LED LIGHTING GUIDE

silversun

LED Lighting Premium Systems

INDEX

Luminous flux in Lumen [lm]

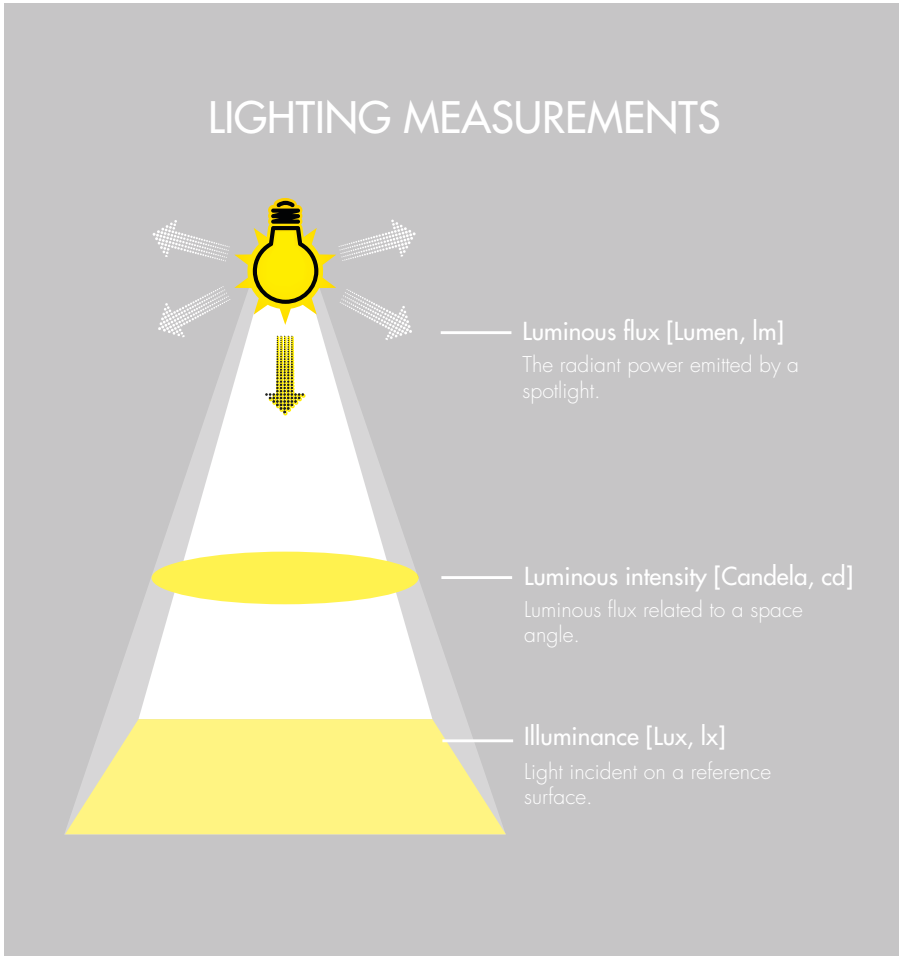
The luminous flux indicates the light output of a light source. It describes the radiated power emitted by the light source in all directions in the visible range. It takes into account the sensitivity of the human eye and can be measured with the aid of an integrating sphere.

Illuminance in Lux [lx]

Lux is the unit for the density of the luminous flux. It indicates how much luminous flux [lm] falls on a certain surface. It is a lux, when the luminous flux from a lumen illuminates one square meter of surface evenly: 1 lux = 1 lumen/m^2. The illuminance is the most important value when comparing lighting technologies (or the lighting quality) and is defined for different working areas in guidelines. In the workplace directive, the lux value for a workstation is 500 lux.

Luminous intensity in Candela [cd]

A light source does not radiate its luminous flux (its light) uniformly on all sides. The light intensity is that part of the luminous flux that radiates in a certain direction. Originally, 1 Candela corresponded to the light intensity of a normalized candle.



Efficacy in Lumen/Watt [lm/W]

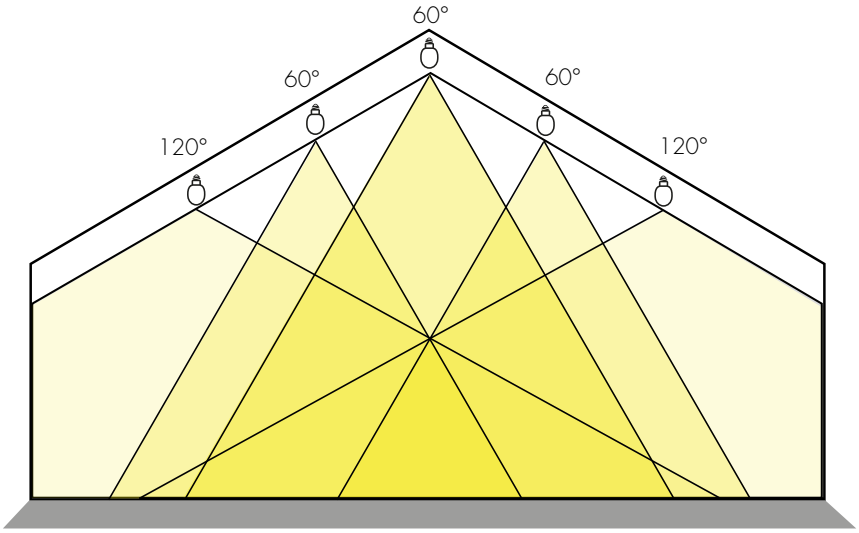
The energy efficiency of different lamps can be compared with the light output. This is the guideline for the savings potential in the conversion from conventional to LED lighting. With LED technology, up to 90% of the electricity can be saved under ideal conditions. As a rule, values of 50 - 70% are realized with the conversion, with an equivalent or better light output.This is clearly shown by a comparison of three T8 tubes:

Tube type	Light output/Luminous flux		Efficacy
T8 - Fluorescent	58W/5.000lm	LOWER CONSUMPTION BETTER EFFICACY	86lm/W
T8 LED Tube - Standard	28W/3.500lm		125lm/W
T8 LED Tube - High Power	24W/3.500lm		145lm/W

Beam angle

In addition to the light spot height, the light position and the number of light points, the beam angle of the LED is also decisive for the best possible lighting result. In contrast to conventional luminaires, which are usually limited and deflected by a reflector, the angle of the LED is determined by the shape of the lens.

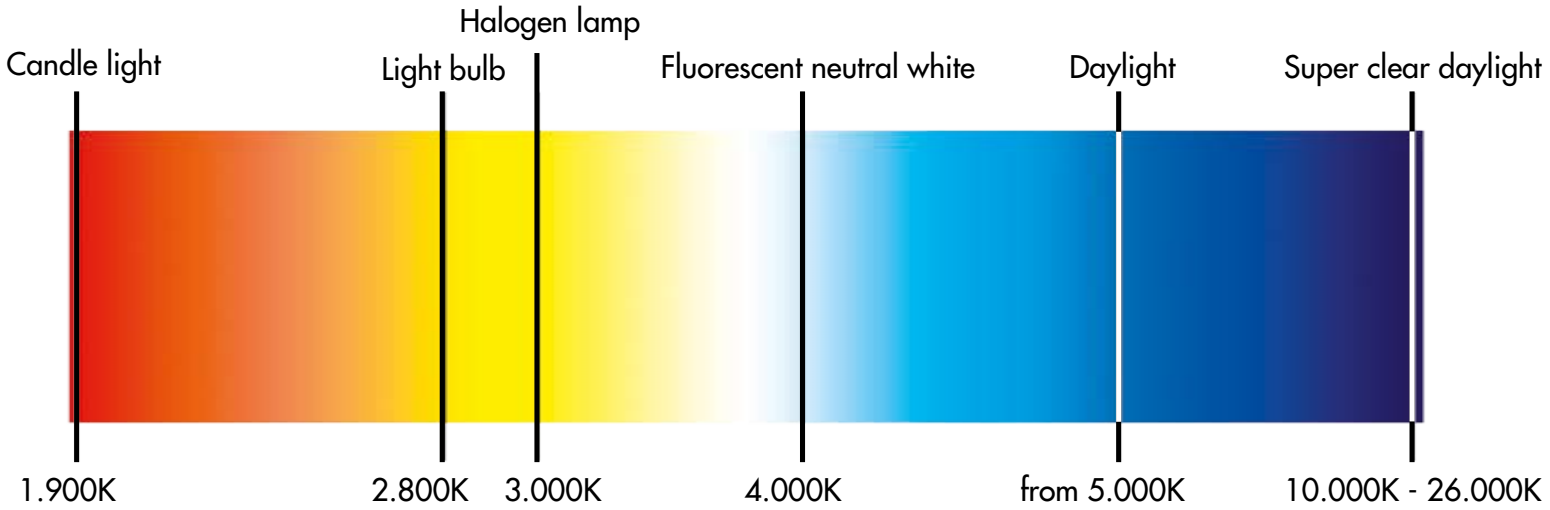
At the same height, the diameter of the light cone on the ground becomes larger the larger the angle of radiation. A special feature which is currently used in the high-bay area are asymmetrical radiation angles (for example 60/90 °). The simulation of the lighting intensity (Lux / m^2) via the DIALux lighting planning provides an ideal lighting result.



Correlated Color Temperature [CCT] in Kelvin [K]

The light color characterizes the color appearance of a light source using the color temperature of a Planck radiator. Different light colors are selected depending on the application. The spectrum ranges from 2,700K (warm white) to 6,500K (frozen white). On many lamps there is a 3-digit "number code", the second and third digit for the light color. Location and individual requirements are the criteria for the light color. The following values are a guideline:

Location	Color temperature	Designation	Number code
Private areas, restaurant, hotels	2.700K to 3.500K	Warm white	827 to 835
Offices, shops, corridors	4.000K to 4.500K	Neutral white	840 to 845
Factories, warehouses, sport centers, car parks	5.000K to 5.500K	Cool white	850 to 855
Factories, warehouses, car parks	5.700K to 6.500K	Frozen white	857 to 865



Color Rendering Index [CRI]

The CRI specifies how true-to-life colors are reproduced in the light of a lamp. It is derived from eight existing light colors. The highest CRI of 100 corresponds approximately to the CRI of a conventional incandescent lamp. The type of visual task determines which CRI value is needed. The higher the CRI, the higher the color brilliance and the contour sharpness. In practice, CRI values between 80 and 90 are quite sufficient. In the 3-digit "number code", it is expressed by the first digit. Different requirements:

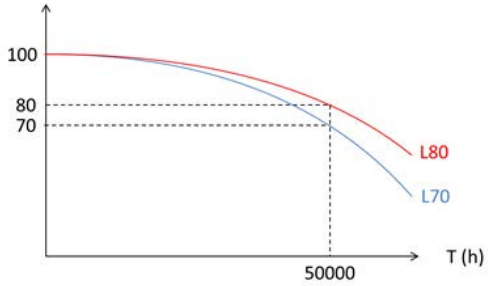
Requirement or type of vision	Required CRI value	Number code
Low requirement - e.g. Underground car parks	CRI > **60**	**6**40
Low requirement - e.g. Logistics areas	CRI > **70**	**7**40
Medium requirement - e.g. Offices, factories	CRI > **80**	**8**40
Highest requirement - e.g. Paint testing	CRI > **90**	**9**40

Sodium-vapor high-pressure lamps have a CRI value of approx. 18-30 and mercury vapor lamps of approx. 45 - despite the very low values, these lamps are often installed in areas requiring a CRI of > 50. Lack of color brilliance and contour sharpness often have a negative impact on the work results.

Medium useful life [LxxByy]

New International standards on how lifetime should be declared on LED luminaires have been published. The standards are IEC 62717 LED-modules for general lighting – Performance requirements and IEC 62722-2-1 Particular requirements for LED luminaires. IEC 62722 states both test method and minimum required time for testing LED lifetimes. The minimum test time is 6000 hours where the luminous flux is recorded every 1.000 hours. These values are extrapolated using a method stated in IES TM21.

The lifetime of a LED module inside a luminaire is related to the luminous flux depreciation at a given ambient temperature. L_{70}, L_{80} or L_{90} indicates how many lumens (in percentage related to the initial lumens) that remains after end-of-life.

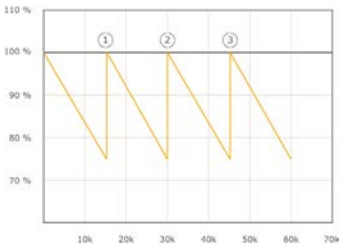


The failure fraction for B_{yy} expresses only the gradual light output degradation as a percentage 'y' of a number of LED modules of the same type that at their rated life designates the percentage (fraction) of failures. The value B_{50} indicates that the declared L-value will be achieved by minimum 50% of the LED modules and that the remaining 50% may have a lower lumen value.

The value B_{10} means that minimum 90 % of the LED modules will meet the declared L-value and only 10% will have a lower flux level. A B_{10} value is therefore more conservative than B_{50}. In practical terms it means that B_{10} is reached at an earlier stage in the life time on a set of LED modules compared to B_{50}.

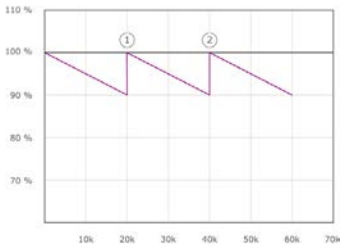
The figures below show lamp lumen maintenance factor (LLMF in %) over time (k= 1.000 h) and number of light source shifts up to 50.000 hours for various light sources.

Fluorescent (T8)



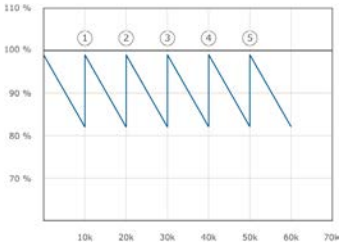
LLMF= 0,75

Fluorescent (T5)



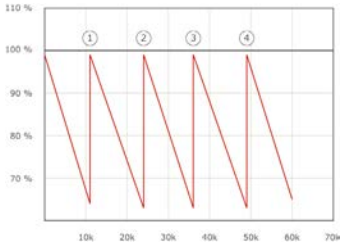
LLMF= 0,90

Compact fluorescent



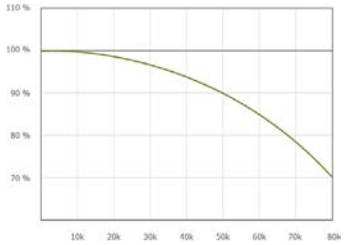
LLMF= 0,83

Metal halide



LLMF= 0,66

LED



LLMF= 0,90

Unified Glare Rating [UGR]

The UGR value is a dimensionless parameter which provides information about the degree of psychological glare of the lighting installation in an indoor space. UGR values are defined in steps within a scale of 10 to 30. In the final instance these steps express the statistical perception of glare experienced by a large number of observers. So UGR 19, for example, means that 65% of observers "did not really feel disturbed" by the glare. Conversely, of course, this also means that the remaining 35% felt disturbed by the glare. The lower the UGR value, the less direct glare is experienced by the observers.

UGR is based on a glare formula. This formula takes account of all the luminaires in the system that contribute to the sensation of glare. UGR levels for luminaires are determined using the tabular method according to CIE 117. The new European standards stets UGR=19 as the maximum permissible value for offices, which is equivalent to the luminance limiting curve for 500 luxes. This figure refers to the UGR value which the luminaire would have in a reference situation with room dimensions of 4H/8H and degrees of reflectance of 20% for the floor, 50% for the walls and 70% for the ceiling.

'8' gives UGR numbers which nicely sit in a range from about 5 to 40

This sum simple means take into account all the luminaires in the room

One luminaire's luminance squared

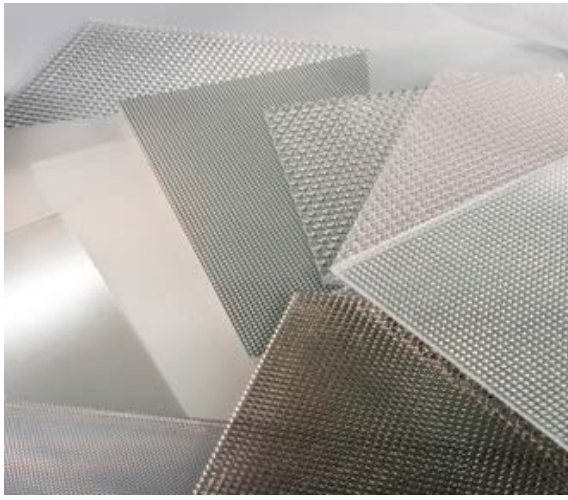
The solid angle of the luminaire from the viewer's position

$$UGR = 8\log_{10}\left[\frac{0.25}{L_b}\sum\frac{L^2\omega}{p^2}\right]$$

Our eyes respond logarithmically to light

Dividing by the background luminance has the effect of reducing the UGR value

The Guth index gets bigger the further the luminaire is from the line of sight of the viewer



Panel diffusers that reach UGR<19

IP protection rate

In accordance with the European Standard EN 60529, luminaires are classified on the basis of the protection derived from their elements of construction. The degree of protection is indicated by the letters IP followed by a 3-figure number, through only the first two numbers are shown. The first figure indicates the protection of the material against the entry of foreign bodies and dust, as well of people coming into contact with live parts in the device. The second figure indicates the protection of the material against the entry of moisture.

IP1. Against foreign bodies & dust		IP2. Against the entry of moisture	
0	Not protected	0	Not protected
1	Protected against foreign objects >50mm	1	Protected against vertically falling drops of water
2	Protected against foreign objects >12mm	2	Protected against water drops with housing tilted at 15° with respect to the vertical
3	Protected against foreign objects >2,5mm	3	Potected against rain
4	Protected against foreign objects >1mm	4	Protected against splashing
5	Dust protected	5	Protected against jets of water
6	Completely dust-tight	6	Protected against powerful water jets
		7	Protected against temporary inmersion
		8	Sumersible material

Some application examples (without guarantee) - the actual degree of protection requires an individual check of the standards/regulations for each project:

IP rate	Example
IP20	Offices, corridors, lobbies
IP44	Damp areas
IP44/54	Collective garages
IP54	Dusty environment - Factories
IP65	Outdoor and industry lighting
IP66/67	Street lighting

IK protection rate

The IK classification indicates how resistant housings of electrical equipment are to mechanical stress. Protection classes 00 to 10 are internationally standardized and indicate the shock resistance up to a certain impact energy in Joules (J). For particularly vulnerable areas, e.g. Truck ramps, outside storage or in railway stations, etc.

Class	Resistance to impacts	Class	Resistance to impacts
IK 01	up to 0,150J	IK 06	up to 1,0J
IK 02	up to 0,200J	IK 07	up to 2,0J
IK 03	up to 0,350J	IK 08	up to 5,0J
IK 04	up to 0,500J	IK 09	up to 10,0J
IK 05	up to 0,700J	IK 10	up to 20,0J

Power factor

In AC circuits, the power factor is the ratio of the real power that is used to do work and the apparent power that is supplied to the circuit. The power factor can get values in the range from 0 to 1. When all the power is reactive power with no real power (usually inductive load) - the power factor is 0. When all the power is real power with no reactive power (resistive load) - the power factor is 1.

The power factor is equal to the real or true power P in watts (W) divided by the apparent power |S| in volt-ampere (VA):

$$PF = P_{(W)} / |S_{(VA)}|$$

PF - power factor.
P - real power in watts (W).
|S| - apparent power - the magnitude of the complex power in volt-amps (VA).

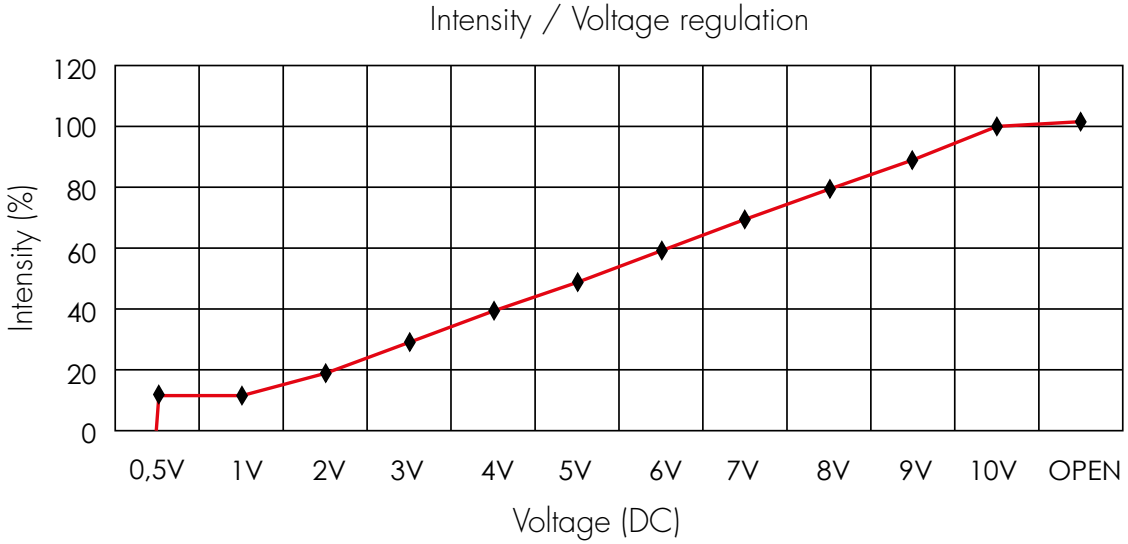
Dimming 1-10V

The efficacy of an LED luminaire can be increased even further by means of a light control/dimming, thus saving additional energy. Analogue and digital dimming are basically different. In general, when changing to a LED, the correct dimming function must be indicated. SilberSonne supplies products for 1-10V.

Analog dimming:
0 to 10V or 1 to 10V - Here the dimming is controlled via a potentiometer. There is no "real" switching on and off. The lamp brightness is adjusted via a switch.

Digital dimming:
The control via the DALI protocol is a standard for digital dimming. Direct addressing of the control units (power supply units) is possible. Many building and lighting management systems support DALI. SilberSonne is working on a possible implementation in its product range.

Dimming 1-10V operation



Dimmable power supply has an input to regulate the intensity of light through an external device. Depending on the voltage detected at this input (1 to 10V DC) the light intensity is adjusted proportionally between 10% and 100%. If no device is connected the luminaire operates at 100%.

Motion sensor

With an innovative approach, motion sensors can detect motion through plastic, glass and thin non-metal material, except the maximum mounting height. The sensor allows saving energy without compromising comfort, achieving tri-level of regulation, which makes it ideal for using in areas where a change of light is required before its complete switch off. The lighting system has automated controls that either turn off or dim artificial light in response to the daylight in the place. If the luminaire does not have dimmable options, motion sensor only will turn the light on and off when movement is detected. This is how it works:

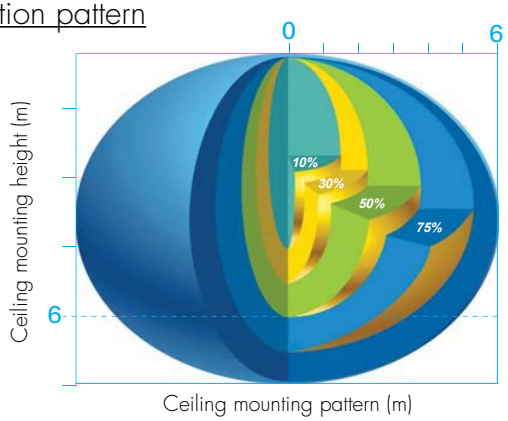
With sufficient ambient light, the sensor does not switch on the lamp.

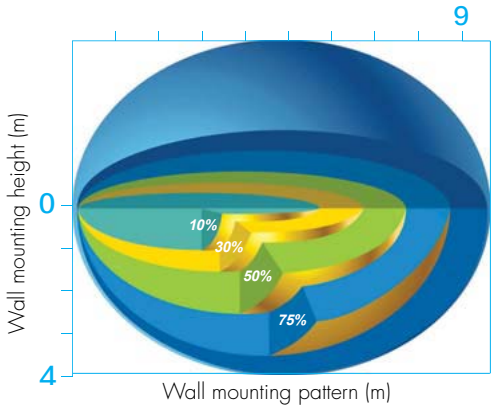
With insufficient ambient light, the sensor switches on the lamp when motion is detected.

After hold time, the sensor dims the lamp at a low light level if no new motion trigger.

After stand-by period, the sensor switches off the lamp if no motion is detected in its detection zone.

Detection pattern





Light regulator

Light regulators are the ideal complement for dimmable LED lamps, obtaining a wide energy efficiency and a minimum consumption. With an operating range of max. 20 meters, it is suitable for any kind of building, from homes to warehouses. It can be configured to adapting it to different requirements depending on the place where it is installed and the light intensity necessary to turn the lamps on. It has a detachable light sensor that makes the lamp does not turn on if it detects enough light.

With insufficient ambient light, the lamp lights on at full to maintain the lux level.

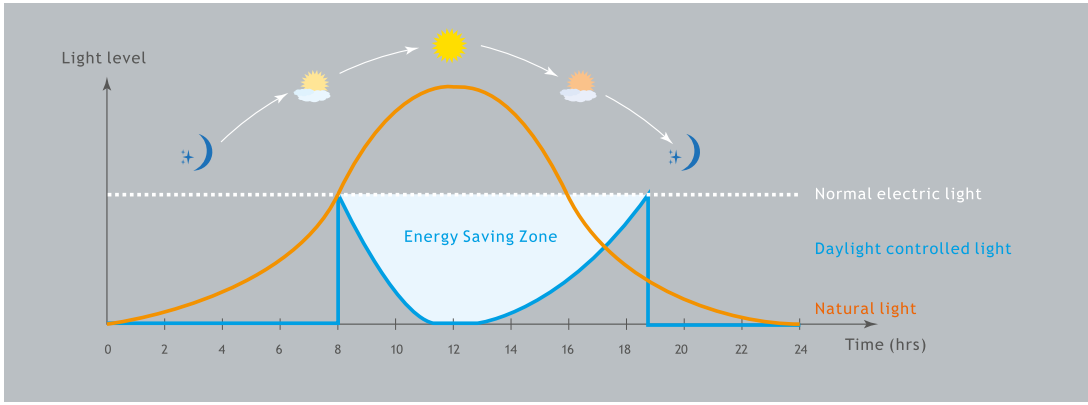
With sufficient ambient light,the lamp dims to minimum but never switches off.

With insufficient ambient light, the lamp lights on at full again to maintain the lux level. Light output regulates according to the level of natural light.

Switch off the light manually while needed.

That photocell daylight sensor reads and measures the surrounding light, and convert the amount of light to 1-10V, electronic signal output.

Additionally, there is a potentiometer to set the brightness level, so that the daylight sensor can read, measure the available natural daylight against the target value, and calculate how much artifical light is needed. This daylight interactive application can be illustrated in below diagram:



Daylight / artificial light interactive diagram

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