

ENERGY STAR®. The simple choice for energy efficiency.



THE LIGHT BULB REVOLUTION

EPA predicts widespread consumer adoption of LED lighting by 2020 if utility programs persist.

October 2017

Acknowledgements

The ENERGY STAR program would like to thank the following partners and stakeholders for providing data, images and insight in the preparation of this report.

- Apex Analytics
- Consumer Federation of America
- Eaton Lighting
- GE Lighting
- Pacific Gas & Electric
- Philips Lighting North America

In addition, EPA would like to acknowledge Laura Wilson, NAVITAS Partners and Daniel Rogers, ICF for their oversight and contributions.

This report was written by EPA's ENERGY STAR Lighting Program Manager Taylor Jantz-Sell.

Recommended citation: EPA Office of Air and Radiation, Climate Protection Partnerships Division. Light Bulb Revolution: EPA Predicts Widespread Consumer Adoption of LED Lighting by 2020 if Utility Programs Persist. U.S. EPA, 2017.



IMAGE SOURCE: ENERGYSTAR.GOV

Why a dramatic change in the light bulb market can really happen this time.

Energy efficient alternatives to incandescent light bulbs have been available for a long time. For one reason or another, they have not taken hold in a significant way - all that is about to change.

As of 2017, market conditions have converged such that LED bulbs are poised for widespread consumer adoption. Prices are down, savings are up, and an independent certification process against rigorous performance standards is bolstering customer satisfaction.

Traditional incandescent light bulbs, the familiar 100, 75, 60 and 40W bulbs, have served American's basic lighting needs for more than a century, but 90% of

efficient, and replacements for the most widely used light bulbs, the 40 & 60W incandescent, can now be purchased for \$2 or less across the US.

Utilities learned the hard lessons of the early CFLs rebate programs, which pushed price over performance. Today, the millions of dollars in incentives offered in communities around the country are tied to LED lighting that meets strict performance standards designed to support broad, long-term consumer acceptance.

Three light bulb technology choices.

While there are a variety of more efficient technologies and innovations in the market today, three main technologies now dominate the light bulb choices commonly available to Americans in 2017. The least efficient option is the incandescent halogen, which is about 30% more efficient than traditional incandescent light bulbs. This technology uses a small halogen filament capsule inside the bulb to produce light. The second option, compact fluorescent light bulbs (commonly known as CFLs or spirals), are about 75% more efficient than traditional light bulbs, and the third -- light emitting diode (LED) light bulbs are about 90% more efficient than traditional bulbs. For some high or low lumen output, or specialty, products, traditional inefficient incandescent lamps can still be found.

The average American home has approximately 50 sockets. About 60% of them still contain an inefficient light bulb. Two-dollar, high-quality LED bulbs can fill those sockets and save Americans more than \$6 billion a year to light their homes.

the energy used is wasted heat and only 10% is used to deliver light, essentially lighting homes with small heaters. LED bulbs, on the other hand, are about 90%

Quality LED light bulbs pay for themselves in a few months

Common LED bulbs (the 40 and 60W replacements) can be purchased today for \$2 or less per bulb, but that is just the upfront cost. More important to consider is avoiding the hidden cost of operation due to excess electricity use. A \$2 LED bulb pays for itself in energy saved in a few months with typical use. The chart in Figure 1 shows annual energy costs

vary significantly by technology. When lifespan of the product and purchase price are factored in (Figure 2), the total cost of ownership for the most common 60W replacement light bulb is \$99 for the old technology and \$18 for the new technology. Over its lifetime, a single 15,000-hour ENERGY STAR® certified LED bulb would save about \$80 compared to the 15 halogen-incandescent bulbs needed to operate over the same time period.

FIGURE 1



IMAGE SOURCE: ENERGYSTAR.GOV

Common Bulb Technologies with Annual Electricity Cost

Did you know? With greater access to innovative LED technology, consumers are discovering that LEDs are not all the same. Only bulbs with the ENERGY STAR label are independently certified, undergoing extensive testing to assure they perform as promised. Just like early CFLs, LED technology has its challenges—in particular suffering from limitations affecting brightness and light distribution. However, the government-backed ENERGY STAR label works as a “seal of approval” for LED bulbs, to indicate they save energy, deliver on brightness, and work the way you expect light bulbs should.

The options American households have today will save them \$50-100 on average per year compared to using all older traditional incandescent light bulbs. With an average of 50 light bulbs per American household¹ Americans have the potential to save \$6 billion annually in energy costs.

FIGURE 2

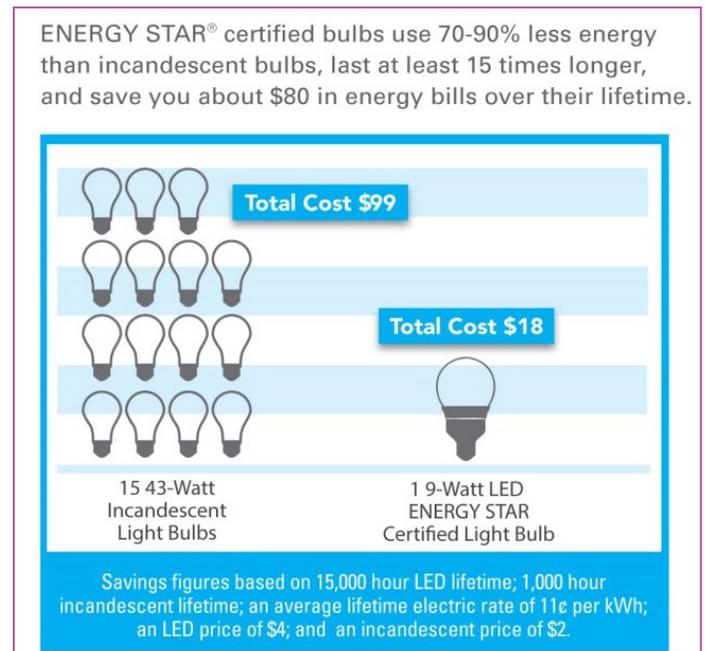


IMAGE SOURCE: ENERGYSTAR.GOV

Lifetime Savings

¹ Source: DOE 2012 Residential Lighting End-Use Consumption Study. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_residential_lighting-study.pdf

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The simple light bulb’s rocky road

Thomas Edison invented a commercially viable electric light in 1879. Throughout the 20th century, researchers worked to improve on Edison’s design, looking for ways to make the bulb more efficient and last longer, with limited success. In the latter half of the century, researchers started looking for new ways to produce light more efficiently. A variety of inventions and the oil crisis in 1973 helped pave the way for a new technology. Drawing from developments in discharge and commercial fluorescent lighting, engineers at Sylvania and General Electric created the first compact fluorescent light bulbs (CFLs) which eventually hit retail shelves in the mid-1980s at \$25-\$35 per bulb.

Importance of the ENERGY STAR® label

ENERGY STAR® is widely recognized by consumers as the simple choice for energy savings. The little blue label means a lot more than that for light bulbs. To earn it, LED bulbs must conquer the historical limitations associated with LED technology and demonstrate they have what it takes to overcome traditionally negative perceptions about energy efficient lighting. ENERGY STAR’s strict guidelines include:

- Verified compliance with 26 separate industry standards and procedures
- Third-party testing of products off the retail shelf
- High heat testing to stress the products in operating environments similar to actual field operation
- Minimum 3 year warranty

ENERGY STAR Third Party Certification

- Products are tested in accredited labs
- Performance is reviewed by independent, accredited certification bodies
- Products are subject to random off-the-shelf testing

Right away, electric utility companies saw the opportunity to get light bulbs that are more efficient into their customers’ homes as a way to help reduce and manage energy demand. They worked with manufacturers and retailers to help reduce the cost of more efficient light bulbs for their customers, a practice that is still going strong across the United States today.

Early CFLs were expensive, bulky and had some performance drawbacks that people were not happy about such as buzzing, poor light color, and slow warm up to full brightness. CFLs have come a long way in the last 30 years. With manufacturing advances and national voluntary performance standards like ENERGY STAR, modern day CFLs are small, efficient, produce better light faster, and are available in a variety of sizes, shapes and light colors. There are special CFLs that work on dimmers or three-way switches. But even modern day CFLs can’t match the full performance consumers expect from a light bulb and have not always lived up to their long life claims. Slow warm up time and disposal concerns remain pain points. Despite over a decade of promotion from efficiency groups, CFLs could not meet consumers’ needs enough to replace the beloved light bulb.



IMAGE SOURCE: ENERGYSTAR.GOV

LED bulbs even had some challenges to overcome – but in a short time exceeded our expectations.

The first LED bulbs that entered the market around 2007 produced very low light levels and were not ideal replacements for traditional bulbs. Some early designs were otherworldly; many of the early bulbs used LEDs on the blue (cool) end of the white light spectrum, and they could not match the light output or distribute the light the way traditional bulbs could. In addition, early-to-market designs did not manage the small amount of heat produced by the LEDs themselves so they burned out prematurely.

Today, LED bulbs look and act just like familiar traditional incandescent bulbs: instant on, quality light all around. Most are designed to dim; some get warmer in color as they dim; and some are designed

to match the look of trendy vintage-style bulbs. Efficiency continues to improve. The first true 60W replacement LED used about 13 W in 2012. Today, the average ENERGY STAR certified LED 60W replacement uses 9W, while some, like the vintage-style, use as little as 7W. The last big hurdle for consumer satisfaction

is the dimming experience, and efforts to solve this are reaching a major turning point. This year consumers will have the tool available to identify compatible LED bulbs and dimmers with ease.

LED bulb prices plummet

As prices were dropping for LED light bulbs, a major shift occurred in 2015 when retailers shocked the market with two-packs of LED bulbs for \$4.97, and Black Friday sales at \$0.99 for a single LED bulb. All the while prices in many parts of the country had been further reduced by utility incentives. In 2016, the cost of LED bulbs came down so significantly across the board that there were affordable, high-quality ENERGY STAR certified options for almost

FIGURE 3

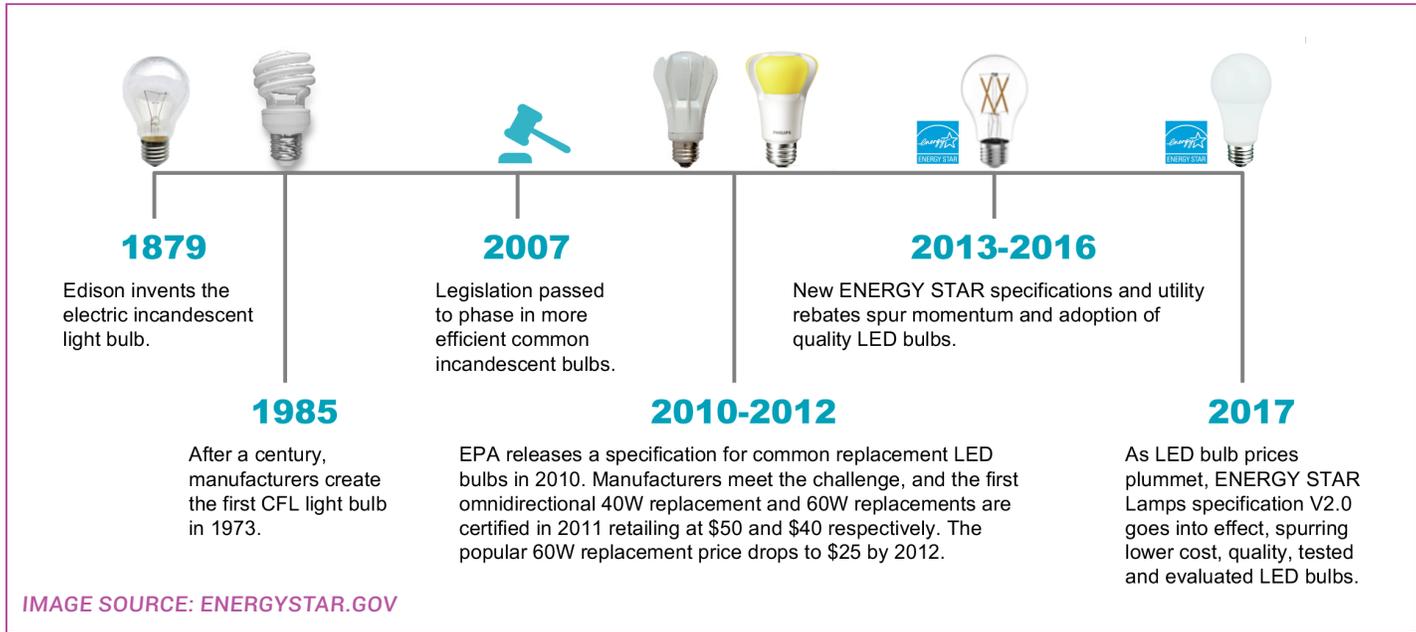


IMAGE SOURCE: ENERGYSTAR.GOV

Light Bulb Technology Milestones

FIGURE 4

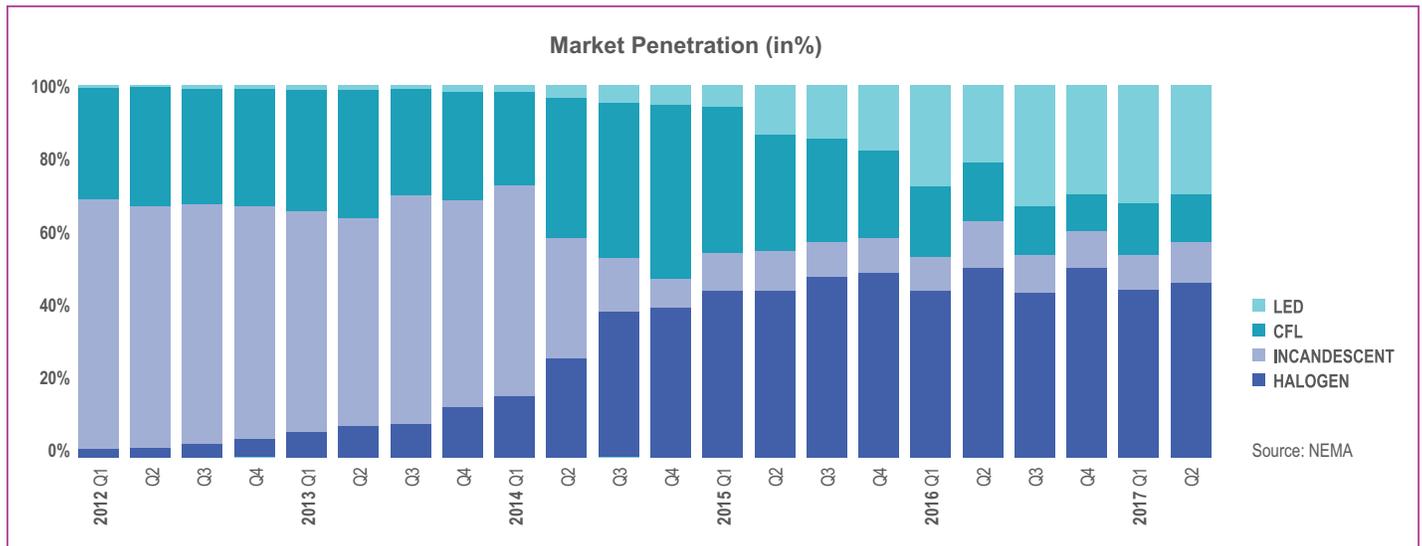


IMAGE SOURCE: ENERGYSTAR.GOV

Quarterly Shipments of General Service Light Bulbs

every socket. Typical 40 and 60W replacement bulbs that have earned the ENERGY STAR can be found in multipacks for as low as \$2 a bulb, without rebates. In some parts of the United States, ENERGY STAR certified LED light bulbs are on sale for \$1 or less per bulb. This reflects a significant market development for the light bulb that hits high performance levels, has been rigorously tested, is third-party certified and is estimated to last at least 15,000 hours (about 12 years with typical use). The role played by utilities across the U.S. will have proven to be pivotal in reducing the upfront cost of ENERGY STAR LED lighting and helping speed adoption of quality LED lighting.

Market shift away from CFL and incandescent to LED and Halogen

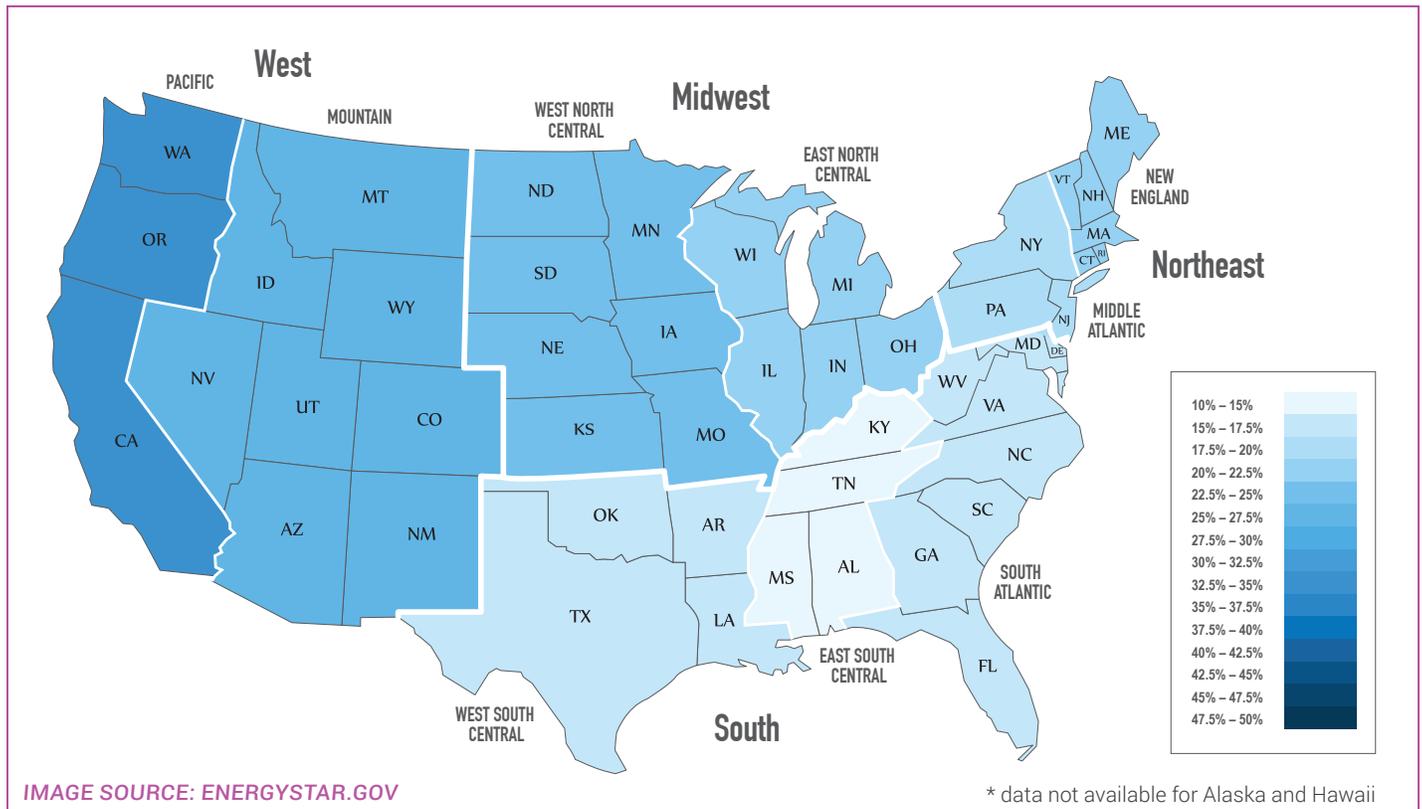
While legislation passed in 2007 has prompted a shift away from traditional incandescent light bulbs, the long-term viability of any replacement hinges on the extent to which consumers are satisfied. Recent market trends show a shift away from CFLs towards LED bulbs as the better and more efficient option. While CFLs were highly promoted and incentivized as an energy saving option, widespread adoption never occurred. The highest saturation of CFLs in the country exists in areas where they were heavily rebated and promoted by utility efficiency programs,

but even in these areas, the highest estimated saturation has topped out at around 35% of sockets.

The lead up to what promises to be a dramatic change towards LED bulbs, can be seen in Figure 4. This chart from the National Electrical Manufacturers Association (NEMA) depicts quarterly shipments of general service light bulbs by four main technologies (this chart includes traditional incandescent technology). EPA predicts that LED will be the dominating light bulb technology in 2018 if awareness and promotion of LED bulbs remains strong by retailers, manufacturers, and utilities.

The map below (Figure 5) shows the percentage of LED bulb sales compared to sales of other common technologies in the continental U.S. LED lamp sales range from 10-43% of all bulb sales in the states with notably higher percentages where utility programs have been promoting LED bulbs. Overall, LED bulbs sales are not yet dominating light bulb sales. The majority of light bulb sales are still the least efficient (incandescent and halogen) bulbs on the market. Figure 6 compares sales based on utility program activity where the percentage of LED lamps sales has been seen to increase in a state from 5-10% based on utility program spending. It is clear that adoption is happening but sustained effort is needed for

FIGURE 5

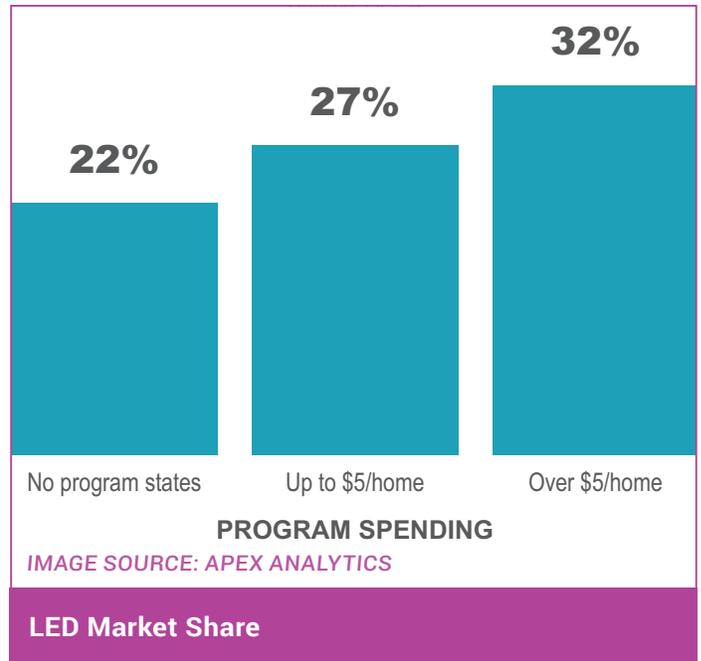


2015-2016 LED Bulb Sales as a Percentage of Other Technologies Sold² by Census Region and Division*

widespread consumer adoption of LED bulbs. Even in areas of the country, such as the San Francisco Bay area, characterized by a population of environmentally conscious early adopters with generous utility program incentives, residential LED bulb adoption is estimated at only 14%. Sustaining the efforts that have led to increased availability, discounted prices and growing awareness of benefits will further accelerate the adoption of quality LED lighting and deliver on the full savings opportunity.

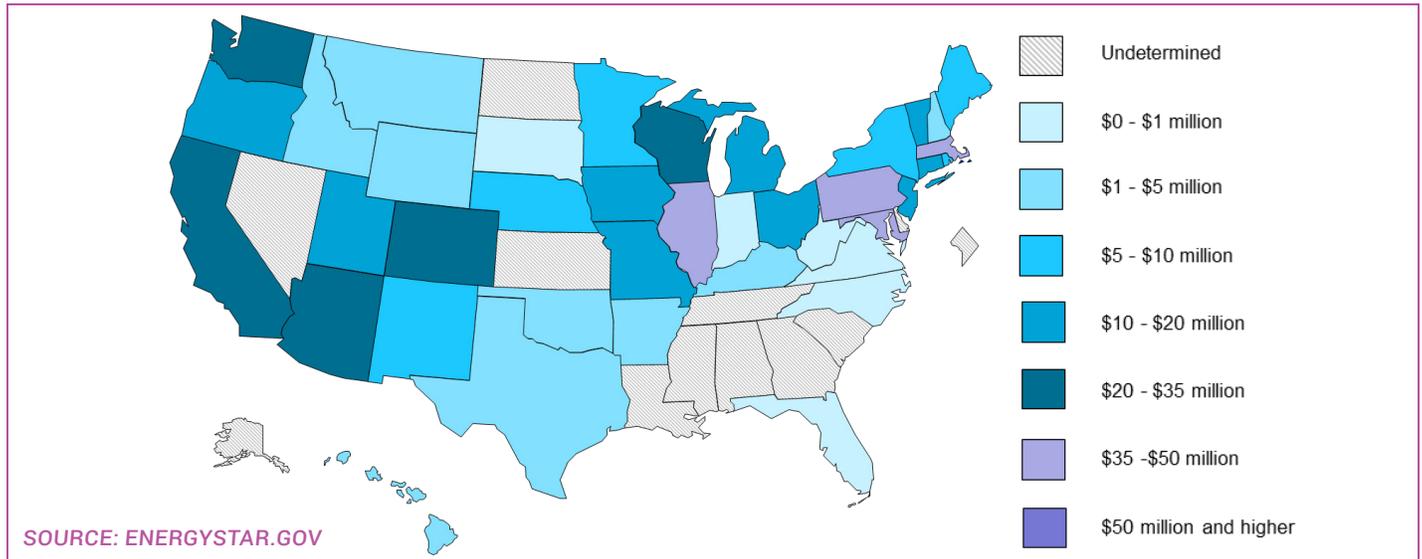
The map on the following page (Figure 7) shows utility program spending for lighting programs in 2017. It includes spending for all efficient lighting including CFL.

FIGURE 6



² This information is based in part on data reported by IRI through its Advantage service for, and as interpreted solely by Lighttracker, Inc. Any opinions expressed in the data used to make the map reflect the judgment of Lighttracker Inc. and are subject to change. IRI disclaims liability of any kind arising from the use of this information. In addition, the data presented include LightTracker calculations based in part on data reported by Nielsen through its Strategic Planner and Homescan Services for the lighting category for the 52-week period ending approximately on December 31, 2016, for the available state level markets and Expanded All Outlets Combined (xAOC) and Total Market Channels. Copyright © 2016, Nielsen.

FIGURE 7



Utility Program Spending for Lighting Programs in 2017

If **every American home** replaced their five most frequently used light fixtures or the bulbs in them with **LED bulbs that have earned the ENERGY STAR**, we would:

- Save enough energy to light **33 million homes** for a year.
- Save nearly **\$5 billion** each year in energy costs.
- Prevent greenhouse gases equivalent to the emissions from nearly **6 million cars**.

As shown in Figure 8, data from the 2015 Residential Energy Consumption Survey³ (RECS) show that, as of 2015, most homes in the United States used

more than one type of lightbulb, primarily a mix of incandescent and compact fluorescent (CFL). Adoption of light-emitting diode (LED) bulbs has been increasing, with 29% of U.S. households reporting at least one LED bulb installed.

Residential lighting generally has shifted from less energy-efficient lighting, primarily incandescent bulbs, to more energy-efficient lighting, including CFLs and LEDs. In 2009, 58% of all households used at least one energy-efficient bulb indoors. In the 2015 RECS, which was administered from August 2015 to April 2016, 86% of households reported using at least one CFL or LED bulb. Nationwide, 18% of households reported no incandescent bulbs in their homes.

FIGURE 8

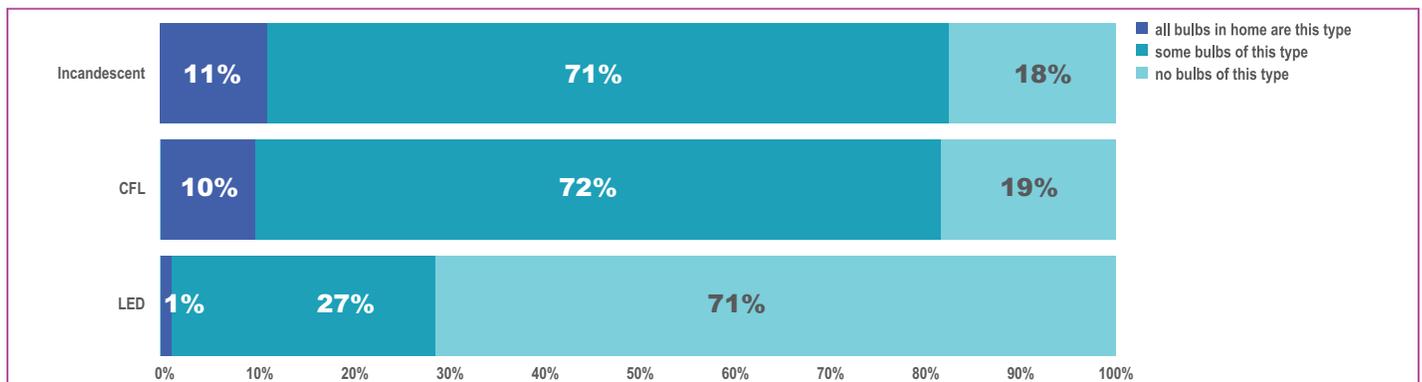


IMAGE SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION, 2015 RESIDENTIAL ENERGY CONSUMPTION SURVEY

Residential Lighting Adoption by Technology Type (percent of homes)

³ <https://www.eia.gov/consumption/residential/data/2015/>



IMAGE SOURCE: PHILIPS LIGHTING® ENERGY STAR CERTIFIED CONNECTED BULBS

However, many consumers still do not know the benefits of LED bulbs. In June 2016, ORC International surveyed, for the Consumer Federation of America, 1,007 representative adult Americans about their views and behavior related to socket light bulbs typically used in their homes. The survey⁴ revealed that most consumers: know little or have modest knowledge about the different types of light bulbs, do not have LEDs as the “main type of light bulb” in their living room or bedroom; and when their current bulbs burn out, do not plan to replace them with LEDs.

Respondents were also asked what they considered a reasonable price for a single 60-watt bulb for a table or floor lamp. The mean response was \$3.30 while the median response was \$2.00. The survey suggests that consumer education has the potential to increase consumer sales of energy-efficient LEDs.

The SYLVANIA Socket Survey⁵ also revealed an upswing of LED lighting adoption as it continues to gain popularity, with nearly 70% of Americans having purchased at least one LED bulb. 48% have purchased at least one LED bulb in the last 12 months, a 17% increase over last year. According to the survey, 38% of consumers have switched to LEDs since the phase-out of standard incandescent bulbs, making LEDs the number one replacement option for Americans.

Major manufacturers and retailers are embracing the LED light bulb

IKEA, who was ahead of the game in dropping incandescent bulbs in 2011, announced in 2015 that they were dropping CFLs and only selling LED lighting. Other leading U.S. retailers of light bulbs quickly followed suit. Costco shifted in store offerings to all ENERGY STAR certified LED bulbs, The Home Depot, and Walmart stopped buying CFLs in 2016.

FIGURE 9

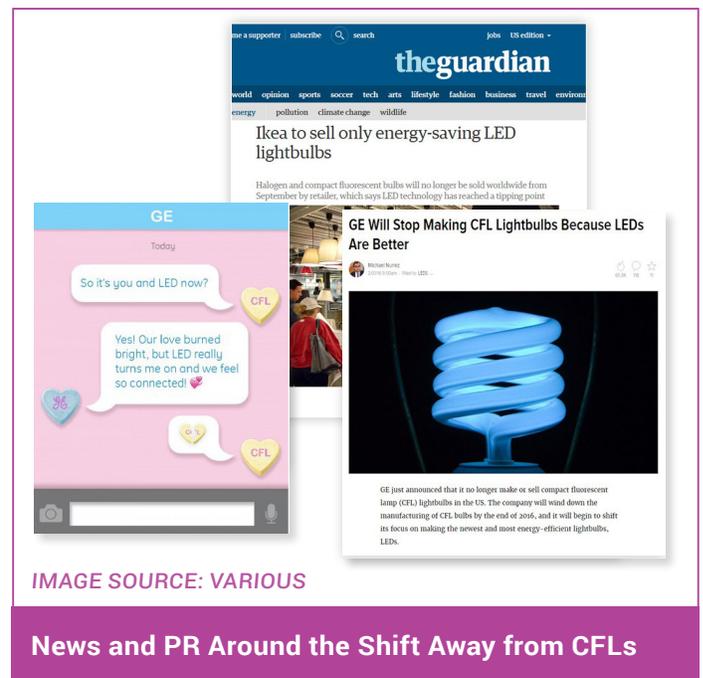


IMAGE SOURCE: VARIOUS

News and PR Around the Shift Away from CFLs

⁴ CONSUMER VIEWS AND BEHAVIOR RELATING TO LIGHT BULBS: FINDINGS OF A NATIONAL SURVEY, Report on Survey Undertaken By Consumer Federation of America and ORC International, January 2017 <http://consumerfed.org/wp-content/uploads/2017/06/CFA%20Lighting%20Survey%20Summary-January%202017.pdf>

⁵ <https://www.sylvania.com/en-us/newsroom/press-releases/Pages/2016-Socket-Survey.aspx>



IMAGE SOURCE: WWW.DESIGNRULZ.COM

GE announced in February of 2016, that they were breaking up with CFLs, ramping down production to cease by the end of the year.

What the future holds for lighting

Soon the upfront price for basic light bulbs of any technology will be comparable (i.e. within \$1), while operating them will be where consumers either sip or gulp energy depending on which technology they choose. LED lighting will continue to increase in efficiency. The energy needed to power a typical 60W

replacement (producing about 800 lumens) has gone from 13W to 8W in the last 3 years.

LED technology is dynamic compared to other lighting technologies offering a long list of potential features that were never possible before and plenty of benefits beyond energy efficiency and long life. With a small discrete form factor, LEDs presents opportunities to integrate lighting into spaces and furniture or hide it under cabinets for task lighting, allowing for a lot of creativity. Their low power consumption is well suited for battery or solar operated products that do not require connecting to a source of electricity. When it comes to controlling the light -- not just brightness but also color -- LEDs allow great customization to accommodate preferred light color and adjust color to your day, supporting your wakefulness and circadian rhythm. They can also work easily in tandem with natural light through the use of sensors and controls. The possibilities are endless.

Research is already suggesting that LED lighting can potentially enhance well-being. For example, at a senior living facility, an LED pilot installation⁶ included adjusting the spectrum and brightness of light in

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HU20 Magnetic Puck LED Undercabinet

Eaton Lighting's ENERGY STAR Certified Magnetic LED Puck Light for Undercabinet Lighting

IMAGE SOURCE: ENERGYSTAR.GOV

⁶ Tuning the Light in Senior Case: Evaluating a Trial LED Lighting System as the ACC Care Center in Sacramento, CA, August 2016, <https://www.energy.gov/eere/ssl/articles/new-gateway-report-tunable-lighting-senior-care-facility>

ENERGY STAR LED BULB FINDER



IMAGE SOURCE: ENERGYSTAR.GOV

corridors according to the aging eye to improve sight and reduce falls. Tuning the light color throughout the day for nurses' stations helped increase the alertness of staff working the night shift. In addition, new, inviting light stimulated more socialization.

Although LED lighting design and shapes are potentially unlimited, traditionally shaped light bulbs to fit into the billions of existing sockets will be around for many years. Today American consumers can find LED bulbs to meet basic lighting needs, and then some. More light bulbs that are "intelligent" are entering the market and consumer demand for these products continues to grow. Manufacturers are integrating microchips into LED bulbs to enable them to be controlled remotely, to turn on and off or dim or operate on a schedule or based on occupancy of a space. These latest light bulb innovations provide for ease of control, added comfort and peace of mind. According to a 2016 market research report, the total smart lighting market is expected to reach 1.27 billion units by 2022, at a compound annual growth rate (CAGR) of 71.3% during the forecast period.⁷

Smart bulbs offer features that include allowing the end user to select custom light colors in shades of white. Some bulbs let you pick from anything on the

rainbow. Some have built in speakers or cameras or even Li-Fi (like Wi-Fi enabled by microchips inside a bulb). They often utilize software applications to control the light, dimming, off/on, and color changes. Some can be programmed to operate while you are out of the house, so it looks like you are home, but using minimal energy. They can also act as security cameras and Wi-Fi hotspots (aka Li-Fi). According to a March 2015 survey⁶ of Osram Sylvania consumers, 83% of Americans

think "smart lighting" is a good introduction to home automation technologies. Even more, 72% of Americans think "smart lighting" will eventually replace regular light bulbs.

Smart bulbs, that allow for lighting customization and control such as scheduling or on demand control of light color and brightness, are already available today. Some use sensors and algorithms to learn your patterns and adjust accordingly to optimize the settings to your lifestyle. An important thing to note is that like any connected device, these bulbs consume energy 24 hours a day -- most of the smart bulbs on the market draw a watt or more even when they are not really "on" which is not a lot of energy but adds up. ENERGY STAR certified smart lamps use no more than half a watt in standby and have to meet the strict efficiency and performance criteria met by all other ENERGY STAR labeled bulbs. Products providing you the ability to control brightness and color to enhance everyday life are already here and their availability is expected to grow. Lighting that allows for this level of control eliminates the need for dimmers or even picking the right light color in the first place, ultimately simplifying and customizing our lighted spaces while saving energy. The solutions are here and now plentiful and efficient.

⁷ "Smart Lighting Market by Product Type (Smart Bulbs, Fixtures, and Lighting Controls), Light Source (Fluorescent, LED, HID), Communication Technology (Wired, and Wireless), Software & Service, Application, and Geography - Global Forecast to 2022," <http://www.marketsandmarkets.com/Market-Reports/smart-lighting-market-985.html>

Finding the right light bulb

What are the most important things to consider when buying a light bulb today? Think of them as the light bulb ABCs: Application; Brightness; and Color. This guide will help with the trickier items many are not familiar with such as figuring out how much light is needed or what color light someone may prefer. There is also an interactive mobile version: energystar.gov/choosealight.

Application: The type of light fixture dictates the bulb shape and it is important to purchase the bulb designed for your application. Another important consideration is whether the bulb is going to be used

	BULB TYPES				
TABLE OR FLOOR LAMPS		 STANDARD			
PENDANT FIXTURES		 STANDARD	 GLOBE	 MR16	 CANDLE
CEILING FIXTURES		 STANDARD	 CANDLE		
CEILING FANS		 STANDARD	 CANDLE		
WALL SCONCES		 STANDARD	 GLOBE	 CANDLE	
RECESSED CANS		 MR16	 SPOT	 FLOOD	
ACCENT LIGHTING		 MR16	 SPOT		

IMAGE SOURCE: ENERGYPSTAR.GOV

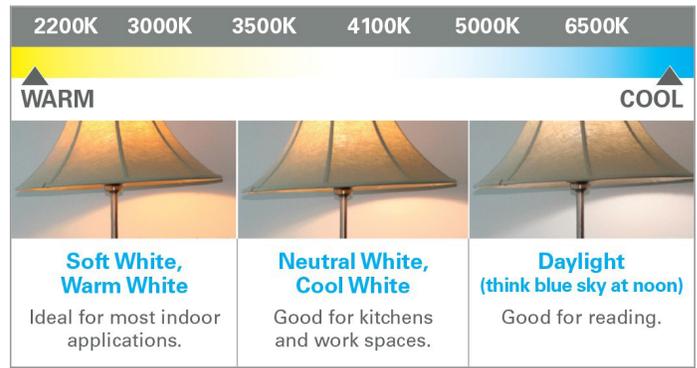


IMAGE SOURCE: ENERGYPSTAR.GOV

on a dimmer switch. Proper application information or restrictions will be listed on the packaging.

Brightness: The amount of light the bulb produces is indicated in lumens, and right on the front of the package. LED bulbs can produce the same amount of light (lumens) while consuming 70-90% less energy.

Color: LED bulbs are available in a wide range of light color, from warm like traditional incandescent light to cool bluish light often referred to as "Daylight". Check the package to make sure you are getting the light color you like.

Learn more at www.energystar.gov/lighting.

Standard Bulbs (Watts)	ENERGY STAR Bulb Brightness (Minimum Lumens)
40	450
60	800
75	1,100
100	1,600
150	2,600

IMAGE SOURCE: ENERGYPSTAR.GOV