

Energy Efficient Homes: Compact Fluorescent Lamps¹

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Quick Facts

- Compact fluorescent lamps/bulbs, commonly referred to as CFLs, cost less than regular incandescent lighting in three ways.
 - CFLs consume significantly less energy than incandescent bulbs. To produce the same brightness, an ENERGY STAR–certified CFL uses only about $\frac{1}{4}$ of the energy that an incandescent bulb uses.
 - By using ENERGY STAR–certified CFLs, you’ll save on air-conditioning costs because they generate $\frac{3}{4}$ less heat than regular incandescent bulbs.
 - An ENERGY STAR–certified CFL should last up to 10 times longer than an incandescent bulb. This means fewer bulbs to purchase and fewer trips to the store, saving you both the time and the travel costs you would normally spend on replacing burned-out incandescent bulbs.
- Replacing incandescent bulbs with ENERGY STAR–certified CFLs in the rooms where you spend the most time should result in tangible dollar savings and comfort.
- Fluorescent lighting is available in varieties to suit almost any need from ambient mood lighting to crisp task lighting.

Terms to Help You Get Started

Ballast: The device that stabilizes the electric current for stable operation of a bulb. Depending on the bulb, it can either be attached to the bulb (generally as in CFLs) or be a part of the fixture (as with pin-based and fluorescent tubes). Units with separate ballasts and bulbs are preferable because ballasts last much longer than bulbs.

Lamp/bulb vs. fixture: *Lamp* is the industry term for what we commonly refer to as a light *bulb*, whereas a *fixture* is the housing unit that connects the bulb (lamp) to a power source.

CCT (Color Correlated Temperature): A measurement of the appearance in tone of any given light source, (i.e., how “warm” or “cool” it is), with “warm” being closer to the yellow/orange end of the color spectrum, and “cool” being closer to the bluish end. Measured in Kelvin (K) temperatures.

CRI (Color Rendering Index): A measurement of how accurately the emitted light renders the color of illuminated objects.

CFL (Compact Fluorescent Lamp): A fluorescent tube of small diameter wound into a coil, spiral, or typical

1. This document is FCS3270, one of a series of the Department of Family, Youth and Community Sciences, UF/IFAS Extension. Original publication date June 2008. Revised July 2015, August 2019, and December 2022. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication. This material was initially prepared with the support of the Department of Environmental Protection, Florida Energy Office, which is now the Office of Energy, Florida Department of Agriculture and Consumer Services. The revised versions were completed with the support of the Florida Energy Systems Consortium (<http://floridaenergy.ufl.edu>). Any opinions, findings, conclusions, or recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of the sponsoring organizations.
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incandescent bulb shape so it is comparable in size and shape to conventional incandescent light bulbs.

Efficacy: See *lumens per watt (LPW)*.

Fluorescent: Light source that, when electrical current is applied, glows because of a chain of events initiated by the current's arc.

Hardwired (dedicated) systems: These systems consist of a ballast and fluorescent-bulb socket permanently wired into a fixture by the manufacturer, or as part of a retrofit kit.

Incandescent: Light source that glows because of its filament being heated to a high temperature.

Integral light: Bulbs that combine a bulb, ballast, and standard screw base in a single sealed assembly, which must be discarded when the bulb burns out. They can be installed in any standard screw-type light fixture where incandescent bulbs are normally used.

Kelvin (K): A measurement for the characteristics of visible light in determining color temperature, often used for categorizing CCT.

Kilowatt-hour (kWh): Used on utility bills to define a unit of energy usage, (ex., a 100-watt light bulb is 0.1 kW used for 10 hours), and/or (0.1 kW x 10h) consumes 1 kilowatt-hour of energy during that time.

Lumens: Units of measurement for brightness issued by a light source (ex., a candle generates about 13 lumens while a 100-watt incandescent bulb generates about 1,750 lumens).

Lumens per watt (LPW): An indicator of a bulb's efficiency determined by dividing the number of lumens generated (as indicated on the packaging by the bulb manufacturer) by its wattage; the higher the LPW, the greater the efficiency. Sometimes referred to as efficacy.

Mercury: One of the earth's natural, metallic elements used in small amounts in CFLs and fluorescent tubes that requires special handling because of its behavior when exposed to air.

Modular units: This type of unit has a separate two- or four-pin base bulb that plugs into a separate adapter or ballast. When the bulb burns out, a relatively inexpensive replacement bulb can be installed in the original ballast and pin base.

Reflector bulbs: Perfect for providing directional light, as with recessed lights in kitchens or ceiling fans. There are outdoor reflector bulbs as well that are generally much larger than the reflectors designed for indoor use. The outdoor types are sealed to withstand the weather and generally should not be used with timers, photocells, and motion sensors unless otherwise specified on the package.

Watt: A unit of electrical power/power consumption.

How much would I save by switching to CFLs?

Let's compare an incandescent bulb and a CFL with the same light output. A 60-watt bulb does not necessarily provide more illumination than a 15-watt bulb. Why? Because *watts measure energy use while lumens measure light output*. Lumen information appears on bulb packaging. For example, a 60-watt incandescent bulb produces about 800 lumens. You can replace this 60-watt incandescent bulb with a 15-watt CFL and get the same amount of lumens (light output), but the CFL will use 45 watts *less energy* (U.S. Department of Energy, n.d-a). See Table 1 to compare estimated purchase price and residential energy costs of three different lighting technologies with similar light output (lumens)—incandescent, CFL, and light emitting diode (LED).

Is it true that fluorescent lighting is harsher than incandescent?

This is not necessarily true. Two factors, the color rendering index (CRI) and color correlated temperature (CCT, sometimes called K), affect a light's harshness. Fluorescent lighting is generally more uniform than other light sources.

What is the color rendering index (CRI)?

CRI measures the perceived color of objects under artificial light on a scale of 0 to 100. The higher the number, the more natural and vibrant an object will appear. Incandescent bulbs usually have CRI values of 100. Old-style fluorescents had values of 62, at best, which is why people used to complain that fluorescents gave false colors. A CFL with a CRI of 80 or more is suitable for everyday residential use.

What is the color correlated temperature (CCT)?

CCT is a measurement of the appearance of the light source itself, how "warm" or "cool" it seems. It is measured in Kelvin temperature from 0 to 10,000+ and expressed as (K).

Oddly, the lower the Kelvin number, the warmer (more yellow) the light color. As the number goes up, the bluer the light source will be. For instance, a CCT of a standard incandescent bulb can range from 2800K to 3100K, which provides warm, white lights. A fluorescent with a CCT of 3000K will provide the same warm, white light that an incandescent bulb produces. A 3500K fluorescent bulb gives about the same light as a halogen. Some bulb manufacturers promote 5000K to 6000K, which produces cooler (bluer), white light, as a daylight bulb.

What should I look for when purchasing bulbs?

Efficiency

Compare brands for price, lumens per watt (LPW), and hours of life. To calculate lumens per watt, divide the lumens by the watts. For instance, an 800-lumen, 60-watt incandescent bulb would have an LPW of approximately 13 (800 divided by 60); an 800-lumen, 15-watt CFL would have an LPW of about 53 (800 divided by 15); an 800-lumen, 9-watt LED would have an LPW of about 88. Remember, the higher the LPW, the greater the efficiency and the more light you receive for the energy used.

As a result of changes in the Appliance Labeling Rule, renamed the Energy Labeling Rule, comparing light bulbs is now much easier (Federal Register, 2019). The label on the front of the package must include brightness (lumens) and estimated annual energy cost of using the bulb three hours per day at a rate of 11 cents per kWh. A “lighting facts” label, as seen in Figure 1, must also be on the side or back of the package. This label must include information on brightness (lumens), energy cost, bulb life, color temperature (CCT), wattage and, in some cases, voltage and mercury information. For more information on the “light bulb law,” see the *Energy Independence and Security Act of 2007 (EISA) Frequently Asked Questions* publication at https://www.energystar.gov/ia/products/lighting/cfls/downloads/EISA_Backgrounder_FINAL_4-11_EPA.pdf.

Color

On newer packaging, you will be able to locate the “light appearance” or CCT information on the “lighting facts” label. See Figure 1 as an example. On older packaging, compare CRI and Kelvin Temperature (CCT) if displayed on the product package—CRI will be a 2-digit number and Kelvin will be a 4-digit number with K, for example, 3500K. For an idea of how a room will look in varying shades of white light (warm–yellow or cool–blue), see the ENERGY

STAR® *Choose a Light Guide* at https://www.energystar.gov/products/choose_a_light.

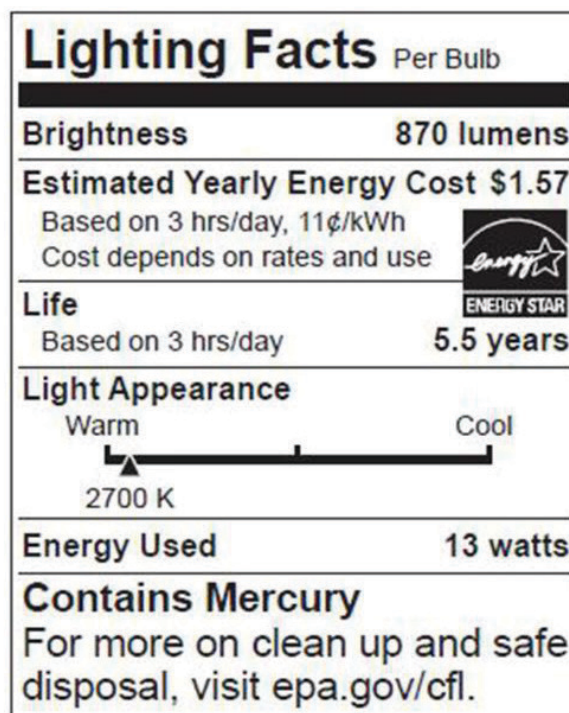


Figure 1. Sample ENERGY STAR–certified CFL label.
Credits: <https://www.ftc.gov/system/files?file=attachments/press-releases/coming-2011-new-labels-light-bulb-packaging>

Instructions for Appropriate Use

When purchasing a bulb, check its packaging for any restrictions on use. For example, some bulbs should not be used in enclosed fixtures, and some may specify that the base be up or down. Many are for specific fixtures, such as recessed cans, dimmer switches, or outdoor fixtures. Bulbs used incorrectly can cause fire and/or electric shock. This pertains to all bulbs, such as using a 100-watt bulb in a fixture that calls for 40 watts.

There have been some reports of people experiencing health issues as a result of operating CFLs in the home. An online document from the government of Canada (<https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/everyday-things-emit-radiation/compact-flourescent-lamps.html>) may be of assistance in this regard. Contact your personal physician if you have questions as the authors of this document are not trained to address medical concerns.

Can I use dimmers or 3-way switches with CFLs?

Yes, but you need to find the correct bulbs. Manufacturers produce CFLs that will work in standard incandescent fixtures with dimmers or 3-way switches, but using the

incorrect kind can be dangerous and costly if the bulb fails. Read package directions carefully to pick the correct CFL for your purpose. Incorrectly installed bulbs can cause fires.

What is different about an ENERGY STAR–certified CFL?

A CFL must meet specific criteria to earn the ENERGY STAR–certified label. These criteria include very specific requirements for efficacy (LPW), CRI, CCT, product packaging, and warranty provisions.

The ENERGY STAR website has links to a wealth of information to help you select and purchase CFLs (ENERGY STAR, n.d.-a). See the ENERGY STAR program requirements for all lamps (light bulbs) at https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V1%201_Specification.pdf or the light bulb key product criteria at https://www.energystar.gov/products/lighting_fans/light_bulbs/key_product_criteria.

It should be pointed out that many consumers have commented to member(s) of this team of authors regarding the cost-benefit of CFLs, and the standard response is qualified by stating that ENERGY STAR is backed by the US government (DOE). Thus, all CFLs are not necessarily created equally. Though we understand the frustration and difficulty in reading labels to choose between the various options of CFLs available in some instances, we only have information to support CFLs certified with the ENERGY STAR label when considering the cost-benefit relationship.

What is different about ENERGY STAR–certified lighting fixtures?

Light fixtures that have earned the ENERGY STAR label combine exceptional features while using less energy. Compared with traditional or standard fixtures, certified fixtures (ENERGY STAR, n.d.-b):

- Use 70 to 90 percent less energy and about 70 to 90 percent less heat than typical models using incandescent light bulbs.
- Deliver convenient features such as dimming capability on some indoor models (fixture must have a dimming ballast to be dimmable) and automatic daylight shut-off and motion sensors on some outdoor models.
- Carry a manufacturer-backed warranty of at least three years.

Should I turn off the fluorescent lights when I leave the room?

Contrary to popular belief, turning off fluorescent lights really does save energy. Frequent switching may shorten bulb life, but electric-bill savings will more than compensate for the shorter lifespan, especially if you end up using more CFLs than incandescents. The U.S. Department of Energy (n.d.-b) recommends that you turn off fixtures using CFLs if you will be out of the room for more than 15 minutes. See the publication *When To Turn Off Your Lights* (<https://www.energy.gov/energysaver/when-turn-your-lights>) for specific recommendations.

I’ve heard that CFLs (like other fluorescent tubes) contain mercury—how do I dispose of them? What if I accidentally break one?

As a general rule of thumb, CFLs require special handling, so don’t dispose of them with the regular household trash. Though CFLs can be recycled, they should not be disposed of in your recycle bin either. Check <https://www.epa.gov/mercury/recycling-and-disposal-cfls-and-other-bulbs-contain-mercury> or <https://lamprecycle.org/en/>, call 1-800-CLEAN-UP, access <https://earth911.com/recycling-center-search-guides/>, or contact your local waste-management agency for proper disposal guidelines in your community.

For current information on what to do and what *not* to do when a CFL is broken, refer to <https://www.epa.gov/mercury/compact-fluorescent-light-bulbs-cfls>. Note that this same website also contains links to information on proper disposal.

By using CFLs, you can reduce power demand that will help reduce mercury emissions from power plants. Mercury emissions in the air come from both natural and manufactured sources. Coal-fired power plants are the largest contributors because the naturally occurring mercury in the coal is released into the air when coal is burned during the process of making electricity. Currently, coal-fired power plants are the highest emitters at about 34% of the mercury emissions in the United States (NYSERDA, November 2022). Though fluorescent bulbs do contain very small amounts of mercury—an average of 4 milligrams compared to older thermometers containing about 500 milligrams—it is sealed within the glass tubing and is not released when

the CFL is intact or in use. Moreover, with proper handling, mercury in the CFLs can be recaptured through recycling.

Summary

As a result of the Energy Independence and Security Act of 2007, effective January 1, 2012, “screw-based light bulbs will use fewer watts for a similar lumen output. The standards are technology neutral, which means any type of bulb can be sold as long as it meets the efficiency requirements” (U.S. EPA, 2011). The way we shop for bulbs changed from looking at watts (how much energy is used) to looking at lumens (brightness of the light). As of 2020, most light bulbs had to be 60%–70% more efficient than incandescents were in 2015. CFLs were one of the first technologies to address a more energy-efficient light bulb for the homeowner. Today, LEDs are even more energy efficient than CFLs, and are also an affordable lighting for the homeowner as they continue to increase in performance while decreasing in price.

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Table 1. Estimated Cost to Household Comparison: Incandescent, CFLs, and LED Bulbs.

Light Output (Lumens)	Bulb Type & Energy Use	Bulb Purchasing Cost ^A	Rate Life (hours)	Energy Cost ^B for 10,000 hours use at \$0.12/kWh	Total Cost for 10,000 hours (Bulb[s] + Energy Cost)	Total Cost ^C for 25,000 hours (Bulb[s] + Energy Cost)
800	Incandescent: 60 watts	\$1.00	1,000	\$72.00	\$82.00	\$205.00
	CFL: 13 watts	\$2.50	10,000	\$15.60	\$18.10	\$44.00
	LED: 8.5 watts	\$8.00	25,000	\$10.20	\$18.20	\$33.50
1,200	Incandescent: 75 watts	\$1.00	1,000	\$90.00	\$100.00	\$250.00
	CFL: 20 watts	\$3.50	10,000	\$24.00	\$27.50	\$67.00
	LED: 16 watts	\$20.00	25,000	\$19.20	\$39.20	\$68.00
1,750	Incandescent: 100 watts	\$1.00	1,000	\$120.00	\$130.00	\$325.00
	CFL: 23 watts	\$4.00	10,000	\$27.60	\$31.60	\$77.00
	LED: 19 watts	\$23.00	25,000	\$22.80	\$45.80	\$80.00

^A Estimated purchasing costs do not include taxes, shipping, handling fees, recycling fees, or travel expenses associated with acquisition of bulbs at point of purchase, nor do they include additional taxes, fees, or charges required by your utility provider.

^B watts × rate life / 1000 = kWh; kWh × price per kWh = Energy Cost

^C CFL bulb cost at 25,000 hours was estimated for 2 bulbs (using a 12,000 hour CFL). In some cases, a third bulb purchase may be required because some CFLs are rated at 10,000 hours. This would increase the CFL cost by 1 bulb.

Note: Actual light output, bulb cost, and rated life may vary by product. Utility rates vary by provider. See the potential savings when choosing more energy-efficient bulbs for your home by visiting the site: <https://essearch.energystar.gov/search?utf8=%E2%9C%93&m=&affiliate=www.energystar.gov&query=Savings+Calculator+for+ENERGY+STAR+Certified+Light+Bulbs+&commit=Search>, and selecting *Savings Calculator for ENERGY STAR–Qualified Light Bulbs*.