LED WATCH

BY JAMES BRODRICK

There's been considerable interest lately in using solid-state lighting (SSL) for outdoor applications, and with good reason. Outdoor use is one area where SSL shows promise for being competitive with the incumbent technology, primarily because of the potential maintenance savings. While energy savings from using LED luminaires are often not enough to offset the high initial cost, maintenance savings can tip the balance in favor of SSL in applications where the cost of maintenance is relatively high. Outdoor lighting—where the luminaires are often difficult to access—can fall into that category.

LED light sources can be easier to maintain than their conventional counterparts because they tend to have significantly longer rated lifetimes—often 50,000 hours or more, compared with 10,000 to 30,000 hours for the high-intensity discharge (HID) lamps that dominate the market for street, roadway, parking lot and pedestrian areas.

It's important to note, though, that we haven't accumulated enough field performance information on the long-term durability of the current generation of outdoor LED products to say with a high degree of confidence that expected maintenance savings will be realized. As with most new technologies, there will no doubt be a number of problems encountered in the field that hadn't been anticipated by product developers. In addition, long-term performance will surely vary highly from product to product. Nonetheless, the underlying LED technology shows great promise for helping to drive down the maintenance costs of outdoor lighting.

BEYOND MAINTENANCE

But maintenance savings don't tell the whole story in outdoor settings. First, unlike conventional lighting sources, LEDs are directional; the light they produce is emitted in a particular direction rather than scattered in all directions. This means they have the potential to deliver light more efficiently than HID lamps, whose luminaire housings can absorb a significant portion of the emitted light. Lensed LED arrays also have the ability to efficiently concentrate lighting only in those areas where it's needed, eliminating or drastically reducing any uplight that contributes to sky glow, as well as the usual spill light that lands on adjacent properties. This in turn can facilitate compliance with local light-trespass ordinances and LEED certification—not to mention make for much happier neighbors, residential as well as commercial.

Second, well-designed LED luminaires can provide more uniform distribution of light across the target area than their HID counterparts, which typically produce bright spots directly below the luminaire and less illumination farther away. Improved uniformity can increase visibility and improve perceptions of safety and security, while saving energy and cutting down on sky glow by achieving suitable illumination at lower average light levels, thus reducing the amount of light that's reflected off illuminated surfaces back into the night sky.

Two other potential advantages of LED luminaires in an outdoor setting are their dimmability and their tolerance for frequent switching, allowing for use of motion-sensing controls. LEDs also contain no mercury and may thus reduce the cost and difficulty of disposal.

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Still another important characteristic is light color, which can affect visibility, and LEDs perform nicely here as well. There's evidence that broad-spectrum lighting improves the sensations of brightness and safety at night. The two main types of lamps used in outdoor area lighting applications—high-pressure sodium (HPS) and metal halide (MH)—have definite tradeoffs between energy efficiency and color quality. HPS emits light in a narrow-band spectrum, with a yellowish appearance and a color

rendering index (CRI) of about 20. MH lamps are broad-spectrum light sources, with CRIs of 65 to 90-plus, but they're generally less efficient than HPS lamps.

By contrast, neutral and cool-white LEDs typically have a CRI of 70 to 75, which is more than adequate for color identification in street and area lighting applications. It's estimated that converting all street and area lighting to LEDs would save 44.7 TWh of electricity annually, which is equivalent to the output of seven large (1,000 MW) electric power plants or what 3.7 million households would consume.

AT AN EARLY STAGE

Some questions have been raised recently about the possible health and environmental implications of LED outdoor lighting, as part of a broader concern about exposure of humans and wildlife to light at night. Light exposure is the main regulator of the circadian system—the "biological clock" in every human and animal, which controls the sleep cycle. The human circadian system is most sensitive to blue light, and many LEDs used for general illumination have a substantial portion of their spectral distribution in the blue range. These cooler-appearing LEDs work more efficiently than warmer-appearing LEDs and thus can save more energy.

Although there are various groups studying this issue, at present we know little about the non-visual effects of light exposure on humans and animals. We simply don't know whether the relatively low light levels used in outdoor applications have any deleterious effects on health, and there's no conclusive evidence that LED outdoor lighting is any more dangerous than other light sources encountered indoors or outdoors. A 2008 IES Technical Memorandum on light's effect on circadian rhythms concludes that it would be premature to make design recommendations based on such considerations.

A premature decision to restrict light levels or spectral content could needlessly increase expenditures while reducing nighttime safety and boosting the emissions of greenhouse gasses. Further research is needed to reach consensus on what limitations, if any, should be applied to outdoor lighting. The U.S. Department of Energy will continue to track the progress of research in the fields of visual performance, non-visual effects and environmental impact to ensure the optimal application of LED technology to exterior environments.

James Brodrick is the lighting program manager for the U.S. Department of Energy, Building Technologies Program. The Department's national strategy to guide high-efficiency, high-performance solid-state lighting products from laboratory to market draws on key partnerships with the lighting industry, research community, standards organizations, energy-efficiency programs, utilities and many other voices for efficiency.