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Green Tools: Energy Conservation for the Gadgetry-Inclined

Many new products and devices use optical technologies to help the environmentally and tech-savvy consumer monitor and conserve energy.

By Beth Kelley

In 2007, the non-profit U.K. organization Energy Saving Trust reported that the world's current love of personal electronics is thwarting efforts to help conserve energy. By 2010, "consumer electronics will become the biggest single sector of consumer electricity consumption," the report says.

So what's an environment- and gadget-loving person to do? Fortunately, many new products are available that can help save energy—or even produce it.

Monitoring the present

Appliances that monitor energy use in the home or small office can alert residents when energy use is too high or too expensive. Products like Ewgeco and Wattson use sensors and colorful displays to give visual reminders about everyday energy consumption.

One device designed for aesthetics as much as functionality is the Ambient Orb, by Ambient Devices. The Orb is a simple ball of glazed glass covering standard RGB LED lights that can be plugged into any 110-V power outlet. Using a wireless Internet feed, the device changes color in a spectrum of green to red to relay information. Originally designed to glow depending on how stocks were performing, the Orb was adapted by Southern California Edison (SCE) in 2004 to help reduce power consumption during peak hours and marketed as the Energy Orb. SCE found the Energy Orb was amazingly effective at getting people to reduce power consumption.

"In studies, the Orb has proved as much as 70% more effective than alternative modes of communication" used before, says Jen Revis Snider of Ambient Devices media relations.

Now, SCE is introducing a new energy monitoring system, SmartConnect energy meters. Still in field tests, five million new solid-state electronic meters for households and small businesses will be rolled out between 2009 and 2012. Integrating ZigBee two-way wireless mesh networks and Itron management systems with other technologies, the meters will transmit energy usage information and price to a cell phone, e-mail address, or Web site, with updates available every five to 10 seconds. SCE will be able to turn power on or off remotely. The new generation of meters will also accommodate solar panels or other alternate energy forms installed at a site.

Southern California Edison's Energy Orb.

Size for Everyone

Environment-friendly devices don't have to be big or designed for large systems.

LED lights, which work in small spaces, are becoming ubiquitous for their adaptability as well as for their energy-saving abilities. LEDs are used on holiday lights, display screens for the Ewgeco, Wattson, and the Ambient Orb, and in products such as Light & Motion or NiteRider's bicycle lights.

The Solio Universal Hybrid Solar Charger, manufactured by Better Energy Systems (BES), is a portable charger that uses solar panels and can be plugged into most small electronic devices such as cell phones, iPods, PDAs, or digital cameras.

The charger uses both wafer-based polycrystalline silicon cells and a thin-film cell based on cadmium telluride. Its charge-loss rate is 2-5% per month, depending on temperature, altitude, and humidity, and its UL rating is four years, or eight years with a new battery. Keeping with the goal of trying to be as "green" as possible, BES is also looking into cellulose-based batteries to replace lithium, "making the battery even more eco-friendly," says Tiffany Markofsky, a spokesperson for BES.

Future of Conservation

Some promising products using optical technologies are moving beyond gadgetry.

One product still in its infancy is a flexible organic solar cell developed by Bernard Kippelen's group at the Center for Organic Photonics and Electronics, Georgia Institute of Technology (Atlanta, GA).

Kippelen's group uses a combination of pentacene and C60 to construct the cells. He originally looked at liquid crystalline materials because they exhibited large charge mobility. "However, the processing of these organic liquid-crystalline semiconductors turned out to be quite challenging," says Kippelen, "and we turned to highly ordered materials that are processed by physical vapor deposition. Pentacene was our first choice, and the combination with C60 turned out to be an efficient way to build organic solar cells."

These solar cells have an energy conversion efficiency of 2% under standardized AM 1.5 G conditions. The typical size of the solar cells is 0.1 cm2, although Kippelen and his group are working on prototypes up to 3.82.

While still in field-test stages, these flexible solar cells are capable of being attached to clothing, tents, flashlights, and other portable devices.

"The early applications we envision are portable power sources for wireless sensors and RFID tags where highly conformable and flexible form factors are important," Kippelen says. Before that can happen, though, "efficiencies will have to be increased, and extended lifetimes of several years need to be demonstrated in large area modules."

Another energy-saving optical technology that is beginning to see the light of day is the electrochromic (EC) window. EC windows can be "tinted" or darkened to block direct heat or bright sunlight and can be lightened during cold weather or when more light is needed. These windows have already proven functional in automotive rear-view mirrors and other smaller applications but are now poised for bigger applications.

Sage Electrochromics Inc. is the first company to mass-produce and sell large-panel electrochromic windows that can reduce peak loads for lighting, heating, and cooling up to 30% when compared to traditional energy-efficient glazed windows.

The company has developed a monolithic solid-state electrochromic glazing technology that is durable enough for heavy use in commercial, industrial, government, and residential settings. A study by the National Renewable Energy Laboratory found that the windows easily survived 100,000 tint/untint cycles, roughly equivalent to switching a window from tinted to clear nine times per day for 365 days across a 30-year lifespan.

The monolithic solid-state electrochromic glazing material consists of a stack of five ceramic metal oxide coatings on a single piece of glass. When a low voltage direct current of less than 5V is applied across the outermost layers, Li+ ions, which are deposited into a charge storage layer during production, move across the ion conductor layer into the electrochromic material at the same time as an electron is also inserted into the electrochromic layer. This causes the electrochromic layer to absorb light and appear tinted. When the voltage is reversed, the process is reversed and the product reverts to its clear or "off" state.

Value in Integration

At a recent trade show, Microsoft, Google, GE, LG, Siemens, and other companies approached Southern California Edison (SCE) about integrating their smart appliances and home automation technologies with SCE's new generation of smart meters.

"There's a whole range of interest in how to enable customer value by linking this information with other products and services" that these companies offer, says Paul De Martini, director, Edison SmartConnect.

EC Window Study

There are still some kinks to be worked out with electrochromic (EC) windows before they are likely to be adopted en masse. The fastest an 18-inch window can switch from clear to opaque is one to four

minutes, and that time increases the colder the outside temperature is and the larger the window. And because they absorb heat, EC windows without a low-e coating could cause considerable thermal discomfort.

A team at Lawrence Berkeley National Laboratory (Berkeley, CA) conducted a three-year field study into the effectiveness of Sage's EC windows in office settings. They found the windows functioned more effectively at controlling solar heat gain than controlling for visual comfort. Having an automated system rather than manual control was also found to be more effective in maintaining comfortable working conditions.

"Even with deeply tinted EC glass of 3–5% daylight transmittance, many occupants were still lowering the blinds when sunlight was in their field of view," says Eleanor Lee, co-principal investigator of the study.

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