SSL DEMONSTRATION:

Street Lighting, Kansas City, MO

The first GATEWAY demonstration to evaluate products side-by-side over an extended period of time highlights some of the challenges involved in evaluating and deploying LED street lighting.

HPS | LED

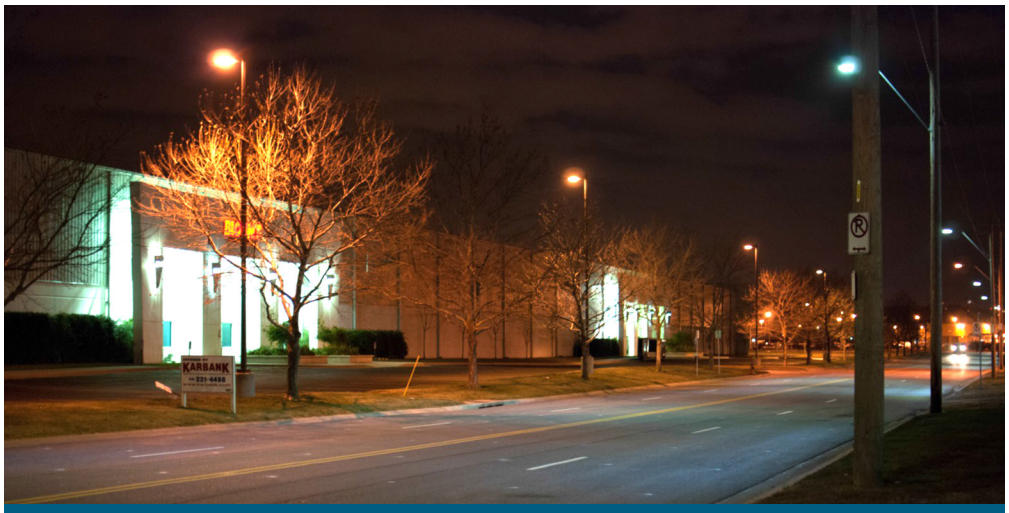
As a general rule, solid-state lighting (SSL) technology has developed to the point where energy savings are a virtual given, when proper care is taken to select the right products and deploy them in the right manner. However, many other factors come into play when evaluating and deploying LED lighting products, and a street lighting demonstration held in Kansas City, MO, brought a number of them to light. The demonstration was conducted by the city in partnership with the U.S. Department of Energy (DOE) GATEWAY Solid-State Lighting Demonstration Program and the Municipal Solid-State Street Lighting Consortium.

In February 2011, nine different LED street lighting products were installed at nine separate Kansas City sites and were compared to the high-pressure sodium (HPS) luminaires they replaced, which spanned a wide range of wattages (100, 150, 250, and 400). Illuminance readings were taken at the outset and every 1,000 hours (approximately three months) thereafter. As a group, the LED products tended to be slightly more efficacious than their HPS counterparts (an increase of 15 percent in mean efficacy across all products), but more of their energy savings was from reducing overall light levels and limiting spill light. The reduced light met the desired performance levels in some cases, but not in others.

Measure for Measure

Some of the most interesting findings of the study had to do with performance measurement. For example, for most of the luminaire types, it appeared that seasonal variables such as temperature and foliage drove as much as a 20 percent swing in measured illuminance on the ground over the course of a year. Seasonal swings may thereby significantly outweigh any temporal lumen or dirt depreciation, at least during the early stages of product life.

Seasonal factors weren't the only ones that affected performance measurement, however. Even in this carefully designed and maintained location, differences in pole spacing, street width, the amount of spill light, and the type and amount of vegetation were all found to play a part. What's more, readings from the different handheld meters that were used to measure illuminance were also found to vary—not only from brand to brand, but also likely based on changes in the ambient temperature. Such variability in field measurements is not unique to LEDs, of course. But the rapid rise in LED popularity has led to greater desire for side-by-side comparisons of different types of streetlights, bringing to the fore the many factors affecting measurement accuracy, as were seen in Kansas City.



HPS spill light sources and trees potentially causing seasonal variation at one of the Kansas City sites. LED street lighting is at right.

A Comprehensive Approach

These variations underscore the importance of taking multiple measurements under different seasonal conditions, and of realizing that field measurements are only one component of a more comprehensive performance assessment. Even with the best design intent, and careful planning and selection, resulting numbers obtained "on the ground" may or may not exactly conform to the original specification, for reasons that go beyond the luminaire. The real world introduces a complex host of combined influences—many of which were encountered in this study and are encountered regularly in field studies of this type.

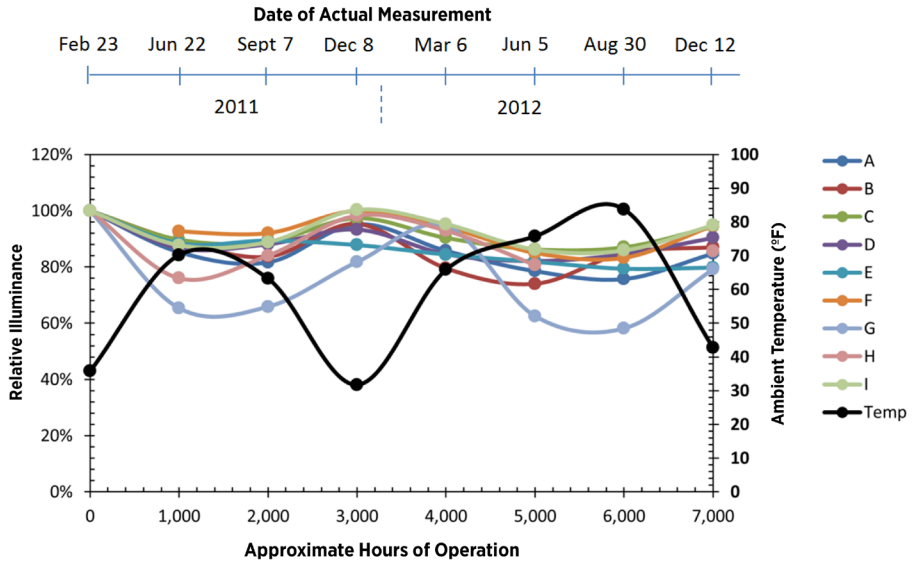
For a site investigating installations of LED street lighting products, the best approach is probably to use laboratory-tested performance values for initial design and selection of products, only relying on field measurements to then ensure there are no problems or issues present in the installed result. Before-and-after comparisons on the same street, with all other variables (such as pole spacing and weather) equal, can provide useful data. But overreliance on field measurements to compare products installed in different locations should be avoided, because the measurements at each location can differ significantly due to reasons having little to do with luminaire performance.

How Lifetime Factors In

Another interesting conclusion of the Kansas City demonstration had to do with design lifetime. The common practice of basing maintained illuminance requirements on end-of-life light levels may not be appropriate for SSL. Using the typical 30 percent lumen depreciation (i.e., L_{70}) output level for the LED product design lifetime means that the resulting illumination requirements are spanning much greater timeframes than for conventional systems—some in excess of 100,000 hours (in this study, L_{70} projections ranged from 50,000 to 121,000 hours)—so that in effect, the luminaires are being sized to meet light levels that may be decades away.

A more practical (not to mention energy- and cost-efficient) approach may be to select a point in time beyond which luminaire lifetime projections become increasingly tenuous—say, 15 years—and, using LM-80 projections for each product (along with dirt depreciation and any other relevant light-loss factors), to determine what the likely illumination levels will be at that point. Products offering higher lumen maintenance will have higher illumination values at that evaluation point, but as long as two products are still meeting the specified levels, the user can make a purchase decision that's based on price or some other attribute. Note that not incorporating L_{70} into the design for products with exceptional lumen maintenance avoids unnecessary over-lighting for most of the early years of their installation, along with corresponding savings in energy use and first cost. In addition, this approach recognizes that other SSL components—such as the power supply and optics—can also influence a product's end of life.

Relative Illuminance Over Time, by Ambient Temperature



Final reports on GATEWAY demonstration projects are available for download at ssl.energy.gov/gatewaydemos_results.html.

GATEWAY Demonstrations

GATEWAY demonstrations showcase high-performance LED products for general illumination in commercial, municipal, and residential applications. Demonstrations yield real-world experience and data on the performance and cost effectiveness of lighting solutions. For more information, see ssl.energy.gov/gatewaydemos.html.

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