MEMORANDUM

To: Massachusetts Electric PAs and EEAC Consultants

From: Monica Nevius, Lauren Abraham, and Greg Englehart, NMR

Cc: Lisa Wilson-Wright, David Barclay, and Lynn Hoefgen, NMR

Date: February 23, 2018

Re: Study RLPNC 16-11: Lighting Market Scan

This fifth and final quarterly market scan memo for the RLPNC 16-11 study presents information published in the third quarter of 2017 on the U.S. residential lighting market. For reference, it also presents the information from four previous quarterly memos (i.e. Q3 2016 through Q2 2017). This memo is organized by topic, then by chronology, with the newest information presented first. All sources are from documents published in 2015 or later and, with a few exceptions we note, based on research conducted in 2014 or later. The market scans focus on information gained from areas outside of Massachusetts.

Section 1 Summary of Findings

Results of the market scan are split into two sections; (1) reports of where the market is headed, and (2) recent estimates of the lighting market. Indicators of where the market is headed rely on national, and state and regional (outside Massachusetts) saturation forecasts, projected lighting sales, and a look at the potential effects of Energy Independence and Security Act (EISA) regulation. Recent estimates draw from reports on residential lighting market share, socket saturation, NTG reports, and information published on ENERGY STAR certified products and their prevalence in the market.

Throughout all five memoranda, results have consistently indicated a national trend of increased LED adoption, demonstrated through studies of market share, socket saturation, and manufacturer and supplier forecasts. There has also been growth in halogen bulbs throughout the market, along with steady decreases to CFLs and incandescents. Most long-term forecasts project LEDs to eventually become the dominant technology over halogens. The reports that were reviewed in this study attribute the LED growth (and the decline of other technologies) to the upcoming implementation of EISA, ENERGY STAR 2.0 (which eliminated CFLs), and increasingly LED-specific program activity. There is some ambiguity

as to the rate at which LEDs will replace halogens as the dominant technology, due to uncertainty surrounding the implementation of EISA.

In all the states and regions that are covered in this report, results suggest that greater program activity has led to increased LED adoption. Along with reports of socket saturation and market share, this study looks at program influence, and presents CFL and LED NTG ratios from across the country. The first memorandum in the Market Scan effort reported LED NTG ratios ranging from 0.64 to 0.99 in various 2015 reports. Later memoranda reported an array of 2016 NTG ratios with slightly decreased ranges of 0.30 to 0.95, although most estimates were around 0.60.

This final Q3 2017 market scan presents a new discussion of the effects of the Energy Independence and Securities Act (EISA) 2020. It also discusses two new reports on regional lighting sales/market shares, a report on socket saturation, and a brief discussion of ENERGY STAR certification updates.

Recent policy shifts have led to uncertainty in the enforcement of EISA. The Department of Energy (DOE) has issued a request for information (RFI) to evaluate the potential advantages and disadvantages of additional flexibility in the U.S. Appliance and Equipment Energy Conservation Standards (ECS) program. According to the RFI, "f*lexibilities could include market-based approaches such as those used to set average efficiency standards, feebate programs, or other approaches that may reduce compliance costs and/or increase consumer choice while preserving or enhancing appliance efficiency."* A specific example mentioned in the RFI was "*the Corporate Average Fuel Economy (CAFE) standards program for light-duty vehicles."* If adopted, this approach could greatly alter the nature of EISA. Despite uncertainty, during interviews as part of a NEEA market scan, several manufacturers reported that they expect EISA to have a limited effect on their future bulb production. Largely due to investments already made in LED technology and growing consumer awareness, they saw the market change towards LEDs as inevitable and do not expect 2020 to be a "watershed" moment, regardless of the state of EISA legislation and enforcement.

Both a 2016 Northwest Energy Efficiency Alliance (NEEA) report and a 2015/2016 California study found that LEDs were the most frequently sold bulbs in both general service and reflector applications. Combined LED and CFL sales were similar in both areas, and efficient lamp sales accounted for over half the total market share in each region. The CA report also found that despite LEDs having the greatest share of sales, they had the lowest availability of any major technology. However, recent trends in CA have shown substantial growth in LED market share (along with halogen share), alongside steady decreases in both CFL and incandescent availability.

Finally, a 2016 residential socket saturation study conducted in Pacific Gas and Electric's (PG&E) territory found that 11% of sockets were filled with LEDs, while 47% were filled with halogens or incandescents. Forty-two percent of lamps contained bulbs that were not EISA compliant. This level of saturation is behind that of Massachusetts in 2016, even though CA began the EISA incandescent phase out in 2011, one year before MA and the rest of the nation. California fully adopted the 45 lumens per watt EISA standard on January 1, 2018, two years before it is scheduled to go into effect nationally. Although the legislation went into

effect as planned, the National Electrical Manufacturers Association (NEMA) is continuing to pursue a lawsuit aimed at blocking its enforcement.

Section 2 Introduction

This market scan memo draws on recently produced,[1] 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

Section 3 Where the Market is Headed

EFFECTS OF EISA

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, an early 2017 DOE rule expanded EISA coverage to 90% of previously exempt bulbs, although current reviews by DOE of both the backstop and the general service lamp definition (stemming from a settlement of a lawsuit brought by NEMA) could lead to revisions to this rule.

The 45 lumen/watt standard was adopted by the California Energy Commission (CEC) in California on January 1, 2018. In March, the CEC had 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. Despite the lawsuit, CEC issued a press release on December 29, 2017 stating this standard would be enforced as planned,

[1] 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.

and followed that up with a January 1, 2018 tweet announcing the standard had gone into effect.

Although the NEMA lawsuit against the CEC would not affect federal EISA legislation, potential changes within the DOE or budget cuts to energy-efficiency standards add 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. While the RFI does not specifically mention EISA or residential lighting, the eventual outcome of any changes to the ECS program may have an impact on lighting. The RFI specifically outlined two potential ways that the new ECS program could be structured. The first would allow for manufacturers to achieve the federal standard for a single product category by reaching the standard as an average efficiency level across all models of that product type that they produce (e.g. the average of all refrigerator models produced by one manufacturer would have to reach the target, but some could be less efficient than the current DOE standard). The second scenario suggests a system where efficiency credits could be traded both across product categories *and* between manufacturers. In this scenario a manufacturer producing inefficient refrigerators could trade credits with another manufacturer from a separate, efficient product that the other manufacturer produces to allow them to achieve the refrigerator standard. This structure would likely complicate the enforcement of federal efficiency standards. The RFI acknowledges that "*these market-based program options will differ from the current DOE compliance structure creating some uncertainty about implementation, interaction with voluntary programs such as ENERGY STAR, certification, and enforcement for both manufacturers and DOE."* The RFI argues that this model could incentivize manufacturers to create products with higher efficiencies than those that are currently being produced, because the credit system would reward them for greatly surpassing the current standards. However, it also acknowledges that this would allow manufacturers to produce products below the federal standard and consumers to access products that "*cannot be produced to meet a given energy conservation standard level, under [the current] mandatory standard."*

Although the RFI is specific to the ECS program and does not specifically mention EISA, it does provide a glimpse of what future federal regulation may look like, and what could be applied to lighting in the future. Additionally, if the new ECS enforcement procedures allow for credit-trading across product types, it is possible that lighting could be pulled into this same credit system. If EISA is enforced but similar parameters are used in its enforcement, the impact of regulation would be significantly different; 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, they may not lead to a significant shift in manufacturer policies. In a recent monitoring study of residential lighting in

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.[2]

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

[2] http://aceee.org/blog/2017/05/making-america-inefficient-budget-s

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, [3] 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 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 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.

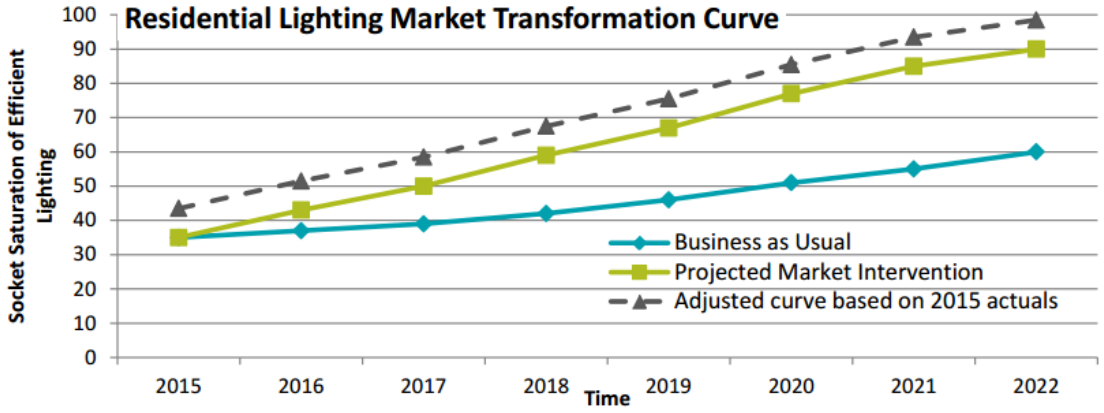
SATURATION FORECASTS

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).

[3] 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.

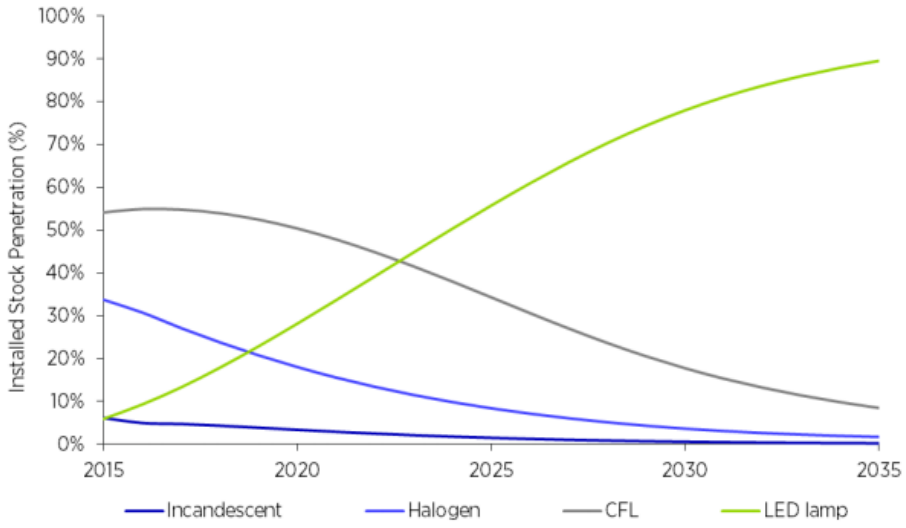
Figure 1: Residential Socket Saturation Forecast for the Northeast



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[4]



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.

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.

[4] 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

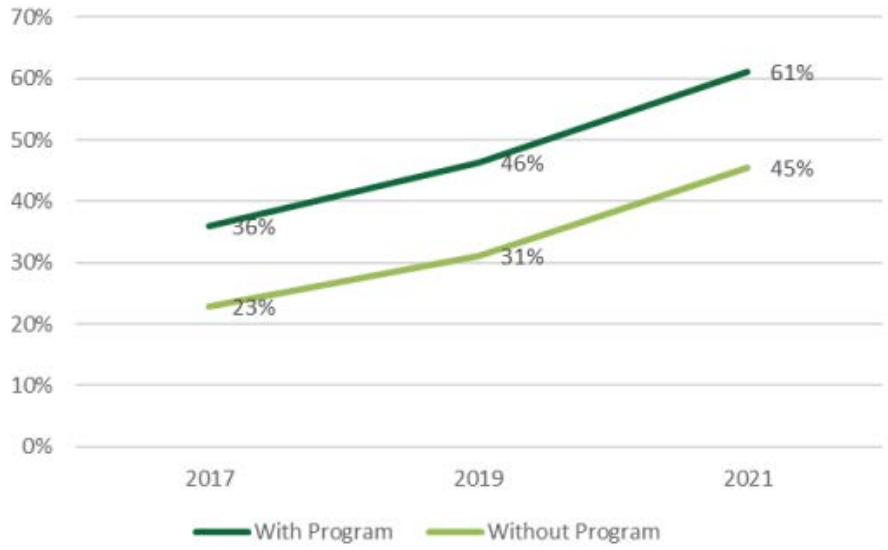


Figure 4: Market Share Predictions for Reflector Bulbs in CT

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 4 Recent Estimates

This section summarizes market share, socket saturation, and NTG findings published in reports for which the time period of study was 2014 or later. It also summarizes other, more qualitative findings from papers published in 2016 and 2017.

SALES

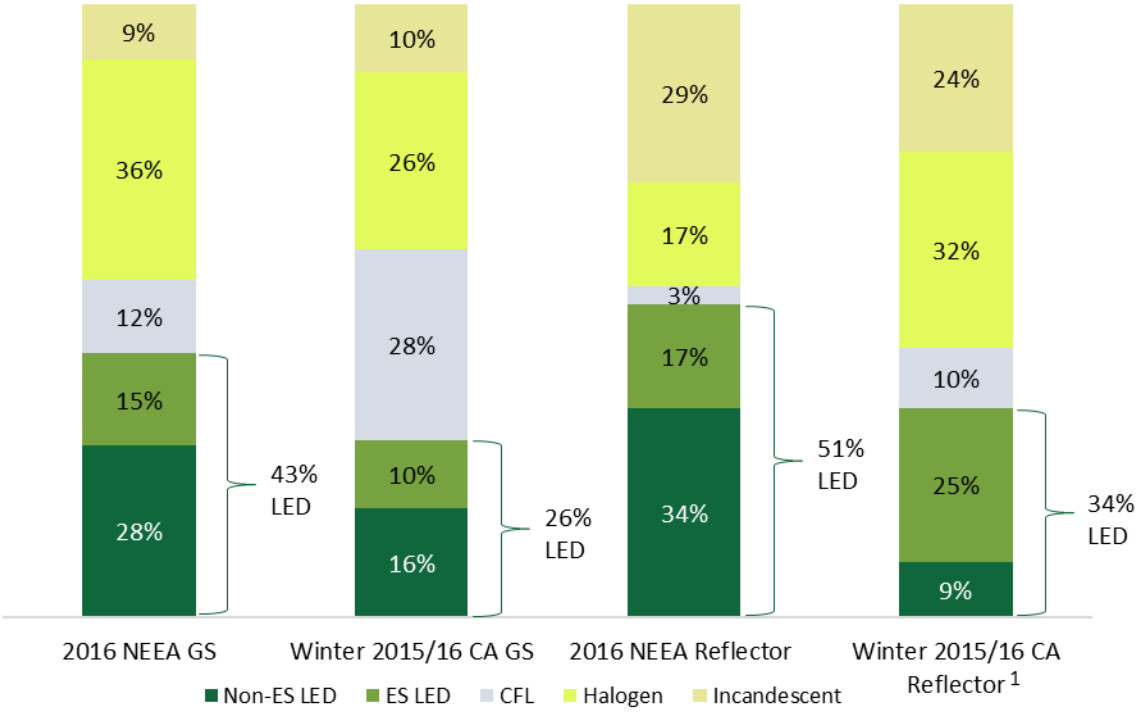
Q3 2017

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 LEDs 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 33% of all sales across all bulb types, ahead of incandescent (27%), CFL (20%), and halogen (20%) lamps. Figure 3 compares the sales of different lamp technologies between NEEA territory and California. It also provides 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. (See: http://www.calmac.org/publications/TRC_PGE_CA_Lamp_Avail_and_Sales_Final_7-27_CALMAC.pdf, pp. 15-6.)

MARKET SHARE

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 percentage sales in CA, despite having the least availability. Meanwhile, incandescents had the greatest percentage of saturation but the smallest percentage of sales. The study indicated changing trends in availability – incandescent shares comprised 49% of the market in the summer of 2013, while LEDs had accounted for just 3% of all lamps at that same time. While shelf stocking does not equate to sales – and this is highlighted by the differences between sales and availability in CA – there are similarities between the two in terms of LED growth trends. From summer 2013 to winter 2015/2016 LED sales roughly quadrupled, going from 8% to 34% of all bulb sales. LED availability was lower to begin with, but increased by more than five times, growing from 3% to 17%.

The study also found that CFL availability 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

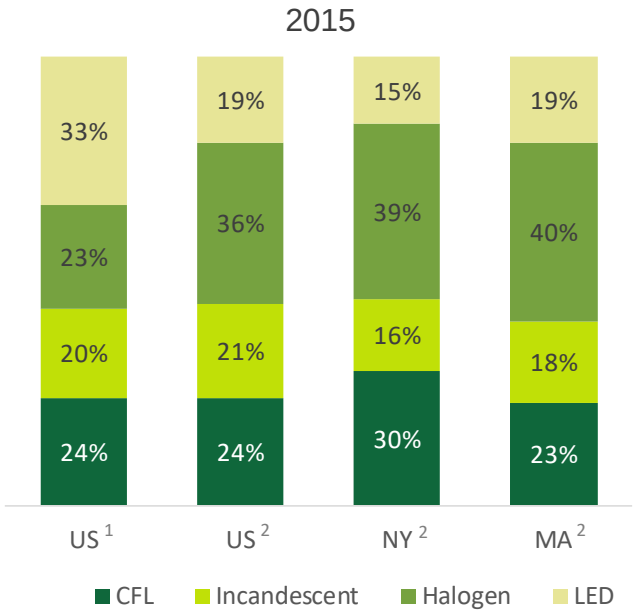
California, while 2% qualified for the CEC specification. Membership clubs carried the most efficient array of lamps, with roughly 70% ENERGY STAR LEDs, and less than 1% incandescent and halogen lamps. Discount stores had the least efficient assortment, carrying about 70% incandescents and just 2% LEDs.

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 5, 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 5 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 6 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).

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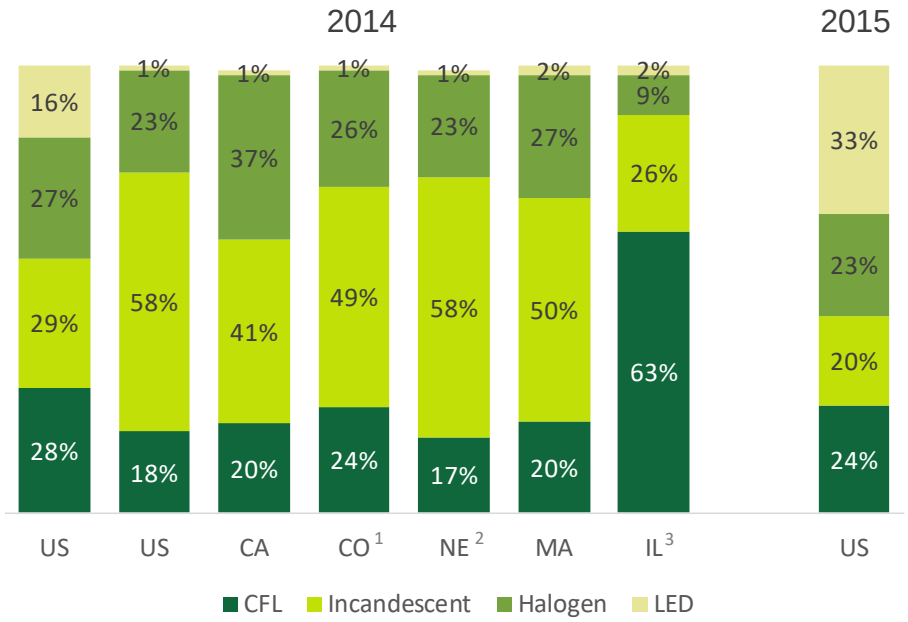
Figure 7: 2014[5] and 2015 Residential Lighting Market Share Estimates



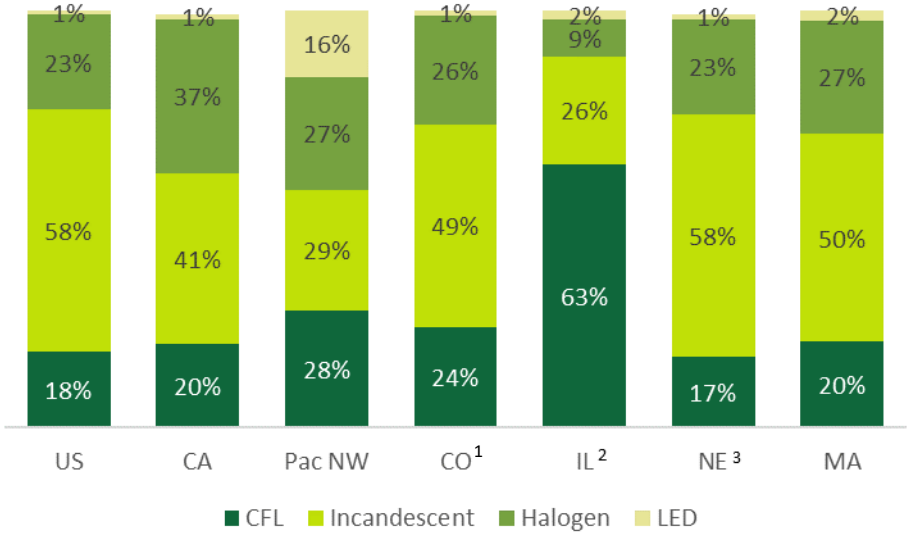
[1] Xcel Energy territory within CO; includes Denver.
[2] Northeast and Mid-Atlantic states.
[3] Ameren territory within IL; includes southern 2/3 of IL.

Q3 2016

Figure 7 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.[6] 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.)

[5] 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.
[6] 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 3.

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.

ENERGY STAR CERTIFICATION

Q3 2017

The NEEA tracking report indicated that manufacturers believe consumer perceptions of "value-LEDs" (i.e. non-ENERGY STAR) are shifting. 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. 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 shelf share of ENERGY STAR certified lamps in the Northwest more than doubled from 2011 to 2015 (from 19% to 40%) across all bulb types. Although the shelf 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 3 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 3, 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 3: 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

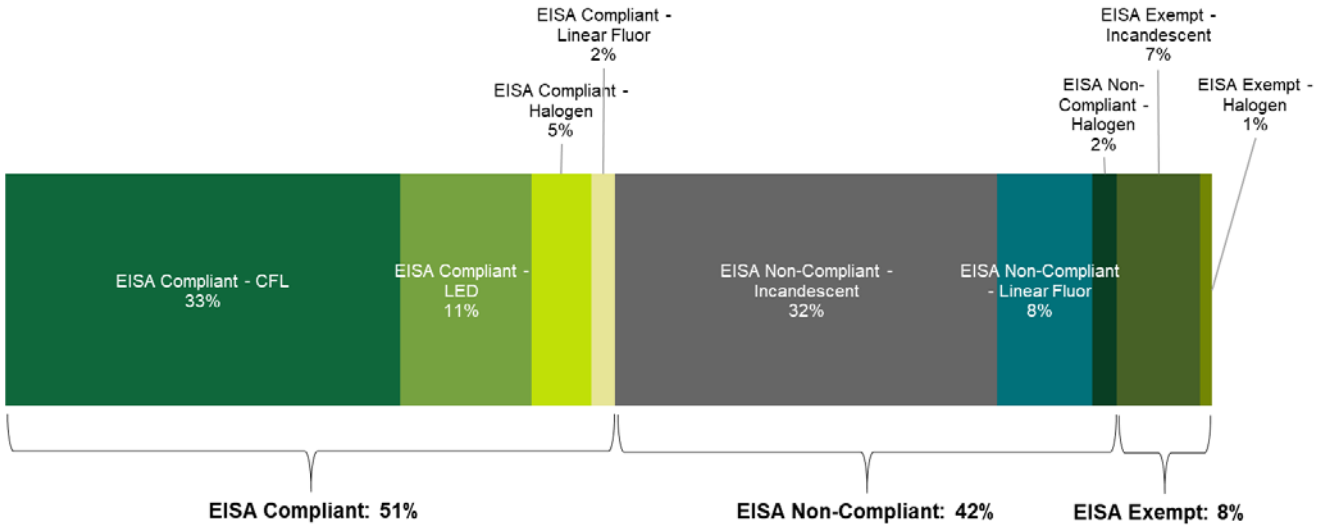
The 2015-2016 Northwest lighting market tracking study also includes lighting suppliers' estimates of the proportion of their LED sales that were ENERGY STAR certified. (This is the first of the studies we have reviewed that asks about this.) Four suppliers stated that they only sold ENERGY STAR LEDs 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%.

SOCKET SATURATION

Q3 2017

Figure 8 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 found 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 4 displays 2014 and 2015 socket saturation estimates for the Northeast, portions of Illinois and Colorado, Connecticut, and Massachusetts.

Table 4: 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.

NTG

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 6) and 0.57 in 2016 (Table 5) for standard and specialty LEDs. In addition, it recommended separate LED NTG ratios for hard-to-reach customers, including 0.83 in 2015 (Table 6) and 0.77 in 2016 (Table 5). 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 5). 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[7] 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 6). 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 5: 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		

[7] 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 6: 2015 NTG Estimates

Region	Retail Channel	Standard CFL	Specialty CFL	Standard LED	Specialty LED	Overall
CA[1]	All		1.1 (A-lamp) 0.31 (>30 W)	0.30	0.39 (reflector)	
CA[2]	All		0.69 (A-lamp) 1.07 (reflector) 0.81 (>30 W)	0.33	0.38 (reflector)	
CA[3]	All	0.21	1.01 (A-lamp) 0.81 (reflector) 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 7 displays lighting program NTG estimates for 2014.

Table 7: 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.

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.

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