



Lighting AI Fresco

Even outdoors, retrofits can eliminate some of the costs associated with outdated or inefficient lighting and still significantly reduce energy consumption

Sunday, January 01, 2012 By Lori Lovely

Comments on Modified article with notes Regarding LED, Induction and other Lighting Products,

Fewer options exist for exterior lights than are available for interior, believes John Noel, president and founder of Energy & Environment LLC, an Atlanta, GA-based company focused on energy audits and retrofits for increased energy efficiency. "You have the basics for roadway lighting: high-pressure sodium, which gives off an orange light and metal halide, which has a white light," says Noel.

Orange lighting is not as bright, but the sodium rates higher than halide on a foot-candle meter taking lumen readings because it reads light from a different spectrum than our eyes see it. The human eye is more sensitive in lower light levels to the bluer spectrum of light, and adapts, but the current light meter does not adapt to the "S" curve.

In fact, according to the World Institute of Lighting and Development,... lighting practitioners have suspected for years that current lighting metrics don't actually reflect human perceptions of the full field of view visual acuity. Recent research has identified physiological causes that explain nuances in different lighting installations, challenging current photometric procedures and shortcomings.

Larry Leetzow, calls for the industry to come up with a total light quality metric. Unfortunately, he says, there are no degrees for lighting engineers.

"Meters look at foot-candles per watt, but it's not the same as actual sight with the human eye, which is sensitive to green during the day and blue at night. Too much blue distorts red and green; you need a source to balance red, green, and blue: white light."



Less Is More

When it comes to color rendering, Bear Shelton, regional director for Blue Sky, a master distributor for select manufacturers and a turn-key provider of energy-efficient lighting, says, "Yellow is traditional lighting, red is HID [high-intensity discharge], and white is LED [light-emitting diode]." He believes since LEDs provide a "truer light," they're better for security purposes.

There are other advantages to LED lights: they're energy efficient and directional, have a longer life than HID lights, and don't radiate heat like traditional lights. "Traditional light sources radiate heat," explains Shelton. "Wasted energy radiates out the front. LED doesn't radiate heat—it creates heat on the backside."

That raises other concerns. Thermal management is a big issue. The fundamental cause of degradation is operating temperature.

"LEDs are susceptible to thermal conditions," says Shelton. "The junction temperature must be kept under a certain level for optimal performance."

Nevertheless, Tim Falk, director of Solid State Lighting at Heatron, which designs and manufactures LED light engines to put into fixtures, calls LED technology “superior.” He says, “They’re more controllable. Incandescent bulbs put out light in all directions; LEDs put light out the front at a certain beam angle.”

The ability to focus light where needed means a lower lumen output is equally effective; that translates to less wasted energy and light. “You can get the same output with lower wattage or fewer lights,” continues Falk....

The good news is that lumens per dollar has decreased 70% over the last six years, due to better manufacturing methods and packaging. “Three years ago, payback on LEDs [when switching from sodium] was five to ten years,” recalls Falk. Streetlights aren’t the only use. Typical applications include parking lots and garages where the fixture is high off the ground, in parks, campuses, and certain airport installations. Timers and occupancy sensors that dim lights to half brightness when there’s no movement make these lights even more suitable for such applications and increase energy savings even further by conserving power.

Custom optics for LEDs have improved the product, so the point sources of light aren’t as obvious as they used to be. Use of diffusers, lenses, and optics to blend the pinpoint light sources helps to eliminate shadowing. ... *Whereas induction there is no shadowing...*

Retro Active... According to the Energy Information Administration, lighting fixtures consume more electrical energy in commercial buildings than any other source—and as much as three times the amount as air conditioning.

Lighting retrofits eliminate some of the costs associated with outdated or inefficient lighting and can still significantly reduce energy consumption and costs (by as much as 75%, with a return on investment in two to three years) without reducing light levels or quality....

LED is just one option for retrofit applications. ... also ... a fluorescent floodlight. ... “It’s ugly,” says Leetow in all seriousness. The 4-foot box is fitted with T5 lineal tube lamps and an aluminum reflector. Highly efficient, it uses less energy, has a long life, and floods light in a lot of directions. Leetow says military installations are installing it.

Other options include ceramic metal halide, but it generates heat. Retrofitted with the existing ballast can increase efficiency, but the bulbs are expensive. **Induction involves an electric current** sent to a frosted bulb. It uses microwaves and provides a lot of light for little energy and has extreme long life.

...Quality components are the key. “A lot of products coming in from overseas don’t follow a testing regimen, so how do you know if it’s good?” he asks.

In addition to its initial performance, it has to last. Look for testing results. LED products will experience lumen depreciation and can eventually reach a point where the light output is below a level sufficient for its intended use. The IES-LM-80-08 is performed by the emitter manufacturer as a test method for conducting accurate and repeatable lumen depreciation measurements of LEDs with a minimum collection period of 6,000 hours at 1,000-hour intervals and at three temperature conditions.

Because LM-80 doesn’t provide a way to estimate a useful life beyond the 6,000-hour test period, Leetow says TM-21 testing is done to extrapolate data in order to determine output at longer intervals such as 50,000-100,000 hours. LM-79 testing takes the data and, based on additional thermal testing, predicts the life expectancy of the fixture.

According to the paper “A Statistical Method to Analyze LED Lumen Depreciation and Project Useful LED Product Life” by Hong A. Qiao, et al., “A strong need exists for a method to represent the life of LED products as a critical part of product design decisions, such as cost-effectiveness analysis. . . . The emerging LED industry lacks a uniform method of estimating future LED life, thus no restrictions can easily be placed on wide-ranging claims of product life. Specific attributes of LED technology make it difficult to accurately measure their true lumen depreciation in an operating environment, thus contributing to the wide variety of life estimates.”



Photo: Columbia
Lighting
Total lighting quality is the ultimate goal.

LED Loopholes

Life expectancy predictions are not the only challenge for LEDs. Magnaray has also been producing LEDs for several years. "We're working with integrators who put the system together for retrofit and new construction applications," explains Leetzow, "but we've had more failures than successes. LEDs just don't perform at the same cost."

One of the problems is the junction temperature. "We recently found out through Canadian research that in warmer climates, the housing becomes overheated and degrades," he continues. "You get only six to nine months of life with less output." indicate LED system failure within 36,000 hours.

LED retrofit devices are being developed to

provide the best solutions for future sources, according to Magnaray, and will only be released to the market when reliable, cost-effective, high-quality products become available. Until then, Leetzow says, "We stuck with twin T5 fluorescent lamp tubes (because linear T5s are extremely hot)."

... T5s or 20 were used in a military project in 2001, and Leetzow reports no ballast or lamp changes yet. With bulbs costing \$10 and a ballast that lasts 15 years, he says the system costs less. It produces 100 lumens per watt. ADG Eco T* fluorescent Warrior style fixture (inserted)

"LED wants to go to 200 lumens per watt," says Leetzow, "but there are inefficiencies in the total system that bring it down to 40 to 50 lumens per watt. You only save 30 to 40 watts at 10 to 12 cents per kilowatt-hour—that costs more than high-pressure sodium."

... "It has a lot of lumens, but a lot of glare from multiple point sources," he continues. "Glare is offensive." Referring to eight manufacturers with products at five sites in Kansas City, he says the glare is even worse in the rain. refer to David Allen, President of NEFLDA and recent study on glare roadway and Michigan (inserted)

"The road is like a mirror with the windshield and chrome," says Leetzow. "Reflected light is dangerous. Do you want safety or do you want to see the stars?"

In addition to the issue of glare, there is concern that higher color temperature sources (blue) bleach the retina. "It can blind you," notes Leetzow. "LEDs save some energy, but at what cost? Nobody followed up."

Instead, he says, with low-quality light, it's possible to reduce the amount required, saving energy. "Reduced intensity of light is better for people. You need a total lighting quality result."

At this time, he doesn't believe that can be achieved with LED technology. "It's very directional. It's too precise; you light the street, but not the sidewalk." Additionally, he says multiples are necessary to light up large areas and if one burns out, the result is a dark spot and the need to replace the whole system because they're not modularized.

Leetzow cites a study by Hsueh-Ming Wang, et al., titled "Reliability analysis of LED-based streetlights on the temperature effect" that states: "An LED-based streetlight has a sequential structure, and so failure of one of the components leads to the failure of the whole system."

That gets expensive and adds to the amount of phosphorous, lead and epoxies deposited in landfills. In contrast, Leetzow says 98% of a fluorescent lamp is recyclable, and 100% of the mercury is reclaimable.

LEDs are gaining, he admits, but there are still "too many problems with outdoor applications, like glare—if you can't see, why are you lighting?" Another is that because it works on AC current, LED has a flicker rate that can cause headache and fatigue, predominantly in countries using 50-cycle current (US uses 60-cycle).

It's an issue that was discussed at the recent International Lighting Commission meeting in South Africa. Leetow has others. "The body needs a balanced spectrum of light, but the acrylic lenses used with LEDs filter out UV."

He hopes the LED industry "does due diligence on lighting as a whole to provide the correct amount, color and quality rather than just intensity or volume—then I could embrace LED systems and use them."

Hello, Hybrid

Degradation rate aside, LEDs continue to demonstrate potential in reducing energy consumption. According to "Influence of the injection current on the degradation of white high brightness light-emitting diodes," by Sebastien Bouchard, et al., LEDs are being used increasingly for lighting in all kinds of applications such as commercial advertising, automobile lights, exit signs, traffic signals, and exterior lighting.

Their low energy consumption combined with their extremely long lifetime make them a good option for newly installed light fixtures or retrofits. Deployed in the field to replace conventional sources, such LEDs will result in enormous benefits that include energy saving, reduction in global warming CO2 emissions, reduction of pollutants, and long-term financial savings. LEDs can also provide additional benefits because they can be controlled to a great extent. That is why they are called "smart lighting sources".

Due to improved efficiency, LEDs are an attractive low-power consumption light source for the appropriate application. "LED roadway light is highly effective," Energy & Environment's Noel says, because the optics allow customization of where the light is directed. The directional nature of LEDs makes them a viable solution for parking lots, where their white light, attractive design, and longer-life bulbs enhance the atmosphere and contribute to long-term cost savings. **However, the disadvantage lies in the initial purchase cost:** in small quantities, they are expensive. One of Energy & Environment's customers in Los Angeles bought tens of thousands of pole lights for \$250 each, Noel reveals, but in lower quantities, the cost would have been \$600 to \$1,000 per light.

Often, the solution is a hybrid plan. "We might place LEDs in a parking lot," speculates Noel, "but around the perimeter, we use cobra head roadway lights to light the trees and shrubs for security." They scheme balances ecology-minded advantages with economic reality.

The outdoor lighting industry is in transition, Noel contends. Comparing the effectiveness of white and LED lighting vs. the ineffectiveness in the environment of sodium lighting, he says it's possible to reduce wattage and get better or the same light, producing energy savings.

Other Options

Realizing the potential savings, ... LED lights—but not for outdoor applications.

"The best fit for high-space lighting—like parking garages—is induction," maintains Shelton. "Nothing on the market now compares. It's the most affordable energy-efficient lighting available."

While it's more expensive than traditional lighting, it is cheaper than LED. However, it has other benefits, such as long life, due to electrode-less technology. Because there are no parts inside the lamp, it lasts "forever," which Shelton equates to 100,000 hours or roughly 20 years if left on around the clock.

LED is an adequate source light, Shelton explains, but it dissipates quickly—induction does not. Well-suited to high-space, high-bay areas, it works well in parking lots, garage structures, and cobra head streetlights. Induction lighting also uses 60% less power than traditional lighting.

"Not another light puts out the same lumens per watt ratio," says Shelton.

It's also getting a lot of traction, he indicates. "It's used in new construction, but a lot of what we see is replacement of traditional lighting—300- to 1,000-watt metal halides."

Fixtures are retrofitted on a case-by-case basis; it depends on the fixture—its reflectivity, bulb placement, and usage.

Many companies and organizations are converting. Shelton mentions a gas station that retrofit its canopy with Blue Sky's bulb and ballast "for a fraction of the price" and another customer that replaced a 320-W pulse start metal halide in their canopy with a 150-W induction light.

"It gave them 60% energy savings and a brighter area," he says. "We're getting a better response from the public."

With a typical return on investment of one-and-a-half to three years, 20-year savings, a 5-year service warranty and reduced maintenance, because the bulbs last longer and aren't interrupted by lightning, the response isn't surprising. *ADG Eco Lighting offers a 10 year warranty with a performance guarantee.* (inserted)

"If you can replace a 1,000-watt light with one 300-watt and gain 40% savings," says Shelton, "you have to wonder why hasn't this caught on before?" It's catching on now. "If their goal is to save money, reduce maintenance, and get the same or **better light, induction is the way people will go**," states Shelton.

Shelton points out that he considers ... (themselves) unbiased, because ... both induction and LED lighting. "We're on the leading edge," he says. "**We see induction as the best choice for exterior high-space** high-bay applications."

Others agree. Shelton lists projects that include tunnel lighting in Atlanta for the Georgia Department of Transportation, the testing phase of a walkway lighting retrofit in the City of Augusta, GA, and the fact that the **Florida DOT uses only induction lighting in their signage.**

Eglin Air Force Base in Valparaiso, FL, chose induction cobra head streetlight fixtures due to the energy and maintenance savings and because of limitations on where LEDs can be used. In addition to reducing their lighting energy consumption by 50%, they discovered the new lighting produces better illumination than the LED streetlights available, according to a statement from Blue Sky.

The Department of Defense is the largest energy consumer in the US. In March 2010 the Department of the Air Force released an Engineering Technical Letter stating that due to a slow ROI and inconsistent performance claims, **LEDs were no longer permitted for interior or exterior applications, other than exit signs, general signage, traffic signals, directional accents, and other low-level uses.**

Similarly, Crippen Auto Mall in Lansing, MI, swapped out 1,000-W metal halides with 250-W induction shoebox fixtures after receiving an energy analysis from Hovey Electric. According to the National Automobile Dealers Association, US dealerships use 18% more energy per square foot than a typical office building because they must keep their inventory well-lit all night long.

Jeff Crippen, owner, expects annual energy savings of \$13,000, which means the new lights will pay for themselves in just over a year. Savings in maintenance costs over the 15-year life of the lamp will also add up. The 5,000-K lamp with a high color-rendering index also provides a sharper light that makes colors appear more vivid—a bonus for auto sales.

Light Control

Lighting costs are hard to quantify, says Paul Meng, principal of Smart Building Technologies in Gambrills, MD. "You never know what could have been if people did what they should—namely, turn off lights when spaces aren't occupied."...

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