Lighting Control Mini Guide

The Lighting Industry Federation

Objectives of the Mini Guide

This guide describes the main benefits of a lighting control system. It provides an overview only and does not drill down into the technologies or design methodologies used in realising a control system.

The principal benefits of lighting controls are:

* Energy saving
* Installation cost reduction
* Flexibility of building use
* Maintenance improvements
* Compliance with standards and regulations
* Safety, productivity and well-being
* Control of lighting effects and specialist applications

This document describes each of these benefits.

It also addresses central management and integration with other building control systems.

Please contact the Lighting Industry Federation (www.lif.co.uk/contact) regarding guides and training courses suitable for those wishing to specify, procure or install a control system and for quantification of the benefits outlined in this document.

Energy saving

This is probably the ‘hottest topic’ in lighting controls at present. Energy savings provide a tangible recurring return on investment in a lighting control system, both in reduced running costs and in tax savings for larger organisations. Also, Building Regulations are currently evolving in a direction that requires energy saving controls to be deployed in both new builds and refurbishments.

A well-designed lighting control system will achieve energy savings while preserving lighting quality and without compromising user comfort or safety. A reputable controls supplier will assist you in realising this for your particular application or business environment.



Lighting can be responsible for up to 40% of a building’s electricity use. Lighting electricity use in commercial buildings can be successfully reduced if a control system ensures that no unnecessary lighting is kept on. In early demonstration projects a number of case studies reported savings of 60% and more. This was achieved without movement and light level sensors, which provide additional benefits and are now regarded as standard components.

Movement sensing

Movement sensors are used to turn off lighting automatically in an area when nobody is there. In some areas, including those with no natural light at all, movement sensors are also used to turn lights on automatically when somebody enters the area.

Some people believe that to be truly energy conscious a lighting control system must operate automatically and it is the users that waste electricity. This is not always the case; fully automatic regimes may use more energy than those relying on the staff to use local switches.

One successful energy reduction control regime can be summed up as ‘request ON, auto OFF’. This means that staff must deliberately switch lighting on when they require it, while the lighting control system will use movement sensors to turn the lighting off when an area is no longer occupied. Typically a ‘request OFF’ is also provided.

Whether ‘request ON’ or ‘auto ON’ will produce the best energy savings and user experience will depend on the application and also on what other lighting control features are employed, for example daylight harvesting.

‘Auto ON, auto OFF’

is often called ‘presence detection’

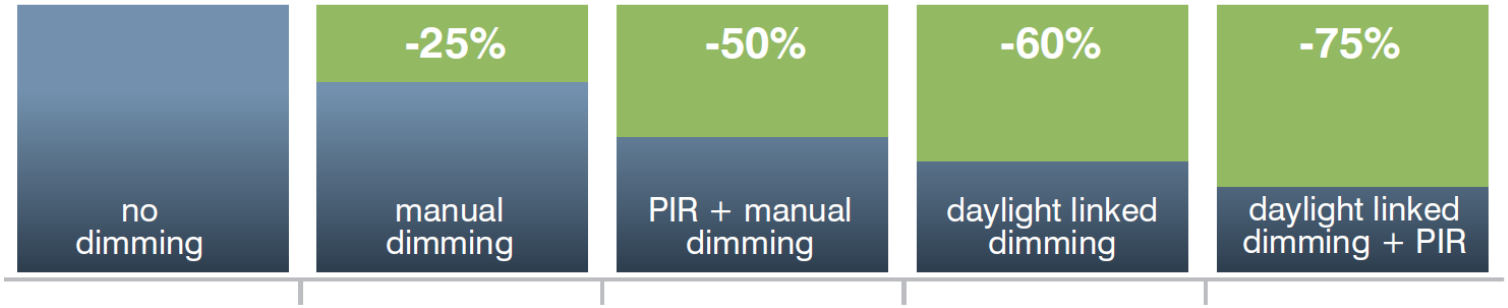
‘Request ON, auto OFF’

is often called ‘absence detection’

Energy saving

Light level sensing and ‘daylight harvesting’

Light level sensors reduce energy consumption by reducing artificial light when there is adequate and suitable natural light. For street lighting and other external lighting, simple ON/OFF operation at dusk and dawn is widely used. In contrast, successful daylight harvesting schemes for buildings are more complex and must operate in a way that is unobtrusive to building occupants. They typically reduce artificial light levels slowly in response to increasing natural light levels. For best results, dimmable light fittings should be fitted. Both fluorescent and LED lighting can be dimmed; dimming is also available for other light sources, such as High Intensity Discharge lamps.

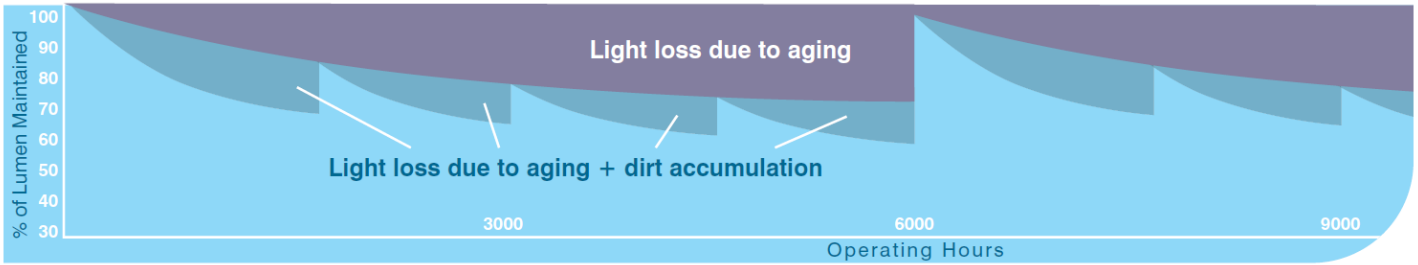


Savings based on fluorescent lighting

Energy saving

Maintained illuminance

Most artificial lighting sources lose some of their brightness over time. Also, when designing a regular grid of luminaires to light a space, an aesthetically pleasing arrangement may not be able to produce exactly the required light level with each luminaire full on. Design specifications therefore refer to the required lighting levels as a ‘maintained level’. The ‘as new’ capability of the installed lighting will be substantially above the maintained level, so that the scheme will be over-lit on day one if it is not controlled. A control system that uses dimming control to keep illuminance down to the maintained level can save between 10% and 20% of the lighting electricity over the maintenance cycle of cleaning and re-lamping, with larger peak savings being achieved on day one.



Maintained illuminance, measured in lux, is the minimum ‘amount of light’ that is required to fall on a square metre on an object that is being lit, such as the surface of a desk. A control system that uses dimming control can be programmed to adjust light levels in compensation for long term changes in performance of the lighting. These changes may be measuring manually, for example using a light meter during hours of darkness. Automatic measurement and compensation by a lighting control system is usually harder to achieve in an office environment because light level sensors are located in ceilings rather than on the surface being illuminated, so that the light readings are affected by items placed on the surface.

Energy saving

Timing control

In some schemes, such as shopping malls, time control is an effective way to reduce energy consumption. Time control may use fixed times, such as the opening hours of a mall, or astronomical times, such as sunrise and sunset.
Time controls may also be used to vary the light level to suit different daily tasks. A factory area may require bright lighting when machinery is being operated but only much lower levels when the area is occupied by cleaners or security staff.

Time control may also be used to affect the control regime. For example a control system may be set up so that users must switch lights on manually during daylight hours but they come on automatically in response to movement during hours of darkness, or vice versa.

Energy saving

Cumulative energy savings

In many installations, several of the above techniques may be deployed together. Each will make an additional contribution to the energy savings achieved. So an office control system may use:

manual ON control to ensure the user really wants artificial light;

dimming control to prevent over-lighting;

time controls to reduce light levels out of working hours;

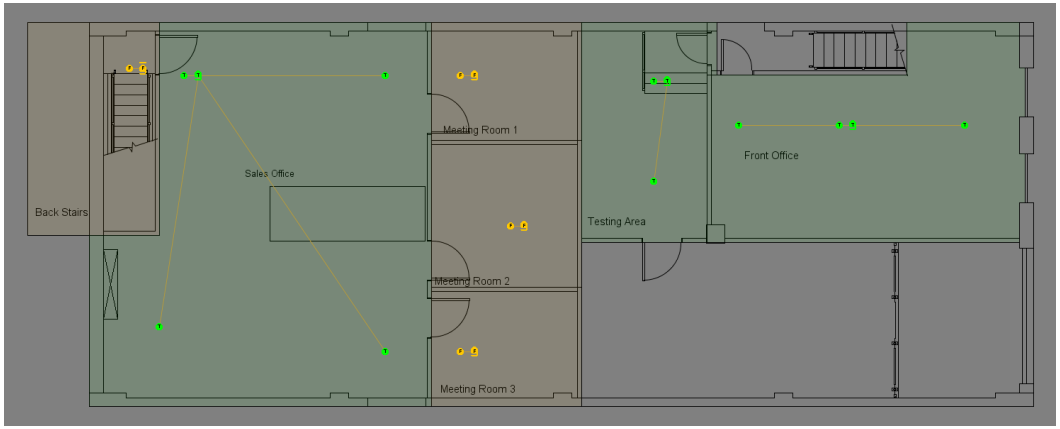
daylight harvesting to dim artificial lighting when there is adequate natural light;

movement sensors to turn off the lights when nobody is present.

Energy saving

Integrated building control

Lighting is the most pervasive and visible of all the building services. Lighting designers often specify movement sensors throughout a building to ensure that user movements are reliably detected.



Significant energy savings can be achieved in other building plant if the occupancy information from the lighting control system is made available for other building control functions. The most popular example is heating/air conditioning. If the temperature in an unoccupied area is permitted to vary just a few degrees from its set level, considerable savings can be achieved.

Installation cost reduction

Most control systems have dispensed with the traditional power cable running from each ON/OFF switch to the lights it controls. Instead separate power and switching control cables are used; a single control cable provides independent control of multiple luminaires fed from a common power cable. This reduces both the quantity of cabling required and the cost of installing it.

Some commercial lighting controls are integrated into the lighting installation in such a way that much labour intensive work is moved from construction site into the factory. An example is chilled beam systems, where a modular beam assembly may be pre-fitted with air conditioning vent, luminaire, movement/light level sensor and power/control cabling. Site assembly requires only alignment of the ducting and jointing the cables at each end. This benefit of a lighting control system is not well understood, even today, and is often ignored when a construction project is priced.

In some applications, control cables may be replaced by radio and/or by control of individual lights using 'power line control' or 'mainsborne' signalling over a common lighting main.

When refitting a building, existing light switches might be bypassed and replaced with radio light switches, with the existing wiring then used for power line control.

There is a range of solutions that can be deployed, whether in new build or to improve the energy performance of an existing building.

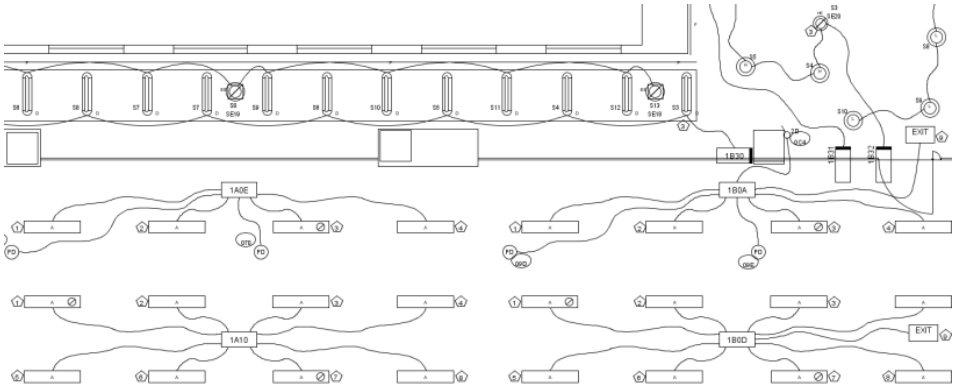
Flexibility of building use

The separation of switching from the mains supply, offered by most lighting control systems, also provides a very cost effective route to making any changes as buildings are altered. Devices like ceiling mounted movement sensors, extra low voltage local switches and remote control devices will all facilitate changes to the lighting to match new partition layouts or changes in use.

Many lighting control systems use software techniques to separate the control regime from the physical wiring, so that any switch or sensor can control any light, irrespective of wiring. This means that when a building is repartitioned, changes are not required to the physical lighting components – only the control system need be reprogrammed to change the associations between switches/sensors and the lighting that they control.

To take full advantage of this flexibility requires a control system that can address every luminaire, switch and sensor individually.

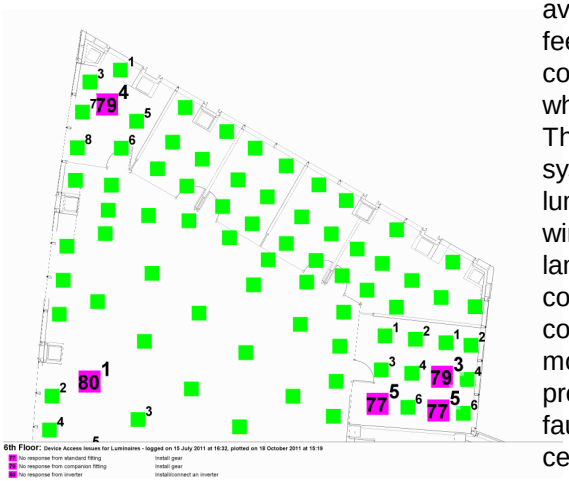
It is also important that the control system is easy to reprogram. In practice this is essential to maintaining good energy savings as a building is reconfigured. When evaluating a lighting control system, a good test to use is “does the supplier offer a suitable, short training course and would my staff then be able to reprogram the system?”.



Many buildings are initially lit as a ‘shell’ – the building has large open plan areas, each with a regular array of luminaires controlled in a simple ‘all on or all off’ scheme. Then when areas are leased to individual tenants, partitions are added and the lighting must be adapted to reflect the tenant requirements. Without lighting controls, this involves rewiring. In contrast, a lighting control system can simply be reprogrammed to suit the tenant’s needs.

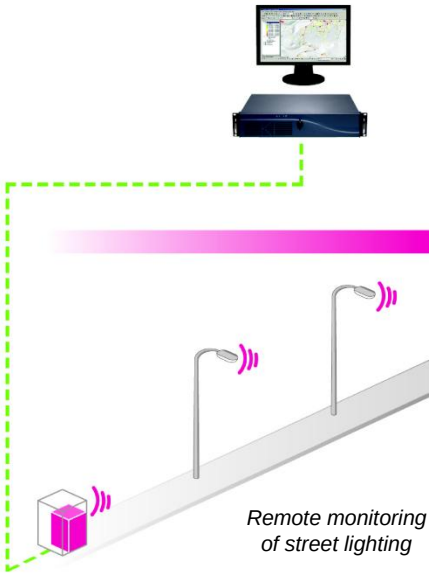
Maintenance improvements

Some lighting control systems offer additional facilities to reduce maintenance costs. Simply by ensuring lights are not ON when they are not needed, the installed life of each lamp can be extended so that re-lamping costs are reduced.



Locations of faulty luminaires displayed on a building floor plan

Luminaires and other lighting components are now available which provide feedback to the lighting control system to indicate when a lamp has failed. They also allow the control system to detect faults in the luminaire electronics or wiring that will prevent the lamp being controlled correctly. Some lighting control systems offer monitoring software that provides alerts for these faults, for example on a central status display or via e-mail, SMS etc. This allows the facilities manager to respond to problems when they occur, rather than waiting for user complaints.



Remote monitoring of street lighting

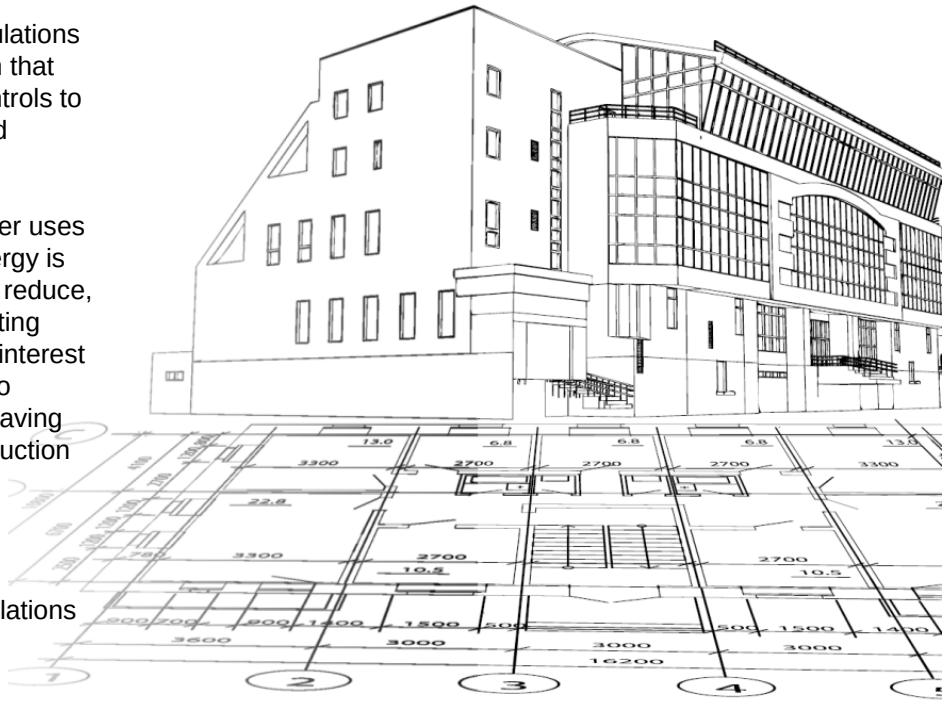
Some control systems log lamp hours run. Along with actual fault logs, this information can be used to draw up much improved planned maintenance schedules, which reflect the actual performance of the lighting installation.

Compliance with standards and regulations

As noted previously, Building Regulations are currently evolving in a direction that requires energy saving lighting controls to be deployed in both new builds and refurbishments.

When compared to the various other uses of energy in a building, lighting energy is one of the most straight-forward to reduce, by deploying lighting controls. Lighting controls are therefore of particular interest to organisations that are required to participate in government energy saving schemes, such as the Carbon Reduction Scheme and Energy Performance Certificates.

Lighting controls can also assist significantly in complying with regulations relating to emergency lighting.



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A full list of applicable standards and regulations is available from the Lighting Industry Federation.

Emergency lighting

There are legal requirements to ensure that a non-domestic building is safe for its occupants. In practice this means carrying out and maintaining records of regular testing of all emergency lighting. Lighting control systems can, and do, help building managers to meet these obligations. Test systems are available which offer some or all of the following capabilities:

automatically carry out the required regular testing;

do so at times when they are non-intrusive to building users and without affecting building safety;

generate lists of repairs required;

automatically maintain test records;

monitor emergency luminaires between scheduled tests for faults such as lamp failures;

carry out testing using power and control wiring that is common to both emergency and non-emergency lighting, thus reducing installation costs.

Safety, productivity and well-being

The design of a building lighting scheme should provide occupants with a safe, healthy and productive working environment. As already mentioned, energy saving schemes should not prejudice this requirement. A single lighting control system that integrates control of the whole lighting scheme can provide a number of important features:

Safety: corridor lighting can be kept switched on, possibly at a low level, to light the exit routes from occupied areas of a building. This is often referred to as a 'corridor hold' function.

Well-being: there is some evidence that lighting which changes in intensity and/or colour during the day enhances well-being by reinforcing circadian rhythms. There is also evidence to suggest that such techniques can play a part in the recovery of patients in a medical facility. Luminaires that can be commanded to change colour are now available; their control requires an automatic lighting control system.

Productivity: often when only a single zone in an open plan area is occupied, the remainder of the area need not be lit brightly but should be lit. A low level of lighting in the remainder of the area is desirable on several grounds. As well as lighting exit routes, a general level of lighting outside the zone gives a greater sense of security and aids productivity. For tasks involving use of computer displays, large light level contrasts in an open plan area should also be avoided as a health and welfare issue. These issues are addressed in standards such as BS EN12464-1.

In general a comfortable and convenient working environment aids productivity. Research into buildings equipped with lighting control systems has demonstrated that those with most convenient and numerous user overrides contain the most content staff, as well as using less lighting electricity.

The value of local manual controls in saving energy is recognised in the Building Regulations. Part L encourages zoned lighting control and proximity of the switching control to the occupier. Energy savings are enabled because the appropriate lighting can be turned ON and OFF as required. An automatic lighting control system can provide users with a relatively high level of control while ensuring building wide requirements are adhered to, including safety. Various modes of manual operation are described below.

Manual controls and scene setting

In some areas of a building, manual controls are used to select from a prearranged menu of multiple lighting effects – this is known as scene setting. Areas where scene setting is commonly used are conference rooms, lecture theatres and executive offices. In a conference room, scenes typically include those suitable for group discussion, viewing a presentation and so on.

A wide range of manual control devices is available, including:

- Push buttons and switches
- Rotary dimmers
- Remote control panels (radio and infra-red)
- Scene setting plates
- Touch screens
- PC and telephone control

The last three options offer increasing possibilities for integration with other building systems. For example each building occupier may have a ‘soft switch’ lighting control program running on a PC, facilitating local manual control without installing additional equipment. Areas such as conference rooms are often equipped with complete AV installations and these may provide signals to control the lighting in these areas.

Specialist applications

Most of the benefits of a lighting control system presented so far are applicable to most types of building. There is also a range of specialist applications that can be supported by a control system. For example:

in a **shop window**, the artificial lighting may often be turned up, not down, as natural light levels increase, so that the items on display remain highlighted. Dynamic light displays can also be used to attract customer attention, potentially while using less energy than static lighting;

in **museums**, conservation of exhibits requires control of light levels and illumination hours. Lighting can be dimmed when nobody is close to an exhibit. A lighting control system can also record the amount of illumination to which an exhibit has been subjected.

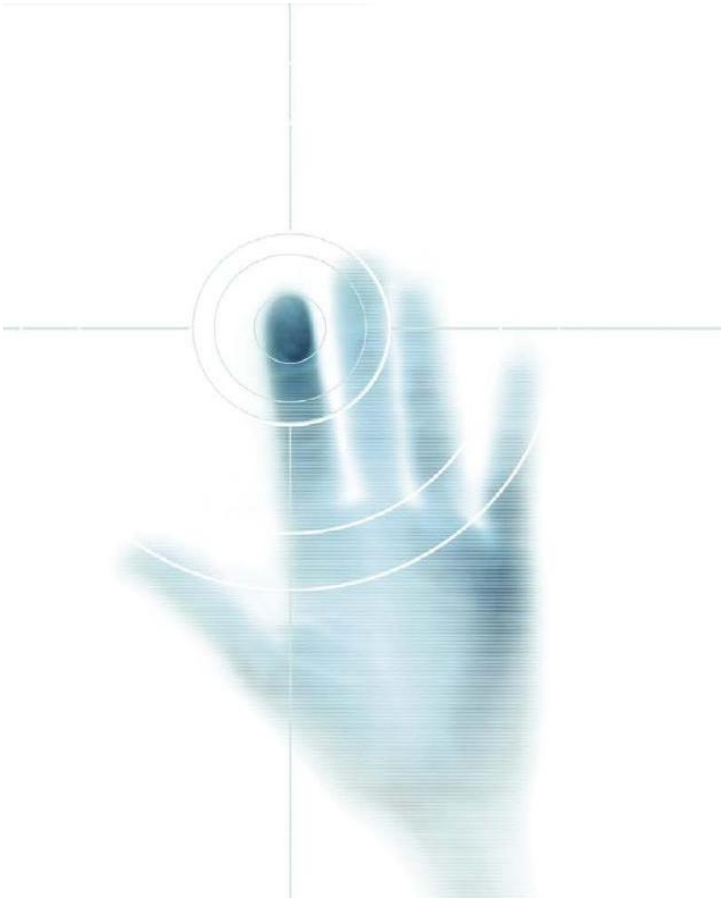
architectural lighting is becoming increasingly popular as part of the aesthetic design of atria, building facades and malls, typically intended to improve viewers' night time experience and the ambience of city spaces. The scope of architectural lighting is limited only by the imagination of the designer and the capabilities of the technology. Architectural lighting can be a significant user of electricity; lighting controls can be used to ensure it is switched off when there is no-one there to appreciate it.

Central management and integration

Integration with other building services has already been mentioned in the context of providing information from movement detectors to save heating/cooling energy - this is currently one of the most popular applications for integration. A lighting control system can also provide benefits by acting on commands from other building systems. For example:

* a lift system sends a command to turn the lighting in a lift lobby on, shortly before the lift doors open at a particular floor;

* a generator or smart meter sends commands for lighting load to be shed.



Load shedding

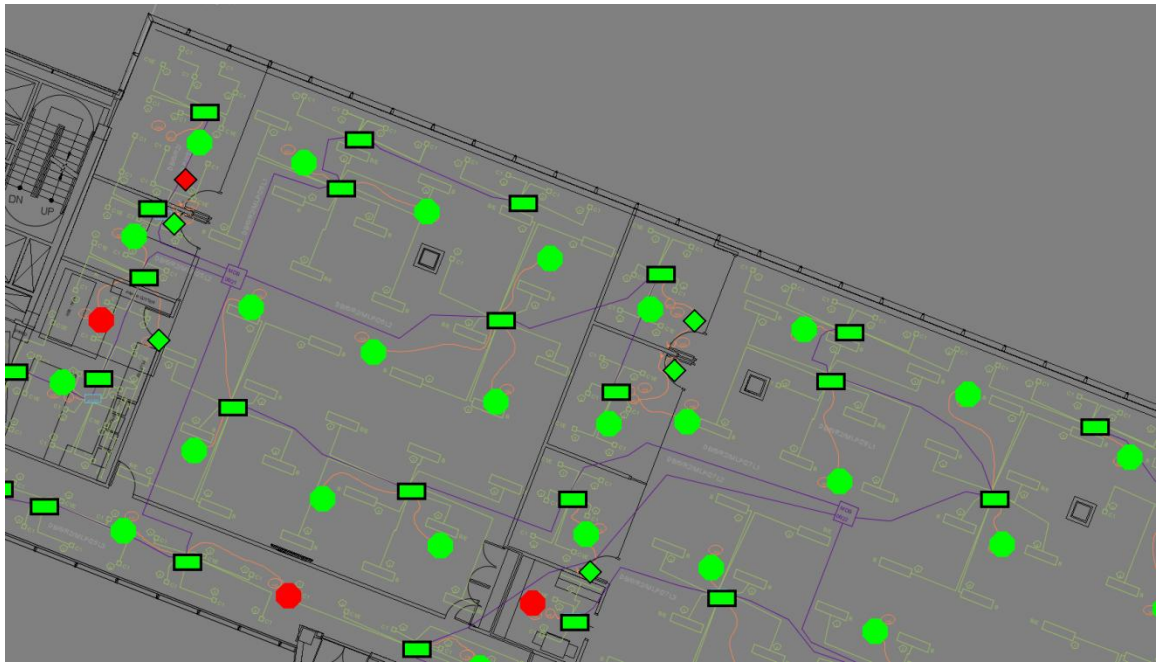
A building may have a generator or other standby facility to provide power in the event of failure of the normal utility supply. During a utility supply failure, often only a set of ‘essential lighting’ is powered – this is an example of load shedding. Historically separate ‘essential supply’ wiring was required to this lighting. In contrast, a lighting control system can switch off or dim non-essential lighting on a signal from the generator. No separate ‘essential supply’ wiring is required, which reduces installation costs.

Utility companies are increasingly using ‘smart tariffs’ to encourage organisations to shed load at peak times. A lighting control system provides the possibility to exploit smart tariffs by dimming or switching off lights at these times, in reaction to a signal from the utility company or from a time control.

Central management and integration

Central management

Many lighting control systems use software techniques to allow the lighting to be programmed from a central lighting control supervisor. Also the central supervisor may provide status displays, alerts for faults, re-lamping recommendations and so on.



A modern building may have a single help desk at which alerts and status information from all building services – heating, lighting etc. – are combined on a single display screen. This is a powerful approach to managing a complete facility in a proactive way. A lighting control system can send signals to allow the help desk screen to display similar status information.

Open Protocols

There are a number of ‘open communications protocols’ that allow different building control systems from different suppliers to exchange information in the ways described above. These vary widely in their true degree of ‘openness’, so that careful technical evaluation is recommended to ensure that the benefits of integration sought are indeed achieved.

The potential to realise many of the benefits of lighting control systems described in this guide has also been significantly enhanced by the emergence of open protocols for control and monitoring of individual light fittings, such as the DALI interface. The intention of such standard interfaces is that any lighting control system can control and monitor any light fitting. Again you should verify that the equipment and interface support the functionality that you require.

This mini guide has set out what can be achieved by deploying a lighting control system. To find out more detail on the design, specification, procurement and installation of a control system, as well as the practical issues and technologies available, please contact the Lighting Industry Federation regarding further guides and training courses.

Acknowledgements

This guide was produced by members of the Lighting Controls working group (LECAP) of the Lighting Industry Federation

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