LED Lighting: Getting It Right

Avoiding common misconceptions about LED sources and fixtures

PHILIPS

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Myth #1: LEDs last forever

Like all light sources, LED sources slowly fade over time. This light output degradation, or *lumen depreciation*, is determined by testing LED sources over a period of 6,000 hours or more. Factors that can cause lumen depreciation include drive current and heat generated within the device itself.

Lumen maintenance describes how long a lighting fixture retains a certain percentage of its initial light output. White light sources used for general illumination are commonly considered to be at the end of their useful life when their light output falls below 70% of initial output. For white and colored accent and non-task lighting, the lumen maintenance threshold is often considered to be 50%.

Well-designed LED lighting fixtures can retain 70% of their initial output for 50,000 hours or more, depending on operating conditions and other factors. At 24 hours per day of continuous use, such fixtures can deliver useful light for six years or longer — many times as long as incandescent sources, and up to twice as long as long-life fluorescent sources.

Myth #2: LEDs are not bright enough

If you compare the raw lumen output of conventional lamps with the lumen output of many LED lighting fixtures, it often seems that LED fixtures deliver less light than the conventional alternatives. Such comparisons, however, are inaccurate and misleading, as they fail to account for the significant amount of wasted light in conventional lighting solutions.

Simply put, lumen output is a poor measure of the suitability of a lighting fixture for a given task. A better measure is *delivered light* — how much light a fixture delivers to a surface or area, as measured in lux (lx) or footcandles (fc). You can make accurate comparisons between conventional and LED lighting fixtures on the basis of delivered light, as it measures how much of a light source's raw lumen output reaches a surface or area you want to illuminate.

To determine how much of a conventional lamp's raw lumen output reaches a task area, you must discount any light lost in the fixture housing (often over 30%), as well as any light lost as a result of lensing, shading, and filtering. Since incandescent and fluorescent lamps emit light in all directions, you must further discount any light emitted in a direction away from the target area.

LED lighting fixtures are integrated systems in which the light sources (LEDs), the fixture housing, and the primary optics are inseparable. Lumen measurements of LED lighting fixtures, therefore, are performed on the entire system, and already account for light lost to the fixture housing and lensing. Furthermore, since LEDs are inherently directional, they emit almost all of their light output in the desired direction, rather than dispersing it in all directions. And since LEDs natively produce intensely saturated colored light, they require no gels or filters which can block a significant percentage of a fixture's light output (over 90% for certain shades of deep blue).

When comparing lighting fixtures on the basis of delivered light, LED fixtures often perform as well, and in some cases significantly better, than conventional fixtures, while consuming far less energy.

Myth #3: White-light LED sources produce over 160 lumens per watt

Many manufacturers test their LED chips on lab benches at room temperature with short pulses that produce a high efficacy that cannot be achieved in practical use. While these results are not incorrect, they do not reflect the typical expected output of LED sources integrated into lighting fixtures. Although percentages vary, it is not uncommon to see efficacy losses of up to 40%.

Reputable LED fixture manufacturers do not base lumen measurements on the test results of their LED source suppliers. Instead, they use independent, third-party testing labs to measure and validate the output of their lighting fixtures according to test conditions spelled out in the LM-79 standard, published in 2008 by the Illuminating Engineering Society of North America (IES).

Some highly efficient white-light LED lighting fixtures can achieve efficacy of over 40 lumens per watt (lm / W), sufficient to earn ENERGY STAR and other energy-efficiency ratings. For example, linear LED cove lights from a leading manufacturer achieve efficacies of 43.9 to 53.1 lm / W in normal operating conditions.

Myth #4: Three-watt LEDs are brighter than one-watt LEDs

Because of incandescent light bulbs, you're probably used to looking at wattage to determine the light output of a light source: a 100-watt lamp puts out more light than a 60-watt lamp.

The fact is that incandescent lamps have a very low efficacy compared with CFLs, high-output fluorescent lamps, and LED light sources. All general service incandescent lamps use the same filament material heated to the same temperature, the only way to increase their light output is to increase the wattage. This is one of the main reasons why incandescent lamps are so energy wasteful.

LED sources are much more efficient at converting watts to lumens. Different materials can be used within the LED sources themselves, each of which has its own light extraction efficacy. For these and other reasons, two different LED sources can consume the same number of watts but differ widely in lumen output.

Because watts can't be used as an index of light output, evaluating the "brightness" of LED sources for a given situation requires you to think differently about lighting. A standard 60-watt incandescent lamp emits a total of about 800 lumens, but the light is emitted equally in all directions. When you're reading at your office desk, your book does not receive all 800 lumens from your desktop lamp, nor do you need it to. As described in Myth #2, the crucial measurement is delivered light. According to the IES, serious reading requires an average of 50 fc or 500 lx on the page. Many linear LED under-cabinet fixtures and other task lights can deliver this level of light while consuming far less than 60 watts. For example, an under-cabinet LED light from a leading supplier delivers 50 fc in typical desktop situations while consuming only about 6 watts per foot.

Myth #5: LEDs generate no heat

Because they produce no infrared energy, the beam of light from an LED source is cool. However, waste heat is produced within the LED itself during the conversion of electricity into light. This waste heat must be properly removed from the lighting system to maximize fixture performance and to avoid damage to the LEDs. In well-designed LED lighting fixtures, heat removal is accomplished through carefully designed and engineered *heat sinks* that draw heat away from the LEDs and dissipate it into the air surrounding the fixture housing.

Myth #6: LED systems cost too much

Initial fixture costs may be higher for some LED lighting solutions than for comparable incandescent and fluorescent lighting solutions. But initial fixture cost does not account for the total cost of owning, operating, and maintaining a lighting system. Because of their long useful life, LED lighting fixtures avoid the maintenance and materials costs which multiple relampings of incandescent fixtures require over tens of thousands of hours of operation. And because LEDs consume far less energy, annual power costs can be reduced by up to 80%.. The total cost of LED lighting systems, therefore, can be significantly lower than conventional systems. In fact, payback on LED lighting solutions can often be realized in less than three years.

Myth #7: LED light quality is poor

Two important measurements of white light quality are *correlated color temperature* (CCT) and *color rendering index* (CRI).

CCT describes whether white light appears warm (reddish), neutral, or cool (bluish). The standard definitions of CCT allow a range of variation in color that can be readily discerned by viewers even when the CCT value is the same. Ensuring color consistency, therefore, is a major concern of LED manufacturers. Leading LED lighting manufacturers use various LED selection schemes (binning) to ensure color consistency from fixture to fixture.

On a scale of 0 (worst) to 100 (best), CRI measures the ability of a light source to reproduce the colors of objects faithfully in reference to an ideal light source — the sun, for example, or an incandescent lamp. Most office, retail, educational, medical, and residential spaces require a minimum CRI of 70 – 90. Many white-light LED lighting fixtures available today achieve CRIs of 80 or better, comparable to many CFL lamps, quartz metal halide lamps, and some cool white fluorescent fixtures sufficient for the vast majority of applications.

Because of well-known shortcomings of the standard CRI test for LED lighting, some LED lighting fixtures with low CRI scores produce visually pleasing light that renders colors appropriately. Color Quality Scale (CQS), a color-rendering standard that better accounts for the unique properties of LED light sources, is currently under development. Until CQS or a similar alternative is in place, you should observe LED sources with low CRI scores in person to evaluate how well they render color.

A Rapidly Changing Landscape

All signs point to a significant and sustained increase in the use of new LED lighting systems, replacement lamps, and retrofits worldwide, with the greatest growth in general illumination applications. White-light LED sources are approaching, and in some cases overtaking, conventional sources in light output and light quality, making LED lighting solutions increasingly attractive. In dozens of nations, green initiatives and energy-efficiency directives are hastening the migration from conventional lighting systems to LED lighting systems, which often deliver the lowest energy consumption and environmental impact, the longest useful life, and the lowest total cost of ownership and operation in a variety of applications.

Because LED lighting is a rapidly evolving technology, LED source and fixture suppliers must continue to leverage innovations and advances to bring the best products to market. Suppliers must also take an active role in educating lighting consumers about the specific advantages of LED lighting and how it differs from conventional lighting. Without a working understanding of LED lighting technology, consumers cannot accurately evaluate the suitability of an LED lighting system for a particular task or application, nor can they accurately compare LED lighting solutions with conventional alternatives.

LED lighting is a fundamentally new kind of lighting, using new principles, materials, and means of control. LED lighting suppliers therefore have the opportunity, if not the responsibility, to help consumers transform their understanding of lighting specification and design. LED lighting solutions can integrate and interact with people and the spaces they use in unprecedented ways. When properly evaluated and deployed, LED lighting systems have the ability to improve both the quality of the environment and the quality of life for people around the world.

Featured Installation

The multi-layered atrium of the World Market Center in Las Vegas features an extensive labyrinth of coves. Thousands of linear feet of eW® Cove Powercore, an LED cove fixture from Philips Color Kinetics, provide seamless blending of light. The LED fixtures reduce the electric load by 60% compared with 13-watt CFL cove lights. Their long useful life dramatically reduces the labor and maintenance costs of servicing lights installed up to 80 feet above the main floor.
Photography: Darius Kuzmickas

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