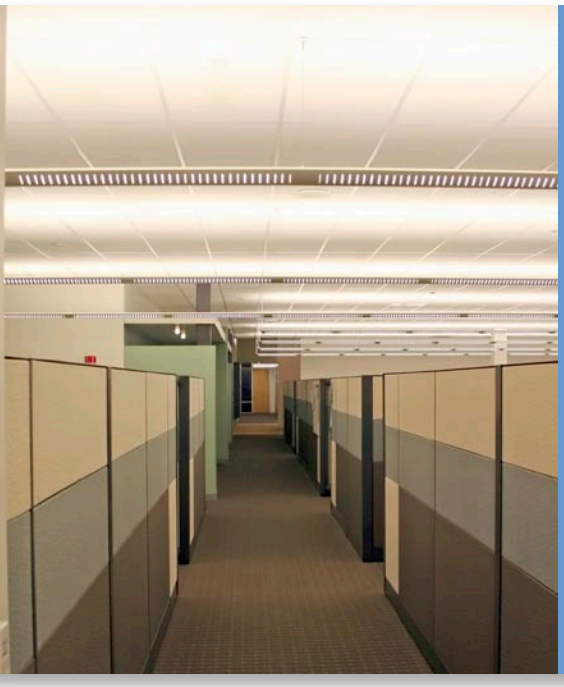
APS Solutions for Business



Energy Answers for Lighting

Lighting plays a critical role in business operations—from highlighting products to illuminating employee functions to ensuring safety. It also comprises a significant portion of the typical electricity bill—from 42% for small offices to 55% for small retail buildings in Arizona. Nationally, commercial buildings account for half of all lighting electricity use. The good news is that lighting upgrades are relatively simple and cost-effective. Reducing waste heat from inefficient lights can also reduce your cooling and/or refrigeration load. This fact sheet provides an overview of common lighting types and strategies for improving efficiency. It also lists resources for more detailed information.

Lighting 101: Terminology

When evaluating and procuring lighting systems, it's important to understand these basic terms.

Lamp is a general term for light bulb, fluorescent tube or other light source.

Light fixture, or luminaire, is a system of components designed to direct light efficiently while providing a high level of visual comfort.

Lumen is a measure of the amount of light delivered by a lamp. The higher the lumen rating, the greater the light output.

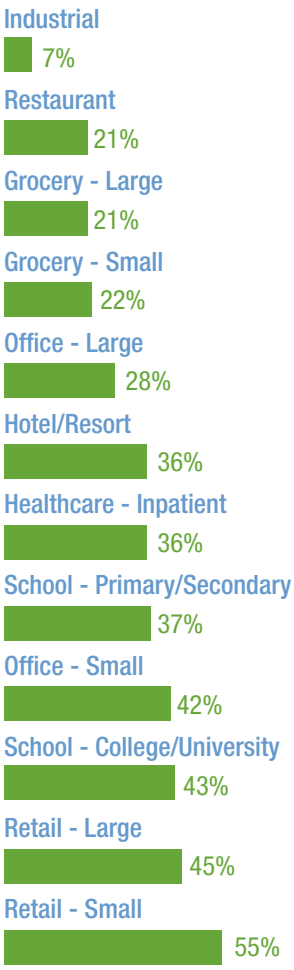
Ballast is the black box on fluorescent fixtures that changes the characteristics of the electric current to make the lamps function. Older magnetic ballasts are much less efficient than the newer electronic ballasts. Electronic ballasts also reduce hum and flicker in fluorescent fixtures.

Color Rendering Index (CRI) measures the ability of a light source to accurately reveal the true colors of objects. The CRI is a relative scale from 1 to 100 with 100 being the daylight standard. Standard incandescent and tungsten–halogen lamps have a CRI close to 100, while compact fluorescent and tubular fluorescent typically deliver 80-85 and 50-90 CRI respectively. Lamps with a higher CRI make people and objects appear more natural and bright.

Color temperature of lamps, measured in degrees Kelvin (° K), refers to the relative warmth or coolness of their light color. The higher the color temperature, the cooler the light source. Lamps with a color temperature of 3500°-4100° K are considered effective for typical applications.

Efficiency is commonly measured as mean (average) lumens per watt, which is the amount of light delivered for each watt of electricity used. Lamp lumens depreciate over time so it is important to use average or mean lumens when designing a lighting system. The efficiencies of each type of light source can vary dramatically, so the choice of light source can have a dramatic impact on lighting energy costs.

Fig. 1 Exterior & Interior Lighting, Percentage of Total Electricity Use



Lighting 201: Types

CFLs come in a variety of types and sizes. They work in diverse applications and last nearly 10 times longer than incandescent lamps.

Light sources vary considerably in performance and features and it's important to match the right light to each task. You can compare the options by considering factors such as light output (lumens), efficiency, lamp life, and color rendering properties.

Incandescent: The screw-in "A" lamp is the most common and most inefficient light source. About 15 percent of the energy consumed by an incandescent lamp is converted to light—the rest is emitted as heat, adding to your cooling load. While inexpensive to purchase their relative inefficiency and short life spans make them expensive to operate. However, they produce a pleasant color that is similar to natural sunlight.

Tungsten-halogen lamps are a type of incandescent lamps. They produce a whiter, more intense light than standard incandescents and are typically used for decorative, display or accent lighting. Halogen spotlights also have good focusing ability in small areas. They are about twice as efficient as regular incandescent lamps and last two to four times longer.

Compact fluorescent lamps (CFLs) are an efficient alternative to screw-in incandescents: they are about four times as efficient and last up to 10 times longer than incandescent lamps. CFLs are available in a range of types and sizes to meet most applications including downlighting, ambience, task and general space lighting. Some are dimmable. ENERGY STAR®-qualified CFLs come in a wide range of color temperatures and lumen outputs to match your lighting needs.

Pin-base CFL systems, common in commercial buildings, feature a ballast and pin-base fluorescent lamp socket that is wired into a fixture by the fixture manufacturer or as part of a retrofit kit. Because they are hardwired, dedicated systems, they eliminate the possibility that a user will return to using an inefficient incandescent bulb.

Tubular fluorescent lamps are common in overhead fixtures in commercial buildings. They are installed in a dedicated fixture with a built-in ballast, either a less-efficient, traditional magnetic ballast or more-efficient electronic ballast. Lamps are identified by the tube diameter in eighths of an inch T12 (1.5 inch), T8 (1 inch), and T5 (5/8 inch). T12s lamps and magnetic ballasts are the oldest and least efficient type; they are also found in about 50% of commercial buildings. These lamps often can be cost-effectively retrofitted with T8 lamps and electronic ballasts. Look for lamps with CRI in the 80s for good color rendering and higher mean lumens per watt.

QUICK TIP

The amount of light impacting a surface is measured in foot candles. Foot candles can be measured with light meters available at photography stores and on the Web.

High-intensity discharge (HID) light sources include (from least to most efficient) mercury vapor, metal halide, high pressure sodium and low-pressure sodium lighting. HID lights require a ballast for proper lamp operation. Color rendering varies widely from the bluish cast of mercury vapor lamps to the distinctly yellow light of low-pressure sodium.

On the Horizon

Advanced lighting research is bringing innovative new technologies to the market. Here are a few to watch for in the coming years.

Cold cathode lamps work much like neon lighting, but are up to five times brighter. They do not get hot and have long life spans at about 50,000 hours. They are mainly used in decorative and specialty lighting but are being developed for more mainstream applications.

Solid-state lighting creates light without producing heat. A semi-conducting material converts electricity directly into light, which makes the light very energy efficient. Light-emitting diodes (LEDs) and organic light-emitting diodes (OLEDs) are two types of solid-state lighting.

Colored LEDs are widely used in exit signs and other indicator applications. White LEDs are available in small applications (e.g., under desk lamps). LED technology is being improved to create a brighter, more efficient white LED light that can be used in a wide variety of applications. So stay tuned!

Lighting 301: Energy Reduction Strategies

When prioritizing lighting upgrades, look first at the systems that run the longest. High-use lights are likely to be the most cost-effective to change. Older fixtures also make good candidates. If you are relamping or replacing several fixtures, consider the entire system.

Turn It Off

The easiest and most obvious way to save is by turning off lighting when it's not needed. Make the task easier by installing automated controls.

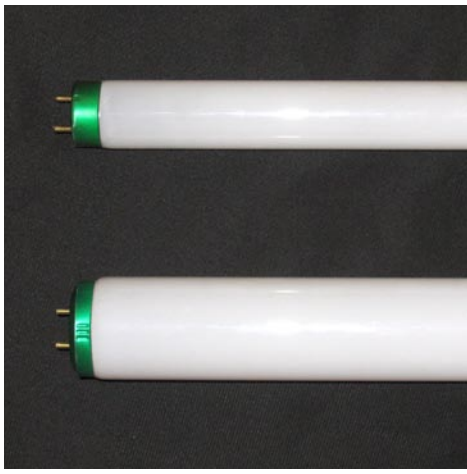
Get Something for Nothing

Save money without spending a penny. In many offices and corridors, two lamps in a four-lamp overhead fixture can be removed while maintaining appropriate light levels. This cuts the electricity use by nearly half.

Take Control

Control over the indoor lighting environment is important for both energy efficiency purposes and occupant comfort and productivity. Automatic lighting controls switch or dim lighting based on time, occupancy, lighting-level strategies, or a combination of all three.

- Dimmer switches can be installed on fixtures designed to be dimmed. Use with lamps that specify "dimmable."
- Bi-level switches have two switches: one switch controls two lamps and a second controls the third lamp in a 3-lamp fluorescent fixture. This strategy enhances occupant control over the lighting environment.
- Timers adjust light levels based on a programmed schedule. They work well in areas with predictable usage, such as exterior lighting.
- Occupancy sensors detect occupant motion and automatically turn lights on or off. They are suited for infrequently used areas such as bathrooms, storage areas, and janitorial closets. In partitioned areas, use ceiling-mounted ultrasonic sensors, which can detect motion over cubicle walls. There are different types of occupancy sensors to meet a variety of applications. Occupancy sensors can save up to 40% of lighting energy use.
- Daylighting with photocell controls uses natural sunlight to supplement or replace indoor artificial light when there is enough light from windows or skylights. Daylighting is easily incorporated into new designs at little or no cost. It should be considered when remodeling or expanding a building.
- Energy Management Systems (EMS) can handle a variety of loads, including HVAC, or purely control lighting. An EMS can significantly reduce energy use in buildings where lights are left on when not needed. It also can be used to dim the lights during periods of high power demand. A common EMS feature is a sweep mode that automatically cycles lights on or off, one section or floor at a time, signaling occupants that lights will soon be shut off. Occupants can then override the shutdown in their area by pressing a local switch or by phoning in a code to the EMS



Businesses that retrofit T12 lamps (bottom) with more-efficient T8 lamps (top) dramatically reduce electricity use and the waste heat emitted by inefficient lamps.

Can We Help?

APS offers incentives for qualified efficiency measures. Learn more about the Solutions for Business program at aps.com

QUICK TIP

More isn't always better. It is common to have more light than is needed. If that's the case, removing some of the lamps from the fixtures, changing to lamps with lower lumens or using task lighting can reduce operating costs and still give acceptable light levels.

Make the Switch

QUICK TIP

Your lighting upgrade and group relamping activities will likely produce lamp waste, some of which may be hazardous. Check aps.com for a list of appropriate disposal locations.

Lighting upgrades typically have short payback periods. When you upgrade to more efficient products, you save money on your lighting energy bills and reduce your cooling load by cutting the heat emitted by inefficient lamps. When installing new lights you should maximize the efficiency of the lamp and ballast. Consider the following strategies.

- Install ENERGY STAR qualified CFLs in place of incandescent lamps. By changing one incandescent bulb that burns 6 hours a day with an ENERGY STAR qualified CFL, you can save $9 on electricity and $3 on maintenance costs each year.
- Replace T12 fluorescent lamps and magnetic ballasts with T8 fluorescent lamps and electronic ballasts and reduce lighting energy use by 30%. Save even more with premium T8s.
- Save $20 per year for each incandescent exit sign you replace with an ENERGY STAR qualified model.
- Replace high intensity discharge (HID) lights in high bay systems (often in gyms and auditoriums) with T5 high output (HO) lamps and fixtures to cut lighting energy use by almost 50%.

Lighting 401: Aim to Maintain

Maintenance expenses rival utility costs in total building operating budgets. Installing efficient lighting will reduce trips up the ladder for replacement, but it will still require some attention. Group relamping schedules the replacement of lamps at their maximum economic value, generally at about 70% of their calendar life. Though it means replacing lamps before they expire, it dramatically reduces the time spent replacing each lamp, which can reduce your overall lighting maintenance budget by more than 25%.

Another major operating expense is the cost of cleaning lamps and fixtures. All lighting fixtures accumulate dirt on the lamps, reflective surfaces, lenses and diffusers. This build-up can significantly degrade the light output. The best time to schedule cleaning is during relamping.

Recommended Resources

APS: Solutions for Business, Energy Survey and "Ways to Save" Technology Fact Sheets
aps.com

ENERGY STAR: Find qualified products and partner resources. Reference the chapter on lighting in the Building Upgrade Manual.
www.energystar.gov

FEMP's Federal Lighting Guide provides guidance for retrofit projects and lists detailed maintenance tips.
www1.eere.energy.gov/femp/pdfs/fed_light_gde.pdf

New Buildings Institute, Advanced Lighting Guidelines
www.newbuildings.org/ALG.htm

Track Your Success

Do you know how much electricity your facilities consume? Do you know how much you could save? The answers to these questions will help you to identify your most cost-effective, energy-efficiency improvements and to track the return on your investment. APS and ENERGY STAR have tools that can assist your efforts.

APS' Energy Information Services (EIS) provides a quick-read summary of all the information you need to manage your energy budget. You may even qualify for an incentive from the Solutions for Business program to upgrade your meter and participate in this service.

ENERGY STAR's Portfolio Manager can help you track and assess energy consumption within individual buildings or across your entire building portfolio. Use the Target Finder to establish an energy performance target for design projects and major building renovations.

The APS Solutions for Business program is funded by APS customers and is approved by the Arizona Corporation Commission.