ENERGY-EFFICIENT LIGHTING

ENERGY Answers for Business

The quality and quantity of lighting affects the ambience, security and function of your facility as well as the performance of your employees. Lighting costs vary from about $0.35/ft^2/year for schools to over $1.00 for some restaurants. Overall, lighting typically accounts for about one-third of the annual commercial business electric bill. The chart on page two will give you an idea of how much it costs to light different kinds of commercial buildings.[1] Advances in lighting technology can make significant reductions in the amount of money you spend to light your space or building.

Different Types of Lighting

While fluorescent lighting is the most common type of general purpose lighting found in commercial settings, a wide range of options are available.

Incandescent – Incandescent lamps have relatively short lives (typically 1000 to 2000 hours of use) and are the least efficient of common light sources. In fact, only about 15 percent of the energy they use comes out as light – the rest becomes heat. However, they produce a pleasant color that is similar to natural sunlight. Incandescent lamps are the least expensive to buy but the most expensive to operate. Reduced-wattage incandescents produce about the same light output but consume less energy than standard bulbs.

Tungsten-halogen – Halogen lamps are a type of incandescent lamp that has become increasingly popular in recent years. 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 than most incandescent lamps.

Compact Fluorescent Lamps – Compact fluorescent lamps (CFLs) are similar in operation to standard fluorescent lamps but are manufactured to produce colors similar to incandescent lamps. They are available

Fluorescent Ballasts

Fluorescent ballasts are devices that control the starting and operation of fluorescent lamps. The lamps and ballast form a system and their overall performance is a function of the lamp/ballast combination. (Note: HID lamps also require a ballast for operation). Common types of fluorescent ballasts include:

- **Standard electromagnetic** – The standard ballast for many years accounting for the majority of currently installed ballasts. As of 1992, standard efficiency ballasts for four-foot and eight-foot lamps are no longer available due to federal minimum efficiency standards.
- **Energy-saving electromagnetic** – Energy-savings electromagnetic ballasts for four-foot and eight-foot lamps that are about 10 percent more efficient than the old standard electromagnetic ballasts. Electromagnetic ballasts must now meet federal minimum efficiency standards.
- **Fixed-output electronic**– Fixed output electronic ballasts with standard lamps are about 20 percent more efficient than energy-saving electromagnetic ballasts, and electronic ballasts with new T8 lamps are about 30 percent more efficient. Early problems with electronic ballasts have been corrected and they are now the industry standard in most applications.
- **Multi-level output electronic** – Multi-level electronic ballasts are able to be switched between different set levels of full light output such as off, 50 percent or 100 percent of full light output.
- **Adjustable output dimming electronic**– These ballasts allow continuous adjustment over a range of about 10 percent to 100 percent of light output.

[1] APS study of energy use in 14 different types of commercial buildings in the Phoenix area.

APS

in a range of types and sizes to meet most applications including downlighting, ambience, task and general space lighting. CFLs are about four times as efficient as incandescents and last up to 10 times longer. Lamp ballast combinations that replace incandescents in standard fixtures are substantially more expensive than their incandescent counterparts.

Tubular fluorescent fixtures – Tubular fluorescent lamps are one of the most common sources of commercial lighting and also are among the most efficient. The new generation of small diameter lamps (T-8 and T-10) is particularly efficient. It is important to understand that lamps and ballasts work as a system and the overall efficiency of a lighting fixture is dependent on the lamp/ballast combination. Traditional magnetic ballasts are less efficient than modern electronic ballasts. All ballasts are now required by the government to meet minimum efficiency standards. Fluorescent lamps last up to 20,000 hours of use.

High-intensity discharge (HID) – This category of high output light sources that includes mercury vapor, metal halide, high-pressure sodium and low-pressure sodium lighting. As with fluorescent lights, HID lights require a ballast for proper lamp operation. The efficiency of HID sources varies widely from mercury vapor – with an efficiency almost as low as incandescent – to low-pressure sodium which is among the most efficient light sources. Color rendering varies widely from the bluish cast of mercury vapor lamps to the distinctly yellow light of low-pressure sodium.

Annual Lighting Electricity Costs

Building Type	Annual Cost Per Square Foot
Large Office	$0.50
Small Office	$0.45
Large Retail	$0.60
Small Retail	$0.45
Sit-down Restaurant	$0.60
Quick-Service Restaurant	$1.10
Large Grocery	$0.90
Small Grocery	$0.80
In-patient Healthcare	$0.70
Out-patient Healthcare	$0.45
Primary School	$0.35
Secondary School	$0.35
College/University	$0.40
Hotel/Resort	$0.45

Characteristics and Efficiency of Different Light Sources

The performance and features of a light source needs to be matched to the lighting task being performed. In order to select the right light source for the job, you should consider important performance variables such as light output (Lumens), efficiency (Lumens/Watt – technically referred to as "efficacy"), lamp life, and color rendering properties measured in terms of the Color Rendering Index (CRI). The CRI is a measure of the degree to which a light source renders colors that are close to true color. For practical purposes it is a number from 0 to 100; the higher the number, the closer to true color. 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. The performance characteristics and efficiencies of common light sources are shown in the table and chart below.

Characteristics of Common Light Sources[2]

Light Source	Efficiency (Lumens/Watt)	Average Lamp Life (Hours)	Color Rendering Index
Standard Incandescent	5-20	750-1000	100
Tungsten-Halogen	15-25	2000-4000	100
Compact Fluorescent	20-55	10,000	80
Tubular Fluorescent	60-100	15,000-24,000	50-90
Mercury Vapor	25-50	Up to 24,000	15-30
Metal Halide	45-100	10,000-20,000	60-90
High Pressure Sodium	45-110	Up to 24,000	9-70

[2] *Lighting Fundamentals Handbook*, EPRI, 1992.

Cost Comparison of Incandescent and Fluorescent Lamps[3]

Lamp Type	Energy Costs	First Cost	Maintenance Costs
Incandescent	Much Higher	Lower	Higher
Fluorescent	Much Lower	Higher	Lower

Lighting Control Strategies

Control of lighting systems ranges from the most basic and familiar manual wall switch to sophisticated computer control lighting management systems. Modern advances on occupant sensing and daylighting add additional cost-effective options for managing lighting systems. Forms of automatic lighting control include:

- **Time clocks and photocells**, simple, reliable and cost-effective methods of controlling lighting systems.
- **Occupancy sensors**, sound and heat-sensing technology used to detect the presence of people in a space and turn lights off when spaces are unoccupied. They include delays and logic systems to avoid false or too frequent turning off of light fixtures.
- **Dimming technologies** include common manual dimming switches as well as more sophisticated technology that automatically reduce light output according to the availability of daylight or other ambient light. While dimming of incandescent lamps is common, dimming of fluorescent fixtures can only be accomplished if they have ballasts designed specially for dimming applications.
- **Daylighting controls** adjust light output levels from fixtures in perimeter areas next to windows or under skylights in response to natural outdoor light entering the building. Daylighting controls are available in continuous dimming and stepped reduction models.
- **Automated lighting management systems** provide centralized computer control of lighting systems.

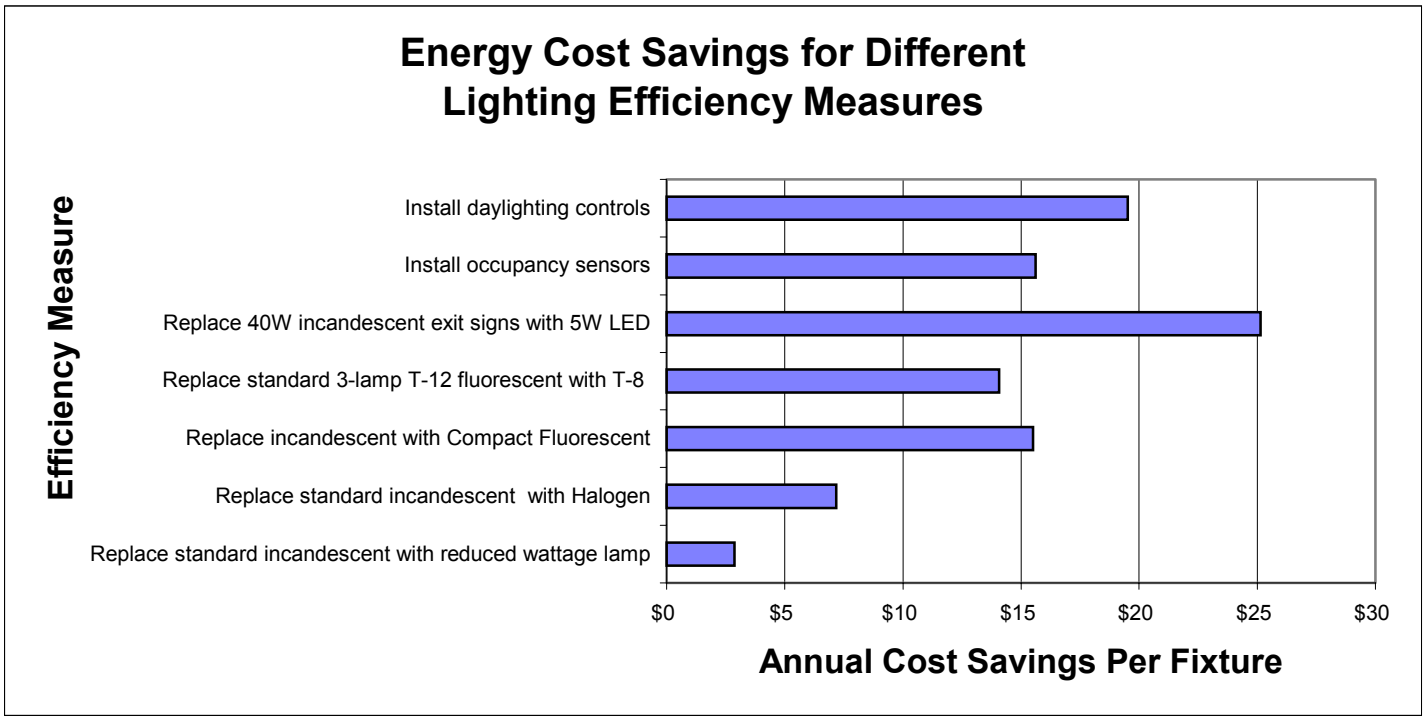
Saving Money on Your Lighting Bill

There are many cost-effective ways to save on your lighting energy bill. Several effective energy efficiency measures are discussed below and the accompanying chart provides estimates of annual energy cost savings.

1. Replace standard incandescent with reduced wattage	• Replace standard wattage lamps with energy saving reduced-wattage lamps with about the same light output. • For example, replace a standard 100 Watt with an energy savings 90 Watt lamp.
2. Replace standard incandescent with Halogen	• Halogen lamps are about twice as efficient as standard incandescent lamps. With their brighter, more focused light, you can replace a high wattage incandescent with a low wattage halogen. • For example, replace a 150 Watt standard incandescent with a 30 to 60 Watt halogen.
3. Replace incandescent with compact fluorescent	• Compact fluorescent lamps and fixtures use about a quarter of the energy of incandescents. • For example, replace a standard 75 Watt downlight with a CFL that uses only about 20 Watts. • If you are constructing a new building or doing a major renovation of an existing one, use recessed fixtures with dedicated CFLs.
4. Fluorescent lamp replacement or removal	• Many older buildings are significantly over lighted. In some cases you can remove lamps and disconnect ballasts and still have excellent light quality. In other cases, simply replacing standard wattage lamps with energy saving lamps can be an effective savings measure
5. Replace magnetic ballasts with electronic	• Replace old, inefficient magnetic ballasts with new, high-efficiency electronic ballasts. • Often this process includes retrofitting fixtures with high-efficiency T-8 lamps.

[3] Energy Star Small Business Guide, U.S. EPA, 1997.

6. Replace incandescent exit signs with CFL or LED	• Incandescent exit signs consume about 40 Watts while CFL signs consume only about seven Watts and LED signs only about one Watt. • Exit signs operate 24 hours-per-day, 365 days-per-year. With year-round operation and the numerous signs that exist in many buildings, significant savings can be achieved.
7. Install occupancy sensors	• Many spaces such as individual offices, conference rooms, storage areas and rest rooms are unoccupied during large portions of the day. • Occupancy sensors that detect the presence of people and turn lights off during unoccupied periods can result in lighting energy cost savings of 25 to 75 percent.
8. Install daylighting controls	• Use daylighting controls to reduce lighting energy costs in perimeter areas of a building next to windows and in open bay areas with natural overhead light provided by skylights. • Properly designed and installed, they can reduce energy use by 40 percent or more and are an excellent means of reducing peak loads on the building's electric system.



For More Information on Energy-efficient Lighting

Contact the web sites of the Illuminating Engineers Society, the U.S. Department of Energy's Energy Efficiency and Renewable Energy Network, and the U.S. Environmental Protection Agency's Energy Star Buildings Program.

For general information regarding electric service for your business, call the APS Business Center at 602-371-6767 or 1-800-253-9407. For an online analysis of your business energy use, visit the APS Web site and take the Energy Survey at http://www.aps.com/aps_services/energysurvey/Default_BUSRES.html?type=b