

## Energy Efficient Lighting

The quantity and quality of LIGHT around us determine how well we see and work. Light affects our health, safety, morale, comfort, and productivity. Lighting also directly affects our economy. In general, We spend about one-third of our (electricity) budget on lighting. Technologies developed during the past 10 years can help us cut lighting costs 30% to 60% while enhancing lighting quality and reducing environmental impacts.

### Lighting Principles and Terms

#### Illumination

A lumen is a measurement of light output from a lamp, often called a tube or a bulb. All lamps are rated in lumens. For example, a 100-watt incandescent lamp produces about 1750 lumens. It is printed on the lamp. The distribution of light on a horizontal surface is called its illumination. Illumination is measured in footcandles or lux. A footcandle of illumination is a lumen of light distributed over a 1-square-foot (0.09-square-meter) area. A lux of illumination is a lumen of light distributed over 1-square-meter area. The amount of illumination required varies according to the difficulty of a visual task. The Illuminating Engineering Society says that illumination of 30 to 50 footcandles is adequate for most home and office work. Difficult and lengthy visual tasks, like sewing for extended periods of time, require 200 to 500 footcandles. Where no seeing tasks (i.e., tasks whose speed and accuracy of completion are affected by quality and quantity of light) are performed, lighting systems need to provide only security, safety, or visual comfort, requiring from 5 to 20 footcandles of illumination. Another lighting term you will hear is efficacy. This is the ratio of light output from a lamp to the electric power it consumes and is measured in lumens per watt. It indicates the efficiency of the light.

#### Light Quality

Light quality describes how well people in a lighted space can see to do visual tasks and how visually comfortable they feel in that space. Light quality is important to energy efficiency because spaces with higher quality lighting need less illumination. High-quality lighting is fairly uniform in brightness and has no glare. For example, direct intense sunlight streaming through the windows of a room with chocolate brown carpets and dark wall paneling will likely give too much contrast in brightness. On the other hand, in a pale-colored room bathed in soft light, you can hardly tell where the light is coming from because no one area of the room appears much brighter than another. The walls, ceiling, floor, and work surfaces are relatively the same light hue.

#### Glare

Eliminating glare (i.e., excessive brightness from a direct light source) is essential to achieving good lighting quality. Suitable shades, fittings shall be used.

#### Light Color and Color Rendering

Lamps are assigned a color temperature (according to the Kelvin temperature scale) based on their "coolness" or "warmness." The human eye perceives colors as cool if they are at the blue-green end of the color spectrum, and warm if they are at the red end of the spectrum. Cool light is preferred for visual tasks because it produces higher contrast than warm light. Contrast is the brightness difference between different parts of the visual field, which is the expanse of space you can see at a given instant without moving your eyes. Warm light is preferred for living spaces because it is more flattering to skin tones and clothing (especially in cold countries- and not in southern states of India). Keep in mind, though, that artificial light sources vary widely in their color rendering indexes (CRI). The CRI is a measurement of a light source's ability to render colors the same as sunlight does. For example, incandescent lamps are rated at a CRI of 100, nearly equal to sunlight, while some high-pressure sodium lamps have a CRI of 22, which means they render colors very poorly.

#### Types of Lighting

There are four basic types of lighting: incandescent, fluorescent, high-intensity discharge, and low-pressure sodium.

#### Incandescent (in general our bulbs)

Incandescent lamps are the least expensive to buy but the most expensive to operate. Incandescent light is produced by a tiny coil of tungsten filament that glows when it is heated by an electrical current. Incandescent lamps have the shortest lives (500-1000 operating hours) of the common lighting types. They are also relatively inefficient compared with other lighting types.

#### Tungsten halogen

This newer type of incandescent lighting achieves better energy efficiency than the standard A-type bulb. It has a gas

filling and an inner coating that reflect heat. Together, the filling and coating recycle heat to keep the filament hot with less electricity. These lamps are considerably more expensive than standard incandescents and are primarily used in commercial applications: theater, store, and outdoor lighting systems.

### Reflector lamps

Reflector lamps (Type R) are designed to spread light over specific areas. They are used mainly indoors for stage/theater and store applications, as well as floodlighting, spotlighting, and downlighting.

### Fluorescent (common Tube lights and CFL)

The light produced by a fluorescent tube is caused by an electric current conducted through mercury and inert gases. Fluorescent lighting is used mainly indoors and is about 3 to 4 times as efficient as incandescent lighting. Fluorescent lamps last about 10 times longer than incandescents. But, to gain the most efficiency, you should install fluorescents in places where they will be on for several hours at a time. Fluorescent lights need ballasts (i.e., devices that control the electricity used by the unit) for starting and circuit protection. Ballasts consume energy. You can increase the energy savings for existing fluorescent lighting by relamping (e.g., replacing an existing lamp with one of a lower wattage), replacing ballasts, and replacing fixtures with more efficient models.

### Tube fluorescent

The two most common types are 40-watt, 4-foot (1.2-meter) lamps and 75-watt, 8-foot (2.4-meter) lamps. Tubular fluorescent fixtures and lamps are preferred for ambient lighting in large indoor areas because their low brightness creates less direct glare than do incandescent bulbs.

### Compact fluorescent

Compact fluorescent lamps (CFLs) are the most significant lighting advance developed for homes in recent years. They combine the efficiency of fluorescent lighting with the convenience and popularity of incandescent fixtures. CFLs can replace incandescents that are roughly 3 to 4 times their wattage, saving up to 75% of the initial lighting energy. Although CFLs cost from 10 to 20 times more than comparable incandescent bulbs, they last 10 to 15 times as long. This energy savings and superior longevity make CFLs one of the best energy efficiency investments available.

### High-Intensity Discharge

High-intensity discharge (HID) lamps provide the highest efficacy and longest service life of any lighting type. They are commonly used for outdoor lighting and in large indoor arenas. HID lamps use an electric arc to produce intense light. They also require ballasts, and they take a few seconds to produce light when first turned on because the ballast needs time to establish the electric arc. The three most common types of HID lamps are mercury vapor, metal halide, and high-pressure sodium. HID lamps and fixtures can save 75% to 90% of lighting energy when they replace incandescent lamps and fixtures. Significant energy savings are also possible by replacing old mercury vapor lamps with newer metal halide or high-pressure sodium lamps. Mercury vapor, the oldest type of HID lighting, is used primarily for street lighting. Mercury vapor lamps provide about 50 lumens per watt. They cast a very cool blue/green white light. Most indoor mercury vapor lighting in arenas and gymnasiums has been replaced by metal halide lighting, which has better color rendering and efficiency. Metal halide lamps are similar in construction and appearance to mercury vapor lamps. The addition of metal halide gases to mercury gas within the lamp results in higher light output, more lumens per watt, and better color rendition than from mercury gas alone. Metal halide lamps are used to light large indoor areas such as gymnasiums and sports arenas, and for outdoor areas such as car lots or anywhere that color rendition is important. High-pressure sodium lighting is becoming the most common type of outdoor lighting. It provides 90 to 150 lumens per watt, an efficiency exceeded only by low-pressure sodium lighting. High-pressure sodium lamps are also reliable and have long service lives. Their color is a warm white, and their color rendition ranges from poor to fairly good depending on design and intended use.

### Low-Pressure Sodium

Low-pressure sodium lamps work somewhat like fluorescent lamps. They are the most efficient artificial lighting, have the longest service life, and maintain their light output better than any other lamp type. Low-pressure sodium lighting is used where color is not important because it renders all colors as tones of yellow or gray. Typical applications include highway and security lighting.

### Energy Efficiency with Lighting

In a typical residential or commercial lighting installation, 50% or more of the energy is wasted by obsolete equipment, inadequate maintenance, or inefficient use. Saving lighting energy requires either reducing electricity consumed by the light source or reducing the length of time the light source is on.

"Relamping" means substituting one lamp for another to save energy. You can decide to make illumination higher or lower when relamping. But be sure that the new lamp's lumen output fits the tasks performed in the space and conforms to the fixture's specifications.

#### Relamping incandescent fixtures

Example, for energy savings of 60% to 75%, many incandescent lamps can be replaced by CFLs. In general, a 60 W bulb can be replaced with 11 W CFL. In selecting CFL: Take from an accepted dealer or shop, commonly known make in India, integral Ballast (choke) is better, if pin type, select 4 pin type. BIS mark in choke is a mark of approval for the choke. Electronic ballast consumes 2-4 W while electro-magnetic choke takes 6-10 W. If electronic ballast, check the symbol (H) which indicates low harmonic distortion.

#### Relamping fluorescent fixtures

Common 40-watt and 75-watt lamps can be replaced with energy-saving lamps of 34 watts and 60 watts, respectively. Energy-saving lamps for less-common fluorescent fixtures are (26 W retrofit) also available. If you need to replace the ballasts in your fluorescent fixtures, consider using one of the improved varieties. The new electromagnetic ballasts reduce ballast losses, fixture temperature, and system wattage. Because they operate at cooler temperatures, they last longer than standard electromagnetic ballasts. Electronic ballasts operate at a very high frequency that eliminates flickering and noise. They are even more efficient than improved electromagnetic ballasts. Some electronic ballasts even allow you to operate the fluorescent lamp on a dimmer switch, which usually is not recommended with most fluorescents. Check the symbol (H) which indicates low harmonic distortion

#### Improving Lighting Controls

Lighting controls are devices for turning lights on and off or for dimming them. The simplest type is a standard snap switch. Other controls are photocells, timers, occupancy sensors, and dimmers.

- Snap switches, located in numerous convenient areas, make it easier for people in large, shared spaces to turn off lights in unused areas.

- Photocells turn lights on and off in response to natural light levels. Photo-cells switch outdoor lights on at dusk and off at dawn, for example. Advanced designs gradually raise and lower fluorescent light levels with changing daylight levels.

- Mechanical or electronic time clocks automatically turn on and off indoor or outdoor lights for security, safety, and tasks such as janitorial work.

- Crank timers, which are spring-driven and similar to old oven timers, limit lights to short durations where the need for light is brief.

- Occupancy sensors activate lights when a person is in the area and then turn off the lights after the person has left. They are popular for areas used infrequently, such as warehouses. They also offer security advantages over continuous lighting: when lights suddenly come on, they startle intruders and alert residents and neighbors to motion in the area.

- Dimmers reduce the wattage and output of incandescent and fluorescent lamps. Dimmers also increase the service life of incandescent lamps significantly. However, dimming incandescent lamps reduces their lumen output more than their wattage. This makes incandescent lamps less efficient as they are dimmed. Dimming fluorescents requires special dimming ballasts and lamp holders, but does not reduce their efficiency.

#### Daylighting

Daylighting means using daylight for indoor lighting. Modern buildings designed for daylighting typically use 40% to 60% less electricity for lighting needs than do conventional buildings. Sunlight and daylight are free and readily accessible. (During a sunny day at noon, light levels at different places- open lawn- 30000 lux or above, a class room with windows open - 400 lux, with windows closed- 160 lux. With 4 tube lights ON in the night-100 lux.

#### POLLUTION from Fluorescent Lamps

All fluorescent lights contain small amounts of mercury, and short-lived radioactive material. Because of these hazardous materials, you should not dump burned-out lamps into the yard. Mercury, antimony, chromium, lead all will ooze out into the drinking water-well,river,pond etc. which is dangerous. Dispose of them with other household hazardous wastes such as batteries, solvents, and paints at your community's designated drop-off point for proper disposal by the panchayat or corporation Light from fluorescent lamps without proper radiation shield contain a very small % of UV rays harm full to eyes. Do not use Tubes/CFL without proper shields.

#### Lighting Maintenance

Maintenance is vital to lighting efficiency. Light levels decrease over time because of aging lamps and dirt on fixtures, lamps, and room surfaces. Together, these factors can reduce total illumination by 50% or more, while lights continue drawing full power. The following basic maintenance suggestions can help prevent this.

- Clean fixtures, lamps, and lenses every 6 to 24 months by wiping off the dust. However, never clean an incandescent bulb while it is turned on. The water's cooling effect will shatter the hot bulb.

- Replace lenses if they appear yellow.

- Clean or repaint small rooms every year and larger rooms every 2 to 3 years. Dirt collects on surfaces, which reduces the amount of light they reflect.

- Consider group relamping. Common lamps, especially incandescent and fluorescent lamps, lose 20% to 30% of their light output over their service life. Many lighting experts recommend replacing all the lamps in a lighting system at once. This saves labor, keeps illumination high, and avoids stressing any ballasts with dying lamps.