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FROM SOURCE TO SITE

Guide to Lighting Control in Buildings

March 2017

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Introduction

This short guide highlights the possible benefits of lighting control systems within buildings of all types. It is intended to offer an overview and practical guidance to lighting designers, electrical contractors and facility managers. This guide does not go into great detail with regard to available technology or design considerations connected to a buildings lighting control system.

Key advantages & benefits of a complete lighting control system

- Compliance with relevant regulations and standards
- Conservation and energy saving
- Flexibility of building use
- Reduction in Installation costs
- Enhancements to upkeep and maintenance
- Safety and comfort for the end user
- Specialist Applications

Typical application areas

- Corridors
- Stairwells
- Entrance halls
- Offices and open spaces
- Storage rooms
- Lavatories and washrooms
- Car Parks
- Pedestrian walk ways and underpasses
- Escape routes and fire exits
- Elevators

Benefits of LED lighting

LED lights use about 50 percent less electricity than traditional incandescent, and halogen options, resulting in substantial energy cost savings, especially for buildings with lights that are on for extended periods. LEDs also transmit light in a specific direction unlike conventional bulbs, which emit light—and heat—in all directions (because LEDs are mounted on a flat surface, they emit light hemispherically rather than spherically). This directional lighting capability reduces wasted light and energy.

Unlike incandescent lighting, LEDs don't "burn out" or fail, they merely dim over time. Quality LEDs have an expected lifespan of 30,000–50,000 hours or even longer, depending on the quality of the lamp or fixture. A typical incandescent bulb lasts only about 1,000 hours; a comparable compact fluorescent lasts 8,000 to 10,000 hours. With a longer operational life, LEDs can reduce labour costs of replacing lamps in commercial situations, achieving a lower maintenance lighting system. LEDs perform better in cold environments unlike fluorescent lamps. At low temperatures, higher voltage is required to start fluorescent lamps, and luminous flux (the perceived power or intensity of light) is decreased. In contrast, LED performance increases as operating temperatures drop. This makes LEDs a natural fit for refrigerated display cases, in addition to outdoor applications such as car parks, perimeter lighting and signage (in temperate climates).

Without filaments or glass enclosures, LEDs are breakage resistant and largely immune to vibrations and other impacts. Traditional lighting is usually contained in a glass or quartz exterior, which can be susceptible to damage. LEDs, on the other hand, tend not to use any glass, instead they are mounted on a circuit board and connected with soldered leads that can be vulnerable to direct impact, but no more so than mobile phones and similar small electronic devices.

Most fluorescent and HID lamps do not provide full brightness the moment they're switched on, with many requiring three minutes or more to reach maximum light output. LEDs come on at 100-percent brightness almost instantly.

Traditional light sources tend to have a shorter lifespan the more they're switched on and off, whereas LEDs are more resistant to rapid cycling. In addition to flashing light displays, this capability makes LEDs well suited for use with occupancy or daylight sensors.
It can quite costly to make commercial fluorescent lighting systems dimmable, but

LEDs, as semiconductor devices, are inherently compatible with controls.

Less than 10 percent of the power used by incandescent lamps is actually converted to visible light; the majority of the power is converted into infrared (IR) or radiated heat. Excessive heat and ultraviolet radiation (UV) presents a burn hazard to people and materials. LEDs emit virtually no IR or UV. Rapid advancements in LED lighting technologies, with more improvements on the horizon, have resulted in lowered costs and increased reliability of LEDs.

The table below is for General Electric Standard light bulbs.

WATTS	LUMENS	L/W	EFFICIENCY %
40	505	12.6	1.86
60	870	14.5	2.13
75	1190	15.9	2.33
100	1750	17.5	2.60

Reference [T.J. Keefe "The Nature of Light 2007"]
https://web.archive.org/web/20120423123823/http://www.ccri.edu/physics/keefe/light.htm

DALI or Integral sensor controlled lighting

When upgrading lighting controls to an existing installation or designing and installing lighting controls to a new built installation there are multiple systems available. It is important therefore to choose a system that will maximise energy efficiency as well as giving the best possible return on any investment made. Two examples of systems commonly specified by consultants are a DALI [Digital Addressable Lighting Interface] addressable system allowing central control of switching and dimming to luminaires at pre-determined times or a system where the lighting is controlled using luminaires with integral sensors.

A DALI system requires a DALI bus in order to communicate digitally between points A and B for instance between head end and DALI devices. In a new installation, this would require the installation of an extra pair of cables between devices and the head end of the system. With a refurbishment, this extra pair is unlikely to be present and to install them would mean considerable expense.

Sensor controlled Lighting, where a movement or daylight harvesting sensor is installed integrally to each luminaire this extra set of BUS wiring is not required. It is in this case possible to utilise the existing phase neutral and earth connections to achieve the required control. Sensor controlled lighting would therefore have significantly lower installation costs over DALI controlled lighting.

Additional costs are encountered with DALI controlled lighting because of the need for the addition of head end equipment such as routers, controllers and computer software. DALI controlled lighting will always need to be commissioned normally by a specialised contractor / commissioning engineer. The cost of this commissioning engineer will be an add-on to the project with any alterations, additions or replacements to the system needing to be recommissioned.

Energy Saving

Currently building regulations and standards are focusing more and more on the requirements to introduce energy saving controls to refurbishments and new builds alike.
Lighting control in buildings can offer palpable and repeated returns on any investment made to a lighting control system. This can be gained by reduced operating overheads and tax benefits for larger buildings and organisations.

The importance of good initial design of any lighting control system will undoubtedly lead to energy saving without any diverse effects to the intended users safety and comfort.

It is known that up to around forty percent of the electricity usage within a building is deemed to be attributable to lighting. This usage of electricity if controlled properly where lighting is not left on unnecessarily can be proven by case study to report savings of more than sixty percent.

Sensor controlled lighting has an element of commissioning but is normally very straightforward and can be carried out by the electrical contractor with no need for a specialist commissioning engineer.

Occupancy sensing

Occupancy sensors can be used to automatically turn lights on and off. In areas where there is no occupancy the sensor would be used to automatically turn the lights off, the sensor would automatically turn lights on when any presence is detected this situation where lights are switched on and off automatically is known as presence detection.

Fully automatic systems are not necessarily the most energy efficient, it may be beneficial for the lighting control system to be semi-automatic instead of fully automatic. For instance, it may be desirable to introduce local light switches where occupants and users will deliberately turn lights on when needed and the lighting control system will extinguish the lights when the area becomes un occupied. This situation where there is a request by the user for the lights to be on and the lights are switched off automatically is known as absence detection.

Daylight harvesting and light level control

Daylight harvesting systems use daylight to offset the amount of electric lighting needed to properly light a space, in order to reduce energy consumption. This is accomplished using lighting control systems that are able to dim or switch electric lighting in response to changing daylight availability. The term Daylight Harvesting has become the standard in the fields of lighting, sustainable architecture, and active daylighting industries.

Daylight harvesting systems are typically designed to maintain a minimum recommended level. This light level will vary according to the needs and use of the space; for example, the commonly recommended light level for offices is 500 Lux on the desktop.

All daylight harvesting systems use a light level sensor, a photosensor, to detect the prevailing light level, luminance or brightness, in open-loop or closed-loop systems. Photosensor's are used to adjust electric lighting based on the available daylight in the space. In an open-loop system, the photosensor detects the amount of available daylight only, and can be positioned on the building's exterior wall or roof, or inside the building facing the window or skylight. In a closed-loop system, the

photosensor detects the total photometric amount of light, from both daylight and electric sources in the space. For example, in an office a closed-loop photosensor can be positioned on the ceiling facing the desktops in order to detect the amount of light on the work surface, as placing the sensor on the desktop itself would be impractical. In both the open- and closed-loop configurations, the signal from the photosensor must be carefully calibrated to accurately indicate the effect of exterior daylight variations on the light level on 'important function' areas in the space.

The signal from the photosensor is interpreted by a lighting control system module, an automated light switching device, in the electric lighting system which can reduce the electric lighting, by shutting off or dimming fixtures as appropriate. If the electric lighting is dimmable, then the artificial lighting may be continuously adjusted in proportion to the amount of daylight available.

If the electric lighting is on-off only, then an electric lighting fixture or lamp must remain on at full output until daylight can meet the entire recommended light level for the space. Non-dimming variants include having multiple non-adjacent light fixtures such as alternate units in the ceiling 'grid layout,' or daylight source adjacent fixtures near windows or skylights, linked for module on-off switching. Dimming systems are generally more expensive than on-off systems. They have the potential to save more energy, because they can reduce electric light output when daylight can only partially meet the needs of the space. However, dimming systems may also require a little more energy for their basic operation. If a dimming system is well-calibrated, the occupants of the space will not notice changes in electric lighting due to daylight harvesting.

Lighting Control using timers

Time control can be an effective method to control lighting in an effort to save energy. Time control may use chronological schedules such as specific times of the day, week, month or year. Alternatively, time control may use astronomical schedules such as sunrise and sunset very often used in conjunction with outdoor or external lighting installations.

Time control may be used to alter the control regime where users need to control lighting manually during day light hours but controlled automatically in response to movement during the hours of darkness.

Collective collaboration of energy efficient lighting and controls

With many techniques, available to control lighting in buildings many of them described above may be used together. Each of these techniques will help and make additional contribution to the energy savings achieved.

- The use of energy efficient LED luminaires
- Manual switching to ensure artificial light is actually necessary as determined by the user
- Day light harvesting reducing the need for artificial lighting when natural lighting is adequate
- Movement sensors to turn lighting off when a lack of presence is detected
- Dimming control to reduce unnecessary over lighting
- Time controls to reduce light levels out of working hours

Lighting control and other building services

If reliable movement detection of users throughout a building can be fed back to other building services from the lighting control system, then further significant energy savings can be made for example with heating, ventilation and air conditioning services. If temperature levels can be varied within an unoccupied area of a building from just a few degrees of its set point, then considerable savings can be achieved.

Cost savings in relation to installation

A considerable reduction in materials such as cabling and the labour associated with installation of cabling can be gained where conventional switch cable runs are no longer required. Where lighting control is integral to the luminaire intensive and otherwise time consuming labour can be transferred from the construction site to the lighting manufacturer's workshops.

Flexibility of building use

Alterations to the internal layout of a building can be costly when partitions are added or removed and manual conventional light switching is present. Lighting control systems provide a very cost effective and flexible means of making any changes necessary as the buildings internal layout is altered. Many modern-day lighting control systems use computer software to separate the control rational from the fixed wiring. In this case when a floor area is repartitioned physical changes to the lighting is not required just adjustments to the programming is needed to change the association between any switches and sensors and the actual lighting they control.

Enhancement to upkeep and maintenance

If lights are switched off automatically when not needed this will invariably extend the real-time life span of any lighting installation.

Lighting control systems are available that will allow the system to detect faults automatically in the luminaire for instance, lamp failures or battery faults in luminaires that have been converted to emergency lighting. Some lighting control systems have monitoring software that can alert the facilities management team of these faults either on a central display perhaps in the concierge or by means of an email or SMS. This information can be used to log trends and allow for a planned preventative maintenance programs.

Compliance with relevant regulations and standards

The Building Regulations are ever evolving with the requirement to install lighting controls in both new builds and refurbishments. Lighting control allows a very straight forward means of reducing the amount of electricity used within a building. It is therefore widely acknowledged that lighting controls will be of particular interest to any organisations that are required to participate in government energy saving schemes such as energy performance certification and the carbon reduction scheme.

It is necessary and is a legal requirement to ensure that a non-domestic building is safe for its occupants. All emergency lighting needs to be tested and suitable records are maintained in relation to this regular testing. Systems are available to facilitate this automatically as follows:

- The required regular testing can be automatically performed.
- The tests can be performed out of hours or at suitable times as to not the effect the building users or the safety of the building itself.
- Automatically maintain the necessary records.
- Monitor luminaires for faults such as lamp or battery failures
- Generate a report for the facility management team detailing any required repairs.

Safety and comfort for the end user

It is essential the design of any lighting design scheme adopted should afford its occupants with a safe, healthy and productive environment in which to work. A lighting control system which has integrated control of the lighting installation can provide its occupants with some vital and important key features.

Safety: Corridor luminaires can be dimmed down to a pre-set level usually ten percent of its normal level when a lack of presence is detected. This will keep the escape routes illuminated from areas of the building that may be occupied. This is sometimes referred to as "Corridor Function".

Comfort and well-being: There is evidence that lighting which changes in colour temperature and its intensity can enhance comfort and well-being by reinforcing

circadian rhythms. Luminaires that can be controlled to change their colour temperature are now widely available.

Productivity: In interiors with side windows the available day light decreases rapidly with the distance from the window. Supplementary lighting is needed to ensure the required illuminance at the work place and to balance the luminance distribution within the room. Automatic or manual switching and or dimming may be used to ensure appropriate interrogation between electric lighting and daylight. Reference: BS EN12464-1.

It should be noted that a comfortable working environment with convenient user overrides within the lighting control system will improve productivity within the work place.

Specialist Applications

Architectural lighting is commonly used to improve the appearance and viewers experience of the façade to many buildings. This can be very significant in the consumption of electricity and adequate and well thought out lighting controls can significantly reduce the energy consumed ensuring the lighting is switched off when there is no one around to appreciate it.

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