AS LIGHTING TECHNOLOGY AND TRENDS EMERGE, IT'S INTERESTING TO MEASURE ACTUAL ADOPTION AS WELL AS PERFORMANCE OF SAID TECHNOLOGIES. TO GAUGE SUCH MATTERS, ILLUMINATE PRESENTS THE MARKET MAP.

EFFICIENCY, EFFICACY AND PHOTOMETRIC DISTRIBUTION

TYPICAL LIGHT SOURCES, BE THEY LINEAR FLUORESCENT, CFLS, LEDs, HID or halogen, are characterized by their general configuration and application based on optical characteristics. Whether these characteristics are applicable depends on a number of factors including color, starting, physical size and environmental conditions. Therefore, understanding performance metrics is important in making qualified lighting product selection decisions. Choosing which is the most appropriate further requires an understanding of the end use application and lighting result desired. The following is a summary of the core metrics necessary to making qualified energy efficient lighting product selections.

ANALYSIS: As a general rule, when the target area is small, or the desired effect is focused spot lighting, proper beam control is a critical factor. Assuming the desire is to attain a tight focus on a target surface of 100Fc, source "A" delivers the desired illumination level, even though efficiency and efficacy are significantly lower. To attain the same target illuminance using source "B" would require 4 times as many luminaires.

Target Illuminance: The most significant influence on product decision making is founded on selection of the target illuminance and its shape. Spot and accent lighting require a different approach than uniform illumination, which is significantly different than roadway or area lighting.

ANALYSIS: In cases where desired illumination is over a wider area, with a need for high degree of uniformity the use of the more focused source "A" results in a need for 2.5 times the number of sources, and results in poorer uniformity.

Efficacy: The most popular metric, based on a simple ratio of light delivered (lumens) to energy consumed (watts). While superficially, high efficacy means more raw light is delivered for each watt consumed, this metric does not indicate where the light is directed. There are numerous instances where a high-efficacy source delivers far less light on a target surface, due to a poor photometric match between product and application.

Efficiency: The ratio of raw light to the amount of light delivered from a luminaire impacts all other metrics. However, efficiency alone does not provide any information on photometric distribution, or light source conversion of power to light. A high-efficiency luminaire with a low-efficacy lamp inside cannot overcome the inherent poor performance of its source. Further, while a high-efficacy luminaire is also likely to be very efficient, the metric itself does not provide insight into light delivery onto any particular targeted surface.

Photometric Distribution: The characterization of a light source or luminaire, as it directs and re-distributes light from its origin. This provides specific information about how a light source spreads or focuses its light energy, and is used to calculate target illuminance. However, this metric does not indicate how efficient the optical system is, or what the efficacy is of the light source in converting electrical power to light. Through the use of a combination of these metrics, one can determine which product is the best match to an application. By focusing on selecting and achieving a target illuminance result, the photometric parameters to be met will be established. The next step is to find the lighting product that efficiently directs its light into the desired photometric zones. Finally, seeking the product with the greatest source or luminaire total efficacy will result in the lowest total energy use to achieve the desired illuminant result.

FIGURE 1.

ILLUMINANCE VS. EFFICACY/EFFICIENCY

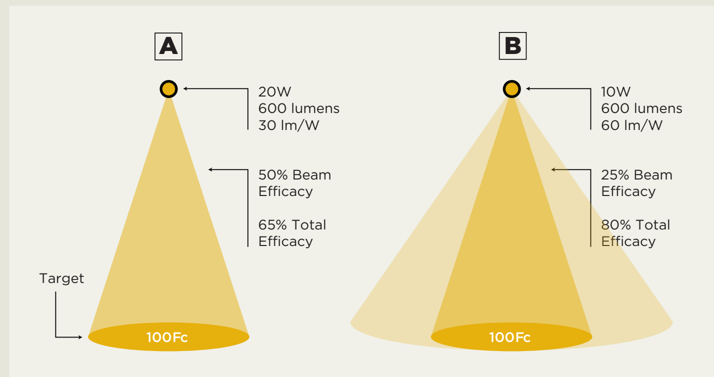


FIGURE 2.

TOO TIGHT OF CONDITIONS

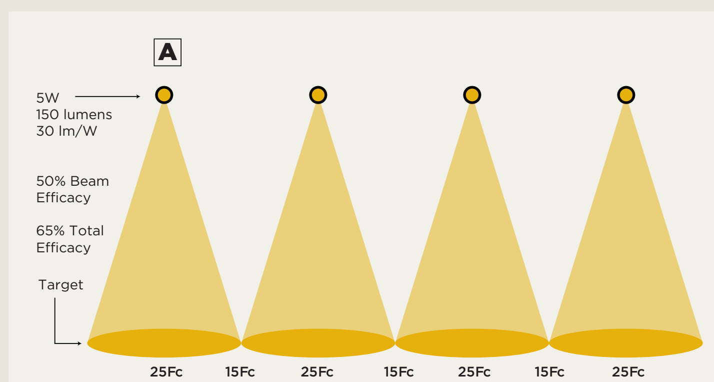
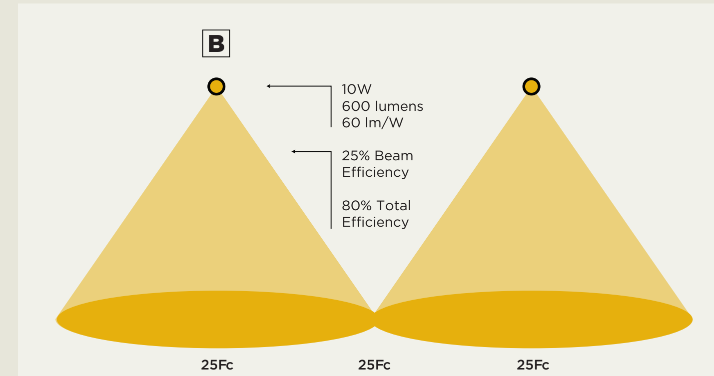


FIGURE 3.

UNIFORMITY WITH LESS LIGHT



ANALYSIS: Source "B" offers the advantage of greater uniformity and lower energy use from being a better photometric match to the design goal. Little control, however, can cause glare or unwanted light distribution away from the target surface.

FIGURE 4.

Light Source Characteristics

General Configuration and Application Based on Optical Characteristics

Light Source	Optical Controllability	Typical Efficacy Range	Typical Luminaire Efficacy Range	Best Photometric Use
Linear Fluorescent	Limited longitudinal, good laterally for wide distribution and asymmetric distributions	65-100 lm/W	35% to 92%	Wide area general illumination and wash application
CFL	Limited due to source size for light output capacity	35-65 lm/W	25% to 75%	Medium to wide small area general illumination
HID	Generally good for most distributions	65-150 lm/W	25% to 85%	Wide area, spot & accent. Outdoor
Halogen	Good for most distributions	17-21 lm/W	30% to 75%	Focused spot and accent
LED	Excellent for most distributions	35-135 lm/W	40% to 90%	Focused spot & accent. Outdoor

While the efficacy of a light source, such as fluorescent or LED, may be attractive, if they are not well suited to the desired photometric distribution, efficiency and the resulting surface light levels will not be met. None of these metrics are valuable in isolation, or out of context. Efficiency and efficacy particularly are only worthwhile in comparing like products based on photometric distribution.

CODES:

NEW NATIONAL ENERGY STANDARD

Energy codes are designed to set minimum energy efficiency standards for design and construction. In review, ASHRAE/IES 90.1, Energy-Efficient Design of New Buildings Except Low-Rise Residential Buildings, is not just a code, it is a standard that jurisdictions frequently use as a model code. In fact, most states have adopted either 90.1 or the International Energy Conservation Code as their commercial building energy code, have a code based on one of them, or created their own code containing similar requirements. Since Dec. 30, 2008, the 2004 version of 90.1 has been the national energy standard. According to EnergyCodes.gov, 33 states are compliant; four states will likely catch up while another 13 may not comply for various reasons.

DOE estimates that the 2004 version of ASHRAE 90.1 will generate energy savings of about 12% compared to the 1999 version, the previous standard. According to Eric Richman, LC, a senior research engineer with the Pacific Northwest National Laboratory, and a member of DOE's Building Energy Codes Program, three major changes stand out: The first is a completely updated set of interior lighting power densities; second is an expanded set of exterior lighting requirements; third is a set of initial requirements for installing occupancy sensors in specific space types.

Automatic lighting shutoff: In both versions of 90.1, interior lighting must be shut off when it is not being used in buildings larger than 5,000 sq. ft. The 1999 standard lists "by occupant intervention" as a method of control. This error was corrected in 2001 and later versions, which identify "a signal from another control or alarm system that indicates the area is unoccupied," such as a security system, in addition to occupancy sensors and scheduling controls. The 2004 standard also recognizes more exceptions, such as patient care spaces.

Occupancy sensors: The 2004 standard requires occupancy sensors be installed in classrooms (but not preschool through grade 12, lab and shop classrooms), conference/meeting rooms and employee lunch and break rooms. "With the availability of easy-to-install equipment of this type, this requirement should be of minimal installation impact but with potentially large energy savings," says Richman.

Exit signs: The 2004 edition simplifies mandatory requirements for exit signs by requiring that internally illuminated exit signs not exceed five watts per face—Basically, this means LED.

Lighting power densities: The maximum allowable LPD values have been completely revised and are on average 20% lower than 90.1-1999. "The interior lighting power density requirements are based on complete updates of all the inputs to the models used to develop the power limits for each space and building type," says Richman. "These updates include IES-recommended light levels, equipment efficacy, light loss factors and common design practice. Good design is already meeting these levels."

Exterior lighting power allowances: Exterior lighting power allowances are dramatically expanded in 90.1-2004, with requirements covering 17 common applications from parking lots to drive-up windows. "The expanded set of exterior lighting power density requirements is intended to make sure that exterior lighting limits are incorporated into the code along the same manner as interior lighting," finishes Richman.

—Craig DiLouie, contributing writer