# RLPNC 18-8 Residential Lighting Market Scan

FINAL REPORT

March 25, 2019

Sixth Update

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

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# 1

# Section 1 Introduction

This market scan report for the RLPNC 18-8 study presents information published in Q4 2017 through early 2019 on the U.S. residential lighting market.[1] For reference, it also presents the information from five previous quarterly memos (i.e. Q3 2016 through Q4 2017). This report is organized by topic, then by chronology, with the newest information presented first, framed in green, followed by earlier information from previous memos. All sources are from documents published in 2015 or later and, with a few noted exceptions, based on research conducted in 2014 or later. The market scans focus on information gained from areas outside of Massachusetts.

## 1.1 Summary of Findings

This market scan presents a new discussion of the effects of EISA 2020, as well as a new report on regional lighting sales/market shares, a national level report on lighting sales/market shares, and net-to-gross (NTG) estimates from two midwestern states.

In previous iterations of this market scan, we reported on uncertainty surrounding the future of EISA. That uncertainty has come to a head with the February 2019 release of a Department of Energy (DOE) notice of proposed rulemaking (NOPR) stating intentions to roll back the expanded definitions of general service lamps (GSLs) and general service incandescent lamps (GSILs) that DOE had approved in January 2017. If this rollback occurs, very few non A-lamp bulbs would be subjected to the 45 lumen per watt requirement set forth by EISA, which sales data on currently EISA exempt lumen bins suggest would lead to far less LED presence in exempt categories and cost consumers a reported $12 billion per year in energy savings.

In both regional- and national-level reports, we found that LEDs continued to grow as the dominant technology in the A-lamp category. This prominence is not the case for specialty and directional bulbs, highlighting the potential impacts of DOE rulemaking scaling back the expanded GSL definitions. A study of the lighting market in 2017-2018 for the Pacific Northwest found that LEDs made up 47% of all general-purpose bulbs, but incandescents were still the dominant technology among decorative and candelabra-based lamps (74%). The National Electrical Manufacturers Association (NEMA) also found LEDs to be the dominant technology in the A-lamp market, reporting that they accounted for 65% of shipments in the third quarter of 2018. NEMA updated their methodology for producing these estimates, as discussed in detail below, and NEMA now excludes incandescent bulbs from its A-lamp estimates. Despite the increases in LEDs in the market, we did not see drops in NTG ratios in the areas with new studies available (Illinois and Missouri). The NTG ratios for upstream lighting programs in those regions ranged from 0.58 to 0.87 depending on bulb type, on par with, or greater than, many of the values we have observed in prior market scans.

Finally, we present new findings on the hard to reach (HTR) market and on LED penetration in specific retail channels. A recent study conducted in Michigan found that LEDs were significantly more expensive in areas with a greater proportion of the population below the

[1] We have stylized any new updates under the “2018” heading for the sake of brevity.

poverty line. An additional study showed that discount stores were typically less likely to stock and display LEDs than big box retailers, which may explain some of this variation.

## 1.2 CONTENTS

This market scan report draws on recently produced,[2] publicly available research, reports, and evaluation results to provide insights into how program administrators and consumers across the nation are responding to changes in the lighting market. It addresses the following topics:

1. Where other program administrators think—and evaluation results suggest—the market is headed in terms of the implementation of EISA 2020 and response to CFLs no longer being ENERGY STAR qualified
2. Market share of various bulb types (e.g., by technology but also by ENERGY STAR status, EISA exemption)
3. Socket saturation and household penetration of various bulb types
4. Recent estimates of net-to-gross ratios for CFL and LED programs

Note that NMR prepares this document for informational purposes. Therefore, this report does not present overall conclusions or make any recommendations.

[2] All publications were produced in 2015 or later. Estimates are based on data for 2014 or later. Some recent forecasts are based on data going back to 2009; these are noted.

# Section 2 Where the Market is Headed

## 2.1 Effects of EISA

### 2018

Uncertainty surrounding EISA continues to be the main topic of discussion regarding the future of the residential lighting market. This ongoing discussion received new fuel when the DOE issued a pre-publication notice in February 2019 of a proposed rulemaking (NOPR) concerning the definition of GSLs. This proposed legislation would cover both GSLs and GSILs. Under DOE definitions for these lamps, as of January 2017, the lamps considered to be GSL and GSIL were set to expand in 2020 to cover additional categories, namely five specialty incandescent lamps regulated under 42 U.S.C. 6295(l)(4), including rough service lamps, vibration service lamps, 3-way incandescent lamps, high lumen lamps and shatter-resistant lamps. The inclusion of these lamps under GSL or GSIL definitions would have meant that they would be included under EISA legislation, and subject to the 45 lumen per watt backstop which has already gone into effect. The proposed ruling of February 2019 would withdraw these expanded lamp types from GSL/GSIL coverage and maintain the original definitions. Additionally, this would mean that DOE would maintain the exclusion of incandescent reflector lamps (IRLs) from the statutory definitions of GSIL and GSL, as well as a variety of specialty shaped lamps, including most medium screw base candelabra, globe, and torpedo shaped lamps.[3] Further, mini or small-screw base candelabra incandescent lamps would not be considered GSL because the existing definition of GSIL applies only to medium screw base lamps.

These revised definitions have sparked significant reactions from various stakeholders and organizations due to the major impacts that they would have on EISA coverage. The NOPR acknowledges various organizations including the Sierra Club, Earthjustice, the Southeast Energy Efficiency Alliance, and the California Energy Commission have commented that rolling back the standards would be a violation of the DOE's own anti-backsliding rule, which prevents reduced coverage. The Appliance Standards Awareness Project, and possibly others, are expected to sue DOE on these grounds to prevent the rulemaking. Conversely, NEMA has come out in support of rollback of expanded definitions.

The outcomes of the decision to roll back or keep the expanded definitions will have major consequences for the US lighting market. According to research from the Lawrence Berkeley National Laboratory (LBNL) about 2.9 billion bulbs sold in 2015 fall under the expanded categories. This is compared to 3.5 billion regular A-lamp lamps sold in the same year. According to LBNL the resulting impacts of this move are expected to cost consumers $12 billion per year in lost electrical savings. This issue should be closely monitored as it will have a significant impact on the need for intervention in the lighting market.

[3] The definitions specifically cover "T-shape lamps that use no more than 40 W or have a length of more than 10 inches, B, BA, CA, F, G16-1/2, G25, G30, S, and M14 lamps of 40 W or less."

## Q3 2017

As the 2020 EISA deadline approaches, uncertainty remains around its future. After missing the deadline to adopt new efficacy standards earlier this year, the 45 lumen/watt backstop was triggered to go into effect in 2020. Additionally, with regulations set in early 2017, 90% of previously exempt bulbs will now be covered. The 45 lumen/watt standard is set to be adopted by the CEC in California on January 1, 2018. In March, the CEC issued an advisory stating their intention to enforce these standards as planned. However, in August, NEMA filed a lawsuit against the CEC to prevent them from enforcing these standards, arguing that the upcoming federal standard should preempt a state standard. It is still undetermined if this will have any effect on national legislation or manufacturing trends.

Although the NEMA lawsuit against the CEC wouldn't affect federal EISA legislation, potential changes within the DOE or budget cuts to energy efficiency standards adds another layer of uncertainty towards what will happen in 2020. Notably, DOE recently issued an RFI seeking help designing a potential market-based pilot that would adopt more "flexibility" into the Appliance and Equipment Energy Conservation Standards (ECS) program. This idea centers around making efficiency standards more like Corporate Average Fuel Economy (CAFE) standards for vehicles. If this strategy is adopted, even if EISA is enforced, the regulation could look significantly different, as companies could achieve the 45 lumen/watt standard as an average across all bulbs, rather than needing to achieve this level for every product. Additionally, efficiency trading may be allowed, so a manufacturer could have the opportunity to attain allowances to meet the standard.

While policy changes add a layer of uncertainty to the future of EISA, there may not be a significant shift on manufacturer policies. In a recent monitoring study of residential lighting the northwest, manufacturers stated in interviews that they did not believe that EISA 2020 would be a "watershed" moment for LEDs. Many large manufacturers stated their beliefs that LEDs are here to stay and claimed that they had already switched over to LED production by retooling some factories and even shutting down some legacy-technology factories. These manufacturers indicated that after making these investments, they did not plan to move away from LEDs regardless of changes to legislation. This feeling was the most common, but not shared by all. Several smaller manufacturers who were less invested in energy-efficiency indicated that they have not made major changes to their production capabilities. They plan to continue to sell what is allowed within federal standards for as long as possible rather than investing in making technology changes now for an uncertain future.

## Q2 2017

NMR released a draft Connecticut LED NTG evaluation in April of 2017. This included interviews with 16 lighting suppliers, conducted September through November 2016, about their expectations regarding EISA 2020 and ENERGY STAR 2.0. These lighting suppliers expected that EISA 2020 would usher in a decrease in halogen sales and increase in LED sales. They predicted that ENERGY STAR 2.0 coupled with EISA 2020 will greatly curtail CFL sales and significantly decrease CFL market share. This is because the specification excludes most CFLs, which has slowed manufacturers' production of them. They anticipated that ENERGY STAR 2.0

will stimulate LED sales. Some suppliers suggested LEDs and halogens will take the place of CFLs. Note that most supplier interviews were fielded prior to the 2016 election. Some interviewees indicated that their responses might change based upon the results of the election, as a Trump presidency would present a less optimistic future for LEDs. The Trump administration's proposed 2018 budget calls for a 100% cut to the ENERGY STAR program.[4]

### Q1 2017

The Bonneville Power Administration released a brief Lighting Market Intelligence Report covering residential and non-residential lighting in February 2017. The report presents infographics and findings based on retailer sales and shelf data, distributor sales data, interviews with key market actors, and secondary sources. It describes recent and upcoming changes to lighting standards and their anticipated effects on the residential lighting market.

ENERGY STAR 2.0 became effective in January 2017. It raised efficacy standards above those achievable by CFLs, thereby making CFLs ineligible for ENERGY STAR certification. The California Energy Commission (CEC) plans to implement standards in 2018 that are more stringent than ENERGY STAR 2.0, which may influence manufacturers' decisions about the products they produce. Absent any further action by DOE, EISA 2020 will increase efficacy standards to 45 lumens per watt in 2020. In addition, many of the bulbs that have been exempt from EISA standards, including reflectors and candelabra base lamps, will no longer be exempt in 2020. Since halogens are not capable of producing 45 lumens per watt, and some manufacturers have ceased producing CFLs, the Lighting Market Intelligence Report authors predict that LEDs may be the only real option available to consumers in 2020. The authors conclude that EISA 2020 as it is currently written will result in a transition to efficient lighting. However, they caution that the new administration and Congress may alter or eliminate EISA 2020, thereby diminishing its ability to transform the market.

### Q4 2016

In the fourth quarter of 2016, NEEA released the 2015-2016 Northwest lighting market tracking study,[5] which included interviews with lighting suppliers, including eleven manufacturers and five retailers. These interviews were conducted prior to the 2016 presidential election. The unexpected outcome of the election has since introduced considerable uncertainty into the lighting market. The new administration's perspective brings into question whether or not the EISA 2020 requirements will go into effect. Even if the requirements do not change, obtaining funding for enforcement before 2020 now seems very unlikely. The findings from the NEEA study should be considered with this in mind.

Nine of the eleven manufacturers and one of the five retailers interviewed for the NEEA study were aware of EISA 2020, which requires general purpose lamps to have a minimum efficacy of 45 lumens per watt. When asked how they expected EISA 2020 to affect the Northwest, one-half of the suppliers (8 of 16) predicted that it would drive consumers to choose LEDs. One-quarter (4) of the suppliers expected EISA 2020 to result in halogens either becoming more

[4] http://aceee.org/blog/2017/05/making-america-inefficient-budget-s
[5] This study was completed before the 2016 US election and does not take into account any subsequent uncertainty about the future of the lighting market and standards.

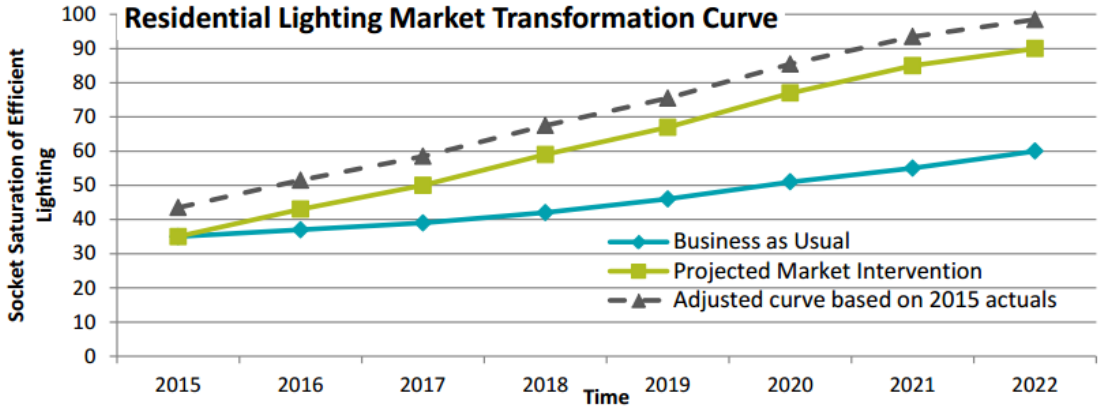
expensive or being phased out. Two predicted that less efficient CFLs would be phased out. Two suppliers declined to comment because of the uncertainty regarding whether Tier 2 of EISA will ultimately be enforced.

## 2.2 SATURATION FORECASTS

### Q3 2016

In July 2016, NEEP published a residential lighting brief containing an updated forecast of efficient lighting socket saturation for the Northeast and Mid-Atlantic. This analysis is based on 2015 socket saturation studies of Massachusetts, Maine and Connecticut. It forecasts efficient lighting socket saturation of 85% in 2020 and 98% in 2022, assuming programs continue to support efficient lighting through 2022 (Figure 1).

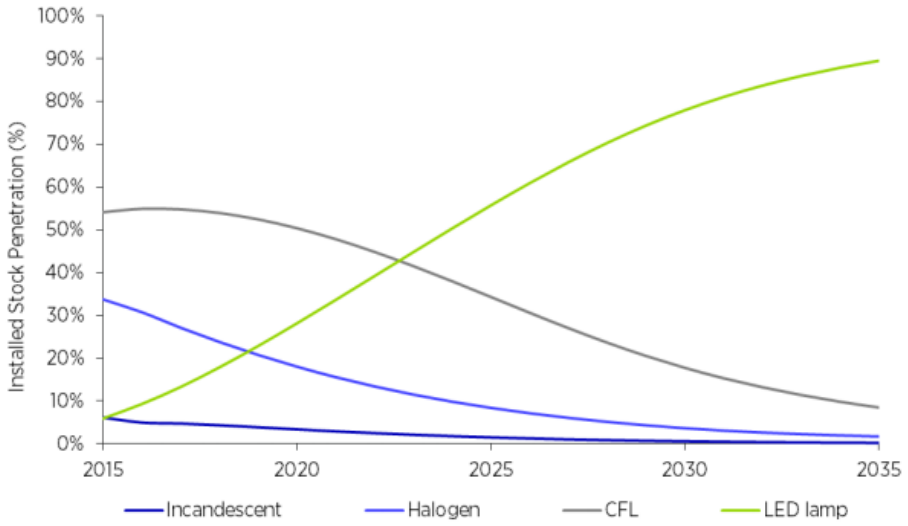
**Figure 1: Residential Socket Saturation Forecast for the Northeast**




Source: http://www.neep.org/sites/default/files/resources/ResLightingBriefFinal_0.pdf

In September of 2016, the DOE published the seventh iteration of its *Energy Savings Forecast of Solid-State Lighting in General Illumination Applications*, which includes installed stock (i.e. saturation) forecasts for LED, incandescent, halogen, and CFL bulbs by sector and submarket. DOE estimates that as of 2015 US residential A-type saturation comprised approximately 54% CFL, 33% halogen, 7% incandescent, and 6% LED. (This estimate is based on data collected between 2009 and 2012. Given the fast-moving nature of the lighting market, a 2015 saturation estimate based on data from 2009-2012 may not be as accurate as other saturation estimates cited in this scan.) With these 2015 saturation estimates as a starting point, the study predicts a rise in LED saturation and a decline in CFL, incandescent, and halogen saturation in the residential A-type submarket between 2015 and 2035 (Figure 2). According to the study, by 2020 saturation in this submarket is projected at 50% CFL, 29% LED, 18% halogen, and 3% incandescent. By 2025, saturation in this submarket is projected at 56% LED, 34% CFL, 9% halogen, and 1% incandescent.

**Figure 2: Residential A-Type Stock Forecast[6]**




Source: http://energy.gov/eere/ssl/ssl-forecast-report

The DOE report presented separate saturation forecasts for the residential decorative, large directional, small directional, and linear fixture markets. The residential decorative and large directional forecasts show the same general trend as the A-type forecast, but with incandescent and halogen bulbs representing a larger proportion of saturation for a longer period of time.

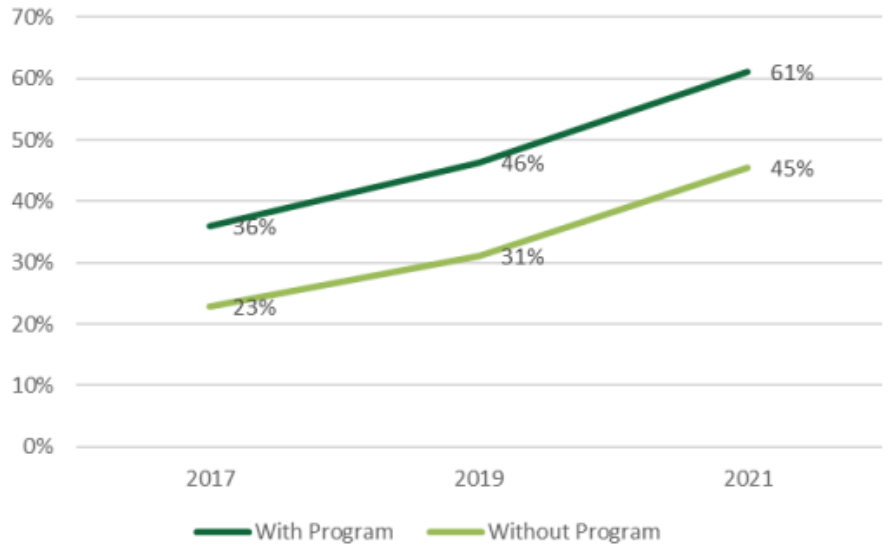
## 2.3 SALES

### Q2 2017

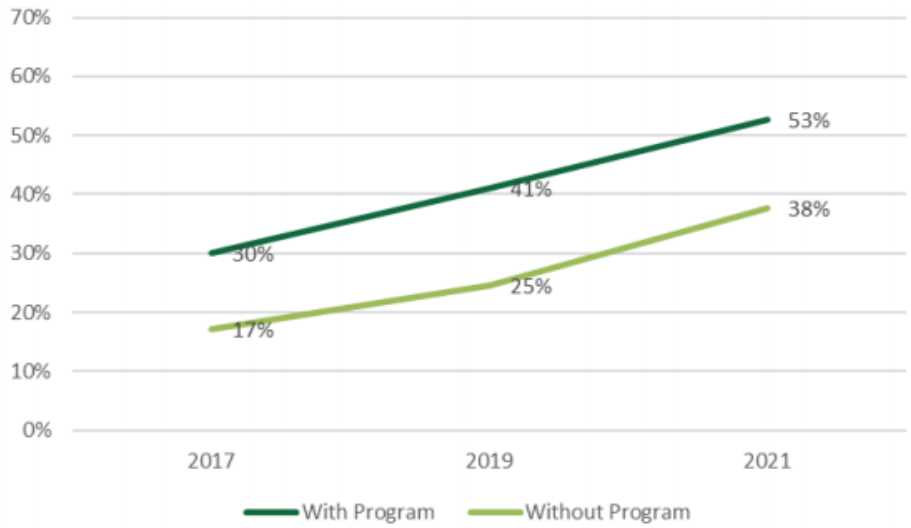
The 2017 Connecticut LED NTG evaluation presented 13 lighting suppliers' predictions of LED market share. Suppliers projected that with continued program support, LEDs would represent 61% of standard residential bulb sales and 53% of reflector residential bulb sales in 2021. However, without continued program support, the suppliers predicted that LEDs would represent only 45% and 38% of standard and reflector residential bulb sales, respectively. Note that most supplier interviews were fielded prior to the 2016 election. If asked today, it is likely that some suppliers would provide lower prospective LED market shares than reflected in Figure 3 and Figure 4.

[6] Note: The DOE report and figures report *installed stock penetration* which is equivalent to saturation (percent of all sockets containing a particular bulb type).

### Figure 3: Market Share Predictions for Standard Bulbs in CT




### Figure 4: Market Share Predictions for Reflector Bulbs in CT




## Q4 2016

In the first market scan memo, we presented the average of lighting suppliers' estimates of their 2018 bulb sales by technology for the Northwest from the 2014-2015 Northwest lighting market tracking study. The 2015-2016 Northwest lighting market tracking study includes lighting suppliers' estimates of their 2017 and 2019 bulb sales by technology. Table 1 shows estimates from the two studies. (The most recent information is in columns with light green headers). Recall when viewing these results, they were obtained from interviews prior to the election results or new administration. The more recent 2017 and 2019 average CFL estimates are both lower than the 2018 average CFL estimate, indicating that suppliers now expect that CFL sales will decline more quickly than they anticipated a year earlier. Similarly, the 2017 and 2019 average LED estimates are both higher than the 2018 average LED estimate, indicating that

suppliers expect that LED sales will increase more quickly than they anticipated one year earlier. Suppliers expect halogen incandescent sales will comprise roughly one-sixth of sales through 2019.

**Table 1: Forecasted Percentage of Sales by Technology**

| Lamp Technology | 2017 Average* | 2018 Average** | 2019 Average* |
|---|---|---|---|
| CFL | 15% | 18% | 9% |
| LED | 54% | 41% | 60% |
| Incandescent | 17% | 16% | 14% |
| Halogen | 15% | 25% | 16% |

*Source: 2015-2016 Northwest Residential Lighting Long-Term Market Tracking Study, n=7. Corrected from original based on personal communication with Geoff Barker, DNV GL, January 12, 2017.

** Source: 2014-2015 Northwest Residential Lighting Long-Term Market Tracking Study, n=9.

### Q3 2016

A 2014-2015 lighting market tracking study for the Northwest included interviews with sixteen lighting suppliers (including manufacturers and retailers) about their expectations for future CFL, incandescent, and LED sales. Almost all of the suppliers interviewed expect their sales of general purpose and specialty CFLs in the Northwest to decline through 2018. About one-quarter of these suppliers expect their CFL sales to diminish to zero over this timeframe. Six out of nine suppliers who manufacture or sell EISA-compliant incandescent lamps expected sales of EISA-compliant incandescents to increase through 2018. All thirteen suppliers who manufacture or sell LEDs expected LED sales to rise in this time. Table 2 displays the suppliers' estimates of their bulb sales by technology in 2018. On average, the suppliers expected LEDs to represent the largest proportion of sales in the Northwest, followed by halogens, CFLs, and incandescents.

**Table 2: Forecasted Percentage of Sales by Technology, 2018**

| Lamp Technology | Average | Range |
|---|---|---|
| CFL | 18% | 10-40% |
| LED | 41% | 20-85% |
| Incandescent | 16% | 0-35% |
| Halogen | 25% | 0-45% |

Note: Percentages may not total 100% due to rounding; n=9.

Source: https://neea.org/docs/default-source/reports/northwest-residential-lighting-long-term-market-tracking-study.pdf?sfvrsn=4

# Section 3 Recent Estimates

This section summarizes market share, socket saturation, and NTG findings published in reports for which the time period of study was 2014 and/or 2015. It also summarizes other, more qualitative findings from papers published in 2016.

## 3.1 SALES

### 2018

One major development that occurred in December 2018 was NEMA's decision to adjust their methodology for calculating the Lamp Index as relates to A-lamps in their reporting of national lighting shipment data. Per their press release, NEMA states that while previous indices correctly captured the *direction* of the market for A-lamp shipments, it underestimated the actual share of LED lamp shipments, due to a significant volume of non-NEMA member imports that were missing from the index. Using government-reported data first available in 2017, NEMA began including these non-member shipments in A-lamp LED data. In addition to making changes in their LED reporting, NEMA made the decision to stop including incandescent A-lamp bulbs in the lamp indices. They state that nearly all incandescent lamps still in the market are low lumen, low wattage lamps, that do not fall under the category of general service. NEMA calculated shipment shares based on this new approach for periods starting in the first quarter of 2017, but did not adjust prior period, causing a substantial change in shipment data when comparing the old methodology with the new under concurrent timeframes. NMR had previously tracked shipment shares for 2017 under the prior NEMA method, allowing us to compare the two approaches (see below).

With these changes in effect, the NEMA lamp indices now show LEDs to be the dominant force in the A-lamp market. In Q1 of 2017, the first adjusted timeframe, LEDs made up 47.6% of all general service lamps. That number has grown steadily, and in the most recently published index (Q3 2018) LEDs controlled 65.1% of the A-lamp market. This increase coincides with a decrease in both halogens and CFLs. Halogens fell from a 39% market share in Q1 of 2017 to 28.1% in Q3 2018, while CFLs dropped from 13.4% to just 6.7% of the market over the same timeframe.

These numbers marked fairly large changes from the prior NEMA data, which was updated with the previous methodology through Q4 of 2017. At the time of the final index using the old methodology LEDs had a 36.1% market share, trailing halogens which composed 47.8% of the market. CFLs and incandescents made up 8.4% and 7.8% of lamps in that report, respectively. For comparison, in Q4 of 2017 under the new methodology, LEDs were the most common lamp type in the market, ahead of halogens (51.1% to 39.9%). CFLs made up the remaining market share at 8.1%. Table 3 shows the market shares compared between these methodologies.

**Table 3: NEMA Lamp Market Shares Under Various Methodologies**

| | LED | Halogen | CFL | Incandescent |
|---|---|---|---|---|
| *2017 Q1 (Old Methodology)* | *32.0%* | *45.1%* | *13.3%* | *9.6%* |
| 2017 Q1 (New Methodology) - First Reported with New Methodology | 47.6% | 39.0% | 13.4% | N/A |
| *2017 Q4 (Old Methodology) - Last Reported with Old Methodology* | *36.1%* | *47.8%* | *8.4%* | *7.8%* |
| 2017 Q4 (New Methodology) | 51.9% | 39.9% | 8.1% | N/A |
| 2018 Q3 (New Methodology) - Latest Update | 65.1% | 28.1% | 6.7% | N/A |

Note that while the prior methodology likely did underestimate the LED presence in the market, NEMA may have some interest in overstating the current LED market share to make a case that EISA or additional GSL expansions are not needed. Incandescents have likely not fully exited the market, despite NEMA's decision not to show the technology, which would increase the market share shown for other technologies. Additionally, NEMA is only reporting on A-lamp lamps, the market that has been transformed to the greatest extent to date. Showing other specialty markets would not tell the same story of dominant LED presence in the market.

We also reviewed residential lighting market shares at the regional level. The Northwest Energy Efficiency Alliance (NEEA) released the 2017-2018 edition of their residential lighting tracking study in January 2019. Similar to the 2016-2017 edition, the study found that LED sales continued to grow in the Pacific Northwest and concluded that "the primacy of LED general purpose and reflector lamps is a huge step towards regional market transformation." According to the report, LEDs accounted for 47% of general service lamp sales, and 50% of reflector lamp sales. Halogens were the second most common technology accounting for 38% of all A-lamp sales, followed by incandescents at 8%. CFLs continued to exit the market, as they accounted for just 7% of all general service bulbs. The study did not find the same uptake occurring for LEDs in the specialty lamp market. Incandescents were still by far the most common technology for decorative and mini-based lamps in the northwest in 2017, accounting for 74% of all bulbs. These specialty lamps accounted for 18% of the total market, while general purpose bulbs made up just over half (51%).

The report also looked at LED prices, and ENERY STAR status. Per the report, the average wattage of both ENERGY STAR and non-ENERGY STAR LEDs were essentially the same at about 8 watts each. After applying utility incentives, the study also found the prices of both qualified and non-qualified bulbs to be nearly identical at around $5 per general service bulb, allowing consumers to freely select ENERGY STAR qualified bulbs at the same price and with the same wattage as non-ENERGY STAR due to program intervention.

### Q3 2017

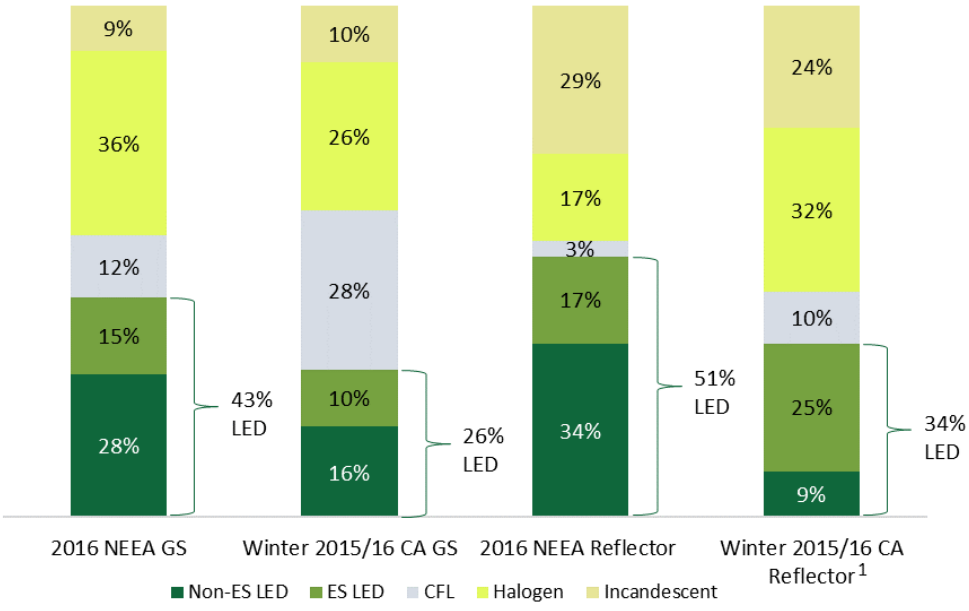
The 2016-17 NEEA residential lighting tracking study found that LEDs were the most commonly sold technology for general purpose and reflector lamps for the first time in any NEEA

monitoring period. The study found that 43% of general purpose lamps sold were LEDs, while they accounted for 51% of reflector sales. Just over one-third of general service lamps sold were halogen (36%), with CFL and incandescent sales lagging well behind at 12% and 9%, respectively. Incandescent lamps still accounted for most specialty sales, accounting for 73% of all decorative and mini-base lamp sales. LEDs were the second-most sold technology in this category, with 25% of sales, having achieved small but steady gains in recent years.

The report found that the increased general purpose and reflector LED sales were largely a function of decreased costs. The average price of an LED bulb (including program support) dropped by 70% from 2011 to 2016. The average price of a general-purpose LED lamp in 2016 was $5.31, down from $18.63 in 2011.

A 2017 study of lamp availability and sales in California also found LEDs to be the most widely sold technology as of winter 2015/16. They accounted for 37% of all sales, ahead of incandescent (27%), CFL (20%), and halogen (20%) lamps. Figure 5 compares the sales of different lamp technologies between NEEA territory and California, as well as a breakdown of ENERGY STAR and non-ENERGY STAR qualified LED sales within those regions. One notable difference comes with regards to the percentage of ENERGY STAR reflector lamps sold. In NEEA territory, non-ENERGY STAR reflectors outsold qualified lamps 2:1, while in California there were nearly three times as many ENERGY STAR reflectors sold as non-ENERGY STAR.

**Figure 5: 2016 NEEA and California Lamp Sales**




[1]At one point in the report, CA high-efficacy reflector sales are listed at 56%, although the numbers reported in the text as well as the graph in the report show the numbers displayed here

## 3.2 MARKET SHARE

### 2018

We reviewed a report on LED availability for low-income customers to help assess the status of HTR markets. A 2018 study conducted by the University of Michigan surveyed 130 stores in the greater Detroit area, finding that LED bulbs were significantly more expensive in high-poverty areas and in smaller stores, compared to affluent areas. Specifically, the study found that the cost to upgrade from a conventional incandescent bulb to an LED was twice as high in the highest poverty areas. In areas with less than 10% of the population falling below the federal poverty line, the average price for an LED was $5.20, compared to an average of $2.10 for incandescents or halogens. The price of incandescents and halogens decreased across every poverty stratum observed, while the price of LEDs increased. This culminated in average prices of $7.87 for an LED versus $1.62 for an incandescent or halogen in areas with more than 40% of the population living below the poverty line. A separate study conducted by the Consumer Federation of America examined the availability and prominence of LEDs at retail outlets in five states (Maine, Pennsylvania, Delaware, Maryland, and Virginia). The study gave the highest grades for LED availability and prominence to major retailers including Home Depot, Lowes, and Walmart. It gave the lower ratings to drugstores and discount stores, with Dollar Tree receiving the lowest ratings. These results may point to opportunities in the HTR lighting market for increased LED program activity.

### Q3 2017

The 2017 California study also tracked lamp availability, finding incandescents to be the most widely *available* lamp type as of the winter of 2015/2016 (34%), followed by CFLs (25%), halogens (23%), and LEDs (17%). As mentioned above, LEDs had the highest reported sales in CA, despite having the least availability. Meanwhile, incandescents had the greatest market share but the least sales. The study indicated changing trends in availability – incandescent shares had comprised 49% of the market in the summer of 2013, while LEDs had accounted for just 3% of all lamps at that same time. The study also found that CFL market share has decreased substantially, down from a peak of 45% in the summer of 2012, and that halogen availability has steadily increased since a low-point of 5% in the fall of 2011. ENERGY STAR bulbs made up 8% of the available lamps in California, while 2% qualified for the CEC specification. Membership clubs carried the most efficient array of lamps, with roughly 70% ENERGY STAR LEDs, and less than 1% incandescent and halogen lamps. Discount stores had the least efficient assortment, carrying about 70% incandescents, and just 2% LEDs.

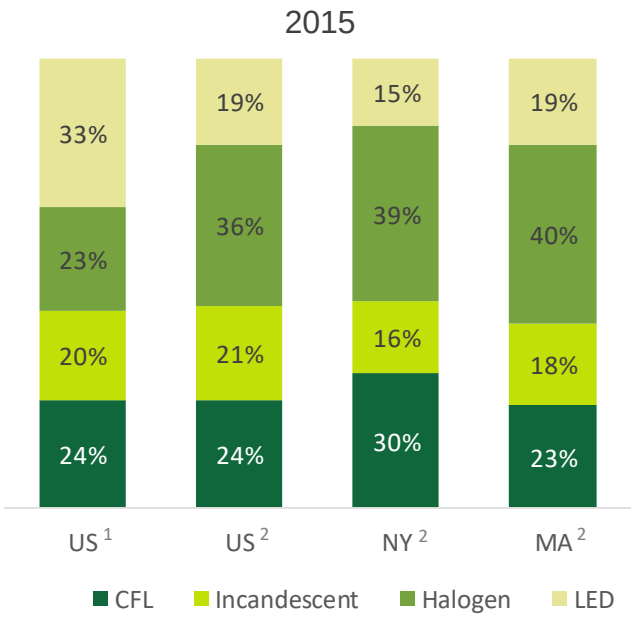
### Q1 2017

The second market scan memo contained only one 2015 market share estimate: a national market share estimate based on interviews with lighting suppliers from the 2015-2016 Northwest lighting market tracking study. The study did not mention the percentage of total sales represented by these lighting suppliers. We added three new 2015 market share estimates to Figure 6, including one national estimate, one for NY, and one for MA. These estimates are based on a consumer panel composed of individuals who scan the UPCs of their

lighting purchases. The consumer panel data were purchased from the CREED initiative for RLPNC 16-5 Sales Data Analysis Tasks 1f and 2c.

A comparison of the two U.S. market share estimates in Figure 6 reveals that lighting supplier estimates and consumer panel sales align in terms of CFL and incandescent market share, but the two sources disagree with respect to LED and halogen market share. Specifically, consumer panel sales point to greater halogen market share (36%) than LED market share (19%), while lighting suppliers tend to estimate greater LED market share (33%) than halogen market share (23%). Plausible explanations for this divergence include the time lag between bulb manufacture and sale to residential consumers, and that the suppliers interviewed for the 2015-2016 Northwest Lighting Market Tracking Study may not have included key halogen manufacturers, may have overestimated their 2015 LED market share, or both. In any event, the RLPNC 16-5 Sales Data Analysis market share estimates, in which we have greater confidence, suggest that the market is farther away from transformation than the 2015-2016 Northwest lighting market tracking study implies.

**Figure 6: 2015 Residential Lighting Market Share Estimates**



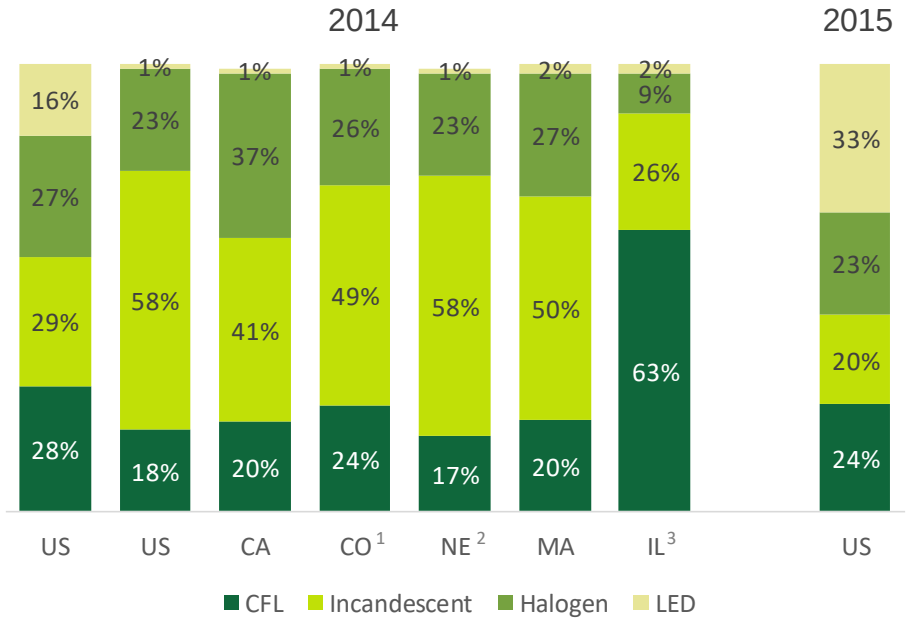

[1]Source: 2015-2016 Northwest Lighting Market Tracking Study
[2]Source: RLPNC 16-5 Sales Data Analysis

## Q4 2016

We identified one new market share estimate, also from the 2015-2016 Northwest lighting market tracking study, since the first market scan. The new data are lighting suppliers' estimates of their 2015 US market shares. The 2015 estimates are averages based on interviews with seven lighting suppliers. Figure 7 presents both the 2014 market share estimates included in the previous scan and the new 2015 market share. On average, the lighting suppliers interviewed for the study estimated their 2015 LED market share at double that of 2014 (33% versus 16%),

and their incandescent market share at almost one-third less (from 29% to 20%). Their estimates of both their halogen and CFL market shares each decreased by about 14% (from 27% halogen and 28% CFL to 23% halogen and 24% CFL).

### Figure 7: 2014[7] and 2015 Residential Lighting Market Share Estimates



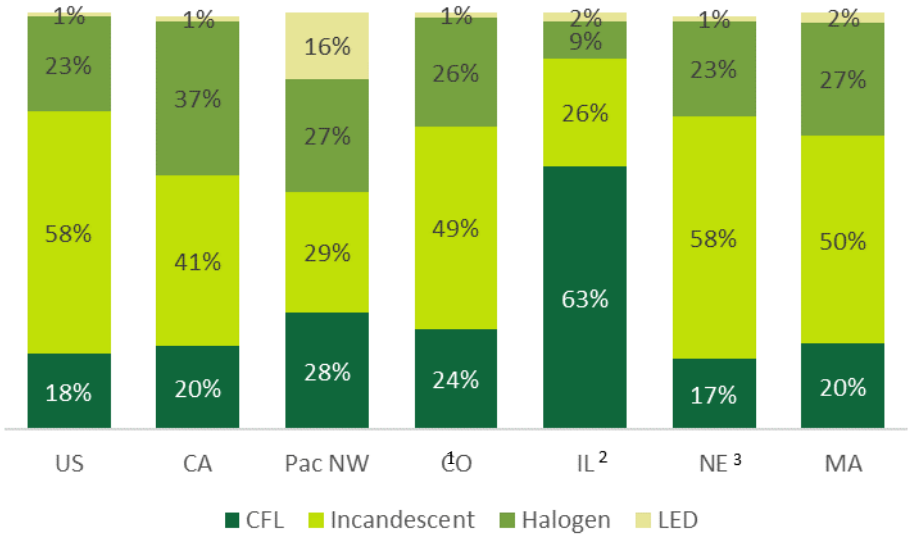

[1] Xcel Energy territory within CO; includes Denver.
[2] Northeast and Mid-Atlantic states.
[3] Ameren territory within IL; includes southern 2/3 of IL.

## Q3 2016

Figure 8 displays 2014 market share estimates for the US and a number of regions, including California, Massachusetts, the Pacific Northwest, a portion of Colorado, a portion of Illinois, and the Northeast.[8] The US, California, Colorado, Northeast, and Massachusetts estimates are based on LightTracker bulb sales data, which include market channels accounting for approximately 15-30% of lamp sales and are for multiple base types and bulb shapes. (The reports for other states did not specify whether the estimates were only for A-shape or screw-base bulbs, or included other bases and bulb shapes.) The Pacific Northwest estimates are based on interviews with nine lighting suppliers. The Illinois estimates were derived from in-store interviews with 1,001 customers. (Note that none of these estimates are based on consumer self-reports, which are particularly subject to recall error and bias.)

[7] Figure 3 in the October 2016 scan mislabeled the first 2014 market share estimate shown above as being for the Pacific Northwest. The estimate is actually for the entire US, as is the new 2015 estimate.
[8] Most of these studies looked only at incandescent, CFL, halogen, and LED bulb types; however, the US, CO, and MA studies also included other bulb types. In order to allow for a more accurate comparison, we removed the other bulb types from the US and CO estimates and adjusted the incandescent, CFL, halogen, and LED estimates to add to 100% in Figure 7.

**Figure 8: 2014 Residential Lighting Market Share Estimates**




[1] Xcel Energy territory within CO; includes Denver.
[2] Ameren territory within IL; includes southern 2/3 of IL.
[3] Northeast and Mid-Atlantic states.

## 3.3 ENERGY STAR CERTIFICATION

### Q3 2017

The NEEA tracking report indicated shifting perceptions in attitudes towards “value-LEDs” (i.e. non-ENERGY STAR). The report noted that value-LEDs are often on par with ENERGY STAR lamps in terms of energy use, and although they typically have lower durability and lifetimes, manufacturers claimed that they have found value LEDs meet customer needs and have become a more popular option of late. At least one utility in NEEA’s territory offers incentives on these lamps. The report suggested the increased gross sales of value-LEDs over time, despite limited program activity, indicates their increasing popularity. Despite this, the report found that the market share of ENERGY STAR certified lamps more than doubled from 2011 to 2015 (from 19% to 40%). Although the share fell slightly in 2016 to 34%, the report predicts that the new ENERGY STAR 2.0 specification will increase the number of qualified lamps in 2017 and beyond. The reduced lifetime requirement from 25,000 hours to 15,000 hours, allows for cost minimization for manufacturers. This may explain the slight dip in qualified bulbs in 2016, as manufacturers were reworking their bulb assortment to prepare for the new specification.

### Q1 2017

Lighting sales data purchased from the CREED initiative for RLPNC 16-5 Sales Data Analysis Tasks 1f and 2c allowed us to estimate the proportion of 2015 CFL and LED sales that were

ENERGY STAR certified in the U.S., NY, and MA. Unlike the consumer panel data mentioned earlier, these data represent actual bulb sales as reported by retailers who agree to take part in the data collection efforts. Therefore, it is important to keep in mind that the percentages presented in Table 4 exclude sales from retailers who did not agree to take part in the data collection efforts, including hardware, home improvement, lighting specialty, and some membership retailers.

In the second market scan, we reported that lighting suppliers interviewed for the 2015-2016 Northwest lighting market tracking study estimated that the proportion of their LED sales that were ENERGY STAR-certified ranged from 35% to 98%. As shown in Table 4, the RLPNC 16-5 Sales Data Analysis found that just 28% of LEDs sold in 2015 through grocery, drug, dollar, discount, and mass merchandiser channels were ENERGY STAR-certified. This divergence can be explained by the same factors described above for the divergence in market share estimates.

**Table 4: 2015 ENERGY STAR Market Share Estimates, ENERGY STAR-Certified Bulbs Only**

| | $US_1$ | $US_2$ | $NY_2$ | $MA_2$ |
|---|---|---|---|---|
| CFL | -- | 84% | 84% | 79% |
| LED | 35-98% | 28% | 19% | 28% |

1 Source: interviews with lighting suppliers, 2015-2016 Northwest lighting market tracking study
2 Source: RLPNC 16-5 Sales Data Analysis

### Q4 2016

The 2015-2016 Northwest lighting market tracking study also includes lighting suppliers' estimates of the proportion of their LED sales that were ENERGY STAR certified. (This is the first of the studies we have reviewed that asks about this.) Four suppliers stated that they only sold ENERGY STAR LEDs in 2015. Among the twelve suppliers that sold both ENERGY STAR and non-ENERGY STAR LEDs in 2015, the proportion of their LED sales that were ENERGY STAR certified ranged from 35% to 98%.

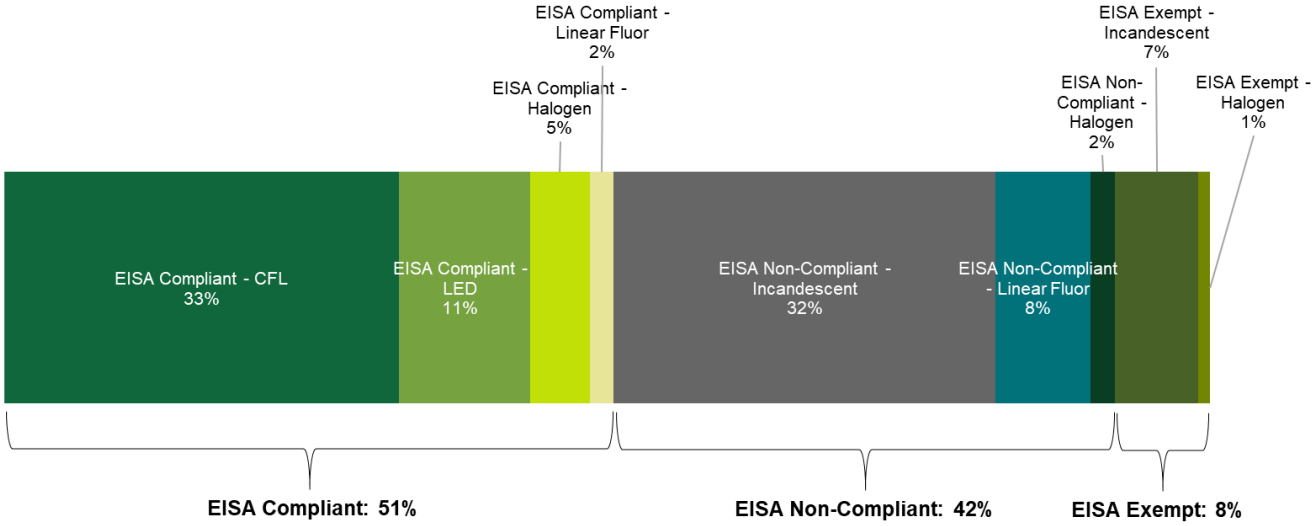
## 3.4 Socket Saturation

### Q3 2017

Figure 9 shows socket saturation estimates from a 2016 study of homes in PG&E territory. Preliminary results found that 47% of sockets were still filled with incandescent or halogen lamps. The measured saturation of LEDs (11%) and CFLs (33%) in this study are similar to those measured in Massachusetts in 2016 (12% LED, 31% CFL). In 2017 Massachusetts LED saturation grew to 18%, while CFL saturation fell to 29%. The PG&E study also found 42% of sockets to contain lamps that are not EISA compliant, while 8% had lamps that are exempt. With EISA scheduled to go into effect in California in 2018, these results may help to shed some

light on what socket saturation could look like just prior to the deadline for the federal standard being enacted.

### Figure 9: 2016 PG&E Socket Saturation




Source: https://www.energystar.gov/sites/default/files/asset/document/ 1 .%20Taylor%20Jantz-Sell_LightingPlenary_1.pdf

## Q3 2016

Table 5 displays 2014 and 2015 socket saturation estimates for the Northeast, portions of Illinois and Colorado, Connecticut, and Massachusetts.

### Table 5: 2014 and 2015 Socket Saturation Estimates

| Type | 2014 | | | 2015 | | | | 2014-15 |
|---|---|---|---|---|---|---|---|---|
| | IL[1] | NE[2] | MA | CO[3] | CT | WI | MA | Range |
| Incandescent | 49% | 48% | 45% | 31% | 33% | 46% | 43% | 31-49% |
| CFL | 38% | 31% | 33% | 31% | 35% | 31% | 32% | 31-38% |
| Halogen | 2% | 9% | 6% | 26% | 6% | 6% | 6% | 2-26% |
| LED | 1% | 3% | 3% | 7% | 10% | 5% | 6% | 1-10% |
| Other | 8% | 10% | 13% | 6% | 16% | 12% | 13% | 6-16% |

[1] Ameren territory within IL; includes southern 2/3 of IL.
[2] Northeast and Mid-Atlantic states.
[3] Xcel Energy territory within CO; includes Denver.

## 3.5 NTG

### 2018

We have identified two reports with new NTG estimates, one in Missouri and one in Illinois. Both of these studies found fairly high NTG ratios compared to what we have observed in previous scans. The Missouri study analyzed the NTG for an upstream program, finding ratios of 0.88 for standard LEDs, 0.71 for specialty LEDs, and 0.83 overall. This was driven by free-ridership values of 0.33 for standard LEDs and 0.50 for specialty LEDs. Spillover for both bulb types was 0.21, contributing to this relatively high NTG. We found estimates for NTG in Illinois for both a direct install program, and an upstream program. The direct install program found a NTG ratio of 0.80. The upstream program NTG values are 0.58 for both standard and specialty LEDs, and 0.73 for LED fixtures. The studies found fairly similar free-ridership across each bulb type (0.49 for standard, 0.45 for specialty, and 0.44 for fixtures), but it found spillover to be for fixtures (0.29) than it did for standard (0.08) and directional (0.13) LEDs. Table 6 shows these NTG ratios in full.

**Table 6: 2018 NTG Estimates**

| Region | Program Type | Standard LED | Specialty LED | LED Fixtures | Overall LED |
|---|---|---|---|---|---|
| MO | Upstream | 0.88 (SO[2]=0.21) | 0.71 | | 0.83 |
| IL | Direct Install | | | | 0.80 |
| IL | Upstream | 0.58 | 0.58[1] | 0.73 | |

[1]Illinois gives NTG values for directional LEDs, not specialty.
[2] Spillover (SO) is often not included in upstream program NTG and is not part of the Massachusetts' paradigm.

### Q2 2017

Since the third market scan, we have identified three new studies with NTG estimates: 2016 NTG estimates for LEDs in CT and WI, 2015 NTG estimates for LEDs in CT, and 2015 NTG estimates for CFLs and LEDs in CA. The 2017 Connecticut LED NTG evaluation presented retrospective (2015 and 2016) and prospective (2017 through 2020) NTG estimates for LEDs for the Connecticut program. The study relied on three empirical approaches (supplier interviews, sales data modeling, and demand elasticity modeling), which fed into a consensus panel process. The panel was composed of lighting suppliers and took place during January and February 2017. The study recommended NTG ratios of 0.63 in 2015 (Table 8) and 0.57 in 2016 (Table 7) for standard and specialty LEDs. In addition, it recommended separate LED NTG ratios for hard-to-reach customers, including 0.83 in 2015 (Table 8) and 0.77 in 2016 (Table 7). The prospective NTG ratios presented in the study decrease each year, declining to 0.33 for non-hard-to-reach customers and 0.53 for hard-to-reach customers in 2020.

A report on a 2016 upstream lighting program in WI found a NTG ratio of 0.72 for LEDs. This ratio includes free ridership, participant spillover, and nonparticipant spillover (Table 7). This ratio is also a triangulation of the results from three net savings methods. These methods

include demand elasticity modelling, national sales data modeling, and surveys with seven corporate retailers and manufacturers. The WI upstream lighting program stopped supporting CFLs in early 2016.

The final source of NTG data was from a study for the 2015 CA upstream residential lighting program. Consumer surveys, supplier interviews, shopper intercept surveys, and a lamp choice model fed into the analysis. The NTG ratio was calculated by multiplying two factors: NTGRq and NTGRu. The NTGRq is "the share of program-discounted lamps that customers would not have purchased in the absence of the program," and the NTGRu[9] is "the ratio of energy savings that the program achieved in the market, compared to the energy savings that the program achieved by efficient lamps that IOU customers replaced in homes." NTG ratios for standard CFLs ranged from 0.21 to 0.46 by IOU, while NTG ratios for specialty CFLs ranged from 0.31 to 1.1 (Table 8). NTG ratios for standard LEDs ranged from 0.30 to 0.33, while NTG ratios for reflector LEDs ranged from 0.38 to 0.52.

**Table 7: 2016 NTG Estimates**

| Region | Retail Channel | Standard CFL | Specialty CFL | Standard LED | Specialty LED | Overall |
|---|---|---|---|---|---|---|
| CT | Non-hard-to-reach | | | 0.57 | | |
| CT | Hard-to-reach | | | 0.77 | | |
| WI | All | | | 0.72 | | |

[9] NTGRu accounts for the fact that the bulbs that were displaced by program bulbs were generally more efficient than the bulbs that customers were replacing with program bulbs.

### Table 8: 2015 NTG Estimates

| Region | Retail Channel | Standard CFL | Specialty CFL | Standard LED | Specialty LED | Overall |
|---|---|---|---|---|---|---|
| CA[1] | All | | 1.1 (A-lamp)<br>0.31 (>30 W) | 0.30 | 0.39 (reflector) | |
| CA[2] | All | | 0.69 (A-lamp)<br>1.07 (reflector)<br>0.81 (>30 W) | 0.33 | 0.38 (reflector) | |
| CA[3] | All | 0.21 | 1.01 (A-lamp)<br>0.81 (reflector)<br>0.57 (>30 W) | 0.33 | 0.52 (reflector) | |
| CT | Non-hard-to-reach | | | 0.63 | | |
| CT | Hard-to-reach | | | 0.83 | | |
| IL[4] | All | 0.63 | | 0.69 | | 0.64 |
| IL[5] | All | 0.54 | | 0.58 | | |
| PA[6] | All | | | 0.61[10] | | |
| PA[7] | All | 0.40[11] | | 0.66[11] | 0.62[11] | |
| PA[8] | All | | | | | 0.68[12] |
| NM[9] | All | | | | | 0.65[13] |
| WI | All | | | | | 0.95[14] |

[1] PG&E service territory.
[2] SCE service territory.
[3] SDG&E service territory.
[4] Ameren service territory; includes southern 2/3 of IL.
[5] ComEd service territory; includes northern 1/3 of IL.
[6] PPL service territory in PA.
[7] PECO service territory in PA; includes Philadelphia.
[8] FirstEnergy Service Territory in PA.
[9] Public Service Company of New Mexico territory; includes Albuquerque.
[10] Based on demand elasticity model; includes free ridership but not spillover.
[11] Based on store intercept surveys; includes both free ridership and spillover.
[12] Based on interviews with corporate retail chain representatives; includes free ridership but not spillover.
[13] Based on store intercept surveys; includes free ridership but not spillover.
[14] Free ridership based on demand elasticity model; spillover based on saturation model.

#### Q1 2017

We have identified two new NTG estimates since the second market scan, both from 2015-2016 upstream lighting programs in Illinois. Evaluators estimated NTG ratios of 0.63 for standard CFLs and 0.69 for LEDs for the Ameren service territory in IL, and 0.54 for standard CFLs and 0.58 for LEDs for the ComEd service territory in IL. These NTG estimates were derived from in-store customer intercept interviews and include both free ridership and spillover. Note that spillover estimates derived from customer intercepts may be limited in what they capture, in that

they usually focus on shoppers purchasing program bulbs and typically represent sales in specific channels during specific time periods.

### Q3 2016

Lighting programs generally support some combination of standard CFLs, specialty CFLs, and LEDs. Evaluations of these programs may estimate NTG values for each bulb type, a combination of bulb types, and/or the program overall. It should be noted that there can be significant differences in programs that can make some of the NTG not completely comparable. For example, the MA program may have a greater target on grocery or other hard-to-reach store categories. Table 9 displays lighting program NTG estimates for 2014.

**Table 9: 2014 NTG Estimates**

| Region | Retail Channel | Standard CFL | Specialty CFL | LED | Overall |
|---|---|---|---|---|---|
| CA | Discount | 0.84 | | 0.69 | |
| CA | Drug | 0.63 | | | |
| CA | Grocery—chain | 0.12 | | 1.00 | |
| CA | Grocery—independent | 1.00 | | 1.00 | |
| CA | Hardware | 0.54 | | 0.56 | |
| CA | Home Improvement | 0.53 | | 0.44 | |
| CA | Mass Merchandise | 0.59 | | | |
| CA | Membership Club | 0.41 | | 0.65 | |
| CO[1] | All | 0.79 | | 0.91 | |
| MO[2] | All | 1.01 | 0.84 | 0.96 | 0.99 |
| IL (N)[3] | All | 0.64 | 0.43 | 0.73 | |
| IL (S)[4] | All | 0.63 | 0.72 | | 0.64 |
| WI | All | 0.53 | | | |
| MA | All | .62 | | .95 | |

[1] Xcel Energy territory within CO; includes Denver.
[2] Ameren territory within MO; includes St Louis.
[3] ComEd territory within IL; includes northern 1/3 of IL.
[4] Ameren territory within IL; includes southern 2/3 of IL.

## 3.6 OTHER

### Q3 2016

Several papers presented at the 2016 ACEEE Summer Study on Energy Efficiency in Buildings provide qualitative findings on the residential lighting market. A comparison of CFL and LED market acceptance found that LEDs are gaining market acceptance more rapidly than CFLs did. Additionally, an analysis of market tracking studies in the Pacific Northwest and California found that in regions that discontinued CFL program support, CFL market share has decreased while halogen market share has increased—even as prices of screw-base LED replacements for A-type incandescent bulbs have dropped.

# A

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