White Paper

The Value of Wireless Lighting Control

Abstract

In commercial buildings, lighting accounts for up to 40% of total energy cost. Reducing this energy consumption has become a major goal for building owners, governments, utilities and many other stakeholders. It's no secret that replacing existing lights with more energy-efficient lighting sources (such as LED) is one of the ways to reduce this massive pool of energy use—but efficiency is only the start.

An even greater level of energy reduction comes from turning off lights when they are not needed, optimizing light levels to suit worker needs, and reducing overall demand for lighting energy. Improving system-wide control over lighting is the best way to ensure that lighting energy is automatically reduced as much as possible. Lighting Control solutions, based on a variety of technologies, have been proven to reduce lighting energy consumption in commercial and industrial buildings by up to 70%. These solutions have been limited in the past by cost, complexity and applicability, but new wireless technologies are providing ways to expand the capabilities of Lighting Control and offer them to a wider set of customers.

This paper looks at the benefits that Lighting Control can provide, and how those benefits can be further enhanced by removing the wires.

Lighting Control systems

In short, lighting control systems deliver the correct amount of light, where you want it, when you want it. Lights can automatically turn on, off or dim at set times or under set conditions; facilities managers can make changes to lighting when appropriate or to meet financial incentives; and users can have control over their own lighting levels to provide optimal working conditions. Lighting control helps to reduce costs and conserve energy by turning off (or dimming) lights when they are not required.

Customers of lighting control systems often apply a set of "lighting control strategies" or applications, each of which uses a specific technology and method to control a subset of lighting usage. These strategies include occupancy sensing, daylighting, scheduling, task tuning and more.

Lighting control systems vary widely according to the technologies used to complete these tasks, as well as their degree of difficulty and cost. Historically though, the more system-wide controls and advanced strategies that are used, the greater the complexity, which can make these solutions difficult or even impossible to implement across large-scale environments.

Lighting control systems include some or all of the following:

- on/off and dimming controls
- occupancy sensors to detect whether rooms are occupied
- photosensors to detect the current illumination levels provided by natural and/or artificial light
- scheduling that turns on, off, and dims luminaires at preset times
- a centralized control system interface (such as a wall panel or computer software) to manage all of the above
- a method of communication between the lighting equipment and control system
- a method of measuring, displaying, and responding to lighting energy usage

Scheduling and timers

The simplest lighting control systems turns off (or dim) lights at a specified time when the building is assumed to be empty, and turns lights back on again before people arrive for work the next day. This is a start, but with today's offices where people are increasingly working longer, more flexible hours, additional controls are needed.

Occupancy sensors

Occupancy sensors are useful not only to address flexible working hours, but also to control lights in areas with irregular usage patterns. When the sensors detect that someone has entered an area, the lights corresponding to the location in which the person is detected can be brightened to provide sufficient illumination.

Occupancy sensors can also be used to create "corridors of light" to follow people like security guards and cleaners as they move through a building.

Photosensors and Daylighting

One of the greatest areas of potential savings is to reduce lighting when illumination is already being provided through natural sources. When sunlight comes through windows or skylights, photosensors can detect the level of natural illumination and dim or even turn off lights in the area. And as the natural light fades, the lights can automatically fade back up to the appropriate level. This helps not only to conserve lighting energy, but also to reduce the amount of heat being emitted by the electric lights, which in turn can help save money on air conditioning costs.

Task Tuning

Traditional lighting systems in existing buildings were often designed to meet a single, consistent level of illumination across all areas, regardless of workers' needs. This results in over-lighting for many users' specific tasks. Task tuning allows system administrators and individuals to instead tune down maximum lighting levels in each area of a building via dimmable lights, based on user requirements.

Similarly, lighting control systems can also place greater personal control in the hands of individuals. People often require different levels of lighting depending on factors such as their age and the type of work they are doing. Lighting systems can provide the ability for office workers to adjust personal lighting levels directly from the PCs on their desks.

System-wide and Individual Control

In older lighting designs, one room is controlled by one switch in a closed loop, and a facility manager could only access the lighting by physically accessing each room. Lighting control systems can change this equation by linking together the control of an entire building or even separately located buildings, and remotely managing and controlling light settings. This vastly improves ongoing management cost and complexity, and provides the capability for facilities managers to reduce energy use in ways that were never before possible.

In addition, each light and device within a lighting control system can be individually addressable. The lighting system uses these addresses to control individual lights, groups of lights, entire floors and entire buildings. Individual lights can belong to multiple groups to provide great levels of flexibility.

Energy Monitoring

Better data often equals better savings, and this is certainly the case in lighting control. With advanced lighting control systems, facility managers can access real-time and historical information about the usage of energy by light, room, zone, building and more. This provides them with a set of tools for better decision-making, as well as the ability to test new strategies, verify results, and make changes over time to get the most energy savings out of their system.

Demand Management

Increasingly, utilities are offering tremendous incentives for buildings to go beyond simple energy efficiency and reduce their demand for energy at peak times. Although these peak times might be rare, reducing demand can make a significant difference – the top 100 hours of electricity use during the year accounts for as much as 20% of total U.S. electricity costs. Lighting control systems can tie into utility demand management and peak-day pricing programs, allowing facility managers to temporarily reduce lighting use in order to gain financial incentives.

Removing the Wires

Although lighting control systems have been shown to provide tremendous benefits, many parts of the commercial building market have been hesitant to utilize these systems in anything but the most basic configurations. This is often due to cost and complexity – many lighting control systems have added costs due to labor, equipment and wiring, and the commissioning, management and upkeep of these systems has resulted in hesitation in the market. Lighting systems have been structured largely the same since the time of Edison, but the addition of lighting controls adds a new, unfamiliar element (control wiring) to the system.

A new generation of lighting control systems is eliminating these cost and complexity concerns, while increasing system capabilities, by removing the dedicated control wiring. Through the use of modern enterprise-class wireless networking technology, the difficult control wiring is eliminated, allowing for system-wide controls strategies without significant upgrades to existing lights or added costs.

Wireless lighting control systems offer full-featured control with added flexibility, reliability, scalability, ease of installation and use. And the cost of wiring alone is incentive for many building owners to look at wireless systems: saving installation costs, reducing copper wire use, and improving payback time.

How wireless works

Wireless Lighting Control systems utilize wireless technology to communicate commands between endpoints – sensors, switches, and the ballasts or LED drivers connected to lights. While traditional lighting control systems utilize a controller that is hard-wired to each device (often with copper wiring), a wireless system uses a controller with an antenna that communicates wirelessly between a set of devices.

In Wireless Lighting Control systems, each endpoint is wirelessly enabled, either directly by the device manufacturer or with an external wireless adapter. A software system provides facilities managers or individual users with access to manage the system and change settings, which are then routed through a controller to the individual endpoints.

Wireless systems are often organized using a "mesh" architecture. This means is that each device in the network can communicate with a controller through

at least two pathways, and can relay messages for its neighbors. Data is passed through the wireless network from device to device using the most reliable communication links and most efficient path until the destination is reached.

The mesh network is self-healing, in that if any disruption occurs within the network (such as a device failing), data is automatically re-routed. The built-in redundancy of having multiple pathways available helps to make the mesh network both robust and reliable.

For more information about the benefits of mesh networks, read Daintree's white paper: What's so good about mesh networks?

Benefits of Wireless for Lighting Control

Flexibility

Wireless solutions provide increased flexibility in the way building space can be used. Instead of placing controls where wiring permits, building owners are free to place controls where they are needed to improve building performance.

For example, in buildings with glass or concrete walls, installers no longer need to worry about where the wires are going to go – they can simply put the controls where they make the most sense. Flexibility and control are further enhanced by a single switch being able to communicate with multiple devices, and a single device able to be controlled by multiple switches.

As the needs of a space change, wireless controls can be reconfigured or expanded to accommodate alterations without the cost- and time-intensive process of tearing apart walls and ceilings for rewiring.

Lights are grouped using addressing and software rather than through hard-wiring. Therefore, changes can be made at any point, or new devices and control strategies added, simply by reprogramming.

Scalability

Once a wireless network is established, that network can grow to cover an ever-expanding area at a low additional cost. Additional sensors, switches and lights require minimal labor and disruption, and utilize the same wireless control system without the need to add a new control infrastructure.

The nature of mesh networks means that simply adding new devices can extend the communication coverage of the network, making it even more reliable. And as new areas or buildings are added, the value of the control system expands – giving facility managers greater control over an enterprise-wide lighting system with the same Web-based interface.

The scalability of the system can extend beyond the lights themselves. Many of the standards-based wireless lighting control systems can interoperate with other building automation systems (e.g. security, HVAC) that are based on compatible standards.

Simplicity and ease of use

One of the primary hurdles of lighting control systems has been properly training the engineers and commissioning agents who install and set up those complex systems. Wireless can improve this relationship by providing less complex and time-intensive methods of design, commissioning and ongoing management. Automated wireless commissioning methods can reduce the difficulty of the process and eliminate some of the common sources of human error.

The same is true for facility managers and building occupants – nobody wants to learn how to operate a complex, confusing lighting system. Wireless lighting can reduce this complexity by providing them with familiar wall switches and simple, Web-based tools for management.

Retrofitting

Finding the right balance of cost, complexity and control has been especially difficult in retrofit scenarios, where existing building infrastructure often gets in the way of installing a lighting control system. Adding wiring is often expensive, unrealistic or even impossible, depending on the type of building and location of the lighting.

Wireless provides an ideal solution for retrofits, allowing the existing infrastructure to remain without unnecessary changes, and enabling new devices such as sensors to be placed where needed, rather than restricted to where they can be wired. This is especially true in challenging environments like high-bay warehouses, large retail and industrial buildings. And existing lights can be adapted for new wireless control systems by adding small radio transmitters that allow them to communicate with the wireless network.

Energy management and ongoing performance

The two-way communication available through mesh networks means that not only can a lighting control system send commands to lights and sensors, it can also receive information back from them. This allows the control system to log the real-time state of each light (e.g. on or off) and device (e.g. changed state), measure and communicate energy usage, and inform if lights are malfunctioning or lamps need replacing.

This two-way data stream can provide facility managers with a wide variety of valuable decision-making information. They can quickly and remotely respond to immediate events, as well as analyze historical data and better tune the lighting control system to conserve the most energy. In addition, maintenance service levels can be improved since faults can be automatically raised to maintenance staff or even pre-empted by alerting staff to impending service intervals on hardware.

Finally, the ongoing stream of energy management data can be used for measurement and verification of energy savings. This is a strict requirement for many of the government and private funding sources that are providing financial incentives for energy efficiency projects.

Cost savings

Because wireless systems reduce the labor and wiring requirements of lighting control, their costs can be significantly lower than traditional systems while offering even greater benefits. A typical 48-ballast building wing for a wired control system requires between 1 and 5 miles of dedicated copper wiring.

As described above, each of the lighting control strategies can provide significant benefits. The following table shows an indication of the types of lighting energy cost savings that wireless controls can deliver:

	Savings
Timers: Dim and turn off lights when rooms are unoccupied	up to 40%
Photosensors: Adjust electric light levels to take natural light into account.	up to 20%
Occupancy sensors: Adjust lights based on occupancy detection.	up to 40%
Task Tuning: Dim lights to reduce maximum light levels for each space	up to 20%
Personal control: Individuals set light levels to suit personal preferences.	up to 10%
Demand response: Reduce lighting levels to take advantage of demand response incentives from utilities.	variable
Combined savings	up to 70%

Demand management

Utilities are increasingly focusing on the management of energy demand, and offering tremendous incentives to companies that can effectively lower their demand during the peak periods of the year. Although this might not equate to large energy reductions, it can have a large financial impact.

In order to take advantage of these programs (such as Demand Response and Peak-Day Pricing), facilities managers require systems that can provide large-scale and immediate control of their energy use. Wireless lighting control systems are perfectly suited to these kind of programs, as they offer both the required level of control and a communications platform for receiving and responding to utility messages.

Tax incentives

In addition to the money saved with the reduced cost of running a smart lighting solution, many governments are also offering tax incentives or direct financial incentives to help pay for the purchase and installation costs of these solutions. These programs often have specific technology or capability requirements such as Demand Response or Measurement and Verification, which can be easily achieved through the use of a wireless lighting control system.

When you include both the cost savings and the tax incentives, it can take as little as two years for a retrofitted wireless lighting control system to pay for itself.

Additional benefits

Building codes and government guidelines

Laws and guidelines—including building codes, energy efficiency standards, and emission trading schemes—are making it more important than ever to be aware of the amount of energy you are using and the ways in which you can reduce that usage.

Having greater control over lighting can not only reduce costs, but also help with compliance and "green" credentials such as LEED. And some of the emerging government codes, such as California's Title 24, are even building in strict requirements for daylighting and other advanced lighting control strategies.

Attracting new tenants

In buildings with multiple tenants, not only can automated lighting control provide less expensive and more flexible lighting, it can also monitor who is using what to enable more accurate billing.

Smart lighting also provides green credentials to help and make buildings more attractive to tenants, and can result in higher retention rates due to enhanced user satisfaction, health, comfort and productivity. In fact, LEED-certified buildings have been proven to deliver a rent premium.

Interoperability through open standards

Standards define the ways in which the devices within the building communicate. When all devices are based on the same (or compatible) standards, they all speak the same language. This makes communications within the building much easier to facilitate than when a number of different proprietary technologies are used. In addition, using standards-based equipment ensures lower cost over time, as high volumes across the industry drives component costs down.

Many wireless lighting control solutions are based on open standards such as the ZigBee® and IEEE 802.15.4™ network protocols. Open standards are widely available to developers of smart devices and automation systems, which helps to provide consumers with a wider selection of options to choose from.

Summary

Lighting is one of the largest sources of energy use on the planet, and the most effective and easily attainable way to reduce this energy use is to turn lights off or down. Lighting control systems can use factors such as occupancy, available daylight and time of day to do so, thus providing significant energy and cost savings, a great level of flexibility and control for building owners and administrators, and added comfort for occupants.

Traditional wired control systems have been limited by cost and complexity. Removing the wires delivers on the promise of lighting control by providing even greater benefits, at a lower cost, and to a much broader set of potential customers.

In short, wireless networking is bringing intelligence to a new generation of lighting control systems – helping companies take simple steps to save money and make our planet greener.

About GE Current

Current is GE's digital engine for intelligent environments. Current makes physical spaces more efficient, productive, and safe by combining LED technology, an innovative Daintree ecosystem, and targeted software applications. Backed by the power of Predix, GE's industrial-strength IoT platform, Current and its ecosystem of technology partners is helping unlock value in spaces ranging from commercial buildings, to industrial facilities.

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