

## Lighting

### Introduction

Energy-efficient lighting design focuses on methods and materials that improve the quality as well as the efficiency of lighting. Daylight is the most energy-efficient means of illuminating a building and thus should be a primary focus. Room, window, and window overhang proportions should be designed carefully to maximize light while eliminating glare, as well as to promote solar heat gain in the winter while reducing or preventing it in the summer. Since daylight is not always adequate or available, use electric lighting to supplement and provide appropriate light levels for particular tasks.

Electrical lighting, still provided primarily by traditional incandescent bulbs, consumes almost 15 percent of household electricity on average. Using readily available alternative lighting technologies can reduce lighting energy use by 50 to 75 percent. Recent advances in lighting controls offer further energy savings by reducing the amount of time lights are lit when not needed. Always keep in mind that the least energy-intensive light fixture is the one that's off.

### Lighting Terms

- **Color Rendering Index (CRI)** is a method for describing the effect of a light source on the color appearance of objects compared to a reference source of the same color temperature (see CCT below). The CRI serves as a quality distinction between light sources emitting light of the same color. The highest attainable CRI is 100, which is equivalent to sunlight. Typical CRI numbers range from the mid 60's to the mid-90s. Lamps with CRIs above 70 are the most commonly used in office and living environments.
- **Correlated Color Temperature (CCT)**, sometimes also referred to as color rendition, is a measurement on the Kelvin (K) scale that indicates the warmth or coolness of a lamp's color appearance. The higher the color temperature, the cooler the

color appearance. Typically, a CCT rating below 3200 K is considered warm, while a rating above 4000 K is considered cool.

- **Efficacy** is the ratio of light output (lumens) to input power (watts). The higher the efficacy, the more energy-efficient the lamp.

### Green Building Benefits

#### Energy Efficiency

Incandescent lamps are dimmable and light up instantly. They produce a warm light and provide excellent color rendition. They have a low efficacy (10 to 17) compared to all other options and a short average operating life (750 to 2,500 hours).

Fluorescent lamps have a high efficacy (30 to 110) and use 25 to 35 percent less energy than incandescent lamps providing the same illumination. They also last about 10 times longer (7,000 to 24,000 hours). The reduced heat generated by fluorescents can also positively influence the cooling load, and thus reduce air conditioning energy use and costs, in warm climates.

Recent technological improvements have resulted in fluorescent lamps with CRI and CCT values comparable to incandescent lamps. Electronic ballasts, now typical, have eliminated the flicker and noise associated with earlier fluorescents, but dimming does require special ballasts. Compact Fluorescent Lamps (CFLs) include built in ballasts and are fabricated into compact shapes with screw thread adapters designed to fit into incandescent lamp sockets.

#### Environmental Pollution

CFLs are efficient, long-lasting replacements for incandescent lamps. One CFL eliminates the need to produce and replace/dispose of up to a dozen incandescent bulbs. Due to the inefficiency of energy production and transmission, a small amount of electricity saved at the home reduces a larger amount of produced power demand at the point of generation, thus reducing the demand for electrical power plants. Rocky Mountain Institute statistics indicate that each CFL



replacement of an incandescent bulb prevents emissions of 1,000 to 2,000 pounds of carbon dioxide (CO<sub>2</sub>), a leading contributor to global warming, and 8 to 16 pounds of sulfur dioxide (SO<sub>2</sub>), a leading cause of acid rain. Preventing the power plant emission of criteria air pollutants monitored by the EPA, such as SO<sub>2</sub> and nitrous oxides (NO<sub>x</sub>), as well as toxic ones such as mercury is another advantage. Replacing incandescents used more than four hours a day with fluorescents in U.S. households would alone save 32 billion kilowatt-hours of electricity per year, the equivalent of 18 large coal-fired power plants. Fewer coal power plants means less pollution, as mentioned above, as well as a reduction in the environmental impacts of the resource extraction required to produce power.

Like many green building features, CFLs are not a “silver bullet.” Fluorescent lamps do contain small amounts of mercury, which when electrically energized produces their light. Mercury is a naturally present, highly persistent heavy metal that can affect the human brain and nervous system at varying levels depending upon such factors as the mercury’s chemical form, the age and health of the person exposed, the duration, intensity, and route of exposure, etc. Children and pregnant women are especially sensitive to elevated mercury levels. Human activities, especially mining and coal-fired power production, have led to increased concentrations of mercury in fish and wildlife at the upper end of the food chain--those which humans typically consume.

To reduce the potential for harmful, mercury-related health and environmental effects of using fluorescents, choose those that contain less mercury and have a longer life span. A higher rated life reduces the amount of lamps (and mercury) generated and thus eventually entering the waste stream. Household CFLs are not legally considered hazardous waste. As their use becomes more widespread, however, and increasingly required for new construction (as in California), the need and opportunities for recycling fluorescents are increasing. Contact your local waste management authority to determine the available recycling options and the proper/required disposal practices for your area. See the resources listed at the end of this fact sheet for additional information.

## Affordability

While CFLs cost more to buy than incandescent lamps, they more than pay for themselves in energy savings, not to mention lower maintenance. Because they last approximately 10,000 hours compared to less than 1,000 hours for typical incandescent lamps, nine fewer CFLs are required for the same use and performance. Just a few years ago CFL’s were still considerably more expensive than incandescent lamps. However, increased demand (and therefore supply) combined with utility rebates and incentives built in to retail prices have drastically lowered prices. CFL’s for household uses can typically be found at \$1-10 each. Additionally, each CFL installed saves roughly \$60 to \$100 over the lifetime of the bulb, figures that will only go up with increasing energy prices.

## Lighting Design Recommendations

To reduce lighting energy use, select fixtures and sources that use energy efficiently. Also, install controls (such as dimmers, light and occupancy sensors) to reduce the amount of time lights are on. Specifically:

- Maximize the availability and use of daylighting through proper design.
- Choose light wall colors to reflect and improve the distribution of daylight and minimize the need for supplemental electric lighting.
- Install fluorescent lighting for all fixtures that will be in use for 2 or more hours each day.
- Use CFLs in portable lighting fixtures that are operated for 2 or more hours a day.
- For recessed ceiling lights use only UL-approved fixtures that are insulation contact rated and airtight (IC-AT) and meet ASTM E283 requirements.
- Use only Energy Star labeled fixtures.
- Install task lights where needed to maintain space functionality while reducing ambient light level requirements.



- Consider motion sensors for indoor lighting and motion and daylight sensors for outdoor lighting.
- Design the lighting arrangement understanding and to use advantageously the differences in ambient, task and spot lighting.

### Green vs. Conventional

Fluorescent Lamps	Incandescent Lamps
Wide color range (65-94 CRI, 2900-7000 K)	Warm color (80-96 CRI, 2600-3000 K)
Less heat produced (up to 80% cooler than incandescent)	Produce lots of heat (90% heat, 10% light)
Needs special ballast for dimming control	Easily dimmed
High efficacy (30-110 lumens per watt)	Low efficacy (10-17 lumens per watt)
Long life (7,000-24,000 hours)	Short life (750-2,500 hours)
Fewer (but increasing) fixture choices	Large fixture variety
Installed cost: higher	Installed cost: lower
O&M cost: low	O&M cost: high
Disposal: consult local waste authority	Disposal: conventional refuse collection

### Installation

Compact Fluorescent Lamps (CFLs) are available in a large variety of shapes and sizes and can be easily installed in fixtures designed for standard incandescent bulbs. If new fixtures are installed, select fixtures that are made specifically for fluorescent tubes and contain the electronic ballast separately. The ballast should last as long as 10-20 bulbs.

### Operation and Maintenance

CFLs not only save money and time, but reduce pollution and protect the environment as well. Wasting energy on incandescent lamps is difficult to justify, given the savings over the lifetime of the CFLs (see table on Lifetime

Costs). In addition, since each CFL will eliminate nine typical incandescent lamps, they mean less hassle changing light bulbs--very attractive in regards to those high ceiling lights and your wobbly ladder.

### Lifetime Costs

Bulb type	Energy cost (\$0.14 /kWh)	Bulb(s) + energy cost for 10,000 hrs
CFL – 15 watt	\$21	\$26
Incandescent – 60 watt	\$84	\$89
CFL – 20 watt	\$28	\$34
Incandescent – 75 watt	\$105	\$113
CFL – 27 watt	\$38	\$45
Incandescent – 100 watt	\$140	\$150

### Bay Area Suppliers

Compact fluorescent lamps are available from almost every retail hardware and lighting outlet, and even many large general purpose or grocery stores. The best selection is at lighting specialty stores, which also typically feature live displays that show off various bulb types and lighting characteristics including fixtures, controls, and uses.

### For More Information

- Search Build It Green's **AccessGreen Directory** to find local suppliers and services: [www.builditgreen.org](http://www.builditgreen.org)
- Online retailer **Bulbs.com** is a useful, comprehensive source for fluorescent bulbs, especially so for those buying in bulk quantities: [www.bulbs.com](http://www.bulbs.com)
- The Department of Energy's (DOE) **Energy Efficiency and Renewable Energy Clearinghouse** offers links to many web resources on lighting: [www.eere.energy.gov/consumer/your\\_home](http://www.eere.energy.gov/consumer/your_home)



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- DOE's **Building Technologies Program** provides clear, concise educational materials on all aspects of lighting:  
[www.eere.energy.gov/buildings/info/components/lighting](http://www.eere.energy.gov/buildings/info/components/lighting)
- The **Energy Star Program's** lighting section provides good, simple answers to lighting questions regarding purchasing and installation:  
[www.energystar.gov/index.cfm?c=cfls.pr\\_cfls](http://www.energystar.gov/index.cfm?c=cfls.pr_cfls)

- The **U.S. Environmental Protection Agency** (EPA) has a variety of fact sheets and other informational resources regarding mercury, its use in fluorescent lighting, and the recycling/disposal of fluorescent lamps:  
<http://www.epa.gov/mercury/consumer.htm>  
[www.epa.gov/epaoswer/hazwaste/id/univwast/lamps/lamps.htm](http://www.epa.gov/epaoswer/hazwaste/id/univwast/lamps/lamps.htm)  
<http://www.nema.org/lamprecycle/epafactsheet-cfl.pdf>
- For more information about Build It Green, visit our web site at [www.BuildItGreen.org](http://www.BuildItGreen.org) or call us at 510-845-0472.

### **Disclaimer**

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