Energy Efficient Lighting

Guidelines and Recommendations for the MENA Region

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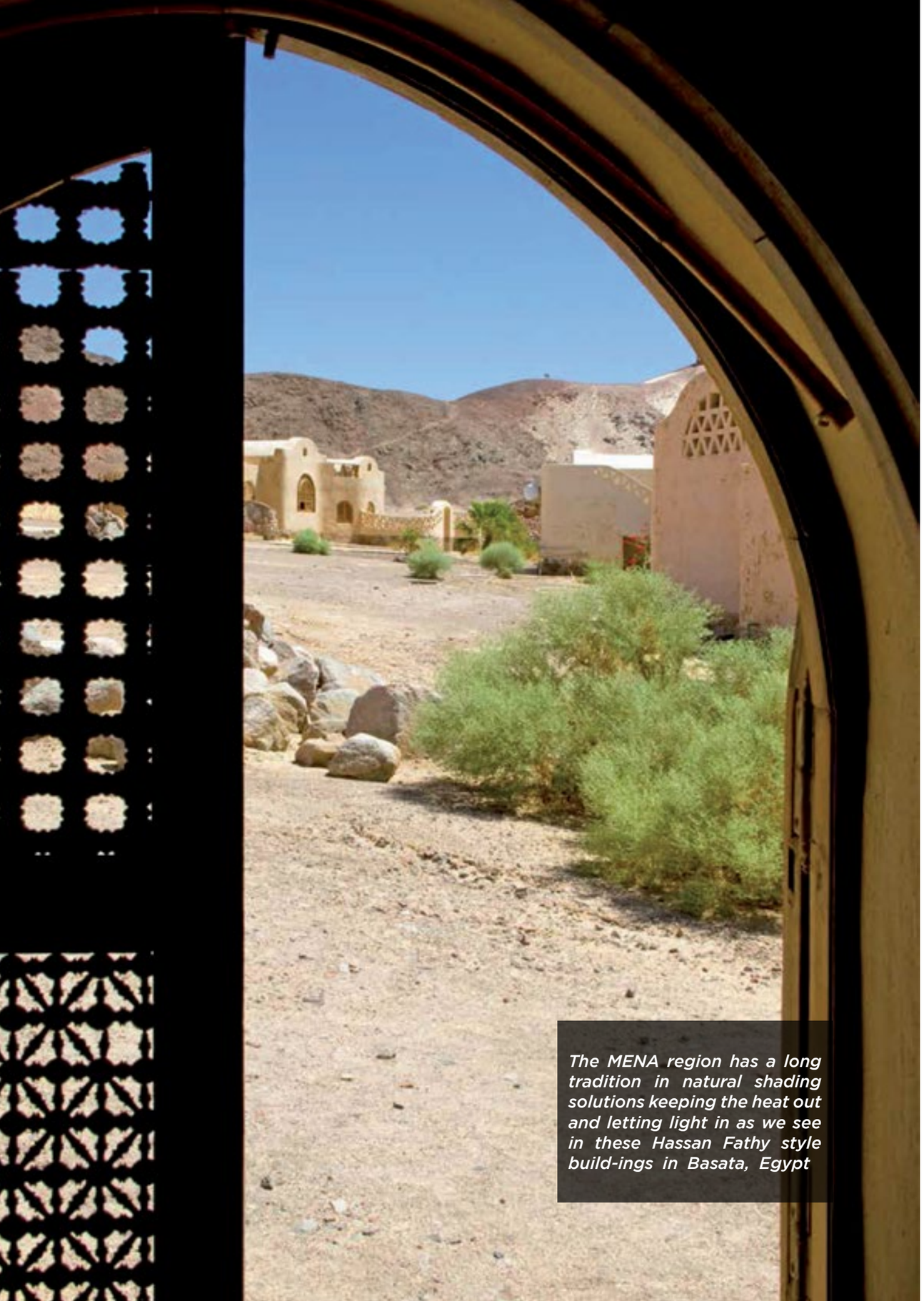
MED-ENEC
Energy Efficiency in the Construction Sector in the Mediterranean



The MENA region has a long tradition in natural shading solutions keeping the heat out and letting light in as we see in these Hassan Fathy style build-ings in Basata, Egypt

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Hibiz Temple by Philipps

The range of EE lighting solutions in office environments, as demonstrated in this office showroom, includes dimming, indirect lighting and different lighting intensities in small areas as required.

1.

Introduction

Many governments in the MENA region have emphasized energy efficiency opportunities during the current economic downturn as a way to stimulate their economies. By focusing investments on energy efficiency initiatives, governments hope not only to reduce its operating cost but also help businesses to be more competitive, save and create jobs, reduce dependence on energy supplies and reduce carbon emissions associated with energy use.

Among energy efficient retrofits, lighting presents a significant opportunity and ought to be on the top agenda of decision makers in the MENA region when it comes to short term improvements to save energy and money. One challenge however, the vast range of technology options to consider can be intimidating. Professional support is vital in order to find the best available solution for «my» project. This is typical in most retrofit lighting projects like office buildings, warehouses, outdoor logistical sites, public buildings, street lighting, hotels, archaeological sites and many other locations. This alone justifies why MED-ENEC focuses on this issue in a comprehensive manner and conducts many Lighting workshops and seminars throughout the region.

The opportunity in MENA region countries is phenomenal. For example, in Egypt lighting is consuming an average of 28-30 % from the produced energy with an annual increase average of 10-11% during the past 2 years and an increase over the past 10 years of 7.2%. Accordingly it will require almost double the existing generation capacity (from 27 GW (2010) to 50 GW) by 2020 and probably another 120 GW by 2050 - in case of «business as usual». Already families and businesses suffer hours of daily blackouts in the whole country during afternoon and evening. The Egyptian government proposed concentrated activities in this field in its 2012 National Energy Efficiency Action Plan. If EE lighting would be implemented accordingly, more than 10% of the power capacity would not be needed tomorrow and blackouts would be history.

Electricity prices are expected to increase matching the international market at an increase of 7% annually, and subsidies are destined to vanish. Additionally, many countries in the region made commitments to reduce global warming and CO_2 emissions. These good reasons present lighting as one of the most convenient as well as cost-efficient opportunities to realize cost efficiency and environmental goals.
The quality of natural light cannot be replaced by anything. The ability to effectively harvest daylight present another opportunity. Further, coupling EE lighting with the use of renewable energies is an additional opportunity. To materialize such opportunities integrated planning and procedures are required which will be discussed in this brochure.

What professionals can do today?
This brochure aims to stimulate building owners and tenants, architects and planners, project developers, contractors and politicians to take an insight look into the components and technologies selecting energy efficient lighting systems. Not only individual components are presented, but also perspectives for correct planning of energy efficient lighting. Much emphasis is given to explain the function of lighting management systems. Finally it is giving hints to those who have to decide which investments will need an EE lighting assessment, which services and products are available and how to prepare for the procurement and tendering accordingly.

Energy efficient lighting design often produces savings between 50% and 80%. Products as well as professional services are available; they have been tested; and proven to achieve excellent results. Also, one should consider the aesthetical advantages: They enlighten modern architecture, beautiful gardens and open spaces much more effectively than conventional lighting systems. However, in the beginning it is of major importance to heed the advice: Integral planning is of great importance.

Dr. Kurt Wiesegart
(Team Leader MED-ENEC)

“Use of daylight - coffee shop in Granada, Spain

2.

The Political Leadership Perspective

Energy is central to sustainable development and poverty reduction. It affects all aspects of development -- social, economic, and environmental -- including livelihoods, access to water, agricultural productivity, health, population levels, education, and gender-related issues.

Climate change is the defining human development challenge of our generation. The way the world deals with climate change today will have a direct bearing on the development prospects of a large section of humanity.

Through energy efficiency and renewable energy practices we can generate significant opportunities for the developing world to address climate change and promote sustainable, innovation-based growth.

Energy Security; using energy more efficiently will help make more energy available to offset future load expansions due to economic growth and help avoid blackouts.

Environmental Commitments; most countries in the MENA region made commitments to reduce emissions, some engaged into binding agreements with financial ramifications if targets are not met. The message should be clear for policy makers:

- The building sector has the most potential for delivering significant and cost-effective GHG emission reductions.
- Countries will not meet emission reduction targets without supporting EE gains in the building sector.
- Proven policies, technologies and knowledge already exist to deliver deep cuts in building related GHG emissions.
- The building industry is committed to action and in many countries is already playing a leading role.
- Failure to encourage energy efficiency and low-carbon practices when building new or retrofitting will lock countries into the disadvantages of poor performing buildings for decades.

Economic benefits; Improving energy efficiency (EE) in the industry sector enhances competitiveness and productivity and provides a range of ancillary benefits. Significant economic benefits will be created by policies that encourage energy efficient and low-emission building activity. The main reasons for such benefits are:

- Cost efficiency
- Increased investments in local industries
- Creation of employment opportunities

Why Lighting?

It is estimated that lighting accounts for nearly 6% of global CO_2 greenhouse gas emissions, or 1,900 million tons of CO_2 per year—which is the equivalent of CO_2 emissions from 70% of the world’s passenger vehicles. We can make a considerable dent in carbon emissions if we make lighting more energy efficient.

Lighting retrofits usually have the highest energy saving potential compared to other energy efficiency retrofits.

Compared to other energy efficiency measures lighting technology is simple, easy to implement and the benefits are easy to demonstrate.

EE Lighting at Renaissance Hotel in New Cairo, Egypt

EE lighting at Hurghada, Egypt airport

3.

The Boardroom Perspective:

The rationale for an individual company or organization to make an investment that will reduce energy consumption varies considerably and depends on a range of factors. These include the return on investment; market conditions; economic sector; company size; energy intensity; cost of energy relative to overall production costs, whether EE improvement is an incidental or ancillary benefit of a process or equipment upgrade (or part of a concerted effort to implement an EE programme); the financial state of the company, whether it is in a growth or sunset sector; and access to finance.

While recognition that energy efficiency is a powerful tool to cut operating costs, improve the economy and reduce environmental pollution has never been greater; the implementation of energy efficiency measures in the MENA region is slow. This is due to a range of barriers including insufficient information, competing priorities within the company and the lack of commercially viable financing options. Policies have a role to play to address many of the existing barriers.

Typical policies that target energy efficiency include regulations and voluntary agreements that directly compel actions; economic policy instruments such as taxes and tax incentives, directed financial support (e.g. subsidies and loans) and differentiated energy prices that seek to influence the cost effectiveness of technical actions; and informational policies, which help to establish a favorable environment for industry to implement EE actions.
Looking into the factors that influence companies to invest in energy savings and proposes a methodology to evaluate the effectiveness of a country's policy mix from the perspective of an industrial company's boardroom. In other words, are companies made more aware of EE benefits and more motivated to invest in energy efficiency projects – which are otherwise normally neglected –as a result of one or a combination of policies?

Essentially, the "boardroom perspective" delves into the major factors or driving forces that decision makers within a large company take into account when deciding to make new investments. In order to assess whether policy packages are effective through this boardroom perspective, the corporate decision making process is simplified and represented by using five driving forces as proxies:

- The financial imperatives of a company
- The policy obligations placed on the company to achieve environmental compliance
- The knowledge of energy savings opportunities within the company
- The commitment of the company to the environment and energy efficiency
- The demands of the public and market to improve the company's environmental or energy performance

EE lighting at a Canadian University Classroom – Cairo, Egypt

Modern office entrance for the company Alshaya using LED and HPS lighting solutions, equipped by Philips

4.

Step by step towards designing EE lighting

Lighting retrofits in most cases have the highest energy saving potential compared to other energy efficiency retrofits. Retrofitting conventional lighting systems with modern lighting technology usually produce savings between 25% and 80%.
Given the potential the question becomes: How can one take advantage of such potential?

A Step-by-Step Process
Retrofitting inefficient lighting can be understood and organized as a step by step process.

First step: Perform a Lighting Energy Survey or Audit
This is a very important first step; the main objective is to have a thorough understanding of how much energy the existing lighting system consumes. A lighting energy audit will also provide detailed inventory of the existing lighting system identifying technology, Watt capacity, lighting control methods used and lighting hours of operation. In addition, as part of the audit lighting levels are measured throughout the facility to identify over lit and under lit areas. As a conclusion of this activity, the pre-retrofit total energy consumption is calculated.

Second step: Apply Post Retrofit Scenarios
Upon understanding of the pre-retrofit lighting system and energy usage, this step helps us to visualize the post retrofit picture.
Qualified lighting designers provide post-retrofit scenarios for the new lighting technology solutions proposed, expected lighting levels throughout the facility, lighting control for different areas, the utilization of daylight. Also, as a conclusion of this activity, the post-retrofit total energy consumption is calculated for each scenario. Software tools can be used to aid professionals in this step.

Third step: Determining the Cost and Savings of Post Retrofit Scenarios
To determine the cost of retrofit, professionals need to pay attention to details so the cost of retrofit is realistic. Often cost items like transportation, project management are missed.

Forth step: Recommending Post-Retrofit Scenarios
The objective of this step is to carefully provide options to the worthy of consideration of the financial decision maker. When considering retrofit options to be presented to the decision maker management some of the factors need to be considered are:

- The core business objectives of the facility ex: needs and wants, effect on productivity, etc...
- Total investment required
- Acceptable level of performance risk.
- Availability of financing
- Level of technical complexity this facility is ready for.

Fundamental light functions
Light is basically determined by its amount, color and direction. Scientists describe this as a “light field”, meeting the assets of EE lighting. Artificial light fields are measured by source, but are influenced by reflec¬tion at surfaces. What our eye consumes is always a mixture. For this artificial light:

- Takes daylight into consideration and incorporates it by influencing quality, intensity and color;
- Allows people to perform physical or visual tasks illuminating workplaces, domestic spaces or recreation areas;
- Creates artificial worlds, skylines, outdoor living places at night;
- Supports safety;
- Enables people to move and orient oneself if daylight is not available;
- Creates environments for staging, presentations and any kind of communication (including light signals, film and photography); and
- Supports harmony and relaxation “good vibrations”.

All these functions are covered better and cheaper by EE lighting systems rather than by conventional lighting in both fixed and dimmable luminaries.

STANDARDS: Workplace Guideline ASR A3.4 and DIN En 12 464-1

Proactive approach: Designing light in new constructions
For new construction, EE lighting starts with the positioning and design of the building. Suitable lighting solutions are planned in order to create comfortable surroundings and to achieve a high quality of living and work environment. This must be clearly understood and indicated from the beginning.

The parameters for designing are the light intensity on one hand and needs for a special type of lighting, colors, places, contrasts and differentiation on the other. Such assessments and requirements can be highly complex and of particular importance for any type of commercial building, research center, industrial building, hospital, museum, event location, restaurant and hotels. Satisfying lighting solutions will not only save energy and money, they will also well contribute to the commercial success and functionality. They may also respect possible changes for its functioning in the future which will lead to a remarkable increase in building values.

Costs factors of EE lighting are:
•EE design and lighting expertise
•Quantity and quality of lighting technologies (lamps) including running costs and lifetime
•Investment in shading technologies, IT-controlling and timing depending on light intensity, requirements, usage times
•Maintenance and replacement (service life)

One Achievement of EE lighting is:
Maximum productive usage of daylight and use of artificial light only for remaining requirements

Tubular Day Lighting (TDD)
TDD devices may be interesting for office buildings and residential buildings bringing daylight into interior spaces where traditional skylights and windows cannot reach access. TDD - also called “light tubes” and “sun pipes” - can be combined with sensors to offer an optimized constant lighting impact according to needs (“smart LED”). Only as much artificial light will be added and electricity consumed as indicated/ programmed. They are modular TDD commercially available which are easy to connect to ceiling systems.

Basic Terminology

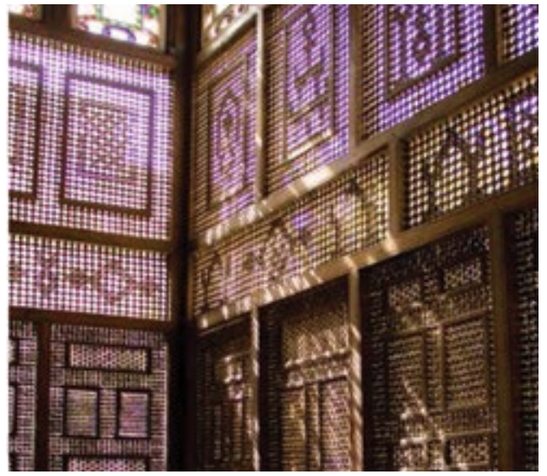
Term	Unit	Abbreviation	Brief Explanation
Light flux	Dv | Lumen	lm	The photometric unit for brightness. Photo-sensitivity of the human eye taken into consideration, regardless of light color.
Lighting intensity	Lux	lx	The same as lm/m2, lumen per square meter, light flux per surface.
Light colour	Kelvin	K	The individual color of the radiated light from a lamp is determined by the so-called colour temperature, measured in Kelvin. Lower numbers (1800-2000) indicate the reddish area, white color stay withing (5000 - 6400) area while higher numbers indicates the bluish (UV) area
Colour rendering index	Ra	CRI	Shows the quality of the colour rendering from lights in relation to a light bulb or daylight.

Useful link http://www.ecosmartelectricians.com.au/starter-kit/d01_03.html

Mashrabeya are flexible letting light inside according to the time of the day, Cairo

- Improved light performances (working, selling, entertaining, living etc...)
- Optimized energy consumption as well as avoiding unnecessary use or “burn times”
- Contribution to a better ambiance, health and environmental quality
- Extended creativity including aesthetics and improved comfort and visibility architecture

Shading - an important topic in the MENA region
In the MENA region, shading systems play a traditional role in energy efficient constructions to avoid cooling of the interior spaces. These are well known as Mashrabiyas and the use of the Patio. In addition modern supply systems react “intelligently” to changes in daylight. Photosensitive sensors and dimmable lamps provide adequate light intensity. Precision sensors prevent unused lighting periods. The use of artificial light will be minimized.



Mashrabeya traditionally are trapping cool wind keeping the heat outside such in this Bayt el Suhaymi house, Khan el Khalili in Cairo

Integral | Integrated planning
Sophisticated, energy efficient lighting systems do not have to be unreasonably expensive, if they are budgeted for at an early stage in the planning of the overall building technology system. In doing so, the cost and benefits will relate to the entire life of the system. All respective components can be intelligently and integrally planned, in necessary by trained specialists. MED ENEC provides such training. Other specialized companies are, among other things, included in the MED-ENEC company’s database.
STANDARDS: Minimum requirements regarding light intensity and light quality for different areas of use are available in the form of European, national and international standards, including DIN EN 12 464-1, ISO 8995/CIE S 008, EN DIN 12665, ASR A3.4 (see appendices).

Traditional building methods provide solutions for energy efficiency
Traditional know-how is often lost, but can, however, be revived using traditional shading systems. In Mashrabiyas (in the Middle East and Egypt), Roshan (in Countries surrounding the Red Sea), Shanashil (Iraq), Koshke (Syria) shading solutions often include ventilation, dehumidification and use of local materials. Architect Hassan Fathy was one of the pioneers to translate such traditions into the language of modern architecture and integral planning.

His pleading was to create and an original, authentic, durable and modern architecture with a local identity in combination with the latest technologies. This includes energy efficient lighting systems providing outstanding design possibilities in combination with daylight control and highly impressive in terms of aesthetics.

STANDARDS: Workplace Guideline ASR A3.4 and DIN En 12 464-1

Surface mounted EE luminaires spending white and bright light (up to 2,000 lux) for working areas. The use of presence detection with LED solutions is a way to reduce energy bills still further, here demonstrated by Philips

5.

State of the Art of Lighting Products

To achieve the optimal balance between functional requirements for indoor/outdoor projects, safety, beauty, comfort, savings and costs it is important to have a closer look to the available products and technologies. Basically, there are three types of lamps/ lighting available

1. Thermal radiators: Light bulbs and halogen lamps
2. Discharge lamps: Fluorescent, high pressure and low pressure lamps.

3. Incandescent emitters: LEDs and OLEDs - (organic) light-emitting diodes.

Product types according to colour and life time
So what makes the difference? One of the key questions is the type of light required. These are the most important lighting characteristics:

- Halogen lamps warm white light
- Mercury vapour lamps - HPL white light
- Metal halogen vapour lamps - HPI, CDO, CPO white light
- Sodium vapour lamps (SON) reddish-yellow light Fluorescent lamps - variety Compact fluorescent lamps - PL variety of white light •Induction Lamps variety of colours •High Pressure Sodium (vapour lamps) yellow light
- Law pressure sodium (not used at present) reddish light
- LEDs variety of colours and white light

In addition, the service or life time differs significantly which is relevant to lighting projects in bigger houses or apartments and almost all public and commercial sites. The list of characteristics underlines this:

- **Halogen lamps,** efficient and long life (approx. 5,000 hrs), outstanding colour rendering and brilliant, warm white light colour.

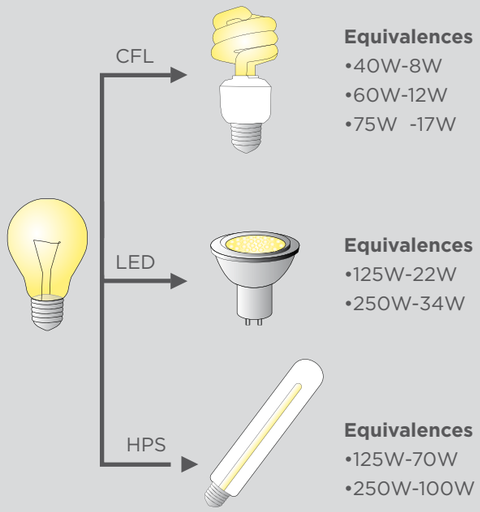
- **Mercury vapour lamps (HPL)** are not energy efficient and, therefore, no longer recommended

- **Sodium vapour lamps (SON)** and metal halogen vapour lamps (CDM, CDO, CPO) are considerably more efficient in comparison with HPL. Good mercury-free sodium vapour lamps have a loss quota of 5% after approx. 16,000 service hours and are, for example, ideally suited for use as efficient and durable outdoor lighting (yellowish light, Ra < 25)

- **Metal halogen vapour lamps (HPI, CDO and CPO)** are amongst the favourites for white outdoor lighting with an efficiency level of up to 100 lm/W. Some types are dimmable and have a service life of 10,000 to 12,000 hours with a loss quota of 10%

Induction street lighting for solar applications, 70W, replacing conventional 500-600W

Lamp alternates



- **Fluorescent and compact fluorescent lamps** are less light intense, their efficiency is temperature dependent and therefore should not be considered for outdoor areas.

Not all types allow to dim (service reduction) and discharge. However, this requires electronic ballasts (EVG) and will extend the by up to 30% reducing electricity consumption. The conventional light bulbs have a widely accepted yellowish colour rendering, but a short service life of 1,000 hours. Due to their low energy efficiency, they should be replaced as soon as possible.

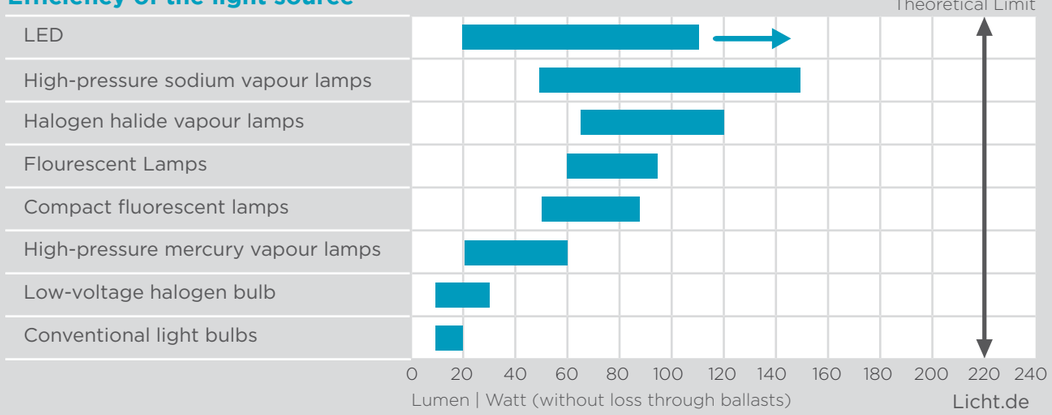
Other parameters influencing investments
Besides functional requirements, size of the project and aesthetical aspects, variations in temperature and humidity must be considered for the best possible solution. These parameters might influence the functioning, product lifetime and economic viability.

Other costs factors are:
1. Procurement, installation and operating costs
2. Maintenance costs (including lamp replacement and wages)
3. Energy costs (up to 70% of the total cost for a lighting system)

The use of efficient lighting technology saves on energy, costs and accordingly CO_2 emissions which are described in the efficiency table below.

LED lights provide coloured lighting and lighting for signals. They can be used for street lighting, pathways and squares, on- and off-grid solutions.

Efficiency of the light source

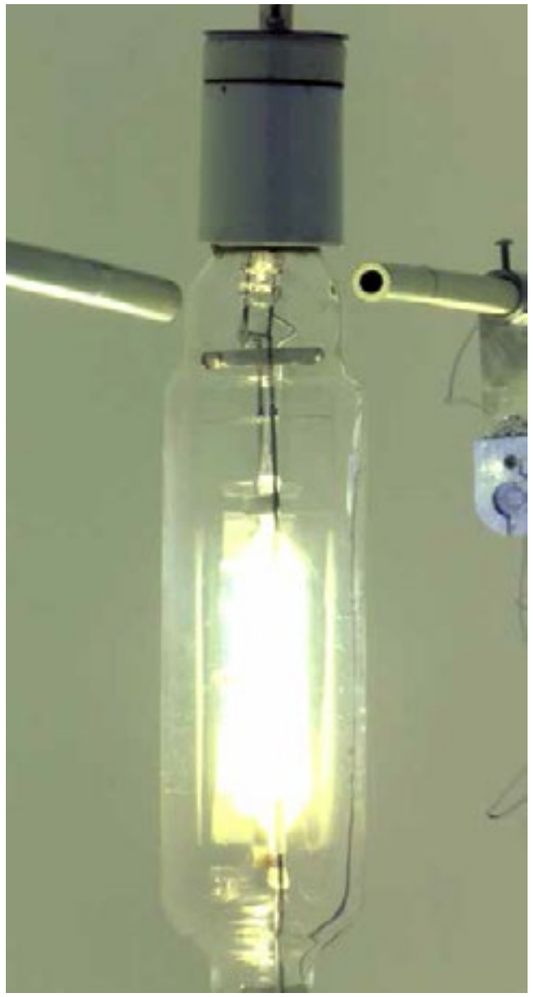


Different types of lamps and positioning
Finally, there is always a broad variety of indoor and outdoor solutions available where to position the light sources and which lamp types to use. There are ceiling lights, wall lights, standard table lamps, conductor rail solutions, floor lights, pendant lights, spotlights and many more. Planning a lighting system the following basic checklist might be useful to overlook the requirements and to ask the right questions to estimate savings and costs.

These include:
1. Requirements
- Purpose, e.g. indoor or outdoor
- Type and number of lamps
- Style, e.g. open/closed lamps
- Types of installation, strip lighting, surface-mounted, wall lamps, floor lamps etc.

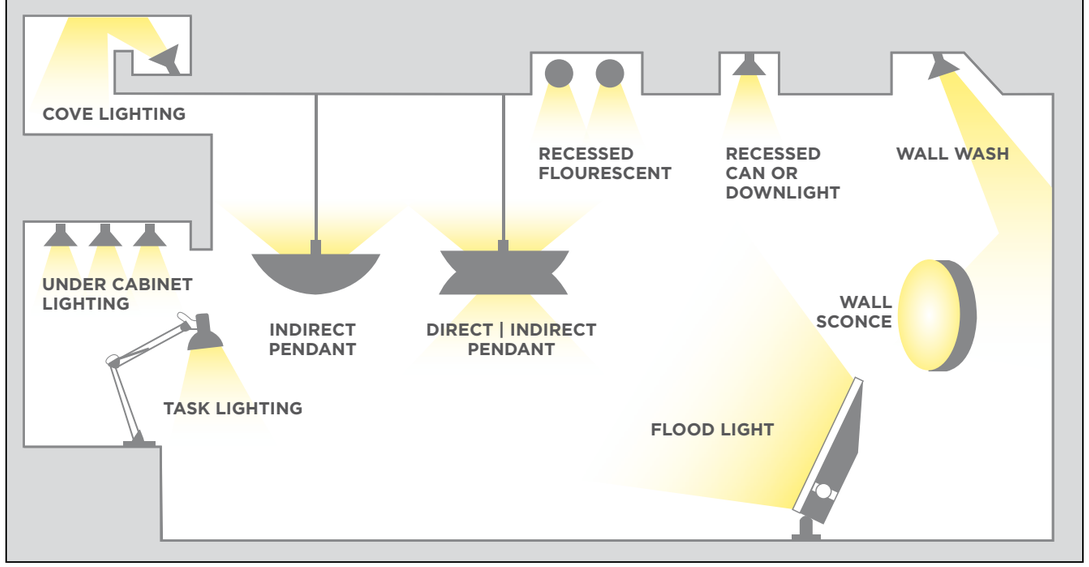
2. Features
- Technical features
- Electrical features
- Mechanical features
- Form and design

Conclusion
Today, EE lighting luminaire products satisfy aesthetic, functional and security requirements. This concerns the color rendering, intensity and type of illumination which has been identified as the “best solution”. The saving potentials add up to significant sums reaching up to 80% of the energy bill. Investments mostly pay off in less than one year.



1,000W Metal Halide lamp in photometric test at Futek

Indoor lights: Example Light types in the office:



Lamp type	Efficiency (lm|W)	Input power (lm|W)	Hazardous chemical content	Control gear	CRI	Applica-tion	Lifetime (hours)	CCT (K)	Dimma-ble
Incandes-cent	6–16	20–100	No	No	100	Indoor, outdoor	1000	2700	Yes (0–100%)
Halogen	16–30	55–300	Halogens	Low voltage (12V) or not	100	Indoor	1000–3000	2700–3500	Yes (0-100%)
Metal halide	75–125	20–24000	Argon, mercury	Needed	70–95	Flood-light, outdoor	6000–20000	3800-7000	Yes (50-100%)
Mercury vapour	40–75	50–500	Argon, mercury	Needed	40–60	Outdoor, street light, facade	4000	3200–4200	No
Fluores-cent tube	70–120	8–80	Mercury, neon	Needed	80–99	Indoor	15000–45000	2700–8000	Yes (3–100%)
Compact fluores-cent	46–80	10–80	Small amount of mercury	Needed or built in	80–90	Indoor	15000	2700–5000	Yes (3–100%)
Low pressure sodium	Up to 200	10–180	Sodium, neon, argon	Needed	30	Outdoor, street light, security	16000–23000	Difficult to de-scribe	No
High pressure sodium	100–150	50–600	Sodium, neon, argon, mercury	Needed	25–85	Outdoor, street light, security	10000–24000	2000–3000	Yes (50–100%)
Induction	60–80	55–165	Mercury	Needed	80–93	Outdoor, tunnels, high bay	60000–100000	2700–6500	Some models (30–100%)
LED	80–160	0,2–150	LED have to be dis-posed in a correct way (Arsenic Phospho-rus)	Needed	65–97	Indoor, outdoor	25000–80000	2700–8000	Yes (0.1–100%)

Light Design and Controlling

Traditional lighting only knows two functions: to switch on or off. But the impact, colour and intensity of light changes throughout the day and season. Therefore mostly too much artificial light and electricity is used which is summing up. The expenses are mostly underestimated. This can be changed – and investments pay off in relatively short periods of time.

Further efficiency potentials rise through the use of controls, presence sensors and daylight sensors. In the case of larger buildings, modern light control systems are thoroughly efficient for different uses. In residential constructions complex control systems mostly are too expensive.

This applies both for new buildings and for the modernization/renovation of old buildings, as well as in the area of outdoor lighting. Up to 75% can be saved on electricity in comparison with old lighting systems.

In light control systems today touch screens are standard

What can be controlled?
The answer is: Nearly any light source can be controlled and combined individually making lighting architectures as efficient as possible – and objected. Also, modern light systems are able to control and modify the amount of artificial light at any time and location.

Sensors respond to the presence of people switching light on or off accordingly. Advanced building technology systems for shading and ventilation contribute to energy efficiency and savings. Modern lighting design technologies are creating new or imitating given light scenarios, influencing our emotions and creating what we would like to see: The room we desire.

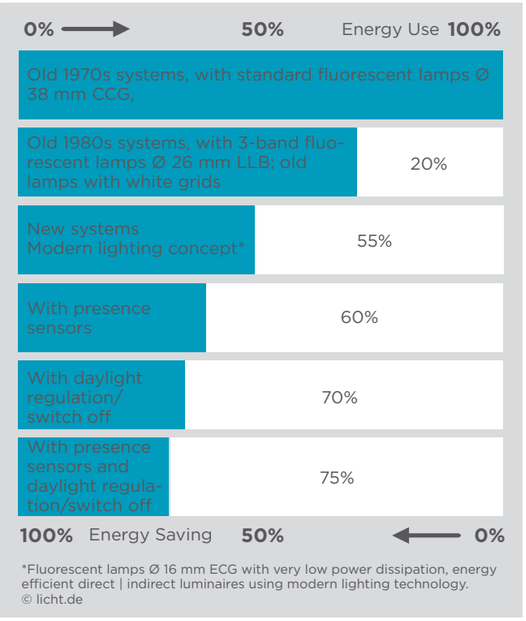
Therefore, control does not only increase energy efficiency, but also contributes to comfort of users and an improved meeting of requirements.

Technologies and components
Lighting control systems basically are networking units which will be connected to a central computing device operating the communication between various system inputs and outputs. Lighting control systems are widely used illuminating industrial and commercial spaces providing the minimum energy needed.

Companies are needed to plan, install and maintain complex control systems. The unmanageable variety of control systems for indoor and outdoor solutions require this. These include:

- Electronic ballasts
- Programmable switches
- Daylight and presence sensors/motion detectors
- A network with data points
- Timers
- Control programmes

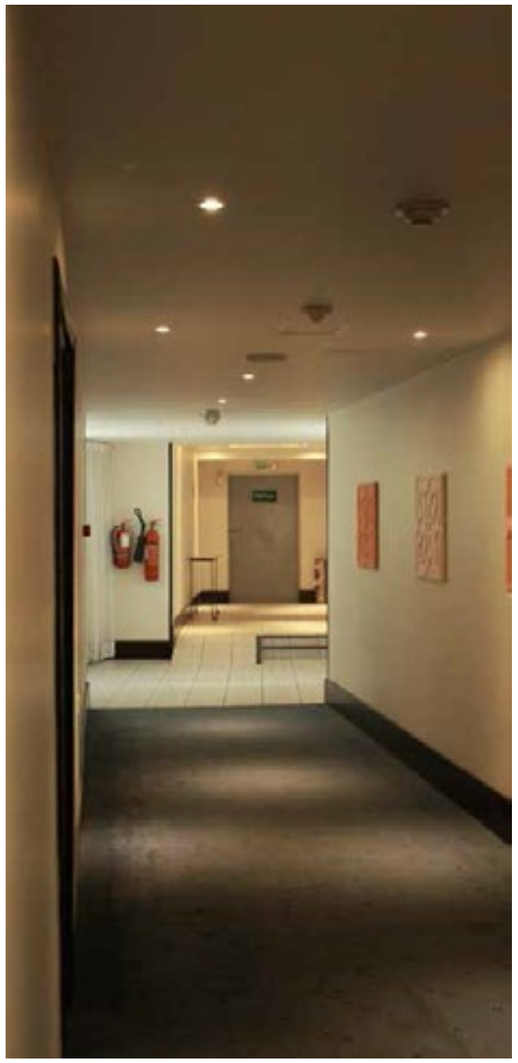
These control components work as a modular system contributing to the highest possible level of energy efficiency.



*Fluorescent lamps Ø 16 mm ECG with very low power dissipation, energy efficient direct | indirect luminaires using modern lighting technology.
© licht.de

Elegant LED illuminant for conference and meeting rooms

All components, from the energy saving lights to the control programme, must be compatible with each other. The complex requirements might make it important to involve specialised light design architects and engineers.



Control system alternatives
However, many sensor technologies already are available as small integrated systems which can be used in private residences for low prices. Some examples:

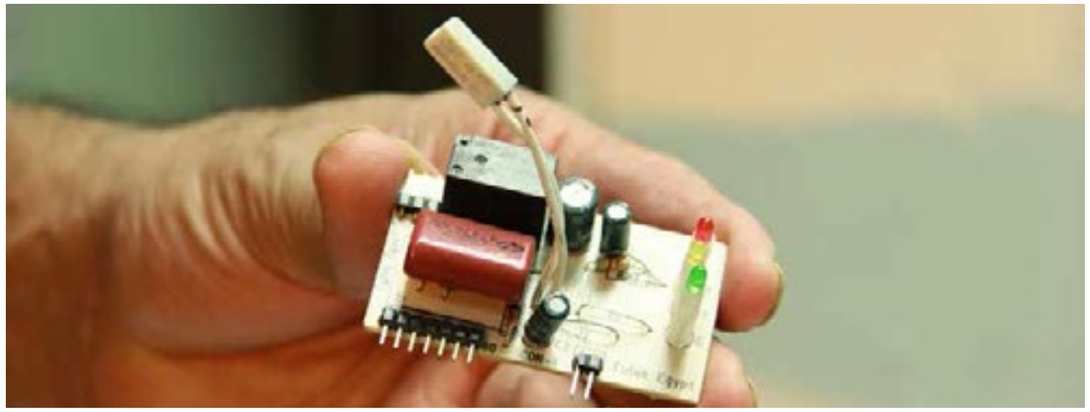
Occupancy sensors:
Such sensors can be used in bathrooms, corridors, stairs, lifts and non-permanent areas. In general, consumption will be reduced by about 40%. Photo sensors can be integrated to avoid occupancy sensors switching on while there is enough natural light.

Photosensors:
Photosensors will be installed in large rooms with sunlight. They are constructed to automatically dim lamps in light flooded areas whilst lightening up darker spaces. The electricity consumption may be reduced by up to 50%.

Planning components of light managemnet

Prior to planning, the following general conditions must be agreed between user and client. The components of the light system must be determined:

- Determination of the desired room conditions and requirements, as well as the system components
- Availability of daylight
- The various minimum lighting requirements
- Requirements regarding the intensity and quality of the light
- Duration of daily lighting requirements (usage/ opening hours from --- to ---)
- Potential retrievable lighting scenarios
- Security lighting
- Sensors for basic or general lighting
- Sensors for workplace lighting
- Security of the power supply
- Sensors for outdoor lighting



Light level sensor for starting phases

Astronomic timers:
Programmed astronomic timers are regulating all outdoor lighting requirements. These are lamps for gardens, streets and facades which need to be switched on and off and controlled according to the daily changing times of daylight and human needs. Later at night they might be dimmed, then switched off and finally switched on again before daytime – especially during the shorter daytimes.

Photoelectric cells:
Photoelectric cells capture sunlight at all times. If a defined minimum level is not reached, lights are commanded to switch on.

Dimming:
Most EE lighting products are easy to dim and to regulate the lighting level by hand or automatically. Other types of lights require compatible ancillary equipment.

Ancillary equipment alternatives:
Changing ballasts and transformers to electronic units is an additional possibility to save energy and money. Basically there are two possibilities:

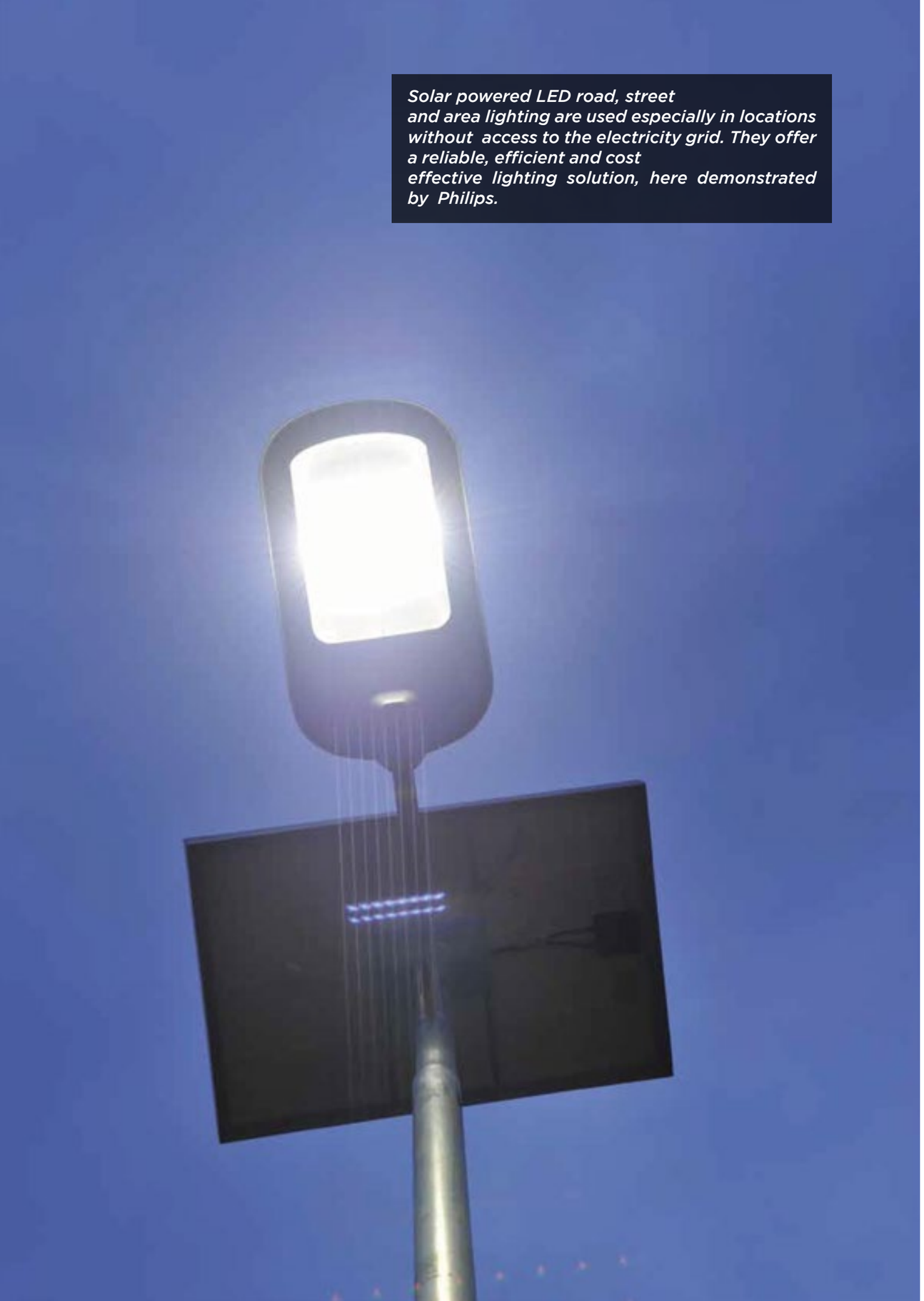
- Ballast units have an extra consumption. Magnetic ballasts consume 20-25% of the lamp wattage will be replaced by electronic ballasts consuming only 2-5%.

- A magnetic transformer consumes 10-15% of the lamp wattage which can be replaced by an electronic transformer which will need only about 2-5%

Summary:
The lighting technologies adjusting the consumption of energy to the absolute necessary and required illumination are simply convincing. Energy efficient lighting respects and fits better into the human biorhythm. Also, the maintenance costs will be reduced and risks are not known.

LED with integrated sensor technology for dimming, switching on and off

Complex lighting management system at Philips headquarters in Cairo



Solar powered LED road, street and area lighting are used especially in locations without access to the electricity grid. They offer a reliable, efficient and cost effective lighting solution, here demonstrated by Philips.

7.

Outdoor Lighting

Energy efficient outdoor lighting already is a success story and a "win-win" strategy for investors and producers as well as for the environment, public and local administration. Advanced products and technologies are constantly evolving. The photonic world market is booming with a growth of 75% during the past two years was worth 615 bn Euro, according to the "photonic report 2013" (photonic includes PV, EE lighting, EE communication, sensor and monitoring technology). EE lighting accounted for around one third of the photonic market in 2011.

The MENA region, where outdoor living and working is an important part of life, is nearly not capitalizing on this "megatrend" so far, although investments are paid off in a few years and maintenance costs are much lower than for conventional systems. Even more, EE lighting products and technologies can deliver any desired effect like adjusting light levels during, dawn, dusk and fog or the light colour to create different effects, which is unimaginable using conventional lighting. Outdoor lighting solutions offer up to 80% in energy saving.

Solar road street by Philips

LED or HID or Induction Lamps?
For indoor lighting the future belongs to LED. Outdoor illumination lighting decisions are more complicated. The features of LED however are convincing: extreme energy efficiency, durability and long maintenance intervals, as well as the high light quality and low attractiveness to insects. The intelligent inter-action between LED, electronic operating devices, reflector technology, thermal lighting management and control are unique. Systems can be dimmed providing savings of up to 30%. The overall savings add up to 80%.

For this, in many cases LED already is the most efficient and best solution. In municipal and residential areas in particular, it will cover all provisions of orientation and safety. LED light is illuminating work areas, streets or sport facilities.

Applications with high-performance lighting provisions such as in shows, photo and film productions and at occasions when especially very bright white light is required, halogen lamps or quartz metal halide lamps might be used (CRI > 92%). This also applies for street lighting in areas with high traffic volumes and high speeds. The efficiency of HID high pressure sodium lamps wieldy used in streets and public lighting can be further improved using a tailor-made lighting gear (using electronic dimmable ballasts to replace magnetic ballasts). Lighting management systems reduce the side effect of high intensity starting current that usually happens at peak load times (reduces starting current 10 times at least). Dimming will also control the lighting intensity during low traffic periods (reducing energy during late night hours).

As an example, Egypt was a pioneer among MENA regions applying for a large tenders for EE street lighting in 2010. 360 000 street lighting poles using high lumen HPS lamps and electronic gear were installed. The next step will be to replace 5 million magnetic ballasts with digital dimmable ballasts until 2016. Street lighting in Egypt is consuming 2,400GWH at present stage and expects to save up to 1,200GWH implementing the NEEAP and using smart lighting harvesting technologies.

What to do next?

1. Mercury vapour lamps (MVL) should be replaced today.

2. Fluorescent lamps (TL and PL) and compact fluorescent lamps (CFL and ESL) are more efficient than MVL. Thermal amalgam lamps are required for outdoor use to overcome fluorescent lumen depreciation when temperatures rise to more than 45C.

3. Induction lamps are an emerging technology especially for hot countries with a service life above 80 000 hours and with low investments. Induction lamps are recommended for tunnel lighting, high-bays and other hot places which are difficult to maintain.

4. Induction Lighting Tips: CRI > 80%, service life > 80 000 hours can replace metal halide lamps and HPS lamps with 50% saving (125W induction lamps can replace the 250W metal halide). New generations of induction lamps for street lighting which are dimmable save between 40% and 100%.

5.Sodium vapour lamps (HPS) provide very efficient yellowish lighting suitable for streets, and parks. New generations of highly efficient HPS offer more sustainable light sources with less depreciation, a good lumen factor (up to 110Lm/w for 150W lamps). HPS lamps are dimmable to 50%.

Branding cities putting architecture and places in a better light

EE lighting stages architecture and green areas useful for urban marketing underlining atmosphere and visually highlighting the unique buildings, markets, squares and constructions. Actually, the success story of LED started with illuminating and projecting brilliant clear colours in texts, images and films attractive also because of low energy costs. LED is replacing the conventional fluorescent tubes used for advertising. LED illuminated advertisements radiate indirect light, which helps reducing light emissions and smog. Illuminated signs, symbols, signals and traffic lights are ideally suited to using LEDs.

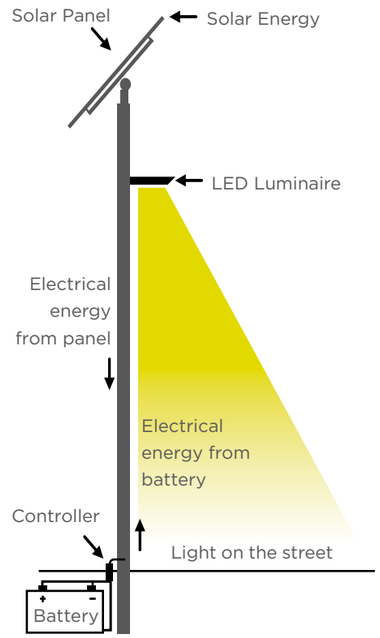
Open-air events and outdoor workplaces

At outdoor events floodlight systems are common which consume energy above the ordinary. LED floodlight lamps are already paying off in smaller football pitches and recreation parks. High-performance, highly efficient halogen metal halide lamps are available for the larger flood lighting systems. Both guarantee white light with good colour rendering.

Outdoor workplaces, industrial facilities, airports, harbours and railway stations require bright, wide-area lighting with excellent colour rendering and flexible, durable solutions. The range of available EE solutions have grown accordingly as an example shows: Reducing the running costs between 25% and 30% suddenly starts to make loading times for ships, trains and HGVs economically feasible improving services

Grid

Rural areas within the MENA region are suited to off-grid solar solutions i.e. on residential streets, pathways and squares, due to the high sunlight impact. Here, expensive cabling is no longer required, thereby reducing the costs. Solar off-grid lights consist of LED bulbs, lights, mast, PV-element, battery and control.



Energy efficient solutions offer higher savings

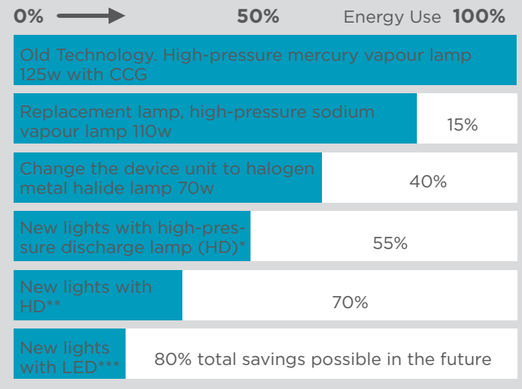
Planning EE outdoor lighting solution can be quite complex according to requirements. For instance, the choice of lamps, as some types tend to attract insects. Or taking into account that the use of two-LED-systems mostly pay back quickly, responding to the simple fact that in the dawn half of the lux fulfils the requirements. Selecting the lamps, calculating investments and economic viability will in most cases be performed by specialists. Various national and international standards are available for the planning process.

Cost efficient solutions are mainly managed by investors which are the end-user in one “person”. In other cases it has been experienced that investing utilities are not very interested in later savings, since the consumer is paying the electricity bill, anyhow. The key standards are listed in appendix

LED flood light solutions in smaller sports areas will lower the electricity consumption by up to 80%, here provided by Philips.

Comparison of energy savings in the case of lamps for outdoor lighting

There is a cascade-like increase in efficiency when using various lamps. To replace conventional 125W bulbs by high-pressure mercury vapour lamps with CCG (conventional control gear) with a modern LED with a regulated usage reduction of up to 50% with an operation period of 2,000 hours. Later the energy consumption is thereby reduced by up to 80 %.
Source: licht.de



* Sodium steam high pressure lamp or halogen metal vapour lamp

** Sodium steam high pressure lamp or halogen metal steam lamp, with regulation system and 50% performance during a period of 2,000 hours

***With regulation system and 50% performance during a period of 2000 hours

Energy efficient street lighting is the future

In recent years MED-ENEC has emphasized the importance of EE lighting pilot projects throughout the MENA region. Some governments have started to put in place legislation, policies and plans to support energy efficiency. Namely the National Energy Efficiency Action Plans (NEEAPs) in Lebanon, Jordan, Palestine and Egypt have set a signal for energy efficient lighting. Lebanon for instance plans a public street lighting pilot with photo-sensor devices and is launching a study on PV street lighting potentials.

Example Egypt

Egypt has developed an “Energy Efficiency Plan in the Electricity Sector” for 2012 – 2015 saving 5,566 GWH – mainly by measures in the lighting sector such as:

- Change to high efficiency lighting in the house hold sector. The planned distribution of 60 million bulbs shall save 3,320 GWH.
- The second phase of program of energy efficiency standards and labelling for household appliances. This shall save 1,663 GWH.
- Energy saving in street lighting of 1,200 GWH, supported by the Association Of Energy Efficiency Engineers (AEEE).

MED-ENEC activities

Practical experiences in the region prove that the payback period for LED street lighting is below two years. The life cycle will be guaranteed for 15 years without further costs for maintenance. In reply to various requests throughout the MENA region MED-ENEC developed a standard training course for experts in the field of EE lighting. Participants will receive:

- An overview of EE lighting solutions
- Reasons and basic costs for intelligent street lighting (energy, climate, safety)
- An overview of European street standards and regulations including EN 13201
- Facts and figures based on EU statistics
- Introduction into methodology and targets for procurement processes and benefits.

A five-day seminar about EE lighting procurement was successfully conducted in cooperation with the Ministry of Energy and Electricity in Cairo in 2013, 2014 and 2015.
Similar training courses have been conducted in Algeria (2013, 2014).

The energy efficient lighting system in Cairo includes offices and conference rooms, realized by Philips.

8.

Public Procurement and Planning

Public projects with energy-efficient lighting need a careful preparation when it comes to the public procurement. In exterior as well as interior projects the tendering can be called the "high art" of good planning.

First steps

A first step will be to decide if a technical approval or even a study is recommended to identify the saving potentials, technical alternatives, risks and challenges. Documentation is required. In larger projects with lighting management systems the costs for operation and maintenance might turn out to be more relevant than the first sight would show.

In a second step specialized engineers will take care of important details. In order to avoid the risk of bad investments the proposed technological solution will be proofed carefully against the list of requirements and experienced alternatives. A feasibility study including a business case and a financial plan might be supportive for further decisions. Practitioners should also accompany the project with planning and advice expertise.

In a third step – particularly in larger projects - it makes sense to appoint a skilled project manager. Work contracts with reliable constructors and service companies should be adjusted against legal requirements with the support of a skilled lawyer.

The following notes are intended as a guide line for the tender.

• **Tender Conditions**

- Tenders are not only the key to a functioning roadmap for project implementation. They function also as a tool for purchasers to clarify their own objectives and means clearly and to design all details which are important to the successful implementation. Tenders must include the following clarifications:

• **Introduction:**

- Background and achieving target / Project requirements

• **Key Conditions of Tender**

- Name & number of Tender | Closing date and time | Contact person | Lodging of Tender
- Number of copies | Tender documents | General conditions of contract

• **Tendering procedure:** briefings, additional information, site visits, discrepancies

• **Extension of time:** requests and reasons to support

• **Rights reserved:** evaluation of tenders, cease to

Name of Tender	Energy Efficiency LED Lighting Retrofit of the City's Public Domain Lighting Luminaires
Tender Number	xxxx
Closing Date	Day, Month, Year
Closing Time	11.00 am
Contact Person	All enquiries relating to this tender should be directed by email to the Council's Tendering Officer as follows: (Full Name) Tel: xxxxx I Fax: xxxxx Email: xxxx@xxxxx
Lodging a Tender	Tenders must be lodged with Council by the closing date and time and in accordance with the standard conditions of tender at the following address or fax : Name | Function | Company | Phone numbers | Emails | Adress The Tender box is accessible between the hours of 8am and 6pm, Monday to Friday / Sunday to Thursday
Numbers of Copies	Submit, as hard copies, one original and three copies of the tender and attachments, signed as required. The front page of each copy (including all supporting information) must be endorsed by the tenderer as a true copy.
Tender Documents	The documents that comprise the request for tender include: Tender Conditions and Forms | Specifications | Drawings | General Conditions of Contract | Appendicies
General Conditions of Contract	The general Conditions of contract for this tender will consitst of **xxxxx - Design and construct**

1,000 W Metal Halide lamp in photometric results

proceed with the process, reject any tender, accept non-conforming tenders.

• Assessment criteria: schedule of prices, key experiences, proposed program for completion of works, methodology, luminaries aesthetics, guaranteed energy savings, warranties, occupational health & safety, financial position of the tenderer

• Additional information for the purposes of clarification or explanation of any tender

• Acceptance of tender & contract: letter of acceptance, written standard contract

• Confidentiality agreement / conflict of interest: offers provide detailed information about the nature and scope of the conflict of interest

Tender Forms

The formal aspects of legal tender are of great importance and should be considered carefully.
The main elements are listed below, but must always be individually adjusted and supplemented.
For this purpose, an experienced lawyer should advise the client.

• Execution by Tenderer
• Specified personal
• Schedule of Prices
• Proposed Sub-contractors & Suppliers
• Statutory Declaration
• Environmental Management
• Statement od Conformance
• Proposed Program & Methodology
• Acknowledgement of Addenda & Notices
• Proposed Schedule of Plant & Equipment
• Insurance and Disability Details
• Details of luminaires
• Company Profile
• Warranties
• References
• Occupational Health & Safety
• Previos work experience
• Key Performance Indicators
• Current Commitments

Specifications

Tenders should describe the required services and work as precisely as possible. It is useful to describe not only the technical elements of energy-efficient lighting, but also the requirements and conditions during installation and subsequent operation of the lighting system. Some key requirements are listed in the box below.
The tender should accurately describe the quality assurance and the rules during the construction requirements and other conditions. These are part of the contract and binding. The requirements serve the orderly conduct of the installation site, quality control, security at the site. This helps to avoid misunderstandings and disputes.

Tender description of works

- Energy efficient lighting retrofit (lm/W, LOR, CCT, CRI, dimming, control gear compatibility...)
- Smart controls (occupancy sensor, dimming control, network infrastructure....)
- Luminaire aesthetics (photographs, computer simulations (DIALux), data sheets...)
- Durability, life and reliability
- Maintenance manuals and operating instructions, on-site training of niminated personnel
- Labels, circuit list/diagrams, testing, inspection and commissioning
- Removal and disposal price of redundant existing installation
- Associated work (carrying out and providing tools, equipment, scaffolding...)

Further specification if needed
- Period specified for completion of works
- Programme of work (percentage to be completed in each phase)
- Room (fixture heights, existing controls...)
- Operation and maintenance
- Guarantees and servicing/commissioning (after completion) to be submitted by the Contractor

The client ensures that the overpayment is prevented by installments. Acceptance of installation works should take place only on presentation of evidence of performance and quality. Furthermore, the client agrees on a financial deduction up to final full and faultless acceptance of installation.

Contracts are including the following agreements and requirements:

•Approvals (materials are to comply with national standards in the relevant content)
•Quality assurance (according to quality assurance standards)
•Harmonics, nuisance, pollutions and Radio inter ference (in accordance to laws, relevant standards, property)
•Standard hours and conduct (special time constraints, special areas, certain tools...)
•Spares (luminaires, lamps, control gears)
•Access to site (accreditations) and site occupancy (lunch facilities, material storage
•Payment for work executed (percentage of payment in each phase completed)
•Verification, commissioning data and test of installation (inspections, tests, reports and certifications...)

Summary

The quality, clarity and accuracy of the tender is the key to a successful energy efficient lighting system for refurbishment, but also for new constructions.
In order to deliver a successful tender, an equally accurate and detailed planning must first be developed.
According to experiences early investments in planning and tendering pay later during the construction phase and are thus important prerequisite for a well functioning energy efficient lighting and finally a satisfied client.

1,000 W Metal Halide lamp in photometric results

Norms and sources

Norms

-EU Guideline 2010/31
-EN 12464-1:2011: Light and lighting - Lighting of work places - Part 1: Indoor work places
-EN 12464-2:2007: Light and lighting - Lighting of work places - Part 2: Outdoor work places
CIE S 015/E 2005 identical in content to EN 12464-2:2007
-EN 12665:2011: Light and lighting - Basic terms and criteria for specifying lighting
-EN 15193:2007: Energy performance of buildings - Energy requirements for lighting-
-EN 15193:2007/AC:2010: Energy performance of buildings - Energy requirements for lighting
-EN 16268:2013: Performance of reflecting surfaces for luminaires
-EN 1838:1999: Lighting applications - Emergency lighting.
-EN 13201-1:2004 street lighting
-EN 12193:2008, light and lighting, sports facility lighting
-DIN V 18599-4 “Energy efficiency of buildings - Calculation of the net, final and primary energy demand for heating, cooling, ventilation, domestic water heating and lighting”

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Abreviations

bn	Billion
CCG	Conventional control gear
CDO	See CPO
CFL	Compact fluorescent lamps
CO2	Carbon Dioxide
CPO	Philips Cosmo White (Metal HalideLamps)
CRI	Color rendering index (of a light source)
DALI	Digital Addressable Lighting Interface
EE	Energy Efficiency
EVG	Electronic Ballasts
GW	Giga Watt
HID	High-intensity discharge
HPL	High-performance lamps
HPS	High pressure sodium (lamp)
IT	Information Technology
LED	Light-emitting diode
MENA	Middle East and North Africa
MVL	Mercury vapour lamps
OLED	Organic light-emitting diodes
NEEAP	National Energy Efficiency Action Plan
PC	Personel Computer
PV	Photo Voltaic
SON	Sodium vapour lamp
W	Watt

Attachment

Recommendations for good lighting - DIN EN 12464-1
Minimum Illuminance
Em is the average minimum illuminance on a defined area (working place). This illumination shall not be exceeded. It is measured in lux (lx)
Examples for indoor workplaces

	Em
Offices:	
Filling, copying etc.	300
Writing, typing, reading, data processing	500
Technical drawings	750
CAD work stations	500
Conference- and meeting rooms	500
Reception desk	300
Archives	200
Traffic Zones:	
Circulation areas and corridors	100
Stairs, escalators, travalators	150
Looding ramps | bays	15
Rest, sanitation and first aid rooms:	
Canteens, pantries	200
Restrooms	100
Wardrobes, washrooms, bathrooms, toilets	200
Rooms for medical attention	500
Retail premises:	
Sales area	300
Wrapper table	500
Restaurants and hotels:	
Reception/cashier desk, porters desk	300
Kitchen	500
Self service restaurant	200
Buffet	300
Conference rooms	500
corridors	100

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