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ALG CONNECTIONS
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Familiar Lighting Metrics and LEDs

By Barb Hamilton

No one in the lighting industry is debating that LEDs as a light source are unique, exciting, and here to stay. For the first time in decades we need a new vocabulary and knowledge base to properly apply this source in our work and for the benefit of customers. This is part of a series of overviews meant to build an understanding of LED technology and what the lighting design community needs to know to confidently discuss and successfully apply this electrifying technology. This discussion centers on how LEDs have become a viable general lightsource in recent years.

LEDs have seen explosive development, driven hard by U.S. Department of Energy (DOE) funding and good oversight . Continued growth and development are planned for through continued testing, industry standard development, and broader market visibility and support.

Unlike any previous light source, solid knowledge of LEDs unique technology and of good system design is of utmost importance to achieve optimal performance. Lighting metrics still apply, but LEDs bring some unique attributes to the table. Here we discuss efficacy and lifetime.

EFFICACY, *a measurement of efficiency in lumens/watt*

LED efficacy gets a lot of press but must be discussed in two ways: as lab measurements and once inside a luminaire. In the creatively developed Figure 1, it is easy to see the effect of luminaire losses. Lab measurements of single LEDs or packages are excitingly high, but from inside a luminaire housing/optics and heat can plummet an LED module's output. The efficacies of LEDs are measured using absolute photometry – different from the

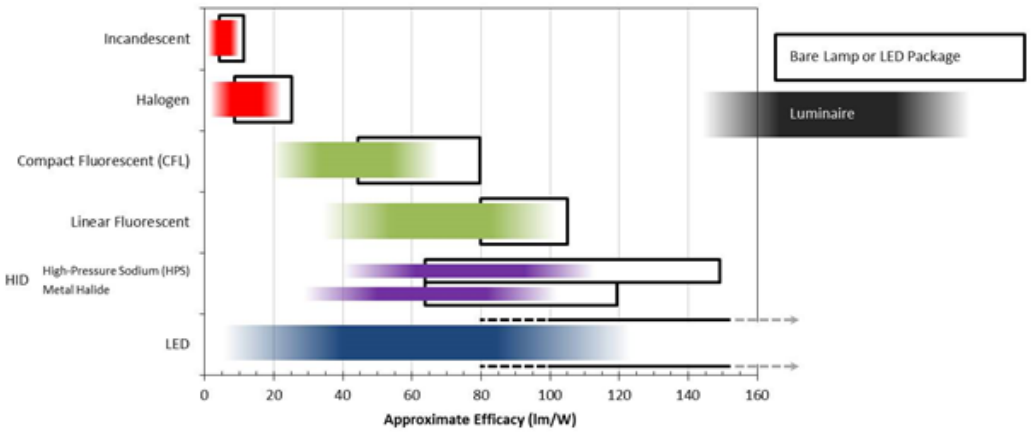

Figure 1: Efficacy comparison by lamp type, by bare lamp/ package and inside a luminaire.

Graphic developed by DOE, as taken from ALG Online.

ABOUT ALG Connections

Through a series of abstracts and synopses, ALG Connections informs readers on timely topics such as research, conference reviews, industry trends and technology updates.

ALG Online is one of the design guides offered by New Buildings Institute (NBI) through its Advanced Buildings® suite of tools and resources.

Visit us for more information about New Buildings Institute at newbuildings.org, ALG Online at algonline.org and Advanced Buildings at advancedbuildings.net.

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relative photometry of incumbent sources. This is why it is best to always compare options at the luminaire efficacy level. According to DOE, of the sources in Figure 1 only LED is expected to significantly improve.

Because of the additional red phosphor conversion needed, warm white LEDs are typically less efficacious than cool white. The DOE goals for 2016 are to have market-ready lamp/luminaire products with ratings of:

Warm white = 112 lumens/watt

Cool white = 131 lumens/watt

While most conventional light sources lose efficacy during dimming, LED luminaires are an exception to this rule; light output and wattage maintain a consistent relationship until the bottom end of the dimming range, when lower internal temperatures resulting from dimming may actually increase light output, and therefore efficacy.

LIFE, *the point, in hours, at which an LED has depreciated to 70% output*

Lifetimes of LED systems vary widely and are a direct function of the quality of the engineering design.

LEDs, like the old mercury vapor lamps, don't "fail" by burnout but actually depreciate over time and become dimmer. Therefore LED "life" is statistically tied to the point at which end users are likely to notice the shift, considered 70% of initial light output. Called "L-seventy" and written as L_{70}, this is defined to be 30% lumen depreciation. Some manufacturers will provide their own life metrics, such as L_{50} or L_{90}, so stay alert to life claims and at what percentage of output they apply.

We have all heard that "heat" is bad for LEDs, specifically a high junction temperature. The "junction" is where the die attaches to its base. When light is produced, heat is a byproduct at this junction, so thermal properties of the system are crucial. Every chip brand and model can be developed with a different junction temperature tolerance. Heat sinking (a thermal path) can vary between luminaire designs and among manufacturers and is required to dissipate the inherent heat to maintain not only life, but output and color.

Some other familiar life-ending issues such as vibration, cold temperatures or on/off cycling do not negatively affect LED life.

For more information on LEDs and other lighting technologies and information, visit: Advanced Lighting Guidelines (ALGOnline.org).

Barb Hamilton is a lighting consultant for New Buildings Institute. Her experience includes lighting design, product sales and marketing and several educational functions. Barb supports NBI's involvement in commercial lighting including development of the Advanced Lighting Guidelines online resource (known as ALG Online) and working to move advanced lighting practices and products into the market.

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