An FPL Technical Brief

Lighting

In Florida, lighting accounts for up to 10 percent of the electric bill for the average home and up to 35 percent of the electricity used in some businesses. Inefficient lighting also places an undue burden on air-conditioning systems. By combining effective design with efficient technologies, we can help you achieve the best lighting performance and energy savings. Systems with efficient light sources, fixtures, and controls can reduce lighting energy use, improve the visual environment, and reduce the energy use and size of HVAC and electrical systems. This Lighting Tech Brief outlines the pros and cons of various energy-efficiency measures and is designed to serve as a quick reference guide for everyday use.

Keep these general guidelines in mind when designing or upgrading a lighting system:

- Design the system to get the right amount of light for the tasks to be performed.
- Distribute that light to prevent glare.
- Use daylight when possible and install controls to reduce the use of electric lights in response to available daylight.
- Use the most efficient light source for the application.
- Use automatic controls to turn lights off or dim lights as appropriate.
- Plan for and carry out the commissioning of all lighting systems to ensure that they are performing as required, and create a schedule for periodic retro-commissioning.
- Include a comprehensive plan for group relamping, fixture cleaning, and proper disposal of old lamps and ballasts.

Use efficient light sources

Daylight is the most efficient source of light and therefore good to use when it's available. In addition, a variety of lamps are available to use for energy-efficient upgrades. Linear fluorescent lamps are the most widely used, but each type has applications in which it can be an effective choice (Table 1, next page).

Daylighting

Systems that use daylight to supplement electric lighting can cut energy use, reduce peak demand, and create a more desirable indoor environment. However, it takes careful planning to achieve all of the possible benefits. Savings can range from 30 to 80 percent of lighting energy use. For more information on daylighting, please visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Lighting, and then Daylighting Controls).

Linear fluorescent Lamps

Fluorescent lighting systems offer high efficacy, long life, and good light quality. They are the best choice for general lighting in commercial, institutional, and industrial spaces with low to medium ceiling height. Fluorescent systems have also become a leading choice for areas with high ceilings (more than 15 feet)—the type of application that used to be the exclusive domain of high-intensity discharge (HID) light sources. For more information on high-bay lighting, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Lighting, and then HID Versus Fluorescent for High Bay Lighting).

Lamps. Modern fluorescent lamps come in T8 and T5 versions, with the number referring to the lamp diameter in eighths of an inch. The most efficient T8 lamps are the high-performance type, also commonly called "super T8s." They can be installed to replace T12 lamps and lower-quality T8s. High-performance T8 lamps provide their biggest boost in efficiency when they are combined with high-performance ballasts.

T5 lamps come only in metric lengths, which means that they are not a good retrofit option unless fixtures are being replaced as well as lamps and ballasts. The efficacy of T5 lamps is similar to that of high-performance T8 lamps, but because they are smaller, they provide better optical control. T5 lamps also offer high lumen maintenance, putting out as much as 97 percent of their original light output at 40 percent of rated life. And T5 lamps offer better performance than T8s in enclosed fixtures and warm spaces because they are designed for a higher operating temperature. High-output T5s (T5HOs) are a good choice in high-bay areas.

For more information on fluorescent lamps, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Lighting, and then Full-Size Fluorescent Lamps).

Ballasts. There are a number of choices for fluorescent lamp ballasts:

- **Instant-start ballasts**, are the most efficient, but they yield the shortest lamp life in applications with frequent on/off cycling.
- **Programmed-start ballasts**, increase lamp life, but they carry some penalty in efficiency. They are the best choice in applications where occupancy sensors are used.
- **Universal-input ballasts**, accept any input voltage between

120 and 277 volts. They make retrofitting easier and reduce stocking requirements, but provide slightly lower efficiency than dedicated-voltage ballasts.

As you're making your selection, check to ensure that the lamps and ballasts chosen are compatible. For more information on fluorescent ballasts, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Lighting, and then Fluorescent Ballasts).

CFLs

Use compact fluorescent lamps (CFLs) to replace incandescent lamps in downlights, sconces, table lamps, task lights, and wall washers. They cost more initially than incandescent lamps, but they quickly pay for themselves through energy and maintenance savings. Replacing a 60-watt incandescent bulb with a 13-watt CFL can save about $37 over its expected life of 8,000 hours at an average cost of $0.10 per kilowatt-hour.

CFLs come in two general forms: self-ballasted or pin-base. Self-ballasted CFLs combine a lamp, ballast, and base in a single sealed assembly that is discarded when the lamp or ballast burns out. Pin-base CFLs, the type most commonly employed in commercial buildings, are used with a separate ballast. They are available in lower-power versions, which can replace incandescent lamps, and in higher-power versions, which can replace linear fluorescent lamps or HID lamps.

For more information on CFLs, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Lighting, and then Compact Fluorescent Lamps).

High-Pressure Sodium

High-pressure sodium (HPS) lamps, which produce a yellowish light, vary widely in their efficacy and color quality. Three basic grades are available, based on color rendering index (CRI): The lowest, with a CRI of about 21, is typically used for outdoor lighting; general-purpose indoor units have a CRI of around 60; and the less common "white" versions boast a CRI up to 80 or higher. The most common application of HPS lamps is for roadway and parking-lot lighting.

For more information on sodium lamps, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Lighting, then High-Intensity Discharge Lamps).

Metal Halide

Metal halide lamps offer good color quality and efficacies of up to 100 lumens per watt, but they suffer from several limitations, including long start-up and restrike times, high ultraviolet output, color shifting over time and when dimmed, and output that is sensitive to lamp orientation (vertical or horizontal). The introduction of electronic ballasts and ceramic metal halide lamps has reduced the impact of some of these issues.

For more information on metal halide lamps, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, Lighting, and High-Intensity Discharge Lamps).

LEDs

Light-emitting diodes (LEDs) are solid-state electronic devices that create light. They offer several advantages over conventional light sources, including long life and vibration resistance. Their small size and the directional nature of their light output are also beneficial in some cases. These characteristics have enabled LEDs to displace incandescent lamps in some applications. They are expensive but continually coming down in price and improving in performance, and are now an effective solution for lighting in refrigerated display cases, recessed cans, and various exterior lighting applications. When buying LEDs, make sure to ask for performance data based on standard tests performed by accredited laboratories.

For more information on LEDs, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Lighting, and then Light-Emitting Diodes).

Induction Lamps

Induction lamps consist of a high-frequency power generator, a coupling device that generates a magnetic field (essentially an antenna), and a glass housing that contains the gases and phosphor coating—no electrodes are required. The main advantages of induction lighting are the ability to produce a substantial amount of light in a relatively compact package and a long lamp life due to the elimination of the electrodes. The major drawback of induction lighting is a high installation cost. In applications where maintenance costs are high, though, induction lighting systems can be cost-effective.

Existing induction-lamp products are aimed at two distinct market niches. The higher-wattage versions available (55 to 165 watts) offer long life (up to 100,000 hours) and can be a good choice any place where relamping and maintenance are difficult or hazardous. Lower-wattage induction lamps (20 and 23 watts) are also available as direct replacements for medium-base incandescent lamps and CFLs, offering an expected life of 15,000 hours.

Use efficient fixtures

To make the best use of an efficient source, it's essential to

consider the efficiency and light distribution of the fixture. The fixture efficiency, a measure of how much of the light produced by the light source actually gets out of the fixture, can vary from about 50 percent to near 100 percent.

Fixture Elements

Elements include:

- **Reflectors,** which are inserts designed to reduce the internal light loss in fixtures by using highly reflective surfaces to redirect light out of the fixture.
- **Diffusers,** which are semitranslucent plastic sheets that hide the lamps and diffuse light evenly across the face of the fixture. Because they spread light in all directions and absorb a large amount of light, diffusers are inefficient and ineffective at controlling glare. Using clear plastic lenses with small prismatic surface patterns instead of diffusers improves efficiency and light distribution.
- **Specular parabolic cube (or "paracube") louvers,** which can reduce the light loss that occurs with translucent lenses. By employing highly reflective surfaces shaped to send light down to a task, these devices reduce the potential for reflected glare in computer screens or other shiny materials.

Indirect Lighting

The best type of lighting system for glare control and visual comfort is an indirect or indirect/direct system. Indirect lighting can make a space feel brighter with less light because it illuminates the ceiling and top portions of walls. If the ceiling and walls are made of a light-colored material, little light is lost with this approach. For more information on indirect lighting, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Lighting, and then Indirect Lighting).

Use appropriate lighting controls

Reducing the connected load of the lighting system represents only one part of the potential for maximizing energy savings. The other part is minimizing the use of that load through automatic controls. The general control strategies used by lighting designers include:

- **Occupancy sensing.** Lights are turned on and off or dimmed according to occupancy.
- **Scheduling.** Lights are turned on and off according to a schedule.
- **Tuning.** Light output is reduced to meet current user needs.
- **Daylight harvesting.** Electric lights are dimmed or turned off in response to the presence of daylight.
- **Demand response.** Power to electric lights is reduced in response to utility curtailment signals or to reduce peak power charges at a facility.
- **Adaptive compensation.** Light levels are lowered at night to take advantage of the fact that people need and prefer less light at night than they do during the day.

For more information on lighting controls, visit **www.FPL.com/bizenergyadvisor** (from this page, select Buying Equipment, then Lighting, and then Lighting Controls).

TABLE 1: TYPICAL PROPERTIES OF LIGHT-SOURCE UPGRADE ALTERNATIVES

Lamp type	Mean efficacy; including ballast (mean lm/W)	LAMP PROPERTY				
		Lumen maintenance (%)	Rated life (hours)	Color rendering index	Correlated color temperature (K)T	Typical applications
Full-size fluorescent (T5, high-performance T8)	80 to 97	92 to 93	20,000 to 30,000	80 to 85	2,700 to 6,500	Open and closed offices, classrooms, high-bay areas, restaurants, and grocery stores
Compact fluorescent	43 to 71[a]	86	6,000 to 12,000	80 to 85	2,700 to 6,500	Incandescent replacements in table and floor lamps, cans, wall washers, and sconces
Quartz pulse-start metal halide	60 to 80[a]	65 to 75	20,000	65 to 70	2,900 to 4,200	Outdoor lighting, high-bay lighting, and remote-source lighting
Ceramic pulse-start metal halide	60 to 80[a]	80	20,000	85 to 94	2,900 to 4,200	Where color is critical, including high-bay and retail applications
High-pressure sodium	60 to 110[a]	85 to 90	24,000	22	1,900 to 2,200	Outdoor lighting and in high-bay applications where color is not critical
Induction	50 to 60[a]	70 at 60,000 hours; 55 at 100,000 hours	100,000	80	2,700 to 4,100	Where maintenance costs are high, including roadways and tunnels, parking garages, escalator wells, warehouses and malls
LED	30 to 80[c]	70[d]	35,000 to 50,000[b]	70 to 90	2,700 to 10,000	Exit signs, parking lot and roadway pole lights, recessed downlights, task lamps, and accent lighting

Notes: K = kelvin; LED = light-emitting diode; lm/W = lumen per watt; mean efficacy indicates light output at 40 percent of a lamp's related life; lumen maintenance is the percentage of initial output that the lamp provides at the end of its life.

a. Higher efficacies for higher wattage lamps.
b. Time at which output has degraded to 70 percent of initial output.
c. Higher efficacies at higher correlated color temperatures.
d. LED life is said to end when the lamp has decreased to 70 percent of its initial brightness.