

Lighting schedules offer timely savings

Abstract

When the city skyline is lit up at night, it may make a pretty sight, but lighting up those empty buildings comes at a high price.



Lighting typically accounts for up to 40% of the energy used in commercial buildings, and the cost of that energy is creeping up year by year. One of the easiest ways to reduce energy use and cut costs is to turn off lights when they are not required.

The most reliable way to turn off lights at the end of each day is to automate the process.

Many of today's lighting control and building automation systems provide "scheduling," which automatically turns on, off, or dims lights at specified times of the day.

These scheduled lighting events can apply to either all lights within a building, or only to those in a specific "zone" (for example, entrance, hallway, cafeteria, or office).

The California Energy Commission estimates that scheduling alone can generate between 5% and 15% energy savings.

Scheduling not only saves energy and money, it also helps buildings to comply with the "automatic shut-off of building lighting" requirements of energy codes such as ASHRAE 90.1 and California Title 24.

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

How does scheduling work?

Scheduling is usually implemented through an automated lighting or building control system. These systems provide an interface (often web-based) through which you specify information including

- the zone(s) for which you want the lighting event to occur
- the day(s) on which you want the event to occur
- the time at which the event begins and ends
- the lighting action to perform (for example on, off, or dim to a specified level)

As a simple example, let's consider an office building where people work from 8:30 a.m. until 5:30 p.m. on Monday to Friday.

You could set up one scheduled event that turns all lights on at 8:00 a.m. and off at 6:00 p.m. each week day, and keeps all lights off over the weekend. That way, all lights would be on each morning before anyone arrives, and would turn off at the end of each day after they go home.

The system could also include manual over-ride controls, such as timers that turn lights on only for a specified period of time. These controls would allow people like cleaners and security staff to access the building outside of regular office hours.

Using zones for granular control

Today's flexible working hours mean that it is rare for everyone to arrive and leave at the same time each day. Therefore, a more real-world solution is to control segments of the building separately in a way that best suits their usage and occupants.

For example, a building might be broken down into zones that include

- entrance and lobby
- hallways
- open plan office
- cafeteria

You could then create different scheduled events to provide the appropriate light level for each zone:

- In an open plan office, where people typically perform stationary tasks that require high levels of illumination, lights could be turned on at 90% illumination between 8 a.m. and 6 p.m. each week day.
- Entrances, lobbies and hallways typically don't require as much illumination as an office, so the lights here could be turned on at 60% illumination between 8 a.m. and 6 p.m.
- Cafeterias, which are typically only used at meal times and are often filled with natural light, could turn lights on at 60% illumination between 11:30 a.m. and 2:30 p.m.



The more granular the control is that you're able to apply, the more efficient you'll be able to make your lighting solution, and the more energy and money you'll be able to save.

Fine-tuning your system

You can make your lighting solution even more efficient by adding sensors and controls:

- occupancy sensors
- photosensors
- timers
- switches

Occupancy sensors can be used to turn lights on or off based on whether anyone is in a zone. These are useful, not only to address flexible working hours, but also to control lights in areas with irregular usage patterns (such as meeting rooms, warehouses, and laboratories).

Photosensors measure the amount of natural light coming in through windows and skylights, and can be used to adjust (dim or brighten) the amount of artificial light supplied. This process, called daylight harvesting, can help not only to reduce energy usage and costs when natural light is abundant, but also to reduce the amount of heat being emitted by electric lights, which in turn, can help save money on air conditioning costs.

Timers turn lights on for a preset period of time. These are useful to allow access to buildings outside of normal office hours, and for low-traffic areas where people typically spend a predictable amount of time such as stairwells and storage cupboards.

You can further reduce costs by having the first employee who enters the building each morning to manually **switch** on the lights. This helps to avoid wasted energy when the building is not occupied. The scheduling system would manage the rest of the on/off/dimming events for the day.

Creating and managing zones

Today's modern lighting and building control solutions are able to identify each light, control, and sensor within your system by a unique address. You use these addresses to create and manage lighting zones through the control solution software.

In the days before automated control and addressing, zones were created by physically wiring together all required devices. This was costly and complex to do, and not particularly flexible when it came to reconfiguring a space if there was a requirement to move devices from one zone to another.

With addressing and automated control software, there is no cost or disruption when it comes to reconfiguring office space and changing the zones to which the individual ballasts and controls belong. Not only is it easy to use software to move devices from one zone to another, you can also include a single device in more than one zone for increased flexibility.

Removing the wires

Many traditional building and lighting control systems are fully wired, with all lights, sensors and switches hard-wired to a central controller (or to a gateway that facilitates communication between the lighting network and lighting control software). Because of the cost of the wiring, and the complexity of covering a large area, these often operate as a number of self-contained systems (for example, one per room or floor).

Newer lighting systems take advantage of wireless mesh networking, which allows the lights, sensors, switches and the central controller to communicate with each other without the need for wires.

Removing those wires provides more flexibility in terms of where switches and sensors can be placed, and also makes it more affordable to include additional sensors in your network (allowing you to obtain more granular information about occupancy and illumination levels).

Wireless mesh also supports more flexible and easier control of larger systems with more devices. It allows you to run your lighting control solution as a single system that covers an entire building (or multiple buildings), as well as room by room (or floor by floor) deployments. This approach provides a system-wide view of operations, current power usage, savings, and more.

Wireless retrofits

Not only is wireless a good choice for new buildings, it is also ideal for retrofits and redesigns.

Retrofits provide the potential for huge cost and energy savings. More than 75% of the estimated five million commercial, industrial and institutional buildings in the US were built at least 20 years ago. Because of their age, many were grandfathered in when stricter energy-use requirements were introduced in the last decade. Updating the lighting in these buildings to include scheduling, daylight harvesting and occupancy controls is an affordable and intelligent way to deliver energy efficiency and improved system performance, and to help bring these buildings into the 21st century.

Existing wired dimmable ballasts and luminaires can often be incorporated into the new lighting system by fitting them with "wireless adapters" that allow them to wirelessly communicate with the rest of the mesh network. Removing the need to run control wiring from every fixture, control and sensor back to the central controller not only saves time and money, it can also help to minimize disruption in buildings that are occupied during the retrofit.

Once the wireless lighting system is installed, control zones and lighting behavior can be changed by simply reconfiguring the lighting software. Sensors and controls are also much easier to add and relocate when they don't have wires.

How wireless mesh networks work

This type of network consists of a mesh of interconnected devices (e.g. luminaires, switches, controllers). Each device contains a small radio transmitter that it uses for communication. These transmitters can be either built in to the device or can be fitted externally.

In a wireless mesh network, each device is typically connected 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. Two-way communication also helps to increase reliability, by allowing devices to acknowledge receipt of data and to require retransmission of data not received.

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

Mesh networks are also highly scalable, in that you can extend the network simply by adding more devices. The network's self-configuring capabilities identify when a device is added: working out what type of device it is, where its neighbors are, and what the best path is through the network. Weak signals and dead zones can also be eliminated simply by adding more devices to the network.

You can find out more about the benefits of mesh networks in Daintree's white paper: [What's so good about mesh networks?](#)

Regulations and initiatives

Lighting upgrades are extremely cost-effective, generally providing an ROI in two to five years (with savings in both operations and maintenance costs).

This is sweetened further by the incentives many governments are offering to promote green building and retrofits, and to stimulate the building industry after the recent economic downturn.

In the US, refer to the DOE's Database of State Incentives for Renewables & Efficiency (DSIRE) at <http://www.dsireusa.org/> for details about available incentives.

Some utilities also provide credits for lighting control solutions that support demand side load-shedding. A lighting control solution can be configured to automatically react to demand response events from utilities, and adjust lighting to pre-set acceptable levels to take advantage of cost savings.

Regulations and codes

Governments around the world are introducing regulations and initiatives aimed at making buildings greener and more sustainable. These include lighting control and scheduling standards and codes for both new buildings and retrofits (such as Title 24, IESNA and ASHRAE).

Codes are being updated regularly to become more stringent, and all are advocating the use of some form of automated lighting control that includes scheduling and occupancy control (for automatic shutoff of building lighting) and daylight harvesting. While these are still guidelines and recommendations in many places, they are gradually making their way into mandatory building requirements.

Find out more about these codes:

- Building energy codes program (including status of state energy codes): www.energycodes.gov
- California Energy Commission (CED) Title 24: www.energy.ca.gov/title24
- Illuminating Engineering Society of North America (IESNA): www.iesna.org
- American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE): www.ashrae.org

Certification

Lighting control systems need to be certified to qualify for many of the available government incentives.

One of the leading certifications is LEED (Leadership in Energy and Environmental Design). Within the US, LEED is the nationally accepted benchmark for the design, construction and operation of high performance green buildings.

You can find out more at www.usgbc.org/leed.

Wireless pros and cons

Mesh networks provide many benefits for lighting control, and removing the wires provides even more including increased flexibility and reduced installation costs. But no single solution is perfect for everyone. Below is a summary of both the pros and cons of wireless mesh lighting control:

- **Cost:** Installation costs are greatly reduced without the need to run control wires from each device back to the central controller. However, wireless sensors and controls are sometimes more expensive than their wired counterparts, so some of the money you save on wiring may go back into purchasing the wireless devices.

- **Security:** Both wired and wireless solutions provide effective security. Most wireless lighting technologies use 128-bit Advanced Encryption Standard (AES) security for communications. This security is robust enough that, in June 2003, the US Government announced that AES may be used to protect classified information.
- **Scalability:** Wireless mesh solutions support more devices over greater distances than wired ones, which makes wireless ideal for multi-office and multi-floor installations. The nature of mesh networks means that simply adding new devices can extend the communication coverage of the network. And the wireless nature of the controls allows you to place them in areas that were previously difficult or costly to access.
- **Reliability:** Both wired and wireless networks use mature technologies that offer great robustness and reliability. There is the potential of radio interference and data loss with some wireless technologies that share the same radio frequency (such as Wi-Fi® and ZigBee®). Fortunately, this problem is easily avoided for your lighting solution by selecting channels within the radio frequency that are not commonly used by other wireless devices. You can further protect yourself by selecting a wireless mesh technology like ZigBee, which can automatically switch to a new channel if it detects interference on the current channel.
- **Flexibility:** This is one of the biggest benefits of wireless. Devices can be installed where they will provide maximum benefit instead of where it is easiest to run wires. Devices are also grouped into "zones" using addressing and software rather than hard wiring, which allows changes to be made at any time through simple software

reconfiguration (no costly or disruptive rewiring required).

- **Complexity:** Wireless allows you to avoid the complexity of connecting wires from hundreds (or thousands) of devices back to a controller, but that comes at a price. It can be more difficult to locate a device when you don't have wires to follow. The good news is that tools are available to help you locate and identify devices during installation and commissioning, and for the ongoing operation, monitoring and maintenance of the system.

Summary

Cost and energy savings are major design considerations for modern lighting systems. A wireless scheduling and lighting control solution provides all this and more.

Removing the wires from the lighting system provides additional benefits, including greater flexibility in where controls can be placed, significant savings in installation (by avoiding the expense and disruption of wiring), and the ability to control and monitor large lighting installations as a single system.

You not only save money on the installation and usage costs, but can also take advantage of the tax incentives offered by many governments to encourage greener buildings and retrofits. And incorporating scheduling into your lighting solution helps you to meet new building codes and regulations and achieve LEED certification.

Stop burning lights in empty offices late into the evening. The time has come for the commercial building industry to embrace something the fashion industry has known for years: Black is Beautiful!

About Daintree Networks

Based in Mountain View, California, Daintree Networks is a clean technology company that provides wireless control solutions for commercial buildings. Daintree has a strong background in wireless sensor and control mesh networking, with extensive knowledge and experience gained through its industry-standard design verification and operational support tool, the Sensor Network Analyzer (SNA). In addition to wireless embedded expertise, Daintree has put together a team of seasoned professionals from the lighting, telecommunications and networking worlds. Daintree's expertise and knowledge is now being focused on the development of cost-effective building automation systems. These provide benefits including reduced energy consumption, costs and carbon footprint, compliance with new "green" building regulations, and cost savings available through government rebates and the ability to take advantage of demand response programs.

Daintree's Wireless Lighting Control Solution (WLCS) allows lighting manufacturers to speed their time to market, and enables them to deliver powerful, comprehensive, flexible, and reliable wireless lighting control systems for commercial buildings. For more information, visit www.daintree.net or email sales@daintree.net

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Daintree Networks Inc
1503 Grant Road, Suite 202
Mountain View, CA 94040 U.S.A

(w) www.daintree.net
(e) sales@daintree.net
(p) +1 (650) 965-3454