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Light Control

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New Light-Control Systems Save Electricity in Old Office Buildings

Why illuminate spaces that are vacant? Daylight and occupancy sensors, digital ballasts, and controls are effective retrofit solutions for older buildings.

• Michael Jouaneh, Lutron Electronics Co. Inc. •

Lighting is the single largest user of electricity in commercial buildings. It accounts for 38% of the electric bill—more than cooling, heating, and equipment. If you walk around a commercial building, you see why: The lights are too bright, they're on for too long, and they illuminate vacant spaces.

To control total energy costs, building owners need to get better control of their lighting costs. Often, the root of high costs is outdated lighting design. The solution is an energy-saving retrofit using light-control technology that may not have been available when the building was constructed.

Georgian College, Barrie, Ontario, Canada, reduced its lighting bill by 70% ($137,000 annually) with a retrofit. The college's lighting system was nearly 25 years old and represented technology and deployment that was characteristic of its time. Jeff Choma, Georgian College's manager of mechanical and electrical systems, oversaw the project.

"We really took the time to select the best technology for our campus," he said. "We looked into full-voltage, DALI, and IP-addressable ballasts. We chose EcoSystem because it was the most versatile and simplest to use." (Lutron Electronics Co. Inc., Coopersburg, PA, manufactures EcoSystem.)

The school hired electrical contractors to retrofit the fixtures and add communication wire where needed. Existing wiring was used whenever possible, with transformers used where this wasn't feasible.

A Lutron wireless sensor adjusts lighting needs based on a room's occupancy.

Georgian College reduced its lighting bill by 70% after installing sensors and controls.

Sensors are ideal for classrooms.

Instructors can control classroom light levels.

Georgian College uses Lutron's EcoSystem.

Once the wiring was in place, daylight sensors, occupancy/vacancy sensors, and in-wall controls were installed, all of which could be programmed by the school staff.

Results and benefits were immediate. Daylight sensors in windowed areas dimmed fixtures to take advantage of daylight. EcoSystem directed lighting fixtures throughout these rooms to react to commands from the daylight sensor as a group. The school is using combinations of daylight and occupancy/vacancy sensors in more than 500 areas. As a result, Georgian is saving more than 70% in energy costs over the previous lighting systems. It is paying off the renovation loan with the savings.

Over-illumination: more is not better

For most of the 20th century, the prevailing attitude toward commercial lighting design could best be summarized as more is better. Building codes stipulated different light levels for different spaces, so designers simply flooded interiors with worst-case electric lighting that was bright enough for even the most visually challenging tasks. This meant that even though general office work required just a fraction of the amount of light needed to proofread a paper document, the entire space would be lighted for proofreading. The challenge of over-illumination has become even more acute as computers have become more prevalent and the need for bright overhead lights has diminished even more. This has led to lost productivity resulting from eyestrain and glare on computer screens.

Since lighting was considered a static, on/off utility rather than a dynamic building system, designers typically treated overhead lights as a single monolithic entity. It is not uncommon for entire floors to be designed with just one or two switches for thousands of square feet of floor space. A single person working late has to turn on all of the lights in the whole floor. It also means that the only alternative to over-illumination is no illumination, that is, turning the lights off altogether. This may work for areas near windows and skylights, but it is not practical for interior spaces.

Besides over-illumination, another energy-waster is the failure to take advantage of available daylight. Large lighting zones covering whole floors mean that perimeter areas near windows or skylights are lighted at the same level as areas in the deepest interior areas. Not taking advantage of natural daylight wastes electricity and adds to the problem of over-illumination.

The purest waste of energy comes from lighting empty spaces. This problem is most common in restrooms, private offices, conference rooms, and storage areas, although it happens wherever lighting zones are significantly larger than workstations. It is also a significant issue when large areas are kept lit at night or on weekends for the convenience of cleaning or security staff that are only active in a small area at any given time.

Lighting-control strategies to save money

Fortunately, these performance issues can soon be a thing of the past. Building owners can significantly reduce commercial-lighting expenses through flexible, scalable retrofits with a payback of just a few years.

Depending on the investment, building owners can shave from 20% to 60% from their lighting costs. What's more, dimming the lights translates directly to lower HVAC costs. With less heat from the lights, there is less need for air conditioning. The rule of thumb is that for every 3 W of lighting reduction, an owner can cut HVAC needs by 1 W.

Lighting-control systems employ a variety of strategies to save lighting electricity. These strategies (and their savings) build on each other, so that light-control systems can be built gradually, one strategy at a time, to suit any space and any budget.

Dimming is the easiest way to cut lighting costs. Dimmers can easily reduce electricity usage 15% to 20% through high-end trim, light-level tuning, and personal light control.

- High-end trim sets the maximum light level for each space. For example, the human eye can barely distinguish between a 100% light level and an 80% light level. Dimming lights to 80% reduces energy use by about 20%.
- Light-level tuning sets the appropriate level for each space. Office space is typically over-lighted by a wide margin. Banks of overhead lights were installed before the widespread adoption of computers. Even when owners employ high-end trim, many offices choose to dim the lights even further to minimize glare on computer screens.
- Personal light control gives people remote-control units to control the lights directly over their workstations. Studies show that giving people direct control over their own lights can reduce lighting energy by at least 10%.

Occupancy/vacancy sensing automatically turns off lights after people leave a room or space. On average, occupancy/vacancy sensors can reduce lighting-electricity use by another 15%. Depending on the use and size of the space, sensors have saved as much as 60%.

Daylight harvesting automatically dims electric lights when enough daylight is present. A light-control system can save an additional 15% in lighting-electricity costs in buildings with many windows or skylights. To ensure maximum savings, daylight-harvesting light controls should be partnered with dimming ballasts, not switching ballasts. Daylight harvesting with stepped-switching systems can only step the lights at predetermined levels, that is, from 100% to 50%. So there are no energy savings until a major threshold is crossed. With continuous dimming ballasts, daylight sensors start to dim the lights as soon as daylight is sensed in the space, thereby immediately saving energy.

Controllable window shades serve a dual purpose: to let daylight in and to keep excess heat and cold out. For total control of the visual environment, shades can open and close automatically at different times of the day to harvest daylight and reduce HVAC costs by as much as 30%.

Demand response/load shedding reduces lighting

load at times of peak electricity pricing. Many utilities offer incentives to customers willing to reduce their electricity use during peak demand periods—the workday. Lighting systems are uniquely suited to load shedding because they are one of the few building systems that can respond quickly and operate safely at a wide range of power levels. Utility incentives vary too widely to estimate savings. Building owners need to consult their electric utility provider for more information.

Scheduling will automatically dim or cut lights off at certain times of the day. Few buildings operate on 24-hr. schedules, and most are thinly populated during the overnight and weekend hours. With scheduling, a building manager does not have to depend on the last person leaving the office to turn off the lights. Scheduling can reduce lighting costs by an additional 10%.

Retrofit/renovation strategies: from simple to complex

The following strategies build on each other, so that light-control systems can be configured to suit any space and any budget. Examples of retrofits into an existing building, one room at a time, include the following:

- Stand-alone solutions are the simplest and most cost-effective way to retrofit for energy savings. It is a matter of replacing switches with dimmers. Using the dimmers for tuning and high-end trim will typically reduce electricity use by 20% in every space.

For fluorescent lights, the stand-alone solution is to replace switches with dimmers, and switching ballasts with dimming ballasts. Prices of fluorescent dimming ballasts are lower and efficiencies are higher. The payback period is less than three years.

- The addition of occupancy/vacancy sensors can save another 15% in a stand-alone system. Sensors turn off lights completely when a room is unoccupied. Lutron Electronics makes a wireless occupancy/vacancy sensor that requires no additional wiring and is ideal for retrofit applications. Install the sensor on the ceiling and replace the on/off switch with a matching Lutron dimmer.
- With dimmers and occupancy/vacancy sensors, stand-alone systems can cut electricity costs by 35% in each retrofitted space. They are best suited for private offices, briefing rooms, small conference rooms, restrooms, and break areas. Simple retrofits provide savings for individual rooms, but multiple rooms containing these controls cannot be tied together and operated as a single system.
- For a fluorescent system retrofit that enables more complex energy-saving strategies, start with a digitally addressable dimming ballast. Used instead of standard dimming ballasts, the digital units provide a flexible, scalable foundation for lighting control systems that deliver electricity savings of more than 50%.

It wasn't too long ago that fluorescent light fixtures were static, individual entities that didn't communicate with each other or with other building systems. The options were to turn them off with a toggle switch, a time clock, or an occupancy sensor.

All of that has changed. With digitally addressable ballasts, light fixtures can be directly networked with time clocks and occupancy/vacancy sensors, not to mention daylight sensors, wall controls, handheld remote lighting controls, window shades, building-management systems, and each other.

Since they are digital, they can be easily reconfigured. As spaces change, lights can be easily regrouped into different zones or to work with different sensors without rewiring. And they allow for maximum scalability from one room to an entire facility.

This new technology makes lighting-control systems extremely flexible. Because of their plug-and-play capability, digital ballasts can accommodate any combination of sensors and controls, depending on the room's or building's lighting requirements.

The equipment is easy to install, maintain, and use. A daylight sensor can be directly connected to a single digital ballast for daylight harvesting. Because one ballast talks to all of the others, all ballasts in that zone will react appropriately.

The new digital ballasts are the primary building blocks of systems that are fully scalable, from the small stand-alone spaces described earlier, to multiple rooms or areas, to whole floors, entire buildings, and even building complexes. Installation is simplified because there is no need for interfaces or power packs. Sensors and wall controls can be added or removed with simple Class 2 wire connections at any fixture. Maintenance is also greatly simplified, as replacement ballasts quickly learn their programming when they communicate with previously installed digital ballasts.

The dynamic nature of these advanced lighting-control systems can keep pace with the dynamic nature of business itself. As the lighting needs of a building change, because of new tenants or restructuring the space of existing tenants, lighting zones can easily be reconfigured without rewiring. Wall controls, occupancy/vacancy sensors, and daylight sensors can be reassigned to different fixtures or groups of fixtures simply, without rewiring.

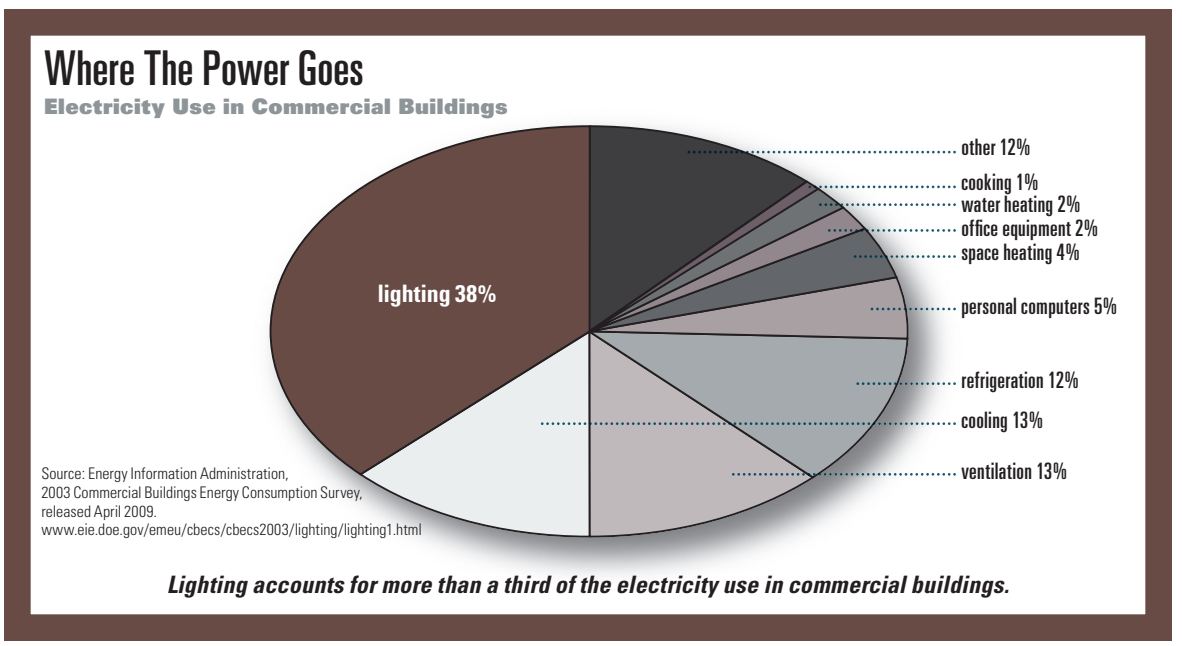
Controlling the sun with sensors

Light control systems can be programmed to control the ultimate light source, the sun. A combination of dimming ballasts, daylight sensors, and automated window treatments can maintain the optimum light level for each space in an office, and effectively use the available ambient light to save energy and improve occupant comfort.

For instance, electrical lights automatically dim (without being noticed by the occupants) when enough daylight is available. Harvesting daylight in this fashion maintains overall light levels and maximizes the use of free sunlight. In addition, sheer window shades automatically close to reduce glare and solar heat gain while maintaining the view.

Three-quarters of the nation's 81 million buildings were constructed before 1979, and still retain the functionality (and performance issues) of their original lighting design. These buildings waste billions of kilowatt-hours every year, costing their owners tens of millions of dollars.

Easy-to-retrofit lighting-control technologies stop the waste. They can save 35% off the electric bill immediately. For more comprehensive renovations, savings from lighting-control systems are 60% or more. These flexible, scalable systems are easy to install and can pay for themselves in just a few years. The next time you walk around a commercial building at night, perhaps it won't be as bright. BP



Lighting accounts for more than a third of the electricity use in commercial buildings.

AUTHOR

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For more information about lighting-control systems from Lutron, circle 20 or visit www.cbpmagazine.com.