Facilities Tech Tips

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Shedding Watts While Shedding Light

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Highlights...

- Laws and executive orders require Federal facilities to reduce energy consumption.
- Many Federal facilities have incandescent lights or older fluorescent lamps.
- Replacing incandescent lights with compact fluorescent lamps and older fluorescent lamps with newer models can reduce energy consumption and save money over the long run.

Recent innovations in lighting technology provide many ways to reduce the electrical power used for lighting in office buildings and residences. This tech tip discusses several options for Forest Service facilities.

Benefits of Energy Conservation

Saving power used for lighting helps reduce greenhouse gas emissions. During 2003, most of the electricity generated in the United States came from coal-fired plants. Natural gas-powered generators ranked third in power sources. Reducing the demand for electricity helps reduce carbon dioxide emitted by powerplants using carbon-based fuels, such as coal and natural gas.

Upgrading lighting technology also helps meet the requirements of the Energy Policy Act of 2005 (Public Law 109–58) and Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management." The executive order mandates a 3-percent annual energy reduction in Federal buildings through the end of fiscal year 2015. Because lighting typically represents a large share of the energy consumed at a facility, a lighting upgrade can cover much of the energy reduction target.

Energy cost savings will depend on local electric utility rates and the increase in efficiency when installed lighting is replaced by updated lighting. Newer models of fluorescent lamps and ballasts can yield energy savings of 20 percent. Adding controls that turn lights off when they are not needed can generate larger savings.

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What Type of Lights Do You Have Now?

Different types of facilities rely on different kinds of lighting technologies. Residential facilities usually have more incandescent lights than fluorescent lamps. Offices and meeting rooms typically have fixtures for tubular fluorescent lamps. Recessed "can" lights (figure 1, also known as downlights) and spotlights are common in reception and display areas. Large work areas may have high-intensity discharge lamps or halogen task lighting.

The age of a building or the date of its last renovation provides clues about the lighting technology that was installed. Most buildings constructed during the last third of the 20th century use 1½-inch diameter (T12) fluorescent lamps with magnetic ballasts. Replacing T12 lamps with 1-inch diameter (T8) or ⅝-inch diameter (T5) lamps (figure 2) and electronic ballasts typically reduces power consumption by at least 20 percent. Efficient design of the fixture's housing also can increase light output. T8 lamps with electronic ballasts may last more than 50 percent longer than T12 lamps with magnetic ballasts; T5 lamps are slightly more efficient than the T8 lamps.

Figure 1—A 16-watt CFL floodlight on the left. A 65-watt incandescent floodlight on the right.

Incandescent A-lamps (standard screw-in light bulbs) are relatively easy to replace with compact fluorescent lamps (CFLs). CFLs generally screw into A-lamp sockets and use only one-fourth as much power when generating the same amount of light as the incandescent lights they replace. Because the CFLs last about 10 times longer than incandescent lights, the energy cost savings will more than cover the cost of replacement. CFLs have a difficult time starting when temperatures are below freezing, but otherwise have major advantages over incandescent lights.

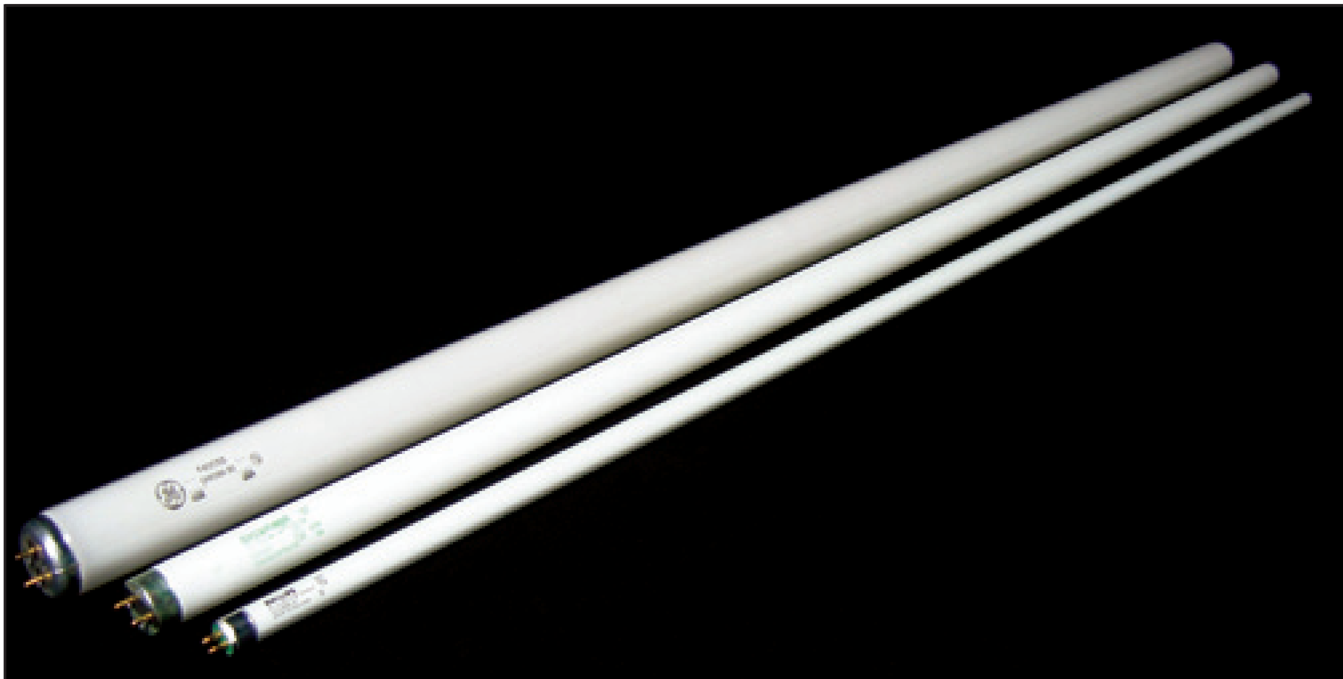

Figure 2—Fluorescent lamps from top to bottom: T12 (oldest, least efficient), T8, and T5 (newest, most efficient) lamps.

Cautions When Using Compact Fluorescent Lamps

CFLs in the 13- to 15-watt power range usually are no larger than the 50- to 60-watt incandescent lights they replace. The ballast housings on larger CFLs may prevent them from seating fully in some lamp sockets. The tubes may be too large to fit inside some enclosed fixtures. You may need to experiment before coming up with compatible retrofits.

Most CFLs won't function properly with a dimmer circuit. Dimmer-compatible CFLs are available (check the information on the packaging), but they cost more than standard CFLs. Using a CFL that is not designed for dimmers in a circuit with a dimmer can shorten its life significantly.

How Much Can You Save?

The cost savings from lighting upgrades depends on the electric utility rates. Some literature cites 8 cents per kilowatt-hour as a typical rate. To put this into perspective, a small office with two dual 40-watt T12 lamps would consume 160 watts when the lights were on. That adds up to 1.28 kilowatt hours for each 8-hour workday. Assuming that the office is occupied 240 days, lighting would use 307.2 kilowatt hours of power each year. The annual bill would be $24.58, based on electricity costing 8 cents per kilowatt-hour.

Converting the lighting fixtures in the example above from T12 to T8 lamps with electronic ballasts would save about $5 per year without further enhancements. If the T8 fixtures have three lamps with user controls to allow one, two, or three lamps to be illuminated, the savings could be significantly greater. If the room was equipped with an occupancy sensor (figure 3) that turned the lights on and off automatically, the power costs could be reduced further.

While the costs of converting from T12 to T8 lamps can take many years to recover through energy savings, occupancy sensors have a much quicker return on investment. These sensors, which cost about $50 each, are especially effective in restrooms, stock rooms, and offices that are occupied by only one person.

Not all fluorescent lamps are manufactured to high standards. One measure of quality is the color rendering index (CRI), an indication of the spread and relative intensity of colors emitted from the lamp. The U.S. General Services Administration (GSA) specification in "Facilities Standards for Public Buildings" (P100) calls for a minimum CRI of 80; higher is better. Sticking with well-known brands and checking consumer product reviews are ways of avoiding poor-quality or short-lived lamps.

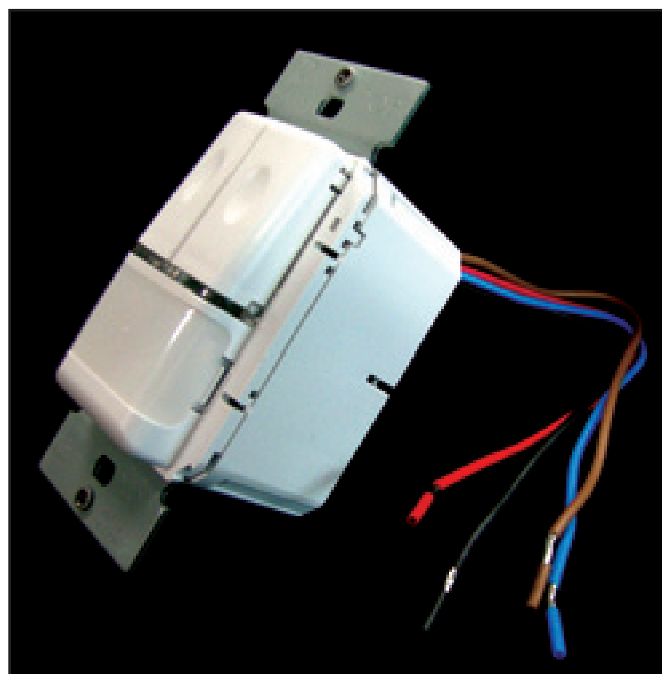

Figure 3—Two models of occupancy sensors.

Commissioning and Disposal

Installation work performed by an electrical contractor should include time for commissioning the new devices. Occupancy sensors, in particular, go through a calibration process—some have a “learning mode,” while others have user settings. Sensors should be checked for satisfactory operation after a “getting acquainted” period.

Fluorescent tubes contain mercury. You can save some headaches if you switch to low-mercury tubes when upgrading lamps or fixtures. Low-mercury lamps have green end caps (figure 4) or green lettering on the lamps. Low-mercury lamps can be disposed with ordinary trash; check with local authorities on disposal regulations. Other fluorescent lamps are considered “universal waste” and have special disposal requirements.

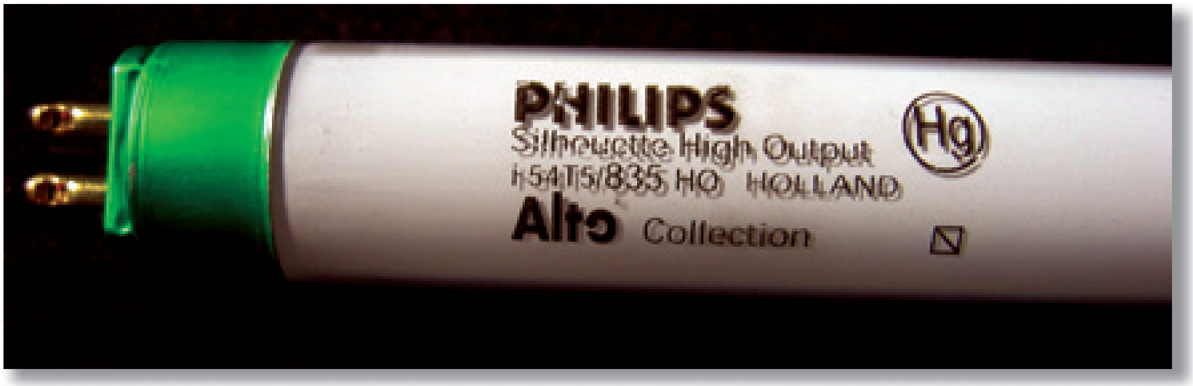

Figure 4—A low-mercury T5 fluorescent lamp with a green end cap indicating that this lamp can be thrown out in ordinary trash.

Building Specifications

The power consumed by lighting in older facilities may exceed the specifications for new buildings in 10 CFR, Part 434, “Energy Code for New Federal Commercial and Multi-Family High Rise Residential Buildings.” The specifications also apply to building additions or substantial renovations. More conservative GSA standards (P100) specify electrical loads of 1.3 watts per square foot for lighting in open offices and 1.5 watts per square foot in closed offices. Some States have tighter specifications, such as Washington’s specification of 1 watt per square foot.

The specifications for electrical loads used for lighting vary with the space’s use as well as the jurisdiction. The ultimate goal is to provide enough illumination for designated tasks. For offices, illumination of about 50 foot-candles is sufficient; less illumination is needed if task lighting is provided. The energy needed to provide that illumination depends on the efficiency of the lamp(s), the color of the walls and ceiling, the lighting fixture or luminaire, and the distance between the lamp and the work surface. With light-colored walls and ceilings and using the current technology in fluorescent lamps, the 50 foot-candle target can be met using about 1 to 1.2 watts of electrical power per square foot of office space.

Upgrade or Replace?

Replacing incandescent lights with CFLs should be automatic; the labor saved in less frequent bulb replacements adds to the savings from reduced energy costs. Incandescent lights are more suitable than CFLs in areas where lights are turned on and off frequently in freezing conditions.

Occupancy sensors also may be an energy-saving option, depending on a building's size, function, and architecture. The appropriate type of occupancy sensor varies with the size of the space. Photo sensors can turn off interior lights when windows and skylights are providing enough illumination. Options for lighting controls are discussed in the report "Incrementally Greener—Improving Sustainability Through Operations and Maintenance" (0673–2843–MTDC). Another resource is the "Lighting Retrofit Workbook: A Practical 'How To' Guide for the National Park Service Visitor Centers" (*http://ateam.lbl.gov/PUBS/doc/NPS_guidebook.pdf* 7.7 megabytes).

While it may take many years to recover the cost of replacing a T12 lamp system with a comparable T8 or T5 system, the age of the existing system is a major factor when considering the options. Energy-saving ballasts are available for T12 lamp systems that can make them nearly as efficient as T8 lamps. A ballast retrofit costs about $35 ($30 for the ballast and $5 for lamps), plus the labor for installation.

Plastic covers (figure 5) for fluorescent lamps become less transparent over the years. If the ballasts and lamps also are due for replacement, the additional cost of a new fixture or plastic cover may nearly equal the replacement costs. New fixtures tend to cost between $150 and $250, depending on their size and the number of lamps and ballasts.

The prices cited above are based on GSA sources. Less expensive components frequently are available through other outlets.

Figure 5—A fluorescent lamp with a luminaire that needs to be cleaned or replaced.

Mixing the Old With the New

In workshops and restrooms, incandescent lights and fluorescent lamps (figure 6) coexist well. Maintaining a few incandescent lights in the mix provides instant illumination when the light switch is turned on. The fluorescent lamps activate a second or two later, and take a minute or so to reach full brightness.

For outside lighting, light selection depends on the application. Motion-activated lights need to turn on immediately. Incandescent lights may be more suitable than CFLs for this application. Lights that are left on continuously should be fluorescent. Several manufacturers of CFLs say their lamp ballasts are effective to at least –20 degrees Fahrenheit. The lamps take a couple of minutes to reach full brightness in cold temperatures but stay bright once they've warmed up.

Some lamps using an array of light-emitting diodes (figure 7) are available in several form factors, including that of incandescent floodlamps. While LED lights are very expensive now, their light output efficiency is comparable to CFLs and they start instantly in cold temperatures. Their expected lifespans may be up to 50,000 hours, so they have special value in locations that are difficult to service.

Figure 6—A vanity light fixture with one incandescent light bulb and two CFLs. The incandescent bulb will provide light while the two CFLs are warming up.

Figure 7—A minispiral CFL, an LED floodlamp, and an LED bulb.

Conclusions

Using the guidelines from this tech tip and related documents, facilities engineers and supervisors can identify opportunities for improving lighting while reducing energy consumption and meeting new energy standards.

The following Web sites will help you locate sources of fluorescent lamps and determine the appropriate sizes of fluorescent lamps:

- *http://www.energystar.gov/index.cfm?c=cfls.pr_cfls*
- *http://www.eere.energy.gov/femp/procurement/eep_fluor_tips.html*
- *http://www1eere.energy.gov/femp/pdfs/pseep_cfl.pdf*

About the Author

Ted Etter joined MTDC in 2002 as an electronics engineer and project leader. He has 20 years of experience working for private industry in the design of test equipment, display devices, and medical instrumentation. In the 6 years before he joined MTDC, he taught courses in the electronics technology program at the University of Montana College of Technology, Missoula. His work at MTDC includes projects in wireless communications, alternative energy sources, instrumentation, and process control. Ted has a bachelor of arts degree in mathematics from the University of Oregon and a master's degree in teacher education from Eastern Oregon State University.

Library Card

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This tech tip discusses opportunities for facilities engineers and supervisors to improve lighting while reducing energy consumption and meeting new energy conservation standards for Federal facilities.

Keywords: CFLs, compact fluorescent lamps, energy conservation, facilities, fluorescent lamps, fluorescent lights, lighting, occupancy sensors, offices, retrofitting, specifications, T5, T8, T12

Additional single copies of this document may be ordered from:

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