

Solid-state lighting and efficiency from a global perspective

WHAT IS THE WORLD'S APPETITE FOR LIGHT?

What if an increase in lighting efficiency does not result in less energy consumption but in more lighting for the same amount of energy? Jeff Tsao, a researcher at Sandia National Labs who studies the technology and economics of lighting, posed this question at the opening session of the Strategies in Light conference last February. Tsao examined data on the worldwide consumption of artificial light for the past 300 years, which covers the introduction of candle, kerosene, gas, incandescent, and fluorescent/high-intensity-discharge lighting.

Over the past 300 years, the world has spent a constant 0.72% of its GDP (gross domestic product) on artificial lighting. This observation translates in the United States to the equivalent of 17 100W light bulbs turned on per capita, per waking hour. Africa's usage equivalent is one 0.5W light bulb burning for every person's waking hours. (Tsao notes that this 0.5W light consumption is the same as the amount that the citizens of London used in 1850.)

This relationship between GDP and lighting usage accounts for increases in the COE (cost of energy) because COE affects the lighting-usage equation by driving down the GDP. That is, people consume less energy for lighting only if the COE increases or their standard of living in general decreases, not because lighting becomes more efficient. As lighting becomes more efficient—that is, cheaper—then lighting usage increases. This conclusion follows intuitively from knowing that, in general, people consume more as costs go down. So, the move toward LED-based SSL (solid-state lighting) may be an effective strategy for lowering energy consumption, but only if it's paired with an increase in productivity.

COE plays a major role in GDP, but it's not the only factor: Another way to increase GDP is to become more productive. Throughout history, lighting has helped productivity. As lighting technology advanced—from kerosene to gas lamps to electricity—lighting became cleaner, light sources took less time to turn on and off, light-induced heat decreased, and fire hazards decreased. The conclusion Tsao reaches is that efficiency alone does not result in a

decrease in energy consumption. An increase in productivity must accompany that efficiency.

Here's a likely conclusion we can draw based on this study: The killer app for LEDs won't be a replacement bulb for 40W home lights because that application won't increase anyone's productivity. Rather, the opportunities for LED lighting will be in applications that have inherent intelligence and can interact with their environments and humans in ways that make both more productive and intelligent.

I discussed Tsao's study in my Feb 22, 2009, *PowerSource* blog (see "LEDs for lighting: Efficiency is not enough," www.edn.com/090409leda). Many readers posted comments, some agreeing and some disagreeing with Tsao's conclusions. Several readers and people at the conference who had heard Tsao's presentation assumed that, by making people more productive, LED lights automatically conserve energy, such as when you network them to automatically turn on and off or dim during premium energy-usage periods. Based on the connection of productivity to GDP, however, it seems more likely that Tsao was referring to LED systems that directly and significantly affect human work output.

"Think ... about the undeveloped world not currently on grid electricity, [often] using kerosene lamps and hardly consuming light at all [compared with] the developed world," he says. "Their productivity would be increased in so many ways ... if they had access to more light." Clearly, Tsao believes that a direct connection exists between access to clean, safe, efficient light and quality of life.

Undoubtedly, the affluent, light-rich world would benefit from the coming shift to SSL. But that benefit will be nothing compared with families and workshops in undeveloped countries, who will no longer have to use dangerous, expensive kerosene lighting to finish a day's work or start a night's schoolwork.

If you're interested in how LEDs will acquire intelligence and enhance productivity, consider attending *EDN's* free Designing with LEDs workshop, which will take place on April 30, 2009, at the Hyatt Regency in Santa Clara, CA. Go to www.edn.com/leds for more information.