Eco-$mart, Inc.
TOLL FREE: (888)329-2705 FAX: (941)377-9460 info@eco-smart.com

LED 101

Why Energy Efficient Lighting?

Lighting consumes 22% of the electrical power generated in the U.S.

When you select energy-efficient lighting, you:

- Save a lot of money;
- Reduce the need for additional power plants;
- Reduce greenhouse gases and other pollution; and,
- Are able to use lighting in ways you never thought possible.

Engineers on large remodeling projects find that energy-efficient lighting affords a higher payback than any other energy-efficient system. That includes heating, ventilation, air conditioning, appliances and computer equipment.

Sustainable resource consumption is everyone's responsibility. Choosing energy-efficient lighting is the easiest way to save money on power. The choice is up to you.What you choose matters to you and the environment.

Why LED's?

Light Emitting Diodes are semiconductors used to create light. There are other types of Solid State Lights ("SSL,") but LED's are the most relevant for general illumination.

Eco-$mart sells many other types of energy-efficient lights besides LED. These include fluorescents, compact fluorescents, and induction lighting products. LED's have the brightest future for the broadest range of applications. And they provide environmental sustainability because they consume less power, last much longer and contain no toxics.

LED's will radically change the energy consumption patterns of the world over the next few years. There's a phenomenal amount of resources being devoted to improving LED technology worldwide. The U.S. has committed an uncharacteristically large amount of industrial policy support for LED research and development, as you can easily discover for yourself, if you choose to wade through the copious recent studies commissioned on the subject. Asia is a hotbed of cutting-edge manufacturing technology and Europe and Canada have led the way in energy efficient initiatives accompanied by some of some of the most innovative design styles you can find anywhere.

Benefits of LED's

- Extremely low power consumption
- Very efficacious-convert energy to light, not heat
- Extremely long life span (50,000-100,000 hours)
- Durable, insensitive to vibration
- Dimmable and programmable, in many cases
- Super-fast turn-on, unlike compact fluorescents
- Lightweight and compact
- Color, without the use of filters and lenses
- No reflectors are required to direct the light
- Very environmentally friendly—no mercury or other toxics. Recyclable

LED 101

LED Applications

LED's are already the best light source for traffic signals, vehicular tail lights, emergency lighting and flashlights. Increasingly, they are viable for accent, task, landscape, portable and even area lighting. LED's let you do things you just can't do effectively with other light sources, especially due to LED's low power consumption.

Imagine powering a string of lights ½ mile long from a single electrical socket. You can, with our commercial line of LED Christmas lights! With LED's you can use more light than ever before, and still save money. Plus, they last so long, you can design complicated installations without worrying about frequent and costly bulb replacement projects. LED's have been used to create the most innovative lighting for stage shows, restaurant and hotel interiors, building exteriors and bridges.

General applications of LED's include:

Accent lighting. Nothing beats LED's for color. Programmable color changing, underwater applications, tiles, strings, ropes and tubes are all easier with LED's. LED landscape lighting provides innovative colors, compact designs and increasingly effective solar-powered solutions that do not require underground cabling. LED lamps are in the trendiest hotels and restaurants around the world.

Task lighting. Reading lamps, portable work lights, flashlights, wearable head lamps—LED's are compact, lightweight and highly directional.

Area lighting. LED's are increasingly competitive for illuminating larger spaces; however, LED's are not yet effective for illuminating large halls, parking lots, streets and the like. Use care in selecting LED's for area lighting. We encourage you to order a sample to check to see if the light levels are adequate for your purposes.

Haitz Law says that the luminous efficacy (light output per watt of power consumed) doubles every 18 months. That's fast! It means that LED's will become the dominant light source for many area lighting applications with certainty—it's just a matter of time. New products for path and area lighting are being introduced constantly, and we'll bring you the latest ones that meet our tough standards.

Portable lighting. LED's are great for flashlights and wearable safety products, such as flashing vests. They're bright, last an extremely long time and promote long battery life because they use so little power. No wonder LED flashlights are the choice for serious SCUBA divers and marksmen, as well as law enforcement and fire departments.

LED 101

How Bright is that LED Bulb?

How bright is it? That's a simple question that deserves a simple answer.

How do we compare the brightness of Compact Fluorescent Light ("CFL") bulbs to incandescent lights?We say that a 13 watt CFL with the brightness of a 60 watt incandescent bulb is a "60 watt-equivalent, 13 watt CFL." The CFL bulb uses only 13 watts of power (what you pay for,) but it generates the light of a 60 watt incandescent bulb. Therefore, the CFL uses only 13/60 = 22% of the power of the incandescent to generate the same brightness.

For white LED's we use the same system, and rate our bulbs by "wattequivalent," with incandescent light as the reference just like before. So, a 7- watt LED that generates the brightness of a 70-watt incandescent bulb is a "70 watt-equivalent, 7 watt LED." The LED uses only 10% of the power of the incandescent to generate the same brightness. That 90% energy savings is typical for LED's, versus incandescents. (Incandescents are inefficient light sources: they generate over 90% heat and less than 10% light.) That may be all you wanted to know about "how bright it is." Just compare watt-equivalents to get an idea how that LED will compare with an incandescent in brightness.

You may notice we've marked a few of our bulbs down in "watt equivalents." The reason is that, while our center beam measurements support the former ratings, our customers are using the bulbs for some general illumination applications, and not just task, accent and spot lighting. Therefore, to give a better indication of substitutability, we've taken the numbers down. Call if you have questions. Directional versus "General" lighting.

LED's are inherently directional. Directional lighting means illumination on the work-plane or an object mainly from a single direction. Incandescent bulbs are inherently non-directional—they send the light out in all directions from the glowing filament. Incandescents (and Compact Fluorescents) are better for "general" lighting, such as filling a space with light.

Measuring Light: Lumens versus Footcandles

Directional lights should be measured using Footcandles (the light that arrives where you directed it.) "General" lighting should be measured using lumens (the light sent out in all directions.)

Since LED's are inherently directional, they make excellent spot and flood lights and less-effective "general" lights. Therefore, it doesn't make much sense to measure LED floods and spots in lumens. We measure their brightness in illuminance, convert to luminance, and then to watt equivalents. To simplify things, we assume that the light delivered per watt for an incandescent is constant.

What's the matter with using Lumens to measure directional light?

Lumens are a spherical measurement, not a directional one. Incandescents generate a lot of lumens, but much of that output is useless or even annoying. You may be surprised by how much useless light comes out of the back of the incandescent reflector bulb. In a ceiling can, that light bounces around your ceiling can and heats up your ceiling. You might also notice how much light an incandescent sends sideways from the bulb. That light creates annoying unwanted glare.We can do much better than lumen output for measuring directional light. That's why we measure luminance.

LED 101

What does “Brightness” really mean?

Let’s refine what we mean by “brightness.” The photometric quantity most closely associated with brightness perception is luminance, measured in units of luminous intensity (candelas) per unit area (square feet or square meters). Brightness at the center of the beam is called Center Beam Candle Power (CBCP) (in candelas, formerly candles.) It’s easy to measure illuminance with a light meter, but you have to multiply it by the distance from the light squared to get the luminance at beam center, the CBCP.

A light meter measures illuminance, in foot-candles (or, in the metric system, lux.) Illuminance is the light arriving at a surface, expressed in lumens per unit area; 1 lumen per square foot equals 1 footcandle.

At Eco-$mart, we measure illuminance 6 feet from the light. We multiply the footcandles by the distance (6 feet) squared to get the Center Beam Candle Power, or brightness. A typical 65 watt incandescent R30 flood light has illuminance of 11 footcandles 6 feet from the bulb, so the luminance at beam center, (Center Beam Candle Power) is 396 candelas [11 footcandles x (6 feet) x (6 feet)]. That’s how “bright” it is.

Beam Spread

The beam angle is the angle across the cone of light from one beam edge to the opposite beam edge. The beam edge is the cone-shaped surface where the beam intensity is 50% of what it is at the center of the beam. (50% is somewhat arbitrary, but seems to be the most commonly used figure.) A flood light has a beam spread of around 22 degrees or more. A spot has a beam spread of less than 21 degrees. (21° is also arbitrary, but commonly used as the dividing point between floods and spots.)

If you compare a flood and spot with the same light elements (and lumen output,) the flood has a lower “brightness,” as defined by Center Beam Candle Power (luminance) because the bulb is spreading the light over a larger cone. That may not seem entirely fair to the flood light, but research has linked human perception of “brightness” with luminance, so using CBCP is valid. And converting CBCP to Watt-equivalents using a constant ratio is also valid for our purposes.

It is interesting to note that when we sell a flood and spot with the same light elements and prices, the floods out-sell the spots, but the spots “look” brighter. This suggests that people care about the beam spread at least as much as the overall perception of brightness.

Summary

The question, “How bright is that light?” can be answered for a flood or spot light by multiplying the Center Beam Candle Power, in candelas, by (0.17 watts/candelas), which is the typical ratio of watts to candelas at beam center for incandescent reflector bulbs.

Example:

An LED with a measured illuminance of 15 footcandles 6 feet from the face of the bulb has a CBCP = 15 x 6 feet x 6 feet = 540 candelas. That LED is a 92 watt-equivalent bulb (540 cd x 0.17 watts/cd = 92 watt-equivalents.) Scientists may argue over the approximations and simplifications we have made; however, this is a useful, easy to understand way of understanding how bright a directional light is without getting too technical.

Compare “watt-equivalents” to answer the question “How bright is it?” It's that simple.

We test your LED bulbs so you don’t have to. And we tell you what they can do, by the numbers. But the ultimate judge of the quality of light is YOU. So try some of our LED lights and see which you like best.

LED 101

Glossary of Terms Relating to “Brightness”

- **accent lighting:** directional lighting to emphasize a particular object or to draw attention to a part of the field of view. See directional lighting.
- **beam angle:** the angle between the two directions for which the intensity (candlepower) is 50% of the maximum intensity as measured in a plane through the nominal beam centerline (center beam candlepower).
- **beam spread:** (in any plane) the angle between the two directions in the plane in which the candlepower is equal to a stated percent (usually 10%) of the maximum candlepower in the beam, the Center Beam Candle Power.
- **brightness:** see luminance.
- **center beam candlepower (CBCP):** Center beam candlepower is the luminous intensity at the center of a beam, expressed in candelas (cd).
- **direct lighting:** lighting by luminaires distributing 90 to 100 percent of the emitted light in the general direction of the surface to be illuminated. The term usually refers to light emitted in a downward direction. (See accent lighting.)
- **directional lighting:** illumination on the work-plane or on an object predominantly from a single direction.
- **footcandle, fc:** a unit of illuminance equal to 1 lumen per square foot. One footcandle equals 10.76 lux.
- **general lighting:** lighting designed to provide a substantially uniform illuminance throughout an area, exclusive of any provision for special local requirements.
- **glare:** excessive brightness that may be caused by either direct or indirect viewing of a light source; any brightness or brightness relationship that annoys, distracts or reduces visibility.
- **illuminance:** light arriving at a surface, expressed in lumens per unit area; 1 lumen per square foot equals 1 footcandle, while 1 lumen per square meter equals 1 lux.
- **luminance, L:** light reflected in a particular direction; the photometric quantity most closely associated with brightness perception, measured in units of luminous intensity (candelas) per unit area (square feet or square meters).
- **lumen, lm:** a unit of luminous flux; the overall light output of a luminous source is measured in lumens. A unit measurement of the rate at which a lamp produces light. A lamp's light output rating expresses the total amount of light emitted in all directions per unit time.
- **lux, lx:** a unit of illuminance equal to 1 lumen per square meter. One lux equals 0.093 footcandle.
- **watt,W:** a unit of electrical power (energy) equal to 1 joule per second. Volts times amps.
- **work plane:** the plane at which work usually is done, and on which the illuminance is specified and measured. Unless otherwise indicated, this is assumed to be a horizontal plane 0.76 meters (30 inches) above the floor.