Solid-State Lighting:
Technology at a Turning Point

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Just a few short years ago, the use of solid-state lighting (SSL) was limited to traffic signals, exit signs, and holiday lights as light-emitting diode (LED) manufacturers struggled to produce white light that was suitable for general illumination.

Today, things are quite a bit different. LED products are competing in a growing number of applications and seem to be turning up everywhere we look—from the shelves of big-box retailers to the nighttime skylines of cities and towns. SSL technology has brought us to the verge of what promises to be a major lighting transformation.

Some might see that as a sign that the battle has been won and that SSL has finally "arrived." But the truth is that it still has a long way to go to fulfill its potential for lighting efficiency. Estimates are that SSL has only reached the halfway point in that regard, which leaves a lot still on the table—not just in terms of energy efficiency, but also color quality and control, as well as other advantages that remain largely untapped. While sales of SSL products are rapidly accelerating now, installations still represent only a small fraction of total lighting.

SSL is at a turning point. With inefficient incandescent products giving way to higher-efficacy technologies such as linear fluorescents, compact fluorescents, and now LEDs, SSL's ultimate success—and the energy savings that will result—depends on technology (which is already outperforming earlier generations) continuing to improve.

What Will It Take?

First, we'll need R&D breakthroughs that take efficiency to the next level—light sources approaching 250 lm/W. Although LED luminaire efficacy is improving all the time and some products have surpassed 100 lm/W, that's still only half of the U.S. Department of Energy's (DOE) ultimate goal of exceeding 200 lm/W. Price, too, needs to continue to drop.

We'll also need to increase market penetration. How will we do that? Many feel the key lies with SSL's unique attributes that will serve as "value-added" differentiators. For example, SSL's controllability makes it well suited for use with sensors in "smart lighting" applications that increase energy savings. Its potential to control the visible spectrum offers the possibility of changing chromaticity to optimize mood, health, and productivity.

What's more, because SSL is not bound by the same limitations as conventional lighting technologies, it lends itself to new form factors—especially with organic LEDs (OLEDs), which can be easily made on thin, flexible substrates that are several years behind LEDs in terms of development for general illumination. They have a number of major cost and performance hurdles to overcome before they can compete with conventional lighting.

It's also important to address the critical issues that affect today's SSL products, such as dimming, flicker, and reliability. Although LED lighting products are often touted as fully dimmable, that's frequently contradicted by real-world experience—especially with phase-cut dimmers, which were designed for incandescent lighting and thus can be incompatible with LED drivers.

SSL flicker, too, depends on the LED driver; and while some drivers don't produce any visible flicker regardless of the amount of light output, other drivers cause noticeable flickering at every level of output, and still others only flicker in a dimmed state. System reliability and lifetime, which are so important to consumers, are hard to measure in LED lighting, because LEDs comprise just one component of a complex system that also includes such elements as optics, housing, thermal management, and driver.

Issues like these will have to be resolved if SSL is to turn the corner and have a significant impact on our energy consumption. But they're not easy issues to resolve. We've come halfway "there," but now the going has gotten tougher. In order to succeed, industry will have to work together and collaborate on a wide scale. This is already happening—for example, the NEMA-led efforts to develop dimming standards, and with the DOE-industry working group that's developing strategies to predict reliability and lifetime.

We'll need much more of the same. Because when it comes to solid-state lighting, we're all in the same boat—which will only reach its destination if the oars are pulling in the same direction.

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