS data both imply that Massachusetts's rate of market share increase slowed between 2017 to 2018 compared to 2016 to 2017. In contrast, the unadjusted Massachusetts FCD market share shows a relatively steady increase in the rate of LED market share over the same time period. In short, the use of the adjustment factor complicates NMR's ability to draw conclusions about whether LED market share rates have slowed. What is clear, however, is that the US and non-program areas experienced large increases in LED market share between 2017 and 2018. The US LED market share increased 46% and non-program states by 73% between 2017 to 2018, exceeding any of the estimated rates of increase for Massachusetts, which ranged from 8% to 39% for the same time period.

Figure 8: Massachusetts and Comparison Area Market Share by Bulb Technology 2015-2018[1,2]



[1] All retail channels.
[2] In 2017 and 2018, CREED adjusted LED sales in some states (including Massachusetts) for better alignment with program sales data. Prior to the adjustment, 2017 LED market share in Massachusetts was 36% and 2018 was 50%. See Section 1.2.1 for more detail.

Figure 9: Massachusetts Market Share for Subset of Channels, 2009-2018[1]



[1] Includes discount, dollar, drug, grocery, mass merchandise, and some membership stores, and represents approximately 31% of the Massachusetts market.

Table 4: Comparison of Massachusetts and National Market Share 2016 to 2018 by Data Set and Program Sales Adjustment[1]

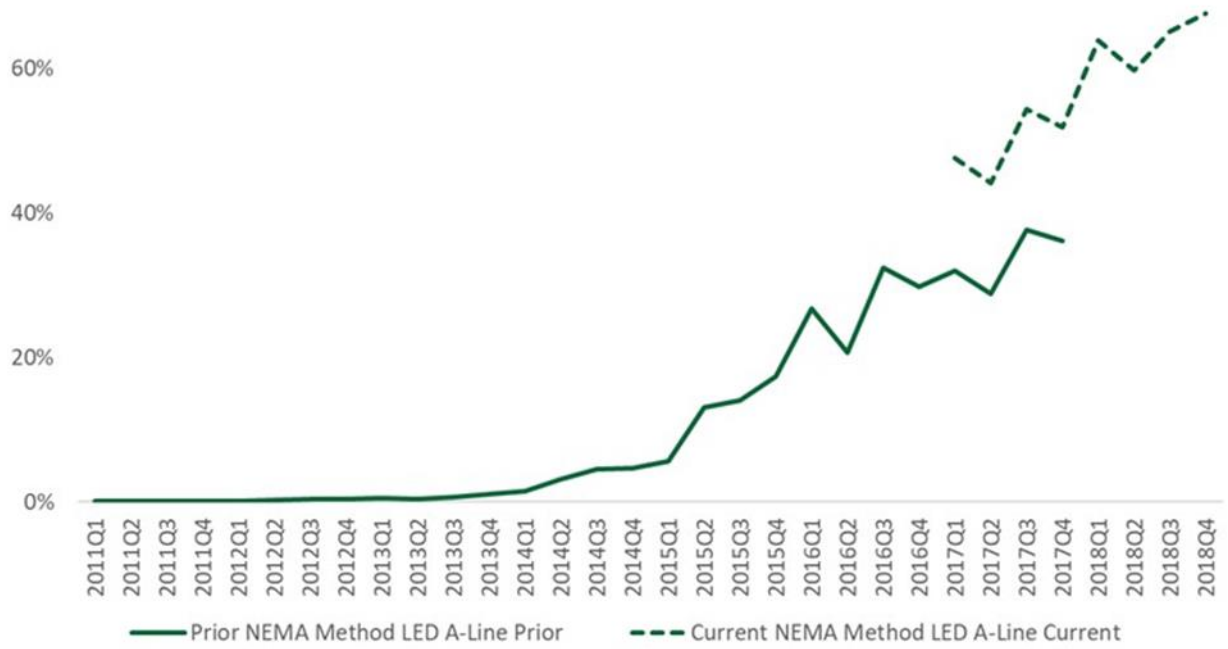
Data Set	Measure	2016	2017	2018
Massachusetts Adjusted FCD	Market Share	26%	49%	53%
	Rate of Increase		▲88%	▲8%
Massachusetts Unadjusted FCD	Market Share	26%	36%	50%
	Rate of Increase		▲38%	▲39%
Massachusetts POS	Market Share	15%	30%	40%
	Rate of Increase		▲100%	▲33%
National FCD	Market Share	26%	35%	51%
	Rate of Increase		▲35%	▲46%
Non-program area FCD	Market Share	20%	26%	45%
	Rate of Increase		▲30%	▲73%

[1] Rate = ([T2 ÷ T1] -1) x 100%.

NEMA Shipment Share

NEMA publishes national shipment shares for A-line bulbs. It is important to remember that sales often lag shipments, as bulbs sit in warehouses before being placed on store shelves and sold to customers. As described above (Section 1.2.2), NEMA recently revised its approach to estimating shipments, incorporating international sales and dropping incandescents and low and high lumen bins from the shipment share calculations. In Figure 10, the solid line shows the LED portion of A-line bulb shipments of NEMA members from Q1 2011 to Q4 2017 (the prior method). The dashed line shows the LED portion of A-line bulb shipments of NEMA members augmented with data on international shipments into the US for Q1 2017 to Q1 2019 (the current method).[21] Both methods point to the same trend of growing LED market share, but they differ in magnitude. The average LED shipment shares for 2017 were 34% using the prior method and 50% using the current method, a difference of 16%. The most recent update (Q1 2019) placed LEDs at 71% of all shipments.

Figure 10: A-line LED Shipment Share Over Time per NEMA (Prior and Current Calculation Methods)



[1] Market coverage is unknown, but the *prior* method excludes international shipments and the *current* method excludes incandescents and low and high lumen bins.

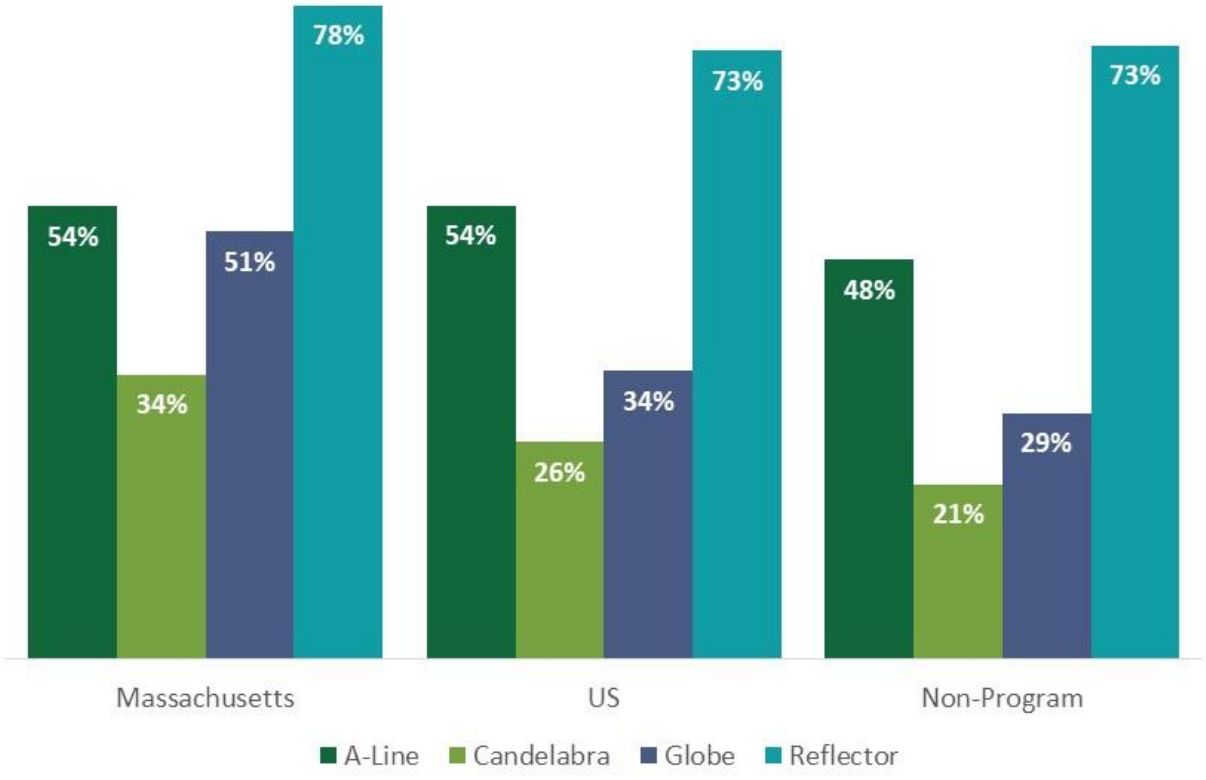
[21] Appendix A.2 compares the shipment share for all four A-line bulb types. The prior method included incandescents in the calculation of shipment share, while the current method does not.

2.1.2 Market Share by Bulb Shape

Although LED market share in Massachusetts surpassed the nation and non-program areas for every bulb shape, reflector market share was at least 70% in all areas considered, and A-line market share was near or above 50% in all areas.

Reflector market share in Massachusetts was 78% and 73% nationally and in non-program areas. The LED market share across all retail channels for globes in Massachusetts was 51% in 2018, compared to 34% for the nation and 29% in non-program areas (Figure 11). A-line market share in Massachusetts (54%) equaled that of the nation (54%) but remained higher than non-program areas (48%). Likewise, candelabra LED market share in Massachusetts stood at 34% compared to 26% for the nation and 21% in non-program areas. From a market transformation standpoint, it appears that the nation has made a great deal of progress on reflectors. The long-life and directional nature of LEDs makes sense in typical reflector applications, namely recessed ceiling cans and exterior floods. A-line market share also shows strong transformation progress. In contrast, while Massachusetts's market share of globes is above 50%, globes nationally and candelabra bulbs in all areas show far less progress towards transformation.

Figure 11: 2018 LED Market Share Bulb Shape in Massachusetts and Comparison Areas[1,2]



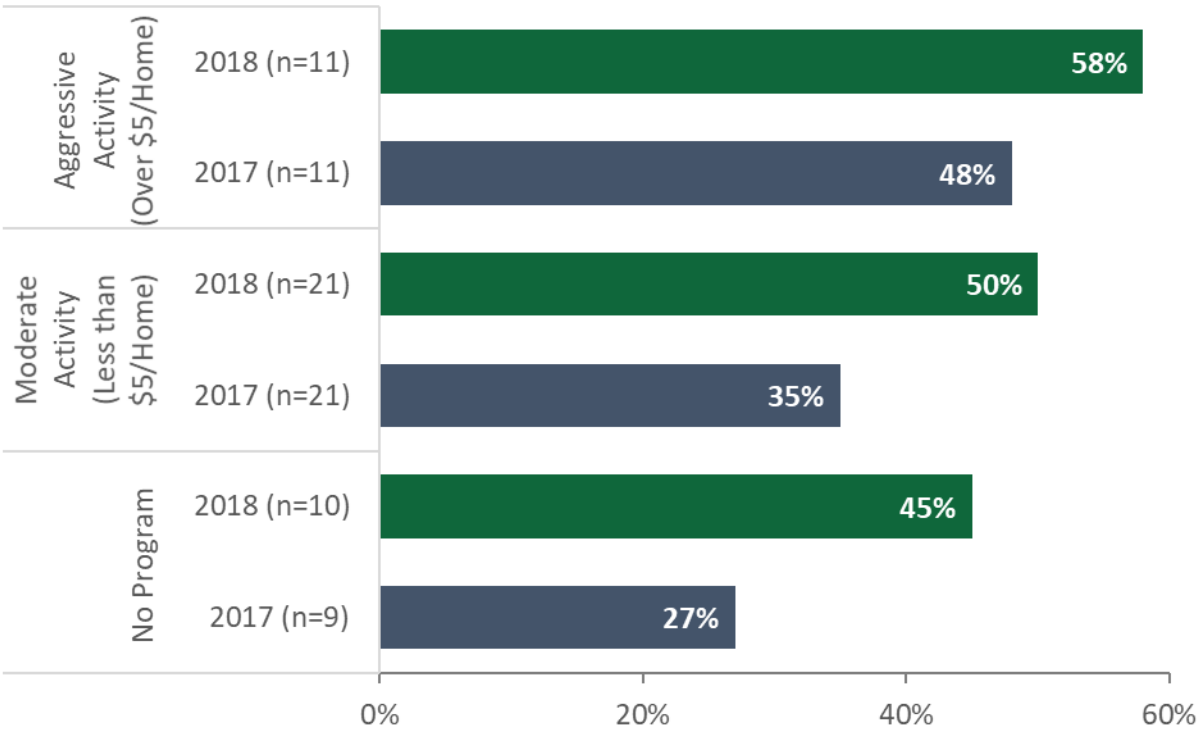
[1] All retail channels
[2] Market shares reflect LED adjustment for known program sales.

2.1.3 Market Share by Program Activity Analysis

States with more aggressive program spending per household and LED spending per bulb had higher LED market shares than states with moderate program spending and non-program states.

Figure 12 presents LED market share as a function of program spending (including incentives, marketing, and administration), and exhibits a clear increase in LED share as program spending increases.[22] States with aggressive program activity (including Massachusetts) spent over $5 per household on upstream lighting programs. The average LED market share among these states was 58%, up from 48% in 2017. The average LED market share among non-program states in 2018 was 45%, compared to 27% in 2017.[23] Moderate activity states fell in between, with LEDs garnering 50% of the market share in 2018 and 35% in 2017. Although program activity was clearly associated with higher market share in 2017 and 2018, the rate of market share increase was lowest among the most aggressive states and highest among non-program states.

Figure 12: 2018 Program Spending and LED Market Share[1]



[1] All retail channels.

[22] State-level spending varies for three primary reasons. First, the first being that the incentive levels and number of lamps incented can differ across states. Second, unlike in Massachusetts, in some states, not all PAs support upstream lighting., or the level of support by PA can vary. Finally, the non-incentive costs (e.g., marketing and outreach, allocation of admin) can also vary by PA, which could affect both program spending per household.

[23] See Appendix A for details on which states are included. Some states lacked sufficient program activity information to be included in this analysis. Note that CREED was able to secure adequate information for 41 states in 2017 and 42 states in 2018.

Similarly, Figure 13 and Figure 14 show Massachusetts' LED market share relative to other states with sufficient data for 2017 and 2018, respectively. Note that the states are numbered sequentially by year, so that State 1 in 2017 and 2018 are not necessarily the same state. The states denoted in dark green had aggressive programs (program spending more than $5 per household) in 2018. Light green bars represent non-program states, and blue bars represent states with spending between $0 and $5 per household. LED market share in Massachusetts placed below the median of other aggressive program states. As shown in Figure 13, in 2017, aggressive program states exhibited the highest market shares among the reported states, and every non-program state fell within the bottom one-half of market shares, and non-program states accounted for seven of the lowest ten shares in the nation.

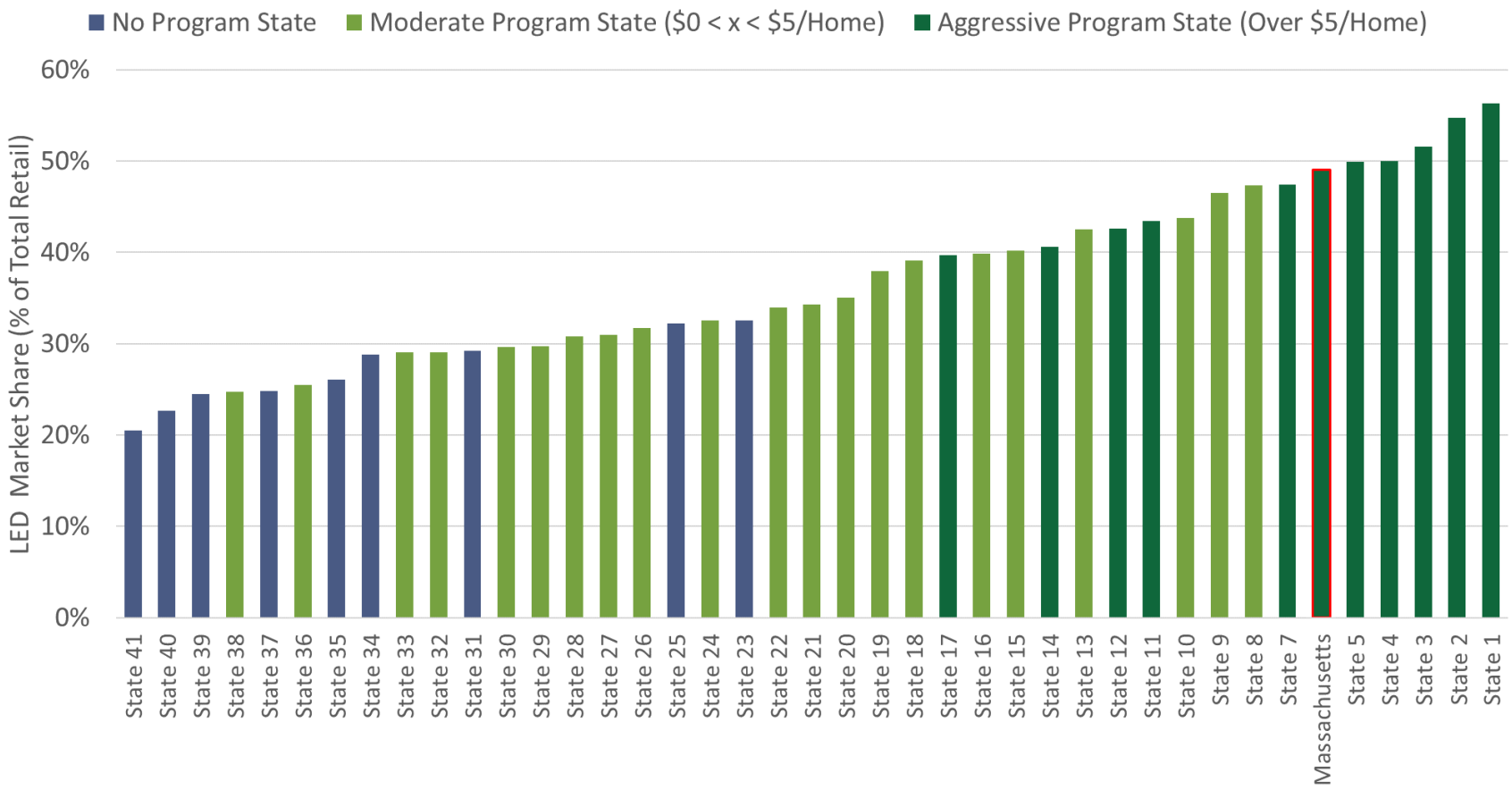
Figure 14 suggests that the story has changed. In 2018, aggressive, moderate, and even one non-program state (it used to have a program) share the top ten market shares in the nation. Massachusetts ranked 21st (post-adjustment) for LED market share. The shifting market share ranks lend support to the argument that the rates of natural market adoption of LEDs increased rapidly in 2018, with market share in moderate and non-program states rivaling or exceeding those in many aggressive program states, including Massachusetts.

With LED socket saturation at 34% (in the most recent on-site visit) [24] and likely on the rise, it will be increasingly difficult for the program to induce conversion of the remaining inefficient sockets to LEDs. Consumers have likely not converted these sockets due to a combination of less frequent use (consumers usually replace bulbs on failure) and concerns about aesthetics, light quality, and performance. In contrast, other areas are catching up to Massachusetts, converting the remaining low-hanging fruit and experiencing rapid increases in market share as a result.

The apparent decrease of program influence on market share nationwide certainly points to a transforming market, but it would be imprudent to place too much emphasis on the individual rankings of states. The CREED market share estimates can be noisy: they are sensitive to the sample size of panelists, and, as discussed above (See Section 2.1.1), efforts to align LED sales to known program sales complicates assessments of the market share.

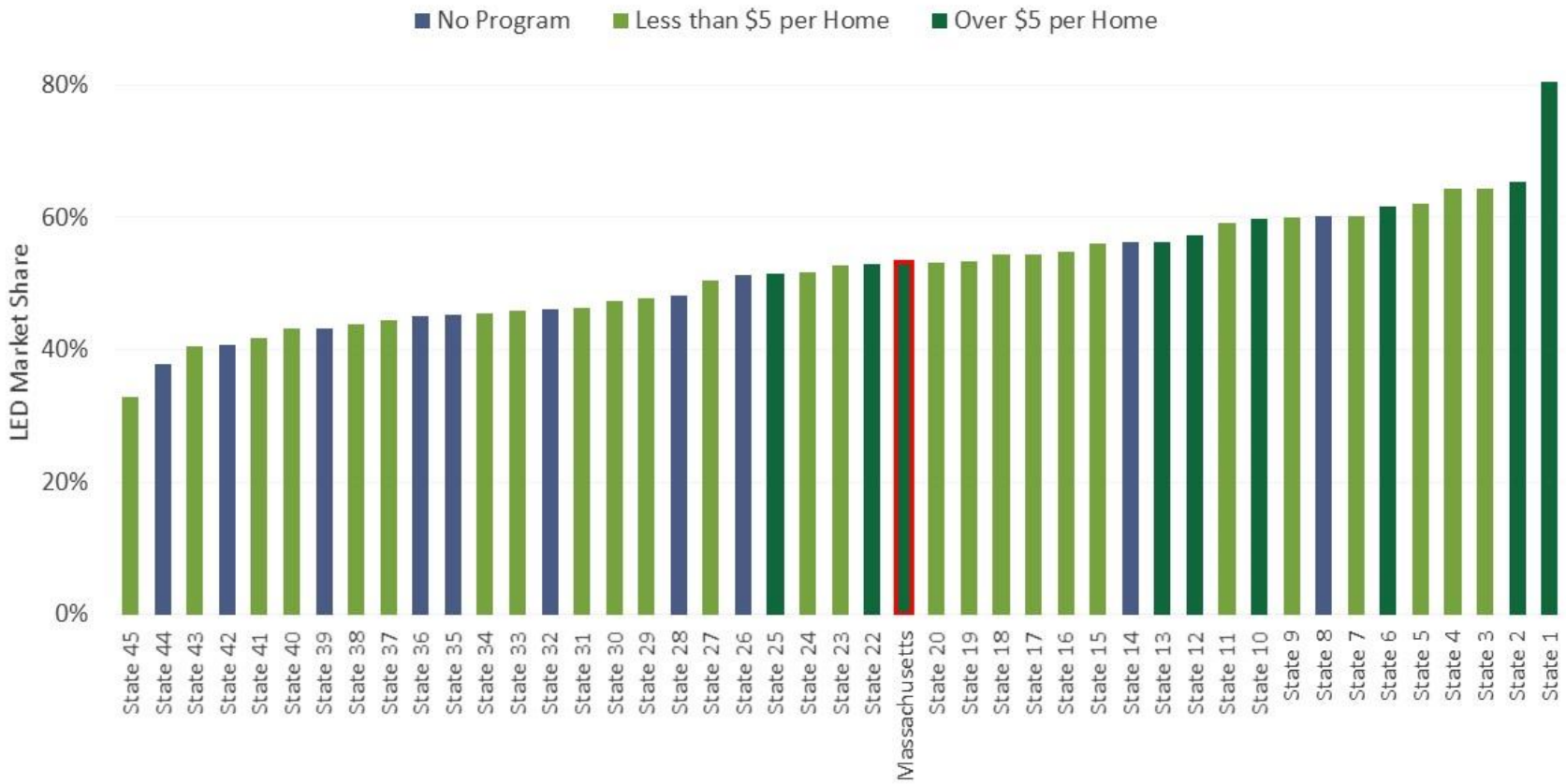
[24] NMR Group (2019). *RLPNC 18-10 Residential Lighting Market Assessment Study.* Delivered to the PAs and EEAC consultants March 29. Available at http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_1810_LtgMarketAssessment_FINAL_2019.03.29.pdf

Figure 13: 2017 LED Market Share Across States by Program Spending[1]



[1] All retail channels.

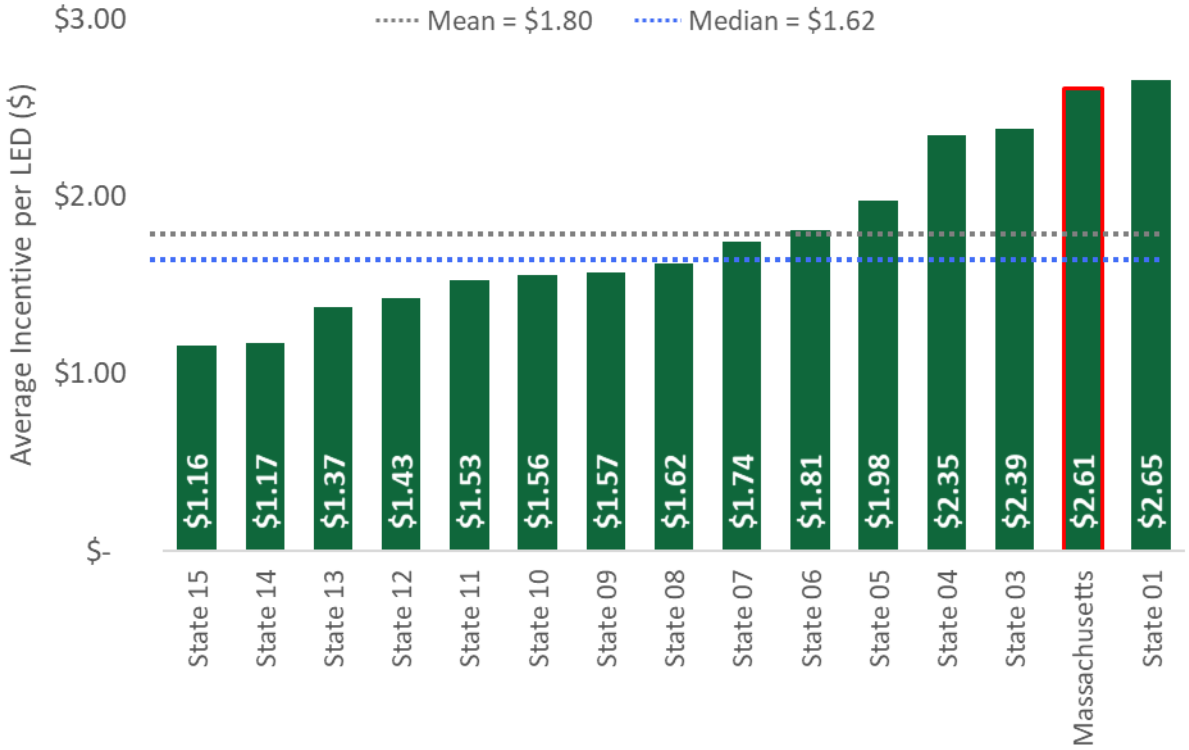
Figure 14: 2018 LED Market Share Across States by Program Spending[1]



[1] All retail channels.

The LightTracker team was able to obtain LED incentive dollars for 15 of the program states.[25] A simple calculation of LED incentive dollars (a portion of total spending) divided by program LEDs yielded average LED incentives per state. As shown below (Figure 15), per-bulb LED incentives in 2018 ranged from $1.16 to slightly above $2.65; the average LED incentive was $1.80.

Figure 15: Average 2018 Upstream Incentive per LED (Program States)[1,2]

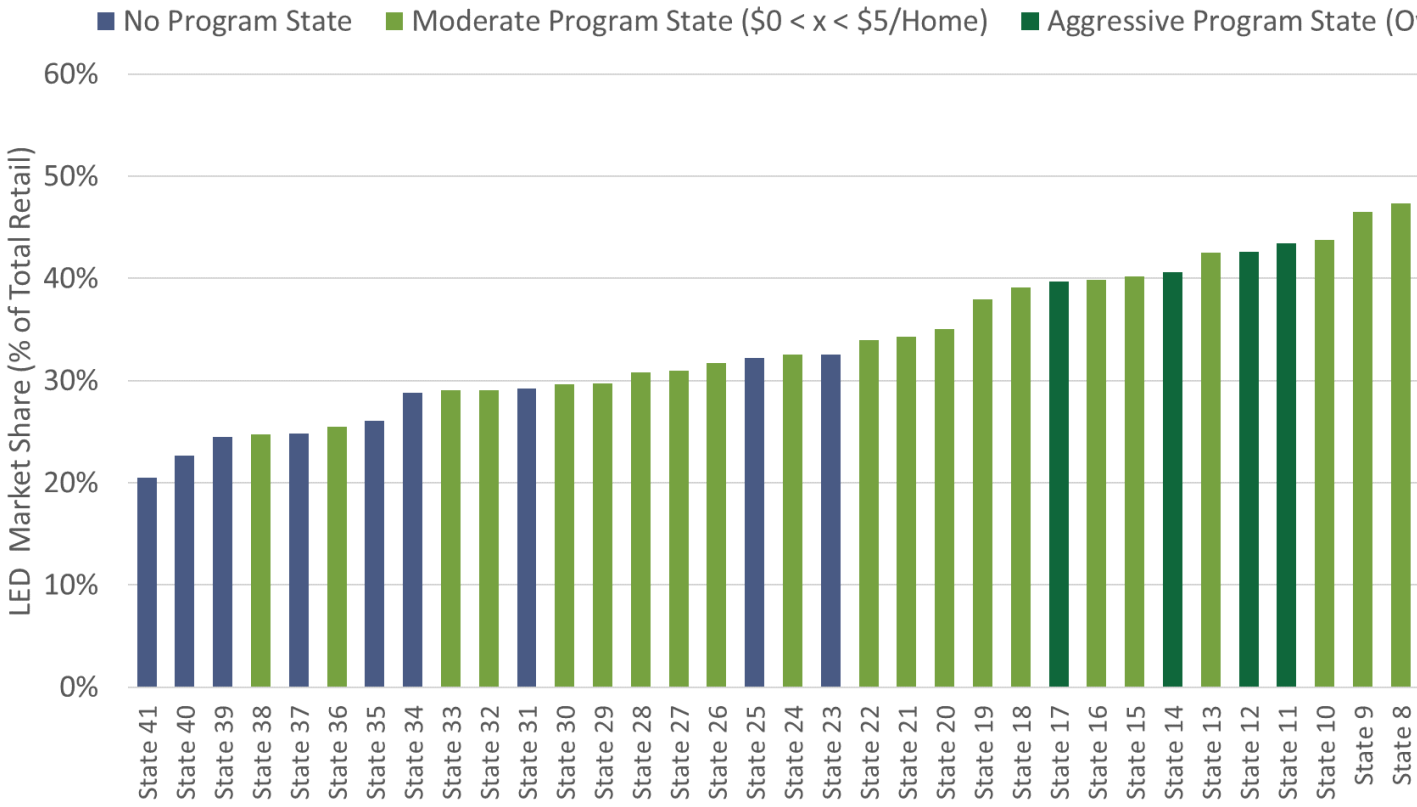


[1] All retail channels.

[25] Note that this analysis focuses solely on incentive dollars, while Figure 12 and Figure 13: 2017 LED Market Share Across States by Program Spending1

[2] LightTracker was able to isolate LED spending for only 15 states. Therefore, some program states listed in Figure 14 do not appear in Figure 15. Likewise, CREED renumbers the states when it anonymizes them, for example, State02 is not the same state across figures.

Figure 14 and Figure 15 show that Massachusetts has high program spending and LED incentives. However, Massachusetts does not have the highest market share, and it also saw smaller increases in LED market share than some other areas between 2016 and 2018. This raises the question of whether incentives in Massachusetts are higher than needed. NMR used LightTracker data, supplemented with information on cost-of-living,[26] to explore this question for the 14 program states for which we had adequate data on LED-specific incentives and proportions of A-line and specialty bulb program sales.[27] We considered the potential role played by A-line versus specialty program sales proportions and cost-of-living on incentive levels. The cost-of-



[1] All retail channels.

Figure 14 include all program spending.

[26] Missouri Economic Research and Information Center. 2018. *Cost of Living Data Series*. Accessed August 20, 2019. https://meric.mo.gov/data/cost-living-data-series

[27] A fifteenth state actively manipulated its incentive levels to slow their residential upstream lighting program sales and divert funds to less successful programs in their portfolio, so we removed it from the analysis.

living data are indexed to the US; any state with a cost-of-living greater than the nation as a whole has an index above 100 and any state below the nation has a cost-of-living below 100. Of the 45 states in the LightTracker dataset, Massachusetts has the third highest cost-of-living index (134). The 35 program states on average have an index of 105, while the average index in the ten non-program states was 95. Factors other than those considered in the analysis almost certainly play into setting incentive levels, but we could only assess variables for which we had adequate data.

We ran Pearson's correlations[28] to explore relationships among LED incentives, the proportion of specialty program sales, LED prices + known incentives (LightTracker LED prices include the application of program incentives), halogen prices (which, unlike LED prices, are not biased by program incentives), and the state cost-of-living index. There are two important things to keep in mind for Pearson's correlations. First, the closer a correlation is to +1 or -1, the greater the positive or negative relationship, respectively, between two variables. Second, correlation does not equal causation; the relationship may be due to a shared third, unmeasured factor or be coincidental.

Table 5 presents the correlations we ran to explore these relationships. The results seem to indicate that cost-of-living is more closely associated with halogen prices and LED incentives (alone or considered with prices) than is the concentration of specialty bulbs in the program. Of particular interest is the positive relationship between halogen price and cost of-living, implying that bulb prices generally are higher where the cost-of-living is higher. Again, we stress that this analysis is not meant to imply causation, but it does suggest that the high incentive levels in Massachusetts may in part reflect higher bulb prices in the state, which in turn could be due to the cost-of-living. Therefore, while this report includes a consideration about incentive levels, incentive adjustments should reflect the conditions in Massachusetts and not be based on simplistic comparisons to the rest of the nation.

Table 5: Exploring Incentive Prices

Relationship	Correlation	Sample Size (states)
Cost-of-living / LED Price + Incentive	0.82	14
Cost-of-living / LED Incentive	0.69	14
Cost-of-living / Halogen Price	0.67	45 (all LightTracker States)
% Specialty / LED Price + Incentive	0.56	14
% Specialty / LED Incentive	0.42	14
Cost-of-living / % Specialty	0.34	14

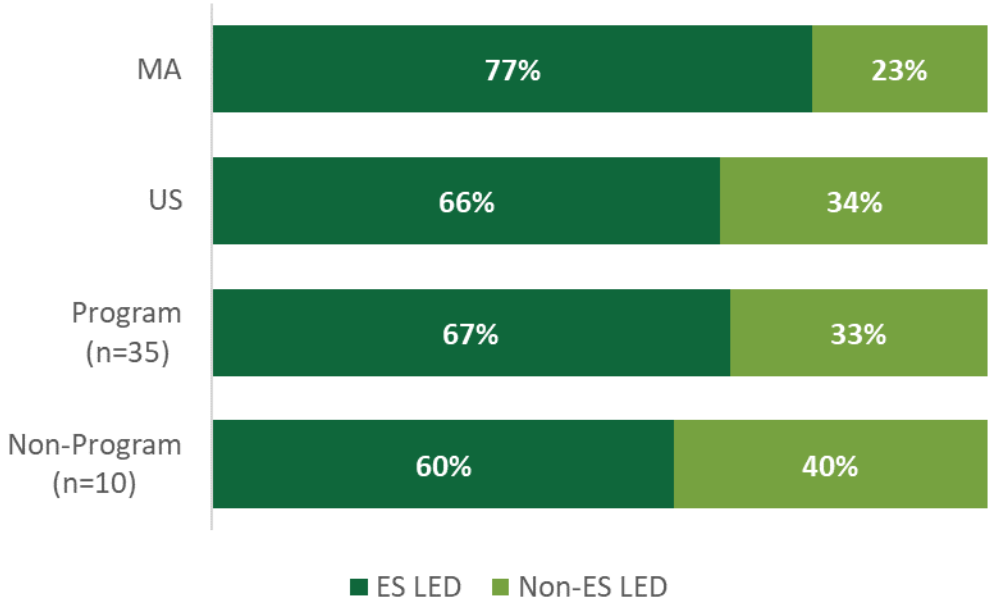
[28] Wikipedia offers an overview https://en.wikipedia.org/wiki/Pearson_correlation_coefficient. NMR recognizes that the data are based on a small number of states that were neither randomly selected nor adhere to the normal curve. These characteristics violate the assumptions of Pearson's correlations and related tests of statistical significance. Therefore, while NMR presents the correlations, we refrain from reporting *p-values* (a test of significance) and stress that the results should be considered indicative.

2.1.4 LED Market Share by ENERGY STAR Qualification

Market share of ENERGY STAR qualified LEDs in Massachusetts exceeded that of other areas.

The LightTracker Initiative identified LEDs qualified for the ENERGY STAR label in discount, dollar, drug, grocery, mass merchandise, and some membership stores largely based on the rated lifetime of bulbs.[29] Recalling the shortcomings of the dataset for determining ENERGY STAR qualified market share (Section 1.2.1), their exclusive support of ENERGY STAR qualified bulbs is evident in the LightTracker data. Among LEDs of verified status in the subset of retail channels, 77% were ENERGY STAR-qualified in Massachusetts in 2018 (Figure 16). This is higher than in the US (66%), program states (67%), and non-program states (60%). Massachusetts ranked 11th nationally for the percentage of LED sales that were ENERGY STAR, eight percentage points behind the 85% held by the leading state.

Figure 16: ENERGY STAR Status of 2019 LED Sales in Massachusetts and Comparison Areas[1]



[1] Includes discount, dollar, drug, grocery, mass merchandise, and some membership stores. Represents approximately 31% of the Massachusetts, 35% of the US market, 33% of the program state market, and 46% of the non-program state market.

[29] CREED assumed that, with ENERGY STAR Specification 2.0, bulbs rated 15,000 hours or higher were almost always ENERGY STAR qualified, while those under 15,000 hours rarely were qualified. NMR's review of shelf stocking data collected by Lockheed Martin in Massachusetts and Rhode Island suggests that this assumption may not be accurate. Because CREED applied this criterion universally, the implication is that the proportion of ENERGY STAR LEDs may be overstated for *all states.* Therefore, NMR believes it presents a fair representation of the relative size of ENERGY STAR qualification across areas, even if the exact percentages may be overstated.

2.1.5 Market Share by Lumen Bin

EISA 2007 increased efficiency standards on most A-line general service lamps. A second phase of EISA (EISA Phase II or EISA 2020) was supposed to go into effect in January 2020, but its status remains uncertain due to a series of regulatory and legal actions (and inactions).[30, 31] The PAs asked NMR to examine 2018 market share for the LightTracker sales data to assess the percentage of bulbs sold by type that are currently EISA exempt and that most likely will remain so when the EISA Phase II (EISA 2020) regulations go into effect.. We used the following definitions, although we stress that they may differ in the future pending the outcome of regulatory and legal decisions:

- Currently exempt from EISA: A-line bulbs that exceed 2,600 lumens or fall below 310 lumens
- Exempt from EISA 2020: A-line bulbs that exceed 3,300 lumens or fall below 310 lumens

Table 6 lists the overall percentage of A-line bulb sales that fell into each lumen bin. The table includes all technologies but only for the POS dataset (discount, dollar, drug, grocery, mass merchandise, and some membership stores). The table also indicates whether the lumen bin is currently EISA exempt and will remain so in 2020 (if implemented) and its approximate A-line incandescent wattage equivalent.[32] Assessing market share by lumens highlights the market share of bulbs between 310 and 2,600 lumens once held by incandescents. According to the data for this subset of retail channels, about 2% of A-line sales fall into lumen bins that are currently exempt from EISA (greater than 2,600 lumens and less than 310 lumens).

Table 6: A-line Lumen Bin Description

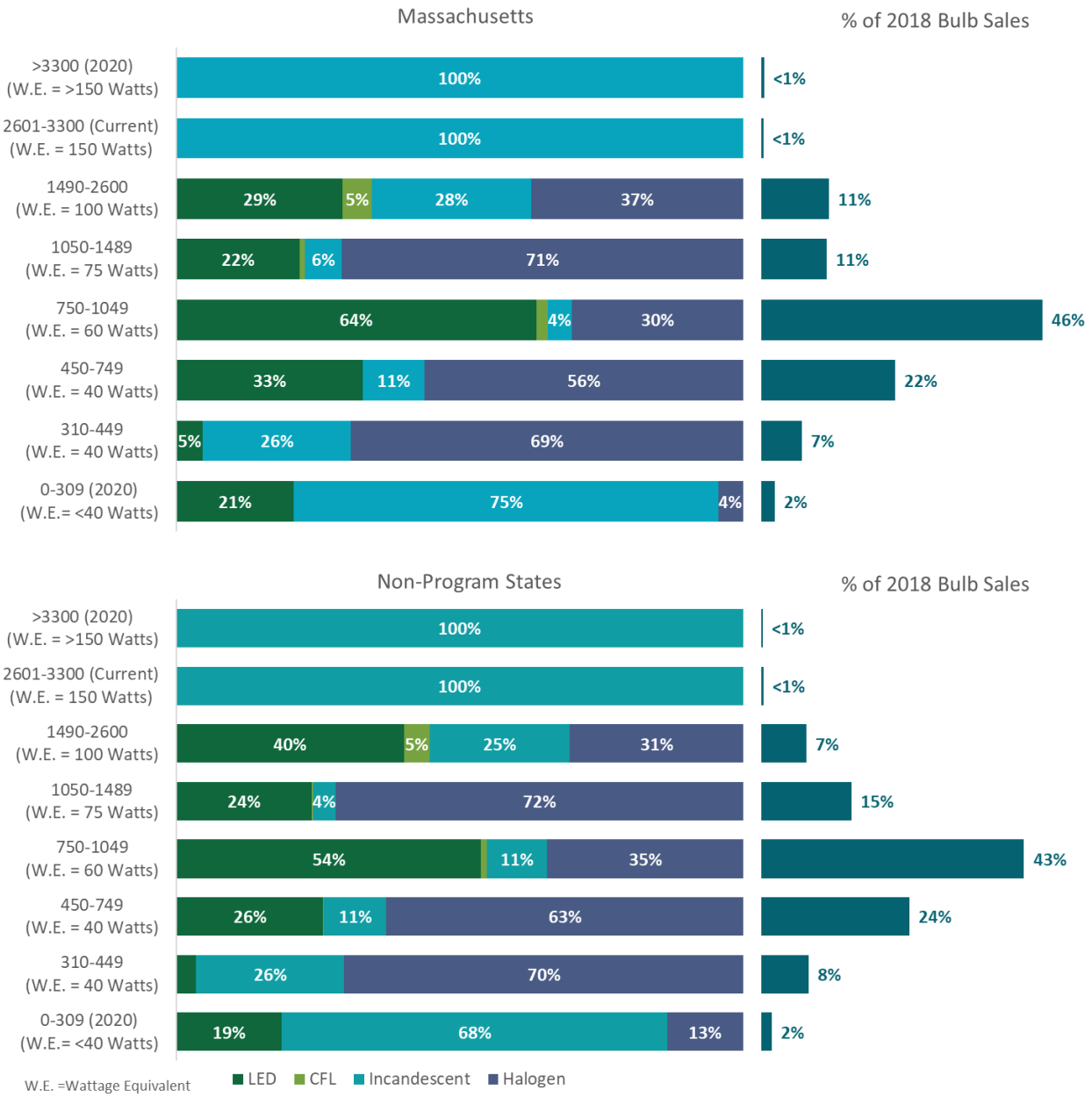
Lumen Bin	EISA Exemption	Approximate A-line Incandescent Wattage	Percentage of 2018 A-line Bulb Sales (MA)	Percentage of 2018 A-line LED Sales (MA)
0-309	Current and 2020	Below 40 Watts	2%	21%
310-449	Not exempt	40 Watts	7%	5%
450-749	Not exempt	40 Watts	22%	33%
750-1049	Not exempt	60 Watts	46%	64%
1050-1489	Not exempt	75 Watts	11%	22%
1490-2600	Not exempt	100 Watts	11%	29%
2601-3300	Current	150 Watts	<1%	<1%
>3300	Current and 2020	Above 150 Watts	<1%	<1%

[30] Early in 2017, the DOE issued a rulemaking expanding the definition of general service lamps to include reflectors, globes, candelabras, and some other bulb types currently exempt from EISA, but the DOE has since rescinded the rulemaking. The DOE has also indicated that the EISA 45 lumens per watt backstop general service lamps may not have been triggered, but the department has not released a final rulemaking on this topic. The outcome if, how, and when EISA 2020 will be implemented will most likely be cleared up in the courts as the outcome of lawsuits.
[31] While exempt from the first phase of EISA, reflector bulbs must adhere to their own set of efficiency standards that vary by size and shape. See https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=23.
[32] Wattage equivalents vary considerably, so these are approximations only.

LED sales in Massachusetts are strongest in the lumen bins most closely associated with the 60-Watt incandescent bulbs.

Figure 17 presents the A-line market share by bulb type and lumen bin for A-line bulbs in Massachusetts and non-program states in the grocery, drug, dollar, discount, merchandise, and some membership channels. LEDs were the majority of A-line sales (64%) in only one lumen bin - the 750 to 1,049 lumen bin, which accounted for 46% of all A-line sales. In contrast, halogens composed the majority of sales in all other lumen bins currently subject to EISA, while incandescents accounted for almost all sales in bins that are currently exempt from EISA.

Figure 17: Massachusetts 2018 A-line Bulb Market Share by Lumen Bin[1,2,3]



[1] Includes discount, dollar, drug, grocery, mass merchandise, and some membership stores, and represents approximately 31% of the Massachusetts market, 35% of the US market and 41% of non-program states. Labels for subtotals less than 2% are omitted for aesthetic purposes.
[2] Bins currently EISA Exempt: less than 310, above 2,600; bins exempt from EISA 2020 (if implemented): less than 310, above 3,300 (i.e., the 2,601 – 3,300 bin will become subject to EISA in 2020).
[3] As shows in Table 6, the percentages of sales represented in the lumen bins below 310 and above 2,600 are very small. Likewise, small sample sizes of bulbs in these bins, while still in the thousands, are much smaller than the hundreds of thousands of bulbs in the 450 to 2,600 lumen bins.

Market share of LED A-line bulbs with lumens less than 1,050 was higher than non-program states; non-program states had higher LED shares in the 1,050 to 2.600 range.

Massachusetts has made greater progress than non-program areas in LED market share in the EISA covered lumen bins with the highest sales: the 450 to 749 and 750 to 1,049 lumen bins. Despite long-standing, aggressive program activity, Massachusetts had lower LED market share than non-program areas in the EISA covered 1,490 to 2,600 lumen bin and comparable share in the EISA covered 1,050 and 1,489 lumen bins. Market share in the EISA exempt very low and very high lumen bins are nearly the same in Massachusetts and non-program states.

Table 7: A-line Lumen Bin Comparison [1]

Lumen Bin	EISA Exemption	Approximate A-line Incandescent Wattage	LED Share	
			MA	Non-Program
0-309	Current and 2020	Below 40 Watts	21%	19%
310-449	Not exempt	40 Watts	5%	3%
450-749	Not exempt	40 Watts	**33%**	**26%**
750-1049	Not exempt	60 Watts	**64%**	**54%**
1050-1489	Not exempt	75 Watts	22%	24%
1490-2600	Not exempt	100 Watts	**29%**	**40%**
2601-3300	Current	150 Watts	0%	0%
>3300	Current and 2020	Above 150 Watts	0%	0%

[1] Teal text = MA higher by 5% or higher; Red text = Non-program higher by 5% or higher. NMR cautions that the estimates become less reliable in low-sales bins

2.2 Bulb Price Analysis

NMR compared the average price of LEDs and halogens for Massachusetts and the various comparison areas using the FCD lighting data (all retail channels). The prices in the LightTracker dataset reflect the application of program incentives. However, the third-party sources do not report prices for private label bulbs (also known as store brands). Store brands usually sell for less than brand name models, so the prices reported in this section should be considered on the high end of what consumers pay at the register.

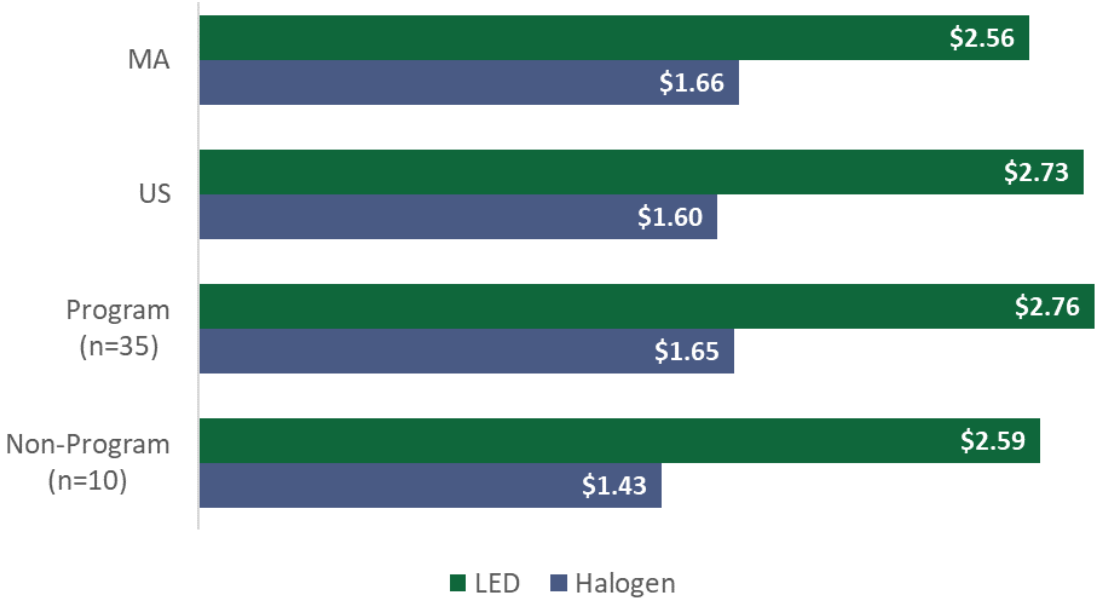
Massachusetts's high incentives have contributed to it having one of the lowest shelf prices (including the application of incentives) of LED among the areas considered.

Figure 18 displays the shelf price – including the application of program incentives – for LEDs and halogens.[33] Massachusetts had the lowest LED price ($2.56), but the price was not meaningfully different than that of non-program states ($2.59). Halogen prices

[33] The small sample sizes of CFLs and incandescents leads to large swings in pricing across areas.

NMR believes that the low average LED price in non-program areas likely reflects a combination of factors. First, data collection and reporting error could underlie the result. Second, the prices include both ENERGY STAR and non-ENERGY STAR LEDs; non-program states had the highest proportion of non-ENERGY STAR LEDs, which tend to be less expensive than ENERGY STAR models (Figure 16).[34] Yet, it could also be that retailers have discounted the price of all LEDs in non-program areas either because of the lower cost-of-living in non-program states or to boost LED sales, given that, prior to 2018, LED sales in non-program areas lagged those in program areas. Although the explanation remains unclear, the low price of LEDs in non-program areas provides additional evidence that market transformation is progressing across the nation.

Figure 18: 2018 Average Price per Bulb in Massachusetts and Comparison Areas[1,2]



[1] All retail channels.
[2] Does not include private label bulbs sold at specific retailers, so the prices reported here are likely somewhat higher than actual prices.

The pricing of LEDs and halogens likely helps explain market share differences across areas.

LEDs cost about 90 cents more than halogens in Massachusetts, compared to about $1.10 more in the other comparison areas. By reducing the price of LEDs considerably, the Massachusetts PAs have likely help to increase market share of LEDs relative to halogens. In contrast, lacking such supports – and also likely influenced by cost-of-living – low halogen prices in non-program areas probably contribute to the higher market share of halogens in those states.

[34] Manufacturers and retailers also reported at the ENERGY STAR Partners meeting in September 2019 that sales of non-ENERGY STAR LEDs are higher in the absence of program incentives for ENERGY STAR qualified bulbs.

Appendix A Data Sources and Data Cleaning

This appendix provides a detailed discussion of data sources, data cleaning, and the strengths and weaknesses of each source.

A.1 Lighting Sales Data

The LightTracker Initiative dataset compiled by CREED. These data fill a gap in the availability of market-level lighting sales data. While many program partners readily share program sales data, they are reluctant to share non-program sales data. Non-program retailers and manufacturers also rarely share sales data with PAs or evaluators. The LightTracker Initiative pools the resources of multiple PAs to make a new source of market level information available. While not perfect (see Section 1.2.1 for a listing of strengths and weaknesses), it offers improved estimates of market-level sales for all retail channels and most states. LightTracker provides data for 45 of the 50 United States (see Table 8 for a listing of states).

Though the dataset CREED received included detailed records of lighting data purchases, the data required a considerable effort to ensure data integrity and inclusion of all the necessary bulb attributes. For example, some records did not have critical variables populated, such as bulb type, shape, or wattage. In addition, some records had clearly erroneous values (e.g., 60-watt LEDs). After thorough review and quality control of the dataset, CREED re-classified and standardized the data. CREED also populated missing records, created additional variables, and performed general enhancements to the data. To populate missing records, validate existing records, and include additional bulb attributes, CREED created a proprietary Universal Product Code (UPC) database with approximately 36,000 bulbs from the following five sources:

- Manufacturer product databases provided to LightTracker
- Product catalogs downloaded from manufacturer web sites via web scraping
- Product offerings downloaded from retailer web sites
- Automated lookups of online UPC databases, such as www.upcitemdb.com
- ENERGY STAR databases available online at https://www.energystar.gov/productfinder/product/certified-light-bulbs

Table 8: Program Strength and Data Quality Confidence

Program States	Non-Program States	Unable to Categorize/ Excluded from LightTracker[1]
Arizona	Alabama	Alaska
Arkansas	Delaware	Hawaii
California	Kansas	Iowa[2]
Colorado	Kentucky	Montana
Connecticut	Mississippi	North Dakota
Florida	Nebraska	
Georgia	Nevada	
Idaho	Tennessee	
Illinois	Virginia	
Indiana	Wyoming	
Louisiana		
Maine		
Maryland		
Massachusetts		
Michigan		
Minnesota		
Missouri		
New Hampshire		
New Jersey		
New Mexico		
New York		
North Carolina		
Ohio		
Oklahoma		
Oregon		
Pennsylvania		
Rhode Island		
South Carolina		
South Dakota		
Texas		
Utah		
Vermont		
Washington		
West Virginia		
Wisconsin		

[1] LightTracker was unable to assign program status to these states or the states lacked sales data or LightTracker.
[2] CREED was able to obtain program data for Iowa, but the state's representation in the POS and NCP data used to create the LightTracker dataset is too small to allow for estimation of bulb sales and market share.

CREED then merged the bulb database with the POS/Panel data, populating fields based on a hierarchy of data sources believed to be most reliable. Prioritization was typically in the following order: manufacturer specifications, UPC lookups, original data provider (IRI and Nielsen) database values. The team also conducted manual web lookups on individual bulbs to determine final assignments.

In addition, CREED investigated the bulb assignment and the quantity of bulbs per package by examining the average price per unit and by identifying outliers in terms of per bulb prices. This process helped identify misclassification of certain bulb types (e.g., bulbs that were flagged as low-cost LEDs but were really LED nightlights, so they needed to be moved under the *other* category) and misclassification of bulb counts that represented box shipments (e.g., a package identified as having 36 bulbs was really a six-pack of CFLs that was shipped with six packages per box).

Key aspects of the final lighting dataset include the following:

- 2018 sales volume and pricing for CFLs, LEDs, halogens, and incandescent bulbs for all channels combined, and broken out by the POS and non-POS channels
- Data reporting by state (with 45 states included) and bulb type
- Inclusion of all bulb shapes (e.g., candelabra, globe, etc.) and controls (e.g., three-way, dimmers, etc.)

A.2 NEMA Shipment Data

We also examined quarterly NEMA bulb shipment data. Section 1.2.1 of the main body of the report describes the NEMA shipment data and discusses the recent change NEMA made to its method of calculating shipment shares. Section 1.2.1 presents data on LED shipment shares using the prior and current NEMA estimation methods and compares the shipment shares to sales shares. Figure 19 and Figure 20 present the shipment shares over time for all bulb types, from 2011 to 2017 using the prior NEMA calculation method and including incandescents (Figure 19) and from 2017 to Q1 2019 for LEDs, halogens, and CFLs (Figure 20). Both figures demonstrate the shrinking CFL share. Figure 19 also shows the decline in incandescent shares. Figure 19 and Figure 20 differ in that the former suggests relatively steady market share for halogens from late 2015 through 2017, with LEDs encroaching on CFLs and incandescent. The latter figure suggests that LEDs are also encroaching on halogen shares.

Figure 19: NEMA Shipment Share, All Bulb Types (Prior Calculation Method)

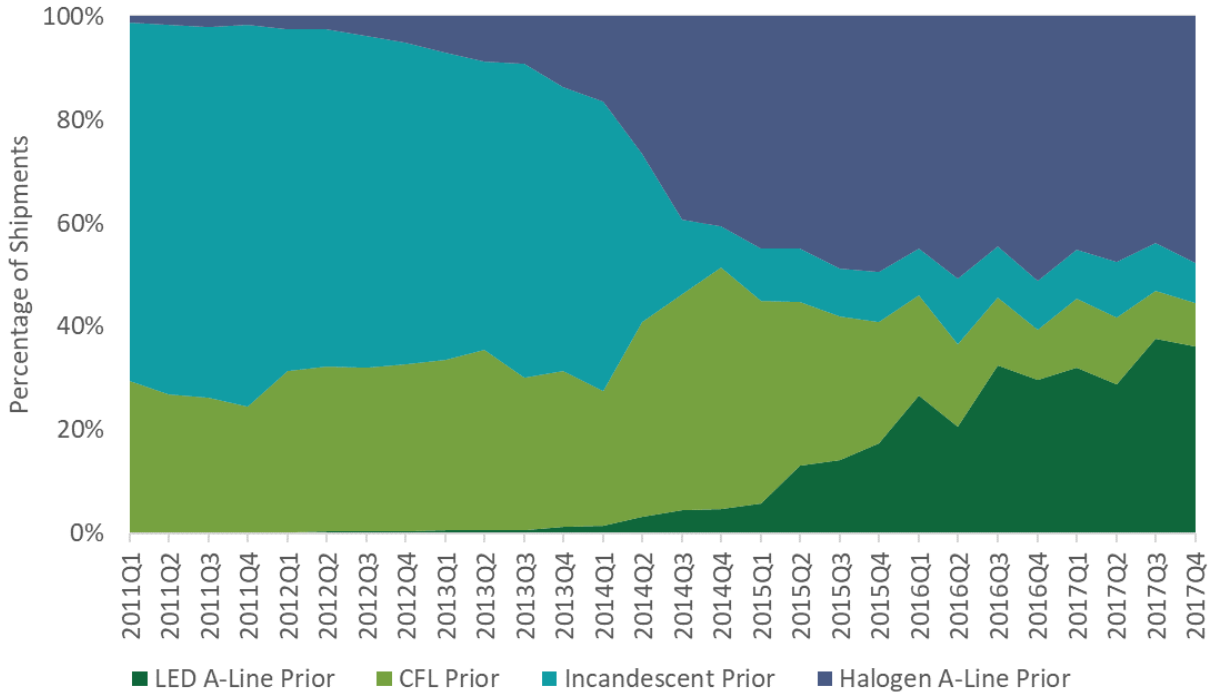
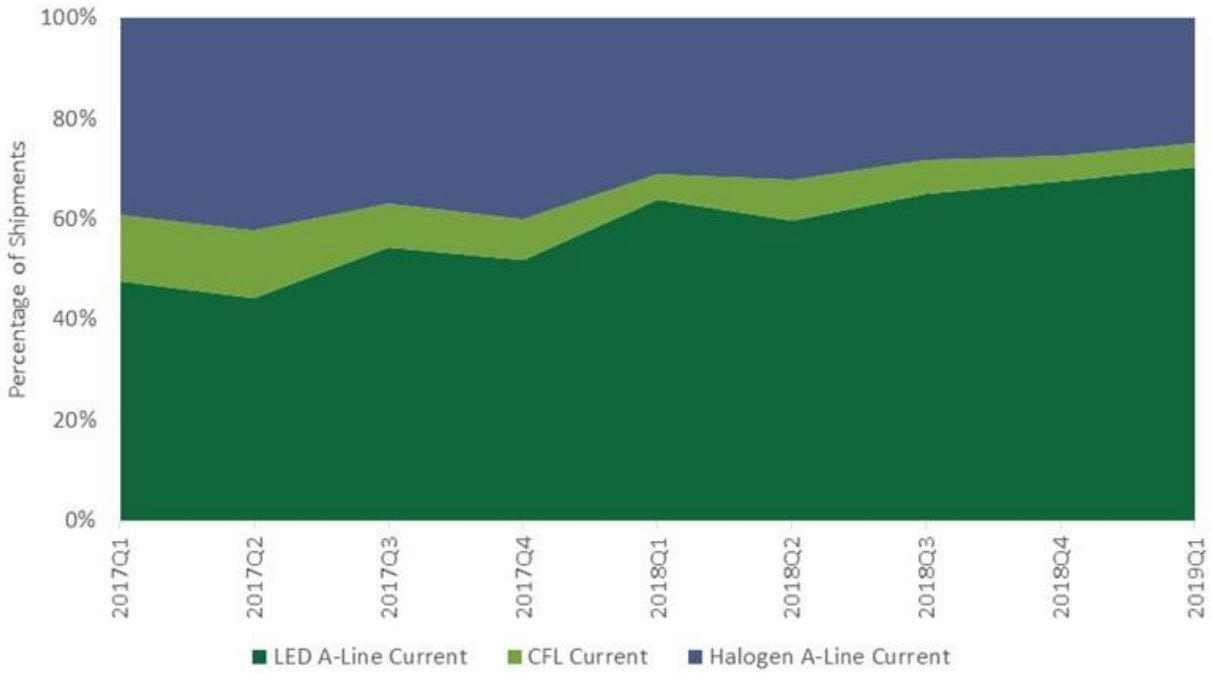


Figure 20: NEMA Shipment Share All Bulb Types (Current Calculation Method, Excludes Incandescents)



A.3 PROGRAM ACTIVITY

To research program activity, the LightTracker team used internal resources and conducted a literature review of publicly available reports that were found on the internet or provided by PAs or their evaluators.[35] The team contacted local utilities in each given area when reports with the relevant information were not available. Additionally, the team accessed DSM Insights, an E Source product that provides a detailed breakdown of program-level spending, including incentives, marketing, and delivery for over 100 PAs around the country.[36]

The team collected the following program data:

- Total number of claimed LED upstream program bulbs reported by each program
- Upstream LED incentives
- Total upstream program budget

Where available, the team used actual program data. In other cases, it turned to DSM Insights, ENERGY STAR reported expenditures, or planning values as proxies.[37]

All states with at least some program activity in 2018 were designated *program states; the* remaining states were designated *non-program states*, as shown above in Table 8.

[35] Specifically, the team began by searching the ENERGY STAR Summary of Lighting Programs website https://www.energystar.gov/ia/partners/downloads/2018%20ENERGY%20STAR%20Summary%20of%20Lighting%20Programs.pdf and referenced the Database of State Incentives for Renewables & Efficiency (www.dsireusa.org).
[36] E Source. "DSM Insights." April 2018.
[37] Note that because the ENERGY STAR report only included expenditure ranges, the midpoints of the ranges were used to represent the expenditures.