

Mini Guide
to
Lighting Controls
for
Building Regulations
Part L (2013) Compliance

April 2013

Lighting Industry Association



Overview of this Guide

A revised version of the Building Regulations, Part L will come into force in 2013.

It will require a significant increase in lighting efficiency.

Lighting controls will play a key role in achieving this.

The revised Part L will introduce a new method for measuring lighting efficiency.

It is called LENI (the Lighting Efficiency Numeric Indicator) and it measures the efficiency of the whole lighting installation, not just the components.

Lighting efficiency calculations must be supplied as part of the approval process. In addition, the approval process requires that:

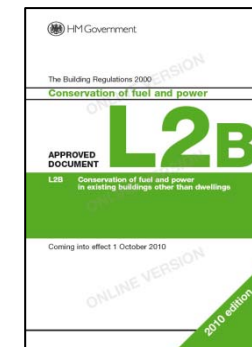
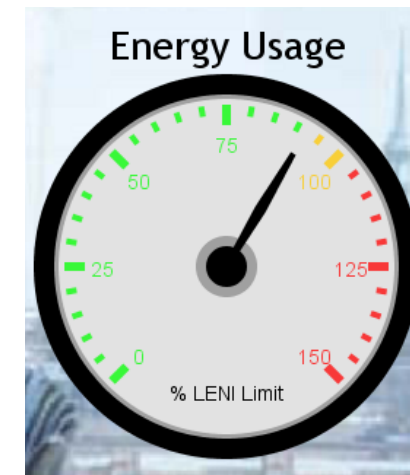
lighting energy use is separately metered throughout the building – usually automatic data collection is also required;

the building occupier is provided with a strategy for ongoing improvement in energy performance.

This guide explains how lighting controls can be used to meet all of these Part L requirements.

This edition of the guide (April 2013) sets out the Part L requirements for 2013 as currently advised by government.

The guide is mainly concerned with compliance with Part L2 – i.e. with buildings other than dwellings. Part L1 deals with dwellings and its controls requirements are addressed at the end of the guide.





Motivation for the Part L changes

Under the Climate Change Act 2008, the UK has committed to legally binding greenhouse gas emissions reduction targets by 2020 - at least 26% relative to 1990 levels.

Part L of the Building Regulations supports this commitment, addressing conservation of fuel and power.

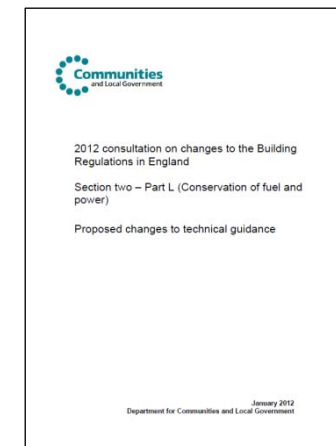
Up to 2010, Part L has concentrated on component improvements in order to reduce emissions. Tighter requirements for insulation and glazing have been a major focus; lighting improvements have been largely focused on individual luminaires.

Lighting **system** improvements are seen as the next big win for 2013. The authorities realise that controls are key to improving lighting performance.

There is a strong business case for deployment of lighting controls and attractive payback times can be demonstrated. However commercial building contracts are usually awarded on the basis of lowest compliant capital cost for the build, not on a whole-life cost basis.

Hence the authorities are taking steps to make lighting controls necessary for compliance.

Planned Timetable for 2013 Regulations



Consultation period ended:
Spring 2012

Final draft:
Spring 2013

Laid before Parliament:
Spring 2013

Coming into Force:
October 2013

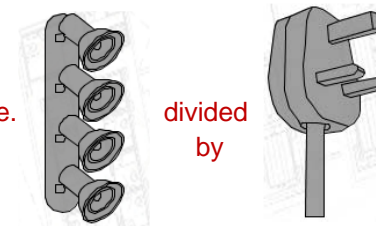
Current Part L Requirements

The 2010 regulations are focused on the efficacy of luminaires.

If no controls are fitted, the minimum performance required is currently 55 LL/cct watt.

Luminaire lumens per circuit watt (LL/cct watt):

- is light power emitted by a fitting, divided by power into the fitting,
- is termed 'luminaire efficacy';
- is the figure of merit for an individual luminaire.



Deployment of particular types of lighting control gives the designer an allowance, permitting use of lower efficacy luminaires.

The regulations permit 'control factors' down to 0.85, allowing use of luminaires down to 47 LL/cct watt.

Allowances are available only for deployment of:

- absence detection;
- daylight harvesting in naturally lit areas.



Absence detection is also known as manual ON, auto OFF

Whereas presence detection is also known as auto ON, auto OFF

If a lighting control system is not fitted, Part L requires 240V light switches to be located within 6m of the lights that they control.



New Efficacy Requirements

In 2013 the standard luminaire efficacy requirement is tightened from

55 to 60

luminaire lumens per circuit watt.

This would put considerable constraints on the choice of luminaires for a lighting design.

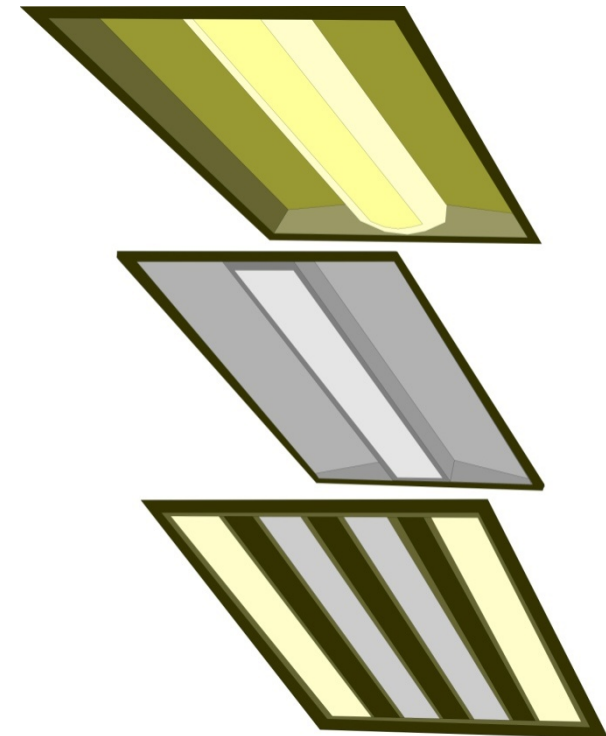
Example luminaires from leading manufacturers (July 2012) compared with the 2013 requirement -

Manufacturer A:

Modular single Lamp	61~71	LL/cct watt	✓
Modular Twin Lamp	50~53	LL/cct watt	✗

Manufacturer B:

Modular 1x55W	62	LL/cct watt	✓
Modular 2x24W	57	LL/cct watt	✗



But there are new, more comprehensive control factors to compensate.

If the maximum control factors are used, minimum efficacy has gone **down** from 47 to **42** LL/cct watt, allowing designers a wider choice of luminaires without compromising energy efficiency.

Other Design Requirements

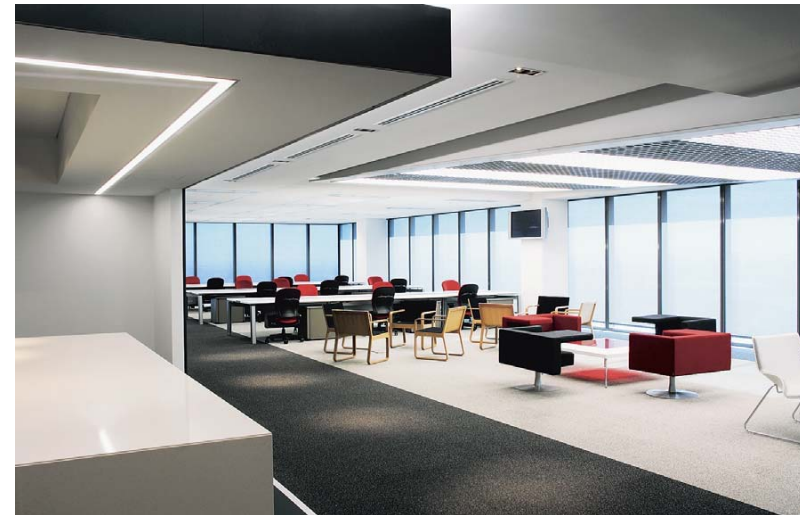
Other standards and requirements prevent the designer from simply deploying the highest efficacy luminaires in order to comply with Part L.

For visual comfort, account must be taken of:

- Adequate illumination of each work task
- Unified glare rating
- Contrasts between task zones and boundary zones
- Brightness of walls and ceilings

See for example EN12464-1:
"The lighting of workplaces"

EN12464-1 is a recommendation rather than a regulation. But it is referenced in current Health and Safety guidance as a test of whether the lighting provided by an employer provides a safe and healthy working environment, which makes it quite a strong recommendation.



Fortunately 2013 introduces a wider range of control factor allowances, allowing designers to achieve both better energy efficiency and a high quality visual environment.

The techniques that EN12464-1 recommends can be used to improve the energy performance of a building once it is occupied, at the same time as providing a pleasant and productive working environment. We will return to these techniques later on.



New Control Factor Allowances

2013 Control Factors for the Luminaire Efficacy Calculation Method:

Table 44: Recommended minimum lighting efficacy with controls in new and existing buildings

Controls	Control factor	Initial luminaire lumens/circuit-watt
		60
		Reduced luminaire lumens/circuit-watt
a daylit space with photo-switching with or without override	0.90	54
b daylit space with photo-switching and dimming with or without override	0.85	51
c unoccupied space with automatic on and off occupancy control	0.90	54
d unoccupied space with manual on and auto off occupancy control	0.85	51
e space not daylit, dimmed for constant illuminance	0.90	54
a + c	0.80	48
a + d	0.75	45
b + c	0.75	45
b + d	0.70	42
e + c	0.80	48
e + d	0.75	45

← Increase from 2010 value – was 55

← Greater credit available for daylight harvesting if it uses dimming fittings

← Allowance now available for presence detection

← New category of allowance: 'constant illuminance'

← Decrease from lowest 2010 value - was 47

For the luminaire efficacy method daylight harvesting and constant illuminance cannot both be claimed as factors in the same space

The figures in this table are the required average efficacy over applicable building areas – i.e. office/industrial/storage

There are different requirements for other types of area and for display lighting – these are unchanged in 2013 and control factors cannot be applied for compliance

Extract from the 2013 technical guidance

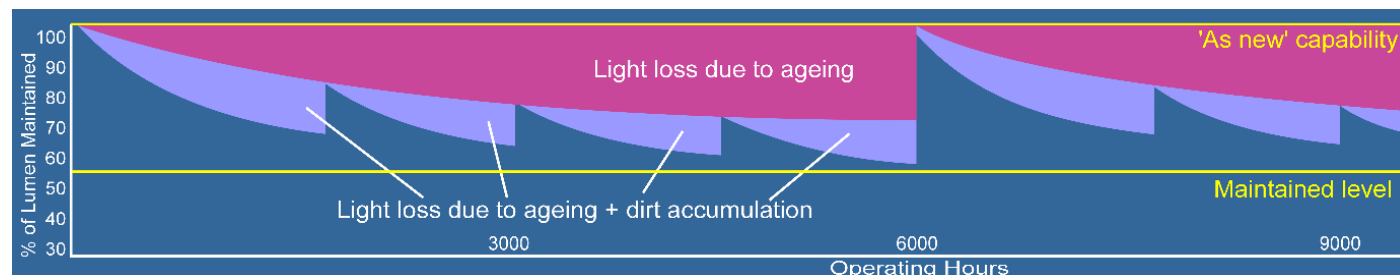
These are the control factors that will apply if luminaire efficacy is used for Part L approval calculations.

2013 will also introduce LENI as an alternative calculation method. The control factors allowed for LENI calculations are different. We will describe LENI shortly.

What is Constant 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 **minimum** required level throughout the whole design life of the building. 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.

Maintained illuminance level, measured in lux, is the minimum 'amount of light' that is required to fall on a square metre of an object that is being lit, such as the surface of a desk. The maintained level may be as low as 50% of the 'as new' capability – meaning the scheme is 100% overlit on day one. Overlighting may be increased still further due to component variations – e.g. 'equivalent' ballasts that generate light levels differing by 15% or more into the same lamp.



A constant illuminance system is a system where the **maximum** artificial illumination is limited to the maintained level required in each area and is adjusted over time as components age and on cleaning and relamping.

Constant Illuminance vs Daylight Harvesting

Constant Illuminance means limiting the maximum output of artificial lighting to that required for a task

- Long term adjustments
- Initial calibration and ongoing adjustment measurements required during hours of darkness
- Measurements can be manual or automatic

Whereas daylight harvesting dynamically reduces artificial lighting when natural light is available

- Short term reactions to each day's weather patterns and daylight behaviour

Both techniques can be deployed in the same space to provide compounded energy savings

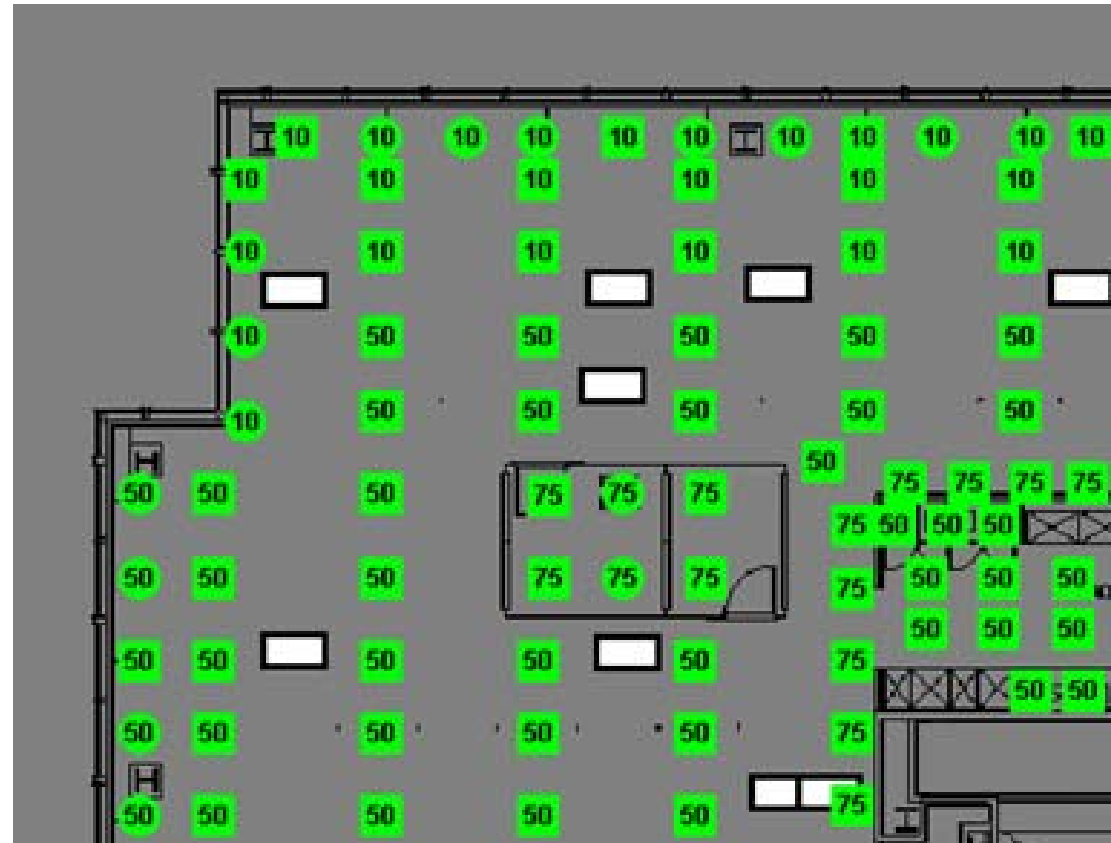
Effect of Constant Illuminance

This best practice example illustrates the energy savings available by dimming lighting down to the maintained level.

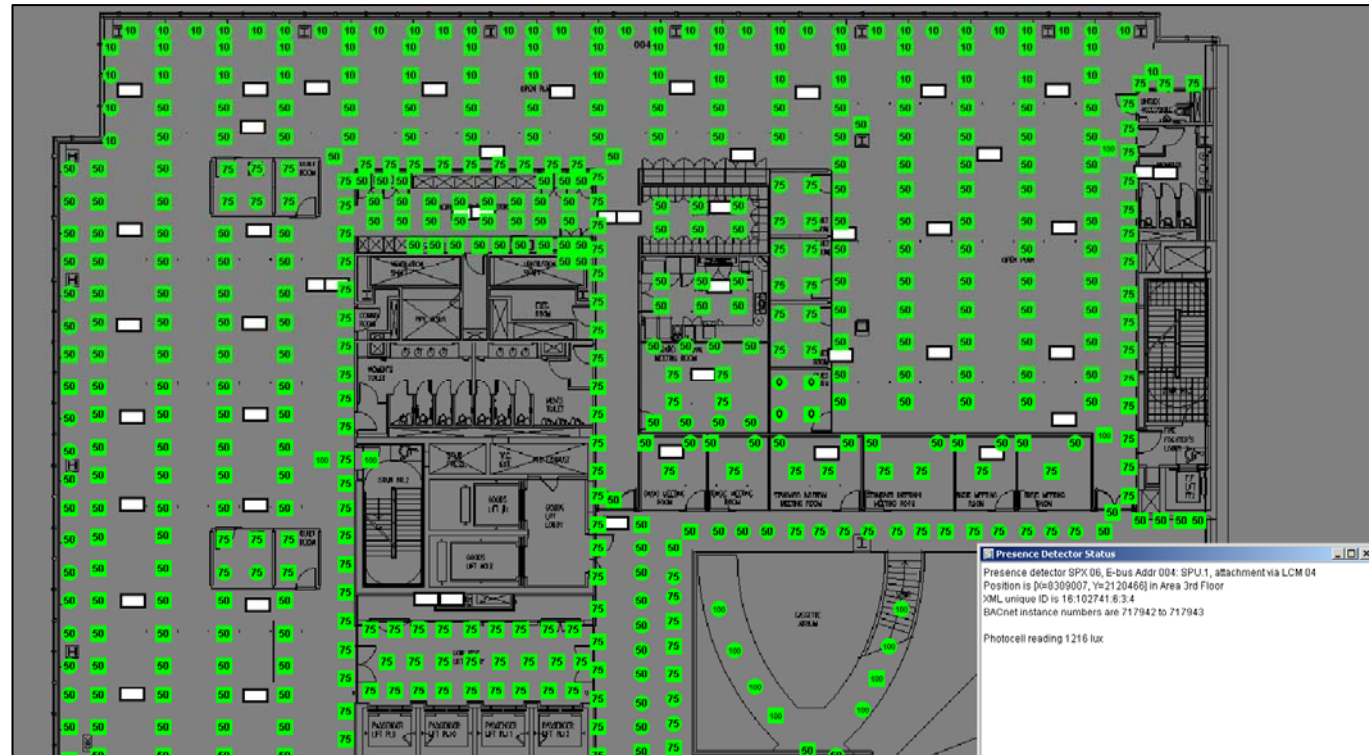
The green icons represent luminaires and the numbers are current % of full output levels for each luminaire.

In the body of the building the luminaires are all on at their maintained levels. Keeping lighting down to the maintained level produces long term savings. These were the levels in use in the building three years after fit-out.

This example was recorded on a weekday afternoon. The sun was shining from the top of the figure, so that the top rows of luminaires have been dimmed down further on account of the natural light available.



Effect of Constant Illuminance



A wider view of the same building shows that there are energy savings through the whole building due to constant illuminance, at all times the building is occupied.

In this case daylight harvesting is providing a lesser effect – along one edge of the building only – but this example is a ‘deep plan’ city office block, located where floor space is very expensive. Other building designs will have a greater proportion of natural light available.

Achieving Constant Illuminance

Calibration and Adjustment

A constant illuminance system requires initial calibration – measuring the light level on the objects being lit and adjusting the maximum luminaire outputs until that light level is down to the maintained level.

It then requires regular adjustments – rechecking the light level on the objects being lit and adjusting the maximum luminaire outputs to keep the light level at the maintained level.

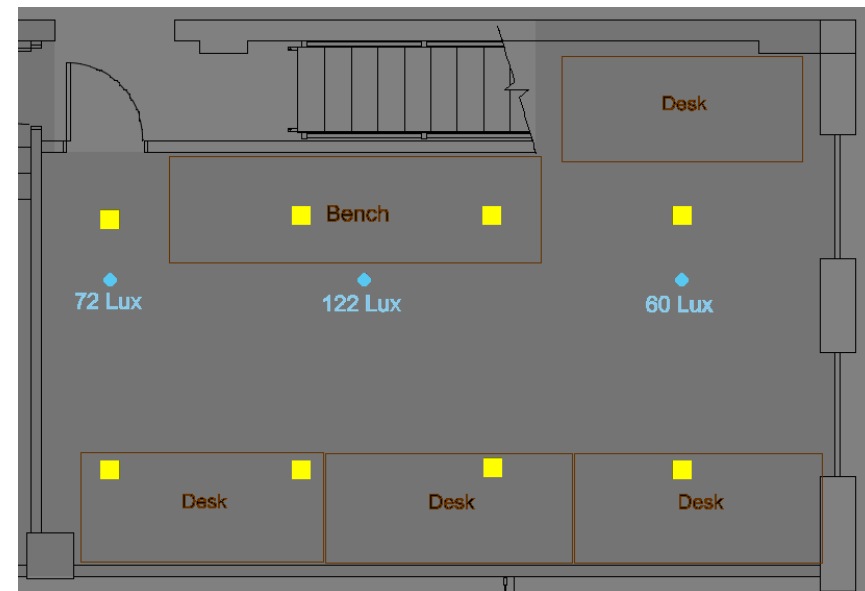
These measurements need to be carried out at the objects being lit – a measurement at the ceiling, for example, is not acceptable. A real example will help to illustrate this.

The room shown on the right has 8 luminaires (yellow) and 3 ceiling-mounted combined occupancy/photo detectors (blue).

The ceiling detectors have been carefully located for their original purposes - good response to occupancy and to sunlight changes.

In this room the carpets are dark, the desks are light brown and the bench has silvery objects on it – but the silvery objects were not there the previous week.

The lux measurements shown were made by the ceiling-mounted detectors with the room unoccupied and all lights on in hours of darkness. All desks were well lit at the time.



In this example constant illuminance is required on the desks (the ‘working plane’), not on the carpets or the ceiling. The ceiling measurements simply do not reflect the lighting on the desks.

Calibrating illuminance in the working plane requires . . .

. . . measurement in the working plane.

Lighting control zones

Part L (2013) specifies that lighting controls are to be fitted to new and refurbished buildings according to the guidance in BRE Digest 498, 'Selecting Lighting Controls'.

A building is divided into zones according to:

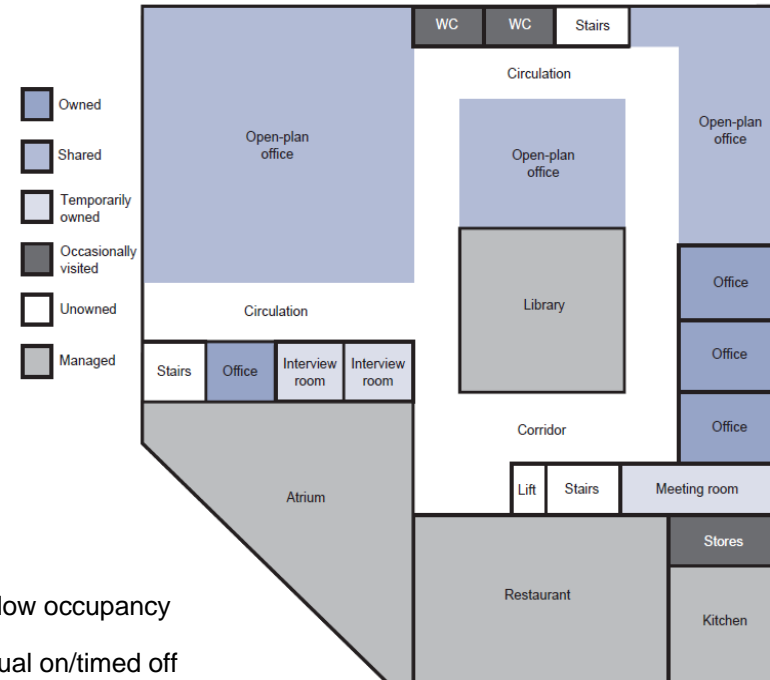
- 'ownership'/use (office/corridor/meeting room . .)
- availability of natural light

Appropriate controls are then selected for each zone.

For example:

Corridor

- Category: unowned, non-daylight, low occupancy
- Recommended technique: presence detection
- Also consider: absence detection, manual on/timed off



Extract from BRE Digest 498

If Part L compliance is to be demonstrated using the new LENI methodology, the building must also be zoned so as to reflect the type of task carried out in each zone and hence the appropriate maintained illuminance for the zone.

Appropriate illuminance levels are set out in EN12464-1. For example:

- Reception desk: 300 lux
- Writing, typing, reading, data processing: 500 lux
- Assembly of IT equipment: 750 lux



What is LENI?

LENI methodology calculates energy usage per m² and compares it to a Part L allowance

LENI is the *Lighting Energy Numeric Indicator*

It promotes efficient use of lighting, not just efficiency of individual lighting components.

LENI was first defined in EN.15193-2007 - in this standard the LENI calculation is highly complex

Part L(2013) uses a much simpler LENI calculation

- It is based on standard rule-of-thumb control factors
- These are similar to the factors for luminaire efficacy, but are more generous

The LENI methodology

Divide your building into zones, according to:

- task type – and hence required illuminance
- daylight availability
- annual usage

Calculate annual 'all lights on' power for the annual usage for each zone

Discount by applicable control factors

Add a fixed allowance for standby power consumption

Compare the result with the Part L allowance

LENI control factors:

Occupancy Factor (Fo)

if an automatic control system detects the presence or absence of people in a room and switches off the lights when there is nobody using the room, within 20 minutes of the room being empty

Factor for Daylight (Fd)

in zones with adequate daylight, if the electric lighting dims in response to daylight being available

Constant Illuminance Factor (Fc)

in zones where a constant illuminance system is implemented and operated

Both Fd and Fc:

- can be claimed for the same zone
- require dimming luminaires to be fitted throughout the zone

Effectively, the power that would be used if the first person into the building each day switched all the lights full on and the last person out turned them all off.

In 2013 the option to use LENI methodology for compliance runs in parallel with the option to use the luminaire efficacy method.



LENI Allowances

maximum lighting energy consumption kWh per sqm per year		
Illuminance (lux)		
Hours	300	500
1000	5.17	8.41
1500	7.70	12.53
2000	10.24	16.67
2500	12.79	20.82
3000	15.37	25.01
3700	19.01	30.95
4400	22.73	37.00
5400	28.18	45.89
6400	33.87	55.16
8760	48.43	78.96

Extracted from the 2013 technical guidance

The LENI allowance for a zone is an annual energy budget per unit area.

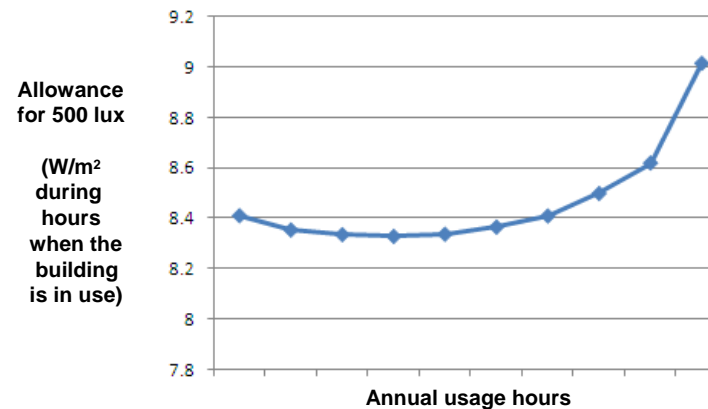
Part L provides a table of values, dependent on:

- maintained illuminance level – determined from the task type
- annual usage

The table extract on the left shows allowances for:

- 300 lux – e.g. reception desk
- 500 lux – e.g. general office

These allowances can also be expressed as power consumption per unit area, in W/m^2 during hours when the building is in use. The graph below shows that, for a specific illuminance level, the power consumption allowance per unit area expressed in this way is approximately independent of annual usage hours.



So it is vital to identify the correct task type for LENI calculations, but accurate prediction of annual use is much less important.

For very high annual usage (the right of the graph above), the W/m^2 allowance for hours when the building is in use rises as this includes a greater proportion of hours of darkness. But this is only relevant to around 1% of applications.

Benefits of Using LENI

Benefits to the regulator:

LENI measures the thing that really matters -
Energy usage per m² is the true figure of merit for a lighting installation.

Benefits to the designer:

Using the LENI method, desired lighting effects can be achieved using a range of luminaire types, provided that the design as a whole comes within the LENI allowances.

Whole-building energy compliance calculations must be done in W/m² anyhow, so that use of LENI for lighting compliance calculations is a logical, complementary step.

The full LENI calculation will be set out in the Part L technical guidance document.

In practice the calculation will be done using graphical software tools.

The designer can design a few sample areas (open plan office, corridor etc.) and check their LENI performance.

Once the sample areas comply, the whole building design is then specified and checked.

In practice, these same steps must be followed for a calculation using the luminaire efficacy method, since that calculation requires the total number of luminaires of each type in the building to be known, in order to calculate an average efficacy for the building.

Benefits to the building owner/user:

LENI can be calculated at design time.

It can then be measured in the live building.

This approach provides:

- the basis for ongoing energy improvements;
- a route to compliance with Part L
'recommendations report' requirements.





Part L Recommendation Reports

Once the design of a building meets the Part L requirements and it is built, Part L requires that the whole lighting system, including its controls, is tested to ensure that it performs as the designer specified. CIBSE 'Commissioning Code L' sets out how this should be done. After commissioning, Part L then also requires that an ongoing energy improvement strategy is in place.

6.3 ... The occupier should... be provided with the recommendations report generated in parallel with the 'on-construction' Energy Performance Certificate. This will inform the occupier how the energy performance of the building might be further improved.

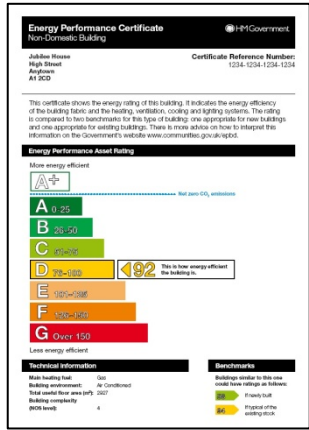
Extract from 2010 Technical Guidance

The energy certificate provided for a non-domestic building will inform the landlord/occupier of a strategy that has been devised to provide ongoing improvements in the energy performance.

Lighting controls can be used as the basis for this strategy, at the same time as meeting the requirements for sub-metering.

Sub-metering means providing separate metering of the electricity consumption of each major class of usage – which will always include lighting.

In 2013, sub-metering should follow the guidelines in CIBSE TM39, which normally means recording energy usage each half hour.



Administrative Information	
This is an Energy Performance Certificate as defined in BS5901:2001 as amended	
Assessment Software	ESDM 2.1a
Issuing Reference	10112271812
Assessor Name	John Smith
Assessor Number	AB012345
Accreditation Reference	ABC Accreditation Ltd
Employer/Trading Name	EnergyMaster Ltd
Employer/Trading Address	John Smith, New City, Birmingham, B1 1AA
Issue Date	01 Dec 2008
Valid Until	01 Dec 2016 (unless automatically a new certificate)
Related Party Information	EnergyMaster are contracted as Building Manager
Recommendations for improving the property are contained in Report Reference Number 1234-1234-1234-1234	
If you have a complaint or wish to confirm that this certificate is genuine	
Details of the assessor and the relevant accreditation scheme are on the certificate. You can get contact details on the accreditation scheme from the government's website on energy certification guidelines, together with details of the procedure for confirming authenticity of a certificate and for making a complaint.	

Metering Requirements for Lighting

The table on the right lists the three metering options set out in Part L.

Of these three options, the use of kWh meters on dedicated lighting circuits is generally an expensive option – not just for the meters themselves but also the cost of separating out the different services on all distribution boards.

Various common and useful practices, such as running extractor fans and fan coil units from the lighting control infrastructure, can no longer be used where Part L compliance is achieved using kWh meters.

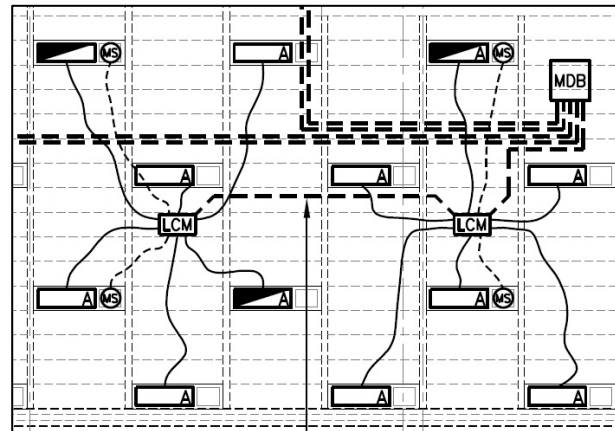


Table 46: Recommended minimum standards for metering of general and display lighting in new and existing buildings

	Standard
Metering for general or display lighting	<ul style="list-style-type: none"> a. kWh meters on dedicated lighting circuits in the electrical distribution; or b. local power meter coupled to or integrated in the lighting controllers of a lighting or building management system; or c. a lighting management system that can calculate the consumed energy and make this information available to a building management system or in an exportable file format. (This could involve logging the hours run and the dimming level, and relating this to the installed load.)

in buildings with a **total useful floor area** greater than 1000m², automatic meter reading and data collection facilities.

Extracts from
2010 Technical
Guidance

Lighting controls can be used to implement either of options b. or c. In both cases the lighting control system will need to be of a networked type, for those buildings where the automatic data collection requirement applies.

The basis for option c. is that the lighting control system is responsible for turning all lights on and off and for dimming them, so that it can satisfy the requirement by logging what it does.

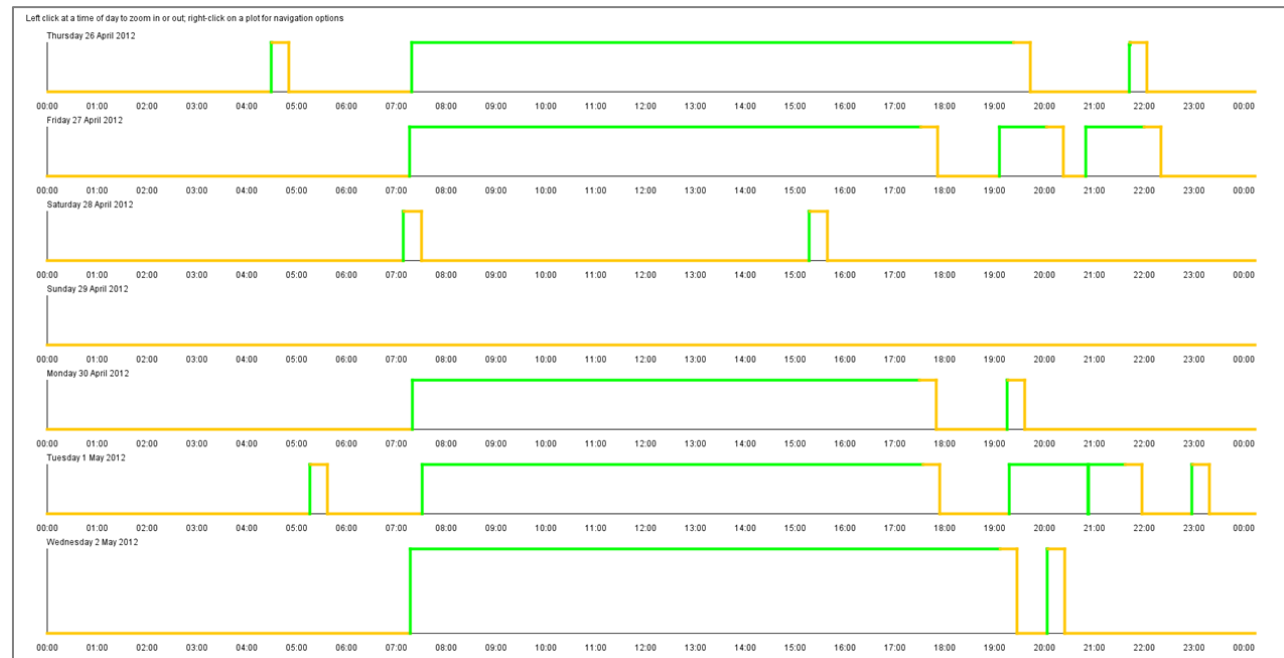
Option c. has the advantage that it enables logging energy usage by LENI zones – it can do this even after a building refit, since logging can track the zones rather than the wiring.

Metering Analysis: Building Usage

Data collected from a lighting control system can be used to analyse and improve the energy performance of a building.

A typical cycle will be to:

- measure and analyse energy use;
- make changes to the control regime as suggested by the analysis;
- measure again and compare results.



An important piece of information available from the lighting control system is actual building usage.

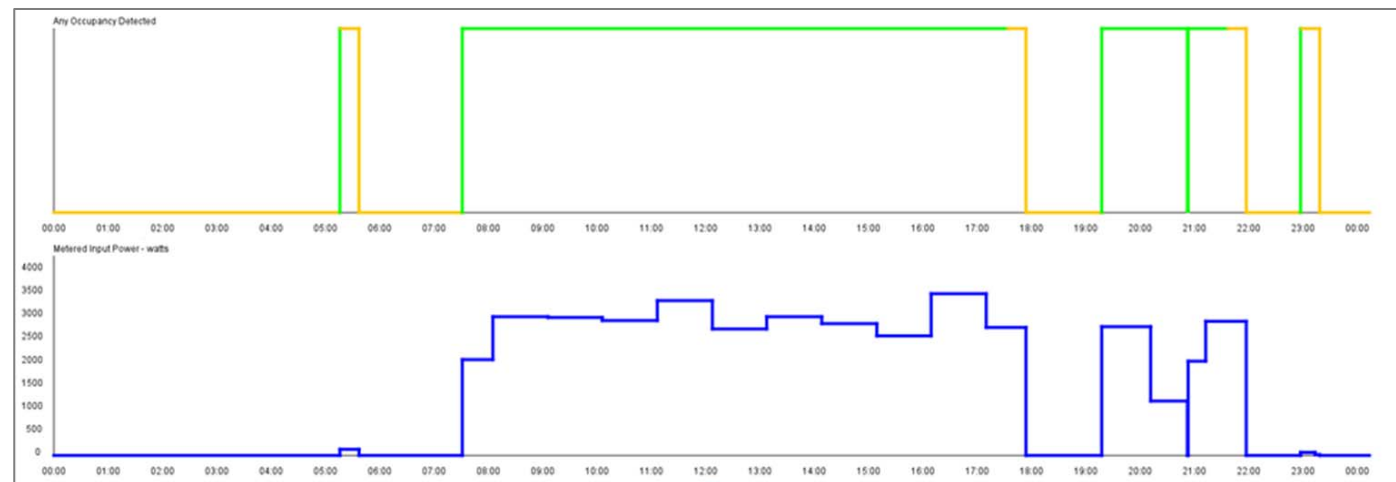
Many lighting control systems can provide this information provided there are presence detectors attached to the control system – this is increasingly common since their deployment is necessary in order to claim the corresponding controls factor during Part L approval.

The figure above shows actual occupancy of a building over a week (in this case from a Thursday to a Wednesday) as collected from the presence detectors. Occupancy is not in the Part L metering requirements but is relevant for performance improvement.

Energy usage against occupancy

A very important question that any facilities manager should ask is:

'How does energy usage match building occupancy?'



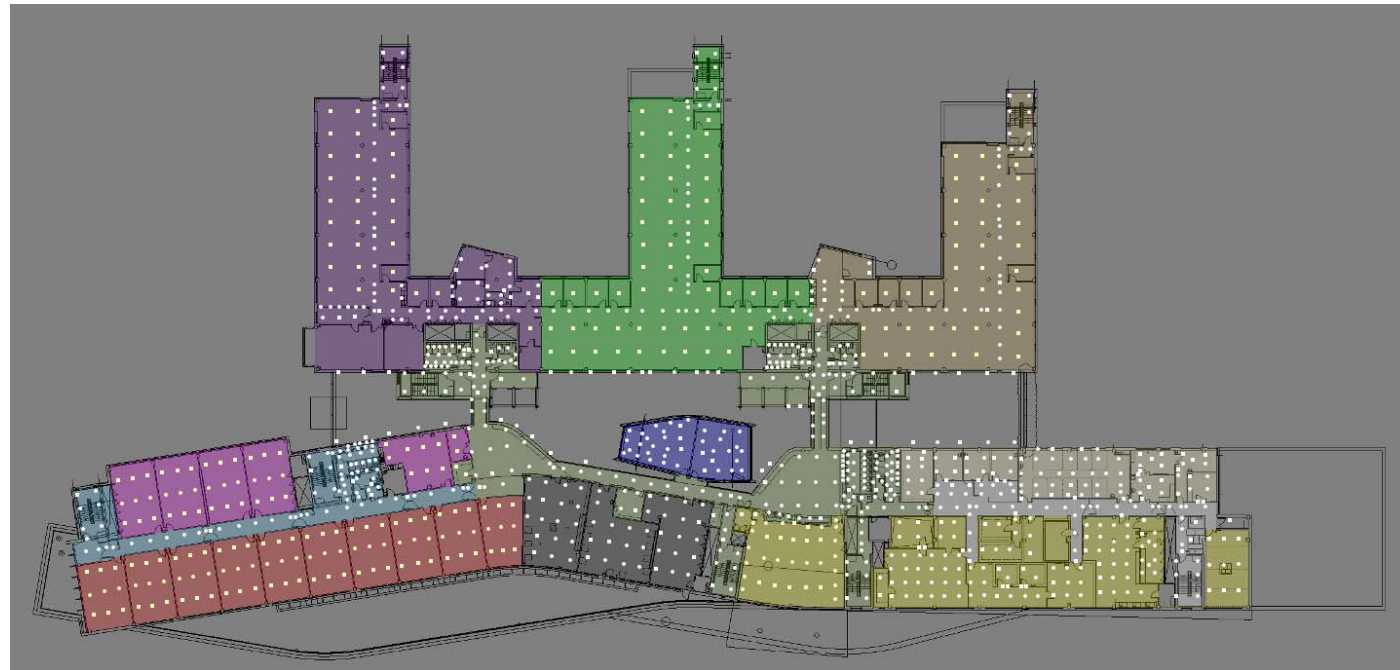
Some lighting control systems can provide all the data to answer this important question.

The example above shows the effects of employing a well-adjusted lighting control system.

- Lighting power (the blue line) directly correlates with occupancy of the building (the green line);
- The building has localised controls in use; these are acting to ensure that lighting is on only in areas and at times where it is needed. This is reflected in the fluctuations in the blue line. The effect on overall energy use is clear.

Spatial Analysis of Energy Use

Some lighting control systems are spatially aware – i.e. they understand the layout of a building and the locations of the light fittings within it. This type of system can provide energy usage information by zone, expressed in terms of Part L LENI targets.

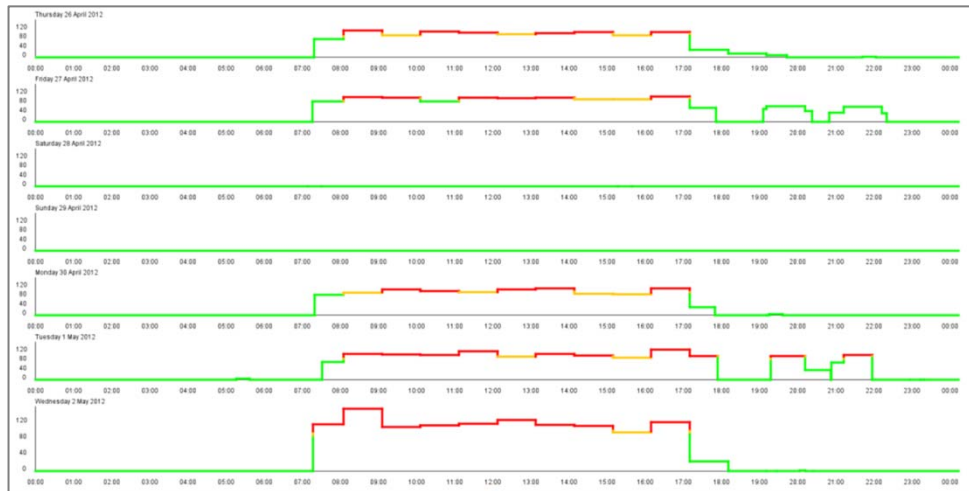
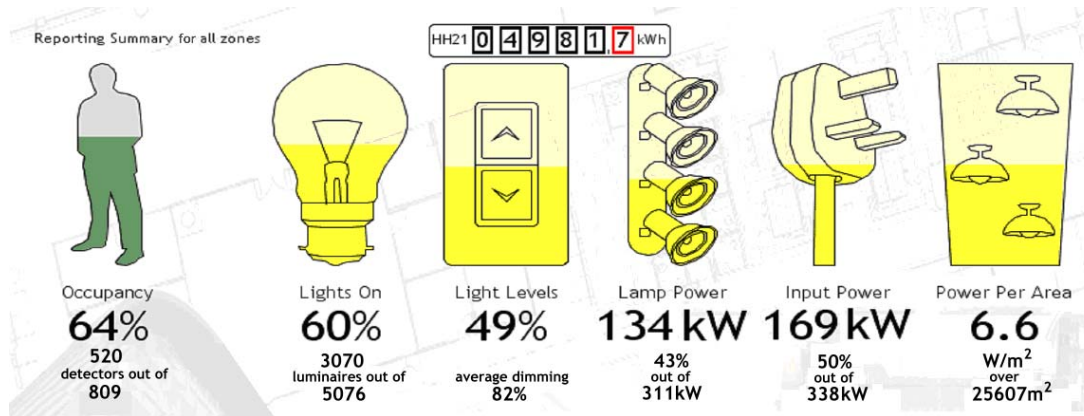


This figure shows a building that has been divided into monitoring zones, following the requirements for Part L approval using LENI methodology.

The live building is now being monitored in zones and their performance is being compared with the Part L LENI allowances.

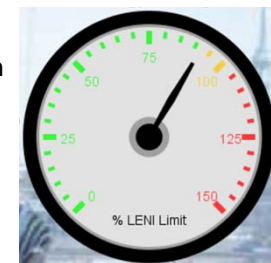
Performance against LENI Limits

This illustration shows the instantaneous performance of a complete building, including the key figure of merit – energy usage per m².



This illustration shows the performance of a complete building over a week, measured against the LENI allowance expressed in W/m² during hours when the building is in use.

This data in turn can be used to obtain the overall performance for the whole week.



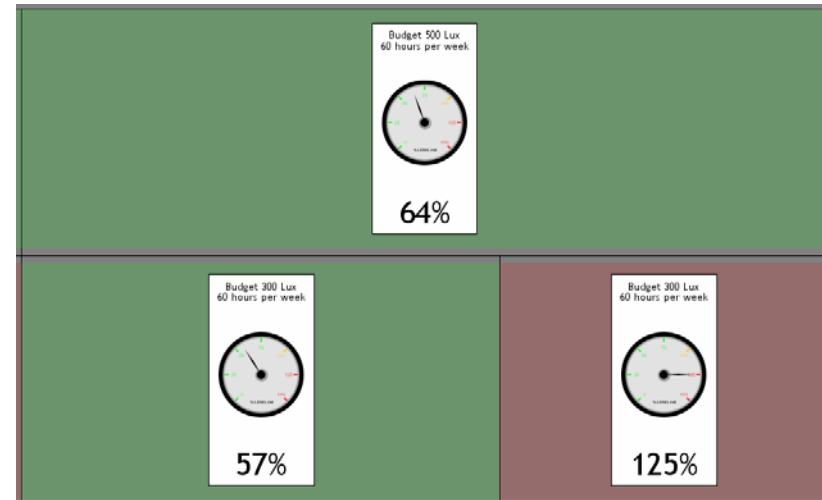
Analysis by zones

Performance breakdowns by zone can be used to locate problem spots in a building.

They enable the facilities manager to target improvements to the lighting control regime.

This illustration shows a building where one particular zone was performing badly.

Analysis of the key parameters for that zone showed that there was very little dimming in that zone. This suggested a check to see if the zone was overlit.



Weekly Energy Use as % of LENI Limit	125
Average dimming for lights that are on - %	97

The metering data gathered by a lighting control system can be used to project annual energy bills and to show:

- the energy savings that are attributable to the different control techniques in use;
- how these techniques vary in effectiveness in different zones in a building.

Without controls	Add area occupancy control	Add local control	Add adjusted illuminance
£2614	£2009	£1648	£989

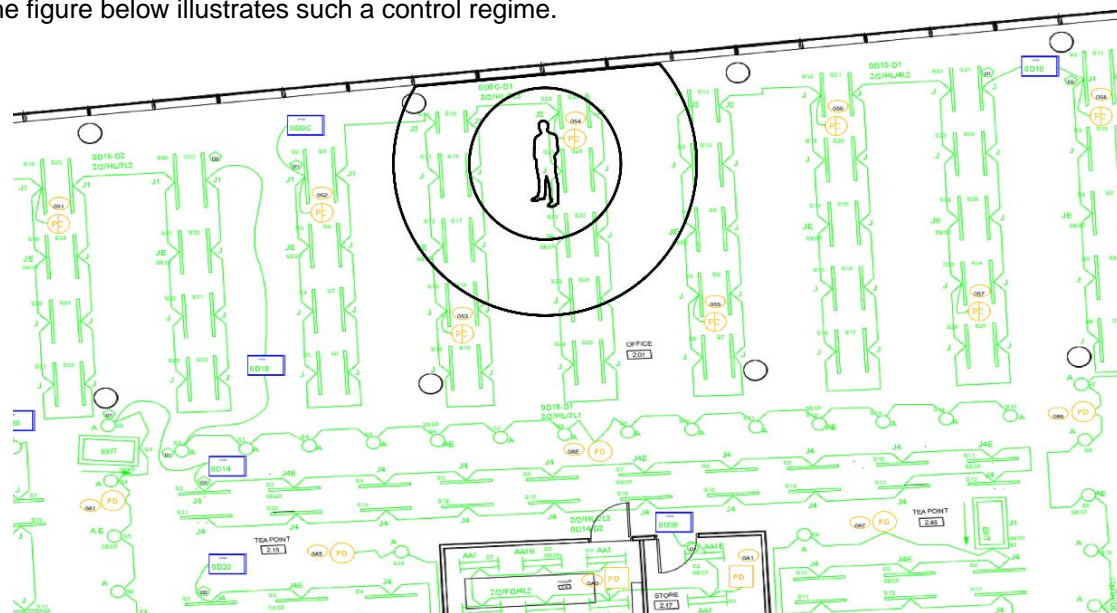
Actual energy cost figures for a 400m² zone

Performance Improvement Techniques

Studying the savings attributable to the different control techniques will provide important information to help improve the energy performance of the lighting. Two other important sources of techniques are:

- the different control regimes recommended in BRE digest 498 for each zone type – is the most appropriate technique being used in each case?;
- the lighting design guidelines in EN.12464-1. This standard includes techniques for providing a pleasant working environment while at the same time also saving energy.

For example, an open plan office area may be occupied at only a few positions; at these positions a maintained level of 500 lux should be provided. It is unacceptable for the surrounding space to be unlit, but it can be lit at below 500 lux. EN-12464-1 defines acceptable contrast ratios for near and far surrounding spaces. A lighting control system can be used to light the whole area to appropriate levels automatically, in response to occupancy detected in particular positions. The figure below illustrates such a control regime.



Overall Energy Management

Facilities managers are increasingly concerned with managing the energy used by all building functions, of which lighting is just one.

This need is being met by a range of products generally known as EMSs or Energy Management Systems.

On one hand there is a benefit to using a single EMS to aggregate all energy usage. On the other hand, when measures to improve the performance of the lighting are being considered, a tool which is tailored to analysing and refining the lighting control regime is highly desirable.

This conflict can be resolved by using open protocol interfaces to feed energy usage data from the lighting control system to the 'umbrella' EMS. The EMS can integrate the whole building performance, while the lighting control system can generate performance improvements.



Energy Usage versus Occupancy

We have already seen that this correlation provides key information to help improve energy performance for lighting. The same is true for other categories of energy usage, for example heating/cooling and information technology (desktop computers etc.). These are both significant consumers of energy which should be checked against occupancy.

Presence detectors are normally attached directly to the lighting control system, because the lighting needs to react in real time as soon as occupancy is detected.

Open protocols can be used to convey this occupancy information to other building management systems, including to the EMS where it can be correlated with all categories of energy use.

Controls for Domestic Dwellings

So far this mini guide has concentrated on Part L2 – i.e. on buildings other than dwellings. This is because most of the controls requirements are in Part L2, as are all of the new requirements being added in 2013.

The controls requirements in Part L1, for domestic dwellings, are simple and they all concern exterior lighting.

All exterior lamps must be controlled such that they switch off automatically when daylight is sufficient. They must also switch off automatically when the area they are lighting becomes unoccupied, except in the case of high efficacy lamps which may be manually controllable.

A 'security light' is a common example of an exterior light fitting with both daylight and occupancy detection.



The only Part L requirement for interior domestic lighting is that a proportion of the lamps fitted must be high efficacy lamps.



More about lighting controls . . .

This mini guide has focused on the use of lighting controls to comply with the evolving requirements of the Building Regulations, Part L.

There are many other benefits to deploying lighting controls that have not been touched on in this guide.

For more general information on lighting controls, please see the:



available at www.thelia.org.uk, along with details of training courses and more extensive guides both to lamps and to lighting controls.

Timescales for Part L(2013):

At the time of publication of this guide, the best information available to the Lighting Industry Association is that:

- the final draft of Part L(2013) will not be available until Spring 2013;
- the sections relating to lighting will be unchanged from the Spring 2012 consultation document;
- some small amendments to the 2010 regulations are expected but these do not include stipulations or parameters relating to lighting.

All references in this guide to the 2013 regulations are taken from the Spring 2012 consultation document.

This guide was produced by members of the Lighting Controls working group (LECAC) of the Lighting Industry Association.
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