

Energy Efficient Lighting

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This fact sheet is one of several fact sheets that focus on everyday energy conservation measures for Arkansas households. Lighting accounts for about 15 to 20 percent of an electric bill in the average Arkansas home. Choosing the best lighting has multiple benefits, including helping us to be as energy efficient as possible. Switching from traditional light bulbs (also called lamps) to a compact fluorescent lamp (CFL) is a change you can make to reduce your energy usage and energy costs at home.

What is light quantity?

Measuring the light level (or quantity) is valuable to help determine the type of lamp you need and how it will help you to reduce energy costs. Light output from a lamp is measured in different ways. It is commonly measured in the quantity of light leaving the lamp (lumens), or it may be measured by the amount of light falling on a surface (foot-candles). The label on the package of a lamp should have the lumen output of the lamp, and this number should be used to compare one lamp with another.

For example, a 23-watt (W) compact fluorescent light bulb produces about 70 lumens per watt (or 70 LPW) for a total of about 1,610 lumens. (We will show how to calculate lumens per watt next.) This number can be compared to an incandescent light bulb which produces about 20 lumens per watt or is

one-fourth as efficient as the compact fluorescent lamp. Lamps get dimmer over their life, so usually lamps are replaced after a certain length of time, even though they might not actually be burned out.

The foot-candle is another method to measure the light output. Foot-candle (fc) is the light level at the working surface. This is the quantity measured with a light meter. Outside on a bright, sunny day in midsummer the light level may be around 8,000 fc. Inside, we consider a brightly lit desk-top surface to be at about 100 fc. A dimly lit street at night may be at $\frac{1}{2}$ to 1 fc. One foot-candle equals one lumen per square foot.

What is light quality?

Knowing the light quality of a lamp is useful when using lighting for reading or work that requires color recognition. Light quality is commonly measured by two things: color temperature and color rendering index. Color temperature is measured in degrees Kelvin (K). A higher color temperature number indicates a lamp will emit a bluer or “cooler” light, and a lower color temperature number indicates a lamp will emit a warmer or more orange/red light. A cool blue light might have a color temperature of 4,200 degrees Kelvin, and a warm yellow lamp might have a color temperature of 3,000 degrees Kelvin. Most manufacturers provide a color on the packaging like “warm white” or “cool blue.”

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Color Rendering Index (CRI) is a measure of how well the lamp makes colors look compared to sunlight. Be aware that CRI is measured at a given lamp's color temperature. CRI uses a scale of 0-100. The larger the number, the closer the lamp renders a color the same as sunlight would. A value of 0 indicates colors all look the same under the lamp.

Although lumens describe the actual lamp output or quantity of light, light color (quality) also affects your perception of comfort and light quantity. Thus, when replacing a lamp, consider both lumens output and light color.

What is the light efficacy?

The efficiency of a light bulb is called lamp efficacy. Efficacy is the lumens per watt (LPW) which represents how much light (lumen) is put out compared to how much power (watt) is required to operate the lamp. To determine the efficacy, divide the number of lumens by the wattage. Look on the package for the lamp to find both lumens and wattage.

How do I know the amount of light I'll get if the wattage is different?

On lamp packages, you will find both wattage and lumens. Watts indicates the amount of energy used, whereas lumens indicates light output. You can use a simple efficacy calculation as discussed to determine the most efficient lamp for your application. The following example may help in understanding the comparison.

You have one 100-watt incandescent lamp which is rated to provide 1,710 lumens. Divide 1,710 by 100; it equals 17.1 lumens per watt (LPW).

On the other hand, you have a 28-watt compact fluorescent lamp which provides an average of 1,750 lumens. Divide 1,750 by 28; it equals 62.5 lumens per watt (LPW).

The second option is better because the higher the LPW, the more light you receive for the energy used. Keep in mind that lumen output will decline with the life of the lamp, which means average lumens is a more realistic number to compare.

What is the average rated life of a lamp?

Average rated life is a way of determining how long lamps will last before burning out. The average rated life is usually determined in laboratory

conditions at the point where 50 percent of the initially installed lamps have burned out. For most of the lamps, the light output and quality change over time. The economical life of the lamp provides a more appropriate everyday measure of lamp life and includes considerations such as color shifting, lumen depreciation and loss in efficacy. The economical life of the lamp is usually about 60 percent of the average rated life.

What is an incandescent lamp?

An incandescent light bulb (or lamp) (Figure 1) is a source of electric light caused by heat. Incandescent lamps consist of coiled wire filaments in a glass bulb filled with an inert (nonreactive) gas. The wire's resistance to the flow of electricity causes it to become hot enough to glow. These lamps have been the most common light source in the past. They are now being replaced by other types of lamps (see below).



Figure 1. Incandescent lamp

Because an incandescent lamp is quite small with the light emitted from a concentrated area, they are referred to as point sources of light. Incandescent lamps can be dimmed easily. Dimming will increase the lifetime of a lamp, but lamp life is not, however, significantly affected by switching it on and off. The typical life expectancy of an incandescent lamp is about 1,000 hours.

About 90 percent of the energy used by an incandescent lamp becomes heat and 10 percent becomes light. A 100-watt incandescent lamp emits about 1,750 lumens, so the lamp's efficacy is about 17.5 lumens per watt.

What about halogen lamps?

Tungsten-halogen lamps (Figure 2) are another form of incandescent lighting. They produce a crisp, intense white light with generally a 100-color rendering index at warm color temperatures. The halogen gases in the



Figure 2. Halogen lamp

lamps make these lamps slightly more energy efficient than standard incandescent lamps and they are dimmable. When installing halogen lamps, read the directions carefully, and if the directions indicate to use a cloth or gloves when handling the lamp, be sure to do so or the lamp may burn out immediately or have a shortened life.

What is a fluorescent lamp?

A fluorescent lamp or fluorescent tube (Figure 3) produces light by passing an electric arc through a mixture of an inert gas, such as argon, and a small amount of mercury. A full-size fluorescent lamp may be a straight, round or U-shaped tube which requires connectors at both ends. These fluorescent lamps come in many sizes, from 6 to 96 inches in length, and consume 4 to 215 watts. Fluorescent lamps always require a ballast* to start and regulate the flow of current through the lamp.



Figure 3. Fluorescent lamp

Fluorescent lamps use electricity to excite mercury vapor. The mercury radiates ultraviolet energy that is transformed to visible light by the phosphor coating on the inside of the lamp. Fluorescent lamps are available in many different color temperatures. By varying the phosphor blend, colors can be made to vary from warm to cool and several steps in between, allowing one to select the best match for the use and physical characteristics of a space. Fluorescent lamps designed to match the color of incandescent lamps generally have a yellow light at 2,700-3,000 degrees Kelvin (K). “Cool white” fluorescent lamps might have a color temperature of 3,500 to 4,200K, and tri-phosphor or wide-spectrum lamps may emit light at several color temperatures.

**Ballast is a component that starts the lamp and then controls the amount of current a lamp receives.*

Is a fluorescent lamp more efficient than an incandescent lamp?

Yes, compared to incandescent lamps, fluorescent lamps are more efficient at producing light. More of the energy of a fluorescent lamp is converted into light and less into heat. Lower energy cost typically offsets the higher initial cost of the lamp. In fact, their efficacy is three to four times that of incandescent lamps. If you replace a 100-watt incandescent

lamp with a 20-watt fluorescent lamp (T-5), about 60 fewer watts are being required to produce the same light. The average rated life of T-5 fluorescent lamps is around 30,000 hours. If you compare that to the rated life of an incandescent lamp at 1,000 hours, you have a relatively economical source of light. Lamp life is dependent on many variables such as lamp type, ballast type, operating environment and how often they are switched on and off.

What are the pros and cons of fluorescent lamps?

Fluorescent lamps use less energy and last longer than incandescent lamps. On the other hand, fluorescent lamps are bulkier, more complex, do not perform as well under cold temperatures (light output drops), their light is difficult to focus since they are not a point source and some may not give full output when first turned on, taking a few seconds to come up to full brightness.

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

Yes. Contrary to popular belief, turning off fluorescent lights saves energy. Frequent switching does shorten lamp life, but electric bill savings will make up the difference.

Can I use dimmers with fluorescent lights?

Some fluorescent lamps are dimmable. In order to dim fluorescent lamps, you have to have dimmable ballast. Not all dimmable ballasts will work with conventional dimmers, so the overall dimmer/ballast/lamp must be selected as a system for the best results. If a non-dimmable lamp is used with a dimmer, the lamp will usually just go out. Continuing to use the lamp improperly with a dimmer will likely shorten the lamp life significantly and may also be a fire hazard.

What is a compact fluorescent lamp (CFL)?

A compact fluorescent lamp (CFL) is a type of fluorescent lamp used to replace a common household screw-type incandescent lamp. They are called “compact” because they are smaller than regular fluorescent lamps. CFLs have single or multiple pairs of slender parallel tubes, are shaped like a “corkscrew” or globe shaped lamp, require a connector at only one

end, can be 4 to 22½ inches in length and consume 5 to 80 watts. Compact fluorescent lamps (CFLs) come in a variety of sizes and shapes, as shown in Figure 4.



Figure 4. Variety of CFLs

The original concept behind the CFL was to provide an energy-efficient replacement for the incandescent lamp. Therefore, CFLs can fit into most existing light fixtures formerly used for incandescent lamps. CFLs operate on the same principle as regular fluorescent lamps. Using CFLs can save energy and save consumers money even though the up-front purchase cost is higher than incandescent lamps. CFLs last up to 10 times longer and may use only 25 percent of the energy an incandescent lamp uses.

The right CFL has light characteristics similar to the incandescent lamp it replaces. The main difference to note is that CFLs require a short “warm-up” time before the full illumination from the lamp is available.

Some consumers find this a desirable characteristic, allowing vision extra time to adjust to lighting. CFLs do not immediately overload vision with their brightness, especially when turning lights on in the middle of the night. Manufacturers are producing dimmable CFLs that will work in standard incandescent fixtures. Read package directions carefully (if incorrect lamps are installed, it is not safe).

What are the pros and cons of CFL?

CFL lamps use less energy and, therefore, avoid pollution associated with electric generation, including acid rain, “brown cloud” and greenhouse gases. You can expect a CFL to last about 10 times longer than an incandescent lamp. It saves about \$40 over its lifetime and pays for itself in about 6 months

compared to an incandescent lamp. On the other hand, CFL lamps cost 6 to 10 times more than incandescent lamps. While it is true that CFL lamps contain mercury, mercury is also released from burning fossil fuel used to provide energy for the inefficient incandescent lamp.

To have the same amount of lighting in a space, you can replace a 100-watt incandescent lamp with a 26- or 28-watt compact fluorescent lamp (CFL). It uses about 70 watts less energy. The luminous efficacy of CFL sources is typically 60 to 72 lumens per watt; however, the luminous efficiency of incandescent lamps is often 8 to 17 lumens per watt. In addition, a CFL produces far less heat, so you may also reduce your cooling costs. Although CFLs are initially more expensive to buy, you save the initial cost of the lamp many times over. A CFL used for an average of four hours a day will probably not need to be changed for at least four or five years. This means less maintenance for you and less waste to landfills. For the biggest energy savings, replace incandescent lamps with CFLs in the rooms you spend the most time in, such as your family room, living room and kitchen.

What is the energy use and lifespan of CFL?

CFLs use significantly less energy than incandescent lamps (50 to 75 percent less). If every home in America replaced just one incandescent lamp with an ENERGY STAR qualified CFL, we would save enough energy to light more than 2.5 million homes and prevent greenhouse gas emissions equivalent to that of 800,000 cars. In addition to using less energy, fluorescent lamps will last 6,000 to 15,000 hours, whereas incandescent lamps will last 750 to 2,500 hours.

Will compact fluorescent light lamps really make a difference to my electric bill?

Yes. For example, an 18-watt CFL operating six hours a day costs around 25 cents a month in electricity. As a point of comparison, an equivalent 100-watt incandescent lamp operating the same length of time will cost about \$1.44 a month in electricity. If every American family replaced the kitchen light, ceiling lights, table and floor lamps in the living and family rooms and outdoor porch lights with CFLs, each family would save about \$60 a year in energy costs.

To determine the best fluorescent lamp for your home application, visit the Energy STAR web site at http://www.energystar.gov/index.cfm?c=cfls.pr_cfls_guide.

How can I dispose/recycle light lamps?

Don't throw CFLs away with the household trash. Because of their mercury content, CFLs need to be safely disposed of in hazardous waste recycling programs. The following website (<http://www.earth911.org>) locates disposal options by zip code. You can also contact your local waste-management agency for guidelines in your community. For a list of programs in Arkansas, visit http://www.adeq.state.ar.us/solwaste/branch_recycling/hhwcc.htm. Also, please never send a CFL or other mercury-containing product to an incinerator or place it in a burn barrel.

What should I do when a CFL breaks in my home?

Because CFLs contain a small amount of mercury, you need to follow the EPA recommendations for clean-up and disposal:

1. Have people and pets leave the room, open the window for 15 minutes or more and don't let anyone walk through the breakage area on their way out.
2. Shut off the central forced-air heating/air conditioning system.
3. Wear disposable rubber gloves, if available (do not use your bare hands).
4. Carefully scoop or pick up glass fragments and powder using stiff paper or cardboard and place them in a glass jar with metal lid (such as a canning jar) or in a sealed plastic bag.
5. Use sticky tape, such as duct tape, to pick up any remaining small glass pieces and powder.
6. Wipe the area clean with damp paper towels or disposable wet wipes. Place towels in the glass jar or plastic bag.
7. Do your best to avoid the use of a vacuum or broom to clean up the broken lamp on hard surfaces.
8. If vacuuming is needed after all visible materials are removed, vacuum the area where the lamp was broken.
9. Remove the vacuum bag (or empty and wipe the canister), and put the bag or vacuum debris in a sealed plastic bag.

10. For more information, visit the following web site: http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf.

What is daylighting?

Daylighting (Figure 5) uses windows, light tubes or skylights to allow sunlight into your home. Daylighting reduces the need for electric lighting and can save you 30 to 80 percent on lighting energy costs. South-facing windows let more winter sunlight into the home and can reduce heating costs. If properly shaded, south-facing windows let in less sunlight during the summer, reducing cooling costs. North-facing windows are also good for daylighting and provide less glare and softer light. Daylighting can be most efficiently integrated during a home remodel or during new construction.



Figure 5. Daylighting

Light tubes are becoming a common daylighting method due to their flexibility to work in many different types of applications. Light tubes are tubular skylights that operate by collecting light, usually in a clear dome on the roof, and reflecting the collected sunlight through the tube to the inside of the home. Light tubes are very effective at providing daylight in areas where windows and traditional skylights may not work well.

What is a light-emitting diode (LED)?

A light-emitting diode (LED) is another efficient light source. The LED (Figure 6) is usually small in area (less than 1 mm²) with integrated optical components to shape its radiation pattern and assist in reflection.



Figure 6. Light-emitting diode

LEDs present many advantages over traditional light sources including lower energy consumption compared to incandescent and CFLs, long lifetime, improved robustness, smaller size and faster switching. However, they are relatively expensive and require more precise current and heat management than traditional light sources. LEDs are used as low-energy indicators but also for replacements for traditional light sources in general lighting and automotive lighting. LEDs work well for task lighting or accent lighting but less well as lamp replacements in most homes. The compact size of LEDs has allowed new text and video displays and sensors to be developed, while their high switching rates are useful in communications technology.

What is different about ENERGY STAR lighting fixtures?

Light fixtures that have earned the ENERGY STAR label combine quality and attractive design with high levels of energy efficiency. They last at least 10,000 hours (about seven years of regular use), distribute light more efficiently and evenly than standard fixtures and come in hundreds of decorative styles including portable fixtures such as table, desk and floor lamps.

For more information, visit the following web sites:

1. http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf
2. <http://www.energystar.gov>
3. https://www.energystar.gov/products/lighting_fans