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## Green Promise Seen in Switch to LED Lighting

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To change the bulbs in the 60-foot-high ceiling lights of Buckingham Palace's grand stairwell, workers had to erect scaffolding and cover precious portraits of royal forebears.

So when a lighting designer two years ago proposed installing [light emitting diodes](#) or LEDs, an emerging lighting technology, the royal family readily assented. The new lights, the designer said, would last more than 22 years and enormously reduce energy consumption and carbon dioxide emissions — a big plus for [Prince Charles](#), an ardent environmentalist. Since then, the palace has installed the lighting in chandeliers and on the exterior, where illuminating the entire facade uses less electricity than running an electric teakettle.

In shifting to LED lighting, the palace is part of a small but fast-growing trend that is redefining the century-old conception of lighting, replacing energy-wasting disposable bulbs with efficient fixtures that are often semi-permanent, like those used in plumbing.

Studies suggest that a complete conversion to the lights could decrease carbon dioxide emissions from electric power use for lighting by up to 50 percent in just over 20 years; in the United States, lighting accounts for about 6 percent of all energy use. A recent report by McKinsey & Company cited conversion to LED lighting as potentially the most cost effective of a number of simple approaches to tackling [global warming](#) using existing technology.

LED lighting was once relegated to basketball scoreboards, cellphone consoles, traffic lights and colored Christmas lights. But as a result of rapid developments in the technology, it is now poised to become common on streets and in buildings, as well as in homes and offices. Some American cities, including Ann Arbor, Mich., and Raleigh, N.C., are using the lights to illuminate streets and parking garages, and dozens more are exploring the technology. And the lighting now adorns the conference rooms and bars of some Renaissance hotels, a corridor in the Pentagon and a new green building at Stanford.

LEDs are more than twice as efficient as [compact fluorescent bulbs](#), currently the standard for greener lighting. Unlike compact fluorescents, LEDs turn on quickly and are compatible with dimmer switches. And while fluorescent bulbs contain mercury, which requires special disposal, LED bulbs contain no toxic elements, and last so long that disposal is not much of an issue.

"It is fit-and-forget-lighting that is essentially there for as long as you live," said Colin Humphreys, a researcher at [Cambridge University](#) who works on gallium nitride LED lights, which now adorn structures in Britain.

The switch to LEDs is proceeding far more rapidly than experts had predicted just two years ago. [President Obama's](#) stimulus package, which offers money for "green" infrastructure investment, will accelerate that pace, experts say. San Jose, Calif., plans to use \$2 million in energy-efficiency grants to install 1,500 LED streetlights.

Thanks in part to the injection of federal cash, sales of the lights in new "solid state" fixtures — a \$297 million industry in 2007 — are likely to become a near-billion-dollar industry by 2013, said Stephen Montgomery, director of LED research projects at Electronicast, a California consultancy. And after years of resisting what they had dismissed as a fringe technology, giants like General Electric and Philips have begun making LEDs.

Though the [United States Department of Energy](#) calls LED "a pivotal emerging technology," there remain significant barriers. Homeowners may balk at the high initial cost, which lighting experts say currently will take 5 to 10 years to recoup in electricity savings. An outdoor LED spotlight today costs \$100, as opposed to \$7 for a regular bulb.

Another issue is that current LEDs generally provide only "directional light" rather than a 360-degree glow, meaning they are better suited to downward facing streetlights and ceiling lights than to many lamp-type settings.

And in the rush to make cheaper LED lights, poorly made products could erase the technology's natural advantage, experts warn. LEDs are tiny sandwiches of two different materials that release light as electrons jump from one to the other. The lights must be carefully designed so heat does not damage them, reducing their lifespan to months from decades. And technological advances that receive rave reviews in a university laboratory may not perform as well when mass produced for the real world.

Britain's Low Carbon Trust, an environmental nonprofit group, has replaced the 12 LED fixtures bought three years ago for its offices with conventional bulbs, because the LED lights were not bright enough, said Mischa Hewitt, a program manager at the trust. But he says he still thinks the technology is important.

Brian Owen, a contributor to the trade magazine LEDs, said that while it is good that cities are exploring LED lighting: "They have to do their due diligence. Rash decisions can result in disappointment or disaster."

At the same time, nearly monthly scientific advances are addressing many of the problems, decreasing the high price of the bulbs somewhat and improving their ability to provide normal white light bright enough to illuminate rooms and streets.

For example, many LEDs are currently made on precious materials like sapphire. But scientists at a government-financed laboratory at Cambridge University have figured out how to grow them on silicon wafers, potentially making the lights far cheaper. While the original LEDs gave off only glowing red or green light, newer versions produce a blue light that, increasingly, can be manipulated to simulate incandescent bulbs. And researchers at dozens of universities are working to make the bulbs more usable.

"This is a technology on a very fast learning curve," said Jon Creyts, an author of the McKinsey report, who predicted that the technology could be in widespread use within five years.

So far, the use of LEDs has been predominantly in outdoor settings. Toronto, Raleigh, Ann Arbor and Anchorage — not to mention Tianjin, China, and Torraca, Italy — have adopted LEDs for street and parking garage lighting, forsaking the yellow glow of traditional high-pressure sodium lamps. Three major California cities — Los Angeles (140,000 streetlights), San Jose (62,000) and San Francisco (30,000) — have embarked on some LED conversions.

Ann Arbor adopted the technology early, working with Relume Technologies, of Oxford, Mich., to design LEDs that would fit the globes of downtown fixtures. The \$515 cost of installing each light will be paid back in reduced maintenance and electrical costs in four years and four months, said Mike Bergren, the city's field-operations manager.

Because the light from LEDs can be modulated, in Ann Arbor they have been programmed to perform various useful tricks — to become brighter when someone walks under a light or to flicker outside of a home to guide paramedics to an emergency. And because they do not emit ultraviolet light, they attract no bugs.

People who live around Carolina Pines Park in Raleigh say they are pleased with the park's new LED lights because they can be directed downward, away from home windows.

The lights are also rapidly moving indoors, where they could have an enormous effect on climate change. About 20 percent of carbon dioxide emissions associated with buildings in the United States and the United Kingdom are related to indoor lighting; in some houses the number is as high as 40 percent.

This month, LED lights were for the first time the centerpiece at two of the world's major trade shows for lighting, Lightfare International in New York and EuroLuce in Milan. A growing number of builders are starting to fit them into public buildings, offices and homes.

Ted Van Hyning, director of event technology at the Renaissance Hotel in Cleveland, said the new LED lights in the hotel's conference rooms use 10 percent of the electricity of the fluorescent lights they replaced. And maintenance costs are far lower: A fluorescent bulb might last 3,000 hours while an LED fixture lasts more than 100,000 hours, Mr. Van Hyning said, adding: "We have six-figure energy costs a year, and these lights could represent a huge saving. Besides, they're cool and sexy and fun."

Buoyed by the improvements in the technology, Peter Byrne, a lighting designer and energy consultant for Buckingham Palace, installed the 32,000 custom LEDs in the ceiling of the grand stairwell when older fixtures wore out.

Mr. Byrne recognizes that Buckingham Palace is not the average home. "They need high-quality light — they have a lot of gold," he said, "and gold tends to look silver if you light it poorly."

Still he has started using the technology in other projects, for their light and their environmental benefit. He estimates that half of lights in homes, and particularly those in offices and stores can already be replaced by LEDs.

"At this point, LEDs can't be used in all lights but that's changing every month," Mr. Byrne said. "If you go into Wal-Mart, and look at all those twin 8-foot fluorescents above every aisle, you realize that the potential is enormous."

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