



Lighting

Introduction

Energy efficient lighting design focuses on methods and materials that improve both the quality and efficiency of lighting. Daylight is the most energy efficient way of illuminating a building. To take advantage of daylight, room, window, and roof overhang proportions should be designed carefully to reduce summer heat gain, promote winter heat gain, and maximize light while eliminating glare. Since daylight is not always adequate or available, electric lighting should be used to supplement and provide appropriate light levels for particular tasks.

Electrical lighting consumes almost 15 percent of household electricity. Traditional incandescent bulbs still provide most household illumination. However, use of new 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 on but not serving a useful purpose. Always keep in mind that the most efficient light fixture is the one that's not on.

Lighting Terms

- **Color Rendering Index (CRI)** is a measurement of a light source's accuracy in rendering different colors when compared to a reference light source with the same correlated color temperature. The highest attainable CRI is 100, which is equivalent to sunlight. Lamps with CRIs above 70 are typically used in office and living environments.
- **Correlated Color Temperature (CCT)** 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 compared to all other options (10 to 17 lumens per watt) and a short average operating life (750 to 2,500 hours).

Fluorescent lamps use 25 to 35 percent of the energy used by incandescent lamps to provide the same amount of illumination (efficacy of 30 to 110 lumens per watt) and last about 10 times longer (7,000 to 24,000 hours). Recent technological improvements have resulted in fluorescent lamps with color temperature (measured in "Kelvins") and color rendition (measured in "color rendering index" or CRI) comparable to incandescent lamps. Electronic ballasts, now typical, have eliminated flicker and noise known in the past, but special ballasts are needed to allow dimming. The newer Compact Fluorescent Lamps (CFLs) are usually twisted into compact shapes, have built-in ballasts and screw thread adapters for application in fixtures designed for incandescent bulbs.

Environmental Pollution

Compact fluorescent lamps (CFLs) are energy-efficient, long-lasting substitutes for incandescent lamps. Statistics from the Rocky Mountain Institute indicate that each incandescent bulb replaced with a CFL prevents the emission of 1,000 to 2,000 pounds of carbon dioxide from power plants (a leading cause of global warming) and 8 to 16 pounds of sulfur dioxide, which causes acid rain. One CFL also eliminates the need to produce and dispose of up to a dozen incandescent bulbs.

In addition, mercury is a highly persistent and toxic chemical that is building up to dangerous concentrations in fish, wildlife, and human beings. By choosing high-efficiency lamps that contain less mercury, you help reduce the environmental impacts and health risks of lamp breakage during use, transport, and disposal. Using lamps with a higher rated life reduces the overall amount of mercury entering the waste stream, because the lamps are changed less frequently.

Affordability

While CFLs cost more to buy than incandescent lamps, they actually pay for themselves in energy savings, as opposed to incandescents. Since they last approximately 10,000 hours, compared to less than 1,000 hours for typical incandescent lamps, you'll buy nine fewer CFLs. Each CFL you purchase (for \$3-10) and install, saves you roughly \$25 to \$50 over the lifetime of the bulb (try getting that kind of return from any other investment!).

Lighting Design Recommendations

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

- Maximize the use of daylighting.
- Install fluorescent light fixtures for all fixtures that will be on for more than 2 hours each day.
- Use compact fluorescent lamps in portable lighting fixtures that are operated for more than 2 hours a day.
- If recessed lights are used in a ceiling use only UL approved fixtures that are IC-AT (insulation contact rated and airtight), and meet ASTM E283 requirements.
- Use light wall colors, which reflect, to minimize the need for electric lighting and improve daylight distribution.
- Use only Energy Star labeled fixtures.
- Install task lights where needed to reduce ambient light levels.
- Consider motion sensors for indoor lighting and motion and daylight sensors for outdoor lighting.
- Design your lighting arrangement by understanding and using 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 fixture choices	Large fixture variety
Installed cost: high	Installed cost: low
O&M cost: low	O&M cost: high

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, which can be as long as 20 years.

Operation and Maintenance

By using CFLs you not only save money, but reduce pollution and protect the environment as well. The use of energy wasted on incandescent lamps is difficult to justify, given the savings over the lifetime of the CFLs (see table on Lifetime Costs). In fact, if all the incandescent light bulbs in U.S. households that are used more than four hours a day were replaced with fluorescents, we would save 32 billion kilowatt-hours of electricity a year. In addition, since each CFL will eliminate nine typical incandescent lamps, that also means less hassle and money changing light bulbs (think about not getting on a ladder to change those high ceiling lights).

Lifetime Costs

Bulb type	Energy cost \$0.08 /kWh	bulb(s) + energy cost for 10,000 hrs
CFL – 15 watt	\$12	\$22
Incandescent – 60 watt	\$48	\$53
CFL – 20 watt	\$16	\$30
Incandescent – 75 watt	\$60	\$65
CFL – 27 watt	\$22	\$40
Incandescent – 100 watt	\$80	\$85

Bay Area Suppliers

Compact fluorescent lighting is available from almost every retail hardware and lighting outlet. The best selection is typically at a lighting specialty store, which also typically has the best live educational displays that show off the characteristics of different types of bulbs and lighting uses.

- Search the **Materials Database** from Bay Area Build It Green to find local suppliers and services: www.build-green.org

For More Information

- **Dept of Energy, Energy Efficiency and Renewable Energy Clearinghouse:** (www.eere.energy.gov/EE/buildings_lighting.html) offers links to many internet resources on lighting
- **Dept of Energy, Building Technologies Program:** (www.eere.energy.gov/buildings/info/component_s/lighting) offers good, clear, concise education on all aspects of lighting.
- **Energy Star Program (EPA/DOE):** (www.energystar.gov/index.cfm?c=cfls_pr_cfls) this section on lighting provides, good, simple answers to questions on lighting purchasing and installations.
- For more information about Green Building, visit our website at: www.greenaffordablehousing.org or call Bruce Mast at 510-271-4785.

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