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LEDs deliver breakthroughs in general-lighting applications

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New technologies are poised to replace traditional lighting solutions in professional and consumer applications, delivering energy savings and better performance.

The use of LEDs for solid-state lighting (SSL) is gaining ground in professional and consumer applications thanks to technological advances achieved over the past two years. White-LED performance has dramatically improved in lumen output, efficiency, color-rendering index, color-temperature availability, and binning structure. These advances enable—for the first time—LED-lighting applications that rival the performance of traditional technologies.[1] However, before LEDs move into mainstream lighting applications, several issues must be addressed including cost, system lifetime, efficiency, and light quality. Here, we briefly describe some initial applications that take advantage of the improved performance and cost-saving benefits.

In professional applications, key market drivers are innovative features and total cost of ownership (TCO), i.e., the total cost of the lighting solution incurred over its lifetime. Two early applications that benefit from SSL include freezer lighting and downlighting modules, where a number of manufacturers have introduced initial products (see Figure 1).[2] Traditionally, freezer-lighting applications use fluorescent tubes. However, these are inefficient due to the low freezer temperatures and the light distribution of the tube. By incorporating LED solutions into new freezer designs or LED retrofits into existing products, significantly less power consumption and substantially better product visibility are achieved.

In downlighter applications, LEDs can be built into a system with very high optical performance, bringing the overall system efficiency of a Fortimo downlighter (see Figure 2) to 60lm/W.[3] This rivals or exceeds conventional compact-fluorescent-lamp (CFL)-based systems. Supported by manufacturers' and the Department of Energy's LED roadmaps, LED-based downlighting solutions will soon surpass many conventional downlighting systems in efficiency.

Figure 1. *Philips' Affinium freezer product consumes less energy and improves product visibility compared with traditional lighting technology.*

However, efficiency is only one parameter in the choice of lighting source for professional lighting applications. Price and lifetime, combined with application requirements, similarly feed into the TCO calculation, which yields a payback time expressed in number of years. Several key factors impact the adoption of SSL in professional markets. One of the biggest issues is cost. The initial price of the product has a strong influence on payback time and is often considered a roadblock to upfront investment even if the TCO is positive, especially in these times of low financial investment. LED cost (lm/$) must therefore drop rapidly to enable more cost-effective lighting applications.

Another concern is the lifetime of LED lighting systems. The rated life of SSL luminaires, for example, is far below the claims of LEDs, with an operational life of up to 100,000h. This disparity should be communicated clearly and LED lifetime must be adequately engineered into lighting systems. Reliable quality and quality standards are crucial to live up to the promise of SSL.

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They must be aimed high in the market and not be compromised under any circumstances. In addition, two key specifications—lighting quality and efficiency—are of key importance. Light-quality norms and standards for various applications remain the guiding principle and are still a challenge for LED performance. In times of ever-rising energy prices (even the current economic crisis will only be an interruption and not change the principal trend), increased LED efficiency will greatly improve TCO and be a key contributor in reducing future energy consumption in lighting. To address these concerns, Philips introduced its first LED retrofit bulbs at the 2008 Light and Building Fair. Crucially important for the large-scale implementation of SSL technology is its adoption in the consumer market, with retrofit bulbs playing a leading role (see Figure 3).[4]

Reflector-type lamps such as the Philips GU10—a 6.3W Master LED: see Figure 4—can replace a 35W halogen light source, a lamp type for which no real alternative previously existed. In the hospitality industry, where halogen lamps are widely adopted, substantial energy savings can be realized with a positive TCO by adopting LED retrofit bulbs. Again, the superior optical performance of LEDs delivers substantially improved system efficiency compared to a traditional reflector lamp where the halogen burner provides poor optical results.

Much more so than in the professional segment, the key decision criterion in consumer lighting is initial price. While current LED pricing makes the first retrofit bulbs too costly, it is expected that rapid LED price declines will open up new home-market applications. However, incentive schemes are needed to speed up the introduction and adoption of SSL. Growing environmental concerns have prompted recent worldwide government efforts aimed at saving energy, resulting in many incandescent-bulb phase-out programs.[5] For example, the European Union will ban 100W light bulbs from September 2009. While currently targeting CFL alternatives, LED-retrofit bulbs will eventually be included as well. As in the examples for professional markets, niche applications exist for bulbs where LED retrofits will soon demonstrate superior performance even over compact-fluorescent-lamp integrated (CFLi) lighting, such as in outdoor environments. Again, the importance of quality and consistency in market introduction cannot be overemphasized.

Figure 2. *Philips' Fortimo downlighter module outperforms fluorescent equivalents in both energy efficiency and light quality.*

Figure 3. *Philips' Master LED A55 E27 bulb (also available in an E26 120V version) offers significant energy savings compared to halogen and incandescent lamps.*

SSL technology is on the verge of widespread adoption in general-lighting applications. It has the potential to achieve the

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Figure 4. *The Philips Master LED GU10 25D/40D reflector replaces 35W standard dichroic-halogen 230V lamps and 9W compact-fluorescent-reflector lamps.*

energy savings required by global climate protocols and deliver lower energy consumption to offset the rising cost of energy. However, product quality and attractive price targets must be coupled with incentive schemes, market education, and consistency in market communication. Lessons can be learned from the past where new technologies were similarly introduced on a large scale.[6] If done right, even in these dire economic times, SSL has a bright future ahead.

All figures courtesy of Philips.

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