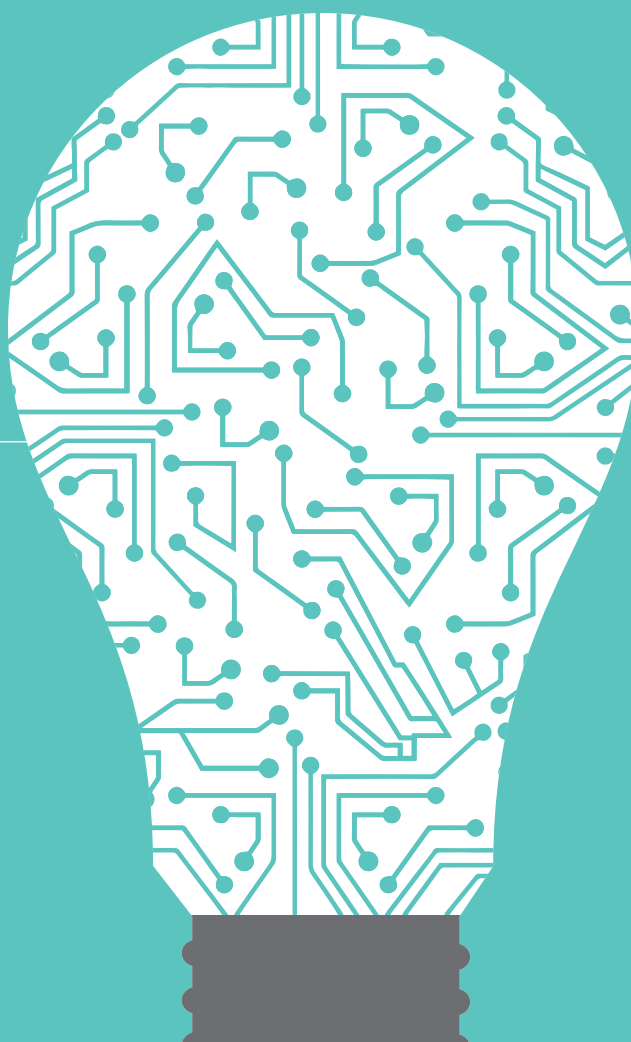


LED Market Intelligence Report



What does the LED revolution
mean for lighting managers?

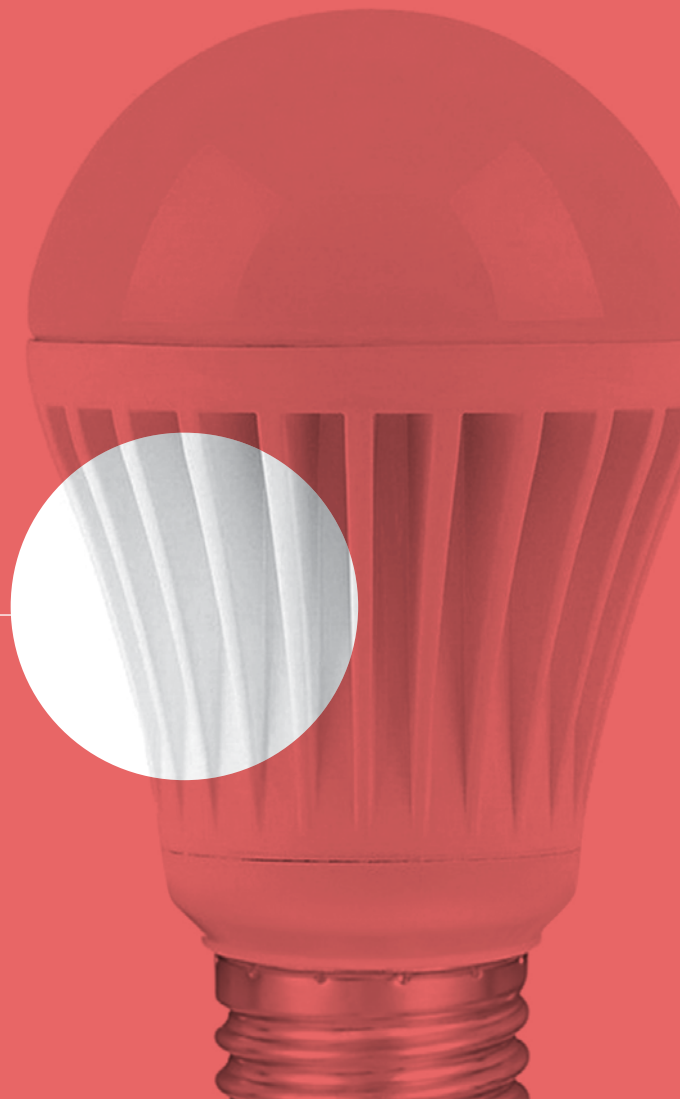
April 2015 Issue



About This Report

The information and analysis presented in this report comes from a ongoing Lighting Market Characterizing research project. The research team conducted more than 30 interviews with regional lighting program staff, lighting distributors, retailers, and manufacturers. Sales data was collected from Northwest Electrical distributors through the cooperation of NEEA and BPA staff. A full list of sources and documentation will be available on BPA's web site. A final report is due to be published in the summer 2015.

A-Line Lamp



The Focus of Our Research



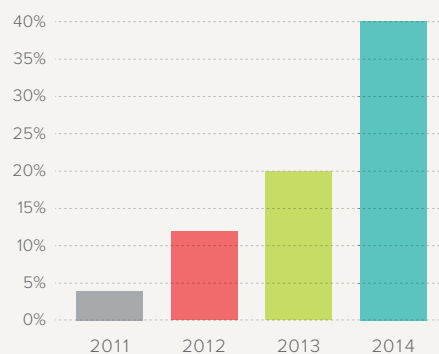
The LED Transition is Under Way

It is no surprise that the LED lighting market is taking off. But it's difficult to overstate just how rapid this transition to LED has been. Meaningful changes in the product mix are revealing themselves not over three to five year cycles, but from quarter to quarter. Just six years ago, Acuity Brands, the country's largest lighting fixture manufacturer earned nothing from LED luminaires. In 2015, LEDs will drive half of the fixture giant's total revenue. The company projects the market will be 80% LED by 2020. See Figure 1 for the developing trend.

Six years ago, CREE didn't make lamps or luminaires; they just supplied LEDs to those who did. Impatient with the pace of LED lighting adoption, CREE started making the fixtures and bulbs themselves. Since then, they've driven their cost per 1000 lumens (75W equivalent) down by 90 percent. And despite those rapidly falling prices, CREE lighting revenue has grown roughly 50 percent per year year—meaning unit sales are growing even faster.

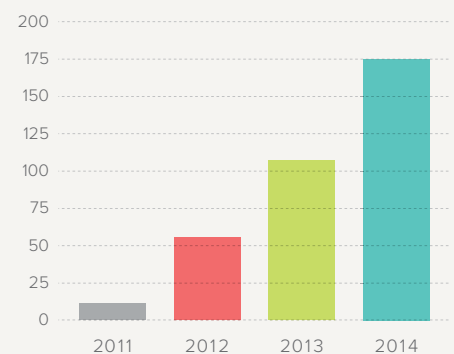
The company's CREE Bulb was born just two years ago. It's now the best selling LED bulb in the country. And it's already three generations old. Yes, things are moving fast. TCP, another manufacturer, rode the LED transition to an initial public offering on the New York Stock Exchange. See Figure 2 below.

FIGURE 1 / Acuity Brands LED-based Luminaires As a Percentage of Total Sales



SOURCE: Acuity Brands Annual Reports from 2011-2014

FIGURE 2 / TCP Annual Revenue from LED Sales in Millions



SOURCE: TCPI S-1 Filing from 2014



The momentum has been broad-based, in 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 PAR lamps, and street lamps, for example. Commercial screw-in sales may have already peaked. Meanwhile, performance and cost improvements have opened up many new applications to LEDs, from high-bay, high-lumen applications to the smaller MR16 replacement lamps illuminating retail displays.

Consider two bellwether lamps: the classic general purpose residential bulb, also known as the A-Line lamp (shown on page 2) and the T8 linear fluorescent lamp, which is the dominant commercial lamp (shown here).



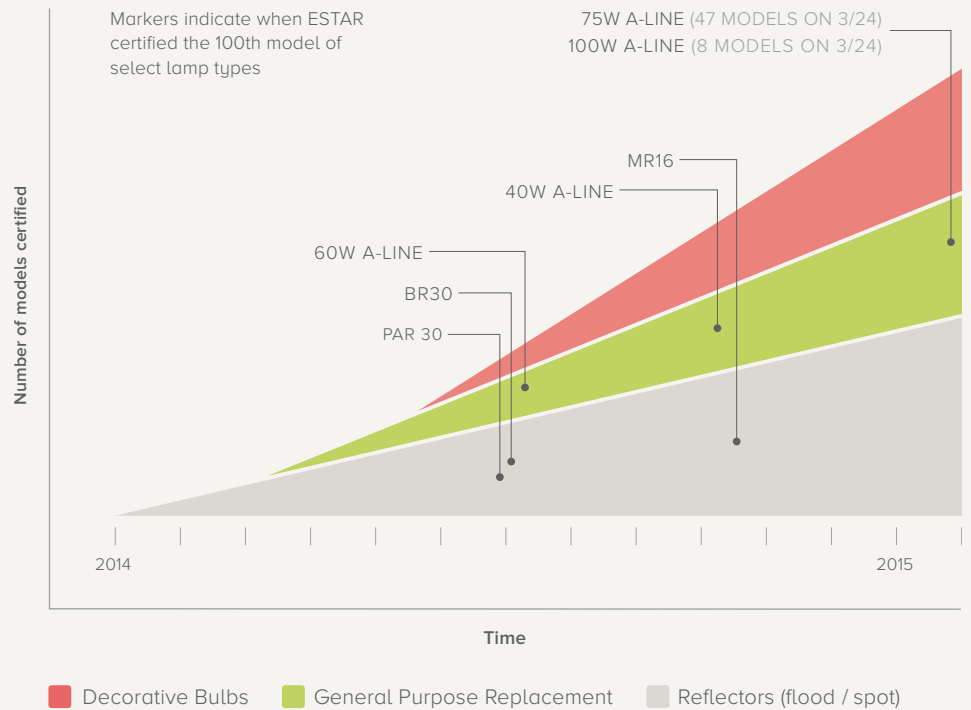
T8 Linear Fluorescent Lamp

Growth in Product Listings: Energy STAR

In the Q3 '14 (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, it was roughly 1 in 50.

And the A-Line is just one area of development. LEDs, being an inherently directional light source, were a natural fit for the downlight applications, as shown in Figure 3 below where LED PAR lamps led a wave of screw in replacement lamps in the market. LEDs have quickly spread their reach into other applications.

FIGURE 3 / Residential Explosion Chart



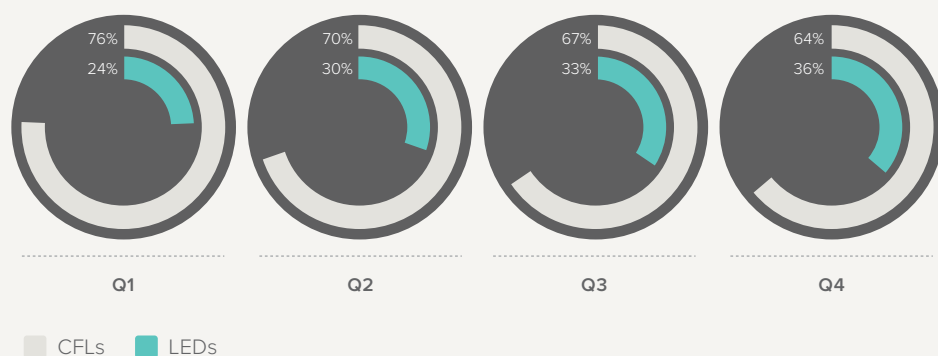
SOURCE: Energy Star



As LEDs penetrate the overall market, they are also quickly becoming the efficient technology of choice, rapidly gaining on CFLs. Figure compares the relative quarterly retail sales mix of CFLs and LEDs in the Northwest throughout 2014, based on data gathered and analyzed by ClearResult. In just one year, LEDs halved the share difference.

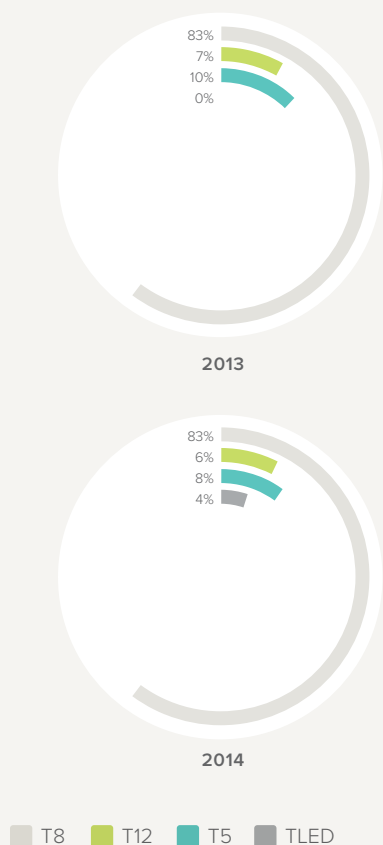
Many thought the T8 fluorescent lamp, itself a cost-effective and efficient choice, would withstand the LED revolution for some time. But the fruit of the T8's success (shown in Figure 4)—its massive installed base—was just just one big retrofit pie to LED manufacturers. Enter the TLED.

FIGURE 4 / Share of CFL and LED Retail Sales



SOURCE: BPA 2013-2014 Lighting Market Characterization

FIGURE 5 / Linear Tube Sales Mix Among Northwest Electrical Distributors

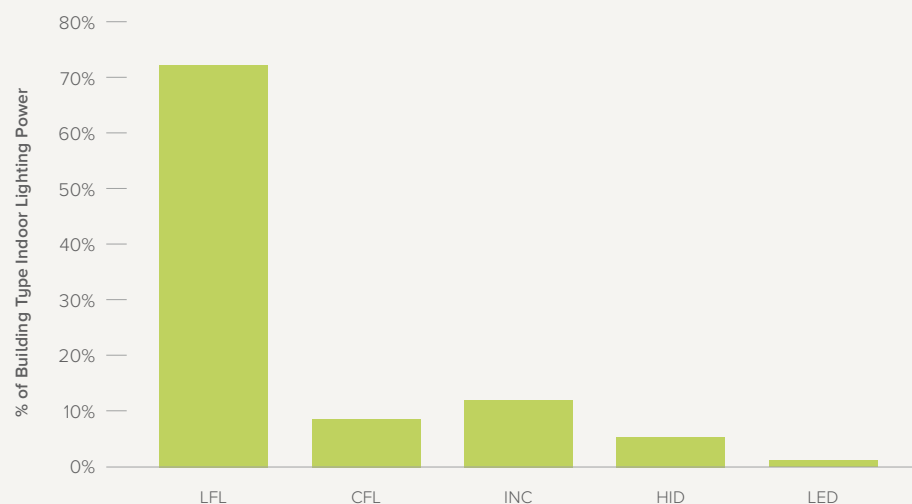


SOURCE: BPA 2014-2015 Lighting Market Characterization

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 (see Figure 5).

A four percent share gain might not seem like much, but when you consider TLEDs went from essentially no sales to 4 percent of the biggest commercial lamp market in 12 months—it's a massive movement (see Figure 6). TLEDs will almost certainly pass T12s in 2015. Figure 7 on page 9 shows the rapid growth in product listings on the Design Lights Consortium (DLC) Qualified Products List (QPL).

FIGURE 6 / Indoor Lighting Power of Linear Fluorescent Lamp

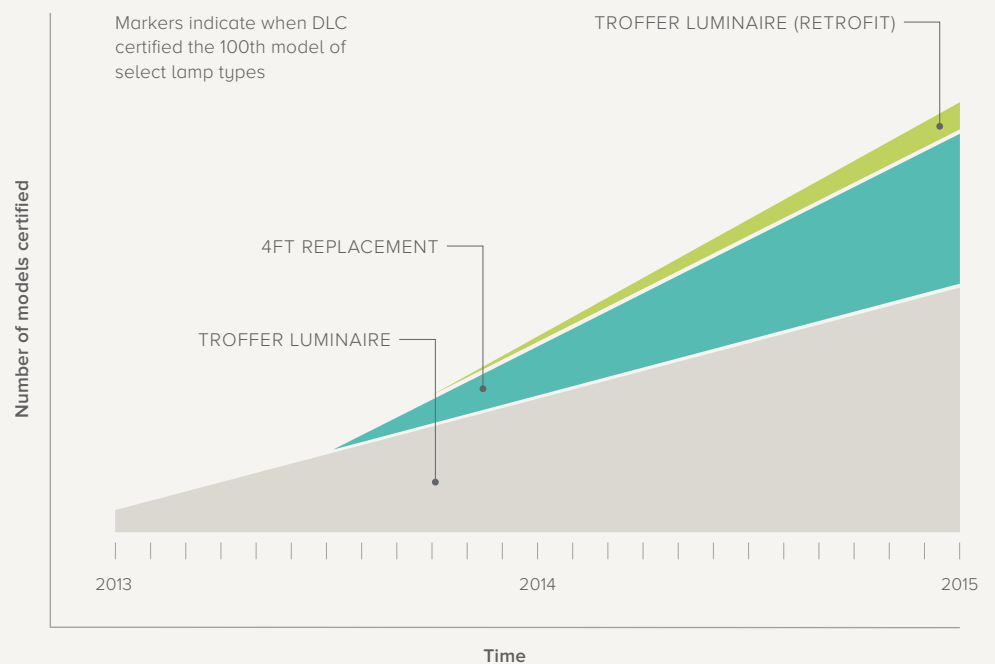


SOURCE: Commercial Buildings Stock Assessment, Northwest Energy Efficiency Alliance



One reason for the accelerating LED adoption, of course, are the dramatic cost reductions the technology has experienced over the last few years. Manufacturers expect intense competition to drive continued innovation in LED chip, package and system design and manufacturer. 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 8-10 on the following pages show the recent dramatic price declines of three common LED applications.

FIGURE 7 / Growth in Product Listings: Design Lights Consortium



SOURCE: DLC QPL Listings, March, 2015

FIGURE 8 / LED A19 60W Equivalent Pricing Trends (\$/unit)



FIGURE 9 / LED PAR38 75W Equivalent Pricing Trends (\$/unit)





FIGURE 10 / 4 FT. TLED Historical Pricing Trend (\$/unit)





What Does This Mean for Program Planners and Managers?

- 1 The rapid penetration of LEDs into the sales mix means baselines should reflect the flow of sales, not the installed stock.
- 2 Adopt agreed-upon baseline frameworks that can be easily updated with new sales data. Update baselines at least annually because longer update cycles will likely lag the market, risking liberal baselines and an overallocation of program dollars.
- 3 Collect full category lighting sales data. When the product mix changes as quickly as currently is the case, full category data (incandescent, halogen, CFL, LED) is all the more important to maintaining appropriate baselines. Lighting baselines cannot be addressed with good engineering assumptions—they need market data.
- 4 Consider creative incentives for shifting the market mix beyond a given level, as an alternative to basic upstream buy down designs.
- 5 Track LED product cost trends closely and update incentives as necessary. During interviews, some distributors mentioned rebates that were higher than the actual product cost. On the non-residential side, market actors reported a two-year payback being the sweet spot for when lighting measures really took off. Incentives that make the deal better than that may not be necessary.

Quality Assurance

LEDs are fundamentally different from traditional light sources. Test methods for characterizing their performance attributes (lifetime, efficacy, color, etc.) in various configurations and operating conditions are still emerging. Rapid product design cycles render time-consuming testing and certification processes inadequate. The proliferation of suppliers and infinite form factor and configuration possibilities make even product definitions difficult, let alone quality assurance. The Design Lights Consortium's (DLC) filled a huge program need with its Qualified Products List (QPL) for commercial luminaire and applications.

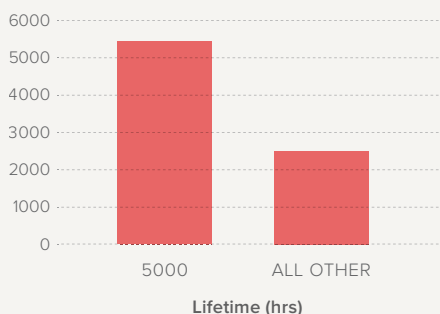
However, there is only so much the DLC QPL's information can tell us given the state of the test methods. Program managers should understand what the LED tests do and don't allow us to conclude about LED performance, so they can make informed program decisions and keep trade allies and customers aware of the uncertainties associated with many of the great performance claims of LEDs.

Lifetime is a good example. Clearly, the long LED lifetime is of compelling value. But what do the lifetime claims actually mean?

For LEDs—which gradually dim over time—lifetime refers to the length of time manufacturers estimate it will take until the lamps emits just 70% of its initial lumen output (L70s). This prediction—based on extrapolation of shorter-term trends—applies only to the light source, assuming the other components work properly. The LED driver is acknowledged as the weakest point in a fixture and likely to fail first. Figure 11 shows the great variation in lifetime claims for LED products listed on the DLC QPL.

The only way to fully characterize the useful life of an LED lamp or fixture would be to devise a test of the reliability of each system component, as it operates together within the LED system. Unfortunately, no such test exists.

FIGURE 11 / Frequency of Lifetime Claims



SOURCE: DLC QPL listings, March 2015



LED Testing: What Does it All Mean?

The three primary testing requirements for the DLC QPL are LM-79, ISTMT and LM80. Unfortunately, L70, LM-79, LM-80, TM-21, ISTMT are terms that are frequently misunderstood, misused and misapplied.

L70

Predicts when the LED reaches 70% of initial lumen output. This is the level at which humans notice a difference in light output.

LM-79

A standardized method for photometric (lumens, CCT, CRI) and electrical (power factor, input AC, input voltage) measurements of LED products.

LM-80

A standard that specifies test conditions and measurement for the useful life span of an LED package, array or module.

TM21

A method for forecasting long-term lumen maintenance of LEDs beyond the 6000 hours of testing that LM-80 documents.

ISTMT

In-Situ Temperature Measurement Test - A measure of the LED within the luminaire or lamp. The measurement is used as the basis for lifetime interpolation in TM21.

A Disruptive Technology

When electronic ballasts arrived on the scene in the late '90s, several major electronics companies with no history in lighting saw an opportunity and dipped their toes in the ballast market. When LEDs arrived a few years ago, several hundred semiconductor manufacturers jumped into the lighting pool.

An industry long dominated by three lamp companies—GE, Phillips, and Osram Sylvania—is now seeing incredible fragmentation.

FIGURE 12 / Simplified Supply Chain

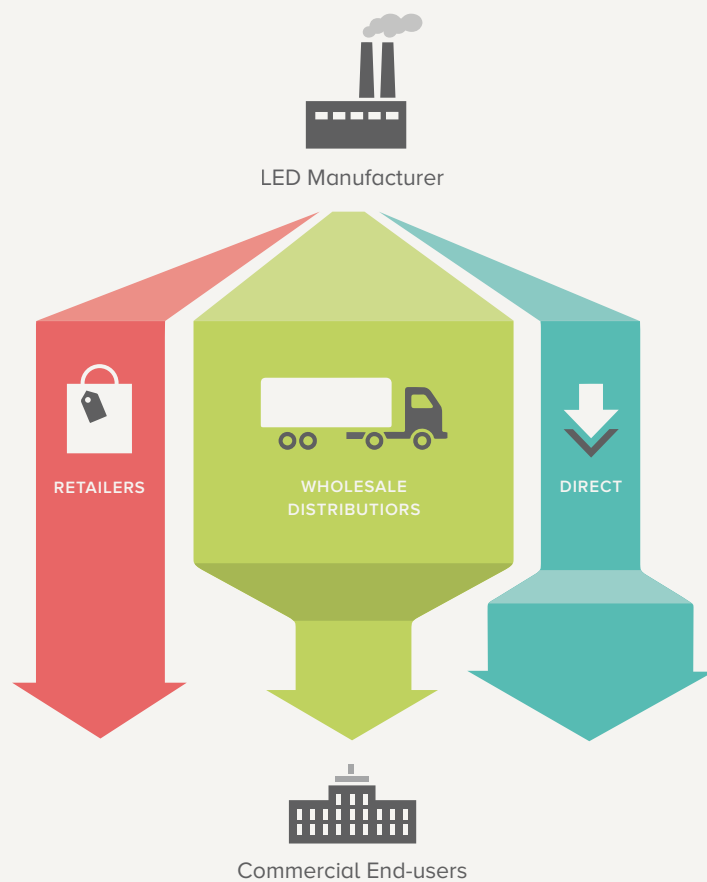




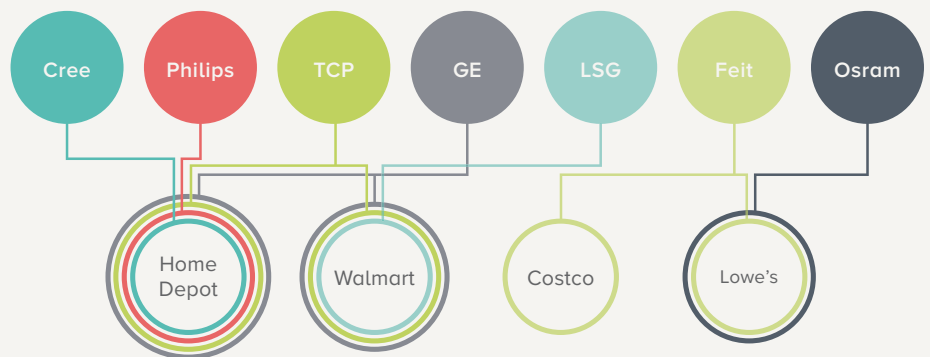
Figure 10 displays a simplified supply chain, illustrating the sequence of players involved in the distribution of LED products to end-users for the non-residential market. The traditional chain is shown in green: LEDs are brought to the end-user by way of wholesale distributors. In recent years, the profusion of suppliers has overwhelmed traditional channels.

Threatened incumbents have tried to wall off access to their established market channels—their electrical wholesale distributors, retail partners, and independent sales representatives. In response, upstart LED companies have increasingly taken their lamps and luminaires directly to the end-user, instead of going through the wholesale distribution channel. While it's too early to know how the distribution channels will ultimately change, it appears the direct-to-market channel is growing at the expense of the stocking electrical wholesaler.

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?

On the residential side, there are still many suppliers but fewer paths to the customer. The retail channel (see Figure 13) is heavily concentrated with a handful of players (The Home Depot, Walmart, Costco and Lowe's) dominating the sale of lamps to residential end-users.

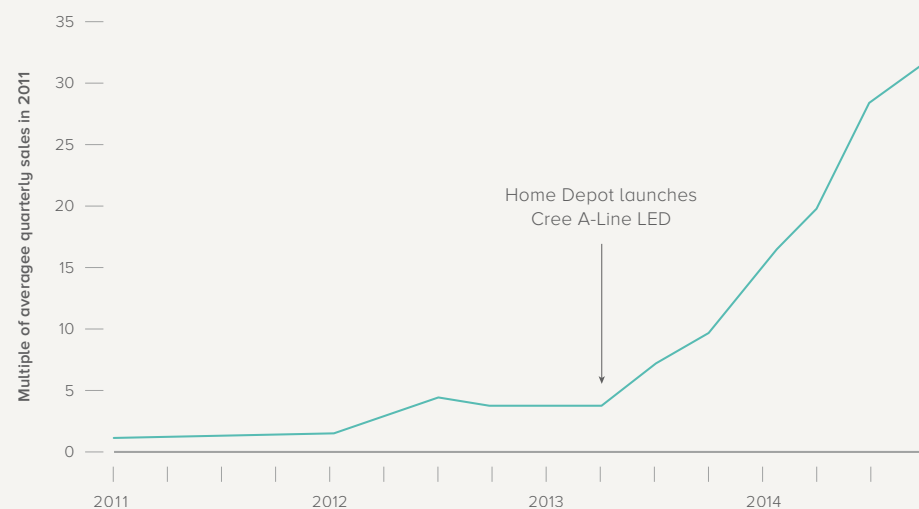
FIGURE 13 / Supply Relationships for the 60W A-Shape LED





Retailers, with their product placement, pricing, and promotion strategies, have a very strong ability to influence LEDs sales, even independently of the utility rebates that drive yet more volume. When one of the major lighting retailers decides to really push a technology, it can have a major effect on the sales mix and trajectory of LED penetration. Costco's move to sell only CFL and LED lamps is one example. Home Depot's launch and promotion of the CREE Light Bulb coincided with a national inflection in LED sales growth, as shown in Figure 12. CREE's bulb is the best selling bulb in the country, and it is only available at Home Depot.

FIGURE 14 / LED A-Line Sales



SOURCE: NEMA A-Line Sales Index

FIGURE 15 / Residential Lighting Regulatory Glance



SOURCE: NEMA A-Line Sales Index



A closer look at retailer strategy can inform residential strategy. The residential programmatic talk (and retailer strategy) in recent years has centered on the impact of EISA, which has been fully phased in for more than a year. Nuances in the regulations and other DOE standards make the complete regulatory landscape difficult to grasp at a glance. Figure 15 on the previous page puts residential lighting in complete regulatory context. Every wattage regulated (in light gray) is effectively halogen or a more efficient technology.

Where are the gaps in coverage? Most notably, candelabra base, PAR and reflector bulbs—often called “specialty” in programs—speak—have more exemptions than the A-Line bulb.

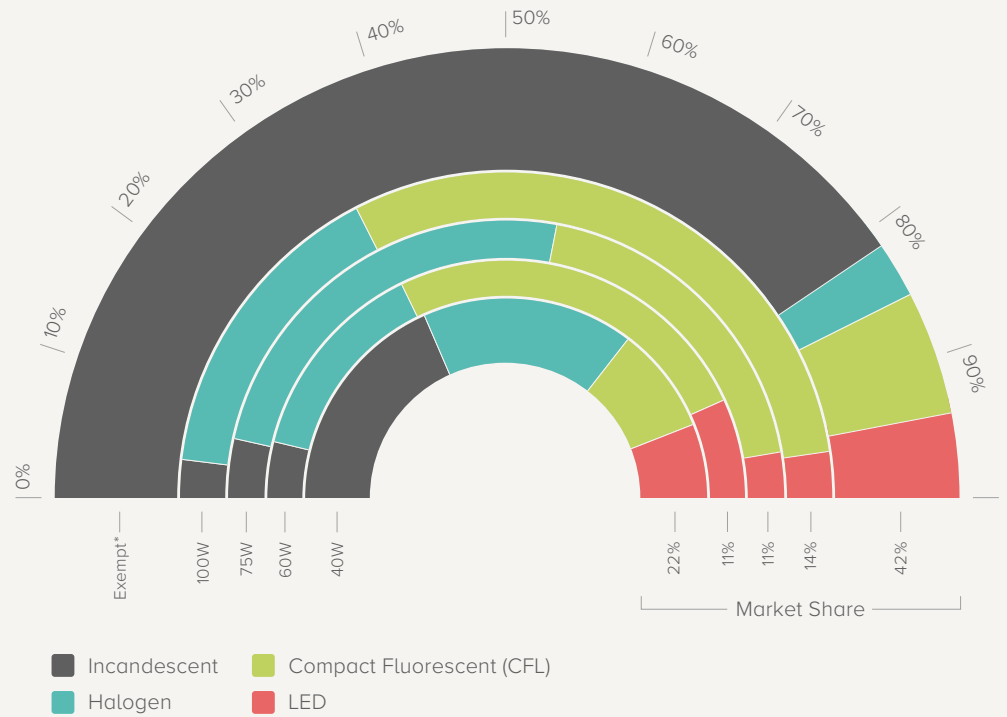
To see how the market reacted, we used NEEA's most recent shelf survey¹ to investigate the NW market technology mix on shelves, nearly a year after EISA was fully phased in. The law initially applied to the 100W equivalent category on January 1st, 2012. It applied to the 75W category one year later, and to the 60W and 40W categories on January 1st, 2014.

Using store weights based on subchannel and retailers' market share estimates developed through interviews and a variety of measures, the team estimated the actual total NW market technology mix on the shelves for each of the three basic residential lamp types: general purpose, decorative and reflector.

The shelf availability of technology is clearly correlated to a couple factors: The timing of the phase in and the availability of LED solutions. The longer EISA has been in effect, the lower the share of incandescent. For example, in figure 16 on the next page, the share of incandescent bulbs diminishes, moving from the 100W category (effective in 2012) to the 40W category (effective in 2014). We can observe too the stark difference in incandescent share between the exempted and unexempted categories. The law clearly worked—where it applies. Some 40% of the units and Watts on the shelves are exempt or not covered by another DOE standard (In nearly all such cases, the share of incandescent lamps is dominant).

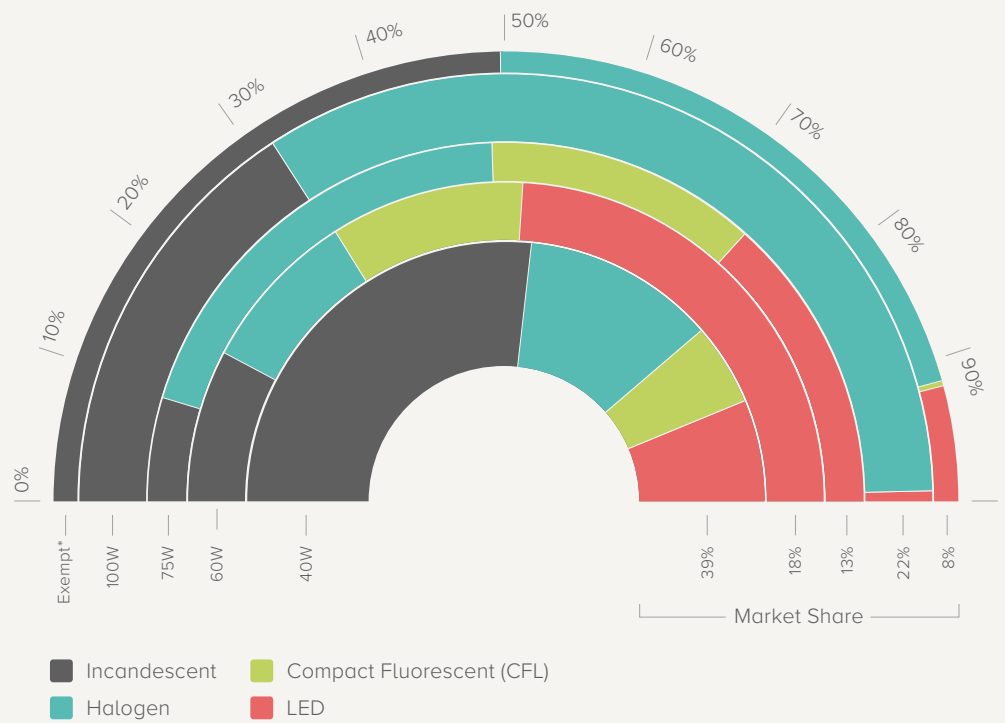
¹Source: Northwest Energy Efficiency Alliance, “2013-2014 Northwest Residential Lighting Long-Term Market Tracking Study” January 2, 2015 and Navigant and Cadeo Analysis. The Team used an analytical approach, coined the Chain Logic Method to estimate the market share of each vendor or group of vendors in the region. The team then used the NEEA shelf survey to compute the technology distribution across different applications and wattage equivalents.

FIGURE 16 / General Purpose Lamps



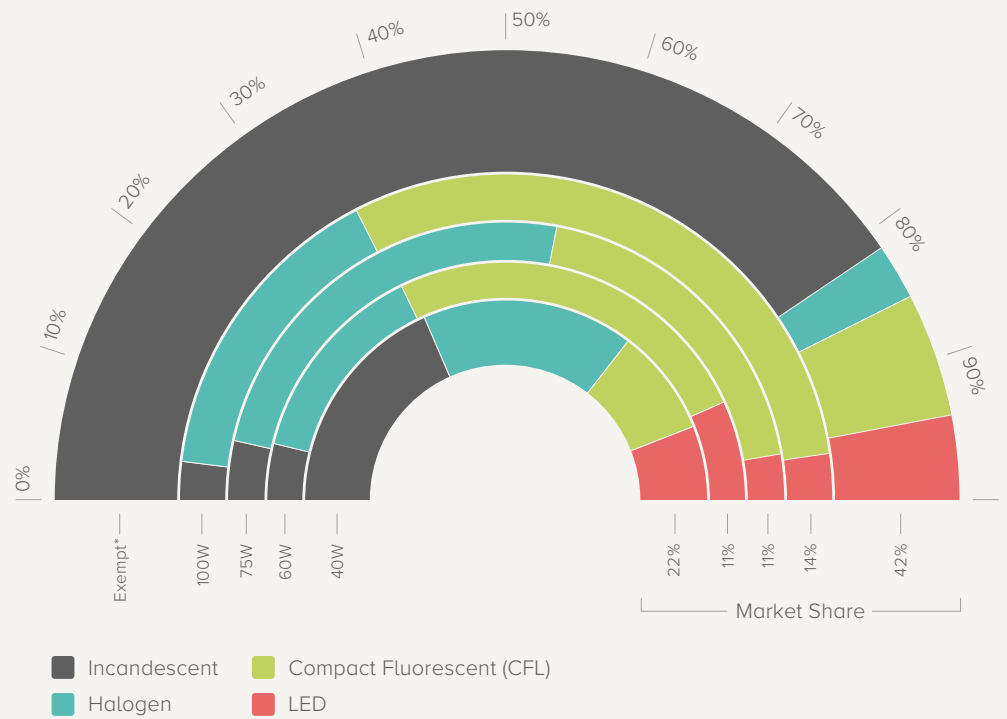
*3 way lamps < 310 lumens, > 2600 lumens

FIGURE 17 / Reflector Lamps



* < 310 lumens

FIGURE 18 / Globe & Decorative Lamps



*3 way lamps < 310 lumens, > 2600 lumens



One might expect a similar trend at the high end of the efficiency mix: LEDs should have the greatest market share where EISA has been effective for the longest time—namely the 100W equivalent category. However, technological development for the higher wattage categories has lagged the 60W category.

FIGURE 20 / CREE A-Line Launches

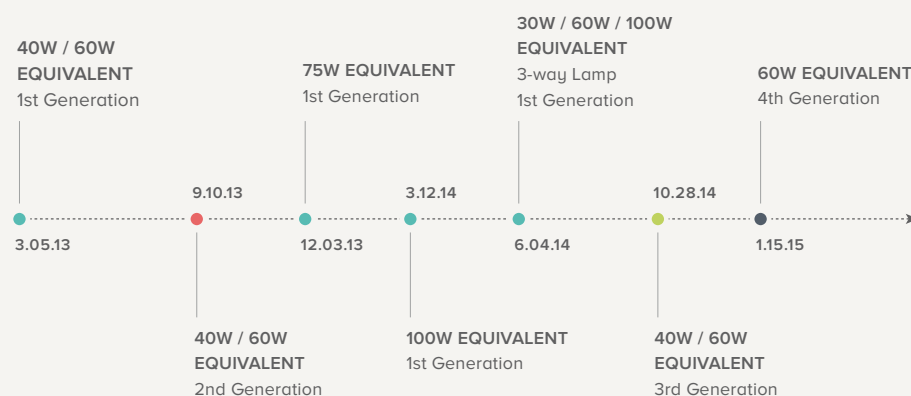
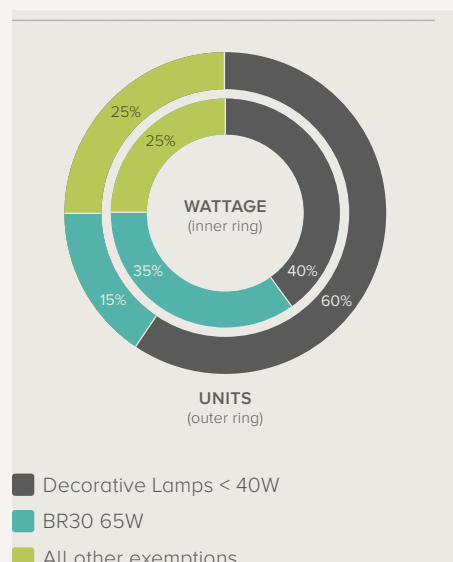


FIGURE 19 / XXXXXXXXX



SOURCE: Northwest Energy Efficiency Alliance, "2013-2014 Northwest Residential Lighting Long-Term Market Tracking Study" January 2, 2015



What Are The Program Implications?

Segment the market and consider focusing on the EISA coverage gaps that matter. Support the development of LED solutions where none or few exist. These are often in the decorative or specialty niches that only collectively add up to substantial potential resources.

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The Great System Race

Two forces are driving the lighting world from lamps to systems. One is economic: The profusion of LED chip manufacturers has and will likely continue to drive price declines and commoditization at the LED component level. The second is technological: Fundamentally, light emitting diodes are an enabling technology. They are a source of light, not an interchangeable, standardized bulb sold separately from ballast and fixture. “The coordination required to produce an LED light fixture has forced the luminaire manufacturer to assume the role of the source provider.”² In other words, it has pushed higher profit margins for luminaire manufacturers.

These two facts have driven many lighting companies, and nearly all the large ones, to seek refuge higher in the value chain, seeking to become ‘solution providers’ rather than bulb manufacturers. Retailers and manufacturers would prefer the light source shift from a ‘need’ to a ‘want’, from a widget to an experience. Experiences are more profitable.

Integrated systems with sophisticated controls and people-centered functionality promise not just superior efficiency but also many non-energy benefits, from remote program evaluation to high-speed internet access to enhanced mood, sleep, and productivity to, well, feeding the next 3 billion people on planet. (Who would want to sell light bulbs when you can get paid to do that?)

² 2014 U.S. Department of Energy, Specifying LED in a World of Continuous Change.



What Does This Mean for Program Planners and Managers?

- 1 Lighting programs will need to think critically about what they promote and are willing to pay for. These additional features will be bundled, in many cases, with the energy efficiency potential.
- 2 Enable rather than prescribe. The efficiency benefits of 'system thinking' are well established.
- 3 Educate more, dictate less. The confluence of hardware, software, new lighting performance metrics, and user-experience will be dynamic and ever changing. Rather than attempt to provide answers, programs may do well to arm trade allies and customers with the ability to ask the right questions in this new world.
- 4 Focus on the market dynamics around systems. Which market actors make the decision on the project, who frames the options, who coordinates the project?

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