prEN 15193

To calculate energy usage for lighting (W_{total})

The total energy consumed for lighting is calculated according to the formula and is stated kWh/year: $W_{total} = W_{light} + W_{parasitic}$

W_{light} is the estimated energy consumption to power the lighting in the building during a given period. All light sources and ballasts included.

$W_{parasitic}$ is the estimated energy used when the lighting is extinguished. That is to say, the energy used by the ballast in standby mode or for charging emergency luminaires.

Which factors affect the lighting's output in operation, W_{light}?

W_{light} is affected by the following factors

P_n is the total installed lighting output within a room or zone, measured in watt ($P_n = \sum P_i$)

F_C is a correction factor for constant illuminance in a room or a zone.
F_C is affected by:
- maintenance factor (β)
- maintenance plan.

When constant light control is used:
F_C = (1+retention factor)/2, otherwise the standard value 0.9 is used.

F_D is a correction factor for daylight. F_D relates use of the total lighting output to the availability of daylight in the building.

F_D is affected by :
- the daylight factor (amount of daylight)
- illuminance
- type of control

F_O is a correction factor depending on presence. F_O relates use of the total lighting output to the availability of presence time in the building.

F_O is affected by:
- presence/absence
- the type of control
- total utilization time (t tot) day+night (t_N+t_D)

The formula to calculate the energy consumption: $W_{light} = [\sum(P_n \times F_C) \times [(t_D \times F_D \times F_O) + (t_N \times F_O)]] / 1000$ kWh/m², year

Which factors affect the lighting's output when it is extinguished, $W_{parasitic}$?

$W_{parasitic}$ is affected by the following factors

Emergency lighting system

P_{em} charging power for emergency lighting-within the building.

t_{em} is the charging time for emergency lighting (standard value for t_{em} is 8760 h/year)

Control system

$P_{light\text{-}off}$ parasitic "standby" power for control equipment when the lighting is in the "off position".

$t_{light\text{-}off}$ time when the lighting is in the "off position" [t_Y - (t_D + t_N)] (standard value for t_Y is 8760 h/year)

The formula to calculate the parasitic energy: $W_{parasitic} = [\sum P_{pc,\ Light\text{-}off} \times t_{Light\text{-}off} + (P_{em} \times t_{em})] / 1000$ kWh/m², year

Ex. 1 Calculated energy usage for the lighting of offices

The example is calculated according to prEN 15193 Lighting Energy Estimation

Example cellular office 2.4 x 4 m

Lighting planning

In accordance with the European standard for lighting indoor workplaces EN 12464-1 and the UK lighting guide LG7.

Average illuminance in operation ≥ 500 lux on the working plane and ≥ 300 lux within the immediate surroundings.

Lighting solution

A cellular office with a workplace oriented pendant, equipped with Ten Lamell 2 x35 W.

LOR 74.9 % Circuit watts 77 W.

Part L 2 luminaire-lumens/ circuit watt calculation 75.5 (incorporating L2B control factor).

Control system

- Daylight/Constant light control.
- Absence control.

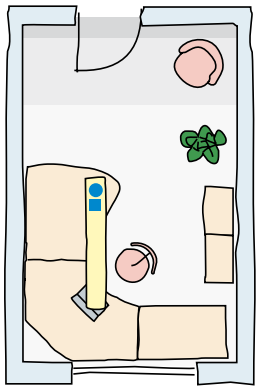
Energy usage

W_{light} 47 kWh/year

$W_{parasitic}$ 9 kWh/year

W_{total} 56 kWh/year

$LENI_{sub\text{-}area}$ 5.8*



A cellular office where we have used a position oriented lighting system with a T5-luminaire where the lighting is oriented according to the workplace. Control is integrated in the luminaire. During the entire usage time which is normally 20 years for a lighting installation, light control represents a saving of in total 1690 kWh compared with the same room with manual On/Off control during the same period.

W_{total} with traditional manual On/Off control is calculated to 140 kWh/year, a saving of 60 % is attained in the example by using control.

**The LENI number is normally an indicator for the whole building's energy efficiency. The value has been broken down to a sub-area for comparison between different sub-areas.*

Ex. 2

Example two person office 4.8 x 4 m

Lighting planning

In accordance with the European standard for lighting indoor workplaces EN 12464-1 and the UK lighting guide LG7.

Average illuminance in operation ≥ 500 lux on the working plane and ≥ 300 lux within the immediate surroundings.

Lighting solution

A two person office with localised general lighting with four recessed Multifive Beta 1x28 W luminaires.

LOR 87.2% Circuit watts 33 W.

Part L2 luminaire-lumens/circuit-watt calculation 80.8 (incorporating L2B control factor).

Control system

- Daylight/Constant light control.
- Absence control.

Energy usage

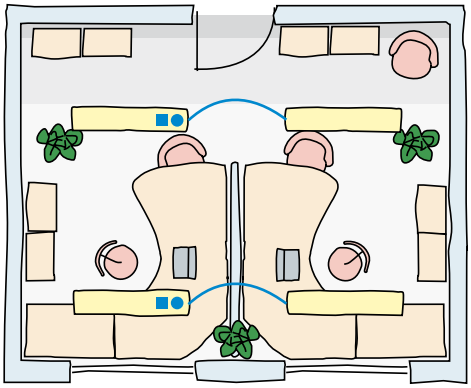
W_{light} 87 kWh/year

$W_{parasitic}$ 30 kWh/year

W_{total} 117 kWh/year

$LENI_{sub\text{-}area}$ 6.1*

**The LENI number is normally an indicator for the whole building's energy efficiency. The value has been broken down to a sub-area for comparison between different sub-areas.*



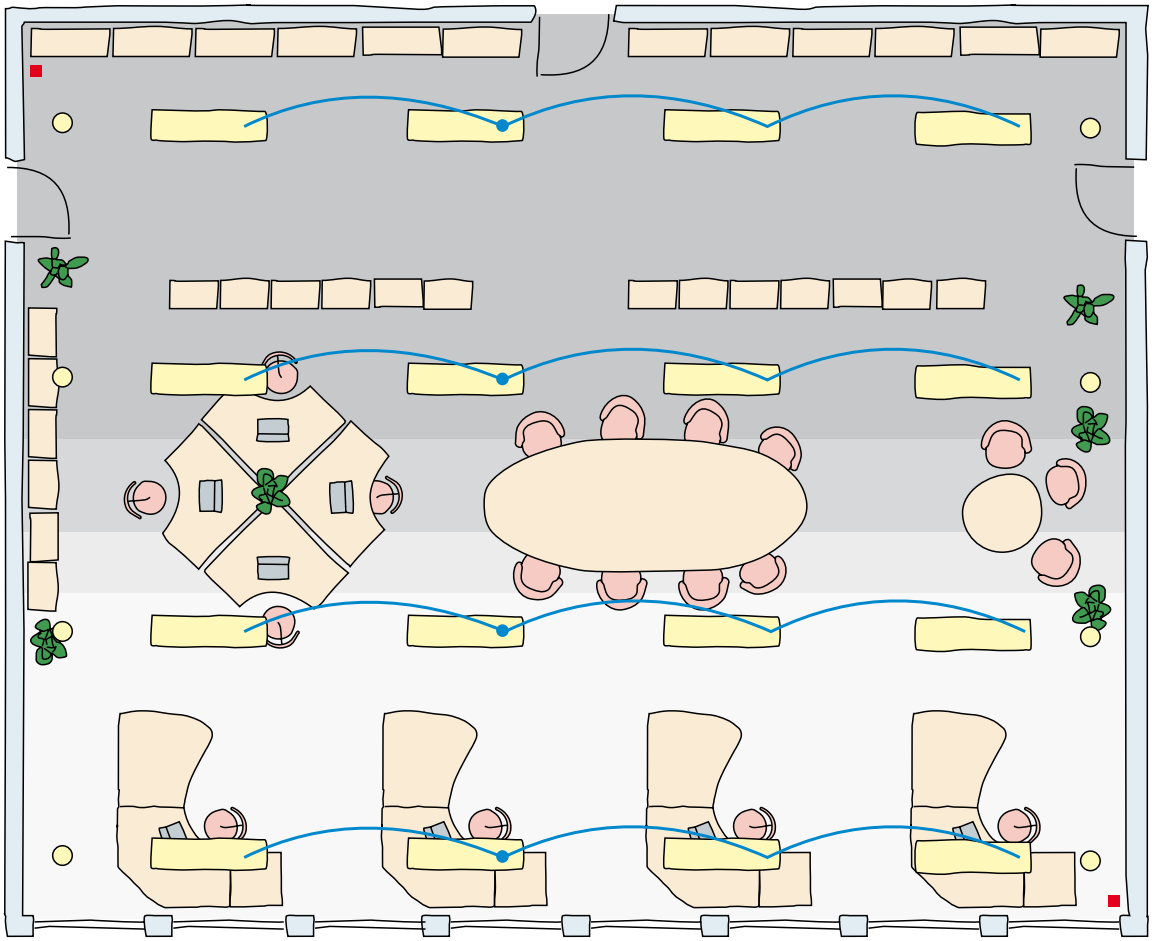
An office where we have used a localised general lighting system with four T5 luminaires. Control is integrated in two of the luminaires and these control the other luminaire in the same zone.

During the entire usage time which is normally 20 years for a lighting installation, light control represents a saving of in total 2090 kWh compared with the same room with manual On/Off control during the same period.

W_{total} with traditional manual On/Off control is calculated to 222 kWh/year. The saving in this instance is 47 %.

Ex. 3 Example of the implementation of prEN 15193

The example is calculated according to prEN 15193 Lighting Energy Estimation



Example large office 12 x 10 m

Lighting planning

In accordance with the European standard for lighting indoor workplaces EN 12464-1 and the UK lighting guide LG7.

Average illuminance in operation ≥ 500 lux on the work plane.

Lighting solution

A large office with general lighting made up of Sixteen Como Wide 2 x28 W ref. **206101** LOR 60%, circuit watts 62 W

and eight Pleiad Compact Matt 1x26 W ref. **76142** LOR 50%, circuit watts 26 W.

Despite the non compliance of the Pleaid downlight in this instance, when calculated with the Como luminaire, the space becomes compliant with a Part L2 luminaire-lumens /circuit watt calculation of 53.0 (incorporating L2B control factor).

Control system

- Daylight/Constant light control.
- Presence control.

Energy usage

W_{light} 1867 kWh/year

$W_{parasitic}$ 141 kWh/year

W_{total} 2008 kWh/year

$LENI_{sub\text{-}area}$ 16.7*

**The LENI number is normally an indicator for the whole building's energy efficiency. The value has been broken down to a sub-area for comparison between different sub areas*

A traditional large office with general lighting consisting of recessed T5 luminaires and and compact fluorescent down-lights.

A general lighting system with 500 lux on the working plane results in higher energy consumption than with a local-ised lighting system. In addition the general lighting system requires local lighting on each workplace.

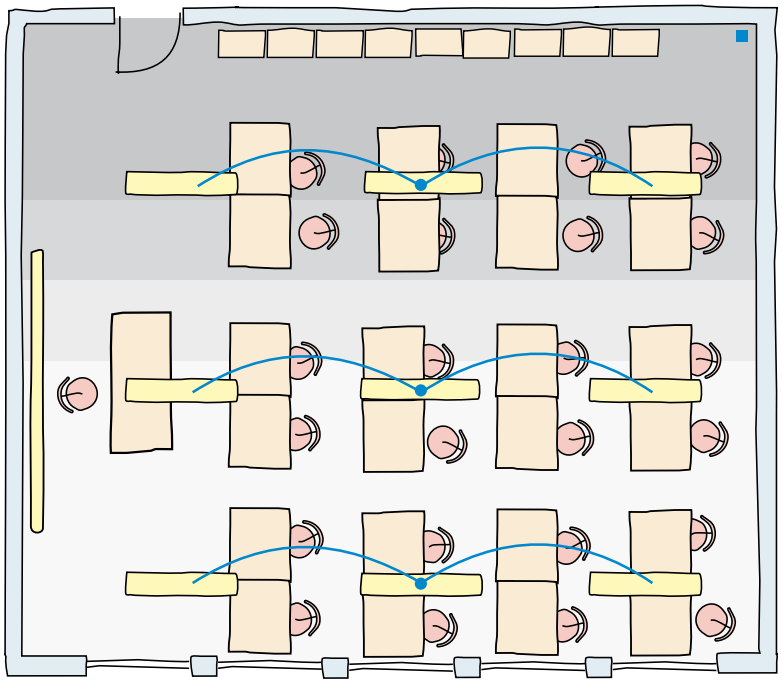
Control is integrated in one of luminaires in each row of luminaires and this controls the other luminaires in the same row. The standard requires one presence sensor per 30 m^2 in this type of room.

During the entire usage time which is normally 20 years for a lighting installation, light control represents a saving of in total 13468 kWh compared with the same room with manual On/Off control during the same period.

W_{total} with traditional manual On/Off control is calculated to 2682 kWh/year, a saving of 25 % is attained in the example by using control.

Ex. 4 Example of the implementation of prEN 15193

The example is calculated according to prEN 15193 Lighting Energy Estimation



Example Classroom 8.4 x 7,2 m

Lighting planning

In accordance with the European standard for lighting indoor workplaces EN 12464-1 and the UK lighting guide LG7.

Average illuminance in operation ≥ 500 lux on the work plane.

Lighting solution

A classroom with general lighting with nine Zora Beta 1x49 W ref. **28275**, LOR 88.1 %, circuit watts 56 W and three Lento 1x28 W ref. **19842**, LOR 85 %, circuit watts 33 W.

Part L2 luminaire-lumens/circuit watt calculation 76.4 (incorporating L2B control factor).

Control system

- Daylight/Constant light control.
- Absence control.

Energy usage

W_{light} 600 kWh/year

$W_{parasitic}$ 71 kWh/year

W_{total} 671 kWh/year

$LENI_{sub\text{-}area}$ 11.1*

**The LENI number is normally an indicator for the whole building's energy efficiency. The value has been broken down to a sub-area for comparison between different sub-areas.*

A classroom with general lighting consisting of nine pendant T5-luminaires and picture lighting with three T5 luminaires. We have planned a general lighting system with 500 lux on the work plane.

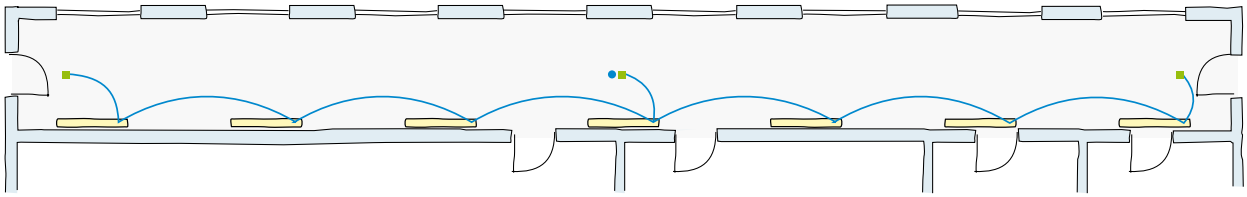
Daylight control and constant lighting control are integrated in one of luminaires in each row of luminaires and this controls the other luminaires in the same row. The room is equipped with a central absence control.

During the entire usage time which is normally 20 years for a lighting installation, light control represents a saving of in total 6230 kWh compared with the same room with manual On/Off control during the sameperiod.

W_{total} with traditional manual On/Off control is calculated to 983 kWh/year. The saving here will be 32 %.

Ex. 5 Example of the implementation of prEN 15193

The example is calculated according to prEN 15193 Lighting Energy Estimation



Example School corridor 21 x 1.8 m with daylight

Lighting planning
In accordance with the European standard for lighting indoor workplaces EN 12464-1 and the UK lighting guide LG7.

Average illuminance in operation ≥ 100 lux on the floor.

Lighting solution
A corridor with with daylight and general lighting with seven Sektor 1x28 W ref. **17402**, LOR 73 %, circuit watts 33 W.

Part L2 luminaire-lumens/circuit watt calculation 63.9 (incorporating L2B control factor).

Control system
- Daylight/Constant light control.
- Presence dimming.

Energy usage
W_{light} 90 kWh/year
$W_{parasitic}$ 55 kWh/year
W_{total} 145 kWh/year
$LENI_{sub\text{-}area}$ 3.8*

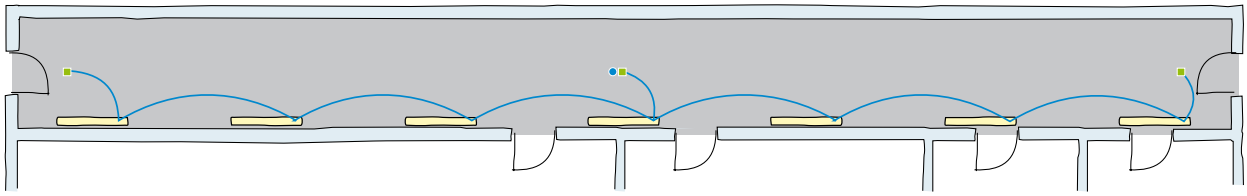
**The LENI number is normally an indicator for the whole building's energy efficiency. The value has been broken down to a sub-area for comparison between different sub-areas.*

A corridor with general lighting consisting of seven T5 luminaires. Sensor for daylight control and constant light control centrally placed and three presence sensors (one at each end and one in the middle of the corridor).

During the entire usage time which is normally 20 years for a lighting installation, light control represents a saving of in total 3206 kWh compared with the same corridor where the lighting is on during the whole usage time via time control.

W_{total} with traditional manual On/Off control is calculated to 305 kWh/year. Control in this instance gives a saving of 53 %.

Ex. 6



Example School corridor 21 x 1.8 m without daylight

Lighting planning
In accordance with the European standard for lighting indoor workplaces EN 12464-1 and the UK lighting guide LG7.

Average illuminance in operation ≥ 100 lux on the floor.

Lighting solution
A corridor without daylight and general lighting with seven Sektor 1x28 W ref. **17402**, LOR 73 %, circuit watts 33 W.

Part L2 luminaire-lumens/circuit watt calculation 63.9 (incorporating L2B control factor).

Control system
- Constant light control.
- Presence dimming.

Energy usage
W_{light} 242 kWh/year
$W_{parasitic}$ 55 kWh/year
W_{total} 297 kWh/year
$LENI_{sub\text{-}area}$ 7.9 *

**The LENI number is normally an indicator for the whole building's energy efficiency. The value has been broken down to a sub-area for comparison between different sub-areas.*

A corridor with general lighting consisting of seven T5 luminaires. Constant light control sensor centrally placed and three presence sensors (one at each end and one in the middle of the corridor).

During the entire usage time which is normally 20 years for a lighting installation, light control represents a saving of in total 2732 kWh compared with the same corridor where the lighting is on during the whole usage time via time control.

W_{total} with traditional manual On/Off control is calculated to 434 kWh/year. Control in this instance gives a saving of 32 %.

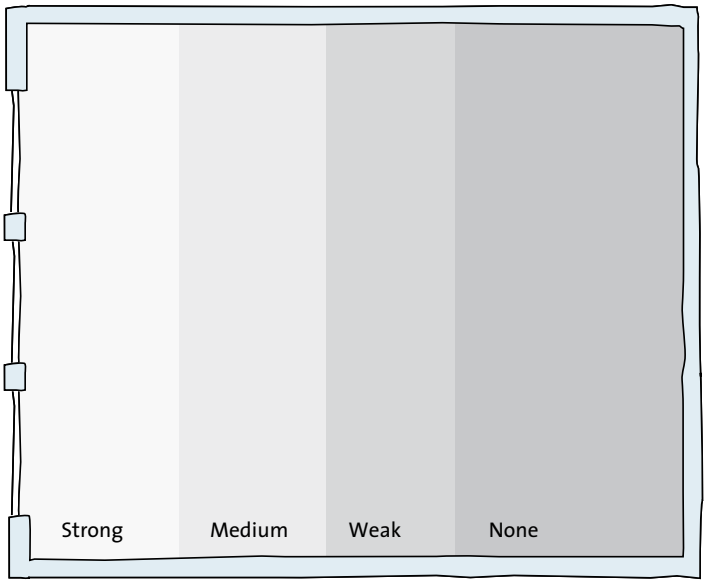
Availability of daylight

In the examples on the previous pages the availability of daylight is shown as in the illustration to the right. This EN calculation for daylight uses strong, medium and weak whereas the UK SBEM software incorporates a continuous spectrum of daylight.

The availability of daylight divides the room into different zones. The different zones describe a specific daylight interval. The zones are divided by daylight factor: Strong, Medium, Weak or None. Luminaires located in the stronger zone can utilize a larger devaluation of the utilization time, which reduces the total power consumption.

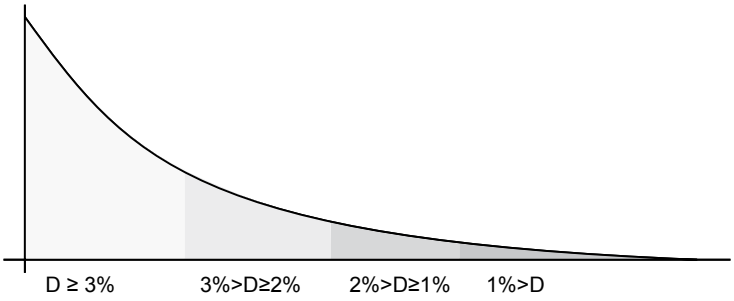
The daylight factor is obtained by making a light measurement of indoor illuminance and expressing the measurement result as a relation to the outdoor illuminance at the same time.

The formula becomes D(%) = E indoors x 100 / E outdoors.



Daylight factor (D)

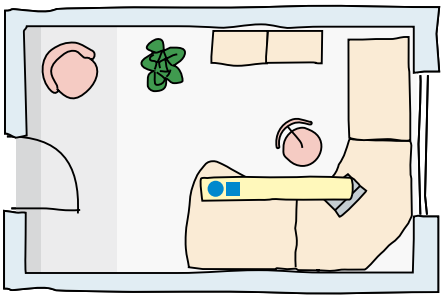
Example of the zone division within an area with incident lighting.



Control

In the examples on the previous pages the different types of control are shown by symbols. An explanation to the different types of control we have used is given to the right.

The cellular office below has both daylight/constant light and absence control.



● Daylight control/Constant light control

Daylight sensor: A light sensor that adapts the lighting output to the amount of daylight (natural light).

Constant light sensor: A light sensor that adapts/corrects the lighting output to the operating value according to /following the retention factor.

■ Presence control

Presence control switches the lighting on and off automatically. After the last presence detection with max. 15 minutes delay the lighting is automatically turned off.

■ Absence control

Absence control prevents the lighting from automatically switching on, on detection. Manually switching of the lighting is required. After the last presence detection with max. 15 minutes delay the lighting is automatically switched off.

■ Presence dimming

Presence dimming switches the lighting automatically on detection. Light dims to a low level, maximum 20 % of the operating value. With a short delay after the last presence detection, for example, from 2 min. – max. 15 min., the light is automatically dimmed to the lower level.