

LIGHT EMITTING DIODES (LEDs) – FACT SHEET

“Lighting consumes 22 percent of electricity produced in the U.S” (U.S. Department of Energy)

LED Basics

LED stands for light-emitting diode, and is also referred to as “solid-state lighting”. Unlike incandescent bulbs (which generate light with filaments) and compact fluorescents (which create light from gases encased in airtight glass containers), LEDs feature semiconductors that turn electricity into either white or color lights.

The technology has been in existence for decades, used in electronics (VCR clocks, microwave displays), and backlighting most portable devices (cell phones, PDAs). More recent types of LEDs include traffic signals, automotive lighting, outdoor displays (Times Square), stadiums and airport runways. Recently, significant improvements in LED light output, coupled with a decreasing cost curve, have spurred the development of a number of new applications. The market now stands at the threshold of a phase of potentially explosive growth.

As of 2006, the global market for high-brightness LEDs stands at \$4.2 billion, with Mobile Appliances (48%), Signs/Displays (14%) and Automotive (15%) the largest category. The LED industry is forecast to grow anywhere from \$8.3 billion to \$11 billion by 2010.

The Promise of LEDs: How do they compare to CFLs and incandescents?

The two key benefits of LEDs are their long-life span and low power consumption. According to manufacturers, LEDs can last up to 50,000 hours (although the US Department of Energy rates them at 35,000-50,000 hours) compared to about 10,000 hours for fluorescents and 1,000 hours for incandescents. This reduces maintenance and replacement costs significantly, especially for commercial users such as retailers, hotels and casinos.

Today LEDs rank somewhere between CFLs and incandescents in terms of energy consumption levels. Compared by lumens per watt (the amount of light produced per watt), the best incandescents average 17 lumens/watt, the best CFLs produce 60 lumens/watt, while top LEDs reach as high as 231 lumens/watt. In addition, LEDs provide a much more focused and “directed” light, which reduces the required level of overall light output. Further improvements in energy usage are expected, as LEDs have doubled in energy efficiency and brightness in only the last two years.

While still much pricier than other lighting options (up to \$26 compared to \$6 for CFLs and \$2 for incandescents), LEDs have dropped an average of 20% in price every year since the 1970s. For example, the cost of individual white-light diodes, which go into an LED bulb and comprise much of the cost, have come down in price from about \$8 to \$1.50 in a year. Increasingly lower costs would make LEDs extremely competitive with CFLs.

Among the other benefits of LEDs:

- More durable than current incandescents and CFLs, which reduces replacement costs
- More compact than incandescents and CFLs, which can ease new installations and reduce the size and materials of future light fittings.
- Fully dimmable. Most CFLs today are not dimmable and several of the dimmable models don't perform very well.
- “Programmable” to emit light in virtually any color, without requiring filters. This expands LEDs reach into the market for aesthetic-minded, user-controlled lighting.

- Contain no toxic mercury, unlike CFLs (though the amount of mercury is very small). More information is needed however to better understand the chemicals used in the LED manufacturing process.

The Big Players: who is most involved in the LED industry?

Many of today's top lighting companies are starting to invest heavily in LEDs, with a host of startups also heavily engaged. Those companies with large luminaire businesses are at an advantage, as they can offer fully-integrated LED products and leverage existing distribution advantages.

Philips, via recently purchased subsidiaries Lumileds and U.S. based Color Kinetics, is considered the leader in the field. Recently, Philips signed an agreement with Siemens lighting business, Osram, to license each other's technology for LEDs. Philips' competitors in the LED segment include U.S.-based General Electric, Japan-based **Nichia** Corporation and the aforementioned Osram. North Carolina based **Cree**, a leading LED manufacturer with technology used for back lighting in cellphones and displays, is rumored to be an acquisition target for General Electric.

Other recent competitor news includes:

- Koito is the first to commercialize an automobile headlight using LEDs as light source. The new headlight is expected to be installed in Toyota's Lexus LS600h luxury sedan.
- Toshiba is developing high-performance LED products for offices and stores
- Matsushita will introduce five LED lighting products and expand a LED design service.

The Future of LEDs

The versatility of LEDs (e.g. their "programmability", size and so forth) may drive new designs in lighting, and provide consumers greater lighting options in terms of shape and color. A host of applications are being developed for numerous markets, including transportation (auto, aviation), retail, electronic and residential. For example, leading companies are looking at LEDs to make flat-screen computers and television sets brighter. Apple recently announced it would replace fluorescent tubes with LEDs in its laptop computers, while Samsung Electro-Mechanics recently announced it would begin mass production of white LED modules for LCD TVs.

Other groups are looking at LEDs to save money. The Taiwanese government plans to swap traditional bulbs with LEDs in each of the country's 770,000 traffic lights within three years to save power costs. Los Angeles International Airport and the Hard Rock Casino recently converted to LEDs for the considerable cost savings in energy consumption and maintenance. Even Wal-Mart is installing LED lighting strips in their refrigerator and freezer cases, as the cold can dim fluorescents while incandescents produce too much heat.

For some, the biggest market opportunity is in developing a drop in replacement bulb that would fit the roughly 4 billion screw-based sockets in the US. One company features an LED "bulb" that screws into a standard medium-sized socket and produces warm light equivalent to a 25-watt incandescent, while consuming just 5.8 watts. Unfortunately, it currently costs \$26, 13 times that of an incandescent and 4 times that of a CFL.

Ultimately, no matter how the LED industry grows, the future of the incandescent bulb is looking increasingly dim. California and Canada have decided to ban the sale of incandescent bulbs by 2012 and Australia is banning them earlier, in 2010. The European Union is also looking at banning production of the bulbs while US policy makers at the federal and state level are

considering proposals that would phase out inefficient incandescent light bulbs within the next 5 to 10 years. Therefore, the future of energy-efficient lighting may evolve into a competition between CFLs and LEDs. In that lighting involves 22% of all U.S. electricity demand (and a significant proportion of global use as well), there will be plenty of room for both technologies. However, the effectiveness of each technology in driving down costs, boosting demand and solving existing technical challenges may well determine who comes out on top.