A brighter life for everyone

Commercial and industrial lighting

Eskom

Table of contents

1. Introduction 2

2. Role of lighting in organisations 2

3. Energy smart lighting systems 2

- 3.1 Lights 3
- 3.2 Control gear (ballasts) 3
- 3.3 Luminaries 4
- 3.4 Natural lighting 4
  - 3.4.1 Fenestration 4
- 3.5 Skylights 4
  - 3.5.1 Types 4
  - 3.5.2 Features 4
  - 3.5.3 Considerations 5
  - 3.5.4 Benefits 5

4. Steps towards saving energy in lighting systems 5

- 4.1 Switch to energy efficient lamps 5
- 4.2 Remove unnecessary lamps 6
- 4.3 Match light provided with demand 6

5. Considerations for selecting a lamp 7

6. Calculate the savings 7

7. Conducting a lighting audit 7

- 7.1 Assess existing conditions 8
- 7.2 Assess opportunities for increasing lighting energy saving 8

8. What can Eskom do for you to improve lighting efficiencies and save 9

9. References 9

Improving lighting efficiency in commercial and industrial buildings

1. Introduction

Lighting accounts for a substantial portion of the monthly energy consumption and costs of commercial and industrial buildings. In fact, lighting is estimated to be responsible for between 35% and 45% of electricity consumption in office buildings. For companies, curbing electricity consumption by lighting is a way to drive down energy costs substantially.

2. Role of lighting in organisations

It's important to understand a bit about light and the role that lighting plays in a commercial or industrial setting. The primary function of light and lighting is to see. Artificial lighting enables indoor work and activity every day, around the clock.

Colour rendering (how well a light reproduces colour) and illumination (the amount of light received on a surface) influence the way people feel and perceive colours, and how they experience thermal comfort.

So, lighting has a major impact on peoples' moods, energy and behaviour. Studies on the influence of both artificial and natural lighting have shown that people are more energetic and productive when they're exposed to daylight and when they work in an appropriately lit environment.

The amount of light or illumination (measured in lux) needed depends on the activities planned for the room. For instance, more lux is needed for intricate tasks such as sewing or working with small parts than is required for reading or cleaning.

From a lighting point of view, in commercial and industrial buildings, illumination is the most important factor because of the role that lighting plays in human behaviour and productivity. However, from an energy-savings perspective, luminous efficacy (the ratio between input energy and the light emitted) is crucial.

Luminous Flux (lm) - Total light emitted by a given source.

Luminous efficacy/efficiency - a measure of the lamp's ability to convert electrical power into visible light expressed in lumen/watt (lm/W).

Colour rendering index - on a scale of 0-100, is a measure of how well a lamp renders colour. A lamp with a CRI of 100 makes objects appear as they do in sunlight. All lamps have various characteristics in terms of colour rendering. Therefore, various systems can be more or less appropriate for a given application.

Against the backdrop of South Africa's drive to reduce electricity consumption and find more energy efficient, environmentally friendly ways of living and working, companies must strike a balance so that the need for lighting is met in the most appropriate and energy efficient way.

Companies can dramatically reduce the amount of electricity consumed by lighting by using new generation, energy smart lighting technologies; employing energy smart lighting design, and adopting energy smart lighting practices.

3. Energy smart lighting systems

The use of outdated lighting technologies is still widespread in South Africa. Energy usage can be reduced by 50% if up-to-date, energy efficient technologies are embraced (Policy Declaration of the Illumination Engineering Society of South Africa (IESSA)).

New generation lighting systems use less electricity, are kinder to the environment and generally have a longer lifespan than older lighting technologies.

The large variety of components available today means there are energy efficient solutions to fit almost any context.

3.1 Lights

There are significant differences between the efficiencies, colour rendering and light colour of different types of lights. This table provides a snapshot of the lifespan, efficiency, light colour and colour rendering of the various light sources.

Type of lamp	Average life span (hr)	Efficiency (lm/watt)	Light colour	Colour rendering
Incandescent lamp				
Normal lamps	1 000	6 - 15	Extra warm white	Very good
Halogen lamps	2 000 - 4 000	10 - 24	Warm white	Very good
Low pressure mercury vapour lamps (fluorescent lamps)*				
Tubular lamps (TL)	12 000 - 20 000	45 - 105	Warm white to cool white	Good to very good
Compact lamps (CFL)	10 000 - 15 500	40 - 80	Warm white to cool white	Good to very good
High pressure mercury Vapour lamps**				
High pressure mercury vapour lamps	12 000	30 - 60	Warm white to cool white	Moderate
High pressure sodium lamps	25 000	46 - 150	Yellow white	Bad to good
Metal halide	12 000 - 18 000	72 - 110	Warm white to cool white	Good to very good
Induction lamps	60 000	50 - 80	Warm white to neutral white	Good
Low pressure sodium lamps	18 000	100 - 200	Monochromatic orange	None
LED (light emmiting diode)	30 000+	90 - 150	Warm white to cool white	Good to very good

Table 1. Efficiency of various light sources

Note: Induction and LPS lamps MUST be replaced due to their inefficiency.

*Banned in South Africa
** This is old technology that is no longer available

3.2 Control gear (ballasts)

Figure 1. Different types of ballasts

Gas discharge lamps such as fluorescent and high intensity discharge (HID) require a ballast to operate. The ballast provides the lamp with the required starting and operating electrical voltage and current. The primary types of lamp ballasts are electromagnetic, commonly referred to as magnetic.

Electromagnetic ballasts perform the essential functions required to start and operate a lamp. However, electronic ballasts are more efficient, have longer expected lives, and virtually eliminate the flicker that electromagnetic ballasts sometimes produce. In addition, special electronic ballasts can provide dimming capability, though these can cost 50% to 100% more than non-dimming ballasts.

The typical expected life of electronic ballasts is 50 000 hours. The actual life of a ballast is severely impacted by the ambient temperature. A higher ambient temperature than the product is rated for will lead to a significant decline in ballast life. On the other hand, a drop in the ambient temperature of 13°C could double the ballast life. In addition, the number of hours per start affects ballast life. A 50 000 hour rated life could assume 12 hours per start. If the average is only one hour per start, the actual life will be much shorter. The switch to electronic high-frequency ballast leads to an increase of 30% to 40% in system efficiency.

3.3 Luminaries

A luminary is the complete light system, consisting of the fixture, light source, the reflector for directing light, an outer shell and a driver (in the case of gas discharge lamps). Their role is to control the distribution of light from the lamp in terms of quality, direction and uniformity. The best and most efficient luminaries deliver light only where it's needed, limiting light pollution (or the spillage of light) into areas where it's not needed.

3.4 Natural lighting

What is the best way to light an environment? Use natural daylight. Day light maximises the amount of light brought into a building with 100% diffusion, eliminating hot spots, low glare, or Ultra-Violet light damage to the interior surfaces of a space with the use of windows or skylights. Day light harvesting is also used to supplement previously installed lighting systems with controls to maintain the same level of light in a building at all times.

Daylight influences the human being as a whole, physically, emotionally and mentally, and therefore it is important to admit daylight into buildings. Daylight is a far more efficient source of illumination than artificial light. Daylight provides a more pleasant atmosphere inside a building and is a superior quality of light to artificial lighting. Daylight also adds a heating load to the building therefore the amount allowed and the type of glazing must be suitably selected.

The optimal application of day lighting in the commercial or industrial building is a building with high open ceilings. By removing drop ceilings, building owners are finding more opportunities to disperse and diffuse natural light.

3.4.1 Fenestration

Daylight is admitted into buildings via windows and skylights, both of which improve the aspects of the environmental performance of the building. The collective term for windows in buildings is fenestration.

Fenestration is vital to the functioning of the building, and the occupants by admitting light and heat from the sun as well as ventilation. The quality and availability of the daylight inside a building is governed by several factors:

- The nature and brightness of the sky
- The size, shape, and position of the windows
- Reflections from internal surfaces
- Reflections and obstructions outside the room
- Orientation of the building.

3.5 Skylights

Skylights are a wonderful way to increase daylighting. They allow natural light to come into a building directly. Skylights are wide windows that are inserted at the roof of buildings or houses. They distribute light more evenly over an area and are excellent to use in combination with natural daylight. Here is some more information about skylights if you are interested in making a purchase.

3.5.1 Types

There are three popular types of skylights that are most commonly used. These include the fixed skylight (a skylight that does not open), ventilating skylight (opened to enable air to pass through) and tubular skylight (a skylight directing the light down a tube into the rooms or narrow hallways). Other common skylights include flat skylights, dome skylights, polygon skylights, hip ridge skylights, ridge skylights, round skylights, barrel vault skylights, pyramid skylights and lean-to skylights.

3.5.2 Features

Some features to look for when picking out a skylight are tinting (filtering of UV rays and heat), insulated thermal glass (stopping loss of heat in winter and increasing cool during summer), blinds or shades (screening the full sun), total block out shades and insect screens (keeping insects outdoors).

3.5.3 Considerations

Know your roof support system details and measurements, as well as the thickness and type of your roof (this will help you figure out what kind of roof flashing or mounting you will need). You will also need to be familiar with your ceiling, particularly if you have a cathedral, wooden panel ceiling or a standard ceiling.

3.5.4 Benefits

Skylights can bring great benefits to the building and occupants. Not only can they increase the amount of beautiful natural light, they can make the room appear larger, not forgetting the use of less energy in heating and artificial light requirements.

4. Steps towards saving energy in lighting systems

4.1 Switch to energy efficient lamps

Retrofitting fixtures with energy efficient lamps represents the best opportunity for companies to cut back on lighting consumption and costs. Companies can also improve their carbon footprint through a direct reduction in greenhouse gas emissions, and at the same time, help to alleviate the country's energy constraints.

The simple payback of a retrofitting project can be from six months to three years. That's because energy efficient lamps and fittings generate more light per electrical energy (Watts) consumed and lamp lifetimes are much longer, leading to lower maintenance and replacement costs.

It is very important to make sure when doing retro fitting the light levels still meet the prescribed South African National Standards (SANS) regulations. It is best to do recalculation and design before retrofitting.

Quick ways to reduce watts:

- Replace incandescent lamps with LED
- Replace T12 fluorescent tubes with energy efficient T5 fluorescent or LED options.
- Replace conventional electromagnetic ballasts with electronic ballasts
- Replace the conventional 50 watt halogen downlights with LED replacement equivalent. Please note that if an existing 12V is being replaced with a 220V option, an electrician is required to ensure that the existing transformer is removed and the system rewired.

- Replace Mercury Vapour lamps with energy efficient options, and this could, depending on lighting requirement and SANS standards, be retrofitted with the following options:
  - LED lamps
  - Linear Fluorescent
  - High Efficient Metal Halide or High Pressure Sodium Highbays.

Although High Pressure Sodium lamps have the highest efficacy (Lumens/watt), they are generally not the preferred choice where colour is important due to their bad colour rendering index.

4.2 Remove unnecessary lamps

Companies save electricity simply by removing unnecessary lamps and ballasts in overlit areas. Overlit areas can be identified by measuring the light levels as per SANS standards requirements.

There are standards for the illumination levels required for different activities. Where illumination exceeds these recommendations, lighting can be reduced. Below is a list of recommended illuminance values for commercial buildings

1500 Lux

- Colour matching, colour inspection, goods inspection
- Assembly of precision equipment (electrical)
- Production of jewellery, retouching, etc.

750 Lux

- Technical drawing
- Metal marking and inspection
- Flaw inspections
- Selection of veneers
- Grinding, polishing of glass, precision assembly

500 Lux

- Offices for data processing, meeting rooms
- Assembly
- Work on woodworking machines
- Trade fair stands, control desks
- Register at sales areas

500 Lux continued

- Enameling, glass-blowing, turning, drilling, milling, semi-precision assembly
- Sales areas

300 Lux

- Storerooms where reading is necessary
- Non-precision assembly, cast cleaning, casting rooms
- Rooms with public access in offices
- Archive
- Changing rooms, washrooms and toilets
- Dispatch

100 Lux

- Storerooms
- Persons and vehicles access routes in buildings
- Stairwells, escalators
- Boiler house
- Entrance hall

4.3 Match light provided with demand

When lighting supply exceeds the demand, it's a waste. Lighting control technologies such as motion and daylight sensors limit electricity wastage by controlling when and where light is provided. Lighting controls have been shown to reduce lighting energy consumption by 50% in existing buildings and by at least 35% in new construction. These savings can be the result of reduced use of electricity, reduced peak demand, reduced heating, ventilation and cooling (HVAC) demand, lower maintenance costs, and improved productivity.

Occupancy sensors control lighting based on occupant detection. These can be used to control lighting in intermittently occupied areas such as meeting rooms, toilets and print rooms.

Daylight sensors brighten, dim or even switch off lights according to natural light levels as they change throughout the day. Building Management systems can switch off lights automatically or step down lighting levels for night time security or reduced occupancies.

5. Considerations for selecting a lamp

Use the following criteria to determine whether the lamp selection is compatible with lighting needs for a given location.

- Light output
- Input wattage
- Efficacy/efficiency
- Cost
- Rated life
- Size
- Colour rendering/ temperature
- Brightness
- Re-start time and temperature
- Dimming capability
- Requirements of additional equipment (ballast)
- Electrical, physical and operational characteristics of light, ballast and controls [ballast, effects on other equipment, total harmonic distortion (THD)]
- Ability to handle both typical and atypical operational conditions (break in power)
- Maintenance required

6. Calculate the savings

For each change use the following formulae to calculate annual savings by comparing the existing installation with the new installation costs:

(__watts x __ hours/day x __ days/year)/ 1,000 = ___kilowatt hours (kWh)

___ kWh x cost/kWh per year = ____ total annual kWh charges saved by this change.

7. Conducting a lighting audit

7.1 Assess existing conditions

To conduct a lighting audit you will first need basic lighting information, such as the number of lights, their location, and their time in use to help you understand the current energy use attributed to lighting in the facility. This information will help you understand how much you are currently spending and the potential savings available from lighting efficiencies.

7.2 Assess opportunities for increasing lighting energy saving

Determine if the following opportunities exist for a given location. Each checkbox represents an opportunity for energy savings followed by suggestions on how to best take advantage of the opportunity.

Checklist for the most important energy efficient options:

	Check	Date	✔
1.	**Turn off lights in unoccupied areas** • Post reminder stickers to turn off lights when leaving the area. • Install time switches or occupancy sensors in areas of brief occupancy and remote areas (warehouses, storage areas, etc.). • Rewire switches so that one switch does not control all fixtures for multiple work areas. • Ensure wall-switch timers function properly.		
2.	**Determine if existing lighting levels are higher than recommended levels** • Use a light meter to measure light levels and consult the SANS Standards illumination requirements. • Reduce lighting levels where appropriate. • Employ uniform or task delamping to reduce power and lighting.		
3.	**Review outside lighting needs** • Eliminate outdoor lighting where possible and where safety and security are not compromised. • Manually turn off lights. • Replace burned out lamps with lower wattage lamps. • Replace exterior incandescent lights with more efficient lights such as CFLs, Fluorescents, LED, High Pressure Sodium (HPS) or metal halide (MH). • Install photoelectric or motion sensors where light needs are intermittent.		
4.	**Control gear** • Install more efficient ballasts. Ballasts typically have a long life; therefore, replacing ballasts that are still working can be one of the most cost-effective energy improvements		
5.	**Remove unneeded lamps (delamp)** • Remove fluorescent lamps controlled by magnetic ballasts in pairs since they are operated and wired in pairs (two fluorescent lamps from a four-lamp fixture). With electronic ballasts, each lamp is controlled individually. Some facilities have seen energy savings of more than 30 per cent or more from this action. • Remove unnecessary tubes and replace them with "dummy" tubes that draw little current and provide the effect of uniform lighting. • Disconnect ballasts, as the ballast will continue to use energy when the fixture is switched on.		
6.	**Install more efficient lighting** • Replace incandescent lamps in offices, workrooms, hallways, etc. with compact fluorescent lamps (CFLs) and LEDs. • Replace standard fluorescent lamps and ballasts with more efficient T8/5 and matching electronic ballasts (switching from fluorescent to high-efficiency fluorescent can save 10 to 30 per cent in energy costs). • Replace mercury vapour lights with higher efficiency LED lamps, MH HPS and fluorescent lamps.		
7.	**Employ more effective lighting settings** • Lower fixtures or use a lamp extender to increase illumination on a given area. • Install reflectors or lenses to spread out and focus light (specular reflectors can improve efficiency by up to 17 per cent in fluorescent lights).		
8.	**Follow a regular maintenance schedule** • Establish a regular inspection and cleaning schedule for lamps and fixtures. • Replace yellow or hazy lens shading with new acrylic lenses that do not discolour. • Replace old lamps at rated life as these consume the same power as new lamps, but produce less light (up to 40% less). • Replace old reflectors as these cannot be effectively cleaned.		
9.	**Use daylight effectively** • Locate workstations with high illumination needs adjacent to windows. • Install light sensors/dimming equipment that automatically compensate for natural light variance.		
10.	**Upgrade exit signs with the help of an expert** • Retrofit by replacing incandescent lamps with LED lamps, which use one-tenth the electricity of incandescent lamps and have a lifespan of more than 30 000 hours. • Replace old exit signs with new LED signs.		

8. What can Eskom do for you to improve lighting efficiencies and save

Call the Eskom Contact Centre on: **08600 ESKOM (08600 37566)** and log a query for an energy advisor in your area to contact you. Or visit **www.eskom.co.za/advisoryservice** for information on energy efficient technologies and adaptations. Email an advisor at **advisoryservice@eskom.co.za** for assistance.

9. References

- Leornado Energy – Efficient Lighting Guide (Rob van Heur, Laborec)
- US Department of Energy – www.eere.energy.gov
- Pike research – Energy Efficient Lighting for Commercial Markets
- North Carolina Department of Environment and Natural Resources
- www.lightingassociates.org/i/u/2127806/f/tech_sheets/natural_lighting.pdf
- www.ehow.com/about_4587012_skylights.html

Issued by Energy Advisory Service July 2020
Eskom Holdings SOC Ltd Reg No 2002/015527/30