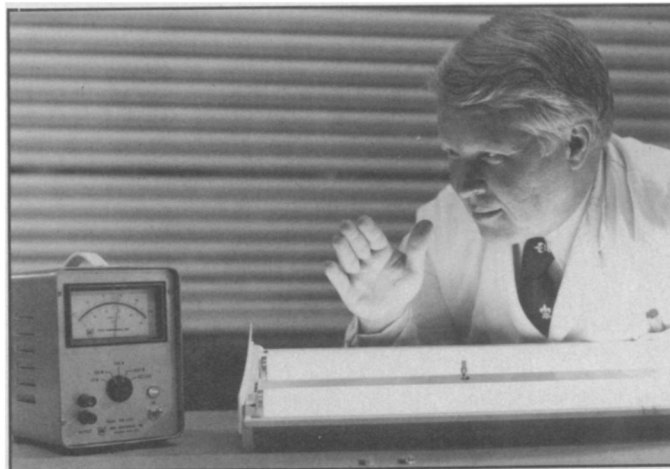


# Saving Watts of Energy

The potential exists today to reduce the energy consumed by electric lights 25 to 50 percent

BY JANET RALOFF



Don Widmayer, Ecalo developer, tests sensitivity of light sensor (shown protruding from fixture between fluorescent lights).

Energy consumed to artificially light the United States represents only about five percent of total energy use, but it is still nearly 400 billion kilowatt hours annually — roughly equivalent on a daily basis to the amount of energy provided by the Alaskan pipeline. Especially since the 1973 oil shortage heightened national awareness of a growing energy problem, engineers have sought to reduce the energy and cost of lighting.

Steve Selkowitz of the National Lighting Laboratory at Lawrence Berkeley Laboratory in California says that lighting energy could be reduced 25 to 50 percent, with little or no capital expense to the consumer, through use of: more efficient bulbs and fixtures, better planning in architectural design, more flexible switching (on-off) and control of individual lights, and the integration of daylight into lighting-conservation schemes.

The most inefficient light bulb, as measured in lumens per watt, is the one found most often in the home — the incandescent. Only 10 percent of the energy it consumes appears as light; the rest is lost as heat. But as bulb wattage increases, so does efficiency. For example, a 100-watt bulb radiates 18 lumens per watt while a 60-watt bulb radiates 14 per watt. Substitution of one 100-watt bulb (1,800 lumens) for two 60-watt bulbs (1,680 lumens) produces more light with less power.

Bulb lifespan is also an important conservation factor. Incandescents are not only the shortest-lived bulbs, but their light output also decreases from its initial value by 20 percent or more near the end. The decrease results from metal deposition on bulb glass, which occurs when metal burns off the coiled tungsten filament. Although the energy consumed by the bulb remains constant, the light escaping is reduced.

Tungsten-halogen bulbs have solved the glass-darkening problem; the halogen keeps the tungsten from evaporating.

These bulbs last four times longer than normal incandescents and operate at about 94 percent efficiency even though their lumen-per-watt rating remains about the same. Because they require special fixtures and because bulb surfaces get very hot, they are seldom used at home.

Duro-Test Corp. in North Bergen, N.J., is developing another line of high-efficiency incandescents. A coating of silver and titanium-dioxide applied to the inside of the bulb glass reflects infrared radiation, normally lost as heat, back onto the filament for a 60 percent saving in energy. The bulbs will be relatively expensive — around \$4 for a 100-watt bulb—but should last twice as long as conventional incandescents.

Fluorescents last six to 10 times longer than incandescents, and are up to five times more efficient in light production. But even they are being redesigned for greater energy saving. For example, many companies are adapting fluorescent lights to screw into incandescent fixtures, thereby expanding the residential market. Litek, similar in size and shape to a 100-

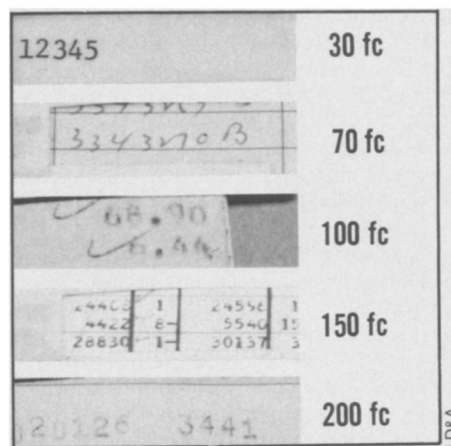
watt incandescent, is one such bulb. Donald D. Hollister, president of Lighting Technology Corp., in Burlingame, Calif., and Litek's inventor, says that the first commercial prototypes should be ready within six months. Producing 50 to 60 lumens per watt, they'll be three to four times as efficient as incandescents and closely resemble incandescents in warm color renditions. In addition, they will last 10 or more times longer.

The Department of Energy, which partially funded Litek's development, is also sponsoring research under the aegis of LBL's National Lighting Lab. One of its major programs is development of a solid-state ballast. Rudy Verderber, manager of the National Lighting Program at LBL, said solid-state ballasts could save 30 percent of the energy consumed by fluorescents with copper-core-winding ballasts.

Instead of heating a filament to produce light, fluorescents light by electrically exciting gases inside a glass tube. Sparks from the ballast cause the gas to discharge, which in turn causes the phosphor coating on the inside of the glass to fluoresce, or glow. Core ballasts cycle 60 times a second. Electronic ballasts discharge 20,000 to 30,000 times per second. The faster cycling brings an increase of 15 to 20 percent to lamp efficiency, Verderber says. And solid-state ballasts suffer fewer operational losses for an additional 10 percent efficiency increase. One of the DOE-supported ballast designs will be continuously dimmable. If tied into a photocell, it can automatically reduce fluorescent output to compensate for incoming daylight, Selkowitz says.

Several firms have already begun manufacturing photosensitive dimmers. Ecalo by Controlled Environment Systems, Inc., of Rockville, Md., is among the simpler ones. An "electric eye" attached to a standard fluorescent fixture senses the amount of incoming daylight and gen-

*Continued on page 382*



Work-related lighting needs (in footcandles) will vary with the average clarity, size and contrast of work materials.

## ... Electric lights

erates an electrical signal to regulate the current going through the lamp. As the level of incoming light increases, the lamp dims (although it will never shut off completely). Don F. Widmayer, Ecalo's inventor and CESI president, says the system can save 40 percent of the energy consumed by fluorescents. And for businesses that air-condition in summer, Ecalo-like dimmers offer a second benefit — reduced heat output. It's estimated that a half watt is needed to remove the heat provided by each lighting watt.

Another advantage of dimmers is that they control the radiant output of a lamp throughout its life. If a 40-watt fluorescent lamp, for example, produces more than the expected 40-watt lumen equivalent (and all lamps overproduce in the beginning), the dimmer will reduce power to the lamp accordingly. Similarly, when lamp performance falls off in later years, the dimmer will boost power to the lamp to increase the lumen output.

The Ecalo system requires no special ballast or fixture, and can be installed, according to Widmayer, in less than 15 minutes. He says energy paybacks depend on sunlight, but the system should pay for itself in one to four years.

Lutron of Allentown, Pa., offers a more flexible system under the trade name Lumar. Unlike Ecalo, it controls the output of all lamps — incandescent, fluorescent and high-intensity discharge (HID), and can vary preset light levels individually or by floor throughout the day. For example, it can be set for partial power in the early morning and evening, full power during business hours and no power from midnight to dawn. A photosensitive dimmer compensates for daylight. Its drawback is cost. Joseph Licata, a Lutron vice president, says Lumar is "very expensive," and that the expected payback time is between three and eight years. Wide-Lite, a manufacturer of HID fixtures in San Marcos, Tex., offers similar systems for HID lamps.

Mercury-vapor, high- and low-pressure-sodium, and metal-halide lamps belong to the most energy-efficient class of lights — HID. Mercury lamps cost the least and last a long time, but their color rendition is not always good. Metal halide lamps are more efficient and have better color, but don't come in sizes smaller than 175 watts. High pressure sodium lights have the best efficiencies — to 140 lumens per watt — and can last to 24,000 hours, roughly three times the life of a good fluorescent. But their yellow color tends to limit their use indoors.

High-pressure sodium lights were used inside the Norris Cotton Federal office building in Manchester, N.H., which is a fully functional energy-conservation laboratory. Soon after, the yellow lights were replaced in an Army recruiting office because they were unsatisfactory for medical examinations. Other employees complained of the eerie environment it

provided, but conceded they were getting used to it.

People management can also make an important contribution to energy and lighting needs. Lighting standards are based on tasks users perform. Reading small numbers on smudgy photocopies, for example, requires high-level lighting. Answering telephones or running a machine may require little lighting. By grouping people with similar lighting needs together, areas can be lit to a minimum.

Techniques to overcome glare can alter lighting needs. It takes less light to read words or numbers printed on matte-finish instead of glossy paper, and to read words written by pen or felt-tip markers instead of by pencil.

Because so many people tend to forget to turn off lights, some firms are developing people sensors; a "smart room" installed with such a sensor would automatically turn off lights as people leave. For some large, complex lighting management purposes, computers are the only answer. In one company, reducing all lighting by two-thirds during a daily half-hour lunch period saved \$100,000 annually.

With a turn toward using less light or more efficient but "unusually colored" light, lighting designers are beginning to worry about what emotional or perceptual values these changes foster in users. John E. Flynn, an architectural engineering professor at Pennsylvania State University, has been studying, with surveys, the effects of low-level lighting and its spatial distribution on impressions of visual quality and one's sense of well being.

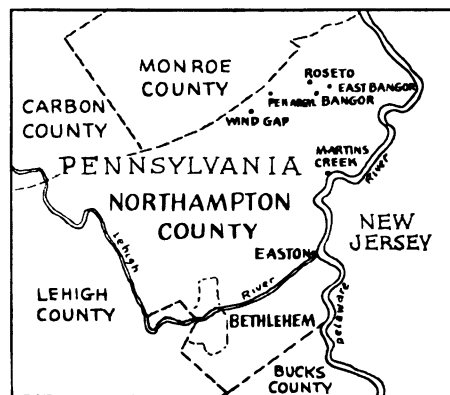
He found that diffuse lighting at 10-foot-candles intensity seemed more monotonous, unsociable, apt to cause tension and dim than the same 10-foot-candle output delivered by overhead "downlighting." His findings, described in the February 1977 LIGHTING DESIGN & APPLICATION, also show that when impressions of clarity and utility are important, overhead lighting is preferred. Non-uniform overhead lamps that light central portions of a room intensify this perception, he says, even if viewers are situated in regions of reduced lighting. Wall and "peripheral" (such as desk) lighting affect mood and feelings of spaciousness most, he found. Uniform wall lighting strengthened impressions of spaciousness while non-uniform peripheral lights combined with warm lighting colors reinforce impressions of friendliness, pleasantness and relaxation.

"We are talking about more than mere aesthetic amenities here," Flynn says. "In an era of more limited energy resources, where lighting watts must be scrutinized with professional attention to function and value, we need to define more adequately what the overall spatial contribution of light is, and what the value of that contribution is relative to the broad competing demands for energy used in buildings." □

## ... Roseto



A Rosetan operates a mechanical hoist in a nearby Bangor slate quarry.



were their parents and grandparents. From the beginning the sense of common purpose and camaraderie among the Italians precluded ostentation or embarrassment to the less affluent and the concern for neighbors insured that no one was ever abandoned."

It is the breakdown of such values that the researchers conclude is primarily responsible for the apparent decline in health and jump in the heart attack death rate. And the findings, Wolf says, have "tremendous implications" not only for Roseto, but for other areas where similar processes have taken or will take place. "Social change and fragmentation of families has been taking place in the western world for centuries," says Wolf. "It may be significant, however, that the lowest prevalence of myocardial infarction... is to be found in those parts of the world where traditions and family ties are strong. Additionally, it may be significant that sudden death is characteristically associated with important losses, bereavement or abandonment.

"As the process of 'Americanization' continues, as family and community ties continue to weaken and as Roseto's Old World culture and traditional values continue to erode, we may expect increased numbers of fatal myocardial infarctions among the young.

"American society emphasizes 'standing on one's own feet' and 'being independent,'" Wolf says. "We just went too far with it." □