Rhode Island 2017 Lighting Sales Data Analysis

FINAL

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SUBMITTED TO:
National Grid

SUBMITTED BY:
NMR Group, Inc.

NMR Group, Inc.

Rhode Island 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 Rhode Island. The study compares market share and bulb prices in Rhode Island, the United States, and various comparison areas with different levels of lighting program activity. The report explores 2017 market share by bulb type, shape, and ENERGY STAR status, compares bulb prices, and considers trends in market share from 2015 to 2017. The sales data analysis strongly suggests that the ENERGY STAR® Lighting Program continued to have a positive impact on the energy efficient bulb market in 2017. NMR will update this study with 2018 data when they become available.

Key Findings

Rhode Island's market share for efficient bulbs (LEDs + CFLs) stood at 60% in 2017, with LEDs alone accounting for 55% of all bulb sales.

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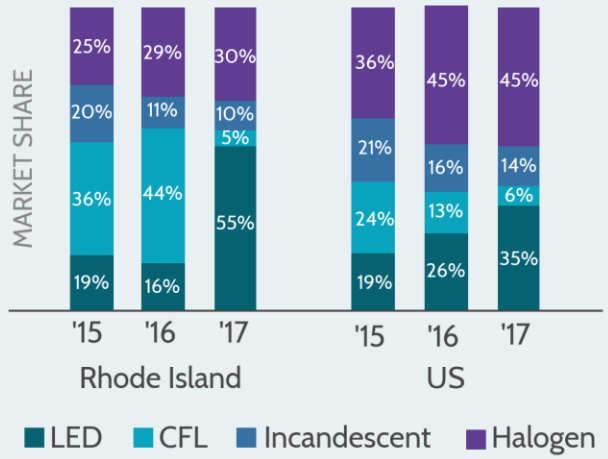
Sales of ENERGY STAR qualified LEDs in Rhode Island outpaced non-ENERGY STAR LEDS four to one.

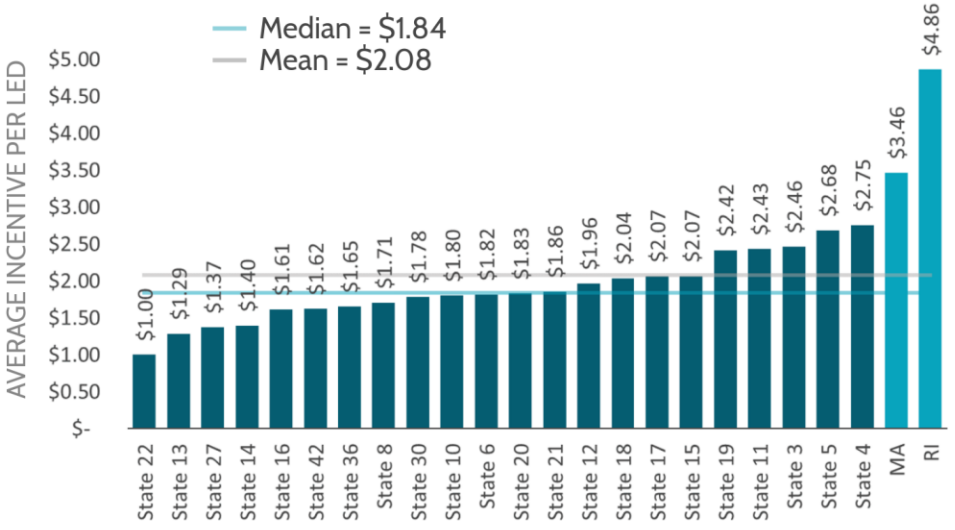
LED sales in Rhode Island are strongest in lumen bins (a measure of brightness) most closely associated with the 60 Watt and 40 Watt incandescent bulbs.

Rhode Island and US Market Share by Bulb Technology (All Channels)



State-level LED Market Share by Average LED Incentive

- Rhode Island's LED market share placed second highest in the nation. LED market share tended to be lower in states lacking upstream lighting programs.
- The strong LED market share in Rhode Island reflects its aggressive incentive, the highest in the nation at $4.86 per LED.



Data Sources

Consortium for Retail Energy Efficiency Data

NEMA shipment

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ES

Executive Summary

This report describes recent screw-base light bulb market share, shipments, and prices in Rhode Island and Massachusetts, the entire United States, states with upstream residential lighting programs (program states), and states without upstream residential lighting programs (non-program states).[1] 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).[2,3,4,5] It addresses four lighting technologies: light emitting diodes (LEDs), compact fluorescent lamps (CFLs), halogens, and incandescents. This study is meant to provide information only and refrains from making recommendations or offering considerations.

Table 1 summarizes the topics explored in this report and their relevant data sources. LightTracker provided NMR with two different datasets: the full category lighting data (FCD) and the Point-of-Sale (POS) data. The FCD cover all retail channels (discount, dollar, drug, grocery, hardware, home improvement, mass merchandise, and membership stores). The POS data include only a subset of channels (discount, dollar, drug, grocery, mass merchandise, and some membership stores) that covers approximately 21% of the Rhode Island lighting market and 26% and 35% for Massachusetts and the nation, respectively. The POS data represent sales as reported by retailers. The FCD draw on the same POS data but also layer in consumer purchase panel (the National Consumer Panel or NCP, in which panelists scan all purchases they make), incorporating protections to avoid double-counting of sales in channels represented in both data sources. NMR uses the acronyms FCD and POS in figures and table titles and footnotes to clarify the data sources covered in the analysis.

CREED cleans and vets the data before releasing the annual LightTracker dataset. They also attempt to mitigate or resolve known shortcomings. One shortcoming prior to 2017 involved a

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[1] The Massachusetts findings presented here are drawn from research funded by the Massachusetts Program Administrators. See NMR Group, Inc. 2018. *RLPNC 18-11 Lighting Sales Data Analysis.* http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_1811_LtgSalesDataAnalysis_26NOV2018_final.pdf.

[2] The study uses data purchased by CREED from IRI and Nielsen. IRI (https://www.iriworldwide.com/en-us/Company/About-Us) and Nielsen (https://www.nielsen.com/us/en.html) track and compile information on sales and purchases in numerous sectors of the economy. Nielsen is better known for its tracking of television-viewing habits.

[3] 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.

[4] 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, 2017, for the available state level markets and Expanded All Outlets Combined (xAOC) and Total Market Channels. Copyright © 2017, Nielsen.

[5] 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.

disconnect between program LED sales reported by administrators and total LED sales in numerous states, most of them with aggressive LED programs. The LightTracker FCD data seemed to undercount total LED sales when compared to program sales data. As discussed more in Section 1.2.1, in 2017, CREED introduced an adjustment to the dataset that brought total LED sales in better alignment with program sales. This adjustment, however, applies only to LED sales and not sales of other bulb types, likely overstating LED market share. As we describe more below, the LED market share estimate for Rhode Island without the adjustment was 42%, and with the adjustment it was 55%. CREED feels that the adjustment serves as a more accurate representation of the market; NMR suggests that the true LED market share for Rhode Island likely falls somewhere between these two bounds.

For most topics, we compared Rhode Island to four comparison areas: Massachusetts, the nation, program states, and non-program states. For FCD, estimates for the entire US reflect extrapolations to the nation and not the sum of individual states. NEMA limits public shipment data to the national level, so our review necessarily occurred at the national level.

Table 1: Study Topics and Data Sources

Topic	Years	Data Source[1]
Current market share (sales) by bulb type	2017	LightTracker FCD
Market share (sales) over time	2015 to 2017	LightTracker FCD
Market share (sales) by bulb shape, lumen bins, ENERGY STAR qualifications	2017	LightTracker POS
Market share (shipments)	2011 to 2018	NEMA
Bulb price analysis	2017	LightTracker FCD

[1] Full category LightTracker (FCD) data includes sales information for all retail channels and represents 100% of the lighting market. Point-of-sale (POS) data include discount, dollar, drug, grocery, mass merchandise, and membership stores, representing 21% of the lighting sales in Rhode Island. POS data exclude hardware and home improvement stores.

OVERALL CONCLUSION

The sales data analysis strongly suggests that the National Grid Rhode Island ENERGY STAR Retail Lighting Program (the Program) continued to have a positive impact on the energy-efficient bulb market in 2017.

The year ushered in a sea change for LEDs, including the following:

- ENERGY STAR Specification 2.0[6] expanded the number, characteristics, and price points of qualified LEDs, so National Grid, which incents only ENERGY STAR, could increase the diversity and price points of bulbs supported by the program
- The natural price point of LEDs continued to decline
- Retailers expanded the number and diversity of LEDS – both ENERGY STAR and non-ENERGY STAR – on their shelves

[6] Although certain aspects of the specification became more stringent (e.g., efficiency), Version 2.0 reduced the minimum rated hours to qualify for ENERGY STAR, which increased the number of products qualifying for the label..

These factors culminated in LED market shares overall and for ENERGY STAR qualified bulbs in Rhode Island that were highest among program states, non-program states and the nation. In fact, while the combined market share of energy-efficient bulbs (LEDs and CFLs) in the nation remained relatively unchanged between 2015 and 2017, the efficient bulb market share in Rhode Island increased. The LED incentive per bulb in Rhode Island was the highest in the nation in 2017, and the state's LED market share was the second highest in the nation. Rhode Island generally showed higher LED and ENERGY STAR LED market share than neighboring Massachusetts, which was also among the states with aggressive program activity in 2017. Generous program incentives help explain why LED prices in Massachusetts, which serves as a proxy for Rhode Island in this case, fell below those of the nation, non-program areas, and even other program states.[7]

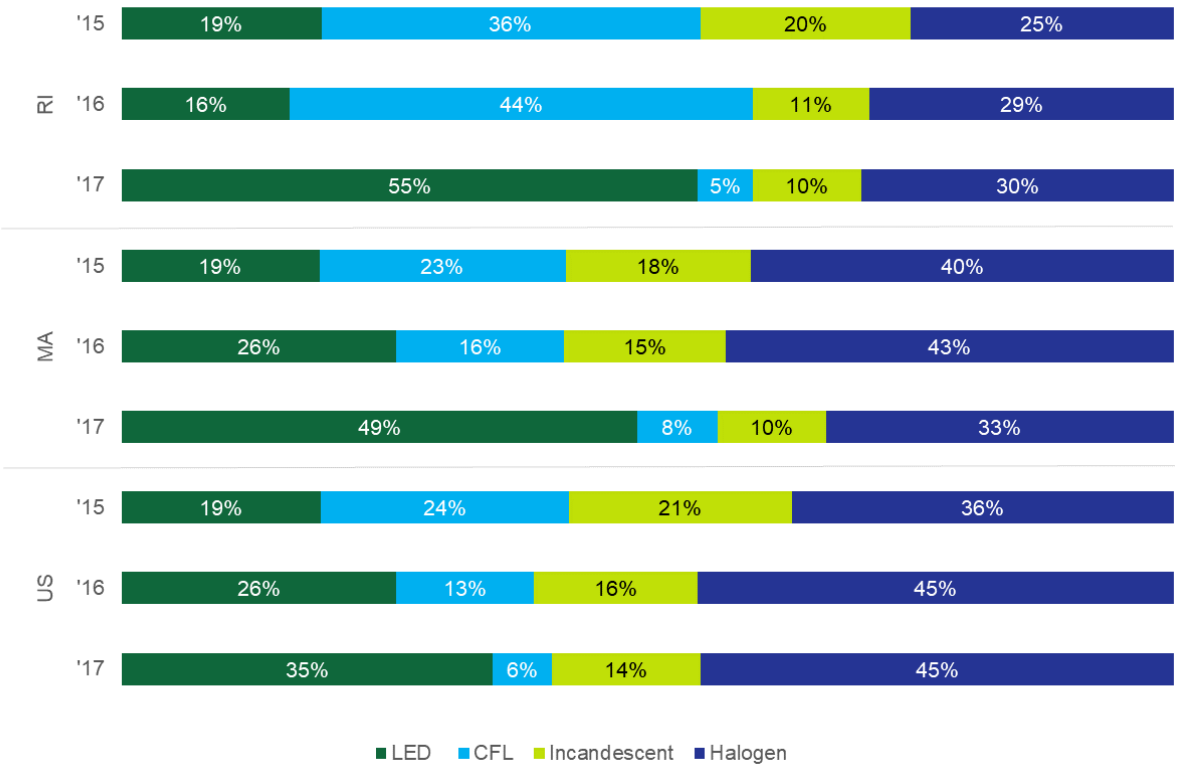
The analysis of the CREED data revealed several key findings, summarized below.

KEY FINDINGS

Rhode Island's market share for efficient bulbs (LEDs + CFLs) stood at 60% in 2017, and LED market share increased from 16% in 2016 to 55% in 2017. Rhode Island had one of the highest efficient bulb market share in the nation in 2017, somewhere between 42% to 55%, depending on the application of CREED's adjustment for program sales. Efficient bulb market share in neighboring Massachusetts was 57%, (post-adjustment; 49% for LEDs) (Figure 1). All program states combined had an efficient share of 43% in 2017, compared to only 30% in non-program states (Figure 7 in the main body also lists program and non-program states). Like Rhode Island, Massachusetts also saw a large boost to its LED market share in 2017 (from 26% in 2016 to 49% in 2017). The national increase was 26% in 2016 to 35% in 2017. As discussed more fully in Section 2.1.3, not surprisingly, program spending was associated with higher LED market share. States with greater program spending per household tended to have greater LED market adoption, with aggressive program states (over $5 / home) demonstrating higher adoption compared to moderate (less than $5 / home) and non-program states. Total program spending in both Rhode Island and Massachusetts was over $5 per household in 2017.

[7] While LightTracker reports prices for Rhode Island, preliminary review of the data suggested that Rhode Island's pricing data patterns diverged from the other comparison areas. This stems from the smaller sample size of Rhode Island households represented in the LightTracker data set. For this reason, we suggest that National Grid consider Massachusetts and program states as proxies for the 2017 pricing data analysis. See Section 2.2 of the main body of the report for more details

Figure 1: Rhode Island, Massachusetts, and US Market Share by Bulb Technology 2015-2017 – FCD[1,2,3]



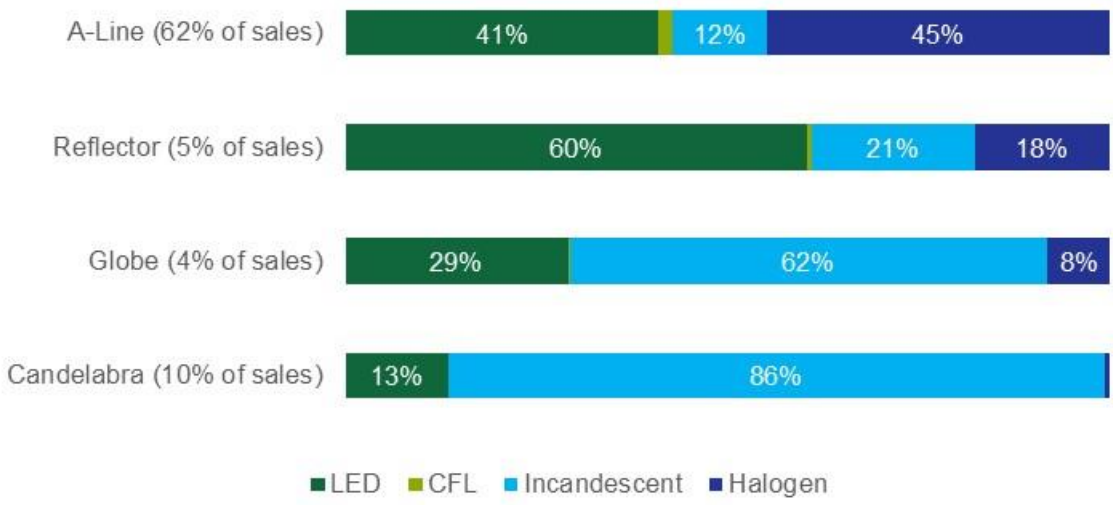
[1] All retail channels.

[2] In 2017, CREED adjusted LED sales in program states for better alignment with program sales data. Prior to the adjustment, 2017 LED market share in Rhode Island was 42%, still a substantial increase from 16% in 2016. The actual LED market share in Rhode Island likely falls between 42% and 55%. See Section 1.2.1 for more detail.

[3] Results subject to rounding error.

LEDs market share was greatest for reflector bulbs in Rhode Island in 2017. Among discount, dollar, drug, grocery, mass merchandise, and some membership stores, LEDs accounted for 60% of reflector bulb sales in 2017, 41% of A-line sales, and 29% of globe sales (Figure 2). In contrast, LEDs accounted for only 13% of candelabra sales. Halogens are the most common alternative to A-line bulbs (45%) and incandescents for all three types of specialty bulbs, but especially candelabras (86%).

Figure 2: 2017 Rhode Island Market Share by Bulb Shape – POS[1,2]

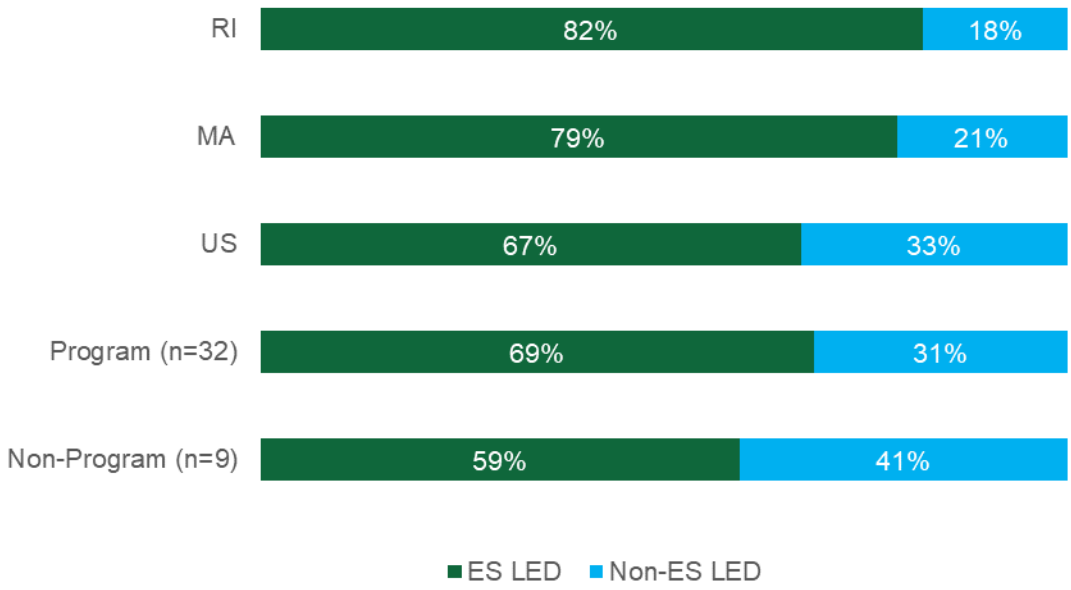


[1] Includes discount, dollar, drug, grocery, mass merchandise, and some membership stores, and represents approximately 21% of the Rhode Island market.

[2] Data labels removed for sales percentages less than 3%; percentage of sales excludes other bulb types (19% of sales); all results subject to rounding error. CFL market share by shape: A-line 2%, Reflector 1%, Globe 1%, Candelabra 1%.

Sales of ENERGY STAR qualified LEDs in Rhode Island outpaced non-ENERGY STAR LEDs four to one. The Rhode Island and Massachusetts upstream residential lighting programs support only ENERGY STAR qualified products.[8] The support is evident in the CREED data. ENERGY STAR LEDs accounted for 82% of LED sales in discount, dollar, drug, grocery, mass merchandise, and some membership stores in Rhode Island and 79% in neighboring Massachusetts (Figure 3). In non-program states, only 59% of LED sales in the same retail channels were ENERGY STAR.

Figure 3: 2017 LED ENERGY STAR Status in Rhode Island and Comparison Areas – POS[1,2]

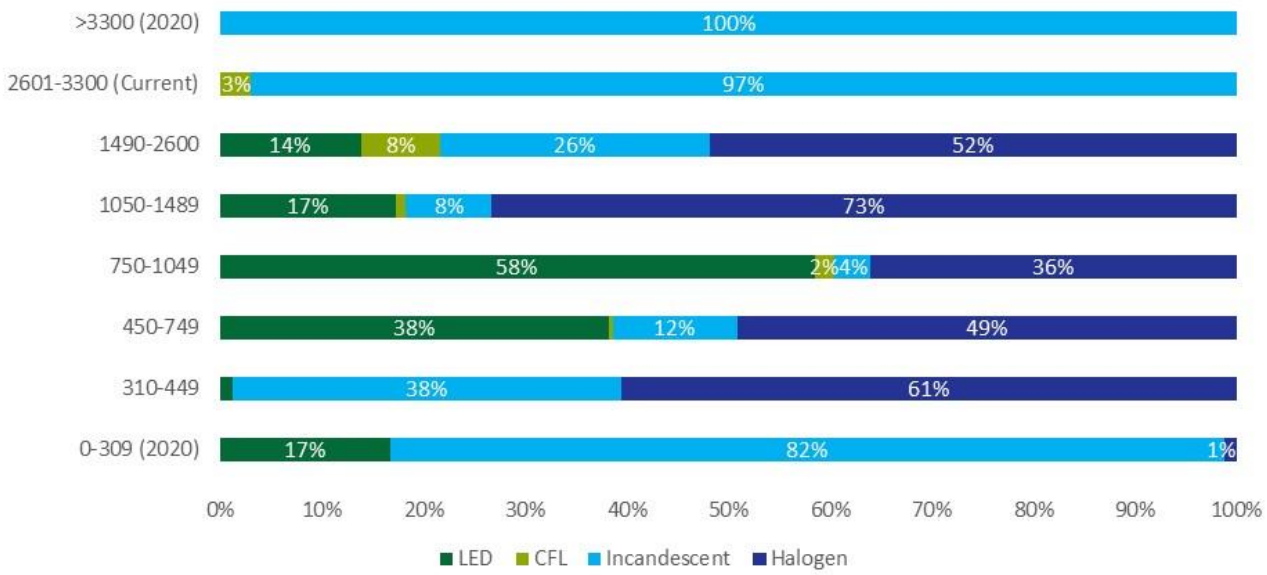


[1] Includes discount, dollar, drug, grocery, mass merchandise, and some membership stores. Represents approximately 21% of the Rhode Island market, 26% of the Massachusetts market, 35% of the US, 33% of program states, and 46% of non-program states. Excludes hardware and home improvement stores.
[2] The ENERGY STAR sales percentages are not affected by CREED's adjustment for program sales, which applies only to the FCD data.

[8] 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, an assumption that may not be accurate. See Section 1.2.1 for more details.

LED sales in Rhode Island are strongest in lumen bins most closely associated with the 60-Watt and 40-Watt incandescent bulbs. Figure 4 presents market share by bulb type and lumen bins. The figure shows that LEDs dominate the 750 to 1,049 lumen bin (52% of all sales) and account for 38% of sales in the 450 to 749 lumen bin (18% of all sales). In contrast, the lumen bins that are currently exempt from EISA (below 310 lumens and above 2,600) remain dominated by incandescents, although they collective garner only 3% of all bulb sales. Table 5 in the body of the report provides a complete crosswalk between lumen bins and incandescent equivalence as well as the percentage of all bulb sales in each lumen bin.

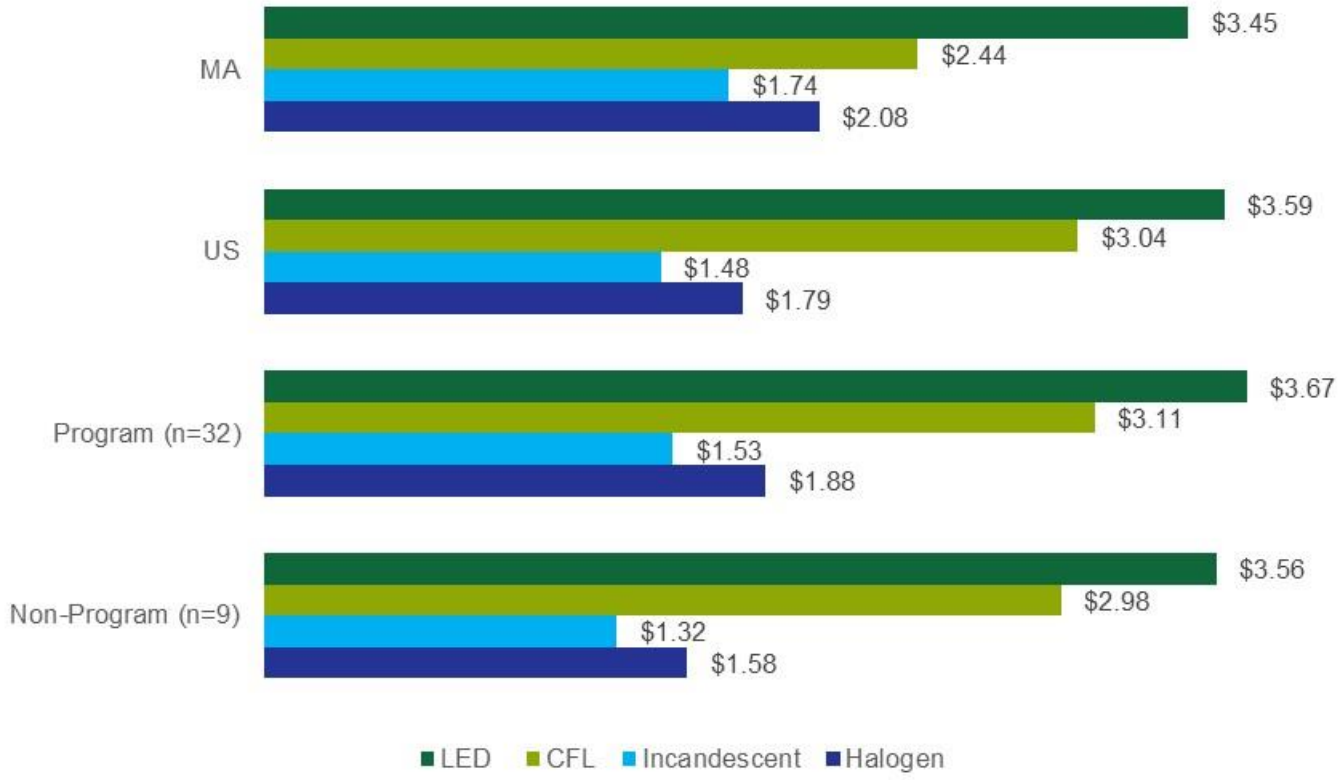
Figure 4: 2017 Rhode Island A-line Market Share by Lumen Bin – POS[1,2,3,4]



[1] Includes discount, dollar, drug, grocery, mass merchandise, and some membership stores, and represents approximately 21% of the Rhode Island market.
[2] Bins currently EISA Exempt: less than 310, above 2,600; bins subject to EISA 2020 (if implemented): less than 310, above 3,300.
[3] Small sample sizes of lumen bins less than 310 and above 2,600, while still in the hundreds and low thousands, are much smaller than the tens and hundreds of thousands of bulbs in the 450 to 2,600 lumen bins.
[4] Data labels removed for sales percentages less than 3%; percentage of sales excludes other bulb types (8% of sales); all results subject to rounding error.

LED and CFL prices were higher than incandescents and halogens in the regions examined – but prices for efficient bulbs were lowest in Massachusetts. Figure 5 displays the shelf price – including the application of program incentives – for bulb types in Massachusetts, the United States, program states, and non-program states. The small sample size of Rhode Island households in the NCP panel yielded unreliable pricing data.[9] Given the similarity of the Rhode Island and Massachusetts programs, NMR suggests Massachusetts as a stand-in for Rhode Island in this analysis. LEDs remained the most expensive technology ($3.45 in Massachusetts) at the point of purchase in all areas. Yet, Massachusetts's market share of more expensive (pre-incentive) ENERGY STAR LEDs was 80% (Figure 3), and the state offered a generous incentive (Figure 13). Among the areas shown in Figure 5, Massachusetts had the least expensive LEDs (which reflect the application of program incentives) and the highest proportion of ENERGY STAR LEDs, which strongly suggests a program impact on price.

Figure 5: 2017 Average Shelf Price per Bulb – FCD[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.

[9] CREED recognizes that the pricing data – especially for smaller states and lower volume sales bins (e.g., CFLs) – may be biased, but the source and direction of bias remains unknown and unclear. Therefore, CREED only releases pricing data for all bulbs, as pricing data by bulb shape, ENERGY STAR qualification, and lumen bins would exacerbate any bias.

Section 1 Introduction

This report describes recent light bulb market share, sales, and shipment trends in Rhode Island, Massachusetts, the United States, states with upstream residential lighting programs (program states), and states without upstream residential lighting programs (non-program states). It is based on analyses of light bulb sales data compiled by the LightTracker Initiative of the Consortium for Residential Energy Efficiency Data.[10,11,12,13] This study also presents updated shipment data from the National Electrical Manufacturers of America (NEMA).[14] Finally, it examines trends in light bulb shelf prices.

1.1 Study Objectives and Research Questions

The study objectives included the following:

- Examine current market share and bulb shipments in Rhode Island, Massachusetts, states with upstream programs, states without upstream lighting programs, and the entire nation[15]
- Provide breakdowns of market share by bulb type (i.e., LEDs, CFLs, halogens, and incandescents), shape (A-line, reflector, globe, and candelabra), lumen bins, and ENERGY STAR status, when data quality allow
- Explore trends in bulb market share from 2015 to 2017, based on LightTracker, and 2011 to 2018 quarterly shipment share as reported by NEMA, highlighting changes in trends (and estimation methodologies) over time

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[10] The study uses data purchased by CREED from IRI and Nielsen. IRI (https://www.iriworldwide.com/en-us/Company/About-Us) and Nielsen (https://www.nielsen.com/us/en.html) track and compile information on sales and purchases in numerous sectors of the economy. Nielsen is better known for its tracking of television-viewing habits.

[11] 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 FCD 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).

[12] 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.

[13] 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, 2017, for the available state level markets and Expanded All Outlets Combined (xAOC) and Total Market Channels. Copyright © 2017, Nielsen.

[14] The data presented in this report come from the NEMA "Lamp Indices" and have been supplemented with data provided to NMR by NEMA. The current lamp indices are available at http://www.nema.org/Intelligence/Pages/Lamp-Indices.aspx. See the main body of this report for more details about NEMA's estimation of bulb shipments.

[15] The Massachusetts findings presented here are drawn from research funded by the Massachusetts Program Administrators. See NMR Group, Inc. 2018. *RLPNC 18-11 Lighting Sales Data Analysis.* http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_1811_LtgSalesDataAnalysis_26NOV2018_final.pdf.

- Compare average prices of LEDs to other bulb types in the bulb price analysis
- Assess A-line market share in very low (<310) and very high lumen bins (>3,300), which roughly coincide with ranges that will remain exempt when Phase 2 of the Energy Independence and Security Act (EISA) goes into effect in 2020

The study aimed to achieve these objectives by exploring the following research questions:

- What is the size of the LED market overall and for specific subgroups and bulbs?
- Does the current LED share of bulbs in very high and very low lumen bins suggest any future program opportunities?
- What is the bulb price of LEDs compared to other bulbs?
- What are the likely connections between the current nature of the light bulb market and program activity in Rhode Island?

1.2 DATA SOURCES[16]

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. The report presents LightTracker data for Rhode Island, Massachusetts, the US, program states, and non-program states for nearly all analyses (noting any exceptions). NEMA only reports data at the national level. Table 3 lists the retail channels included in each data source, with an X denoting coverage in the data source.

Table 2: Study Topics and Data Sources

Topic	Years	Data Source[1]	Market Coverage
Current market share (sales) by bulb type	2017	LightTracker FCD	100% for all areas
Market share (sales) over time	2015 to 2017	LightTracker FCD	100% for all areas
Market share (sales) by bulb shape, lumen bin, ENERGY STAR qualification	2017	LightTracker POS	~21% of RI, 26% of MA and 35% of national markets
Market share (shipments)	2011 to 2018	NEMA	Unknown[2]
Bulb price analysis	2017	LightTracker FCD	100% for all areas

[1] Full category LightTracker data (FCD) include sales information for all retail channels and represent 100% of the lighting market. Point-of-sale (POS) data include discount, dollar, drug, grocery, mass merchandise, and some membership stores, representing 21% of lighting sales in Rhode Island, 26% in Massachusetts, and 35% nationally. POS data exclude hardware and home improvement stores.
[2] Shipment shares prior to 2017 were based on surveys of NEMA members and addressed all four bulb types but failed to account for international shipments into the US. Shipment shares in 2017 and 2018 additionally account for international shipments but exclude incandescent bulbs.

[16] 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.

Table 3: Retail Channel Coverage by Source

Channel	LightTracker FCD	LightTracker POS	NEMA Shipments[1]
Discount	X	X	X
Dollar	X	X	X
Drug	X	X	X
Grocery	X	X	X
Hardware	X		X
Home Improvement	X		X
Mass Merchandise	X	X	X
Membership	X	Some	X

[1] Includes all channels but coverage is unknown due to voluntary nature of NEMA member survey, one of the sources NEMA uses to estimate market share.

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.

The POS dataset represents discount, dollar, drug, grocery, mass merchandise, and some membership stores. It accounts for about 21% of market share in Rhode Island and 35% for the nation.[17] The NCP represents a panel of approximately 100,000 residential households across the US that are provided a handheld scanner for their home and instructed to scan in every purchase they make that has a bar code. 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 full category LightTracker dataset (FCD), CREED uses only those sales from home improvement, hardware, online, and the remaining membership stores.

It is important to note that the FCD data for the entire US represents an extrapolation to the nation and not the sum of available states. In contrast, the analyses for program states and non-program states do represent the sum of available states in each category.

Each year CREED improves its data cleaning and vetting procedures. For the 2017 dataset, 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. NMR's preliminary review of Lockheed Martin shelf-stocking data

[17] 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 dataset.

for Rhode Island suggests that this assumption may not be accurate.[18] In particular, Lockheed Martin reported that 53% of non-ENERGY STAR A-line LEDs on the shelves of Rhode Island program partners had a rated life of 15,000 hours or more (97% of A-line ENERGY STAR qualified bulbs had a rated life of 15,000 hours). The implication is that the percentage of ENERGY STAR sales is likely exaggerated. However, because CREED assigned ENERGY STAR status similarly in all states, the exaggeration would be more pronounced in states that actually have lower ENERGY STAR sales.

The second change involved instituting a process to align FCD 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. In situations in which program-supported sales (which are almost universally ENERGY STAR-qualified across the nation) exceeded or rivaled total LED sales (comprising both ENERGY STAR and non-ENERGY STAR sales) they adjusted LED sales upwards so that program-supported sales accounted for 90% of ENERGY STAR sales.

They made this change only to the FCD data and not POS data (since the latter include only part of the market), and it only applies to LEDs, not other bulb types. The adjustment has two important implications. First, it reduces the percentage of total sales accounted for in the POS data, which is equal to POS bulb sales divided by FCD bulb sales. Prior to this adjustment POS data accounted for 39% of total sales in Rhode Island, and after the adjustment, POS data accounted for 21%. Second, and perhaps more importantly, the adjustment may overstate LED market share in the FCD data because it applies only to LEDs. Prior to the adjustment, LED market share in Rhode Island was 42%, but after the adjustment it was 55%. CREED believes the adjustment offers the best representation of the market available. NMR concurs that unadjusted data appeared to underrepresent true program sales, but we also feel it is important to recognize that the adjustment represents a substantial change in the LED market share. We believe that the true LED market share rests somewhere between 42% and 55%. This adjustment should be kept in mind when assessing the POS data coverage and comparing FCD market share over time. For the sake of comparison, Figure 17 in Appendix A.1 shows Rhode Island market share for all bulb types before and after the adjustment.

This leads us to one word of caution about the use of LightTracker for Rhode Island. Nielsen, the third-party source of the NCP data. selects its panelists so that the resulting sample represents the entire nation, not individual states. States with larger populations have more households in the panel, and this makes the panel a better representation of the state. Therefore, extrapolations from the panelists to larger population states have a higher likelihood of actually representing the state. The same is not true for lower population states like Rhode Island, with about 200 panelists (Massachusetts had about 1,000).[19] The NCP has fewer households from these states, and extrapolations from the panelists likely retain some of the bias related to the characteristics of the

[18] NMR is currently analyzing the shelf-stocking data and will report the results under separate cover. We conducted the preliminary analysis on raw data; cleaning efforts could lead to a different conclusion than reported here. .

[19] Not every panelist purchased light bulbs during the year, let alone purchased bulbs of each type. This is why some analyses rely on POS data only. For example, it is possible that very few (perhaps no) NCP panelists bought a <300 lumen LED in 2017, but the POS sales data captured the purchases that were made.

sample. For example, the purchase of a large number of CFLs by a few panelists could skew the market share results for a given year.

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 is available for most states in the nation
    - Includes characteristics such as lumens, bulb shape, and pricing
- **Weaknesses**:
    - POS data cover only a portion of the market (between 21% with the program sales adjustment and 39% without it), notably missing the important hardware and home improvement changes
    - Method used to assign ENERGY STAR status may exaggerate the percentage of ENERGY STAR qualified LEDs sold.
    - Raw sales data do not always align with program sales, leading CREED to make adjustments that force alignment that may overstate the market share of LEDs but understate the POS coverage of the market
    - Reliability is reduced with small sample sizes of Rhode Island households in the NCP data (which is a part of the FCD data) and for subsets of bulbs (e.g., market share by bulb technology for lumen bins with low sales volumes)

1.2.2 Shipment Data

We also examined quarterly NEMA A-line national shipment data for Q1 2011 to Q3 2018.[20] Prior to 2017, NEMA estimated shipment share from a survey of NEMA members, but in 2017, the federal government began to track international shipments of LEDs and halogens into the US meant for domestic consumption.[21] 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.[22] NEMA also stopped tracking incandescent shipment share in 2017, arguing (and supported by the CREED data in Figure 15) 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 were already excluded from shipment share estimates, so this step brings incandescents in alignment with the other bulb types.

[20] 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.
[21] Prior to this time, the federal government only tracked CFLs. Data are available at http://dataweb.usitc.gov/
[22] Direct correspondence with NEMA.

Given these changes, the strengths and weaknesses of the NEMA data include the following:

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**:
  - Data not available for individual states
  - Break in the time series due to a revision in shipment share calculation approaches
  - Non-reporting of incandescent shipment share under the current method.

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 program administrators or their evaluators.[23] The team contacted local utilities in areas for which 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 program administrators around the country.[24] All states with at least some program activity in 2017 were designated *program states;* the remaining states were designated *non-program states*.

1.4 Approaches

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

- Compared 2017 market share by bulb type (Section 2.1.1) and bulb shape (Section 2.1.2) from the full LightTracker database for Rhode Island, Massachusetts, states with lighting programs (program states), states without lighting programs (non-program states), and the US
- Described trends in market share in Rhode Island and Massachusetts FCD lighting data for 2015 to 2017 (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)

[23] 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).
[24] E Source. "DSM Insights." April 2018.

- Examined the proportion of LED sales in Rhode Island, Massachusetts, other program states, non-program states, and the US that are ENERGY STAR qualified (Section 2.1.4)
- Analyzed market share by lumen bin for Rhode Island and non-program states to assess the distribution of bulb sales by current and future EISA exemption (Section 2.1.5)
- Reviewed prices for all light bulbs in Massachusetts, program states, non-program states, and the nation for 2017 (Section 2.2)

Section 2 Data Examination

The team 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):

- **Full category (FCD)**: used for 2015 to 2017 market share and represents all retail channels, including hardware and home improvement; estimates for the entire US reflect extrapolations to the nation and not the sum of individual states
- **Discount, dollar, drug, grocery, mass merchandise, and some membership club retail channels (POS):** used for analysis of market share by bulb shape, ENERGY STAR qualification, and lumen bins; data reflect 21% of the Rhode Island lighting market, 26% of Massachusetts, 35% of the US, 33% of program states, and 46% of non-program states
- **Shipments:** used for assessment of A-line shipment share back to 2011; represent an unknown portion of the market due to exclusion of international shipments 2011 to 2017 (prior NEMA method) and of incandescents in 2017 and 2018 (current NEMA method)

The results generally describe market share and bulb prices in Rhode Island, 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 Rhode Island, Massachusetts, program states, non-program states, and the nation in various ways, as summarized in Table 4. We note the percentage of the market covered under each figure in the discussion that follows.

Table 4: Summary of Market Share Analyses

Type of Analysis	Dataset	Year(s) Addressed	Retail Channels
Annual	LightTracker FCD	2017	All
Longitudinal	LightTracker FCD	2015 to 2017	All
By Bulb Shape by Lumen Bin by ENERGY STAR	LightTracker POS	2017	Discount, dollar, drug, grocery, mass merchandise, some membership clubs
Longitudinal	NEMA	2011 to 2017[1] 2017 to 2018[2]	All

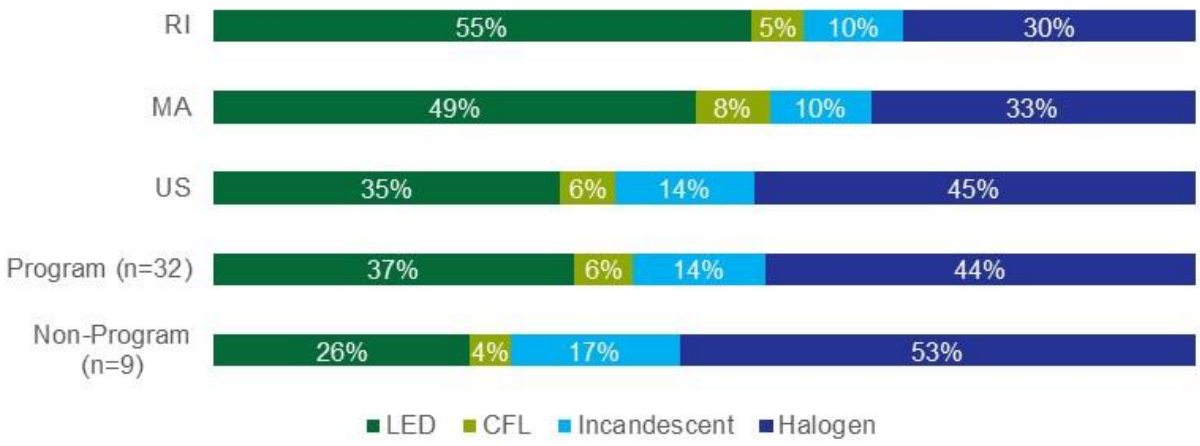
[1] Quarterly data from 2011 to December 2017, excluding international shipments

.[2] Quarterly data from 2017 to September 2018, including international shipments but excluding incandescents

2.1.1 Market Share by Bulb Technology

Rhode Island's market share for efficient bulbs (LEDs + CFLs) stood at 60% in 2017, with LEDs alone accounting for 55% of all bulb sales. Rhode Island had the second highest efficient bulb market share in the nation in 2017 (after the LightTracker adjustment for program sales). Prior to the adjustment, the market share was 42%, and the true value likely falls between 42% and 55%. Efficient bulb market share in neighboring Massachusetts was 57% (post-adjustment), while all program states had an efficient share of 43% (post adjustment)(Figure 6).[25] LED market share in both Rhode Island and Massachusetts exceeded that of the combined other program states, both before and after the LightTracker adjustment for program sales. Efficient bulb market share in non-program states was only 30% in 2017. This information strongly indicates that the aggressive program activity in Rhode Island and Massachusetts helped move LEDs in those two states, relative to the rest of the nation.

Figure 6: 2017 Market Share in Rhode Island and Comparison Areas – FCD[1,2,3]



[1] All retail channels.
[2] CREED adjusted LED sales in some states (including Rhode Island and Massachusetts) for better alignment with program sales data. Prior to the adjustment 2017 LED market share in Rhode Island was 42%. The actual LED market share in Rhode Island likely falls between 42% and 55%. See Section 1.2.1 for more detail.
[3] Results subject to rounding error.

[25] The LightTracker adjustment applied to multiple program states, not just Rhode Island and Massachusetts, and the program states market share incorporates the adjustment for all program states. NMR does not have access to pre-adjusted program state market share.

Rhode Island, Massachusetts, and the nation all showed strong increases in LED market share between 2016 and 2017. LED market share in Rhode Island increased from 16% in 2016 to 55% in 2017, and Massachusetts from 26% in 2016 to 49% in 2017 (Figure 7). LED market share also increased nationally, but from 26% in 2016 to only 35% in 2017. Rhode Island and Massachusetts showed a greater increase in market share over the nation even prior to the adjustment for program sales. Rhode Island does exhibit one deviation compared to Massachusetts and the nation in market share patterns: It saw an increase in CFL market share in 2016, while other states saw that market share decrease. Although this could reflect actual differences in the purchase behavior of Rhode Island consumers, it could also be an artifact of the smaller sample size of Rhode Island households in the NCP data discussed above (Section 1.2.1).[26]

[26] Speculating, one possible for differences in CFL purchase behavior relates to ENERGY STAR qualification. In 2016, ENERGY STAR announced version 2.0 that led to most CFLs losing qualification in January 2017. It is possible that retailers could have reduced CFL prices to move them off shelves in anticipation of this change. If this is the case, while one would expect the behavior to manifest in other states, the small sample size of Rhode Island in the NCP data could have caused it to show up in the Rhode Island data more than in other places.

Figure 7: Market Share in Rhode Island and Comparison Areas by Bulb Technology 2015-2017 – FCD[1,2,3]

[1] All retail channels.

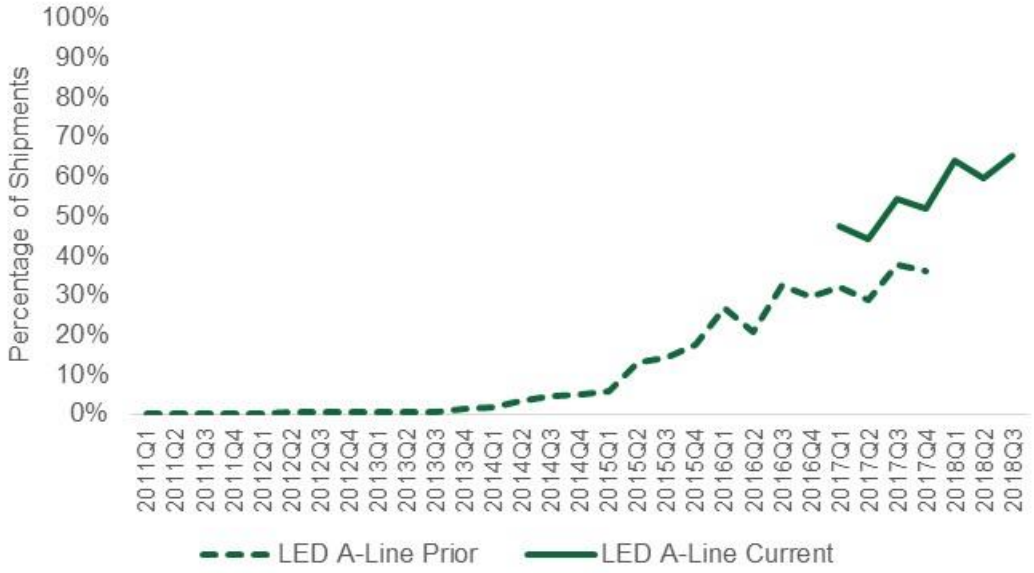
[2] In 2017, CREED adjusted LED sales in states (including Massachusetts) for better alignment with program sales data. Prior to the adjustment, 2017 LED market share in Rhode Island was 42%, still a substantial increase from 16% in 2016. See Section 1.2.1 for more detail.

[3] Results subject to rounding error.

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 from the shipment share calculations. In Figure 8, the dashed line shows the LED portion of A-line bulb shipments of NEMA members from Q1 2011 to Q4 2017 (the prior method). The solid 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 Q3 2018 (the current method).[27] The average LED shipment shares for 2017 were 34% using the prior method and 50% using the current method, a difference of 16%.

Figure 8: A-line LED Shipment Share Over Time per NEMA (Prior and Current Calculation Methods)

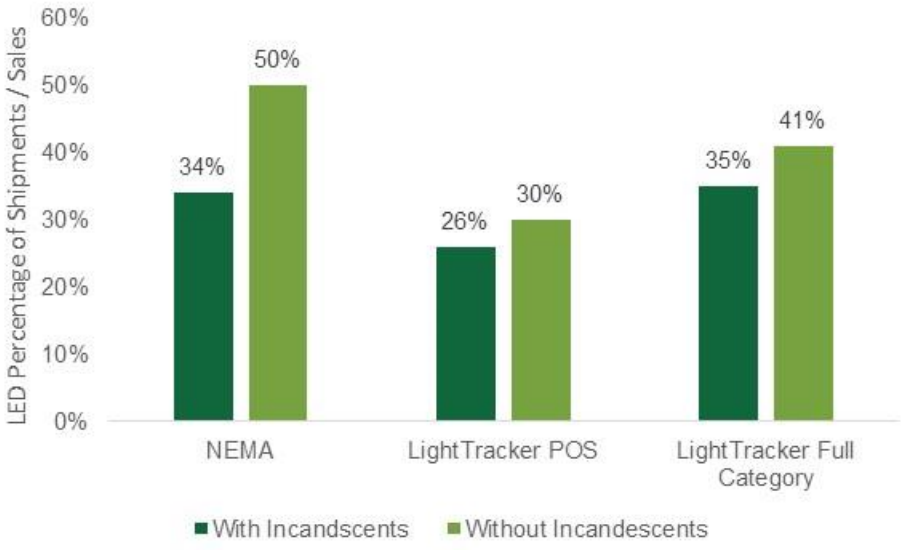


[1] Market coverage is unknown, but *prior* method excludes international shipments and *current* method excludes incandescents.

[27] 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.

As a check on the shipment data, NMR created comparable national level A-line sales market share estimates using the 2017 POS LightTracker data for discount, dollar, drug, grocery, mass merchandise, and some membership stores (the FCD data do not allow us to isolate A-line sales)(Figure 9). LightTracker data suggest that the national A-line LED market share in 2017 was 26% including incandescents (comparable to NEMA's prior method) and 30% excluding incandescents (comparable to NEMA's current method). The discrepancy between the LightTracker POS data and the NEMA data under both calculation methods could be due to bias in either or both data sources. As one last check, it is worth noting that the FCD market share for all bulb shapes put national LED market share at 35% in 2017 with incandescents and 41% without incandescents.

Figure 9: Comparison of NEMA Shipment and LightTracker Market Shares[1,2]

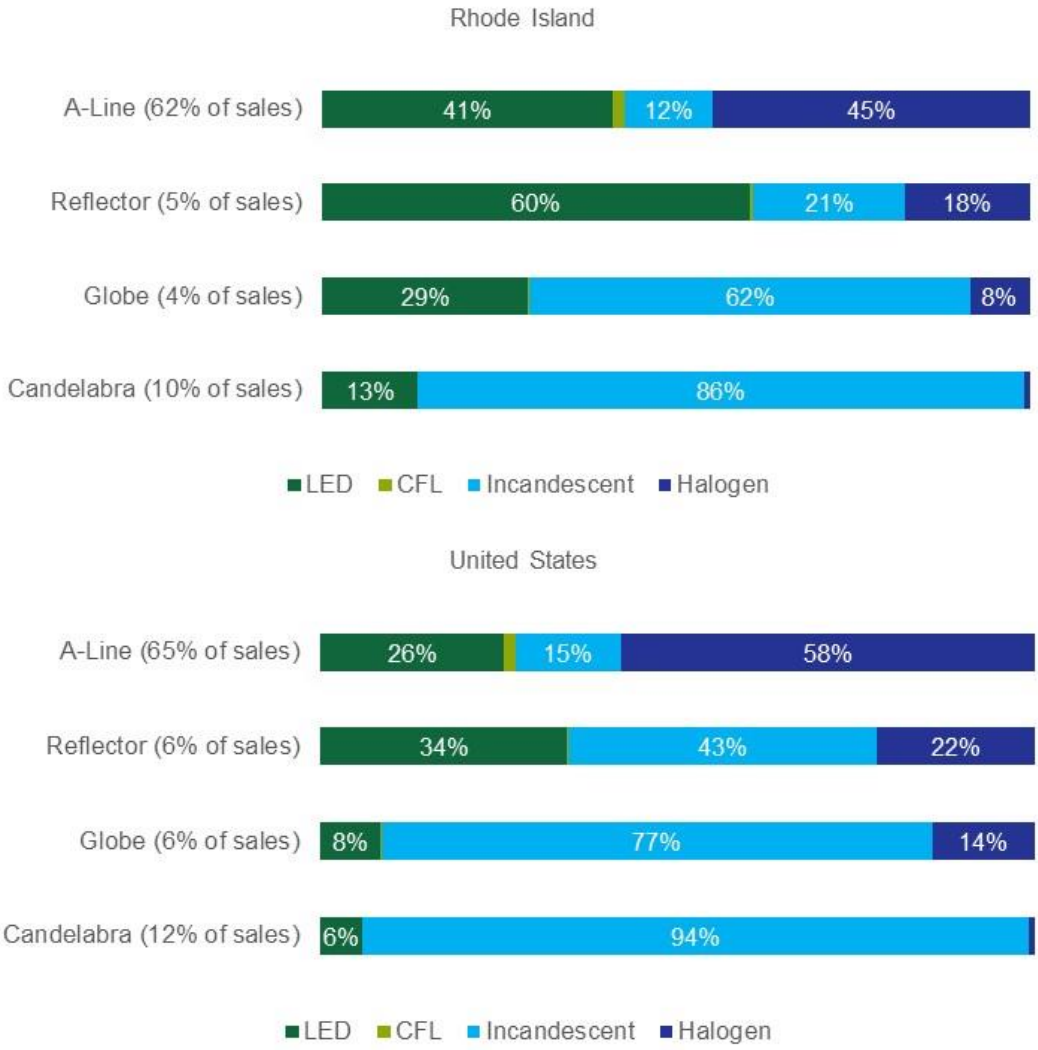


[1] For NEMA *with incandescents* is based on surveys of NEMA members, while *without incandescents* also incorporates international shipments.
[2] Market coverage for LightTracker FCD is all retail channels, NEMA is unknown, and LightTracker POS is about 35% of the national market.

2.1.2 Market Share by Bulb Shape

The 2017 LED market share in Rhode Island for all four bulb shapes exceeds that of the United States. Among discount, dollar, drug, grocery, mass merchandise, and some membership stores, LEDs accounted for 60% of reflector bulb sales in Rhode Island in 2017, 41% of A-line sales (which account for the majority of all bulb sales), 29% of globe sales, and 13% of candelabra sales (Figure 10). National LED market shares followed similar patterns – reflectors having the highest penetration and candelabras the lowest – but they lagged Rhode Island's considerably. For example, LED market share in Rhode Island was 60% for reflectors but only 34% for the US. In both Rhode Island and the US, halogens are the most common alternative to A-line bulbs, and incandescents for all three types of specialty bulbs, but especially candelabras.

Figure 10: 2017 Rhode Island and National Market Share by Bulb Shape – POS[1,2,3]



[1] Includes discount, dollar, drug, grocery, mass merchandise, and some membership stores, and represents approximately 21% of the Rhode Island market

[2] Data labels removed for sales percentages less than 3%; percentage of sales excludes other bulb types (19% of sales); all results subject to rounding error. Rhode Island CFL market share by shape was A-line 2%, Reflector 1%, Globe 1%, Candelabra 1%. The US CFL market share for A-lines was 1%, and for all other shapes fell below 1%.

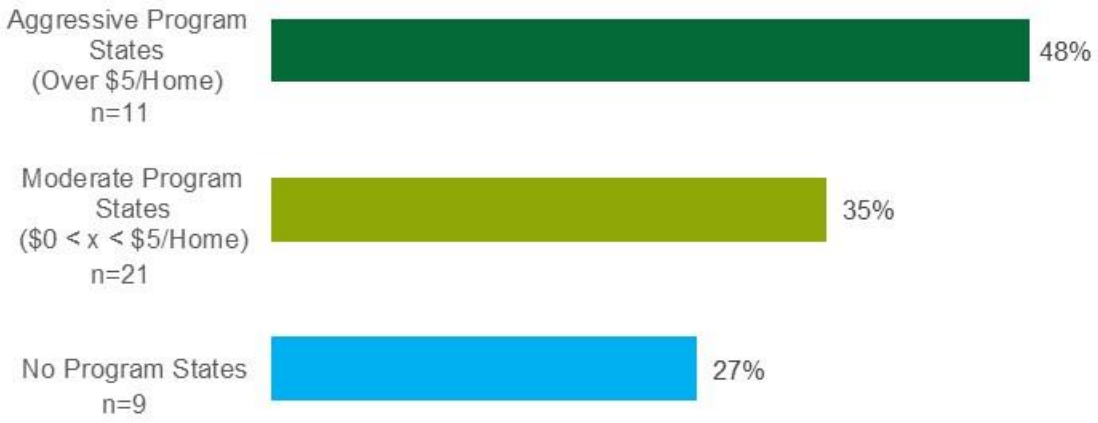
[3] Results subject to rounding error.

2.1.3 Market Share by Program Activity Analysis

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

Figure 11 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. Nine states did not run an upstream lighting program. The average LED market share among these non-program states in 2017 was 27%.[28] States with aggressive program activity (including Rhode Island and Massachusetts) spent over $5 per household on upstream lighting programs. The average LED market share among these states was 48%. Moderate activity states fell in between, with LEDs garnering 35% of the market share.

Figure 11: 2017 Program Spending and LED Market Share – FCD[1]



[1] All retail channels.

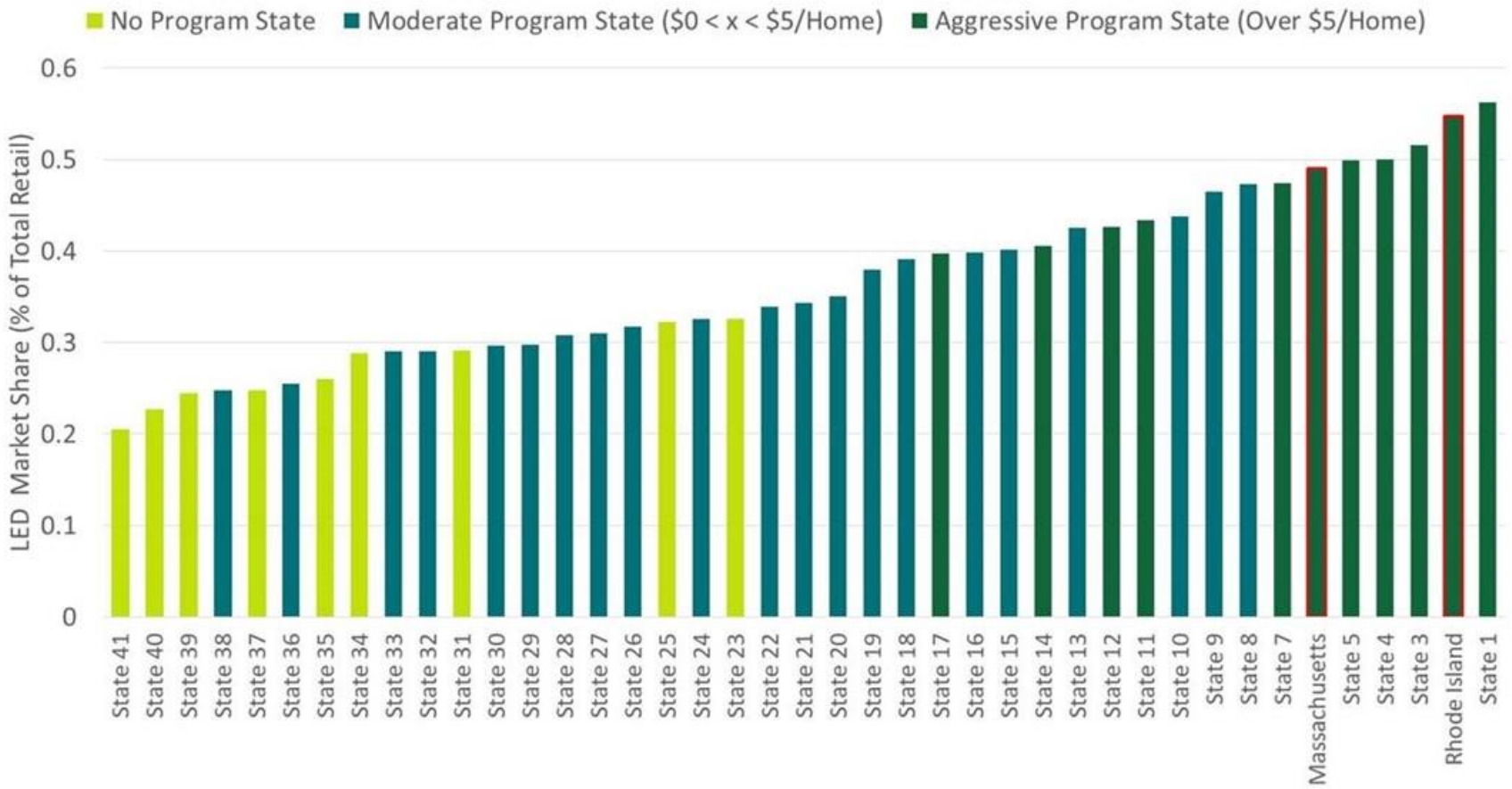
[28] See Appendix A for details on which states are included. Some states lacked sufficient program activity information to be included in this analysis.

Similarly, Figure 12 shows Rhode Island's LED market share relative to Massachusetts's and other states with sufficient data. States denoted in dark green had aggressive programs (program spending more than $5 per household) in 2017. Lime green bars represent non-program states, and teal bars represent states with spending between zero and five dollars per household. LED market share in Rhode Island placed second highest in the nation. As expected, LED market share tended to be low for most states lacking upstream lighting programs. LED market share in states with moderate spending varied considerably.

The LightTracker team was able to obtain LED incentive dollars for 24 of the program states.[29] 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 in Figure 13, per-bulb LED incentives in 2017 ranged from $1 to nearly $5; the average LED incentive was $2.08. Rhode Island had the highest upstream lighting incentive per LED in 2017, offering $4.86 per LED.

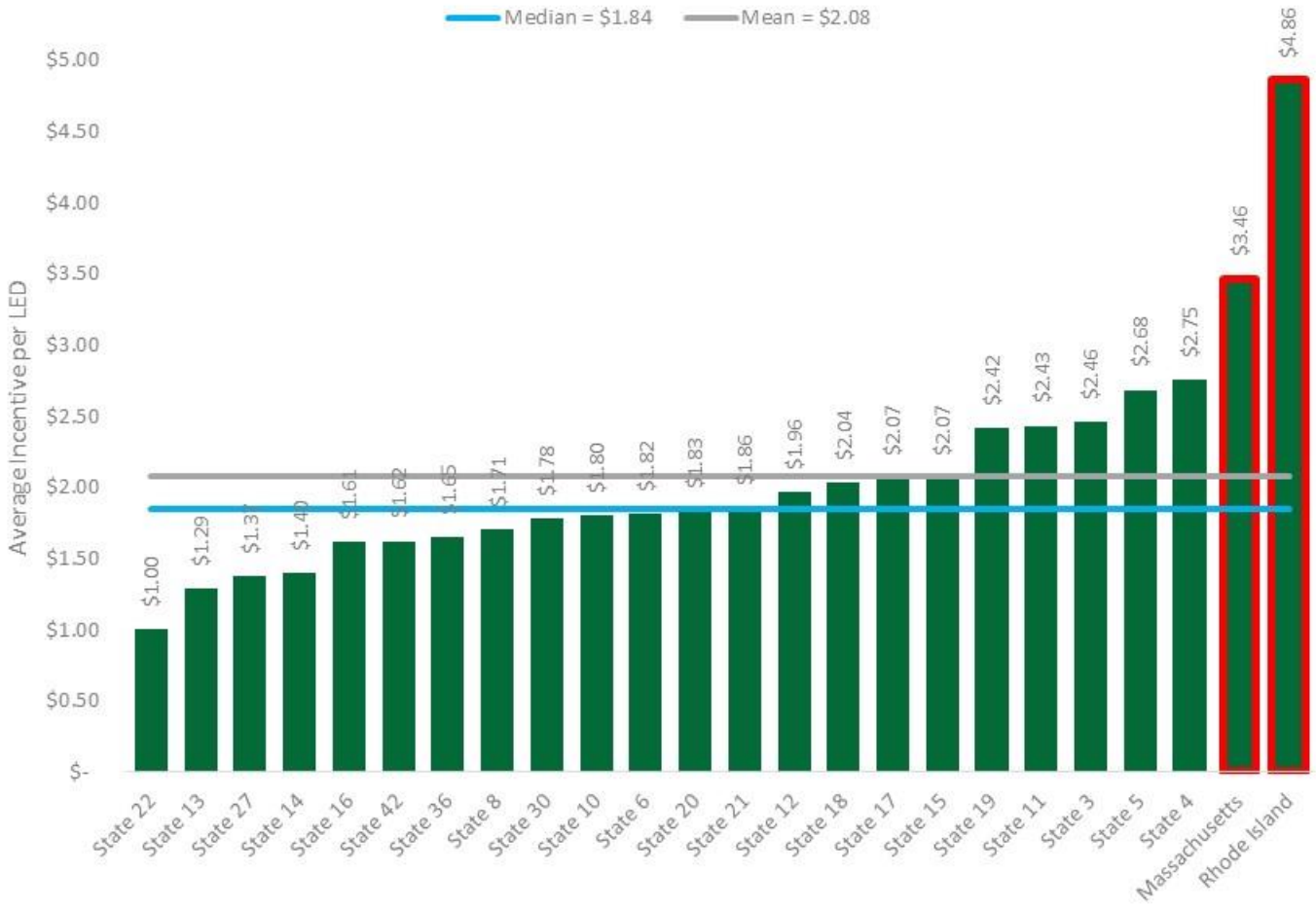
[29] Note that this analysis focuses solely on incentive dollars, while Figure 11 and Figure 12 include all program spending.

Figure 12: 2017 LED Market Share Across States by Program Spending – FCD[1]



[1] All retail channels.

Figure 13: Average 2017 Upstream Incentive per LED (Program States) – FCD[1,2]



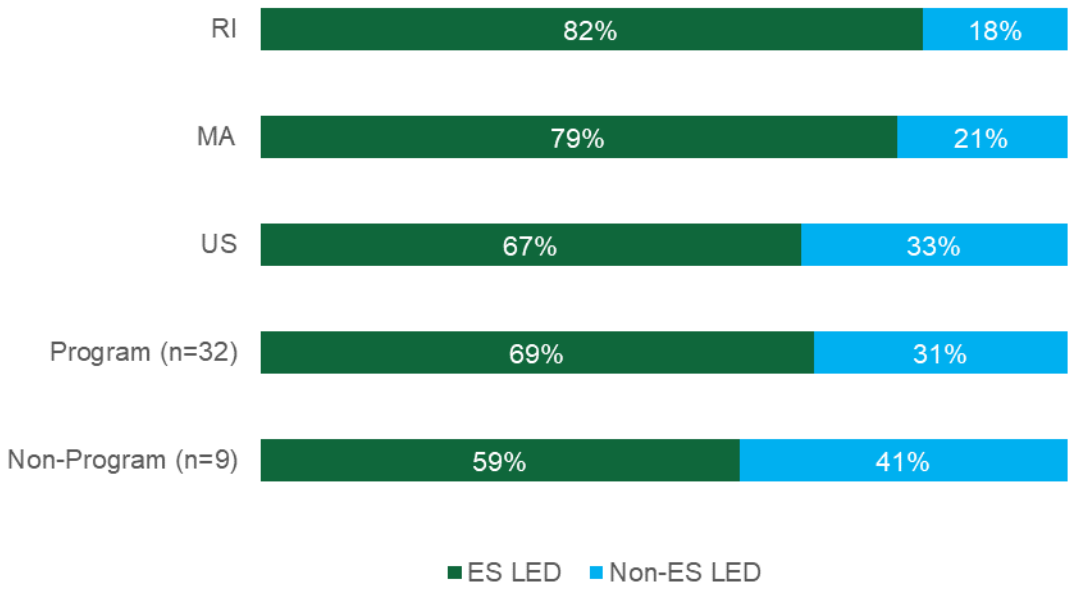
[1] All retail channels.

[2] LightTracker was able to isolate LED spending for only 24 states. Therefore, some states – for example, State1, State7, and others – listed in Figure 12 do not appear in Figure 13.

2.1.4 LED Market Share by ENERGY STAR Qualification

Sales of ENERGY STAR qualified LEDs in Rhode Island outpaced non-ENERGY STAR LEDs four to one. The LightTracker Initiative identified ENERGY STAR qualification for LEDs in discount, dollar, drug, grocery, mass merchandise, and some membership stores largely based on the rated lifetime of bulbs.[30] The Rhode Island and Massachusetts upstream residential lighting programs support only ENERGY STAR qualified products. The support is evident in the CREED data. ENERGY STAR LEDs accounted for 82% of LED sales in this subset of retail channels in Rhode Island and 79% in neighboring Massachusetts (Figure 14). In non-program states, only 59% of LED sales in the same retail channels were ENERGY STAR. These estimates are not subject to the CREED adjustment for program sales, as CREED adjusted only the FCD sales data, not these POS data based on a subset of retail channels.

Figure 14: ENERGY STAR Status of 2017 LED Sales in Rhode Island and Comparison Areas – POS[1]



[1] Includes discount, dollar, drug, grocery, mass merchandise, and some membership stores. Represents approximately 21% of the Rhode Island lighting market, 26% of Massachusetts, 35% of the US, 33% of program state market, and 46% of non-program state market.

[30] With ENERGY STAR Specification 2.0, bulbs rated 15,000 hours or higher are almost always ENERGY STAR qualified, while those under 15,000 hours rarely are qualified.

2.1.5 Market Share by Lumen Bin

The Energy Independence and Security Act (EISA) of 2007 increased efficiency standards on most A-line general service lamps. A second phase of EISA (EISA Phase II or EISA2020) 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). Most parties agree that EISA Phase II standards will apply to A-line bulbs.[31, 32] National Grid asked NMR to examine 2017 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.

Given uncertainly about how specialty lamps will be treated under EISA Phase II and small sample sizes in the LightTracker data in some lumen bins for specialty lamps, we have chosen to break lumens out only for A-line bulbs. We used the following definitions:

- 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

[31] The uncertainty focuses mainly (although not exclusively) on whether the Department of Energy will expand the definition of a general service lamp to include reflectors, globes, candelabras, and some other bulb types currently exempt from EISA. While, some people believe there is a chance EISA could be repealed completely, but NMR feels this is highly unlikely (?)

[32] 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.

Table 5 lists the overall percentage of A-line bulb sales that fell into each lumen bin, including all technologies but available only for the POS dataset (discount, dollar, drug, grocery, mass merchandise, and some membership stores). It also indicates whether the lumen bin is currently EISA exempt and will remain so in 2020 (if implemented).[33] Assessing market share by lumens highlights the market share of incandescent bulbs that fall between 310 and 2,600 lumens. According to the data for this subset of retail channels, about 3% of A-line sales falls into lumen bins that are current exempt from EISA (greater than 2,600 lumens and less than 310 lumens).

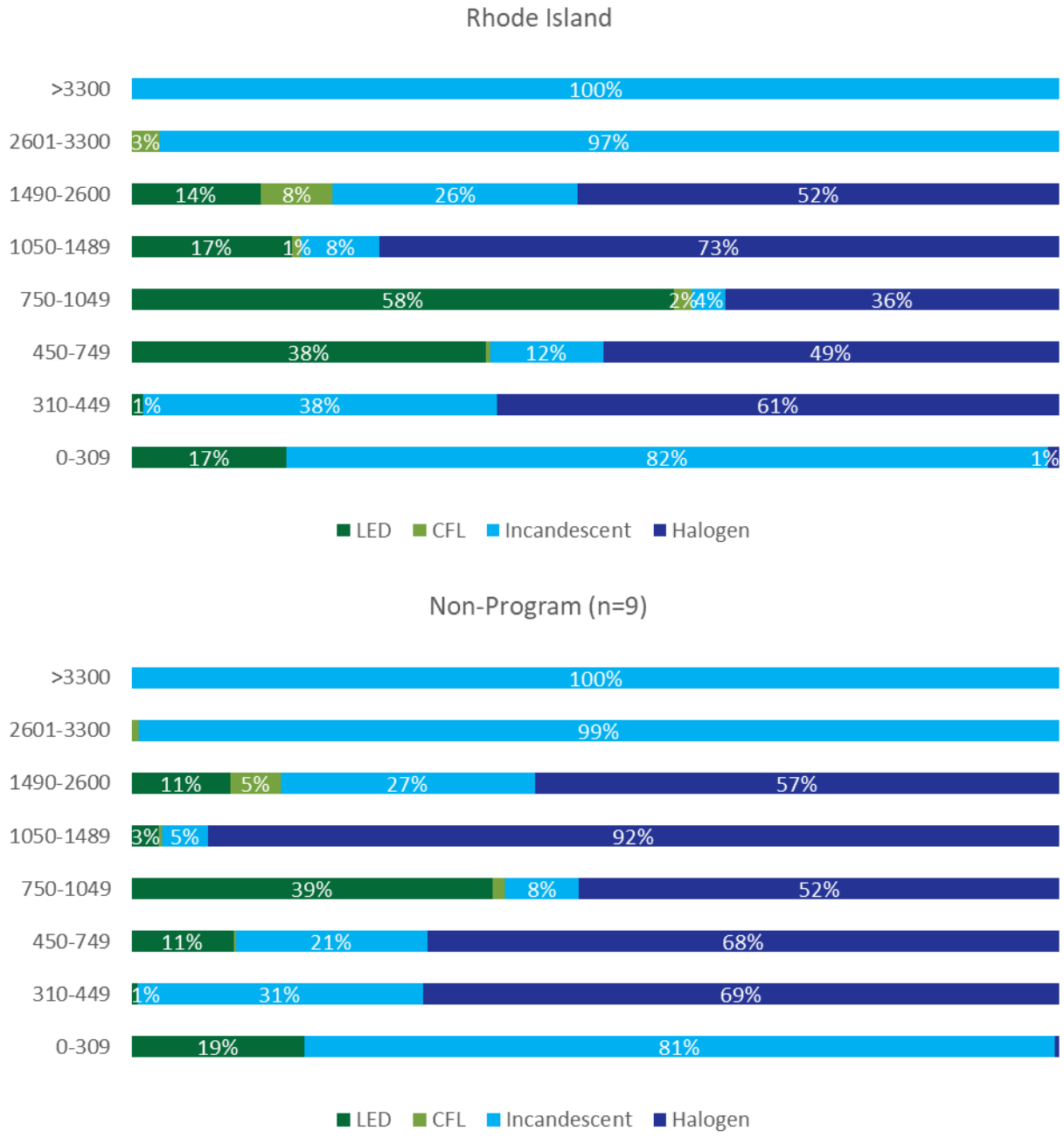
Table 5: Lumen Bin Description – POS

Lumen Bin	EISA Exemption	Approximate A-line Incandescent Wattage	Percentage of 2017 Bulb Sales	Percentage of Category LED Sales
>3300	Current and 2020	Above 150 Watts	<1%	0%
2601-3300	Current	150 Watts	<1%	0%
1490-2600	Not exempt	100 Watts	8%	14%
1050-1489	Not exempt	75 Watts	11%	17%
750-1049	Not exempt	60 Watts	52%	58%
450-749	Not exempt	40 Watts	18%	38%
310-449	Not exempt	40 Watts	8%	1%
0-309	Current and 2020	Below 40 Watts	2%	17%

LED sales in Rhode Island are strongest in lumen bins most closely associated with 60 Watt and 40 Watt incandescent bulbs. Figure 15 presents A-line market share by bulb type and lumen bins. Together Figure 15 and Table 5 demonstrate that the 750 to 1,049 lumen bin garners 52% of sales, of which 58% are LEDs. LEDs also account for 38% of sales in the 450 to 749 lumen bin (18% of sales). In contrast, the lumen bins that are currently exempt from EISA (below 310 lumens and above 2,600) remain dominated by incandescents, although they collective garner only 3% of all bulb sales. A comparison to non-program states reveals much lower LED market shares in almost every lumen bin, except those currently and likely to be exempt from EISA in 2020. Consumers in non-program states generally turned to halogens in the absence of program incentives on LEDs in the highest sales volume lumen bins.

[33] Wattage equivalents vary considerably by bulb shape and manufacturer, so these are approximations only.

Figure 15: 2017 A-line Bulb Market Share by Lumen Bin – POS[1,2,3]



[1] Includes discount, dollar, drug, grocery, mass merchandise, and some membership stores, and represents approximately 21% of the Rhode Island market.
[2] Bins currently EISA Exempt: less than 310, above 2,600; bins subject to EISA 2020 (if implemented): less than 310, above 3,300.
[3] Small sample sizes of lumen bins less than 310 and above 2,600, while still in the hundreds and low thousands, are much smaller than the tens and hundreds of thousands of bulbs in the 450 to 2,600 lumen bins.
[4] Data labels removed for sales percentages less than 3%; percentage of sales excludes other bulb types (8% of sales); all results subject to rounding error.

2.2 BULB PRICE ANALYSIS

NMR conducted a bulb price analysis using the FCD lighting data comparing the average price of different groups of light bulbs sold in Massachusetts, program states, non-program states, and the entire US. We present pricing data for all bulb shapes combined to minimize bias associated with small sample sizes and inconsistently available data for more detailed breakouts (e.g. by bulb shape using only POS data or ENERGY STAR qualification). Even with limiting the data to all bulbs in the FCD, the prices exhibit some eccentricities that cause NMR to suggest viewing them as indicative of trends and not as point estimates of actual prices.

Even so, upon preliminary review, Rhode Island's pricing data patterns diverged from the other comparison areas. While this could reflect a systematic difference in the state's pricing, it more likely stems from the smaller sample size of NCP panelists in the state – a few expensive bulb purchases could artificially inflate the average price. For this reason, we suggest that National Grid consider Massachusetts and program states as proxies for the 2017 pricing data analysis.

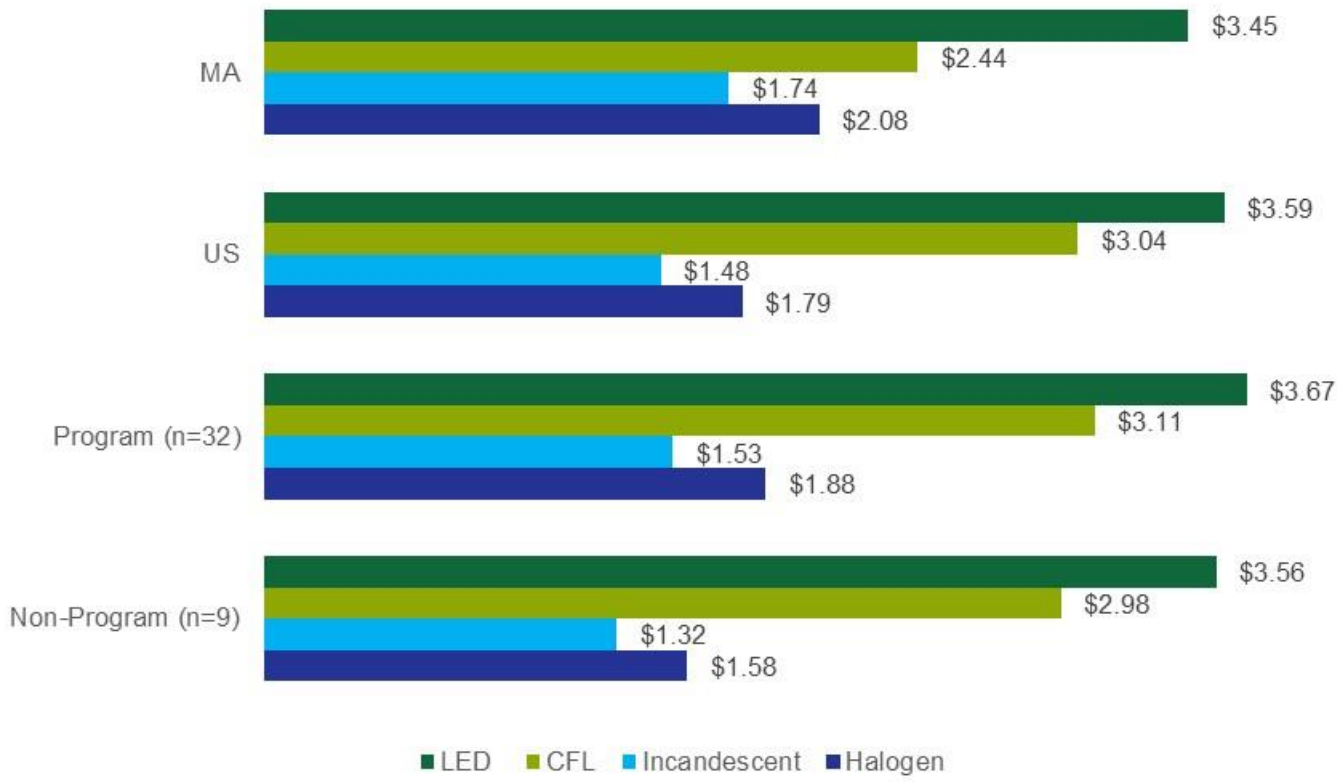
The prices in the LightTracker dataset reflect the application of program incentives. However, the third-party sources do not report prices for private label bulbs (also known as store brands). Store brands usually sell for less than brand name models, so the prices reported in this section should be considered on the high end of what consumers pay at the register.

LEDs remained the most expensive bulb on shelves, even with program price supports.

In 2017, LEDs continued to be the most expensive bulb type (Figure 16). The average LED bulb price from all channels was $3.59 nationally, $3.45 in Massachusetts, $3.67 among program states, and $3.56 among non-program state (Figure 16). Like their Rhode Island neighbors, Massachusetts consumers bought a greater proportion of ENERGY STAR LEDs than consumers in the other comparison areas, and the program administrators offered a generous discount (Figure 14 and Figure 13). CFLs were the next most expensive bulb in all areas, with average bulb prices between $2.44 and $3.11. Average bulb prices were lowest for halogens and incandescents.

Turning back to LED prices, at first glance, it may seem curious that non-program states would have less expensive LEDs than all program states, but we believe this reflects a combination of three factors. First, as mentioned above, the pricing data exhibit some eccentricities, and this finding is one of them; data collection and reporting error could underlie the result that suggest that LED prices are lower in non-program than in program states. Second, the prices include both ENERGY STAR and non-ENERGY STAR LEDs and the application of any program incentives. This made the price of LEDs in the state the lowest of the four areas considered. Non-program states had a higher proportion of non-ENERGY STAR LEDs (Figure 14), which, if they behave like other energy-efficient products, probably cost less than ENERGY STAR models. Third, the level of support in program areas varies from $1 to the nearly $5 incentive in Rhode Island. While some programs buy down the price of ENERGY STAR LEDs so much that they are price competitive with non-ENERGY STAR models, others provide much lower incentives per household across the state that reduce LED prices but not so much that they are competitive with non-ENERGY STAR models.

Figure 16: 2017 Average Price per Bulb in Massachusetts, and Comparison Areas – FCD[1,2,3]



[1] Small sample sizes of NCP panelists introduce bias into the Rhode Island pricing data. NMR suggests that National Grid use Massachusetts and program states as proxies for Rhode Island.
[2] All retail channels.
[3] Does not include private label bulbs sold at specific retailers, so the prices reported here are likely somewhat higher than actual prices.

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 exists to 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 program administrators or evaluators. The LightTracker Initiative pools the resources of multiple program administrators to make available a new source of market level information. While not perfect (see Section 1.2 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 6 for a listing of states).

CREED generates sales data from two sources: POS state sales data as scanned at the register and National Consumer Panel (NCP) state sales data (representing home improvement, hardware, online, and selected membership stores). 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.

The 2017 POS dataset represents sales from grocery, drug, dollar, discount, mass merchandise, and some membership club stores. The dataset accounts for about 21% of the Rhode Island lighting, 26% of Massachusetts, and 35% of the nation. CREED purchases the data from third-party vendors, and the LightTracker team cleans, processes, and calibrates the data for analysis.

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. The use of a scanner avoids potential recall bias, which is prevalent in self-report methods that ask about lighting purchases.

Table 6: Program Strength and Data Quality Confidence

Program States[1]	Non-Program States	Unable to Categorize[2]	Excluded from LightTracker[3]
Arizona*	Alabama	Nevada	Alaska
Arkansas*	Delaware	Oklahoma	Hawaii
California*	Kansas	Utah	Iowa*,[3]
Colorado*	Kentucky	Wyoming	Montana
Connecticut*	Louisiana		North Dakota
Florida	Mississippi		
Georgia	Nebraska		
Idaho	Tennessee		
Illinois*	Virginia		
Indiana*			
Maine*			
Maryland*			
Massachusetts*			
Michigan*			
Minnesota*			
Missouri*			
New Hampshire*			
New Jersey			
New Mexico*			
New York			
North Carolina			
Ohio*			
Oregon*			
Pennsylvania*			
Rhode Island*			
South Carolina			
South Dakota*			
Texas*			
Vermont			
Washington*			
West Virginia			
Wisconsin*			

* States with an asterisk included in Figure 12.

[1] LightTracker was unable to assign program status to these states.

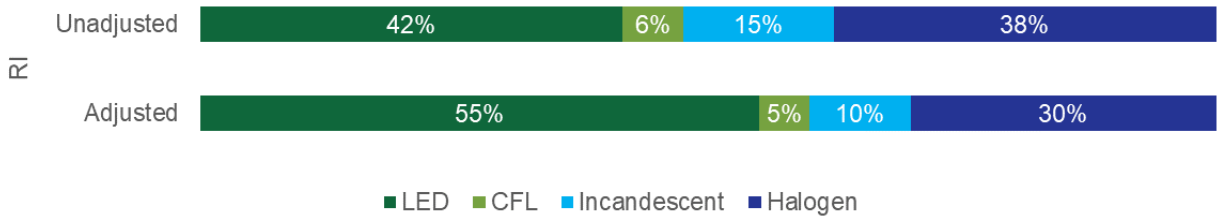
[2] The states lacked sales data or LightTracker.

[3] 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.

Each year CREED improves its data cleaning and vetting procedures. In prior years, comparisons of program-supported sales and LightTracker FCD data have suggested that LightTracker undercounted LED sales in states with aggressive upstream lighting programs. This year, CREED instituted a process to align FCD total LED sales with known program-supported sales in each state. In situations in which program-supported sales (which are almost universally ENERGY STAR qualified across the nation) exceeded or rivaled total LED sales (comprising both ENERGY

STAR and non-ENERGY STAR sales) they adjusted LED sales upwards so that program-supported sales accounted for 90% of ENERGY STAR sales. They made this change only to the FCD data and not POS data (since the latter include only part of the market). Rhode Island and Massachusetts are among the states CREED transformed in this manner. Prior to this adjustment LED market share in Rhode Island was 42%; after this adjustment, it was 55% (see Figure 17). NMR believes the actual value likely falls somewhere between these two estimates. This change should be kept in mind when comparing FCD market share over time.

Figure 17: Pre- and Post-adjusted LED market share in Rhode Island – FCD[1]



[1] All retail channels.

Though the datasets 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

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:

- 2017 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

Section 1.2.2 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 2.1.1 presents data on LED shipment shares using the prior and current NEMA estimation methods and compares the shipment shares to sales shares. Figure 18 and Figure 19 present the shipment shares over time for all various bulb types, from 2011 to 2017 using the prior NEMA calculation method and including incandescents (Figure 18) and from 2017 to Q3 2018 for LEDs, halogens, and CFLs (Figure 19). Both figures demonstrate the shrinking CFL share. Figure 18 additionally makes clear the decline in incandescent shares. Figure 18 and Figure 19 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 18: NEMA Shipment Share, All Bulb Types (Prior Calculation Method)

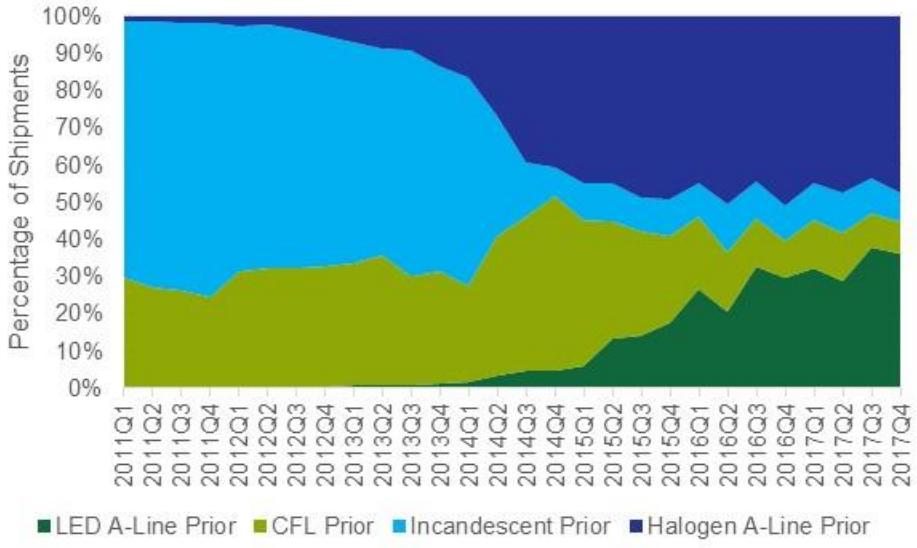
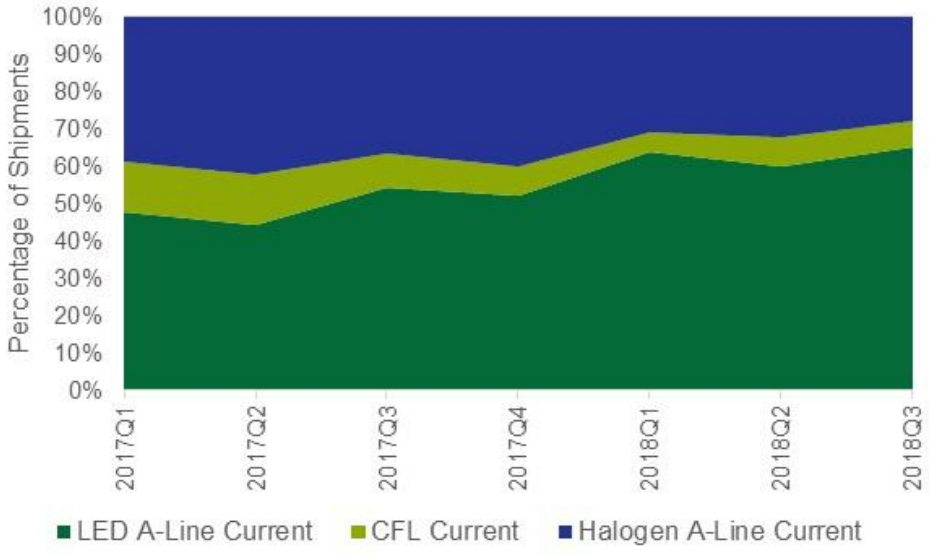


Figure 19: NEMA Shipment Share All Bulb Types (Current Calculation Method, Excludes Incandescents)



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 program administrators or their evaluators.[34] 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 program administrators around the country.[35]

The program data collection activity included:

- 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.[36]

All states with at least some program activity in 2017 were designated *program states; the* remaining states were designated *non-program states*, as shown above in Table 6.

[34] 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).
[35] E Source. "DSM Insights." April 2018.
[36] Note that because the ENERGY STAR report only included expenditure ranges, the midpoints of the ranges were used to represent the expenditures.