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2019 Residential Lighting Market Analysis

Prepared For NEEA:
Jennifer Stout, Project Manager,
Market Research & Evaluation

Prepared by:
Jane Colby, Principal
Jon Koliner, Lead Data Scientist
Katherine Steward, Analysis
Geoff Barker, Sr. Consultant *(DNV GL)*
Benjamin Kiner, Consultant *(DNV GL)*

Apex Analytics
Attn: Scott Dimetrosky
2500 30th Street, Suite 207
Boulder, CO
80301

in collaboration with:
DNV GL

Northwest Energy Efficiency Alliance
PHONE
503-688-5400
EMAIL
info@neea.org

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Executive Summary

Background

The Northwest Energy Efficiency Alliance (NEEA) has tracked trends across the residential retail lighting market since 2005. This study is a 2019-2020 update to NEEA's Northwest Residential Lighting Long-Term Monitoring and Tracking (LTMT) Study and combines this most recent year of data with findings from past studies dating back to 2012. These findings provide valuable insights into longitudinal trends of lighting technologies, prices, and lamp applications in the Northwest region to guide utilities and other stakeholders on lighting baselines, savings, and the rapidly transforming residential lighting market.

Methodology

This LTMT study utilized two primary data sources to assess lamp sales mix (market share), price, wattage, efficacy (lumens/watt), and lifetime rated operating hours within the Northwest for the 2019-2020 update: a shelf stocking study and point of sale (POS) data analysis. Each source provided a unique set of lighting data:

- ***Shelf Stocking Study:*** The research team collected detailed information from lamps on the shelves of 34 small hardware, membership club, and do-it-yourself (DIY) stores in NEEA's utility partners' territories within Washington, Oregon, Idaho, and Montana during the winter of 2020.

- ***CREED***[1] ***LightTracker Point-of-Sale (POS) data:*** The research team purchased from Nielsen detailed POS lighting sales data for mass merchandise, grocery, and drug stores in Washington, Oregon, and Idaho. Starting in 2019, Nielsen stopped offering Montana data, so the team adjusted the 2018 data using the changes seen in Wyoming's data from 2018 to 2019.[2] The CREED team cleaned and corrected all the states' data.

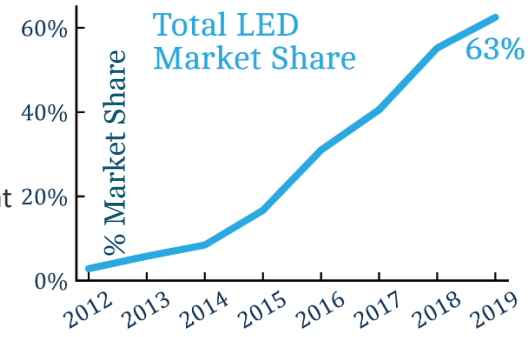
Key Findings

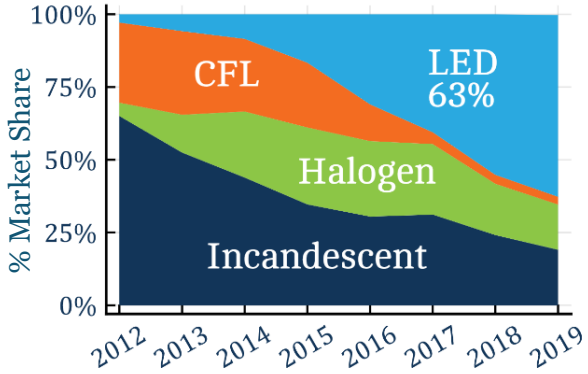
The following key findings emerged from the research team's analysis.

[1] The Consortium for Retail Energy Efficiency Data (CREED) is a consortium of program administrators, retailers, and manufacturers working together to collect the necessary data to better plan and evaluate energy efficiency programs. LightTracker is CREED's first initiative, focused on acquiring full-category lighting data, including incandescent, halogen, CFL, and LED bulb applications, for all distribution channels in the United States.

[2] The methodology section in the body of the report and Appendix A describes the Montana approach in detail.

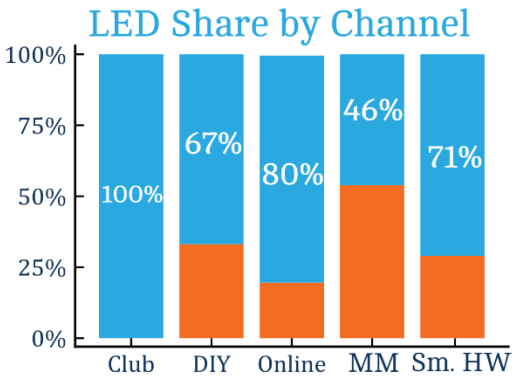
The lighting market continued its shift toward LEDs across all applications in 2019. Overall, LEDs accounted for 63% of all Northwest lamp sales in 2019. LEDs made up a larger proportion of general purpose lamp sales (67%) and reflector lamp sales (70%) than specialty lamps at 58%.

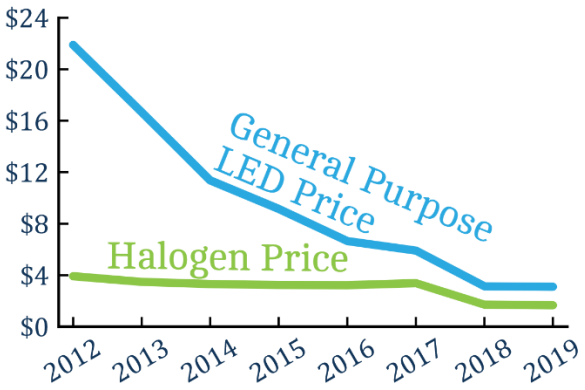




As in 2018, continued gains in LED share in 2019 came at the expense of incandescent and halogen lamps. By contrast, in 2017, the market share of incandescents and halogens largely remained flat while the share of CFLs declined substantially to a very low percentage.

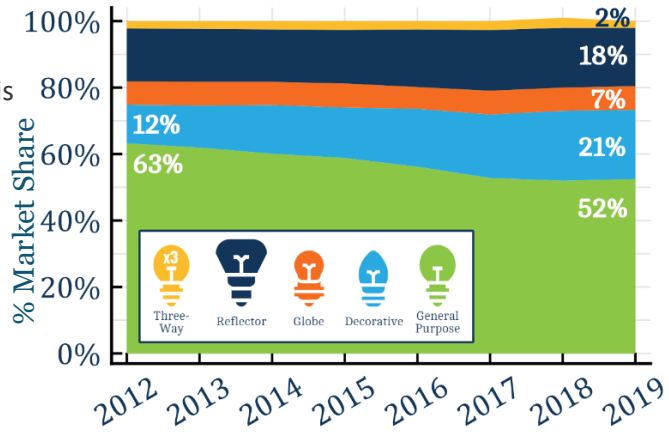
Grocery, dollar, and mass merchandise retailers may present the greatest opportunity to further increase LED market share. In 2019, LEDs grew to 46% of lamp sales on average across the combined grocery, dollar, and mass merchandise channel ("MM"), but the MM LED market share was still lower than other channels. This channel represents the second-largest volume of lamp sales. Do-It-Yourself (DIY) has the largest volume of lamp sales, and 67% of their sales are LEDs. In the membership club, online, and small hardware channels, LEDs make up between 71% and 100% of sales.

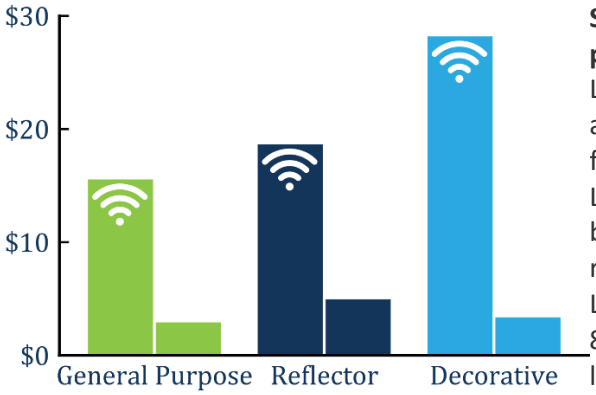




Prices for LEDs across all applications (after any efficiency program, manufacturer, or retailer discounts[3]) began to flatline in 2019, decreasing very little from 2018 prices. General purpose LED lamps cost an average of $3.10 in 2019, a decline of only 0.9% from 2018. On average across all applications, the price of general purpose LED lamps was 1.8 times that of halogen lamps in 2019, down from 5.6 times the price of halogen lamps in 2012.

The sales share for general purpose lamps fell from 64% in 2012 to 52% in 2019. The growing market share of LEDs may be a contributor to this decline, as LED lamps' longer lives result in less need for replacement than the incandescent or halogen lamps they may have replaced.



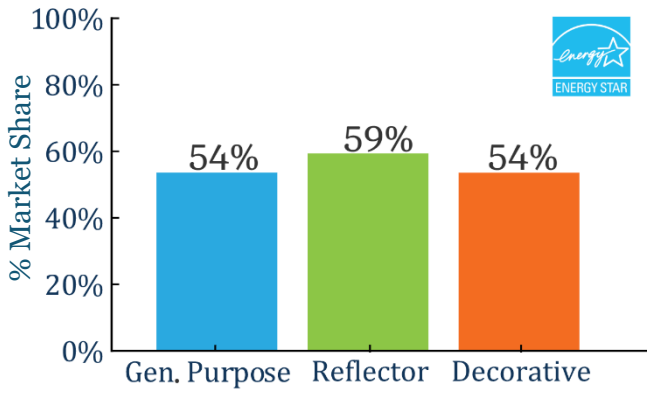


Smart LEDs[4] differ substantially from standard LEDs in price and functionality. The market share of smart LEDs remained small in 2019, at approximately 1% of all LED sales. Smart LED prices were approximately four times higher than standard LED prices. Smart LEDs also showed different patterns in price difference between lamp applications. For example, Smart LED reflector lamps are 73% more expensive than standard LED reflectors, while smart LED decorative lamps are 88% more expensive than standard LED decorative lamps.

[3] As part of the 2017-2018 analysis, NEEA conducted an analysis of pre-incentive lamp prices. The resulting memorandum was not formally published but is available on request. This analysis was updated by NEEA internally in 2018-19, and will be updated by staff of the Regional Technical Forum (RTF) in late 2019-20.

[4] Referred to more generically as "smart lamps," these are LED light bulbs that can be communicated with and controlled wirelessly

Shares of ENERGY STAR-certified LEDs have declined and are the lowest for general purpose and decorative bulbs (54%). ENERGY STAR-certified bulbs have a 35% longer lifetime than non-ENERGY STAR bulbs.



1. Introduction and Objectives

This report presents findings from the 2019-2020 update to NEEA's Northwest Residential Lighting Long-Term Monitoring and Tracking (LTMT) Study, which assesses the current state and historical trends of the Northwest residential lighting market. NEEA has overseen similar studies since 2011 using a consistent methodology that enables NEEA and its regional partners to track trends in the lighting market. NEEA contracted with Apex Analytics, LLC and DNV GL (the research team) to undertake the 2019-2020 study. This report details the methods and findings of this research.

2. Methodology

The research team relied on two primary data collection activities for the 2019-2020 LTMT effort: shelf stocking study and point of sale (POS) data analysis.

Shelf Stocking Study

The research team collected detailed information from lamps on the shelves of 34 small hardware, membership club, and do-it-yourself (DIY) stores in NEEA's utility partners' territories within Washington, Oregon, Idaho, and Montana during January and February 2020. The team surveyed the same store locations that were visited during last year's analysis period.

Table 1 outlines the number of shelf surveys completed at each store type during the 2019-2020 analysis period. These are the store types for which Nielsen POS data are not available. Appendix A (Shelf Survey Sample Design) provides more detail on the sample design.

Table 1: Shelf Survey Sample by Retail Channel

Retail Channel	Shelf Surveys Completed
DIY	11
Small Hardware	20
Membership Club	3
Total	34

CREED[5] LightTracker Point-of-Sale (POS) data

The research team purchased from Nielsen detailed POS lighting sales data for mass merchandise, grocery, and drug stores in Washington, Oregon, and Idaho. Staring in 2019, Nielsen stopped offering Montana POS data so for 2019 the team used the 2018 Montana data and adjusted the market shares based on changes in Wyoming's market shares that occurred from 2018 to 2019. We did not calculate new pricing or wattage data for Montana, and therefore it is excluded from pricing and wattage information across the region.

Sales-to-Stocking Ratio Assumptions

During the 2018-2019 analysis period, the research team had updated the Chain Logic Method sales-to-stocking ratio assumptions. Previous years' studies had used a ratio of 1:1 for all store types. However, findings from the 2018-2019 store manager interviews indicated that small hardware stores understock LEDs and that a better estimate for the sales-to-stocking ratio is 2:1 for LEDs and 1:2 for incandescent and halogen lamps within this store type. Interview findings indicated that the 1:1 sales-to-stocking ratio was still appropriate for store types other than small hardware. The store managers interviewed across all store types also indicated that stocking practices change frequently enough that a single-point estimate of shelf stocking does not accurately represent a full year. Thus, the research team retained the methodology from previous years' studies of using an average of two years of shelf stocking data in calculations.

Chain Logic Method

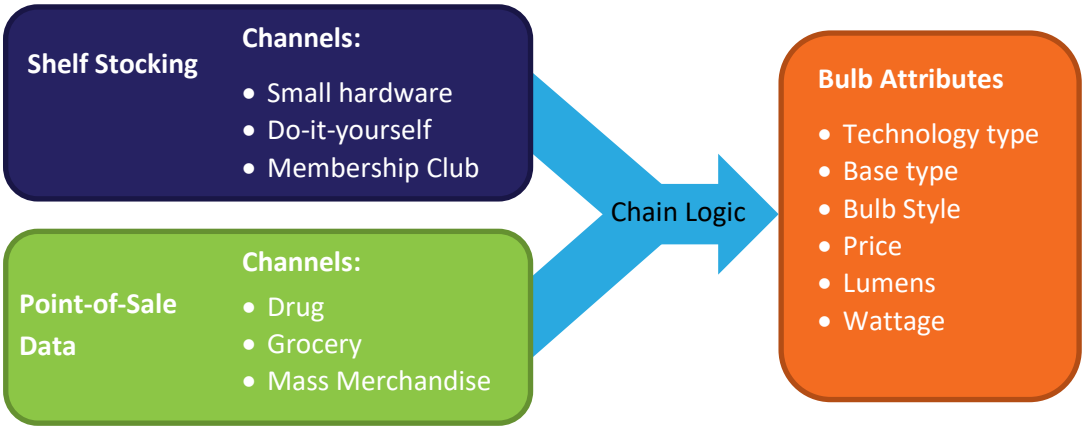
For 2019-20, the research team combined the weighted shelf stocking and POS data using the Chain Logic Method established in the 2016-2017 Northwest Residential Lighting LTMT study.[6] The Method estimates market share based on shelf stocking data. It draws on assumptions about the ratio of products stocked to products sold and the market share of each retail channels, and generates estimates of total sales volume. Figure 1 illustrates how these data sources complement each other to provide data on a range of lamp attributes across retail channels.[7]

[5] The Consortium for Retail Energy Efficiency Data (CREED) is a consortium of program administrators, retailers, and manufacturers working together to collect the necessary data to better plan and evaluate energy efficiency programs. LightTracker is CREED's first initiative, focused on acquiring full-category lighting data, including incandescent, halogen, CFL, and LED bulb applications, for all distribution channels in the United States.

[6] See Appendix C: Chain Logic Model Methodology for further detail.

[7] See appendices for full list of attributes.

Figure 1: Data Sources



3. Findings

This section begins with a summary of lighting market characteristics, including sales and pricing trends, based on the shelf survey and POS data.

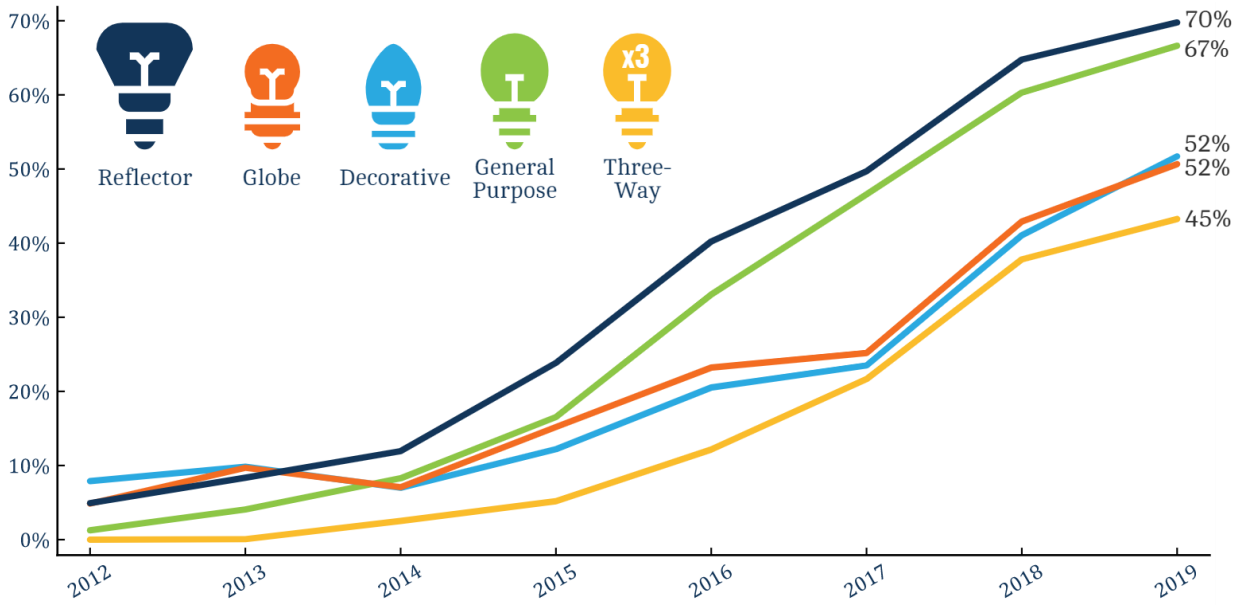
Lighting Market Characteristics

Lamp Sales Trends

The Northwest lighting market continued its transformation toward LEDs in all lamp applications.[8] Reflector lamps continue to have the highest LED technology share (70%), outpacing general purpose lamps (67%), while the non-reflector specialty styles (i.e., globe, decorative and three-way) lag behind both (Figure 2). The LED share of general purpose lamps grew on a similar trajectory to the prior three years. Growth in the share of LEDs slowed for all lamp applications in 2019 compared to 2018.

[8] The lamp applications considered in this study were as general purpose, reflector, globe, decorative, and three-way.

Figure 2. LED Technology Shares by Application, 2012-2019

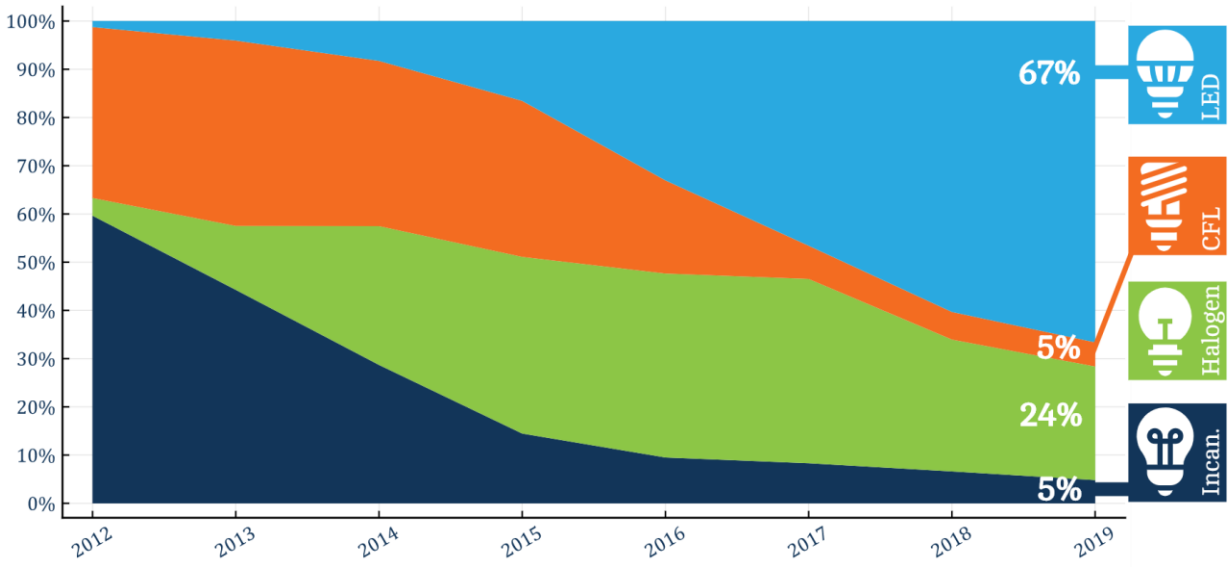


Data source: Weighted combination of sales data and NEEA shelf data

For general purpose lamps (Figure 3), LEDs had the highest share (67%), followed by halogens (24%). CFLs and incandescents were each only 5% of the market. Continued growth in the share of LEDs in 2019 came largely at the expense of incandescent and halogen lamps. By contrast, from 2015 to 2017, LED share growth largely came at the expense of CFLs. Figure 3 shows the technology shares within the general purpose application over the last eight years. The remaining 5% incandescent shares mainly fall in the lumen categories of under 310 or over 2600 that are exempt from EISA. Incandescent bulbs in other lumen categories are presumably rough service[9] and 3-way, although if retailers still have stock on hand from EISA impacted bulbs, they can still be sold.

[9] Rough service incandescent lamps are designed to be resistant to vibration and other external stresses that can damage the filament of a regular incandescent lamp.

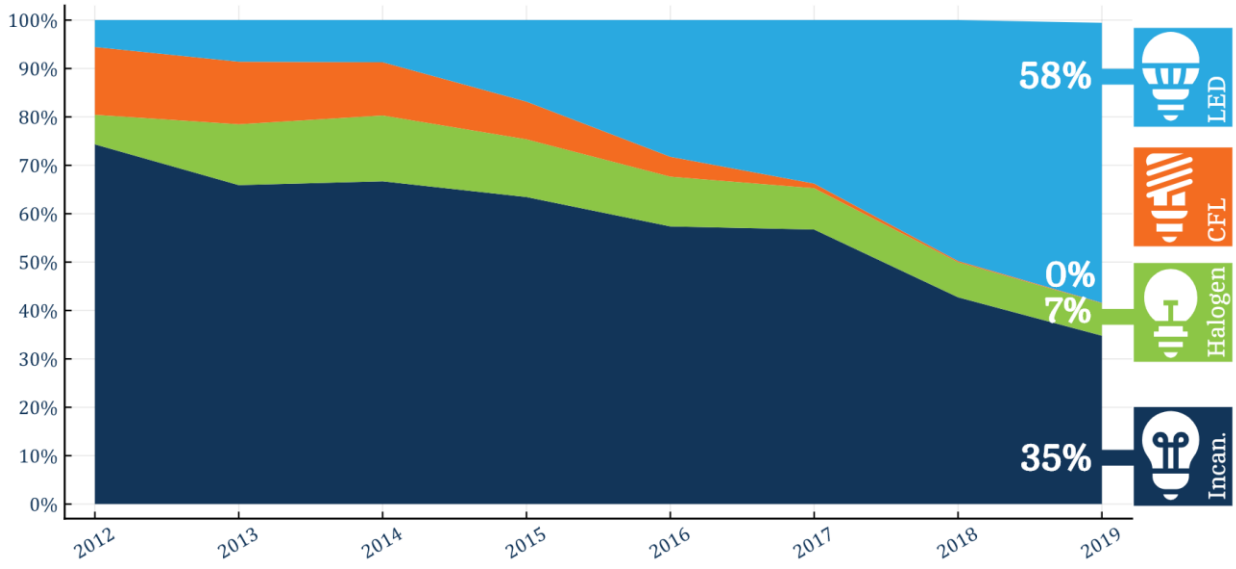
Figure 3. General Purpose Lamps – Technology Shares, 2012-2019



Data source: Weighted combination of sales data and NEEA shelf data

As shown in Figure 4, for specialty lamp categories combined (decorative, globe, reflector, and three-way), incandescent bulbs still hold a 35% share. However, LED technology share increased rapidly in 2019 to 58%, solely at the expense of incandescent lamp

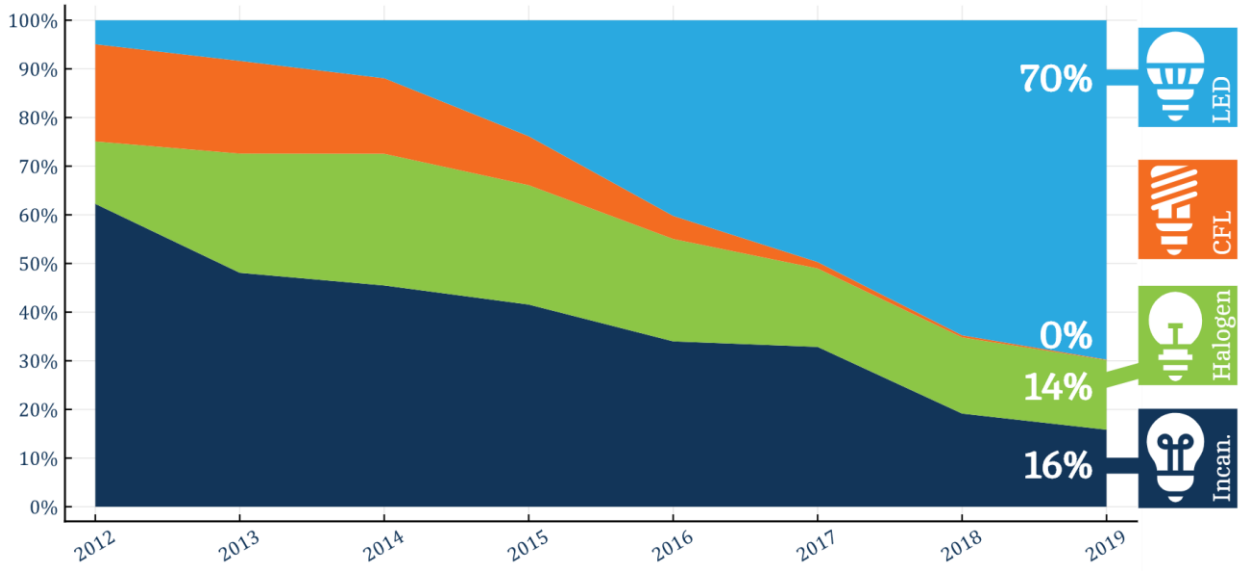
Figure 4. Specialty Lamps (Decorative, Globe, Reflector, and Three-Way) – Technology Shares, 2012-2019



Data source: Weighted combination of sales data and NEEA shelf data

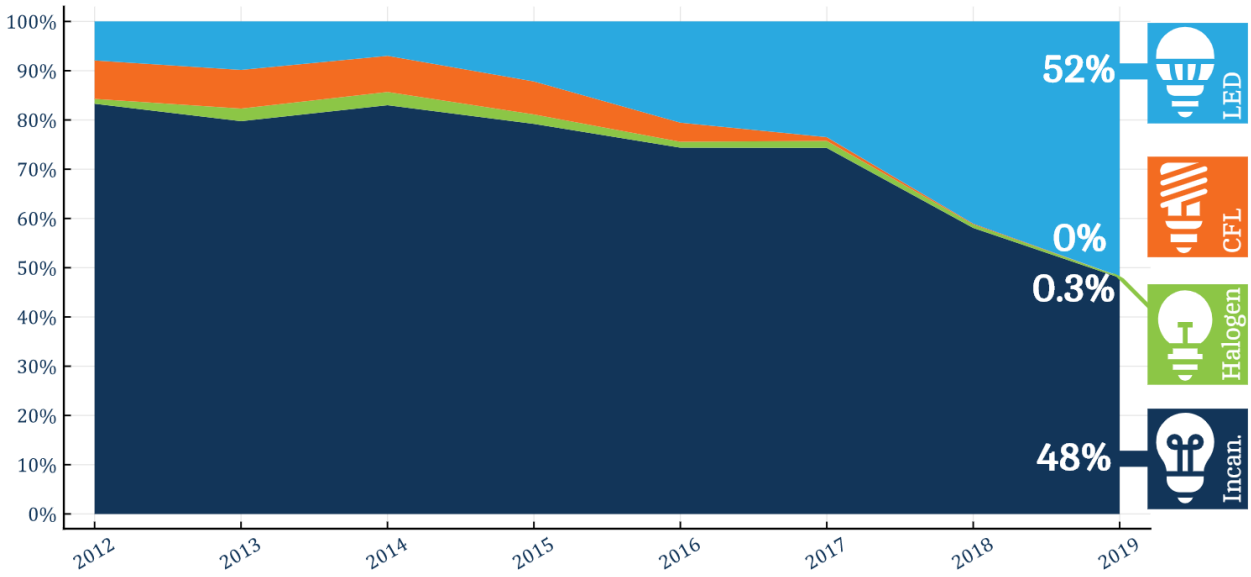
Within various categories of specialty lamps, there are notable differences in the shares of LEDs. In particular, reflector and decorative lamps together comprise 80% of specialty lamps sold but each shows a different market share trend. For reflectors, LEDs gained technology share rapidly from 2014 through 2019 and now comprise 70% of all reflector lamp sales (Figure 5), and halogens and incandescents each account for roughly half of the remaining market share (14% and 16% of the share, respectively). By contrast, for decorative and mini-base lamps, LED adoption has been much slower than for reflector lamps (Figure 6). This year was the first year that LEDs comprised the largest share (52%) of decorative and mini-base lamps, although only marginally larger than the share of incandescents (48%). Halogens have made little headway in decorative and mini-base lamps, comprising a negligible share over the last eight years.

Figure 5. Reflector Lamps – Technology Shares, 2012-2019



Data source: Weighted combination of sales data and NEEA shelf data

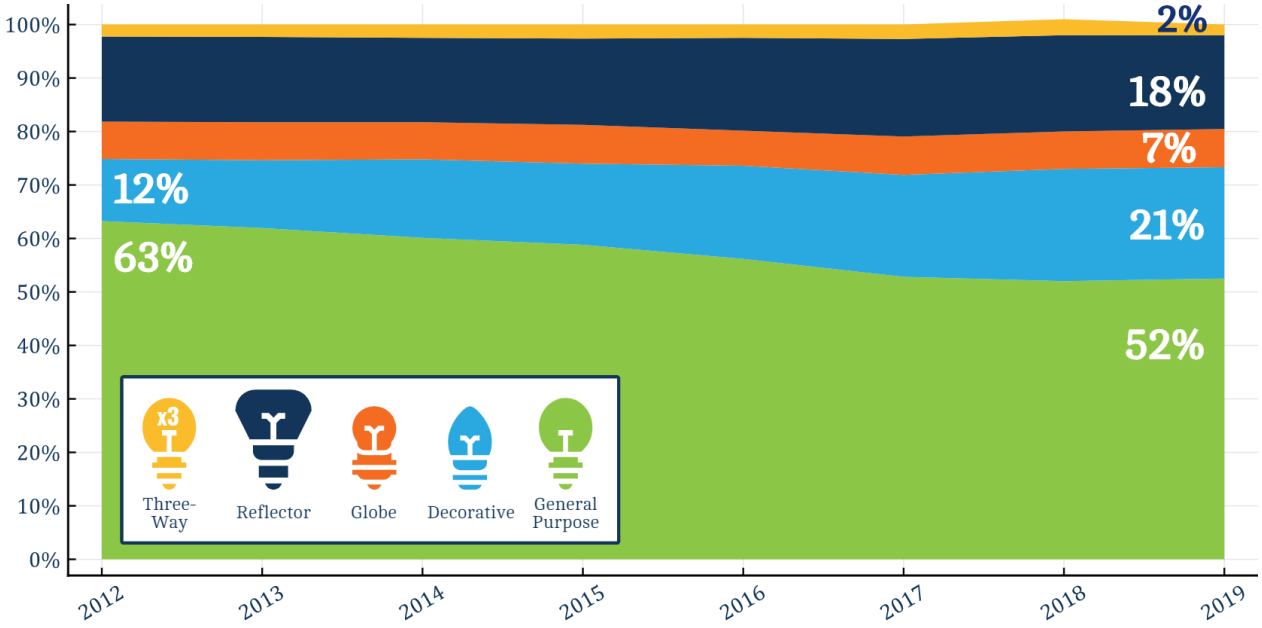
Figure 6. Decorative and Mini-Base Lamps – Technology Shares, 2012-2019



Data source: Weighted combination of sales data and NEEA shelf data

The sales shares of various lamp applications in the residential market have evolved over the last seven years. The sales share for general purpose lamps has declined from 63% to 52% (Figure 7). The growing market share of LEDs may be a contributor to this decline, as LED lamps' longer lives result in less need for replacement than the incandescent or halogen lamps they may have replaced, and thus fewer sales.

Figure 7. All Lamp Sales – Application Shares, 2012-2019



Data source: Weighted combination of sales data and NEEA shelf data

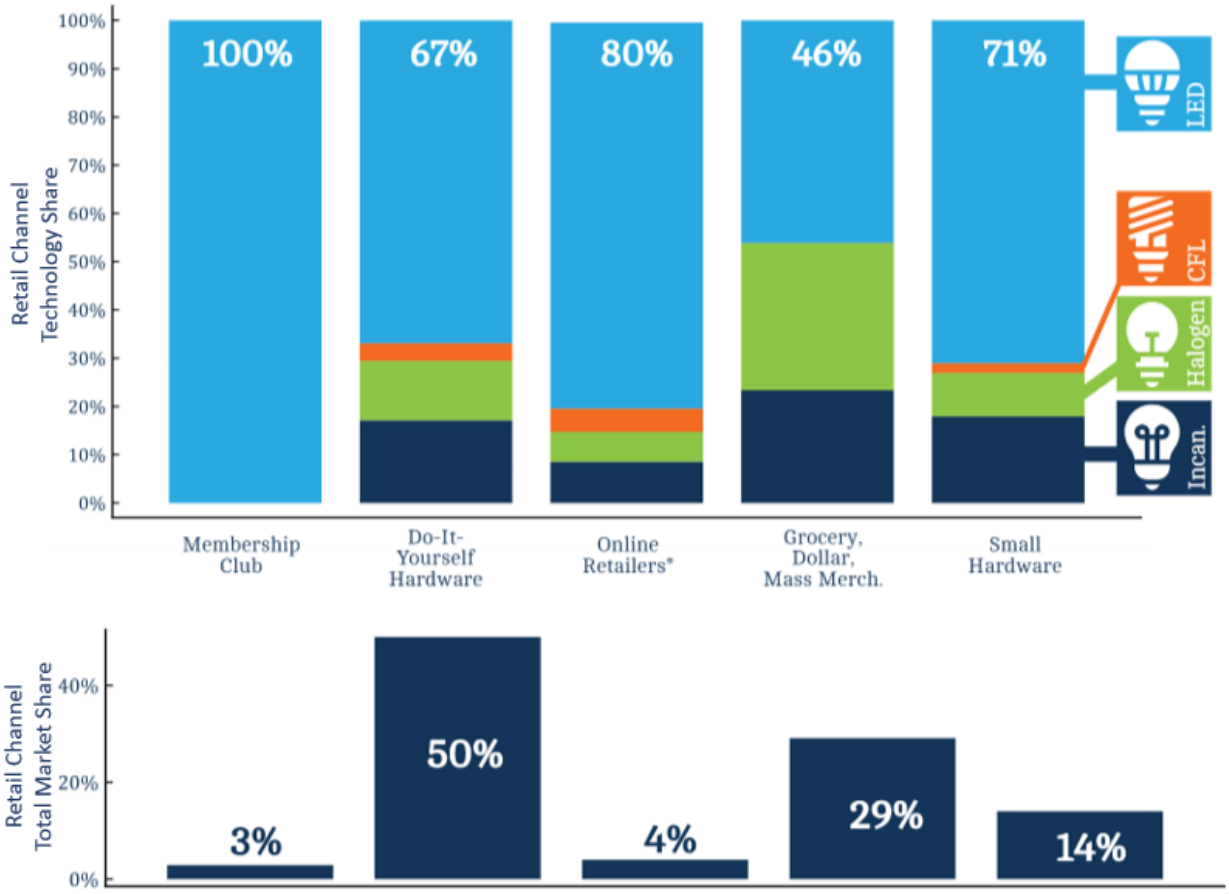
The research team assessed the shares of technologies within various channels (Figure 8). The greatest opportunity to further increase LED technology share continues to be the combined grocery, dollar, and mass merchandise channel. In this channel, the LED technology share was 46% in 2019 and the channel comprises 29% of total sales.[10] LED technology share was 67% in the DIY channel, and the channel comprises 50% of total sales. LED technology share in the small hardware channel was 71%[11] and 80% for online retailers. Finally, although the membership club stores surveyed[12] sold exclusively LEDs as a corporate policy, this channel makes up a relatively small part of the market.

[10] These estimates are based on a presentation by a major retailer at the 2014 ENERGY STAR Products Partner Meeting.

[11] These estimates apply a correction to the sales-to-stocking ratio for small hardware stores, as described in Appendix C: Chain Logic Model Methodology.

[12] For the other membership club store in the Northwest, POS data were available.

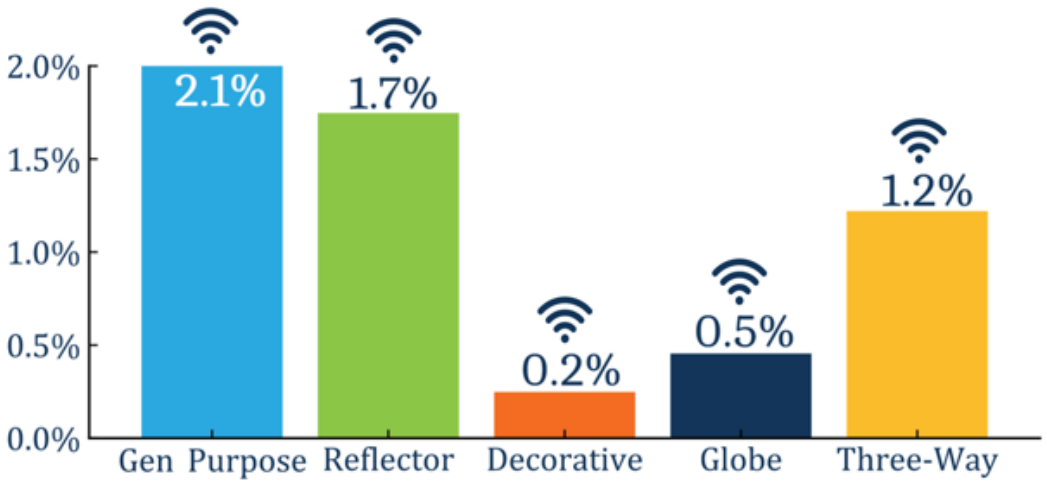
Figure 8. Retail Channel LED Technology Share and Total Market Share, 2019



** Estimated proportionally to DIY store sales, as detailed in Appendix C: Chain Logic Model Methodology*
Data source: Weighted combination of sales data and NEEA shelf data

The research team analyzed both POS and shelf-stocking data on "smartlamps." All smart bulbs encountered over the 2019-2020 analysis period were LEDs. Smartlamps, or Smart LEDs, are LED light bulbs that can be communicated with and controlled wirelessly. Smart LEDs accounted for 1% of all LED sales in 2019 (Figure 9), with the greatest share among general purpose lamps and minimal or no share among decoratives. Given the large price differential between smart LEDs and other LEDs, (discussed in the next section) as well as the additional features smart LEDs offer, both the 2019 and 2018 analyses broke out smart from non-smart LEDs.

Figure 9. Smart LED Share of LED Sales, by Application, 2019



Data source: Weighted combination of sales data and NEEA shelf data

This year, the research team also analyzed POS and shelf-stocking data on ENERGY STAR-certified lamps. ENERGY STAR-certified lamps accounted for 59% of all LED sales in 2019 (Figure 10), with the greatest shares among globes (63%) and three-way lamps (67%). The research team also confirmed that the specific ENERGY STAR-certified LED lamps analyzed through POS and shelf-stocking have considerably longer lifetimes than non-certified LEDs (Figure 11). LED lamps certified by ENERGY STAR were found to have, on average, 35% longer lifetimes than non-certified LED lamps, with the largest differences between reflectors (48%) and general purpose lamps (45%).

Figure 10. ENERGY STAR Certified Bulb Share of LED Sales, by Application, 2019

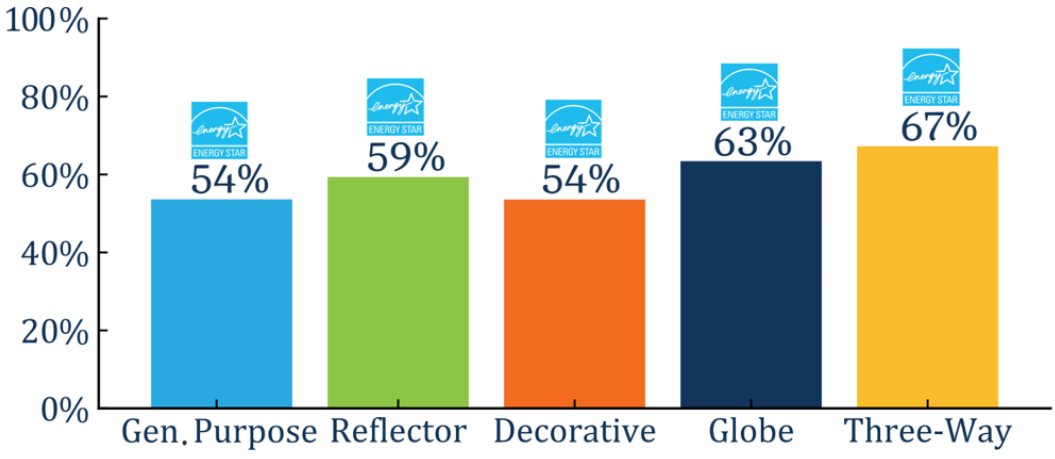
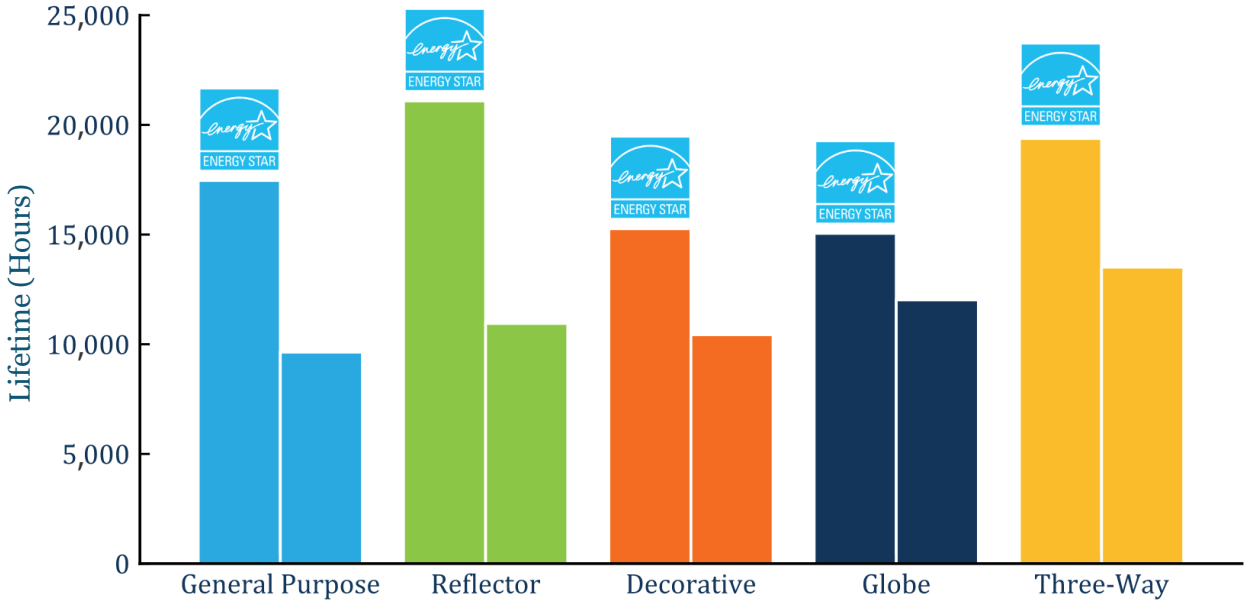


Figure 11. Lifetime Hours for ENERGY STAR LED Lamps and non-certified LED Lamps, by Application, 2019



ENERGY-STAR certified LED bulb shares are the highest at membership clubs, where 100% of bulbs surveyed were certified by ENERGY STAR (Figure 12). The lowest shares of ENERGY STAR-certified bulbs can be found in DIY stores and online, where only 52% of bulbs were certified by ENERGY STAR.

Figure 12. ENERGY STAR Certified Bulb Share of LED Sales, by Channel, 2019

Lamp Price Trends

In addition to assessing technology shares, the research team analyzed prices of LEDs relative to other lighting technologies and tracked changes over time. Figure 13 shows average price per lamp by application and technology for 2019 after any efficiency program incentives, and manufacturer or

retailer discounts. Figure 14 shows price declines since 2012. The decline in prices was slower from 2018 to 2019, compared to the rapid decrease in prices found between 2017 and 2018 . General purpose LED lamps cost $3.10 on average in 2019, a decline of 0.9% from 2018. Prices for general purpose CFL and halogen lamps (which do not typically receive incentives or discounts), also declined from 2018 to 2019, after remaining flat or increasing slightly in previous years.[13]

Figure 13. Average Price per Lamp, by Application and Technology, 2019

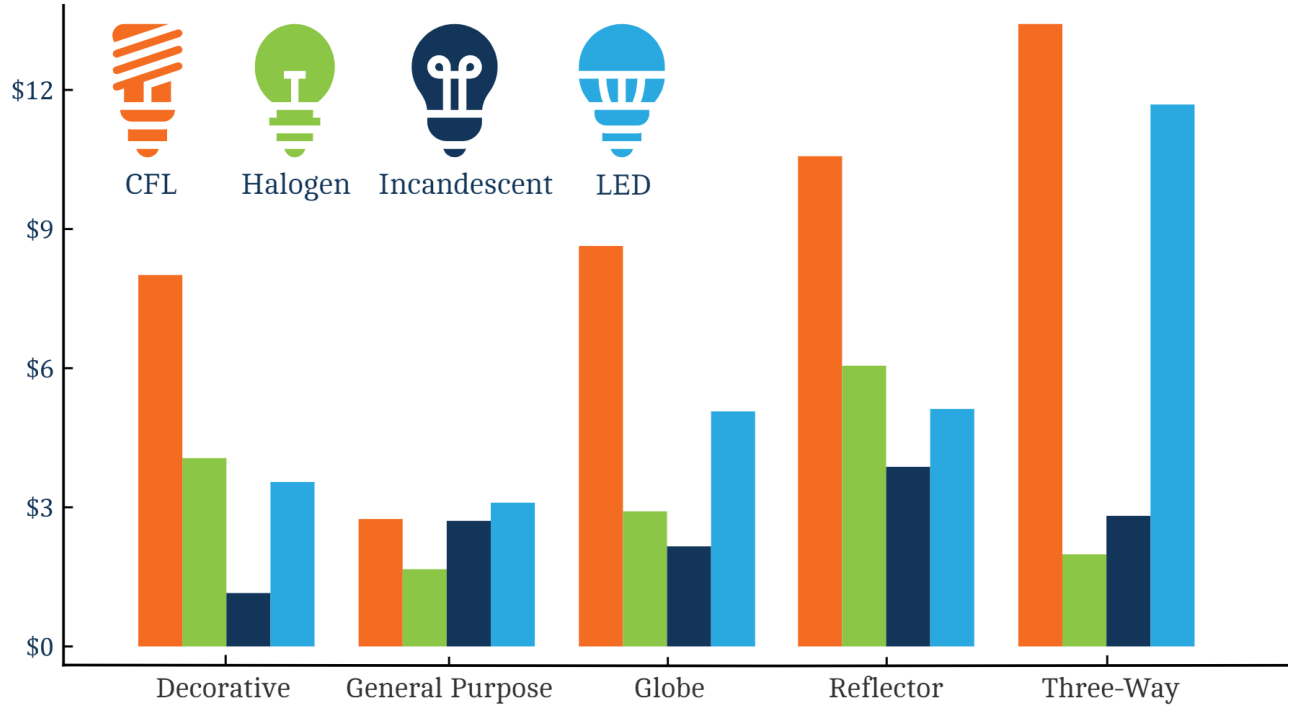


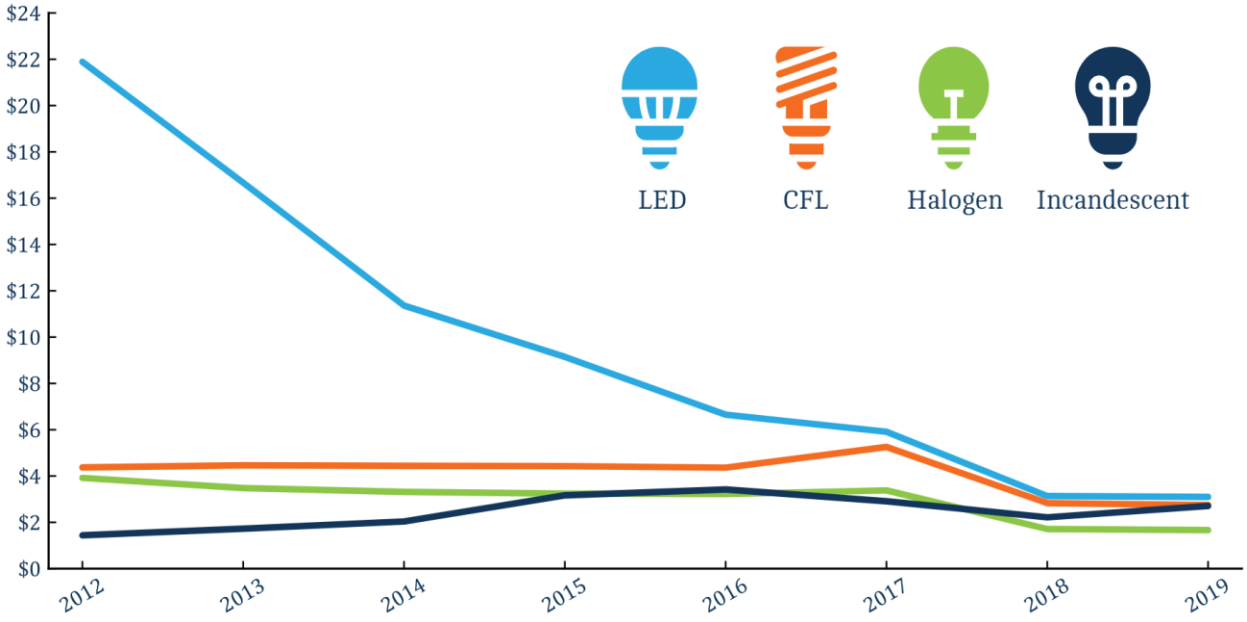
Table 2. Average Price per Lamp, by Application and Technology, 2019

	Decorative	General Purpose	Globe	Reflector	Three-Way
CFL	$8.01	$2.75	$8.64	$10.57	$13.42
Halogen	$4.06	$1.67	$2.91	$6.05	$1.99
Incandescent	$1.15	$2.71	$2.16	$3.87	$2.82
LED	$3.55	$3.10	$5.07	$5.12	$11.69

Data source: Weighted combination of sales data and NEEA shelf data. Note: LED costs include program incentives and retailer or manufacturer discounts which are not typically available for non-LEDs.

[13] NEEA's year-over-year analysis does not normalize for inflation.

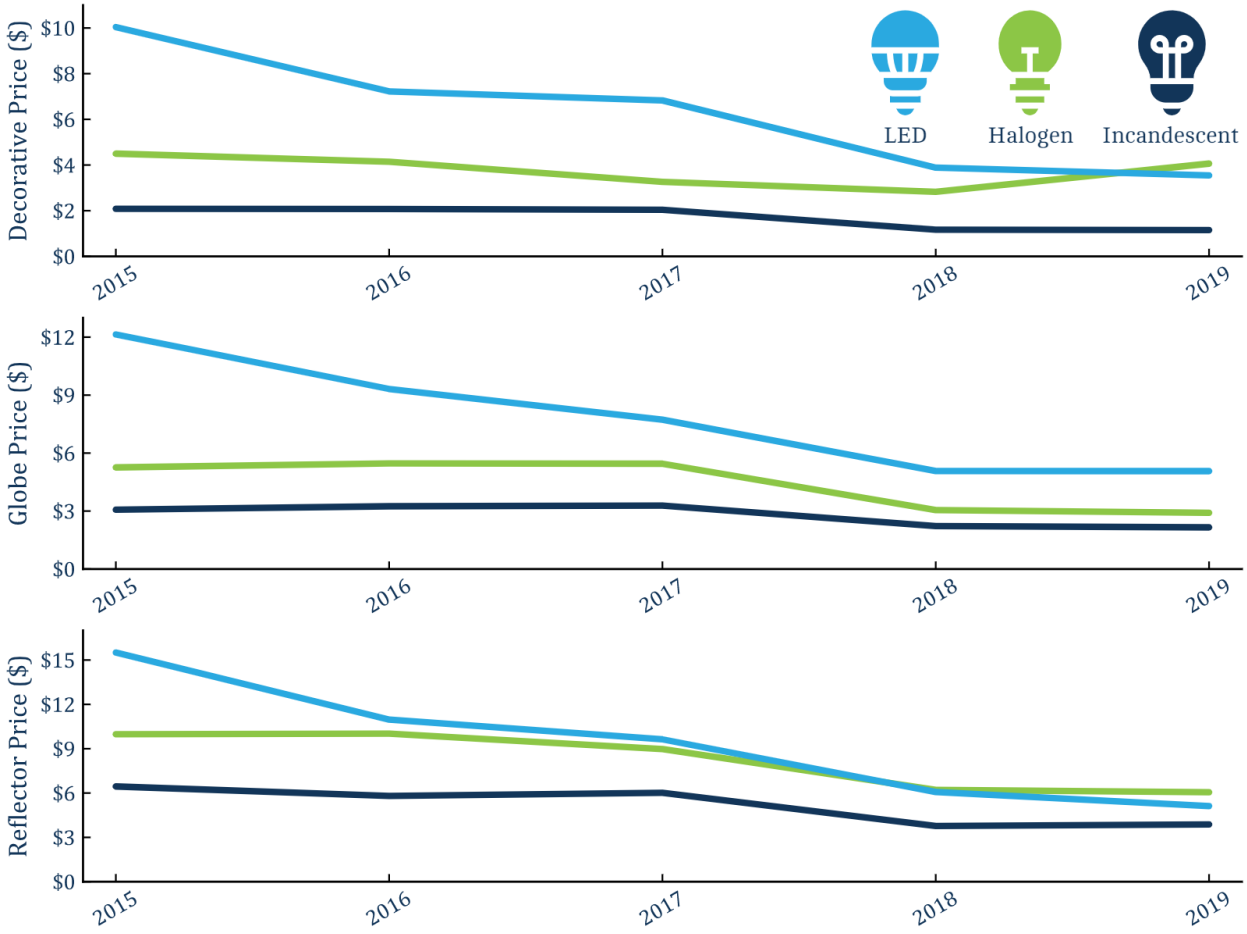
Figure 14. General Purpose Lamps – Average Price ($/lamp) by Technology, 2012-2019



Data source: Weighted combination of sales data and NEEA shelf data

As shown in Figure 15 below, for each application, falling prices for LEDs have narrowed the price difference between LEDs and other lamp technologies. The price difference has narrowed the most for reflector lamps, with average LED reflector prices in 2019 slightly lower than average prices for halogen reflectors and decoratives. The close and slightly lower LED prices are likely a result of program incentives and/or retailer or manufacturer discounts. A price difference still exists for globe lamps. The low incremental cost of LED reflectors likely contributes to their high and rising technology share. In addition, LED technology is a good fit for reflector lamps which provide directional light.

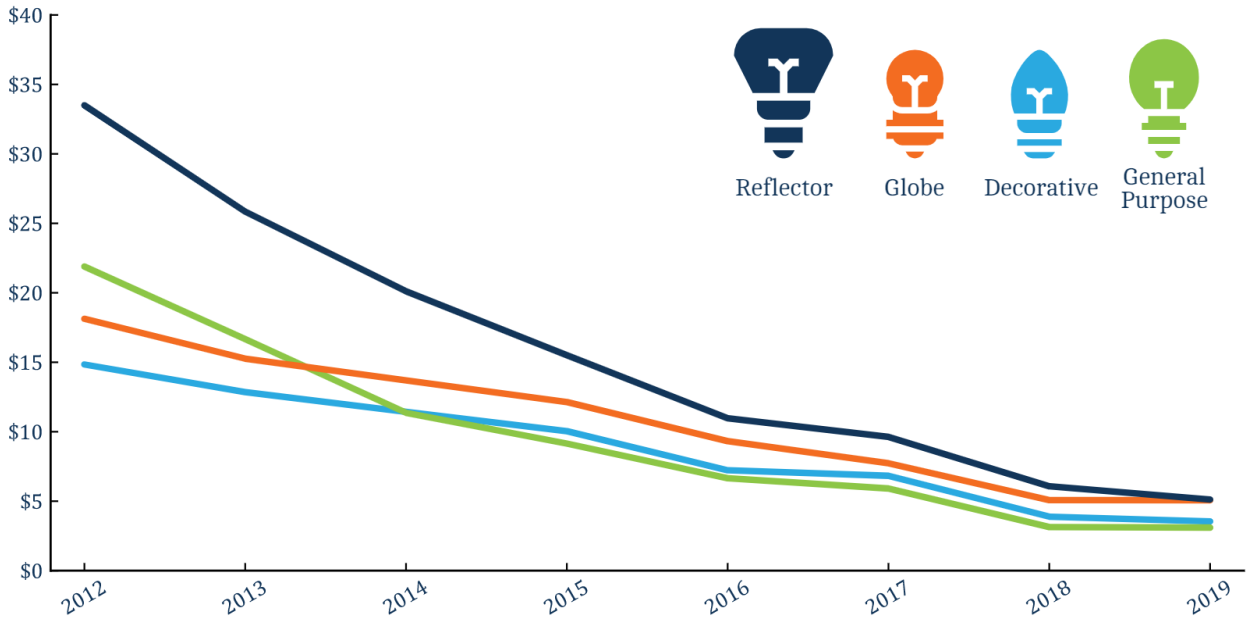
Figure 15. Average Price ($/lamp) by Technology for Decoratives, Globes, and Reflectors, 2015 - 2019



Data source: Weighted combination of sales data and NEEA shelf data

As shown in Figure 16, the differences in LED prices among different applications have narrowed dramatically since 2012, with the largest declines in the average price of reflector lamps (Figure 16).

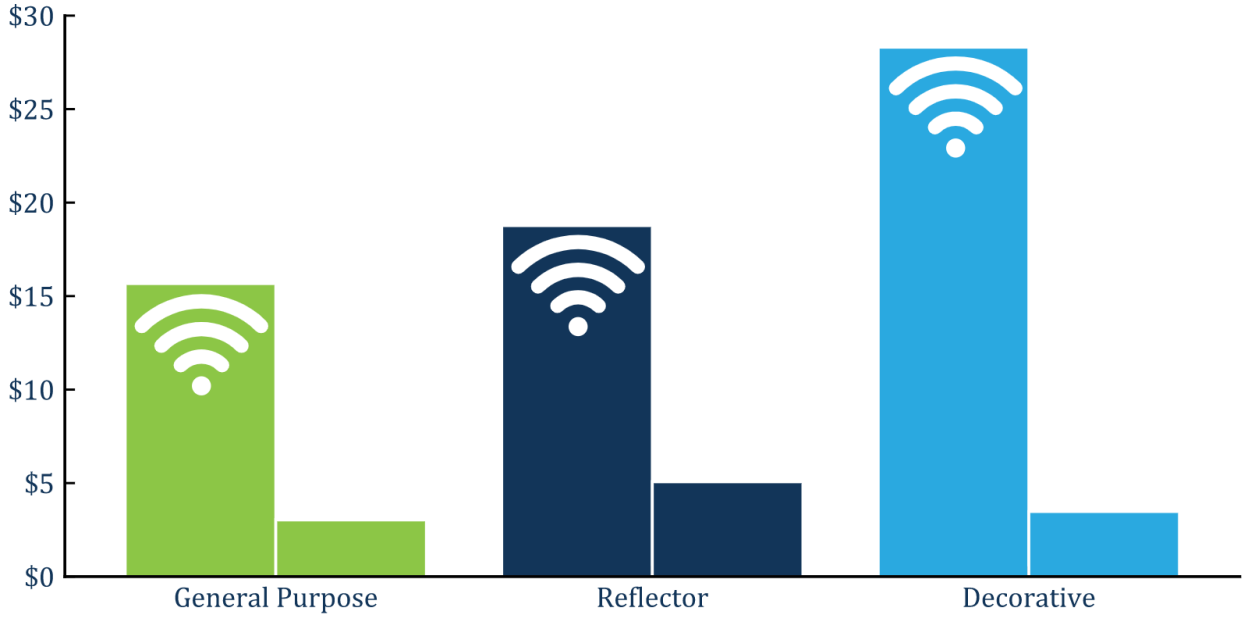
Figure 16. LED Average Price ($/lamp) by Application, 2012-2019



Data source: Weighted combination of sales data and NEEA shelf data. Note: LED costs include program incentives and retailer or manufacturer discounts which are not typically available for non-LEDs.

Smart LED bulbs cost substantially more than LEDs without smart features. The average cost of a smart LED bulb in 2018 was $17.29, roughly four times the average price of other LEDs. Figure 17 shows the average prices for smart and standard LEDs in 2019, by application. The average price of smart LED general purpose and smart LED reflector lamps decreased from 2018-2019, from $17.89 and $28.80 to $15.67 and $18.77, respectively, while the price of smart decorative lamps remained roughly the same over the 2018-2019 period.

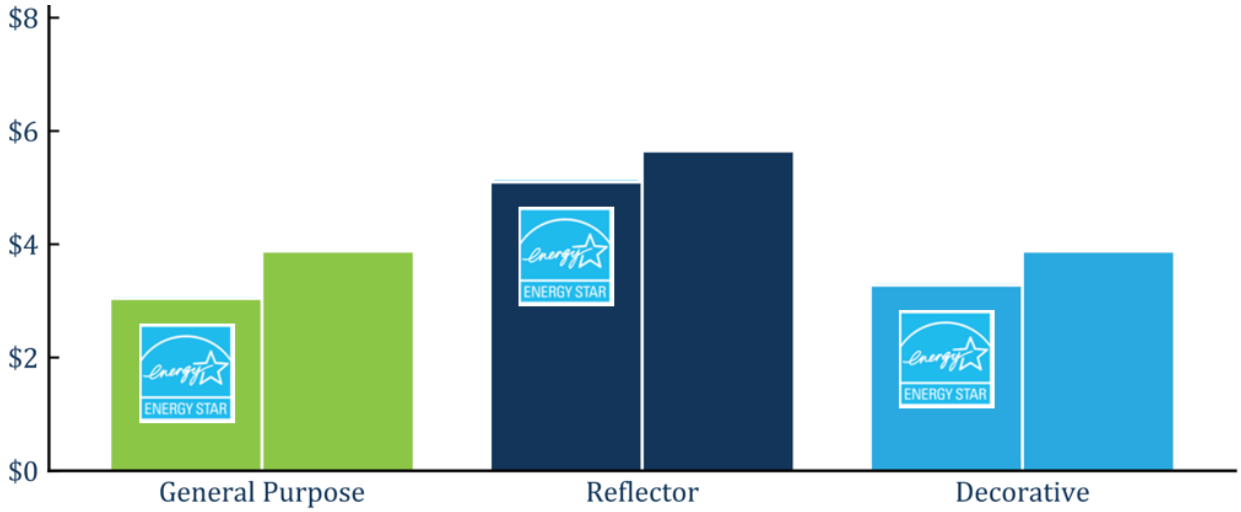
Figure 17. Average Prices for Standard and Smart LEDs, by Application, 2019



Data source: Weighted combination of sales data and NEEA shelf data

The research team found that ENERGY STAR-certified lamps cost less, on average, than lamps that are not certified by ENERGY STAR. Figure 18 shows the average prices for ENERGY STAR-certified and non-certified LED bulbs in 2019, by application. The average cost of an ENERGY STAR-certified general purpose LED (accounting for program incentives or other discounts) was $3.09, which is 14% less than the average cost of a non-certified general purpose LED ($3.58). While ENERGY STAR-certified LED lamps meet strict energy efficiency standards and are the most efficient lamps on the market, leading them to also be some of the most expensive lamps on the market, their prices are often competitive due to efficiency program, manufacturer, and retailer discounts.

Figure 18. Average Prices for ENERGY STAR-Certified and Non-Certified LEDs, by Application, 2019



Note: Most utility programs only offer incentives for ENERGY STAR LEDs, bringing the average price below the average non-ENERGY STAR prices.

Recap of Key Findings

- **The lighting market continued its shift toward LEDs across all applications in 2019.** Overall, LEDs accounted for 63% of all lamp sales in 2019. LEDs made up a larger proportion of general purpose lamp sales (67%) and reflector lamp sales (70%) than specialty (58%).

- **As in 2018, continued gains in LED share in 2019 came at the expense of incandescent and halogen lamps.** By contrast, in 2017, the market share of incandescents and halogens largely remained flat while the share of CFLs declined substantially to a very low percentage.

- **Grocery, dollar, and mass merchandise retailers may present the greatest opportunity to further increase LED market share.** In 2019, LEDs grew to 46% of lamp sales on average across the combined grocery, dollar, and mass merchandise channel ("MM"), but the MM LED market share was still lower than other channels. The MM channel represents the second-largest volume of lamp sales. Do-It-Yourself (DIY) has the largest volume of lamp sales, and 67% of their sales are LEDs. In the club, online, and small hardware channels, LEDs make up between 71% and 100% of sales.

- **Prices for LEDs across all applications (after any efficiency program, manufacturer, or retailer discounts[14]) began to flatline in 2019, decreasing very little from 2018 prices.** General purpose

[14] As part of the 2017-2018 LTMT study's analysis for the 2017 calendar year, NEEA conducted an analysis of pre-incentive lamp prices. The resulting memorandum was not formally published, but is available on request.

LED lamps cost an average of $3.10 in 2019, a decline of only 0.9% from 2018. On average across all applications, the price of general purpose LED lamps was 1.8 times that of halogen lamps in 2019, down from 5.6 times the price of halogen lamps in 2012.

- **The sales share for general purpose lamps fell from 64% in 2012 to 52% in 2019.** The growing market share of LEDs may be a contributor to this decline, as LED lamps' longer lives result in less need for replacement than the incandescent or halogen lamps they may have replaced.

- **Smart LEDs differ substantially from standard LEDs in price and functionality.** The market share of smart LEDs remained small in 2019, at approximately 1% of all LED sales. Smart LED prices were approximately four times higher than standard LED prices. Smart LEDs also showed different patterns in price difference between lamp applications. For example, smart LED globe lamps are 68% more expensive than standard LED globes, while smart LED decorative lamps are 88% more expensive than standard LED decorative lamps.

- **Shares of ENERGY STAR-certified LEDs have declined and are the lowest for general purpose and decorative bulbs (54%).** ENERGY STAR-certified bulbs have a 35% longer lifetime than non-ENERGY STAR bulbs.

Appendix A: Shelf Survey Sample Design

Purpose and Overview

The purpose of this appendix is to describe DNV GL's sampling approach for the January-February 2020 shelf surveys conducted to gather data for the 2019 market analysis (the "2019-20 Shelf Survey"). Section 2 provides background on the 2019-20 Shelf Survey and Section 3 provides details of the sample design.

Background

Shelf surveys involve field researcher visits to retail stores to collect information about the lamps stocked in those stores. Researchers gather detailed information regarding each lamp model including lamp style, manufacturer, wattage, number of lamps per package, package price, and other detailed characteristics.

The evaluation team used the same sampling approach for the 2019-20 Shelf Survey that was used for the 2018-19 Shelf Survey. Since each year we have high quality point-of-sales data for drug, grocery, and mass merchandise stores, we conducted shelf surveys just in a sample of 34 small hardware, membership club, and do-it-yourself (DIY) stores in NEEA's utility partners' territories within Washington, Oregon, Idaho, and Montana. The sampling approach allowed us to collect critical stocking data in stores where detailed point-of-sales data were not available using the most efficient sample possible. (For the 2017-18 Shelf Survey and study years prior, the evaluation team sampled stores from all six store types, sampling 68 to 76 stores.)

Sample Design

The evaluation team used the same sampling frame that was used in previous years, which is a list of retail stores in the Northwest compiled for NEEA by PECI, Inc. in the mid-2000s. We stratified the 2019-20 Shelf Survey sample by store type, but only visited those store types for which we did not have detailed point-of-sales data. Table 3 shows the population and targeted sample of stores by store type for the 2019-20 Shelf Survey, and Table 4 shows the population and completed sample of stores by all six store types for the 2017-18 Shelf Survey for comparison purposes. As mentioned above, the 2019-20 Shelf Survey population and targeted sample of stores is identical to the 2018-19 Shelf Survey. Cells marked in bold in Table 3 represent a change in the number or percentage of stores in the population or sample of stores for a given store type from the 2017-18 Shelf Survey study. As shown in Table 3, for the 2019-20 Shelf Survey we removed all sample points from drug and grocery and mass merchandise store types. For DIY, we added two additional sample points compared to the 2017-18 Shelf Survey, because

this store type has the largest share of lamp sales in the Northwest.[15] Because membership club stores have minimal variation among stores, we kept the number of sample points at three stores, which is the same number of sample points as in the 2017-18 Shelf Survey. Prior to conducting the 2018-19 Shelf Survey, NEEA had asked the evaluation team to update the store sampling frame so that it reflected the number of Home Depot, Lowe's, Costco, Sam's Club, and Wal-Mart stores in Idaho, Montana, Oregon, and Washington as of December 2018. The updated sampling frame showed an increase in DIY stores to 187, an increase in mass merchandise stores to 512, and an increase in membership club stores to 56. Overall, the number of stores in the sample frame increased from 2,538 in December 2017 to 2,611 in December 2018. We used the same sample frame of 2,611 stores for the 2019-20 Shelf Survey.

[15] This sampling approach is identical to the approach used for the 2018-19 Shelf Survey.

Table 3: Northwest Lighting Retail Store Population and Sample Points by Store Type, 2019-2020

Store Type	Store Population		2019-2020 Sample	
	Number of Stores	Percent of Stores	Number of Stores	Percent of Stores
Do-It-Yourself	187	7%	11	32%
Drug and Grocery	994	38%	0	0%
Mass Merchandise	512	20%	0	0%
Membership Club	56	2%	3	9%
Small Hardware	862	33%	20	59%
Overall	2,611	100%	34	100%

Table 4: Northwest Lighting Retail Store Population and Sample Points by Store Type, 2017-2018

Store Type	Store Population		2017-2018 Sample	
	Number of Stores	Percent of Stores	Number of Stores	Percent of Stores
Do-It-Yourself	159	6%	9	13%
Drug and Grocery	994	3%	20	29%
Mass Merchandise	490	19%	16	24%
Membership Club	33	1%	3	4%
Small Hardware	862	34%	20	29%
Overall	2,538	100%	68	100%

Table 5 shows the distribution of sample points by store type and state for the 2019-20 Shelf Survey. The evaluation team completed all 34 shelf surveys on January 31, 2020.

Table 5: Northwest Lighting Retail Store Sample by Store Type and State, 2019-2020 Shelf Survey

Store Type	State				
	ID	MT	OR	WA	Overall
Do-It-Yourself	3	1	3	4	11
Membership Club	1	1	1	0	3
Small Hardware	6	4	5	5	20
Overall	10	6	9	9	34

Appendix B: Montana POS Data Estimation Method

Prior to 2018, Nielsen had provided Montana data in the form of a "custom report" rather than as part of their standard data extract. However, in 2018, Nielsen dismantled their custom report group, and that year NEEA was only able to obtain the Montana report after considerable delay. Further, the data lacked fields for pricing, wattage, and lumens with no information for a portion of private label bulbs. To compensate, the research team found the state most similar in the ratios of bulb technologies and applications to Montana (Washington) based on available 2018 custom report data. Then, we estimated Montana bulb type and application shares for 2018 by imputing Washington results.

For 2019, since a custom report was not available from Nielsen, we assumed any changes in Montana data would correlate with changes in Wyoming (since Wyoming was more similar demographically than Washington). The research team adjusted last year's estimated Montana POS data (by bulb technology and application) based on changes in Wyoming market shares that occurred from 2018 to 2019. We did not calculate new pricing or wattage data for Montana, and therefore it is excluded from pricing and wattage information across the region.

Table 6 below summarizes the market share adjustments that were made to Montana's 2018 POS data based on the market share changes that occurred in Wyoming from 2018 to 2019. General purpose LEDs experienced the largest change in market share from 2018 to 2019, increasing from 37% to 43%, while many bulb technologies changed minimally over this time period.

Table 6. Summary of Montana Market Share Adjustments

Application	Technology	2018 Market Share	WY Market Share % Change	2019 Market Share
General Purpose	CFL	0%	0.04%	0%
General Purpose	Halogen	32%	-0.11%	32%
General Purpose	Incandescent	5%	-1.99%	3%
General Purpose	LED	37%	5.91%	43%
Reflector	CFL	0%	0.00%	0%
Reflector	Halogen	1%	0.11%	1%

Application	Technology	2018 Market Share	WY Market Share % Change	2019 Market Share
Reflector	Incandescent	1%	-0.28%	1%
Reflector	LED	4%	0.19%	4%
Decorative	CFL	0%	0.00%	0%
Decorative	Halogen	0%	0.00%	0%
Decorative	Incandescent	9%	-3.30%	6%
Decorative	LED	1%	0.83%	2%
Globe	CFL	0%	0.00%	0%
Globe	Halogen	0%	0.01%	0%
Globe	Incandescent	5%	-0.44%	5%
Globe	LED	1%	0.00%	1%
Three-Way	CFL	0%	0.00%	0%
Three-Way	Halogen	0%	0.00%	0%
Three-Way	Incandescent	3%	-0.95%	2%
Three-Way	LED	0%	0.28%	0%

Appendix C: Chain Logic Model Methodology

Apex Analytics and DNV GL (the Study team), on behalf of NEEA, conducted the 2019 Residential Lighting Study to assess year-over-year changes in the Northwest lighting market. The Study team updated market shares and average bulb metrics (e.g. price, wattage) with 2019 data. To do this, we followed the "Chain Logic Model"[16] with some modifications to more completely leverage the available data for calculating bulb metrics. While the Chain Logic Model method is documented in the reports from prior study years, this memo describes the modified method designed by the Study team for the 2018-19 study, and used again for the 2019-20study. Each of the steps is detailed below.

Chain Logic Model

Data

As in prior years, the Study team used the following datasets to estimate market shares:

1. **NEEA shelf survey data:** DNV GL conducted the shelf survey in January and February of 2020, building on a historical data set going back to 2012. In a shelf-stocking survey, researchers visit a sample of sites in the territory and gather data on all the relevant products on the shelves, generating a snapshot of the number of shelf lamps stocked for each technology type.[17] The core assumption of this survey is that the number of lamps stocked for a given lighting technology is proportional to the number of that technology's lamps sold. In line with recommendations from last year's store manager interviews, the Study team averaged the 2018-2019 winter shelf stocking data with the 2019-2020 data and adjusted sales to stocking ratios (see below for more detail).

2. **CREED LightTracker[18] point-of-sale (POS) data:** Apex purchased POS lighting sales data from Nielsen, and the Consortium for Retail Energy Efficiency Data (CREED) team cleaned and corrected it. The cleaning involved web scraping, automated online product lookups, and integration with the product database maintained by the CREED team, all with the ultimate goal of filling gaps in the bulb description data (e.g. wattage, lumens) provided.

[16] The Chain Logic Model was originally developed by Bonneville Power Administration and their contractors Navigant and Cadeo Group.

[17] During shelf stocking surveys, field staff collect detailed information (e.g., technology, shape, base type, wattage, price, etc.) for each unique lamp model surveyed in stores. Field staff record the number of lamps in a package and the total number of packages observed for each unique lamp model found on the shelves of a given store. A unique lamp package can represent anywhere from one to thousands of lamps in a given store.

[18] CREED is a consortium of program administrators, retailers, and manufacturers working together to collect the necessary data to better plan and evaluate energy efficiency programs. LightTracker is CREED's first initiative, focused on acquiring full-category lighting data, including incandescent, halogen, CFL, and LED bulb types, for all distribution channels in the United States.

Prior to the 2018-2019 residential lighting LTMT study, the sample of stores for shelf surveys included grocery, drug, and mass merchandise (for simplicity, referred to from here on as Mass Merchandise) stores, but contractors did not use the shelf survey data for this channel in the Chain Logic analysis; they only used the POS data. Because the shelf survey data for this channel had been superfluous to the analysis in prior years, the Team did not conduct shelf surveys in this channel in the 2018-2019 and 2019-2020 studies, decreasing the overall number of stores surveyed from 68 to 34 (the 34 stores included two more stores for the Do-It-Yourself (DIY), Small Hardware, and Membership Club channels than had been included in prior years).

Segment the Market into Channels

Consistent with contractors in prior years, Apex segmented the market into channels with assigned market shares according to a presentation by a major retailer at the 2014 ENERGY STAR Partners Meeting. The assigned market shares roughly aligned with the Study Team's understanding from other market research endeavors in Illinois and Massachusetts, but a direct quantification of channel market share was difficult because retailers do not share sales data. The represented channels in prior years have been:

1. Do-It-Yourself (DIY) Stores
2. Mass Merchandise, Drug, Grocery, and Membership Club Stores
3. Small Hardware Stores
4. Online Sales

Sales to stocking ratio: The default assumption in the years prior to 2018-19 had been that the number of lamps stocked of lighting products of a particular technology type directly correlated with sales of that technology type. However, evidence from store manager interviews conducted as part of the 2018-2019 shelf survey indicated that this ratio was not applicable for small hardware stores. Store managers reported higher sales of LEDs than stocking suggested, and lower sales of incandescents and halogens. For that reason, the Study team prepared two data sets: one with the prior assumption of a 1:1 lamp sales to stocking ratio, and a second data set with a new assumption for small hardware stores of 2:1 sales to stocking ratio for LEDs, and 1:2 for incandescents and halogens.

The 2019-2020 Study team continued to rely on the prior channel types, with two modifications. First, the POS data covers mass merchandise and a membership club retailer with relatively few outlets in the Northwest, but not the largest membership club retailer in terms of outlets. Therefore, Apex broke the "Mass Merchandise and Membership Club" channel into distinct channels for mass merchandise stores and membership club stores. CREED constructs state level sales totals for all states using point-of-sale data and CREED-generated estimates of total bulb sales by state. The Study team estimated the market

share of the Mass Merchandise channel at 29.1% and allocated the remaining share of the prior years' 32.0% market share estimate for the channel (2.9%) to membership club stores. Table 7 provides the resulting market share distributions utilized by the Study team for this effort.

Table 7. 2019-2020 Market Share by Retailer Channel, Including Online

Retailer Channel	Market Share
DIY	50.0%
Mass Merchandise	29.1%
Membership Club Stores	2.9%*
Small Hardware	14.0%
Online	4.0%

**The Study team recognizes that combining old and new calculations has resulted in a smaller channel share for Membership Club stores than in prior years and recommends additional investigation to refresh all shares in the next cycle.*

Assign Site Weights by Region

To extrapolate the sample of stores visited during shelf stocking to the NEEA territory, the Study team calculated weighting values for each channel and region. Oregon represented one region while the other three states were combined into a second region to obtain a statistically valid sample. The regions were:

1. The state of Oregon
2. The three-state region of Washington, Idaho, and Montana

The Study team determined the weights by the ratio of total stores to sampled stores within a channel and region. Multiplying the weights by the bulb counts at the itemized level (product code and store) in the shelf stocking data resulted in an estimate for the total number of bulbs on shelves in the NEEA territory, within the sampled channels. In the 2016-2017 and 2017-2018 studies, contractors calculated store-level averages for bulb metrics, which they later weighted by a factor calculated for each retailer based on total bulbs stocked to calculate weighted averages for prices and wattages at the retail

channel and market level.[19] This approach runs the risk, however, of providing skewed results if a retailer carries a disproportionate number of bulbs with a particular characteristic.

To address this risk, the Study team calculated weighted averages using the weighted bulb counts at the itemized product level, rather than weighting and averages at the store level. Because this calculation was performed at the itemized product level, the market shares, bulb totals, and bulb metrics calculated from of those weighted bulb counts were not skewed as in the aforementioned case.

Online Channel Efficiency Mix

Neither the shelf stocking survey nor the POS data addressed the channel market share or efficiency mix for online sales. The Apex team took the following actions in the 2018-2019 study to attempt to secure data directly from online retailers:

1. Reached out to representatives from bulbs.com, 1000bulbs.com, and amazon.com through at least two points of contact per website
2. Reached out to representatives at Philips, Feit, Osram Sylvania, and GE
3. Reviewed recent publicly-available studies
4. Convened an internal discussion on private studies (to which Apex has contributed) that addressed the question of online market share

The Team was unsuccessful in acquiring direct data for online sales from the market actors listed above. Ultimately, an estimate for the online efficiency mix was informed by two studies from Massachusetts:

1. "RLPNC 17-12 Lighting Decision Making," by NMR Group, finalized on March 2, 2018.[20] Page 16, Figure 13: LED and CFL Market Share by State and Channel.
2. "RLPNC Study 18-10 2018-19 Residential Lighting Market Assessment Study," by NMR Group, finalized on March 19, 2019.[21] Page 37, Table 8: LED Bulbs Obtained.

Starting from RLNPC 17-12, we took the following steps:

1. We calculated the LED and CFL Market Share average across Massachusetts and New York for two channels: DIY and Online. The DIY channel was the most similar to the Online channel in

[19] Prior to this, calculations were not done at the store level prior to adding weights.

[20] http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_1712_DecisionMaking_12Feb2018_Final-1.pdf

[21] http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_1810_LtgMarketAssessment_FINAL_2019.03.29.pdf

terms of efficient market share, and DIY stores have online marketplaces that likely compete on price and offerings with Online retailers.

2. We extracted the ratio of inefficient bulbs (Halogen and Incandescent) between Online and DIY channels from this study. In Massachusetts and New York, inefficient bulb share constituted about half as much share in the Online channel as the DIY channel.

3. We applied this value to the known DIY shares from NEEA shelf stocking surveys to estimate market share for inefficient bulbs in the Online channel, then scaled the efficient bulb shares to fill in the complete Online market channel.

This calculation resulted in estimates for market share by technology and lamp style, but did not provide information on pricing, wattage, or other bulb metrics. We assumed that those metrics were the same in the Online channel as in the DIY channel due to the similarity between the two channels.

Finally, we used the RLNPC 18-10 study to verify the prior Online channel share estimate. That study showed that 7% of LEDs in Massachusetts and New York were obtained online. From qualitative assessment within the study, it is likely that these states purchase online more than other areas. Using the within-channel calculations above and an assumption of 4% channel share, we estimated that 5.4% of LEDs in NEEA territory were purchased online. Given that 7% is most likely an upper bound, we determined the prior 4% online market share estimate to remain accurate for 2019.

Determine the Efficiency Mix within Channels

The Study team multiplied the count of lamps of each UPC at each store by its site weight to arrive at a "weighted bulb count." The UPCs were bucketed into one of six lumen bins according to their lumen output rating, three of which correspond to those reported in prior years. The UPC and store-level weighted bulb count within each channel were then used to calculate the following metrics by lamp style and technology:

1. **Market share:** The total weighted bulbs of a given technology within a lamp style are divided by the total bulbs of that lamp style. The result is market share by technology, within a given lamp style (e.g., percent of general purpose lamps that are LEDs or percent of globe lamps that are Halogens).

2. **Price:** For a given lamp style and technology, the weighted average price by weighted bulb count (e.g., the average price of an LED Reflector bulb).

3. **Wattage:** For a given lamp style and technology, the weighted average wattage by weighted bulb count (e.g., the average wattage of an LED Reflector bulb).

4. **Efficacy:** For a given lamp style and technology, the weighted average efficacy, in lumens/watt, by weighted bulb count (e.g., the average efficacy of an LED Reflector bulb).

5. **Lifetime:** For a given lamp style and technology, the weighted average lifetime, in hours, by weighted bulb count (e.g., the average lifetime of an LED Reflector bulb).

Diagrams of the methodology employed for this purpose prior to the 2018-2019 analysis (Figure 19) and the methodology used in the current year and 2018-2019 year (Figure 20), are shown below. Prior to the 2018-2019 analysis, the total bulb count for each site was used to weight the store-level average bulb metrics. That method had the potential to skew results for stores where the share of a given bulb application (e.g., technology, lamp style) was substantially different than others. For example, if one store sold only CFLs, its influence on average price would be calculated from its total bulb sales versus other stores in the prior method. In the updated method, it would be calculated directly from its CFL sales versus CFL sales at other stores. The differences are demonstrated in the two following figures.

Figure 19. Prior Method for Calculating Within-Channel Bulb Metrics

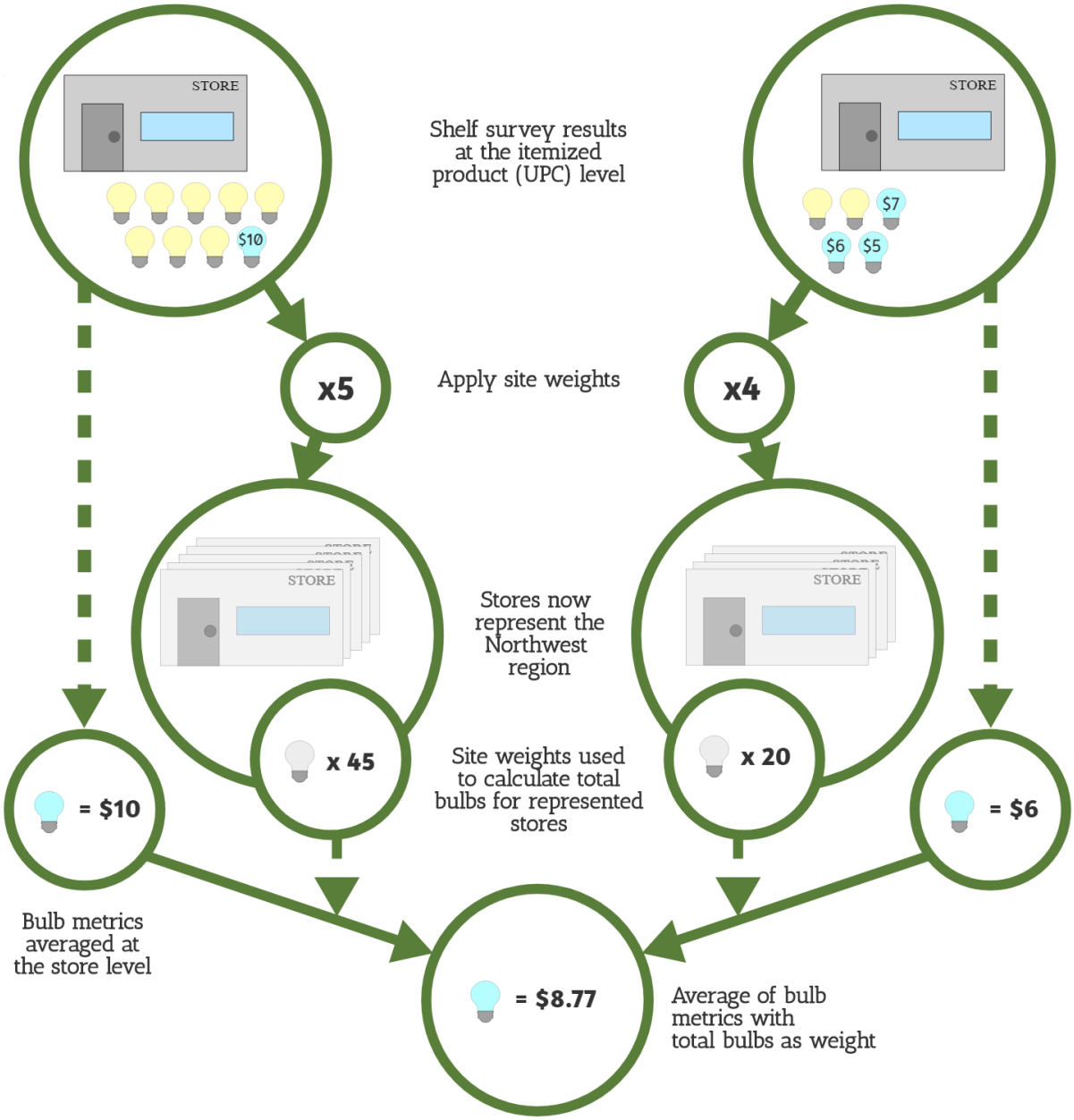
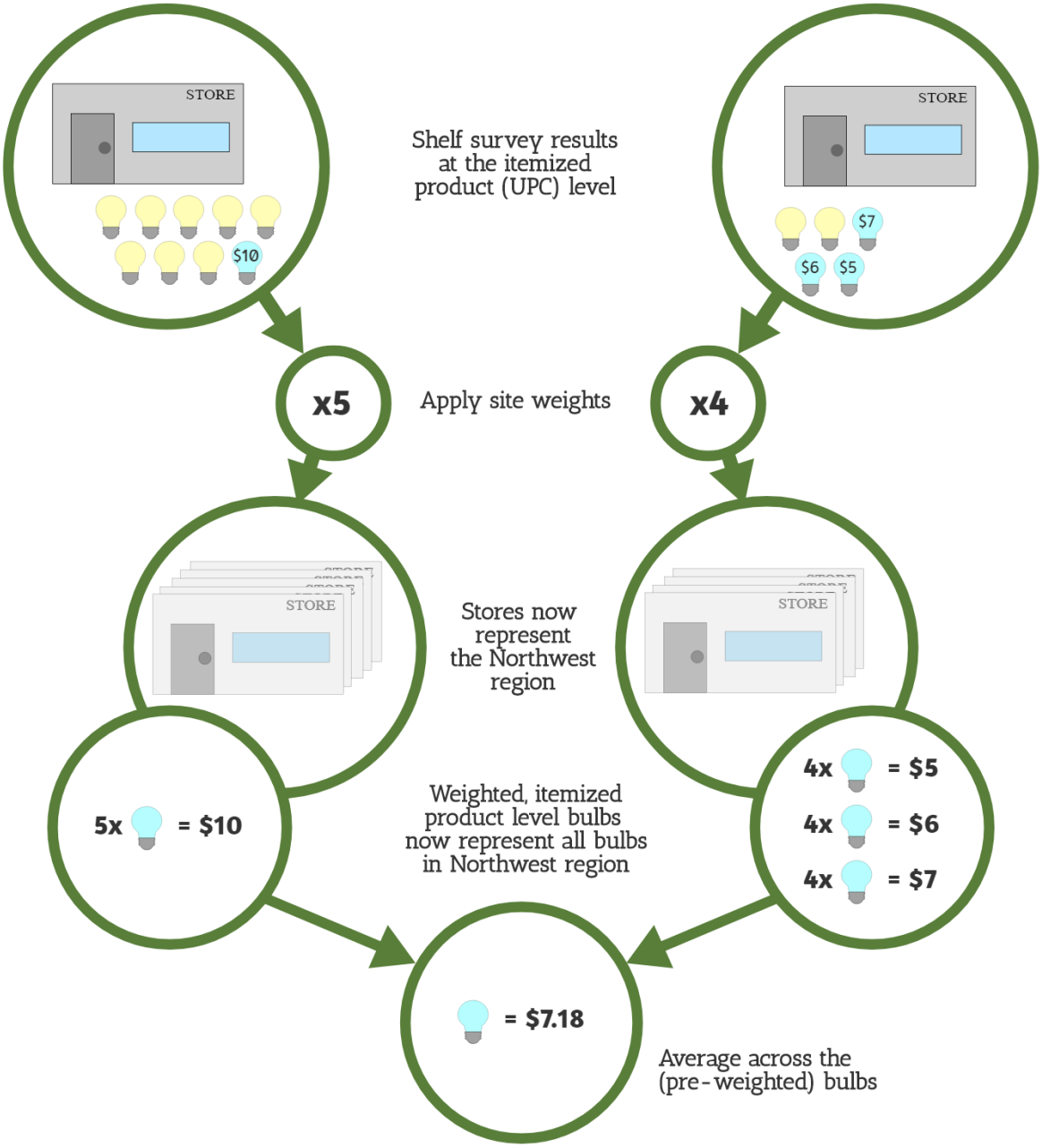


Figure 20. Current Method for Calculating Within-Channel Bulb Metrics



The result of this analysis is one table for each metric, for each channel. These tables are provided in the following form:

Table 8. Example Result Table

(Channel XX)	Lamp Style					
Bulb application	General Purpose	Reflector	Decorative	Globe	Three-Way	All Styles
CFL	$x.xx	$x.xx				
Halogen	$x.xx	…				
Incandescent			…			
LED						
Overall						

The study team performed this analysis within each of the lumen bins to capture these metrics at a further level of detail.

Compute Overall Efficiency Mix and Bulb Metrics

To calculate market shares within lamp style and lumen bins, we combined data from the prior section with the channel shares of total lamp sales. The method we employed for market shares was equivalent to the Chain Logic Model detailed in prior reports. We used the formula below;

Table 9 details the meaning of each variable.

$$\text{Share}_{\text{s,total}} = \frac{\sum_{\text{channels}}\left(\text{Share}_{\text{s,channel}} \times \text{Share}_{\text{channel,total}}\right)}{\sum_{\text{channels}}\left(\text{Share}_{\text{channel,total}}\right)}$$

Table 9. Market Share Calculation Inputs, with Example Data

		$Share_{channel,total}$	$Share_{s,channel}$	$Share_{s,total}$
Channel	Bulb Tech	Channel Share of Total Market	Bulb Tech Share of Lamp Style within Channel	Bulb Tech Share of Lamp Style (Overall)
Mass Merchandise		29.1%	45%	
DIY		50%	68%	
Membership Club	LED	2.9%	100%	58%
Sm. HW		14%	43%	
Online		4%	50%	

For bulb metrics such as price and wattage, the Study team's method differed from prior years. In prior years, the above calculation would be performed with the share within channel $Share_{s,channel}$ swapped for a bulb metric such as price. However, average bulb metrics are a different type of calculation. Whereas a market share calculation is technically a value for all bulbs within the channel (number of bulbs of a given kind divided by *all bulbs*), a bulb metric is only a calculation for bulbs of that kind.

Directly substituting values in the equation used to calculate channel share to calculate variables like average price and wattage ignores that channel share (Table 7) is a measurement of total lamps within a channel while the other metrics are limited to total lamps of a given technology. When channels have very different market shares by technology, the prior Chain Logic Method would apply too little weight to the channels with higher internal market share of that technology, and too much weight to the channels with lower internal market share of the technology. For example, Costco sells only LEDs, and accounts for roughly 3% market share for all bulbs. It follows that it must account for more than 3% of LEDs sold, because other stores do not sell only LEDs. However, its weight in a calculation of LED wattage would be 3% using the prior method.

We add an additional adjustment term to account for the disparate technology and lamp style market shares between channels. The additional weighting term, in the case of Costco, would increase the weighting of its bulb metrics to above 4% for LEDs, as expected. The formula for that calculation is below;

Table 10 details the meaning of each variable.

$$\text{Metric}_{s,t,total} = \frac{\sum_{channels}\left(\text{Metric}_{s,t,channel} \times \text{Share}_{s,channel} \times \text{Share}_{channel,total}\right)}{\sum_{channels}\left(\text{Share}_{s,channel} \times \text{Share}_{channel,total}\right)}$$

Table 10. Bulb Metric Calculation Inputs, by Channel, with Example Data

A	B	$Metric_{s,t,channel}$	$Share_{channel,total}$	$Share_{s,channel}$	$Metric_{s,t,total}$
Channel	Bulb Tech	Average Bulb Price (Within Channel)	Channel Share of Total Market	Bulb Tech Share of Lamp Style	Average Bulb Price (Overall)
POS		$2.72	29.1%	45%	
DIY		$3.13	50%	68%	
Membership Club	LED	$2.73	2.9%	100%	$3.15
Sm. HW		$4.36	14%	43%	
Online		$3.18	4%	50%	

These values are tabulated within lumen bins and across all lumen bins, for all metrics detailed above (price, wattage, efficacy, and lifetime).

In order to demonstrate how this methodology is different than the one used prior to the 2018-2019 analysis, we provide an example diagram of the calculations below. Figure 21 shows the prior calculation method, while Figure 22 shows the current calculation method. Similar to the issue with weighting by total lamps in calculating within-channel shares, weighting channels by only their total lamps skews results when the efficiency mix is different by channel. However, for this calculation we must employ a second weighting scheme instead of a more granular calculation as with within-channel bulb metrics, because of the unknown difference in sales to stocking ratio by channel. For example, we do not know whether a single lamp package turns over 100 times per year for DIY stores versus 15 times at Small Hardware stores. Therefore, we cannot guess the absolute sales numbers for either channel and must combine them with the market share percentages presented in Table 7. The adjustment factor is therefore also calculated using percentages instead of product-level weighting.

Figure 21. Method for Combining Bulb Metrics across Channels Prior to 2018

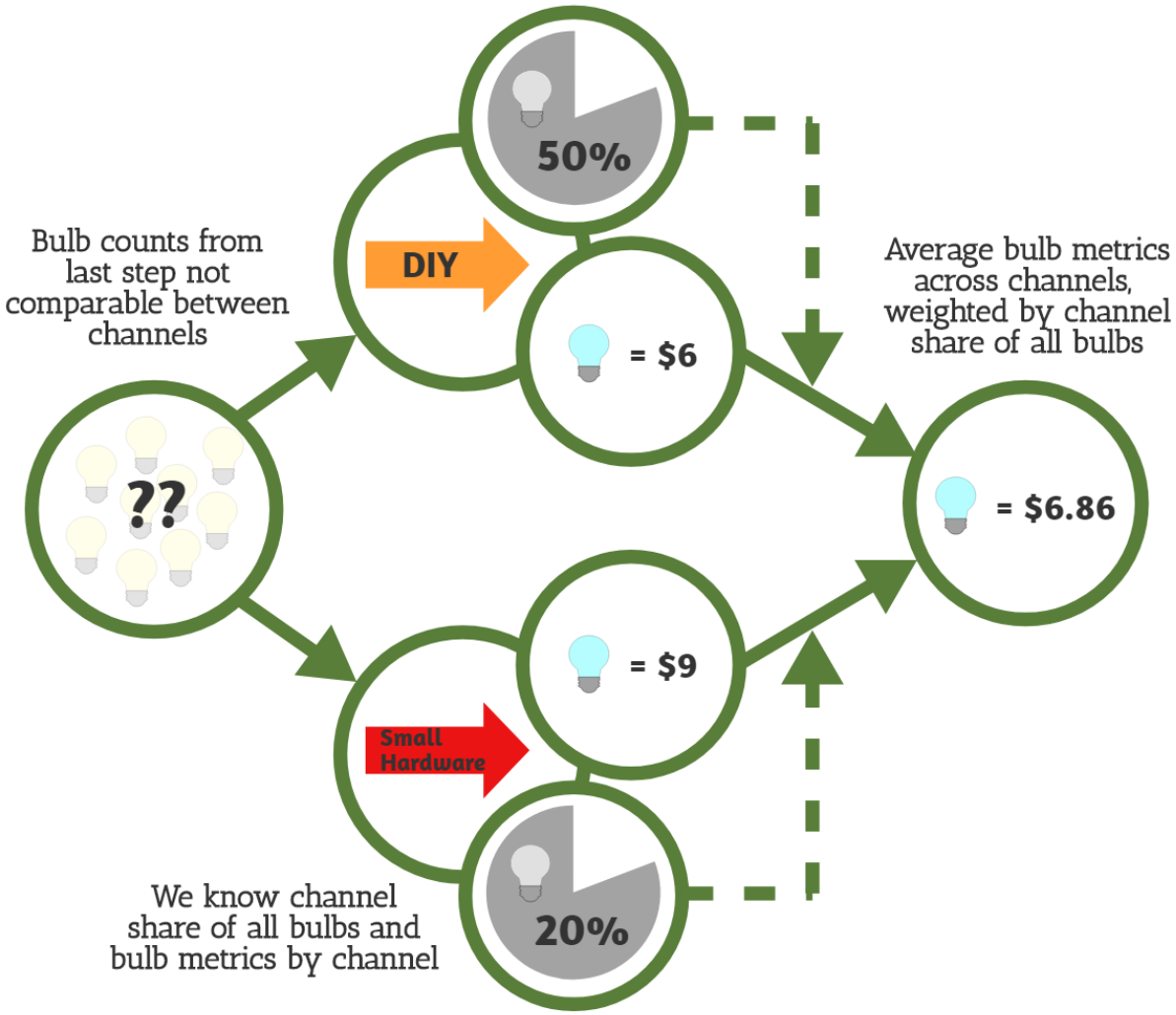


Figure 22. Current Method for Combining Bulb Metrics across Channels