

On the verge: LEDs are ready to challenge incumbent light sources in the streetlighting market

Streetlighting is fast emerging as a potentially strong market for LEDs, particularly now that devices have reached a level of output and efficiency that make them viable replacements for incumbent lighting technologies, writes **Tim Whitaker**.

In common with a number of other lighting applications, LEDs are now starting to challenge conventional lamp technologies in the streetlighting arena. A number of test installations are dotted around the globe to evaluate both the performance of the fixtures and the reaction of both lighting professionals and the general public.

LEDs offer several compelling advantages over other lighting solutions, such as the prospect of reduced energy consumption, fewer expensive maintenance call-outs and enhanced light quality. However, inevitably, there are several hurdles that need to be overcome, not least of which is the higher initial cost of LED luminaires and the general inertia of potential customers.

According to Gunnar Moos, marketing manager for general lighting at Osram Opto Semiconductors, using LEDs for streetlights offers a number of benefits. One is longer and more predictable service intervals, leading to significantly reduced maintenance costs. When high-intensity discharge (HID) lamps break, they have to be replaced very quickly in public areas, and often the local authority will have a maintenance schedule where all lamps are replaced even if they are still functional. A related advantage is enhanced safety for the road user, resulting from the high reliability and long lifetime of the devices.

LEDs also offer the opportunity for dimming to adjust to specific ambient light levels via a feedback loop, as well as flexibility in terms of luminaire design and in areas such as color temperature and color rendering. "As a whole, these advantages will ultimately result in a cost-of-ownership reduction for an intelligent LED solution compared with conventional lamps," said Moos.

Conventional technology

At present, streetlights generally utilize HID lamps of various types. Low-pressure sodium lamps are the most efficient, ranging from 120 to 200 lm/W, but they produce monochromatic yellow light so color rendering is extremely poor – the color rendering index (CRI) is zero. High-pressure sodium (HPS) lamps have lower efficiency (80–120 lm/W) and a similar lifetime of around 12,000 h, but better color rendering with a warm white appearance and a CRI of 22–75. Metal halide lamps are less efficient but have a very good CRI.

Almost all filament-based and gas-discharge lamps used in street-



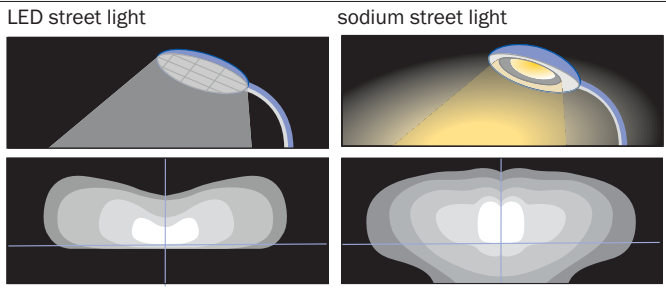
PHILIPS DESIGN

Philips CityWing Pedestrian LED fixtures illuminate a street in the Netherlands city of the Hague. Six fixtures have been installed following a similar project in the Dutch town of Ede (see www.ledsmagazine.com/articles/news/2/7/16). The poles each hold two luminaires containing 18 Luxeon LEDs. A mixture of white and amber LEDs enable warm-white light at a color temperature set in the factory. Bram Lansink, application manager outdoor and LEDs for Philips Lighting, says that the luminaires were chosen because of their innovative nature and to build up knowledge of using LEDs in public spaces. "The design and maintenance factors were also strong reasons to use the LED luminaires," he added. He says that the CityWing luminaire is most suitable for pedestrian areas and is not appropriate for roadway lighting because other sources offer greater output and are more energy efficient. "However, with the growth in lumen output and efficacy, the move to road lighting with LED luminaires can be expected from 2008/2009 onwards," he said. Before then, projects such as this one are important in adding to the experience of working with LEDs in this type of application.

lighting provide light in all directions, so reflectors are required to shape the light output of the fixture. In excess of 65% of the available light output is lost due to inherent inefficiencies in the reflector system, and losses also occur when the light passes through the glass case that houses the HID lamp. LEDs with appropriate optics can be made highly directional, leading to drastic reductions in light loss and high system efficiency, as well as reducing light pollution.

So, although individual LEDs are likely to have a lower efficacy than HID lamps, the system efficacy (which is, of course, crucial) can be much higher, leading to lower power consumption. US lighting manufacturer MoonCell supplied its LED fixtures to the Michigan

STANLEY ELECTRIC

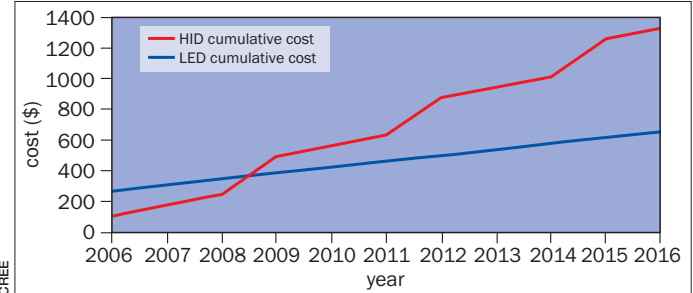


Comparison of lighting patterns from LED and sodium streetlights. The focused nature of the LED system places light on the roadway and also drastically reduces light pollution.

Department of Natural Resources for outdoor lighting in parks and was told that “the 79% cost savings in energy maintenance [of the LED fixture], over the 250 W HPS fixture that it replaced, is just what we were looking for”. Improved light quality, making it easier for staff to look at visitors’ documents, as well as reduced light pollution, were also cited as advantages by the customer.

Light quality and specifications

LED lighting manufacturers would argue that the quality of light from LED lighting fixtures is significantly better than that from other street-lighting technologies, providing better visual acuity and color rendering. Improved color recognition provides contrast and increases depth



Although LED fixtures are more expensive at the outset, the cumulative cost of HID fixtures rapidly increases and a crossover occurs after 2.0–2.5 years.

perception, and CCTV images that are recorded using LED lighting are much clearer. LED light produces less glare and fewer reflections, and it cuts down on the light pollution that is associated with other light sources. There is also the related psychological benefit of making people feel safer.

The improvements in light quality occur because in low light conditions the human eye is much more sensitive to shorter wavelengths of light, rather than the yellow/orange light emitted by many HID lamps. In photopic vision, which occurs in normal daylight conditions, the eye sensitivity peaks at 555 nm in the green part of the spectrum. At lower light levels, scotopic vision kicks in and the peak sensitivity shifts to shorter wavelengths. The spectrum of white LEDs, which usually con-

LEDworx tests LEDs in Dubai



LED luminaires installed in Dubai (left) contain three linear LED modules, each with a total of 28 LEDs.

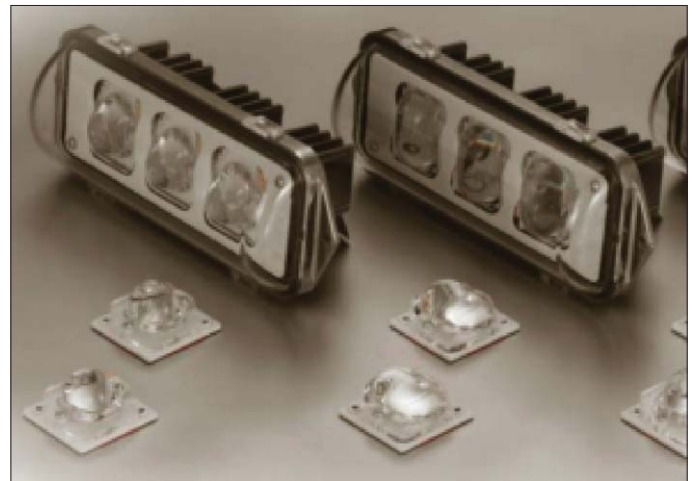
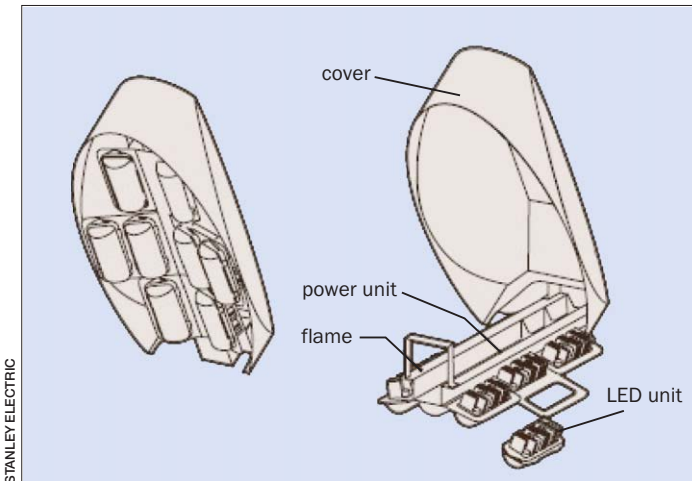
LEDworx GmbH has made a five-luminaire test installation in Dubai to allow customer testing over a three-month period corresponding to the hottest time of the year. Franz Witthalm of LEDworx says that the installation will also allow customers to become familiar with the new LED technology and to prove its reliability. The main reasons for choosing LEDs are long lifetime – which will result in significantly lower maintenance costs – as well as lower energy consumption. Witthalm says that there is also another reason: “Dubai could become the first-ever city to light its streets with LEDs.”

There are a number of challenges that are specific to this installation, explains Witthalm. Most significant is the struggle against the outside temperature in Dubai, which can reach 50 °C in the shade, meaning 70–80 °C in direct sunlight. “We make the construction for 85 °C because streetlights only run for a short time in sunlight,” said Witthalm. “Our product is temperature-compensated,

and the LED current is reduced if the temperature gets too high.” Also, fans are not used since this could counteract the lifetime benefits of the LEDs.

Another issue is light distribution. The distance between the poles is 50 m and the pole height is 8m, so an average full angle of nearly 160° was required. The LEDworx Hawk-Eye luminaire contains three linear LED modules, each of which has an emission angle of 60° and overlap achieves the necessary 160°. Each module contains four circular clusters of seven high-power white (5400 K) LEDs. A total of 84 LEDs produce 4620 lm with an efficacy of 55 lm/W, and the resulting CRI is 75.

The use of LED modules is a first step towards creating a standard for LED applications, says Witthalm, adding that LEDworx has developed control gear that can last as long as the LEDs – up to 100,000 h – and includes power factor correction.



Stanley Electric has developed a modular approach to LED streetlighting based on removable optical units that each contain three lensed LED modules. The three-LED optical unit consumes 15.8 W with a typical current of 400 mA and produces 570 lm. Stanley says that it has used its optical semiconductor and design technology expertise to improve luminous efficiency to a level that is sufficient for numerous lamp-type applications, such as streetlighting. The company's LED fixtures are currently in use in several global locations in association with strategic partners, with encouraging feedback and results.

sists of blue LED emission mixed with longer-wavelength emission from one or more phosphors, is better matched to the eye's sensitivity for scotopic or mesopic vision (mesopic vision occurs at intermediate light levels and is a mixture of scotopic and photopic vision).

Rewriting the specifications

However, this gives rise to other issues relating to streetlighting specifications, which are quite precise as to what light levels are required for a particular area of the ground and on a particular grade of road. The problem, says Dennis Lockwood, managing director of Whiteley Electronics, is that all of the specifications are written around conventional lighting technologies. "When you measure the illuminance in lux, the meter reading tends to favor the older technologies rather than LED technology," he said.

This is because sodium lamps and other light sources emit large amounts of light in regions where the eye is not particularly sensitive. Even so, this light gets incorporated into the specification in terms of a high lux value. "Trying to meet a specification written for fluorescent or sodium lamps, which requires a certain lux level on the road surface, means that you've got to effectively overlight it using LEDs technology to meet those measured levels," said Lockwood. He believes that there should be some reassessment of the specifications to define what LEDs have to do, but this will take a long time.

Mark Hopkins of Advanced LEDs Ltd concurred: "Further research is required into scotopic and mesopic vision ranges to enable people to design a lighting scheme with LEDs that will provide the level of lighting that we actually need. LED lighting is sharper, crisper and provides better color uniformity, and for functional outdoor lighting it makes pedestrians and roadways more visible. We need to get some lighting schemes out there to show lighting professionals the quality of light that can be achieved with LEDs."

Higher-performance white LEDs

Most LED streetlight products and prototypes use high-power white LEDs, although there are some exceptions (see box, "Different approaches"). Cree, one of the leading manufacturers of power LEDs,



These LED fixtures from Whiteley Electronics contain arrays of high-power white LEDs with individual lenses. The firm provided LED lighting to Sheffield United FC, an English football club recently promoted to the top league that required improvements to its facilities, including a new lighting scheme for its main car park. Whiteley supplied its Jupiter48 AC LED light, which is designed specifically to illuminate roads, car parks, pathways and public areas. This 48 W mains-powered LED light contains 48 white LEDs with individual optics, and it reduces energy consumption by up to 75% compared with traditional lighting methods.