*International Journal of Engineering Applied Sciences and Technology, 2022*
**Vol. 6, Issue 12, ISSN No. 2455-2143, Pages 213-216**
Published Online April 2022 in IJEAST (http://www.ijeast.com)

# ENERGY EFFICIENT LIGHTING

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***Abstract*— It has been estimated that lighting accounts for about 20% of the total power generation of the world (nearly 18% in India). The quality and quantity (output amount coming from a source) affect our health, comfort (soothing of eye), safety (for eye, skin also), environment (amount of greenhouse gases) and also economy (price). Many nations have been spending a huge amount of their electricity budget on lighting system.**

**For achieving efficient use of electricity, nations have been taking a switch to the energy efficient lighting which is the most cost effective, safe for human and environment and reliable method of energy-saving. A well-known technology has been in use in the area of lighting to optimize the existing controls and lighting equipment for reducing the energy consumption with higher lighting quality. Let us discuss in detail about this concept.**

***Keywords*— LED, CFL key tag system, motion sensors, occupancy sensors**

## I. INTRODUCTION

**What is Energy Efficient Lighting?**

When the energy consumption of a product is reduced without affecting its output or response and without affecting comfort levels of user and also for environment is referred as **energy efficiency**. An energy efficient product consumes less energy to perform the same function when compared to the same product with more energy consumption. The energy efficiency in the lighting sector gives the required illumination level of the lighting scheme for the application it has been designed for, while consuming the least amount of energy. Simply, energy efficient lighting can save the electricity while maintaining good quality and quantity of the light.

Energy efficient lighting involves in replacement (or re-lamping) of traditional lamps (such as incandescent lamps) with that of energy efficient such as fluorescent lamps, CFL (Compact Fluorescent Lamps) and LED (Light Emitting Diode) lamps. It also incorporates proper lighting controls such as timer controls, PIR (Pyro electric) and ultrasonic sensors-based controls, etc. It includes the turning off lights automatically when they are not in use, especially during daylight. It uses electronic chokes instead of ballasts in case of conventional lighting and also with the use of electronic circuitry; it can achieve dimming of lights when necessary. These energy efficient schemes can be applied for external lighting, internal lighting for residential buildings and internal lighting for commercial buildings also. These schemes not only reduce the energy consumption, but also enhance the lighting quality, increase the safety and staff well-being, and reduce the environmental impacts.

*1)* **What is the Need for Energy Efficient Lighting?**

Lighting is the basic requirement of any facility and it impacts the day-to-day activities of the people. This accounts a considerable amount of total energy consumption in domestic, commercial and industrial installations. Industry sector uses almost nearly about 23% of lighting energy (domestic sector uses nearly 43%). So, it becomes an important area wherein energy consumption to be reserved, especially in the industry and domestic sector. Lighting efficiency solutions therefore play a key role in energy saving opportunities. Due to the high energy consumption, traditional incandescent lamps and high discharge lamps have to be substituted with energy efficient lamps. Traditional lamps not only consume large amounts of electric power, but they use much of its consumed energy to produce heat rather than light (for instance 90% of consuming energy in case of incandescent lamps) and they are not also healthy for human eyes and environment .With the installation of energy efficient lighting system, the amount of energy consumption eventually will get reduced and it results in lower electricity bills (as the power consumption is low but the amount of output of from the source is high).Hence the energy efficient lighting is necessary:1.To reduce electricity consumption (without affecting the output), thereby reduces the electricity bills.2.To save electricity rather than wasting in terms of losses (as in incandescent lamps).3.To lower greenhouse emissions (mainly carbon di oxide) because conventional lamps cause $CO_2$ emissions.4.To achieve peak load reduction. The best and effective solution for energy conservation is the adoption of energy efficient lighting technologies in the lighting sector, which facilitates comprehensive re-designing of lighting and control systems.

- There have been major improvements and innovations in lighting technologies which
- can offer a great potential for energy savings in many lighting applications such as

- Household lighting, street lighting, hospitality and retail spotlights, office and industrial lighting, etc.
- The following are the **techniques or types of energy efficient lighting** which are commonly practiced as energy-saving opportunities.

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*2)* **Re-lamping with Energy-Efficient Lights**

Energy efficient lamps can deliver the same or more amount of lighting (output in lumens) with greater energy saving at low cost and improved power factor, when compared with conventional lamps. Traditional incandescent lamps consume a lot of energy to produce light in which 90 percent of consumed energy is given off as heat and also, they consume more energy, typically 3-5 times more than the actual amount to produce light. Energy efficient lamps overcome these problems by offering many more advantages than incandescent lamps. The two most popular choices of energy efficient light bulbs include CFLs (Compact Fluorescent Lamp) and LED (Light Emitting Diode) lamps.

## II. THEORY

**Compact Fluorescent Lamps (CFLs)**

CFL lamps are miniature or curly versions of long-sized fluorescent tubes. These lamps combine the efficiency of fluorescent lighting with the popularity and convenience of incandescent fixtures. They screw in to the fixtures that allow all standard incandescent lamps, but not into standard fluorescent fixtures of long tubes. Depending on the brand and application use, they come in different range of styles, colours and sizes. CFLs use 75 percent less energy and produce 75 percent less heat for producing the same amount of illumination as compared with incandescent lamps. They last 10 to 15 times longer and cost 10 to 20 more as compared to incandescent lamps. Also, the power factor of these lamp is standard (at least 0.9 for class A CFL). These lamps are made with a phosphorous glass tube consisting of inert gas (argon) and mercury vapor. They use an electronic ballast to create high voltage during the starting and it can be a separate unit or permanently built-in lamp. Some special and older models of CFLs come with separate ballast while some CFLs come with in-built ballast. When an electric current is passed through the electrodes, the electrons that are bound to mercury atoms are excited which in turn emits ultraviolet light. As UV light strikes the fluorescent coating, it will be converted into visible light.

**Comparison chart for incandescent and CFL.**

There are different types of CFL lamps available in today's market. Some of these are spiral lamps, triple tube lamps, standard lamps, globe lamps, flood lamps and candelabra lamps. In case of replacing incandescent lamps, CFLs are chosen to match lumens that indicate the amount of light being generated as shown in figure below.

| **Incandescent** | **CFL** | **Lumens** |
|---|---|---|
| 40W | 11-12W | >490 |
| 60W | 13-18W | >900 |
| 75W | 19-22W | >1200 |
| 100W | 23-26W | >1750 |

*a)* **Light Emitting Diodes (LEDs)**

LEDs are solid state semiconductor devices and are more energy efficient than even CFLs. They produce little heat and higher quality lighting than any other lamp. At the time of inception, the usage of LEDs was limited as single bulb indicators in electronic circuits. Later a number of LEDs are clustered to develop small lamps in battery powered devices such as charging lights, flashlights, etc. Today, LED lamps are available in many new bulb styles which are bright enough to replace traditional incandescent lamps. LED lamps use 75 percent less energy than traditional incandescent and 50 percent less energy than that of a CFL. They can last 8-25 times longer compared to incandescent and up to four times longer than a CFL. Unlike incandescent and CFLs, LED lamps produce no heat and hence they are cool enough to touch. But these are more expensive; however, they are affordable over the long run. Power factor is at least 0.99. LEDs are made up of semiconductor materials to form PN junctions. Whenever current flows across these junctions, it releases the energy in the form of a light. The wavelength and hence the colour of the light depends on the composition of materials. LEDs can generate yellow, red, blue, green and white light. For lighting purpose several white colour LEDs are stacked as clusters to produce required lighting for an application. LED bulbs are available in different shapes, sizes and styles according to the type of application it is intended for. Some of these types include diffused bulbs, dimmable globe LED bulbs, track lighting pin-base type bulbs, flood reflector screw-in base bulbs, flame tip candelabra base LEDs and LED tube lights.

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**Comparison of incandescent, CFL, LED and halogen bulbs and lamps.**

| | **Incandescent** | **Halogen** | **CFL** | **LED** |
|---|---|---|---|---|
| **Lumen/watt** | 15 | 25 | 60 | 72 |
| **Percentage more efficient than incandescent** | | 28% | 75% | 83% |
| **Rated bulb life** | 1.4 years | 4.2 years | 14 years | 34 years. |
| **Mercury contains** | No | No | Yes | No |
| **Recyclable** | No | No | Yes | No |

*1)* **Improving Lighting Controls**

Lighting can be controlled with the use of various sensors to allow the operation of lamps whenever they are needed. These sensors detect the presence of humans, motion, timing or occupancy and based on the sensor output, it switches the lamps ON and OFF. Types of these controls include infrared sensors, automatic timers, motion sensors (PIR and ultrasonic sensors), and dimmers. Photo sensors monitor the daylight conditions and accordingly send the signals to main controller to turn the lamps automatically off at dawn and on at dusk. This type of lighting control is commonly used with street lighting and outdoor lighting. Street lighting is another major area of energy conservation as it contributes considerable power consumption especially in the highways. Centralized control systems are most commonly used in street light control. The popular centralized control is the SCADA (supervisory control and data acquisition) system which ensures remote control of operation of street lights from a central location. GPRS based systems also used to perform the remote-control operation of street lights.

**Replacing of Existing Fixtures and Ballasts**

Replacing energy inefficient accessories with new energy efficient fixtures and ballast gives superior energy savings, longevity, and reliability. The main function of a luminaire or lighting fixture is to distribute, direct and diffuse light. Some fixtures can absorb more than half of the illumination emitted the bulb that reduces the efficiency of the lighting. The higher efficiency fixtures can emit lighter and hence one can save energy and money also. Such fixtures consist of reflectors to direct the light in a desired direction. All discharge lamps require aballast for achieving required operation. Conventional magnetic type ballasts cause power losses which is typically 15 percent of the lamp wattage. It also can raise fixture temperature during operation. So, the proper ballast must be chosen to reduce ballast losses, fixture temperature and system wattage. In today's market, many electronic or solid-state types of ballast are available which can save 20 to 30 percent energy consumption over standard ballasts. By replacing inefficient incandescent bulbs, CFLs and LED lamps can mean **energy savings of 80% or more and can decrease the levels of greenhouse gases** (and other hazardous emissions) related to the provision of electric power.

**Key tag system**

The key tag system uses a master switch at the entrance of each guest room, requiring the use of a room key-card to activate them. Using this technique, only occupied rooms consume energy because most electrical appliances are switched off when the key card is removed (when the guest leaves the room). Along with lighting, the heating, air conditioning, radio and television may also be connected to the master switch.

**Photo sensors**

You can use photosensors to prevent lights from operating during daylight hours. This can help to save energy because you don't have to remember to turn off your lights. Photosensors sense ambient light conditions, making them useful for all types of outdoor lighting. These light-sensitive controls can be less effective inside the home because lighting needs to be varied with occupant activity more than ambient lighting levels. Many LED nightlights, however, have this feature built in which makes them effective and easy to use.

**Occupancy Sensors**

Occupancy sensors detect indoor activity within a certain area. They provide convenience by turning lights on automatically when someone enters a room, and save energy by turning lights off when someone leaves the room or reducing light output when a space is unoccupied. Occupancy sensors must be located where they will detect occupants or occupant activity in all parts of the room or the major part of the room. Ultrasonic sensors detect sound, while infrared sensors detect heat and motion. In addition to controlling ambient lighting in a room, they are useful for lighting applications used for task, such as over kitchen counters. In such applications, task lights are turned on by the motion of a person working in kitchen for instance and automatically turn off the lights after the person leaves the area. An occupancy sensor, that automatically turns

lighting off within 30 minutes, must be installed in **classrooms, conference rooms, storage rooms, printing rooms, private offices, rest rooms, and dressing rooms** etc.

**Motion Sensors:**
Motion sensors automatically turn lights on when they detect motion and turn them off a short while later. They are especially useful for outdoor security and utility lighting. Because utility lights and some security lights are needed only when it is dark and people are present, the best way to control might be a combination of a motion sensor and photosensor.

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