

# Lighting & Lighting Controls

## Upgrades are simple and cost effective

Lighting accounts for 10 percent of energy consumption in small commercial buildings on average.<sup>1</sup> Fortunately, once-expensive lighting upgrades are now affordable, simple and provide reliable solutions that both improve lighting and dramatically reduce operating costs. By upgrading or replacing existing fixtures and lamps and installing easy-to-use control systems, businesses can save 50% on their lighting expenses.<sup>2</sup> Many utilities also offer rebates and incentives for lighting upgrades. Search for available incentives on your local utility web site and at [www.dsireusa.org](http://www.dsireusa.org).

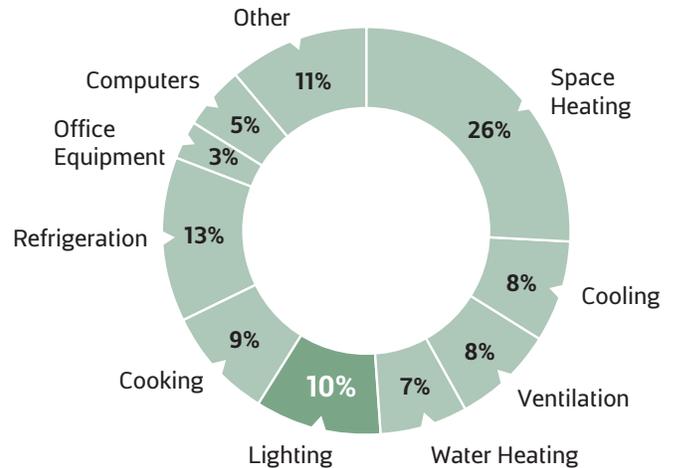


Figure 1. Small Commercial Energy Consumption End Use

Lighting Facts Per Bulb	
<b>Brightness</b>	<b>800 lumens</b>
<b>Estimated Yearly Energy Cost</b> <b>\$1.97</b>	
Based on 3 hrs/day, 12c/kWh Cost depends on rates and use	
<b>Life</b>	<b>7.3 years</b>
Based on 3 hrs/day	
<b>Light Appearance</b>	
<div style="display: flex; justify-content: space-between;"> <span>Warm</span> <span>Cool</span> </div> <div style="text-align: center; margin-top: 5px;"> <span>2700K</span> </div>	
<b>Energy Used</b>	<b>15 watts</b>

Lamp packaging comes with a Lighting Facts label,<sup>3</sup> which provides information to guide lamp selection. The label lists brightness (lumens), estimated yearly energy costs (dollars), life (years), light appearance/color temperature (Kelvin), energy used (watts), and indicates if the lamp contains mercury. Be sure to consult the

Lighting Facts labels to find the most suitable lamps for your applications.

### LED TECHNOLOGY

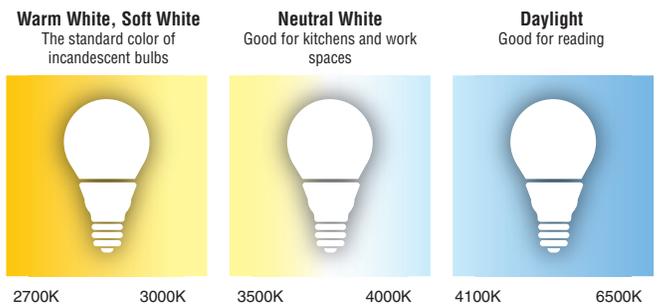


Light Emitting Diodes (LEDs) are a solid-state lighting solution that uses approximately 80 percent less energy than incandescent lamps and 30 percent less energy than compact fluorescents lamps (CFLs). Due to their low life-cycle and maintenance costs, large savings may be attained by switching to LED lighting.

Below are some features that make LEDs superior to conventional incandescent and fluorescent lamps.

- **Directional Lighting** – LEDs emit light in a focused and defined direction – allowing for extreme precision in lighting that decreases unintentional light pollution.
- **Design Flexibility** – Because LEDs are small solid-state chips manufacturers offer light fixtures in a variety of styles.
- **Instant On** – LED lamps reach full lumens as soon as they are powered.

- **Low Waste Heat** – In comparison to incandescent lights, LEDs convert much more energy into light instead of heat and operate at a much lower temperature, reducing a building’s internal heat gain and cooling load.
- **Higher Output** – LEDs produce more lumens per watt than incandescent or CFL bulbs, allowing significant power reduction to maintain the same brightness.
- **Dimming Ability** – Some LEDs are dimmable and are able to operate at reduced brightness levels, providing better lighting control and higher user satisfaction.
- **Color Rendering Index** – CRI is a measure of the ability of a light source to reveal the true color of objects. Most LED lighting has a CRI above 80, with some as high as 90, efficiently producing light that shows an object’s natural color. By definition incandescent lights have a CRI close to 100 because they are blackbody radiators. However, their color temperatures are generally warmer than those of LEDs.
- **Color Temperature** – LEDs are available in both warm and cool color temperatures, allowing personalized environments. The higher the color temperature, the bluer the light source<sup>4</sup>.



- **Color Selection** – LEDs are available in nearly any color, enabling users to creatively use them for non-traditional applications such as advertisements, mood lighting, or accents.
- **Toxicity** – LEDs do not contain any of the toxic compounds present in fluorescent lamps, eliminating maintenance requirements for hazardous waste recycling.

## Lower cost improvements

### REPLACE EXISTING LIGHTING WITH LEDs

Depending on the age and type of fixtures in your facility it may be possible to simply replace your existing lamps with LEDs without modifying the fixture. Below is a list of lamp replacements that you can do today to achieve immediate energy savings.

- Replace all incandescent or CFL screw-in lamps with LED equivalent bulbs
- Replace all T5/T8 linear fluorescent light fixtures with high efficiency LED tubes<sup>5</sup>
- Replace high pressure sodium (HPS) and high intensity discharge (HID) garage and outdoor street lighting with LED lamps

Before making any lamp replacement, it is important to verify the replacement lamp is compatible with the existing fixture. Simply matching the fitting will not always ensure proper electrical compatibility, and replacing the lamp without also replacing the ballast may inhibit the lamp from reaching its full performance potential. For information about ballast replacements and fixture replacements, refer to the *Higher cost improvements* section below and consult a lighting supplier or contractor.

### DE-LAMPING

Take advantage of de-lamping opportunities by cutting power to extra or unneeded fixtures in areas where there is excessive lighting or recently upgraded fixtures. Even removing lamps from vending machines can also offer large savings on monthly electricity bills.

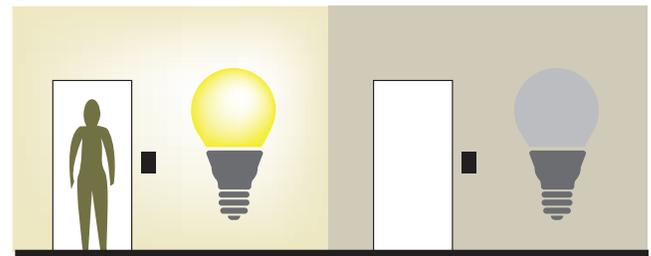
### RETROFITTING LIGHTING CONTROLS

Lighting control systems are affordable and easy to use solutions for improving lighting efficiency and reducing electricity consumption and cooling loads. The most commonly used lighting controls are **occupancy/vacancy sensors, multi-level lighting, and daylighting controls**. Controls can be installed on most existing fixtures relatively easily. Creating an integrated control strategy that combines these three elements can result in 40 percent reductions in energy usage.<sup>6</sup> Consult a lighting designer or contractor before implementing lighting controls. Some questions to consider are as follows:

- What hours of the day is the space occupied?
- Is the space occupied for extended periods or intermittently?
- Do the activities taking place in the space require special lighting considerations?
- Who will have access to the lighting controls?

#### *Installing Occupancy/Vacancy Sensors*

**Occupancy sensors** detect the presence of people in a given space and turn on automatically when occupancy is detected. **Vacancy sensors** differ from occupancy sensors in that they require a user to physically activate a switch in order to turn on the lighting. With both control systems, the lights will turn off automatically if no occupancy is detected for a user-defined “time-out” period.



- **Recommendation 1** – Wall-switch occupancy sensors should be installed in all intermittently occupied spaces (conference rooms, private offices, hallways, etc.) .
- **Recommendation 2** - Restrooms should use ceiling-mounted occupancy sensors that are capable of sensing occupancy within restroom stalls.
- **Recommendation 3** - Equip exterior LED bi-level lights with both motion and daylight sensors. These two controls work together so exterior lights are only at full brightness when motion is detected and daylight is low. Otherwise, these lights remain at a lower brightness when daylight is low.

In lighting controls retrofits where wiring may be especially difficult, **wireless lighting controls** can offer a simple solution. In this application the wall switch is replaced with a receiver that communicates with a wireless occupancy or vacancy sensor to monitor room occupancy. While they reduce effort on the front end, wireless sensors require more periodic battery replacement and are more expensive than conventional switches.

#### *Installing Multi-Level Controls*

**Dimming switches and bi-level controls** enable a lamp to operate at a fraction of its maximum brightness, which reduces electricity consumption and extends lamp life. **Bi-level controls** are great for areas requiring constant illumination but are only occupied intermittently (e.g., hallways, parking decks, stairwells). Fixtures with this feature are required to be equipped with a dimmable electronic ballast that regulates electricity. **Bi-level controls** allow a fixture to operate at a reduced brightness during unoccupied periods, allowing for constant illumination while maintaining a low energy footprint.

#### *Daylighting Controls*

Daylighting controls use photocell sensors to detect when natural daylight levels are bright enough to eliminate the need for indoor lighting and automatically dim or switch the lights in response to changing needs. The need for indoor lighting in the daylight zone can be reduced by up to 60 percent by installing daylighting controls.<sup>7</sup>

#### *Energy Efficient Lighting Habits*

While lighting controls will help to minimize unnecessary lighting, it is ultimately the responsibility of the occupant to ensure lights are turned off when they are not being used. Encourage building occupants to think consciously about their role in energy conservation. One effective strategy is to use visual aids to gently remind occupants to turn off lights. Providing the following adaptive lighting controls is another great way to improve occupant comfort while reducing energy consumption.

- **LED task lighting**, such as desk fixtures or under-cabinet lights, allows occupants to adjust lighting for specific work stations, reducing the need for overhead lights and providing occupant control for individual needs.
- **Dimming switches** allow users to reduce electricity consumption by using only the amount of light needed to illuminate the space as determined by the occupant.
- **Adaptive day lighting controls** - Because unfiltered daylight can often provide more light than needed, providing comfort controls such as blinds and louvres allow users to regulate the amount of daylight entering the space. This also allows individuals to manage glare in their work zones.

## Higher cost improvements

### MODIFYING OR REPLACING LIGHT FIXTURES

When retrofitting older buildings, replacement LED lamps may fit into existing fixtures. However, components may not be designed to support the weight, electrical current, or heat of an updated lamp. For this reason, it may be advantageous to consider either replacing the ballast, or investing in integrated LED fixtures.

#### Driver Replacement

Depending on the age of your facility's fluorescent fixtures, driver replacements may be the only components in need of replacement to offer LED compatibility. By replacing the existing ballast with an LED-compatible ballast with an external driver, the efficiency and performance of an LED fixture can be attained while preserving the original fixture housing and lens. Consult with your lighting contractor to see if your fluorescent fixtures qualify for this upgrade.

#### LED Retrofit Kits

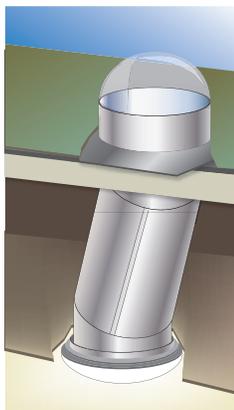
LED retrofit kits provide components needed to convert your existing fixture into an LED fixture. Kits typically include the electrical components, optical elements and the LED lamp. Retrofit kits are available for the majority of troffer types.<sup>8</sup>

#### Full Fixture Replacement

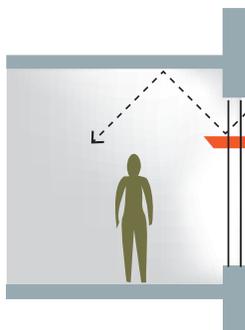
Integrated LED fixtures are full engineered packages, lending themselves to higher operating efficiency and longer lifespans than could be attained with replacement lamps. LED fixtures are available in a variety of styles. Many styles are ENERGY STAR® certified for high efficiency and performance.

#### Daylighting Renovations

Many daylighting measures can only be achieved when they are part of the building's original design and therefore cannot be retrofitted. However, daylight apertures, such as **tubular skylights**, allow natural light to be conveyed to internally located rooms that would otherwise require mechanical lighting. These can be retrofitted into existing buildings, especially during roof retrofits. Daylighting apertures should interface with daylighting controls to manipulate lighting



in response to changing daylight conditions. Integrating skylights with daylight controls is an excellent choice for warehouses.



Another useful method of bringing daylight into your building is to take advantage of light's reflective properties by installing **light shelves**. Light shelves are horizontal reflectors installed above eye level on windows to reflect daylight toward the ceiling and deeper into the building. Installing light shelves on south facing windows can reduce the need for artificial

lighting. Be sure to engage a design professional for this strategy.

When incorporating daylighting strategies into your lighting system, it is important to install daylighting controls to prevent mechanical lighting from being used while the rooms are naturally lit.

#### Replace Older Exit Signs with LEDs

Exit signs are rarely a first priority for lighting retrofits, but, considering they operate around the clock, upgrading their efficiency can result in significant savings. In fact, LED exits have an annual operating cost of only \$4 compared to \$11 for fluorescent and \$28 for incandescent. Additionally, an LED exit sign's lifespan is over 10 times longer than conventional fluorescent models. Look for the ENERGY STAR label when selecting exit signs to ensure efficiency, performance and lifespan. For more information, refer to ENERGY STAR's exit sign [fact sheet](#).

### REFERENCES AND RESOURCES:

- 1 U.S. Energy Information Administration 2012, Major Fuel Consumption (Btu) by End Use for Non-Mall Buildings at [www.eia.gov/consumption/commercial/data/2003](http://www.eia.gov/consumption/commercial/data/2003)
- 2 [www.energystar.gov/sites/default/files/buildings/tools/EPA\\_BUM\\_CH6\\_Lighting.pdf](http://www.energystar.gov/sites/default/files/buildings/tools/EPA_BUM_CH6_Lighting.pdf)
- 3 [www.lightingfacts.com](http://www.lightingfacts.com)
- 4 [www.energystar.gov/products/lighting\\_fans/light\\_bulbs/color\\_mood](http://www.energystar.gov/products/lighting_fans/light_bulbs/color_mood)
- 5 Certain existing fixtures are not compatible with LED retrofit tubes, or may benefit from full fixture retrofit. Identifying the most appropriate plan with a contractor is the key to a safe, financially-responsible upgrade.
- 6 [aceee.org/files/proceedings/2012/data/papers/0193-000071.pdf](http://aceee.org/files/proceedings/2012/data/papers/0193-000071.pdf)
- 7 [www.lutron.com/TechnicalDocumentLibrary/3683587\\_Daylight\\_Sensor\\_Design\\_and\\_App\\_Guide\\_sg.pdf](http://www.lutron.com/TechnicalDocumentLibrary/3683587_Daylight_Sensor_Design_and_App_Guide_sg.pdf)
- 8 [cltc.ucdavis.edu/sites/default/files/files/publication/LED\\_Retrofit\\_Options\\_Linear\\_Fluorescent\\_FINAL.pdf](http://cltc.ucdavis.edu/sites/default/files/files/publication/LED_Retrofit_Options_Linear_Fluorescent_FINAL.pdf)