ADELAIDE CITY COUNCIL GREEN BUILDING FACT SHEETS

Energy efficient lighting

INTRODUCTION

Lighting, energy and greenhouse

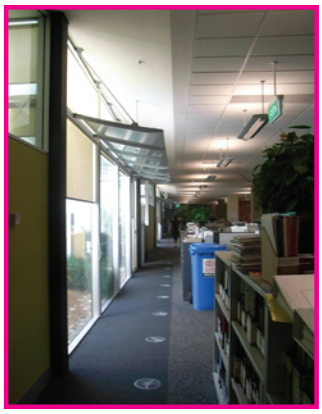
Artificial lighting uses a lot of energy in our homes and work places. In a typical home, lighting will account for about 10% of electricity use. In an office, it can be 30% or more. In a lighting intensive retail environment it could be more than 50%. For small commercial tenants who only pay for light and power it could be as much as 70% of electricity costs.

Inefficient lighting also gives off a lot of heat, increasing the energy needed for air conditioning. Using less lighting and more energy efficient lighting has the potential to significantly reduce a building's greenhouse emissions.

Reduce the need for artificial lighting

Use daylight

The best way to reduce the energy used for lighting is to use free natural daylight through the use of properly designed windows, skylights and light shelves. There are also products available that can be used to channel natural light into spaces even a long way from windows.



John Gorton Building, Canberra

ADELAIDE CITY COUNCIL

However, too much daylight, especially direct sun, can create glare problems and excessive heat. It is essential that glazing and sun control are properly designed to optimise both the lighting and thermal performance (see ACC Fact Sheet Energy Efficient Glazing).

Using light colours for internal surfaces and the external surfaces outside window increases the amount of useful daylight.

Using daylight inside a building also improves the general indoor quality by giving people a link to the outdoor environment.

Use the right amount of light

Many spaces are over-lit for the purpose. Often an entire office floor space will be lit to a level suitable for reading, when only about 10% of that area may require that lighting level. It is better to provide an adequate and safe level of background lighting and use efficient task lights for those spaces that need more light, rather than light everything to the same high level. AS/NZS 1680 has recommended minimum lighting levels for different purposes.

Recommended Illuminance	Characteristics and examples
40 lux	Corridors, walkways
80 lux	Interiors used internittently. Change rooms, liver storage areas, loading bays, stairs
160 lux	Coarse detail. Staff canteens, entrance halls, etc
240	Continuously occupied areas with easy visual tasks of reading, writing, typing, enquiry desks, libraries
320	Routine office tasks of reading, writing,typing, enquiry desks, libraries
600lux	Drawing boards, town planning and enquiry counters dedicated to viewing paper plans

It may be possible to provide general lighting at 160 lux in combination with well designed task lighting providing 320 lux.

Only use lights when they are required

The simplest way is to switch off unnecessary lights. Automatic controls can be used to turn lights on and off, and even control the amount of artificial light according to available natural light levels. These are discussed in more detail later.

CASE STUDY 1

The AGO Offices in Canberra

These offices are located in a basement underneath a ground level car park. This project involved the refurbishment of the basement into new office spaces, while providing daylight and visual connection to the outside using courtyards and skylights.

Day lighting

Four courtyards and six skylights allow natural light into the office space, reducing the need for artificial lighting. Light shelves also reflect daylight into the building, and also help to provide more uniform lighting conditions around the courtyards and skylights. Daylight sensors adjust artificial lighting levels according to the amount of daylight available, significantly reducing energy use.

Artificial lighting

The suspended luminaries comprise three energy efficient T5 fluorescent lamps with dimmable ballasts. Two lamps provide upward ambient lighting, and the third provides downward task lighting. Each is individually controlled, to coordinate with daylight conditions and the optimise energy savings.

Lighting control

A Clipsal ‘C’ Bus system controls lighting via light level sensors at ceiling and desk top height, movement sensors and local area controls. All artificial lighting responds to the levels of natural light within the space. Local switches provide flexibility in the zoning and use of lighting. Movement sensors are incorporated into the program for the beginning and end of the day, and infrequently used spaces such as bathrooms.

TYPES OF LIGHTING

There are several types of lighting technologies in common use in buildings: incandescent, discharge and, more recently, light emitting diodes. The table summarises efficiency and life of different lamps

Lamp type	Efficiency	Life
Watt	Light output per '000 hrs	
Standard light bulbs	10-15	1-2
Halogen1	15-25	2 - 5
T5 fluorescent tube	80-100	15 - 20
Compact fluorescent	50-80	10 – 15
Metal halide	70-120	10 - 20
LED	30-70	20-100

[1] Includes transformer

Incandescent lamps

This includes standard light bulbs and halogen lamps. These are the most inefficient form of artificial lighting. They work by heating an electric element to white heat, and produce much more heat than light.

Standard filament bulbs are more common in homes than in offices. They are cheap to buy but short lived, with a typical life of only about 1,000 hours. They should only be used in places that are lit for short periods and not very often, such as storage cupboards.

Standard Filament Bulb

Tungsten halogen lamps are more efficient than standard bulbs. However, most operate on low voltage and the transformer needed to supply the low voltage reduces their overall efficiency to not much better then standard lamps. They generally last two to three times as long as standard lamps. They are not a good form of general lighting, and are most suitable for display or feature lighting. For example, it requires about four 50W halogen down lights (that's about 250W if we count the transformers) to provide the same level of general room lighting as a normal 75W bulb.

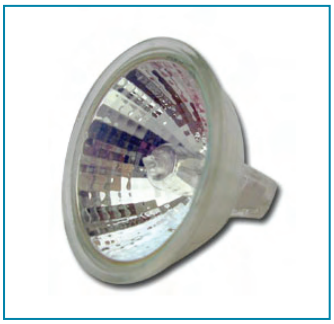
Electronic transformers are available for low voltage halogens. These use only about 3 to 5W compared to about 15W for a standard magnetic transformer.

A more efficient type of halogen is known as an IRC (Infra Red Coated) lamp. These use about 30% less energy to produce the same amount of light as a standard halogen, so a 35W lamp can replace a 50W. If you need to use halogens choose an IRC lamp. They are slightly more expensive but last about 5,000 hours, so they reduce maintenance costs as well as running costs.

CASE STUDY 2

Adelaide City Council's Office Lighting Refurbishment

Five floors of Adelaide City Council's administrative centre received an energy efficiency upgrade in 2002, which included an overhaul of the lighting system. This building was the first in Adelaide to incorporate T5 fluorescent tubes, now standard in best practice office lighting design. Reflectors were also upgraded and a control system including dimmers and movement sensors was installed. The result was a significant reduction in lighting power density, from 24 W/m^2 to around 6W/m^2. The lighting upgrade alone saves an estimated $38,000 and 200 tonnes of greenhouse gas emissions each year.



IRC Halogen Downlight

Discharge lamps

These are much more energy efficient than incandescent lighting, and include fluorescent and metal halide lamps. They comprise two components – the light itself, and a ballast that controls the flow of electric current through the light.

For all discharge lamps, electronic ballasts use less energy and prolong lamp life. These also eliminate the flicker often associated with discharge lighting. You should specify electronic ballasts for light fittings supplied in new premises or lighting refurbishments.

Fluorescent tubes are the most efficient form of fluorescent light. Modern triphosphor lamps are much more efficient than the older halophosphor types. The latest T5 tubes produce about 5 to 6 times as much light output for the same energy input as an incandescent lamp. They can last 15,000 hours or more. T5 tubes also use energy efficient electronic ballasts rather than magnetic ballasts. If installing a new lighting system choose T5 tubes.

Other tubes such as T8 are still available and are by far the most common form of lighting in commercial buildings. These often use magnetic ballasts but can be converted to electronic.

Although T5 tubes are shorter then T8, and cannot directly replace them, it is possible to buy simple conversion kits that allow you to keep your existing light fittings if they don't need to be replaced. However, these do not save as much energy as installing new fittings for T5 tubes.

T5 Fluorescent Tube

CASE STUDY 3

City Central Tower 1, Adelaide

City Central Tower 1, a new office development in central Adelaide, was certified in 2006 as the first South Australian project to reach a 5 Star Green Star rating. This highly energy efficient building is also designed to achieve a CO^2 reduction equivalent to a 20% improvement on a 5 star ABGR (Australian Building Greenhouse Rating). The building uses T5 fluorescent lighting to achieve a lighting power density of $2W/m^2$ per 100 lux. Allowance has been made for occupant lighting control, with dimmable ballasts and switching zones of no more than $100m^2$.

Compact fluorescent lamps (CFLs) now come in a wide range of shapes and can be used to replace almost any incandescent lamp, including halogen downlights. Although generally not quite as efficient as tubes, they are still about four to five times more efficient than incandescent lamps. They have a lifetime of 10,000 to 15,000 hours.

The most common CFLs come in standard bayonet cap or Edison screw fittings and have integral electronic ballasts. In general, these types of lamps are not able to be dimmed. However, it is possible to get separate ballast models. These cost less in the long run as the ballast will outlast several lamps, and replacement lamps are relatively cheap compared to buying integrated lamps. They are also available in higher wattages, providing greater light output. With the right controls, some of these types can be dimmed.

All fluorescent lamps are available in a wide range of colour temperatures to suit lighting requirements and preferences. Warm white is most like conventional incandescent bulbs.

Compact Fluorescent Bulb and Downlight (NECO)

Metal halide lamps are another type of discharge lamp. They produce a crisp white light and are about as efficient as the best fluorescent tubes. Their higher light output means fewer fittings are needed, but they are not as versatile as fluorescent lighting for general office lighting. They are most suitable for uplighting and for areas like indoor pools or depot garages. They are not as suitable for frequent turning on and off.

Earlier models had a shorter lamp life and were slow to start up, but the use of electronic ballasts has greatly extended their life and made start up quicker. The have also become more compact. Newer ceramic metal halide lamps are even more compact and efficient.

LED

Light emitting diodes are a relatively new lighting technology although they have been used for a long time for other uses. They are the little red and green lights you see on appliances and office equipment. They are also commonly used in traffic lights.

LEDs have the potential to be a very efficient light source. At present the most efficient models are comparable in efficiency to CFLs. Their light output is also still limited, but they are improving all the time. One big advantage is that provided they are well designed, they can have a very long life of 50,000 or even up to 100,000 hours. This makes them very useful for lamps in hard to get at places.

LED (Light Emitting Diode)

LIGHT FITTINGS

Efficient lighting is also a function of the light fitting. A poor fitting might result in only half the light produced by the lamp actually reaching the room. A good fitting will only reduce it by about 20%. Although uplights can be used to provide attractive lighting and eliminate dark ceilings, they should be used sparingly as only about one third of the light reaches the area where it is needed.

CONTROLS

There are a range of controls to allow the more efficient use of lighting. The type of system used will depend greatly on the type of space – whether it is open plan or an individual office, for example. Manual switches are the most cost effective and flexible provided people use them sensibly. Simple timers can be used to turn lights on and off at preset times. Occupancy sensors are particularly suitable for meeting rooms, storage areas and washrooms. Light sensors can be used to control perimeter lighting, and are important if a building has been designed to use daylight. Automatic dimming controls are the most sophisticated. They monitor the lighting level in the room and adjust the light output accordingly, but are generally only cost effective in larger open plan offices. Reduced voltage systems reduce the voltage after start-up to a lower level, resulting in energy savings without a noticeable difference in lighting levels.

It is essential to monitor automatic control systems to ensure that they are operating correctly, and using lighting energy only when it is needed.

GAUGING LIGHTING EFFICIENCY

The energy efficiency of an office lighting system can be measured by the 'lighting power density' (watts of lighting per square metre of floor area) used to achieve the required lighting level.

Efficiency	W/m²	Typical system
Average	25-35	Standard ceiling mounted fluorescent fittings. Uniform lighting level
Good	10-15	High efficiency triphosphor lamps and fittings with low loss ballasts. Uniform lighting level.
Excellent	5-8	High efficiency triphosphor lamps and fittings with low loss ballasts providing background lighting. Task lighting for work stations.
Cutting edge	2-5	As above but using daylight in conjunction with automatic dimming.

Adelaide (City) Development Plan Principles

The Adelaide (City) Development Plan provides development opportunities, particularly in the Central Business Area and Mixed Use Zones in the City centre, for growth in residents, workers, visitors and students. At the same time, across the City, a high quality of design is expected, in particular regarding energy, noise, apartment design and built form. Thus, buildings are required by the Development Plan to be sustainable, to minimise use of resources and to make use of innovative energy systems.

The Development Plan supports development which incorporates energy efficient solutions. Passive designs using natural light and solar control should be considered and incorporated during the design, planning and placement of buildings and can be achieved by:

- locating the building so the northern façade receives good, direct solar radiation;
- arranging and concentrating main activity areas of a building to the north for solar penetration;
- incorporation of narrow floor plates to maximise the amount of floor area receiving good daylight; and
- appropriate orientation and shading of windows.

Buildings incorporating these features will more readily meet the Development Plan principles.

FOR FURTHER INFORMATION

AS/NZS 1680.1 Interior Lighting Part 1: General principles and recommendations provides recommended lighting levels and is a useful source of information on using day lighting, avoiding glare, and other lighting principles.

Environment Design Guide TEC09, DES07

Illuminating Engineering Society of Australia and New Zealand

http://www.iesanz.org/content/15

ABGR http://www.abgr.com.au/tenants/ABGR%20Lighting%20Calculator.xls

Energy Smart http://www.energysmart.com.au/

South Australian Department for Transport, Energy and Infrastructure http://www.dtei.sa.gov.au/energy/publications.html