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Tomorrow's Energy Today for Cities and Counties: Buildings that Save Money with Efficient Lighting[1]

U.S. Department of Energy[2]

Energy-efficient lighting is one of the most cost-effective options available to local government officials for reducing energy costs in their buildings.

Lighting is the single largest electricity user in commercial buildings. In 1990, lighting consumed 39% of the electricity used in U.S. commercial buildings. Local government officials looking for ways to save money should consider retrofitting their existing facilities with energy-efficient lighting. Of course, you may also realize greater savings by requiring use of energy-efficient lighting in new buildings. And don't overlook the savings you can achieve by retrofitting street lights for greater energy efficiency.

"Energy-efficient lighting is also inexpensive lighting," say Ronald J. Balon, P.E., Senior Energy Engineer with the Department of Facilities and Services in Montgomery County, Maryland. "Our studies show that the most efficient lighting option is also the least expensive option on a life-cycle cost basis. Our experience in Montgomery County shows that making buildings energy efficient requires more thinking, not more money."

Lighting contributes to electricity consumption both directly, by using electricity to power lights, and indirectly, by increasing cooling use. Considering both direct and indirect costs, lighting accounts for more than half of the electricity used in a typical large office building.

An energy-efficient lighting retrofit thus reduces both lighting and cooling costs. On hot summer afternoons, many utilities experience periods of increased demand for power to cool buildings, and the utilities charge customers a premium during these peak periods. A low-cost lighting retrofit is one strategy for reducing the amount of expensive peak electricity a building consumes.

AN INTEGRATED APPROACH

Lighting upgrades need not add to construction costs. According to Balon, "In Montgomery County, we build and renovate many office and community buildings each year and have demonstrated that highly efficient buildings can be built for no net increase in cost, compared with 'energy hog' buildings. In fact, we've achieved a first-cost reduction in many new buildings by using smaller air-conditioning equipment. The savings on cooling equipment more than compensates for the price premium we pay for high-efficiency lighting. It is possible to have the best of both worlds--lower first cost and lowest operating cost!"

The key to such impressive results lies in improving design strategies, encouraging better communication among the disciplines involved in the building or renovation project, and taking advantage of all the cost trade-offs (downsizing cooling equipment in new construction, for example).

Balon suggests working closely with lighting designers to assure that they use only recommended light levels. "Many designers still light up all areas to a uniform level of 75 or 100 footcandles," he explains. "In terms of energy, this approach leads to lighting wattage densities of 3 to 5 watts per square foot."

This level of lighting is not necessary for occupant comfort, and it can even be detrimental in offices where

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workers read video display terminals all day. Wattage densities in new and retrofitted buildings in Montgomery County generally fall into the range of 0.9 to 1.0 watt per square foot in new construction and 1.0 to 1.3 watts per square foot in renovations, and employees report that the light levels are quite adequate.

OTHER BENEFITS OF LOW-COST LIGHTING

Saving money on energy, although important, isn't the only advantage of an energy-efficient lighting retrofit. Saving energy reduces pollution from electricity generation. For example, replacing one 75-watt incandescent lamp with an 18-watt compact fluorescent lamp prevents the emission of 0.9 metric ton (1 ton) of carbon dioxide and about 9 kilograms (20 pounds) of sulfur oxide from a coal-fired power plant.

Efficient lighting systems that replace standard fluorescents also boast more accurate color and less glare, which may increase worker productivity. Studies have suggested that high-frequency lighting can reduce the incidence of eyestrain and headaches among employees. A lighting retrofit results in lower utility and maintenance costs, which can also raise the market value of a building and provide an edge in competitive leasing markets.

UTILITY INVOLVEMENT

Many utilities are helping their customers buy and install efficient lighting equipment as part of demand-side management (DSM) programs. This way of reducing electricity demand benefits the utility because it allows the utility to put off building expensive new power plants. Although a rebate wasn't available when the lighting retrofit program started, Montgomery County now receives one from the local utility for energy-efficient lighting improvements.

Rebates are a popular incentive among utilities promoting energy efficiency, but the Fitchburg Gas and Electric Light Company (FE&E) in Fitchburg, Massachusetts, took a different approach with its SUCCESS program. In 1989, a pilot program funded in part by the U.S. Department of Energy, clearly demonstrated that when the utility paid all costs, customer participation increased dramatically--from 4% when the utility offered a rebate to 73% when the utility covered all the costs. Even with the utility bearing all the expense of the program, the lighting program remained cost effective as a DSM tool.

Based on these results, FG&E utility holding company, Unitil, now funds 100% of the purchase and installation costs of energy-efficient lighting equipment. The offer is available to customers in FG&E's service area, which includes parts of Massachusetts and New Hampshire, whose monthly energy demands are 30 kilowatts or less.

Many utilities around the country have programs that are saving money for both their customers and the utility. A rebate from your utility can shorten the already impressive paybacks for investing in energy-efficient lighting. The local utility can also be a good source of information on designing and implementing lighting retrofits.

Energy-efficient lighting in new buildings or retrofits is a winning strategy. Local governments save a substantial amount of money in reduced energy costs, utilities reduce electrical demand (and the need to build expensive new power plants to meet that demand), and, when standard fluorescent lighting systems are replaced, employees enjoy adequate lighting without noise, flicker, and color distortion.

WHAT IS THE MOST EFFICIENT LIGHTING SYSTEM?

It depends partly on the specific application, but certain equipment is commonly found in effective lighting systems.

Energy-efficient fluorescent lamps, for example, save 15% to 20% of the wattage used by standard fluorescents (T12-type) and last just as long. Although the efficient lamps (T8-type) are more expensive than the T12 lamps, the energy savings more than compensate for the extra cost. T8 lamps are a popular choice to replace conventional T12 lamps, because they provide 98% as much light as do standard lamps and use about 40% less energy when installed with an electronic ballast.

When replacing standard fluorescents with efficient T8 lamps, it is necessary to replace the existing ballasts with **electronics ballasts**. Electronic ballasts operate at higher frequencies than do conventional electromagnetic ballasts, so these lighting systems convert power to light more efficiently. They also operate 75% more quietly than do conventional electromagnetic ballasts, eliminating the familiar flicker and hum of older fluorescent lights.

Electronic ballasts weigh up to 50% less than do electromagnetic ballasts, resulting in lower shipping

costs, easier handling in lower shipping costs, easier handling and installation, and less stress on ceiling supports. Electronic ballasts feature cooler operation than do conventional ballasts--electronic ballasts are 30 degrees C (54 degrees F) cooler than standard ballasts and 12 degrees C (22 degrees F) cooler than energy-saving electromagnetic ballasts. Cooler operation extends the lives of electronic ballasts and reduces the waste heat from the lights, which contributes to cooling costs.

In Montgomery County, lighting systems in both retrofit and new construction are equipped with T8 lamps and electronic ballasts. Simple payback, recovery on these improvements ranges from 6 months to 1 year.

In some situations, **specular reflectors** can increase the efficiency of a typical lighting unit by about 10 percentage points by reflecting additional light into the work space. Using specular reflectors makes it possible to remove half the existing fluorescent tubes with a minimal reduction in light levels. Retrofitting specular reflectors and reducing the number of lamps can decrease lighting costs by 50%. Specular reflectors installed with energy-efficient fluorescent lamps and electronic ballasts can reduce lighting energy costs by as much as 70%.

Although most lights in commercial buildings are fluorescent, incandescent light bulbs serve about 20% of commercial lighted floor space and account for nearly 40% of commercial lighting energy use. **Compact fluorescents** between 7 and 18 watts can be used to convert incandescents with 20 to 150 watts per fixture. Compact fluorescents last about 10 times longer than do incandescent bulbs. Lights that operate much of the time, such as hallway or stairwell lamps, are popular applications for these lamps.

Designers of Montgomery County's lighting retrofits found an even more efficient alternative to incandescent lamps for use in illuminated exit signs. New **Light-Emitting Diode (LED)** signs use only about 5 watts and last 20 years. The life-cycle cost of LED signs is about one-half that of a compact fluorescent lamp and about one-quarter of the life-cycle cost of an incandescent lamp.

Lighting controls can also play a role in saving energy. Manual controls should be used in spaces that accommodate different tasks or that have access to daylight, and occupants should be encouraged to shut lights off when they aren't needed. Automatic controls such as occupancy sensors are convenient for turning lights off when areas are unoccupied. Autodimming controls are coming on the market that automatically adjust light levels to existing daylight.

FOR MORE INFORMATION

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Ron Balon and his associates have developed a seminar designed to help other local governments save energy in their buildings.

Urban Consortium Energy Task Force
Public Technology, Inc.
1301 Pennsylvania Avenue, NW
Washington, DC 20004
(202) 626-2400

The UCETF works extensively with local governments to document and help share their experiences and represents an excellent information and technical assistance resource.

Rocky Mountain Institute
1739 Snowmass Creek Road
Snowmass, CO 81654
(303) 927-3851

Rocky Mountain Institute is a nonprofit group that seeks to foster the efficient and sustainable use of resources. It is also a good source of information on energy-efficient lighting.

Green Lights Program
U.S. Environmental Protection Agency
410 M Street, SW (6202J)
Washington, DC 20460
(202) 775-6650
Fax (202) 775-6680

Green Lights is a voluntary, EPA-sponsored program that encourages corporations and state and local governments to install energy-efficient lighting technologies.

EREC
P.O. Box 3048
Merrifield, VA 22116
(800) 523-2929

The Energy Efficiency and Renewable Energy Clearinghouse (EREC) is a service funded by the U.S. Department of Energy to provide general information on renewable energy and energy efficiency.

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The DOE Office of Energy Efficiency and Renewable Energy reaches out to the states and private industry through a network of regional support offices. Contact your DOE regional support office for information on energy efficiency and renewable energy technologies.

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