## EDITORIAL

# Behind the Themes and Between the Lines: Shedding Light on the Energy Squeeze

Buried deep on p. A18 of the *New York Times*, May 1, 2001, was a line that caught my attention: "New technology—like computer screens that use far less power and energy-efficient light bulbs—have an important role to play because they can save energy without reducing living standards." The article, which began on the front page, presented the U.S. energy strategy in response to the energy shortages in California, as presented by Vice President Dick Cheney.

What grabbed me was not the significance of this statement, which elicited more of a nod than a feeling of enlightenment, but that this sentence was so deeply buried and far removed from the central theme of the proposed plan. This sentence accounted for 2% of an article that focused on how energy needs require more coal, more oil, more natural gas, and revival of nuclear power.

Increased consumer demands likely will drive expansion and improvements in all of these areas of energy generation and potentially others such as solar, fusion, and hydrogen power.[1] However, this tokenism given to improved efficiency seems to do a disservice to the capabilities and real developments that science and technology present.

One such development that switched on a light for me is the light-emitting diode (LED). Waving colored and white LEDs at the MRS Spring Meeting this year, Gerd O. Mueller[2] of LumiLeds Lighting described two recent advances that are enabling the proliferation of solid-state lighting in the form of light-emitting diodes: (1) the availability of LEDs of all colors and (2) the availability of suitable phosphors for generating white light. LEDs are more energy-efficient than incandescent lights because they emit only the color of light desired and leave behind wavelengths that result only in unnecessary heat.

One of the first broad commercial applications of LEDs for energy-efficient lighting is in the replacement of traffic signals—most economically for red, but now including yellow and green. Santa Cruz, Calif., for example, has replaced its red and green traffic signals with LEDs and estimates reduced power consumption by 80% as a result.[3] In some cases a 1-W colored LED can match the output of a 25-W (filtered) incandescent light.[4] The value of this new technology depends on the function, one producer said, who supplies LEDs to Walmart, Disney World, and the U.S. Navy. With a service life of 50,000–100,000 h—much longer than that of conventional incandescent lights—the maintenance costs are reduced and reliability increased. According to ENERGY STAR,[5] cities can save 51 MkWh of energy and nearly $70,000/yr for every 100 traffic signals replaced. In addition, LED traffic signals will prevent the release of more than 200,000 metric tons of air pollution.

White LED lighting is lagging behind colored lighting, but there do not appear to be scientific barriers to its use. Already Japan is producing 12 million white LEDs per year[6] and has a National Project through METI called "Light for the 21st Century" to develop high-efficiency white LEDs for general lighting services.[7] Commercially available white LEDs are expensive. I was charged $30 for a 1-W bulb that produces about 13 lm (compared to a 75-W bulb that produces 1210 lm), and the directional nature of the light lends itself more to display lighting than general illumination. But the more we can improve the efficiency, the greater will be the energy- and cost savings. White LEDs might not be practical yet on a large scale due to initial costs, low brightness, and color-rendering challenges, but neither is oil in yet-unexplored areas.

In the United States, about 20% of all electricity and about 7.2% of energy is consumed by lighting, and worldwide the percentages are similar.[8] Using LEDs for lighting is a compelling example of how to tip the balance of the energy equation toward efficiency.

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### References

1. See "Materials for the Power Industry" by B.L. Eyre and J.R. Matthews in this month's feature on MATERIALS CHALLENGES FOR THE NEXT CENTURY, p. 547, www.mrs.org/publications/bulletin/21stcen/.
2. G.O. Mueller, "Recent Progress Towards Solid State Lighting," presented at the 2001 Materials Research Society Spring Meeting in Symposium G on Luminescence and Luminescent Materials, San Francisco, April 19, 2001.
3. City Council Agenda Report, February 7, 2001, http://www.ci.santa-cruz.ca.us/cc/archives/01/2-13meeting/2-13rpt/energy.html (accessed June 2001) and personal communication.
4. Advanced Lighting, Inc., LED vs. Incandescent Energy Savings, http://www.aliww.com/comparison.html (accessed June 2001).
5. ENERGY STAR is a government/industry partnership introduced by the U.S. Environmental Protection Agency (EPA) in 1992 as a voluntary labeling program designed to identify and promote energy-efficient products, in order to reduce carbon dioxide emissions. For more information, access Web site www. energystar.gov.
6. K. Kohmoto (Japan Electric Lamp Manufacturers Association, Japan), "Development of White LEDs in Japan," 2nd CIE Expert Symp. on LED Measurement (Gaithersburg, MD, May 10–12, 2001). Editor's Note: According to updated information from a source in Japan, the number of white and blue LEDs produced in 2000 in Japan was on the order of 1 billion, and ramping up quickly.
7. "Development of Compound Semiconductors for High-Efficiency Electro-Optic Conversion ('The LIGHT for the 21st CENTURY')," a project jointly carried out by the New Energy and Industrial Technology Development Organization (NEDO) and the Japan Research and Development Center for Metals (JRCM) through a subsidy provided to NEDO by the Ministry of International Trade and Industry, now called the Ministry of Economy, Trade, and Industry.
8. R. Haitz, F. Kish, J. Tsao, and J. Nelson, "Another Semiconductor Revolution: This Time It's Lighting!" *Compound Semiconductor* **6** (2) (March 2000).





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