Let There Be Light

How a new kind of bulb will transform the developing world.

BY CHARLES KENNY | DECEMBER 13, 2010

We in the developed world are preoccupied with the consumer technologies of the 21st century -- ubiquitous high-speed Internet, the iPad, and the Wii Fit. We forget that vast swaths of the developing world have yet to be transformed by a technological upheaval we experienced more than a century ago: the advent of electric lighting. But the latest illumination innovation could change that, bringing not just greater efficiency to the well-wired West but also better quality of life to everyone else.

The first lighting revolution was powered by gas. As gaslight replaced candles over the course of the 18th century, the amount of artificial illumination produced in Britain each year shot up more than 100-fold. In 1879, Thomas Edison began the second lighting revolution when he strung his Menlo Park headquarters with electric lamps using carbonized bamboo filaments. By 1881, a few blocks of southern Manhattan were illuminated by electricity, and the West has never looked back.

Over the past 100 years, there have been many bulb innovations -- including tungsten halogen, metal halide,

sodium, and compact fluorescent. And thanks to improved manufacturing and design, it **costs** 1,000 times less to light a room today than it did 100 years ago.

Still, the vast majority of light bulbs worldwide today --12 billion of them -- use a filament system similar to Edison's. And for all the progress over the last century, these bulbs remain very inefficient. The amount of energy pushed through a filament that actually emerges as visible light is around 2 percent -- most of the rest is lost as heat. This inefficiency is the big reason why in the United States, the power used to light Edison bulbs produces half as much carbon dioxide as the country's car fleet. And it is why governments around the world are so keen for consumers to switch to more efficient bulbs like compact fluorescents.

But the compact fluorescent is yesterday's news. The new technology leader that will spark the third lighting revolution is the light-emitting diode, or LED. The amount of energy converted to visible light by an LED already climbs as high as 14 or 15 percent. That's a thousand times higher than diodes managed in 1968, and considerably better than today's compact fluorescent bulbs. And efficiency is expected to double again by 2020. Diodes have an array of other advantages: they last five times longer than compact fluorescents (50 times longer than the Edison bulb), they are smaller, less fragile, and inert. That all adds up to a lot less expense in manufacture, storage, shipping, and disposal. And it's likely to mean a considerably easier task for those trying to end our addiction to the filament in the rich world.

Whatever its impact on developed countries, however, the real LED revolution will be in the developing world, where billions of people still live without access to networked electricity. Take Africa -- there are about 110 million households in the region without access to the grid, compared with only 20 million who are connected. The most common way for people offline to get light is to burn something. About half of those homes use kerosene lamps for illumination, while most of the rest still use candles. More than one in ten just pile extra wood or dung on the fire if they need more light. In other words, nearly half of African households are stuck using technologies that were largely abandoned in the United States before the Civil War, and most of the rest use a technology that had passed its prime before World War I.

The technologies of burning stuff to produce light make the Edison bulb seem a model of efficiency. For each joule of energy a candle turns into visible light, 2,500 joules are wasted. That makes traditional lighting expensive and environmentally hazardous. Off-grid households in Kenya and Ghana spend about $80 a year on fuel-based lighting -- and the great majority of that is on the fuel itself. Some households spend as much as 30 percent of their income on lamps and fuel -- this for two or three hours of poor quality light at night. Worldwide, kerosene is a $38 billion industry, and kerosene lamps emit the same carbon dioxide each year as 15 million cars.

Inefficiency also means people have less light to use -- a candle or basic kerosene lamp produces less than one third of a percent of the illumination of a single-watt LED. Fuel lamps are also dangerous -- in India, 2.5 million people are **severely burned** by overturned kerosene lamps each year. And traditional sources emit harmful fumes and soot. Working under kerosene light exposes people to the toxic equivalent of two packs of cigarettes a day.

But, until recently, more efficient lighting that didn't require networked electricity just wasn't practical in developing countries. Lamps that use compact fluorescent bulbs and run off a battery charged by solar power during the day are available, but they're very expensive. Even though you save on kerosene, it takes more than three years after purchase for the total cost of running a compact fluorescent lamp to drop below that of a kerosene lamp and fuel. Poor people in developing countries often can't afford to make such long-term investments. Today, only around 1 percent of houses use solar lamps or solar household systems as a result.

That is about to change, thanks to the LED. The lesser power demands of these more efficient lights mean that you need smaller batteries to run them -- which means that it is possible to charge a battery long enough to provide hours of light using a smaller solar panel. Diodes are also harder to break -- a real advantage for a technology that must endure a bumpy truck ride over the rutted roads of Africa. That means lower manufacturing and distribution costs, which means cheaper products: The new lamps are already priced at around $20, considerably less than the fluorescent version. And between 2010 and 2015, the price is predicted to fall by another 40 percent -- not least because LED prices will fall by three quarters thanks to new manufacturing techniques. The payback period for buying a basic solar lantern over a kerosene lantern will fall from seven months today to below two months in 2015. Going diode will make overwhelming financial sense even for the poorest people.

With decent and affordable lighting, people can work -- or shop, or relax -- further into the evening. In India, the introduction of better lighting was found to increase the amount of time students spent studying at home by over an hour, with a significant impact on test scores. And added to the advantages of a longer day, greater health, improved security, and a lower environmental impact, solar lamps increasingly come with mobile phone chargers -- an important benefit considering off-grid users in Africa spend as much as $155 million annually charging their phones. At long last, the LED will take Edison's revolution global.

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