20. Lighting Requirements

Lighting can account for 10% to 20% of a home's electricity bill. Installing high efficiency lighting such as light emitting diodes (LEDs) and compact fluorescent lamps (CFLs) is one of the easiest steps to save energy. CFLs use approximately 75% less energy than traditional incandescent lamps to produce the same amount of light. They also last longer and produce less heat. Today's LED light sources are six to seven times more energy efficient than conventional incandescent lights, cut energy use by more than 80 percent and can last more than 25 times longer.

The energy code provides two methods for compliance with lighting provisions:

1. **A minimum of 75% of the lamps in permanently installed lighting fixtures must be high-efficacy lamps.**
2. **A minimum of 75% of the permanently installed lighting fixtures must contain only high-efficacy lamps.**

High-efficacy Lamps include compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficacy based on their wattage:

- 60 lumens per watt for lamps over 40 watts
- 50 lumens per watt for lamps over 15 watts to 40 watts
- 40 lumens per watt for lamps 15 watts or less

Efficacy is determined by dividing the lumen rating by the wattage to get lumens per watt. Low-voltage lighting is not required to utilize high-efficiency lamps. Such lighting includes equipment powered through a transformer such as a cable conductor, a rail conductor and track lighting.

The History of Lighting

- 1879 Thomas Edison Patents Incandescent Lamp
- 1930 Fluorescent Lighting Demonstrated
- 1951 More Light in US Produced by Fluorescent than Incandescent Lighting
- 1976 CFLs Demonstrated
- 1980 CFLs Enter Marketplace
- 2000 USDOE Partnered with Industry to Commercialize LED technology
- Today LED Lighting Is Beginning to Dominate the Marketplace

Efficient Lighting Technologies

Compact Fluorescent Lamps (CFLs). Standard incandescent bulbs produce light when an electric current passes through a filament and causes it to glow; they give off 90% of their energy as heat and not light. In contrast, fluorescent lamps give off about 30% of their energy in the form of heat. They produce light when an electric arc

passes between cathodes to excite mercury and other gases, producing radiant energy, which is then converted to visible light by a phosphor coating.

In some cases light quality suffered as CFLs were installed in fixtures designed for incandescent lamps. CFLs can be unsightly when used improperly and were often replaced after the building was occupied. One other concern with CFLs is that they contain a small amount of mercury. Because mercury is harmful to humans and to the environment, CFLs must be disposed of properly, typically through municipal or hardware store recycling programs.

Solid State Light Emitting Diodes (LEDs). LEDs are a type of solid state lighting (SSL) that produce visible light very efficiently. As LEDs come down in price, they are spurring a dramatic change in residential lighting due to their energy savings potential, low environmental impact, long lifetime, maintenance savings, size versatility, and compatibility with lighting controls.

Unlike incandescent and fluorescent lamps, which emit light in all directions, LEDs emit light in a specific direction, which reduces the need for reflectors and diffusers and makes LEDs more efficient for uses such as recessed downlights and task lighting. LEDs emit very little radiated heat. Heat is produced from the power going into the LED and this heat is absorbed and dissipated by a heat sink designed into the base of the LED.

LEDs don't “burn out.” Instead, LEDs experience lumen depreciation, meaning that over the life of the bulb, the amount of light produced decreases and the color appearance of the light can shift. Therefore, an LED product’s life expectancy is determined by when its light output is predicted to decrease by 30%.

When installing dimmable LED lighting, the dimmer switch must be compatible with the light source

ENERGY STAR Certified Lighting. Lighting that earns the ENERGY STAR certification has met strict criteria ensuring energy efficiency, light output, color, and longevity. ENERGY STAR certified light bulbs:

- Use about 70%-90% less energy than traditional incandescent bulbs.
- Last at least 15 times longer and save about $80 in electricity costs over their lifetime.
- Meet strict quality and efficiency standards, are tested by accredited labs, and certified by a third party
- Produce about 70%-90% less heat, so they are safer to operate and can cut energy costs associated with home cooling.

Other Design Considerations

Other ways to reduce lighting costs include adding lighting controls, such as dimmers, motion sensors, and photo sensors, and designing rooms to utilize daylighting with windows, clerestory windows, skylights, and solar tubes. These approaches are not addressed in the code.

Energy consumption is not the only important issue when it comes to lighting design. Color temperature and color rendering are not addressed in the codes but help determine the quality of light provided to the space.

Color Temperature. A concern about high-efficiency lighting has been color rendition. For example, early compact fluorescents often appeared whiter or bluer than traditional incandescent lamps. Light color is measured on a temperature scale using Kelvin (K) units. Energy-efficient lighting products are available today with a variety of color temperatures ranging from lower Kelvin (<3000K) "warm" yellowish lights to higher Kelvin (>5000K) cool white lights. For comparison, daylight is typically identified as 4500K or higher. Lamps rated 2700-

3000K provide warmer light similar to traditional incandescent lamps. Lamps rated 3500K to 4100K provide whiter light. Lamps rated at 5000 k to 6500K provide even starkly whiter light.

Color Rendering Index. The color rendering index (CRI) is the current industry standard for measuring how accurately a light source displays the colors of the objects it illuminates. The maximum CRI value is 100. LED light sources with a CRI of 90 or higher are recommended in residential new construction. Lamps with a similar CRI helps ensure wall colors, carpeting and other materials have a consistent appearance. Most manufacturers can supply information on CRI for their products.

Plan Review

1. Verify a minimum of 75% of the lamps in permanently installed lighting fixtures are specified as high-efficacy or a minimum of 75% of the permanently installed lighting fixtures are specified as containing only high efficacy lamps according to the count of fixtures and lamps as shown on the plans.
2. Confirm each lamp type's efficacy by requiring manufacturer's or independent test data for each lamp type indicating its efficacy rating. If the manufacturer or product packaging has only ratings for lumen output and wattage, divide the lumen rating by the wattage to get lumens per watt.

Field Inspection

1. Inspect representative CFL lamps, linear fluorescents, LEDs, and other lamps to ensure that at least 75% of fixtures or 75% of lamps are high-efficacy by comparing the installed lamp make/model number to the ones on the approved plans.
2. Non-specified lamps should have efficacy rating information supplied at inspection.

Code References

2012 IECC Section R202 Definition – Low-Voltage Lighting. Lighting equipment powered through a transformer such as a cable conductor, a rail conductor and track lighting.

2012 IECC Section R202 Definition- High Efficacy Lamps. Compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficacy of: 1. 60 lumens per watt for lamps over 40 watts; 2. 50 lumens per watt for lamps over 15 watts to 40 watts; and 3. 40 lumens per watt for lamps 15 watts or less.

2012 IECC Section R404.1 Lighting Equipment (Mandatory). A minimum of 75 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps or a minimum of 75 percent of the permanently installed lighting fixtures shall contain only high efficacy lamps.

Exception: Low-voltage lighting shall not be required to utilize high-efficiency lamps.

2012 IECC R402.4.4 Recessed Lighting. Recessed luminaires installed in the building thermal envelope shall be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and labeled as having an air leakage rate not more than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E 283 at a 1.57 psf (75 Pa) pressure differential. All recessed luminaires shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.

Resources

2012 International Energy Conservation Code, Copyright August 2011 by the International Energy Codes Council, Inc., Falls Church, Virginia.

2012 IECC Code and Commentary, Copyright August 2012 by the International Energy Codes Council, Inc., Falls Church, Virginia.

Buying the Perfect Energy-Efficient Light Bulb in 5 Easy Steps, Paige Terlip, 2014, USDOE's National Renewable Energy Laboratory.
https://www.energy.gov/energysaver/articles/buying-perfect-energy-efficient-light-bulb-5-easy-steps

Choose a Light Guide, Online Tool, USEPA.
https://www.energystar.gov/products/choose_a_light