# Light Emitting Diodes.

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Large-scale adoption of retrofit LED lamps are forecasted to lead to $100 billion in global energy savings. Rapid growth in the conversion toward LED lamps for general lighting is expected to generate a market of more than 4 billion. Key legislation banning conventional incandescent bulbs and Europe has helped initiate this trend, while consumers are also realizing the long-term savings associated with LED lamps over competitive options halogen bulbs.

Appearing as practical electronic components in 1962, the earliest LEDs emitted low-intensity infrared light. Infrared LEDs are still frequently used as transmitting elements in remote-control circuits, such as those in remote controls for a wide variety of consumer electronics. The first visible-light LEDs were also of low intensity, and limited to red. Modern LEDs are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness. In 2014, the Nobel Prize in Physics 2014 was awarded to Isamu Akasaki, Hiroshi Amano and Shuji Nakamura “for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources”. Before that work was done, efficient blue LEDs could not be made, and therefore also no white-emitting LEDs as usually needed for illumination purposes. The researchers succeeded in developing efficient blue-emitting LEDs based on indium gallium nitride (InGaN). Methods had to be developed for producing such materials with a high quality. Surprisingly, a high device efficiency could be reached despite still substantial defect densities. LED's have several advantages over conventional incandescent lamps. For one thing, they don't have a filament that will burn out, so they last much longer. Additionally, their small plastic bulb makes them a lot more durable. An LED is often small in area (less than 1 mm2) and integrated optical components may be used to shape its radiation pattern. LEDs, being solid state components, are difficult to damage with external shock. Fluorescent and incandescent bulbs are easily broken if dropped on the ground. LEDs are Eco-friendly as the components are 95% recyclable. They also fit more easily into modern electronic circuits. The main advantage of LED's is efficiency. In conventional incandescent bulbs, the light-production process involves generating a lot of heat (the filament must be warmed). This is completely wasted energy, unless you're using the lamp as a heater, because a huge portion of the available electricity isn't going toward producing visible light. LED's generate very little

heat, relatively speaking. A much higher percentage of the electrical power is going directly to generating light, which cuts down considerably on the electricity demands. Proponents say LEDs can last some 60 times longer than incandescents and 10 times longer than CFLs. And unlike incandescents, which generate a lot of waste heat, LEDs don't get especially hot and use a much higher percentage of electricity for directly generating light. LEDs do not contain mercury, while compact fluorescent lamps do.

Up until recently, LED's were too expensive to use for most lighting applications because they're built around advanced semiconductor material. The price of semiconductor devices has plummeted over the past decade, however, making LED's a more cost-effective lighting option for a wide range of situations. While they may be more expensive than incandescent lights up front, their lower cost in the long run can make them a better buy. In the future, they will play an even larger role in the world of technology.

LED lamps emit no Infrared or Ultraviolet radiation. CFLs (and tubular fluorescent lamps) generate light by exciting the Mercury vapor inside the lamp with electricity, generating Ultraviolet radiation, which stimulates the phosphor coating on the inner surface of the glass bulb, causing it to re-radiate most of the Ultraviolet radiation as visible light.

LED lamps turn on instantly (reaching full brightness immediately). CFLs tend to have a warm-up period which may range from a few seconds to over a minute. During this warm-up period they are not as bright as they eventually become. This can lead to problems ranging from having to wait for light levels to increase to a useful level, wasting your time, to turning the lights on before you really need them, in anticipation of the warm-up period, wasting electricity.

Lighting accounts for approximately 19 percent of the world's energy use at present, according to most studies. IMS Research forecasts that in 2016 about 15 percent of all lighting on the market will be based on LED technology, which would reduce global energy consumption of lighting by at least 20 percent. Retrofit LED lamps use a significantly smaller amount of the power of incandescent lamps for the same light output.

At the consumer level, the benefits of using LED lamps to the general consumer are obvious in the massive reductions in average household energy bills.

What's more, an LED lamp has an average life expectancy of over 30,000 hours, which is roughly 30 times longer than an incandescent lamp, making LEDs the cheapest solution over the long-term. Lifetime is lengthened through proper electrical and thermal design of the LED fixture. For example, power LEDs that dissipate a relatively large amount of power will heat up unless the excess heat is conducted away from the fixture. Additionally, LEDs are rated for a maximum

current that should not be exceeded as this may shorten the lifetime of the unit. Potential energy savings, however, appear to hold more sway with cities and building owners than cost. After all, some 22 percent of all electricity use in the U.S. is devoted to lighting, according to the U.S. Department of Energy—and switching to LEDs could save $280 billion by 2028. In fact, researchers at the Rensselaer Polytechnic Institute in Troy, N.Y., estimate that replacing incandescents with LEDs could save $1.83 trillion in energy costs globally over the next decade and eliminate the need for 280 1,000-megawatt power plants. LEDs generate very little heat, relatively speaking. A much higher percentage of the electrical power is going directly to generating light, which cuts down on the electricity demands considerably.

Potential downsides: individual LEDs must be kept cool, and it may end up that the tiny fans in the multiple LED fixtures used to cool the lights will wear out long before the diodes.

Nevertheless, LEDs will not replace all lightbulbs, because they produce light in only one direction, like a laser, rather than illuminating an area. To fill that lighting need, some companies are creating organic LEDs, or OLEDs, that emit light in all directions and are already used in advanced televisions and other screens. In LED televisions every pixel is made up of tiny red, green and blue LEDs. By varying the intensity of the individual LEDs, millions of different in colours can be generated, including white. Light-emitting diodes are now used in applications as diverse as aviation lighting, automotive headlamps, advertising, general lighting, traffic signals, camera flashes and lighted wallpaper. LEDs that emit visible lights are commonly used as indication lights, e.g. in electronic equipment, but are also used in LED traffic lights and indoor lighting. Infra-red LEDs are commonly used in remote controls and other communication equipment. As of 2015, LEDs powerful enough for room lighting remain somewhat more expensive, and require more precise current and heat management, than compact fluorescent lamp sources of comparable output. LED's are used for many different applications. They can form the numbers on digital clocks, transmit information from remote controls, light up watches and tell you when your appliances are turned on. Collected together, they can form images on a jumbo television screen or illuminate a traffic light.

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