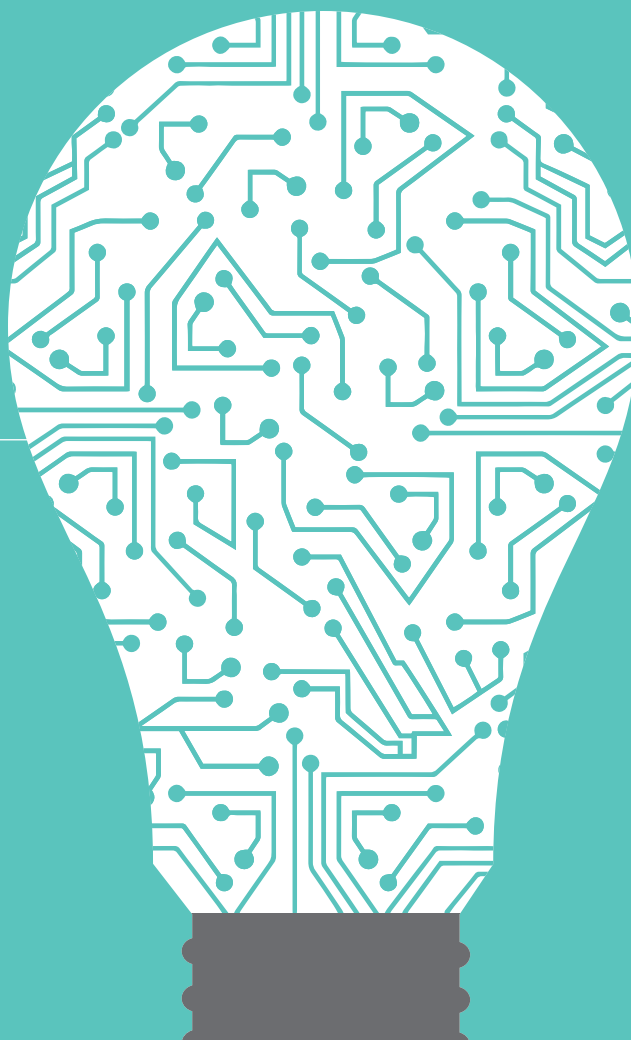


What does the LED revolution
mean for lighting programs?



LED Market Intelligence Report

April 2015





About This Report

This LED Market Intelligence report is based on findings from an ongoing lighting market research project sponsored by the Bonneville Power Administration (BPA). Research began in June 2014 and will conclude in the summer of 2015.

The research team used a variety of sources and information gathering techniques to develop the content of this report, including:

Interviews. The research team conducted extensive interviews with regional lighting program staff, program implementers, lighting distributors, retailers, and manufacturers.

Sales data collection. Working in tandem with BPA staff and the Northwest Energy Efficiency Alliance (NEEA), the team collected 2013 and 2014 full category sales data from 13 electrical distributors serving the commercial market in the Northwest.

LED sales prices. For the past few years, the team has tracked retailer and distributor LED pricing data using a software tool that pulls prices from e-commerce sites such as homedepot.com and grainger.com.

Other data sources. Regional lighting program data, retail shelf survey data, NEEA's regional building stock assessments, and several national data sources aided the team's understanding of the market dynamics.

A full list of sources and analysis documentation for this report will be available on BPA's website in June 2015. A final report covering all research findings will be published in the summer of 2015.

LED A-Line Lamp

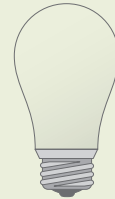
Please contact Carrie Cobb at clcobb@bpa.gov with any questions.



Some of the Lamps in this Report

A-Line Lamps

The most common residential bulb, A-lines are typically rated for 100, 75, 60, and 40 Watts or Watt-equivalent. The A-19 bulb is the most common A-line lamp: the 'A' refers to the bulb's shape; the '19' to its diameter in eighths of an inch. As general purpose bulbs, A-lines almost always have a medium screw base (i.e., socket type). In late 2014, five percent of all A-lines sold nationally were LED.



Decorative Lamps

Decorative lamps, typically used in fixtures where the bulb is exposed, come in many different shapes, sizes and colors designed for visual appeal. "Decorative" has no regulatory meaning. Lamps grouped into this category are often incorrectly assumed to be exempt from efficiency standards. "Candelabra base" lamps (shown left), for example, often have a "decorative" candle or globe shape, yet are restricted to a maximum of 60 Watts.

Reflector Lamps

Reflectors are directional lamps found in all sectors. They are often installed in recessed cans and used for both flood and spot lighting. The three most common types are the parabolic aluminized reflector (PAR), bulged reflector (BR), and reflector (R).

PAR

The PAR lamp has a glass lens with a separate reflector, making it suitable for spot lighting in outdoor and commercial downlight applications (e.g., hallways). A perfect application for the inherently directional LED technology, PAR lamps were among the first to give way to LEDs.



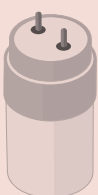
BR

The most common residential reflector, the BR lamp—typically rated at 65W—is made from blown glass and tends to have wider beam angles, making it more suitable for ambient lighting. Cheaper than the similar PAR lamp, it is exempt from efficiency standards.



R

As the second most common residential reflector lamp, the R lamp is also exempt from standards.



Linear Tubes

Linear fluorescent lamps dominate the commercial sector installed base by units and watts. They come in three primary varieties: T8, T5 and the less efficient T12. The older T12 lamp accounts for 11 percent of residential lamps installed in the region. LED options began to penetrate the commercial market in 2014.



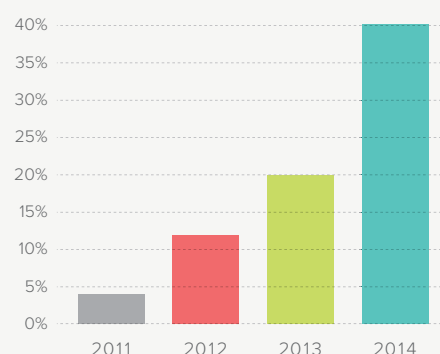
(Really) Rapid Product Adoption

That the LED lighting market is growing is no surprise. It's the pace of change that is stunning. In the third quarter of 2014 (the most recent data available), one in every 20 A-line bulbs sold nationally was an LED. Just one quarter prior to that, it was 1 in 30. A quarter before that, 1 in 50.

Just six years ago, Acuity Brands, the country's largest lighting fixture manufacturer, earned nothing from LED luminaires. In 2015, LED-based sales will likely generate half of the fixture giant's total revenue.

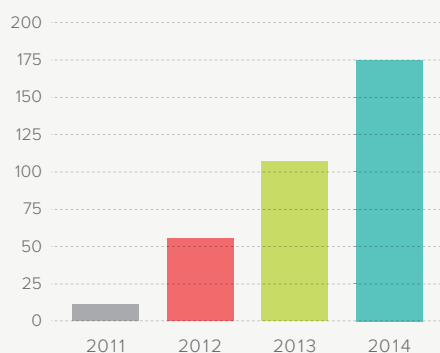
TCP, a smaller lamp manufacturer once focused on CFLs, rode the LED transition to an initial public offering on the New York Stock Exchange. LED sales at the company grew from 4 percent to nearly 40 percent of total revenue in three years.

FIGURE 1 / Acuity Brands, LED-based Luminaires as Percent of Total Sales



SOURCE: Acuity Brands Annual Reports 2011-2014

FIGURE 2 / TCP Annual Revenue from LED Sales in Millions



SOURCE: TCP International Holdings S-1 Filing, 2014

For its part, CREE didn't even make lamps or luminaires six years ago. Since they started, the company has driven its cost per 1,000 lumens (roughly the light emitted by a 75 Watt incandescent lamp) down by 90 percent. And despite these rapidly falling prices, CREE lighting revenue has grown roughly 50 percent per year—meaning unit sales are growing even faster. CREE's A-line LED bulb was born just two years ago. It's now the best selling LED bulb in the country. And it is already three generations old.

Programs? 80 percent of BPA's non-residential lighting savings were LED-based in the last six months.



The momentum of LEDs is broad-based, covering both residential and commercial applications. All major technology groups—HID, linear fluorescent, compact fluorescent, incandescent/halogen—are giving way to LEDs. LED solutions have strengthened their position in applications where they already had a foothold—downlights, commercial screw-in reflector lamps, and street lamps, for example. Meanwhile, improvements in performance and reductions in manufacturing costs have opened up new applications for LEDs, from high-bay, high-lumen applications to the smaller MR16 replacement lamps illuminating retail displays.



LED A-Line Lamp

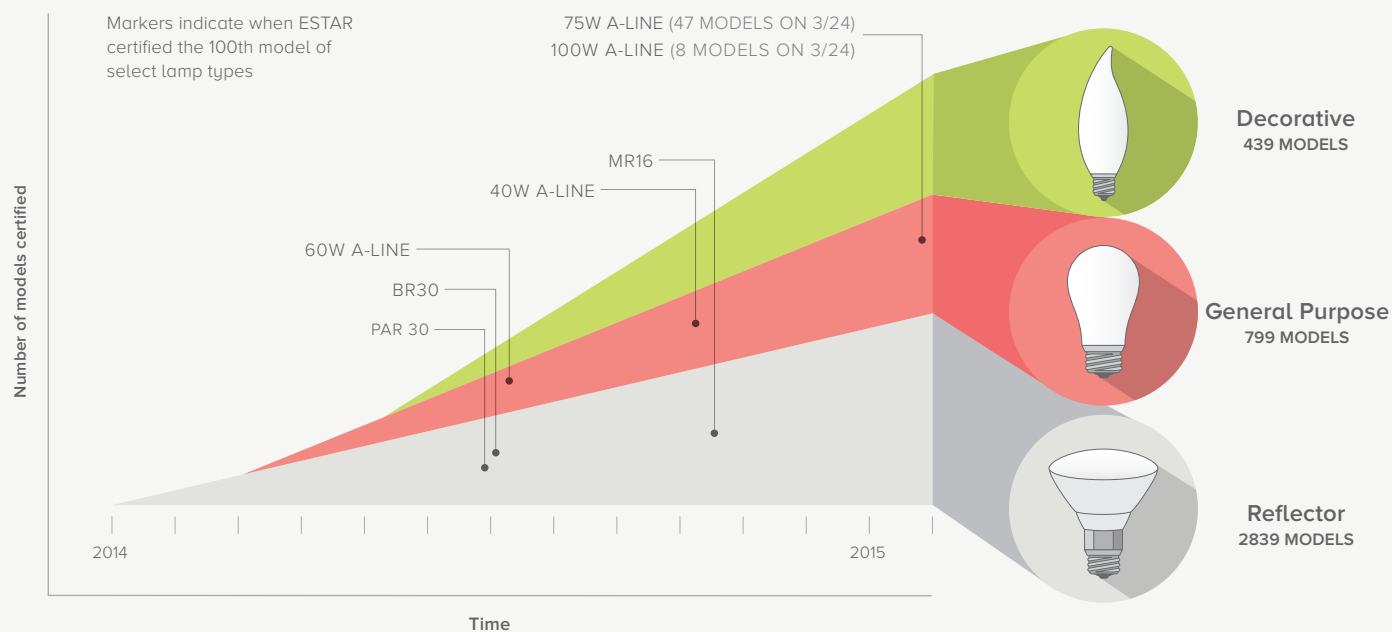
LEDs in the Residential Market

Figure 3 depicts the cumulative total of ENERGY STAR certified LED lamps over the previous 15 months. The chart reveals three trends emblematic of the LED transition. First, the sheer growth in total product availability and number of competitors vying for a piece of the market is striking. Second, LED options first appear in applications that are natural fits for the technology (e.g., inherently directional applications like PAR lamps) or represent large market opportunities (e.g., general purpose A-line). And, third, the quick diffusion of LED products into more product niches demonstrates the short product development cycles that now characterize the industry.

Think of figure 4, a timeline of CREE's A-line product evolution, as a drill-down view of one product on the ENERGY STAR certification figure below. In less than two years, CREE unveiled two generations of its bellwether residential bulb and extended the product line to include 75 Watt and 100 Watt models, a 3-way option, a high color rendering index lamp, and, most recently, a connected 'smart' bulb.

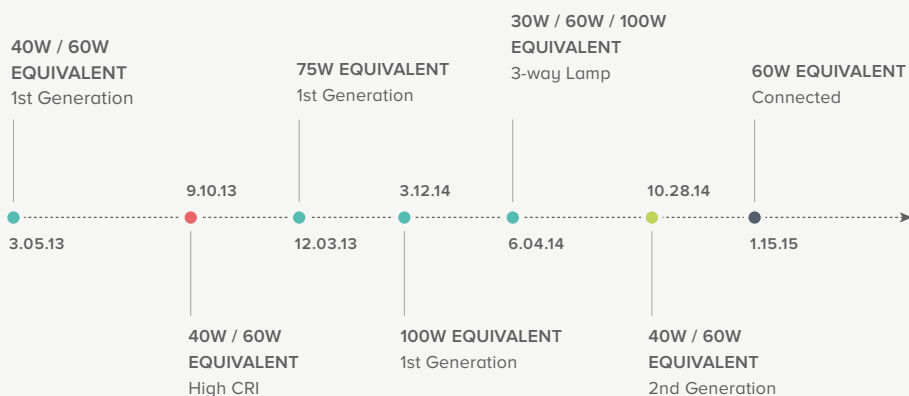
The retail price of the 60 Watt model is 40 percent cheaper than it was two years ago.

FIGURE 3 / ENERGY STAR LED Certifications for Screw in Replacement Lamp



SOURCE: ENERGY STAR

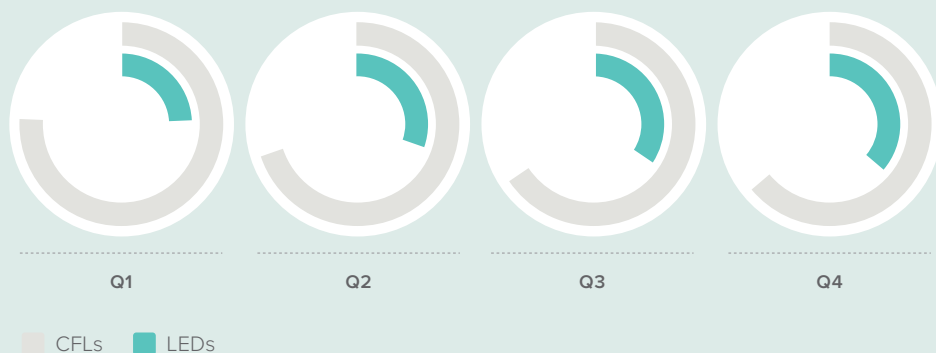
FIGURE 4 / CREE A-Line Product Launches



SOURCE: CREE Press Releases 2013-2015

LEDs are quickly becoming the efficient lighting technology of choice, rapidly gaining on CFLs. Figure 5 compares the relative quarterly retail sales mix of both incandescent and unincandescent CFLs and LEDs in the Northwest throughout 2014. In three quarters, LEDs cut CFLs' market share lead in half.

FIGURE 5 / CFL and LED Retail Sales Mix in the Northwest in 2014



SOURCE: CLEAResult Analysis for NEEA

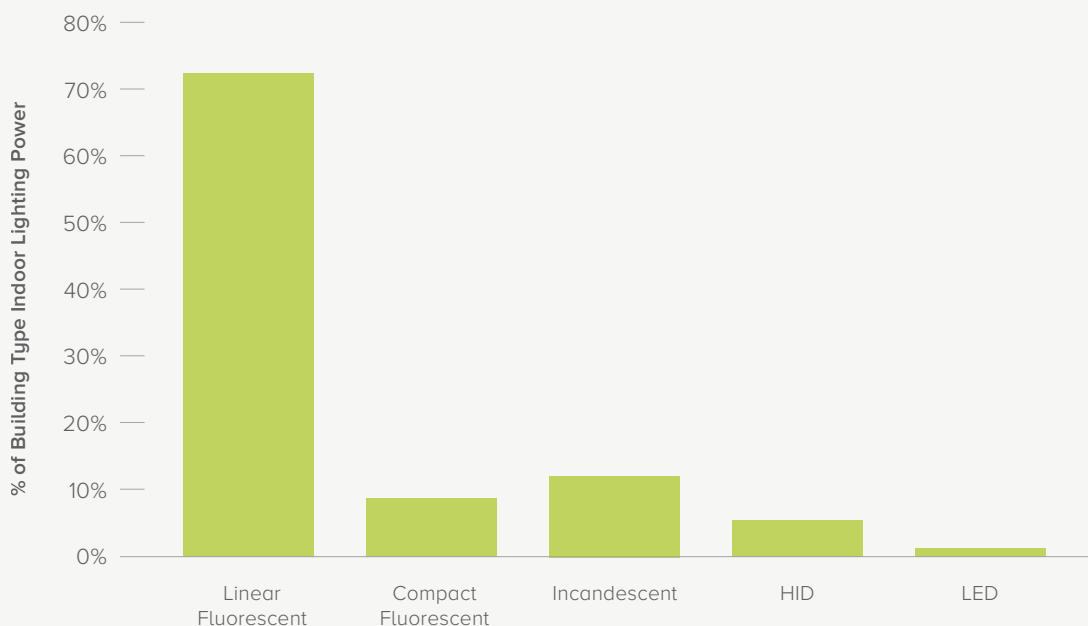


LEDs in the Commercial Market

Preliminary sales figures from Northwest electrical distributors gathered by BPA and NEEA indicate that screw-in LED lamp sales intended for the commercial sector may have already peaked for some applications. With long operating hours and inefficient incumbent technologies (notably, halogen), commercial screw-in reflector and general purpose lamps were low-hanging fruit for LED adoption.

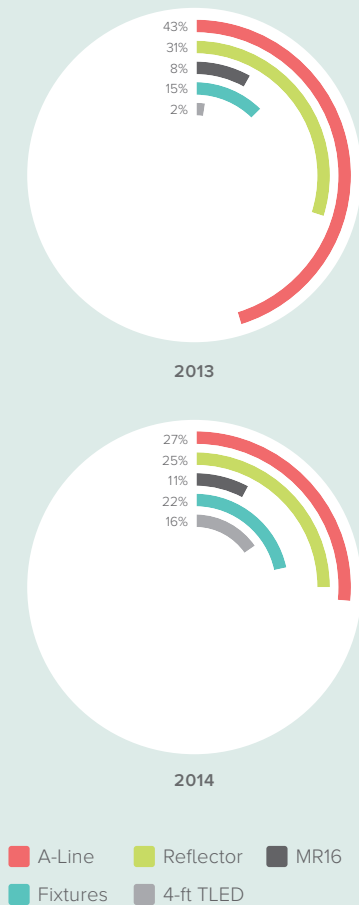
Conversely, many thought the dominant T8 fluorescent lamp, itself a cost-effective and efficient choice, would withstand the LED revolution for some time. But the fruit of the T8's previous success—its massive installed base (Figure 6)—was just one big retrofit pie to LED manufacturers. Enter the Tubular LED.

FIGURE 6 / Indoor Lighting Power for Commercial Buildings in Northwest



SOURCE: Commercial Buildings Stock Assessment, NEEA, 2014

FIGURE 7 / Preliminary Data on LED Sales, as Percent of Total LED Sales in the Distribution Channel



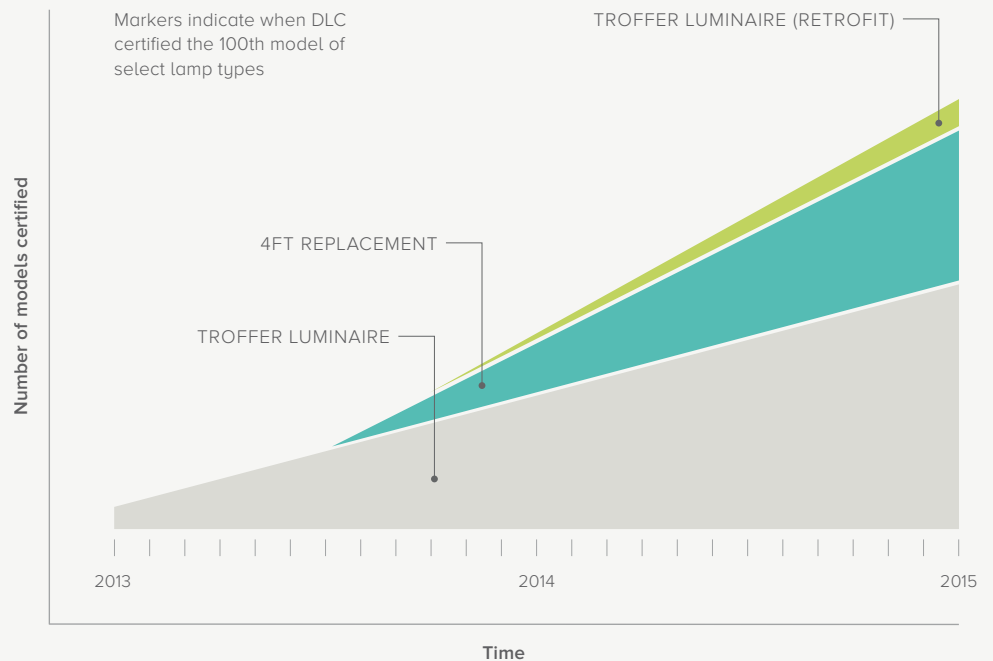
SOURCE: BPA 2014-2015 Lighting Market Characterization

¹Results to date. May be subject to revision based on new information.

Nearly non-existent in 2013, TLEDs boomed a year later as manufacturers launched a slew of next-generation plug and play TLEDs with greatly improved performance and reduced costs. Figure 8 shows the rapid growth in product listings on the Design Lights Consortium (DLC) Qualified Products List (QPL).

Preliminary regional distributor sales data indicates TLEDs were four percent of linear fluorescent sales in 2014. That might not seem significant, but when you consider TLEDs went from essentially no sales to four percent of the biggest commercial lamp market in just 12 months—it is a massive movement. TLEDs will almost certainly pass T12s in 2015.

FIGURE 8 / Growth in Qualified Linear Fluorescent Replacement Products, Design Lights Consortium



SOURCE: DLC QPL listings, March, 2015

Falling Prices

Dramatic price reductions in recent years have in large part driven increased LED adoption. Each year, the payback on LEDs options has improved across the board. Manufacturers expect intense competition to drive continued innovation in LED chip, package and system design. And as further economies of scale take root, product costs and end-user prices are expected to substantially decline over the next few years. Figures 9-11 show the recent price declines of three common LED applications. The forecasts are Navigant projections based on historical trends.

FIGURE 9 / LED A19 60W Equivalent Pricing Trends (\$/unit)

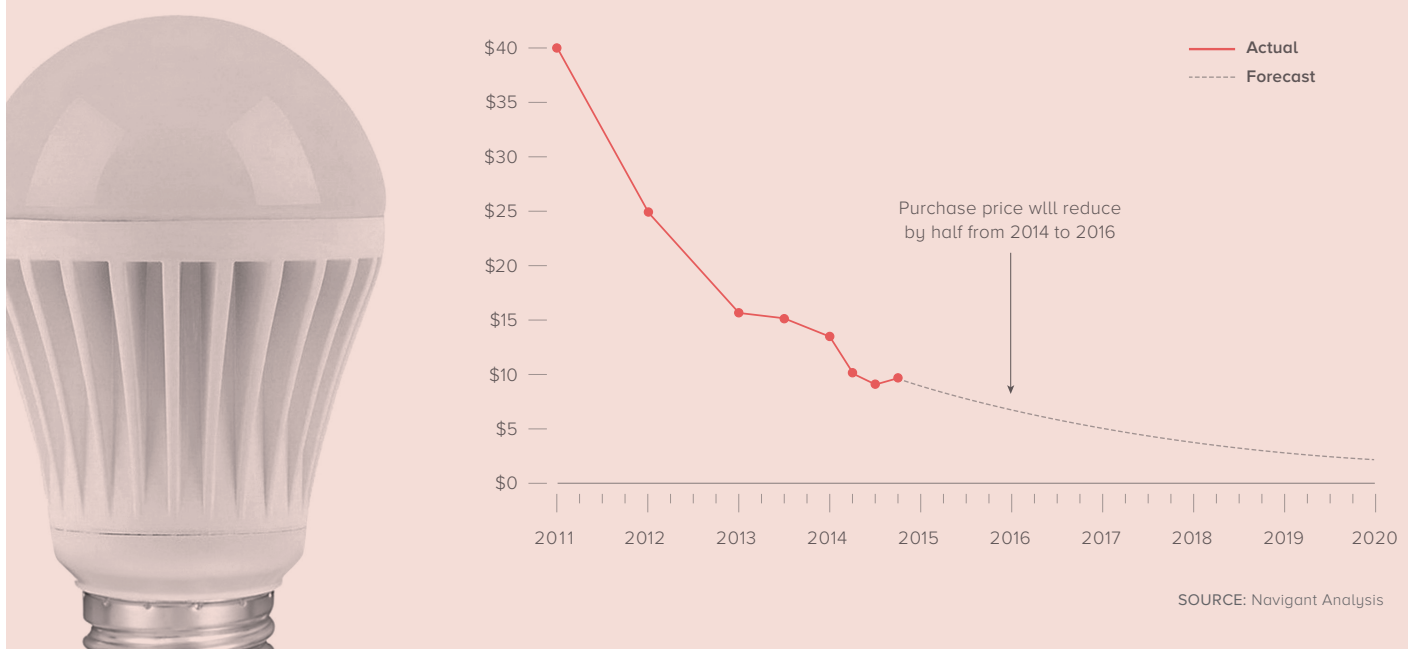


FIGURE 10 / LED PAR38 75W Equivalent Pricing Trends (\$/unit)

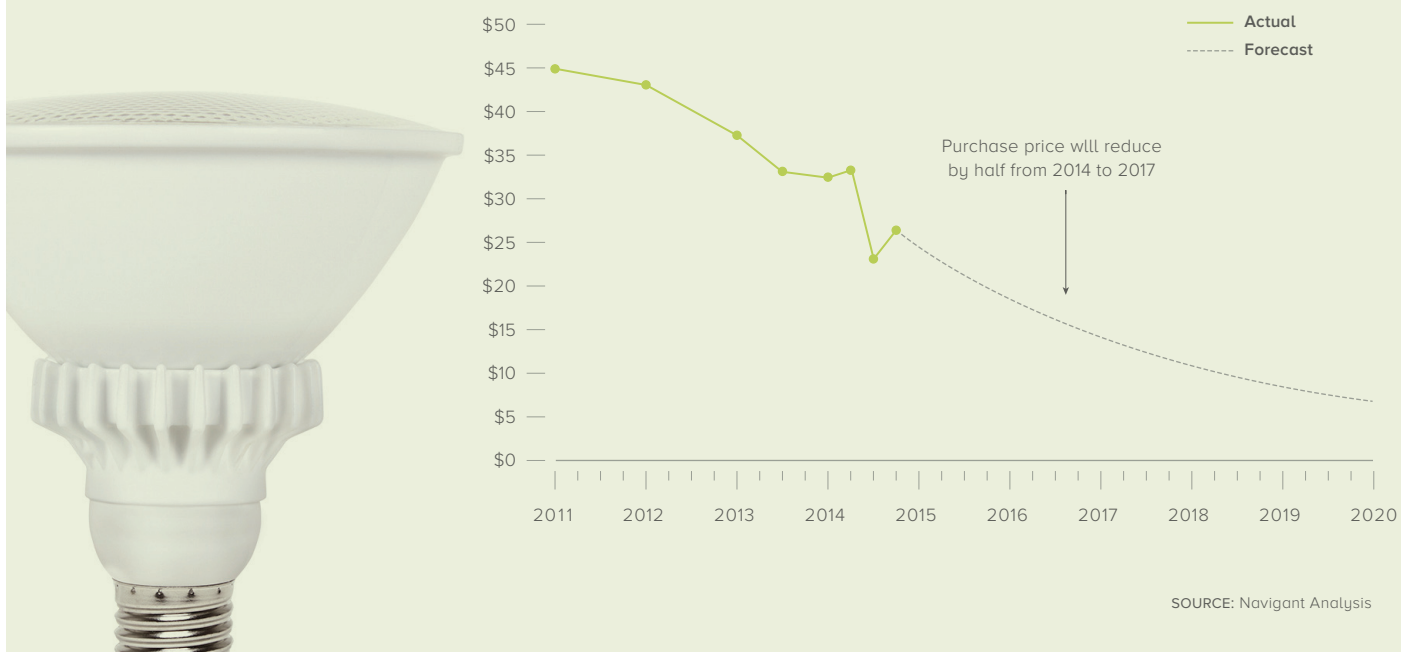
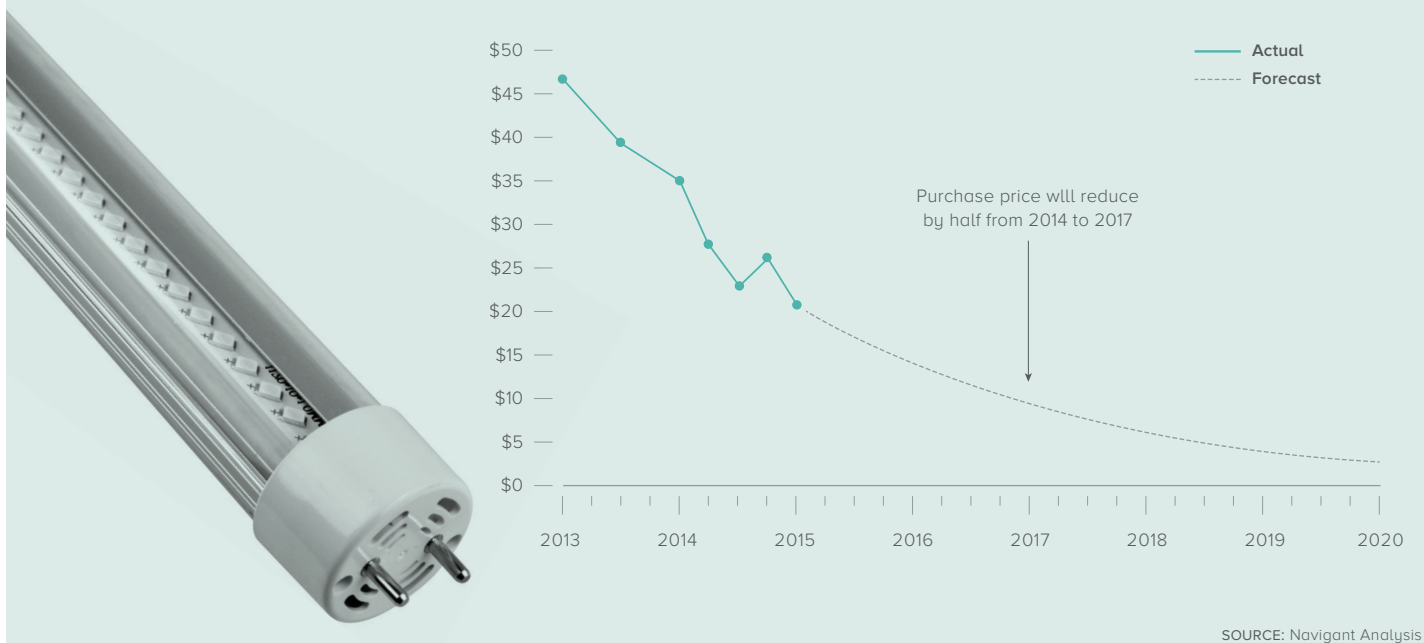


FIGURE 11 / 4' TLED Historic Pricing Trends (\$/unit)





So What Does This Mean for Program Planners and Managers?

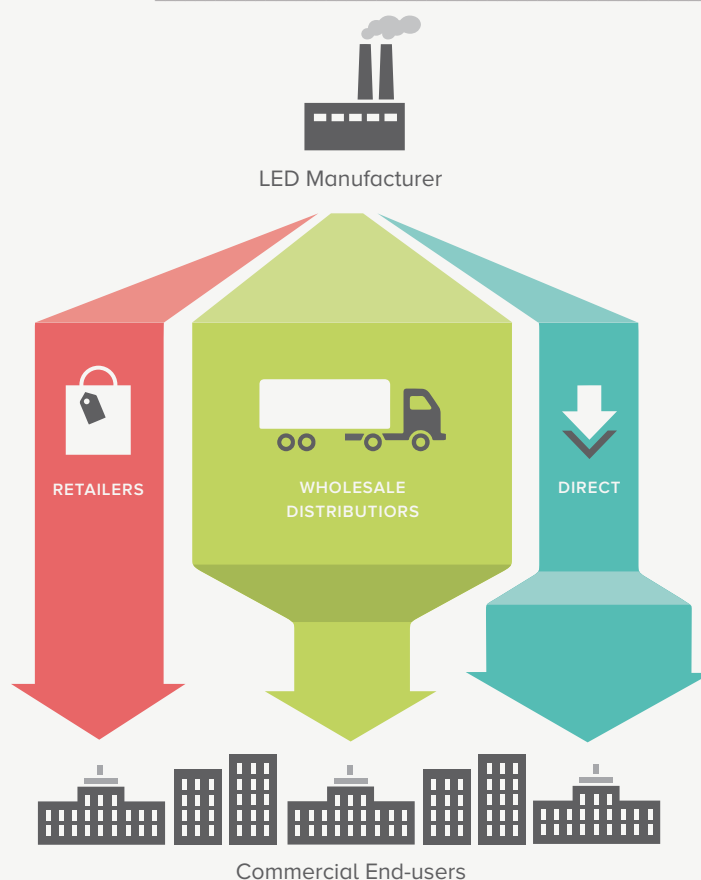
- 1 First, if baselines are meant to represent current market practice, the rapid penetration of LEDs into the sales mix means baselines should reflect the flow of sales, not the installed stock. The technologies already installed in buildings are not reflective of the current sales trends.
- 2 Second, adopt baseline frameworks that represent the changing market and can easily be updated with new sales data. Update baselines at least annually because longer update cycles will likely lag the market, risking liberal baselines and potentially misallocate program resources.
- 3 Third, collect full category lighting sales data. When the product mix in the market changes rapidly, full category data (incandescent, halogen, CFL, LED) is vital in maintaining appropriate baselines. Lighting baselines cannot be addressed with good engineering assumptions—they need market data.
- 4 Fourth, consider creative incentive structures for distributor and retailer partners, aimed at shifting their efficient product mix beyond a given level.
- 5 Fifth, track LED product cost trends closely and update incentives as necessary. During interviews, some distributors mentioned some rebates were higher than the actual product cost. On the non-residential side, market actors reported a two-year payback as the sweet spot for lighting measures. Incentives that lower the payback below two years may not be necessary.

A Disruptive Technology—How LEDs are Changing the Game

The ongoing transition to solid state lighting has disrupted the lighting market in two significant ways. First, an industry long dominated by three lamp companies—GE, Philips, and Osram Sylvania—is now seeing incredible fragmentation, with competition from thousands of new manufacturers.

Threatened incumbents have tried to wall off access to their established market channels, such as their electrical wholesale distributors, retail partners, and manufacturer sales representatives. In response, upstart LED companies have increasingly taken their lamps and luminaires directly to the end-user, bypassing these traditional distribution channels. While it's too early to know how the distribution channels will ultimately change, it is possible the direct-to-market channel is growing at the expense of the stocking electrical wholesaler, as shown in figure 12. As the market moves from lamps and ballasts that are easily stocked and predictably ordered to integrated, non-standardized systems, how will traditional distributors react?

FIGURE 12 / Simplified Commercial Sector Lighting Supply Chain





The second disruption is the shift from standardized lamps to customized lighting systems. LED technology enables an infinite variety of design possibilities in both function and form. However, achieving these possibilities and ensuring a high quality lighting solution, requires an in depth knowledge of both system design and lighting component technology. All system components, from the LED chip (the actual light source) to the driver to the luminaire's optics, must be fully integrated and coordinated. In this way, LEDs stand in stark contrast to the traditional lighting paradigm in which bulbs, ballasts, and fixtures could be sold separately from any number of manufacturers and then installed on site with little technical sophistication.

That business model, in which lamp and ballast manufacturers could capture value independent of the how the complete lighting system was assembled, appears less tenable in an LED world. The design and coordination required to optimize the overall LED system performance means, to no small degree, that the fixture (luminaire) manufacturer is now the provider of the actual light source. Particularly in the commercial market, this places fixture manufacturers at the top of the value chain. As a result, many traditional lamp manufacturers are defining and marketing themselves as lighting solution providers, offering customers an overall lighting experience, rather than just manufacturing replacement widgets.

The technological potential of LEDs, coupled with competitive pressure on manufacturers to differentiate themselves, appears poised to push exciting developments in lighting systems in the near future. Already, manufactures are marketing sophisticated controls and people-centered functionality that promise a range of possible experiences. Luminaires will work more like computers than bulbs, offering non-energy benefits such as light output and color adjustment to circadian rhythms in order to enhance mood, sleep, and productivity. They may function as wi-fi access points, meters, or data analytics devices. In summary, the value-added features of well designed LED systems go well beyond energy benefits. And lighting manufacturers—solution providers—will seek to develop and promote these features to differentiate themselves in the highly competitive lighting market.



What Does This Mean for Program Planners and Managers?

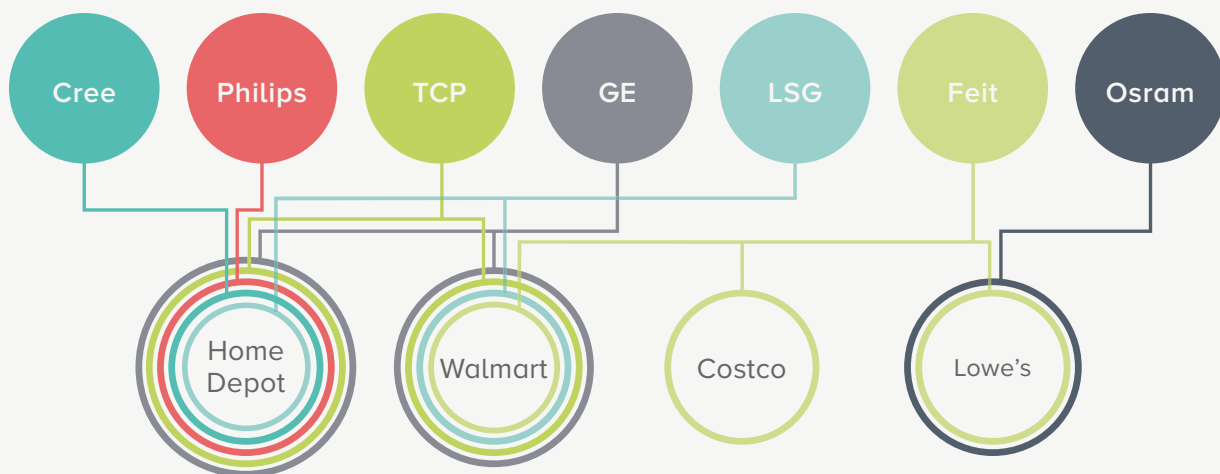
- 1 Continually ask: what is the measure we are after? As more non-energy related bells and whistles are added to lighting systems, lighting programs will need to think critically about what features and benefits they are willing to pay for. Manufacturers will seek ways to add value (and maintain prices) in the face of significant cost pressure.
- 2 Provide application guidance to trade allies for systems installations. The confluence of hardware, software, new lighting performance metrics, and user-experience will be dynamic and ever changing, placing a premium on trade ally education (e.g., installing LED troffers with integrated controls is more complicated than lamp and ballast change outs.).
- 3 Treat different market segments differently. Lighting systems with integrated controls are most cost-effective in major renovation and new construction projects. Focus marketing and education on trade allies and market actors active in these segments. For the lighting maintenance market—complex systems are less likely to be employed, so the focus should be on upstream programs for the distributors and manufacturers, encouraging them to stock and push high efficiency replacement options.
- 4 Support the development of performance test methods for LED systems. Common methods of LED testing for various performance characteristics—including reliability and lifetime—are still emerging. Programs should monitor their progress and when appropriate require their use for product qualification purposes.
- 5 Promote the “interoperability” of controls and technologies. Interoperability is the ability of separate technologies to speak to one another and work seamlessly together. Compatibility issues have frustrated some early adopters of LED technologies, particularly around dimming capabilities.



Retail, Regulations, and LEDs

Like the commercial market, the residential lighting market is served by many suppliers, including many new LED manufacturers. The path from factory to end-user, however, is far more consolidated. A handful of retailers (Home Depot, Walmart, Costco and Lowe’s) dominate the sale of lamps to residential end-users. As a result, lamp manufacturers compete intensely for valuable retailer shelf space at these large chains. This rivalry for access to the consumer reduces manufacturer profit margins relative to the commercial sales channel. The retailers’ market power forces lamp manufacturers, seeking profit, to lower their own production cost because they can’t raise price—or even maintain them—or they’ll risk losing shelf space. For emerging technologies like LEDs, this is especially important because it drives intense research and development efforts aimed at reducing product costs.

FIGURE 13 / Supply Relationships for the 60W A-Line LED Bulb

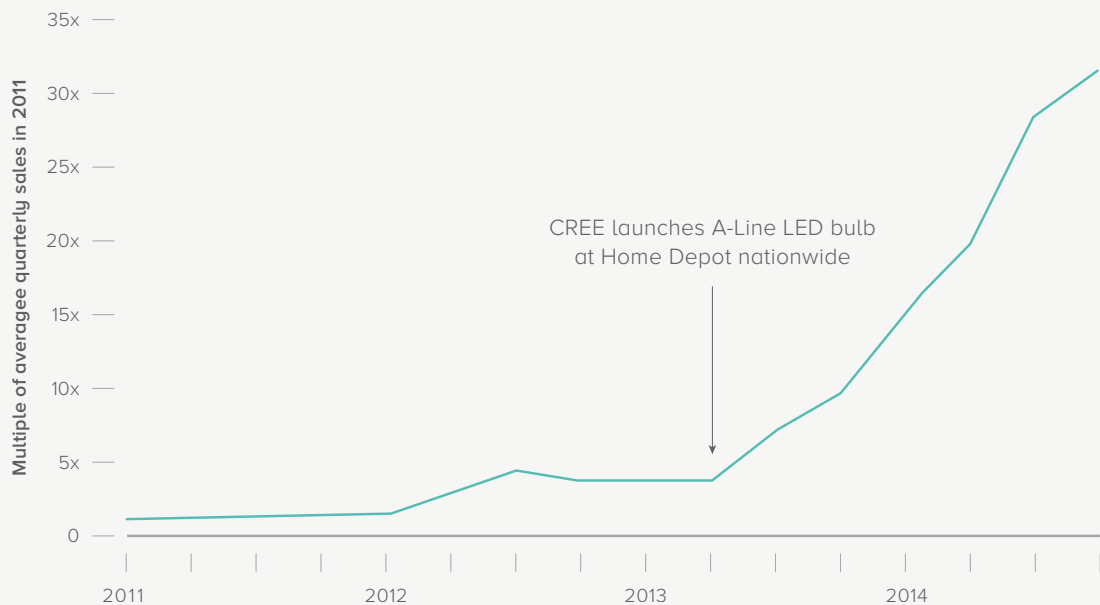




Because of their larger customer bases, retailers have an unrivaled ability to influence the adoption of LED lamps with a single strategic decision. Retailer strategy on lamp placement, pricing, and promotion are pivotal to which lamp types are chosen by the consumer. In interviews, retailers spoke of “activating” LED bulbs at some determined point in time. The notion is revelatory: the pace of LED adoption should not be viewed as the sum of all independent consumer decisions made in lighting aisles across the Northwest. The LED sales trajectory depends more on a higher-order decision first made by the retailer. The retailer’s strategic decision about product placement, availability and relative product pricing frames and influences the choice for the consumer. This means the real leverage comes not in changing consumer behavior, but in influencing retailer behavior.

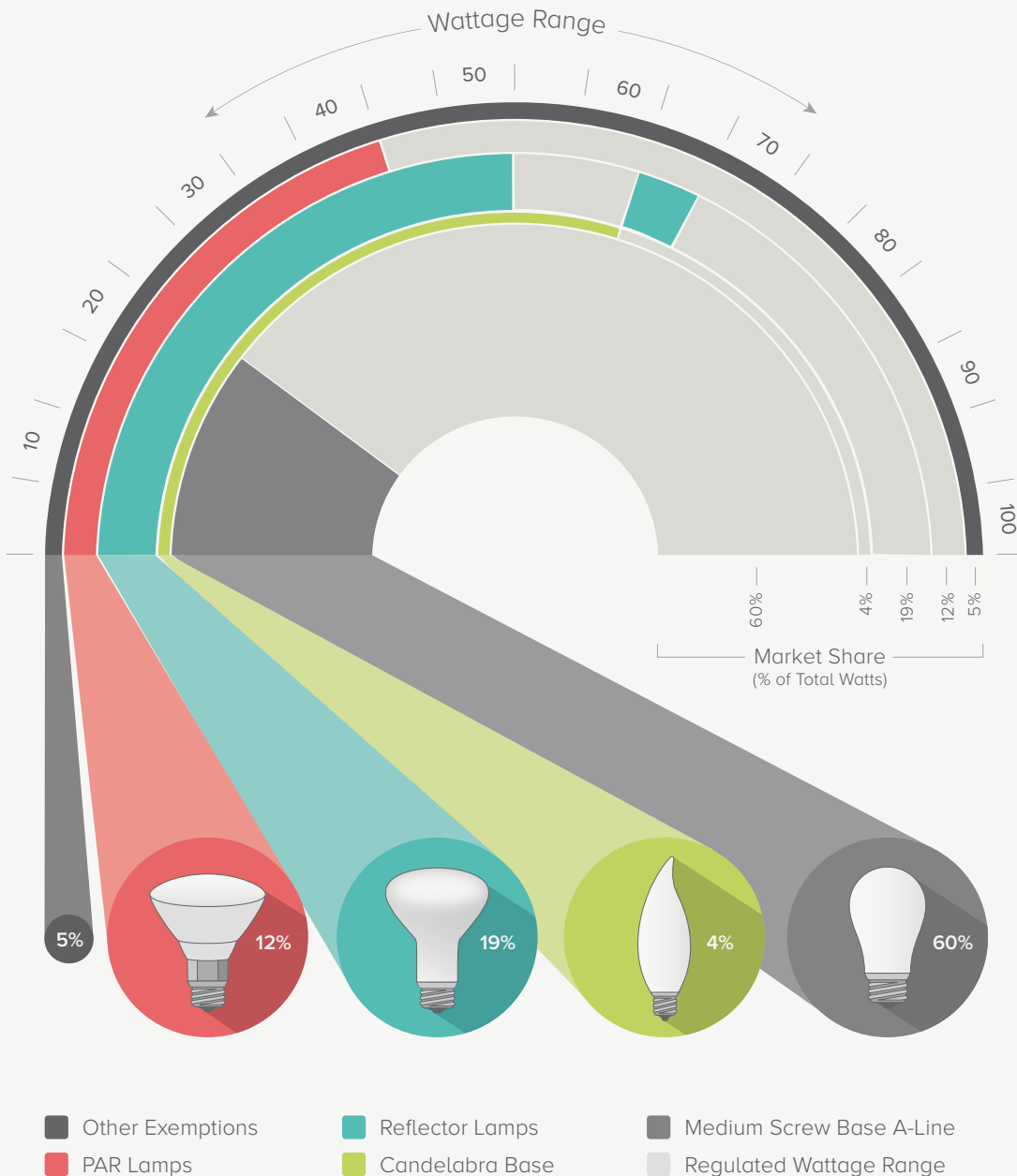
Costco’s move to sell only CFL and LED lamps clearly set the table for its customers. Home Depot’s launch and promotion of the CREE Light Bulb is another example of major retailer power in the retail sector. The promotion of the CREE bulb in Home Depot stores nationwide in April 2013 coincided with the national inflection point in LED A-line sales growth, as shown in Figure 14.

FIGURE 14 / LED A-Line Sales



SOURCE: NEMA A-Line Sales Index

FIGURE 15 / Unregulated versus Regulated Wattages, by Lamp Type

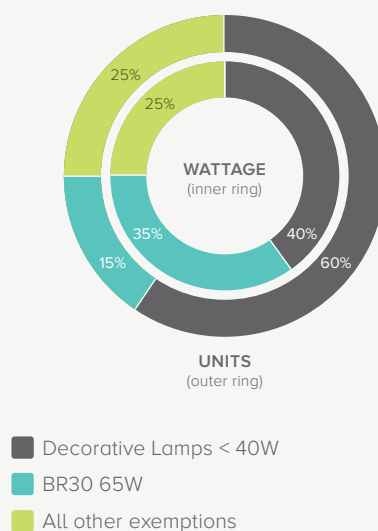


SOURCE: Energy Independence and Security Act of 2007

Retailer strategy aside, the Energy Independence and Security Act's (EISA) lighting standards changed the residential efficiency mix more than any other factor over the last three years. Figure 15 puts the EISA standards (and others) into common context. The light gray area in the arch indicates where standards apply for each lamp type and wattage. Simply put, if standards apply, the lamp must have, at the very least, halogen-level efficiency. This impacts program baselines directly, but perhaps more important, improves the payback (and appeal) of LED alternatives as the baseline lamp is more expensive.

The figure also shows that EISA afforded candelabra base and reflector lamps—often called “decorative” or “specialty” bulbs in programs—more exemptions than the A-line bulb. And now, fully phased in for nearly 18 months, the law’s nuance is revealed on retailer shelves across the Northwest. Figure 16 details which exempt lamp categories have the most retail shelf space in the region.

FIGURE 16 / Exempted Product Mix on Retail Shelves, by Units and Wattage



SOURCE: NEEA, “2013-2014 Northwest Residential Lighting Long-Term Market Tracking Study”
January 2, 2015

Lighting Efficiency Standards 101

Efficiency standards apply to lamps primarily based on their “base-type.” Base-type is lighting geek-speak for the type of socket the lamp goes in. DOE may further delineate lamp types—and therefore set different standards—by brightness level, wattage, and whether it has a reflector. But it all starts with the base-type.

Medium (screw) base lamps. The most common lamp addressed by EISA. The law prescribes four different maximum allowable wattages corresponding to the lumen outputs of its four most typical wattages: the 100, 75, 60, and 40 Watt lamps. Effectively, medium base lamps between 30 and 130 Watts must be halogen or better, unless exempted. Important exemptions include most residential reflector lamps, most notably the very common 65 Watt BR30 lamp in recessed cans everywhere, as well as some specialty lamps (e.g., 3-way).

Candelabra base. This is the second most common base type in the residential sector. Often called ‘mini-base,’ candelabra screw base lamps must use 60 Watts or less. Put differently, if the lamp has a candelabra base lamp and is rated for 60 Watts or less, it has no efficiency requirement. Lighting programs frequently group these into a ‘decorative lamp’ category, which has no meaning with respect to federal standards.

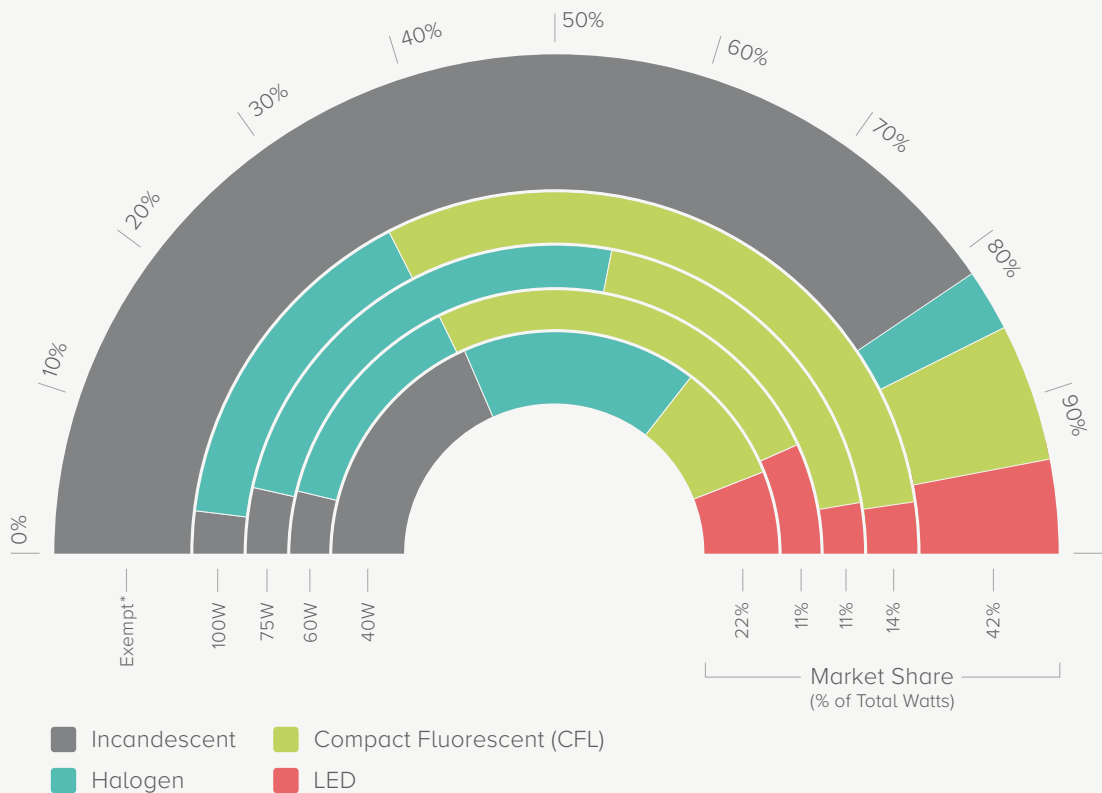
Intermediate base. Relatively uncommon, lamps with this base-type must be 40 Watts or less.



NEEA² conducted a large retailer shelf survey in late 2014, nearly a year after EISA’s full phase in. The team used this rich data source to evaluate how the law impacted retail shelf mix. Recognizing different retailers have dramatically different market shares, the team used market share estimates developed in a separate analysis to weight the shelf survey findings. In this way, the team estimated lamp type and technology mix of all retail shelf space in the Northwest. All figures exclude fixtures, as well as pin-based and linear fluorescent lamps.

Figure 17 shows the shelf technology mix and market share for general purpose lamps by wattage bin and exempt lamps. Clearly, EISA, where it applies, has worked. The longer the law has been in effect, the lower the share of incandescent lamps. LED penetration is highest for 40W and 60W equivalent bins, which were the first LED replacement options developed by manufacturers.

FIGURE 17 / Northwest Retailer Technology Mix in 2014, General Purpose Lamps



*3 way lamps < 310 lumens, > 2600 lumens

² Source: NEEA, "2013-2014 Northwest Residential Lighting Long-Term Market Tracking Study" January 2, 2015 and Navigant and Codeo Analysis. The Team used an analytical approach, coined the Chain Logic Method to estimate the market share of each vendor or group of vendors in the region. The team then used the NEEA shelf survey to compute the technology distribution across different applications and wattage equivalents.

FIGURE 18 / Northwest Retailer Technology Mix in 2014, Reflector Lamps

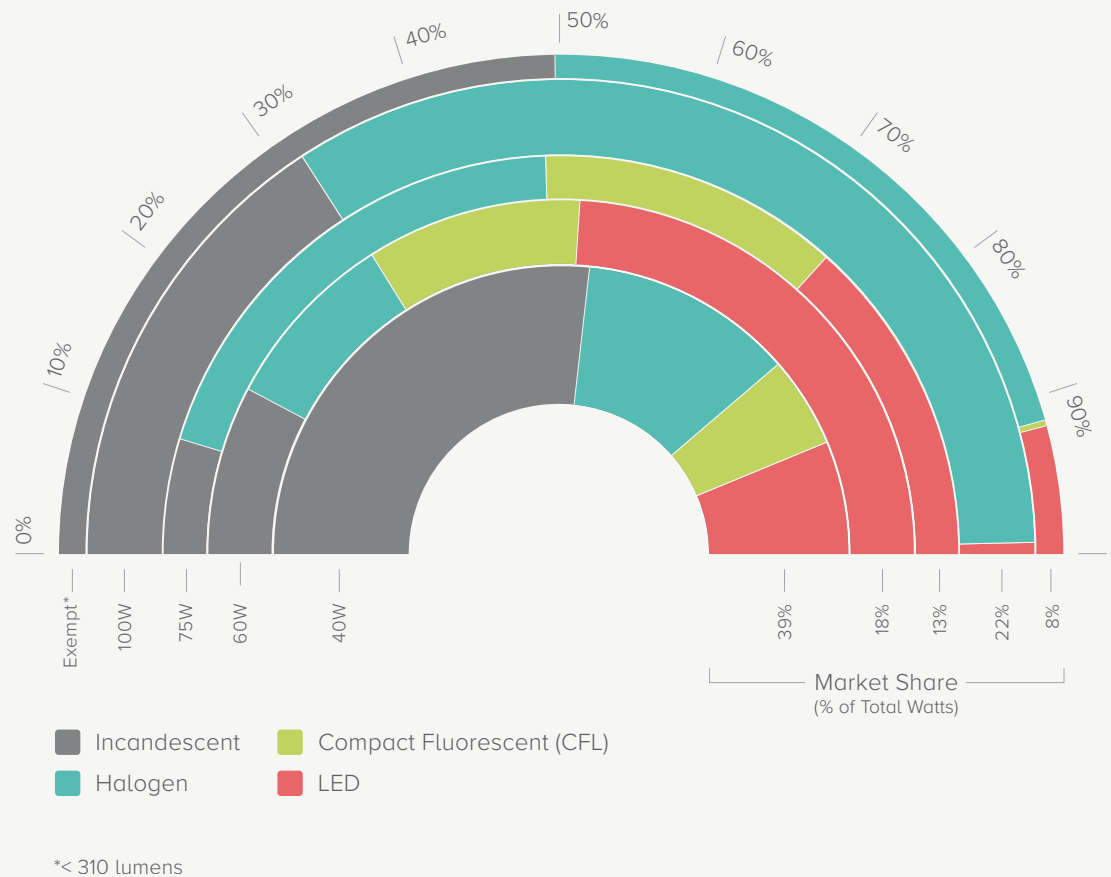
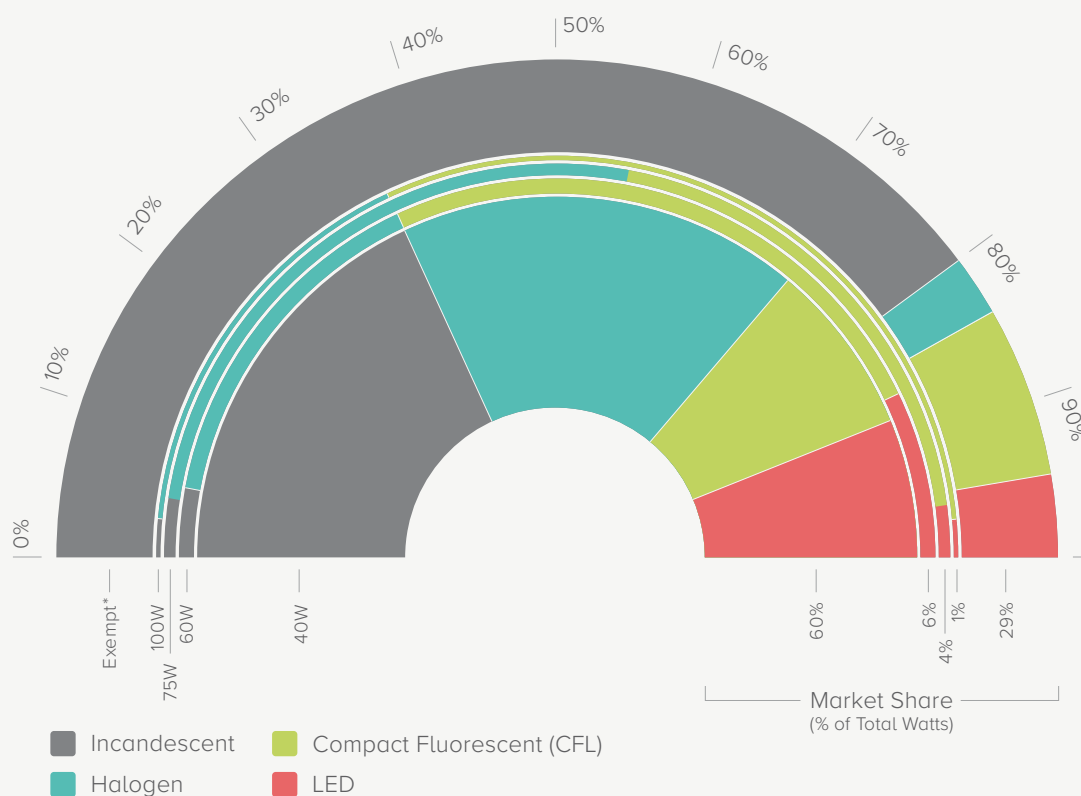


Figure 18 shows the shelf technology mix and market share for reflector lamps. The most common reflector lamp in the residential sector is the BR30 lamp, a notable exemption in EISA. We can see the impact in the 40W equivalent category below, which is more than half incandescent.

FIGURE 19 / Northwest Retailer Technology Mix in 2014, Globe and Decorative Lamps



*3 way lamps < 310 lumens, > 2600 lumens

Figure 19 shows the shelf technology mix and market share for decorative and globe lamps. Decorative lamps are often assumed to be exempt from standards. Not true. What matters for standards is the base-type. Candelabra base-type lamps (sometimes called mini-base) are often associated with decorative style lamps (candle, globe, or flame shaped bulbs). If it has a candelabra base it must be rated 60 Watts or less. The very low share of incandescents in the 60, 75, and 100 Watt equivalent ranges shows the impact of EISA on these lamps.



So What Does This Mean for Program Planners and Managers?

- 1 Increase focus on LED solutions for niche applications. Candelabra or “mini-base” lamp types, for example, have no efficiency standards below 60 Watts.
- 2 Target reflector lamps for increased savings opportunities. The 65W BR30 lamp is the most common residential reflector lamp on the market and is not subject to Federal standards. Other common reflector lamps such as the R20 are also exempt from DOE standards.
- 3 Closely monitor cost and sales trends of general purpose A-line LED lamps for measure cost effectiveness. Programs have rightly targeted the most common general purpose lamps for replacement. However, those same lamps are the most thoroughly regulated by EISA and continue to be the target of LED manufacturer R&D efforts. The result is a narrowing incremental cost for LEDs, which should increase natural adoption practices. Programs should ensure baselines and incentives are continually adjusted for this bellwether lamp.



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